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Amphibians of the Reserva Ecológica Michelin: a high diversity site in the lowland Atlantic Forest of southern Bahia, Brazil

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Abstract

An inventory of the amphibians of the Reserva Ecológica Michelin – REM in southern Bahia, Brazil is presented. Sixty-nine species were recorded during a ten-year sampling period. Amphibians were distributed in two orders (Gymnophiona and Anura), belonging to twelve families [Aromobatidae (1), Bufonidae (3), Centrolenidae (1), Craugastoridae (5), Eleutherodactylidae (3), Hemiphractidae (2), Hylidae (34), Phyllomedusidae (5) Leptodactylidae (7), Microhylidae (4), Odontophrynidae (3) and Caeciliidae (1)]. Fifty per cent of the reproductive modes known for Atlantic forest anurans were recorded. While no threatened species were found at REM, six species are classified as data deficient (DD) by the Brazilian Red List of threatened species and deserve additional attention. *Phasmahyla timbo* and *Vitreorana euryg-*

natha are listed as endangered in Bahia according to the list of threatened species of the state. Despite a higher diversity of amphibians in the Atlantic forest having been reported for mountainous regions, our results revealed that amphibian richness for lowland forests is also high.

Keywords

Anura, biodiversity, Gymnophiona, inventory, species richness

Introduction

A rapid decline in amphibian populations has been reported worldwide over the past decades (Young et al. 2001), and currently amphibians are considered the most threatened vertebrate group on the planet (Hoffmann et al. 2010). Approximately one-third of all extant species are threatened (Stuart et al. 2008), which is a high rate in comparison to mammals (23%) and birds (12%) (Baillie et al. 2004). The major threats to the group are habitat degradation, fragmentation and destruction (Young et al. 2004, Becker et al. 2007, Loyola et al. 2007), competition from exotic species (Vredenburg 2004), infectious diseases (Daszk et al. 2003) and climate change (Carey and Alexander 2003, Pounds et al. 2006).

Within the Neotropics, Brazil harbours the largest number of described amphibian species worldwide (Segalla et al. 2016). According to the national species conservation status assessment (ICMBio 2014), only 4% of Brazilian amphibians are threatened. However, approximately 17% of Brazilian species are classified as Data Deficient (DD) (ICMBio 2014) and as there are still many gaps in distribution data, the real number of threatened species may be underestimated and much basic biogeographical work remains to be done (Brooks et al. 2004, IUCN 2008).

The Amazon and the Atlantic Forest biomes harbour the greatest species richness in Brazil (Haddad et al. 2013, Jenkins et al. 2015). Particular attention should be paid to the Atlantic Forest, which is considered one of the five most important biodiversity hotspots in the world (Myers et al. 2000, Mittermeier et al. 2011) and has one of the highest levels of amphibian richness and endemism recorded in the country (Morellato and Haddad 2000, Silva and Casteleti 2003, Haddad et al. 2013). According to Haddad et al. (2013) more than half of the country's species occur in the Atlantic Forest, of which approximately 75% are endemic to the biome. Unfortunately, this biome has been devastated by logging, urbanization, and agricultural development (Ribeiro et al. 2011). Given the high species richness and endemism, the high degree of threat, and the lack of basic biogeographical information for most species, thorough inventories in previously unstudied areas are an essential step for planning future conservation actions (Campos et al. 2017).

Southern Bahia region is unique within the Atlantic Forest, as this area is believed to have been the largest forest refugium in the biome through the Last Glacial Maximum – LGM (Carnaval et al. 2009) and because of this is expected to harbour a rich amphibian fauna. On the other hand, recent studies have suggested that the Atlantic

Forest probably expanded during the LGM onto the Brazilian continental shelf and this may have played an important role in the species diversification process (Leite et al. 2016). Until recently the only literature report on amphibian diversity from southern Bahia was a swift survey conducted by Silvano and Pimenta (2003), and although the sampling effort was limited, they recorded significant richness for several areas. During the past decade there has been an increase in studies (e.g., Dias et al. 2014a, b) which have revealed high levels of amphibian richness and endemism. They also highlight the biological importance of this region.

Despite the increasing number of publications on amphibians from Bahia over the past decades, there is still lack of data on amphibian distribution patterns. The increasing number of publications reporting the geographic distribution of several species (e.g., Camurugi et al. 2010, Dias et al. 2011, Mattedi and Pontes 2014, Dias et al. 2014a) and the description of new species corroborate this data (e.g., Napoli et al. 2011, Lourenço-de-Moraes et al. 2012, Teixeira-Jr et al. 2013, Caramaschi et al. 2013, Pontes et al. 2014, Juncá et al. 2015, Dias et al. 2017, Marciano et al. 2017, Vörös et al. 2017). Inventories increase our knowledge of amphibian community composition and allow a better understanding of species diversity patterns (Haddad 1998). These studies also allow a better assessment of species conservation status that is pivotal for developing future conservation plans (Verdade et al. 2012). Our study aims to provide an inventory of amphibian species from the Reserva Ecológica Michelin – REM, a lowland Atlantic Forest site in southern Bahia, northeastern Brazil, known as one of the most biodiverse regions of the world.

Materials and methods

Study area

The study was conducted in the Reserva Ecológica Michelin – REM (Figure 1), located in the municipalities of Igrapiúna and Ituberá (13°50'S, 39°10'W), southern Bahia, northeastern Brazil. According to Veloso et al. (1991), the region is characterized as Dense Ombrophilous Lowland Forest. The 3.096 ha reserve supports 1.800 ha of lowland evergreen hill forest distributed in three main fragments (Vila 5/Pancada Grande 625 ha, Pacangê 550 ha, and Luis Inácio 140 ha). The reserve forests have a long history of human disturbance, mostly manioc farming and intensive logging, and the forest is a mosaic of secondary vegetation at different stages of regeneration and primary vegetation logged at varying intensities, with the most intact forests on the steepest slopes and ridge tops. The remainder of the reserve consists of wetlands, small forest fragments and areas with rubber plantations (*Hevea brasiliensis*) overgrown with pioneer vegetation and enriched with native forest trees (Flesher 2015). The landscape to the east supports rubber, cacao, and banana groves, while to the south, southwest and north, the landscape is one of smallholder properties of mixed tree crops and small forest fragments. A 13.000 ha forest, which is contiguous with the Pacangê forest, lies

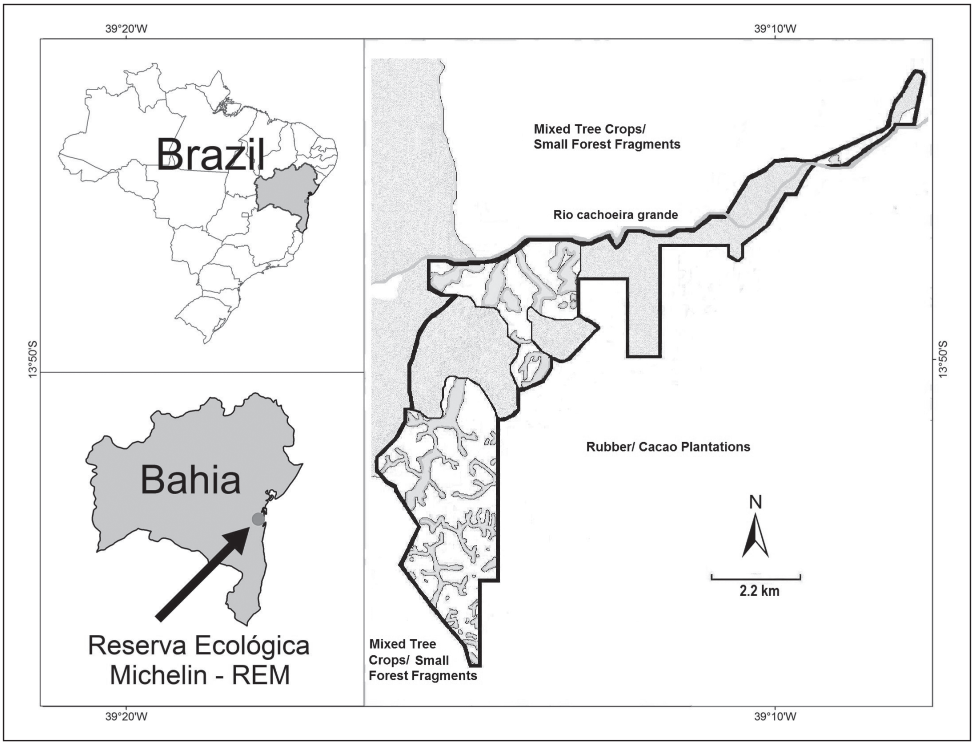

Figure 1. Map of the Reserva Ecológica Michelin, Bahia State, northeastern Brazil.

to the west. The regional landscape (1.000 km²) retains 40% forest cover and a high diversity of agroforestry systems with >60 tree crops planted (Flesher 2006). The average annual rainfall is approximately 2.000 mm with temperatures from 21.7 to 30.8° C (data from REM).

Data sampling

Two research teams [(Universidade Estadual de Santa Cruz (UESC) and Universidade Estadual de Feira de Santana (UEFS)] have studied the amphibian community of the reserve for the past ten years. A preliminary inventory carried out between March 2007 and December 2008 revealed 48 anuran species, distributed in ten families (Camurugi et al. 2010). Between 2010 and 2016 amphibian researchers were continuously active in the reserve, with species diversity recorded through active searching using visual and acoustic cues (Rödel and Ernst 2004) and by opportunistic encounters (i.e., along roads). Between March and December 2015, the terrestrial amphibians were studied using standard pitfall traps (Cechin and Martins 2000, Ribeiro-Júnior et al. 2011), sampling all of the reserve habitats using 24 sets of pitfall traps with 40 cm tall drift fences that included five 30-litre buckets spaced at 8-m intervals, totalling 32 m length. Pitfall traps were kept active during six nights per month, totalling a pitfalls/day effort of 7.200.

All animals were collected according to federal law (ICMBio license #13708-1) and REM protocols. Vouchers were deposited in Bahia at the Museu da Universidade Estadual de Santa Cruz (**MZUESC**) and Museu de Zoologia da Universidade Estadual de Feira de Santana (**MZFS**).

Results

Sixty-nine species of amphibians were recorded in the REM: one species of Gymnophiona (*Siphonops annulatus* – Siphonopidae) and 68 anurans species, belonging to eleven families (Table 1; Figures 2–6). Twenty are new records for the REM, recorded since the study of Camurugi et al. (2010): *Frostius erythrophthalmus*, *Adelophryne* cf. *pachydactyla*, *Adelophryne mucronatus*, *Adelophryne* sp., *Gastrotheca* sp., *Gastrotheca recava*, *Aparasphenodon brunoi*, *Dendropsophus anceps*, *Dendropsophus decipiens*, *Boana exastis*, *Itapotihyla langsdorffii*, *Phyllodytes* cf. *maculosus*, *Phyllodytes megatympanum*, *Phyllodytes* sp. 2, *Phyllodytes wuchereri*, *Leptodactylus cupreus*, *Leptodactylus fuscus*, *Leptodactylus vastus*, *Dermatonotus muelleri* and *Siphonops annulatus.*

According to the Brazilian federal list (ICMBio 2014), most of the species found in the REM are not threatened (N = 54; 78.2%), except *Allobates olfersioides* listed as Vulnerable. Approximately 9% (N = 6) are listed as data deficient (DD) and the conservation status of eight species has not yet been defined. Considering the species identified at the species level or as “cf.”, the majority (n = 44; 63.8%) are endemic to the Atlantic Forest biome, and 20.3% (n = 14) are endemic to Bahia. Two species deserve special attention: *Phasmahyla timbo* and *Vitreorana eurygnatha*, both considered endangered (EN) in the list of threatened species of the state of Bahia (Bahia 2017).

More than half of the species were recorded in lentic habitats (n = 36; 52.17%), of which 18 species were restricted to temporary ponds, four to permanent ponds, and eleven were found in both habitats (Table 1). Twenty-one species were found on leaf litter, of which two and nine, also occupied streams and temporary ponds, respectively. Eight species were found only in forest streams (*Vitreorana eurygnatha*, *Aplastodiscus cavicola*, *A. ibirapitanga*, *A. sibilatus*, *Bokermannohyla capra*, *Phasmahyla timbo*, *Ololygon argyreornata* and *O. strigilata*). Epiphytes and bromeliads were used by species of the genus *Phyllodytes*. The forest canopy was occupied primarily by *Gastrotheca* sp. and *G. recava*, frequently found between two and five meters above ground. *Boana exastis* was most frequently heard calling from bromeliads in the canopy, but was also spotted along streams. *Leptodactylus macrosternum* was the species that demonstrated the highest habitat plasticity and was found in streams, permanent and temporary ponds. Only *Siphonops annulatus* occurred in fossorial habitats. Twenty-nine species were found exclusively inside the forest, ten restricted to open areas and rubber plantations and 31 in both habitats (Table 1).

Table 1. Amphibian species found in the Reserva Ecológica Michelin, southern Bahia, Brazil. ICMBio = Instituto Chico Mendes de Conservação da Biodiversidade; **Conservation status**: VU = Vulnerable; DD = Deficient Data; LC = Least Concern. **Habitat**: F = Forest; RP = Rubber plantation. **Microhabitat**: LL = Leaf litter or understory; SV = Shrub vegetation; S = Streams; TP = Temporary ponds; PP = Permanent ponds; B = bromeliads or epiphytes; C = Canopy; F = Fossorial. **Reproductive Modes** (*sensu* Haddad et al. 2013). * = species only found in the inner forests; † = only acoustic record; # only recorded once or twice during the sampling.

Order/Family/Species	ICMBio	Habitat	Microhabitat	Reproductive modes
ANURA				
Aromobatidae				
Allobates olfersioides (Lutz, 1925)	VU	F	LL, S	20
Bufonidae				
Frostius erythrophthalmus Pimenta & Caramaschi, 2007*	LC	F	SV	?
Rhinella hoogmoedi Caramaschi & Pombal, 2006	LC	F, RP	LL, S	1
Rhinella crucifer (Wied-Neuwied, 1821)	LC	F, RP	LL, PP, TP	1,2
Centrolenidae				
Vitreorana eurygnatha (Lutz, 1925)*	LC	F	S	25
Craugastoridae				
"Eleutherodactylus" bilineatus (Bokermann, 1975)*	LC	F	LL	23
Haddadus binotatus (Spix, 1824)	LC	F	LL	23
Pristimantis paulodutrai (Bokermann, 1975)	LC	RP	SV	23
Pristimantis sp.*	–	F	SV	23
Pristimantis vinhai (Bokermann, 1975)	LC	F, RP	SV	23
Eleutherodactylidae				
Adelophryne cf. *pachydactyla* Hoogmoed, Borges & Cascon, 1994	LC	F	LL	23
Adelophryne mucronatus Lourenço-de-Morais, Solé & Toledo 2012*	LC	F	LL	23
Adelophryne sp.*	–	F	LL	23
Hemiphractidae				
Gastrotheca sp.	–	F	C	37
Gastrotheca recava Teixeira et al., 2012	–	F	C	37
Hylidae				
Aparasphenodon brunoi Miranda-Ribeiro, 1920*	LC	F	SV	1
Aplastodiscus cavicola (Cruz and Peixoto, 1985)*	LC	F	S	5
Aplastodiscus ibirapitanga (Cruz, Pimenta & Silvano, 2003)*	LC	F	S	5
Aplastodiscus sibilatus (Cruz, Pimenta & Silvano, 2003)*	LC	F	S	5
Bokermannohyla capra Napoli & Pimenta, 2009*	–	F	S	2
Dendropsophus anceps (Lutz, 1929)	LC	RB	TP	1
Dendropsophus branneri (Cochran, 1948)	LC	F, RP	PP, TP	1
Dendropsophus decipiens (Lutz, 1925)	LC	RB	PP, TP	24
Dendropsophus elegans (Wied-Neuwied, 1824)	LC	F, RP	PP, TP	1
Dendropsophus giesleri (Mertens, 1950)	LC	F, RP	TP	1
Dendropsophus haddadi (Bastos & Pombal, 1996)	LC	F, RP	PP, TP	24
Dendropsophus minutus (Peters, 1872)	LC	F, RP	TP	1
Dendropsophus novaisi (Bokermann, 1968)	LC	RP	TP	1
Dendropsophus aff. *oliveirai* (Bokermann, 1963)	LC	RB	PP, TP	1
Boana albomarginata (Spix, 1824)	LC	F, RP	PP, TP	1

Order/Family/Species	ICMBio	Habitat	Microhabitat	Reproductive modes
Boana atlantica (Caramaschi & Velosa, 1996)	LC	F, RP	PP, TP	1,2
Boana crepitans (Wied-Neuwied, 1824)	LC	RB	PP	4
Boana exastis (Caramaschi & Rodrigues, 2003)*	LC	F	B, C, S	4
Boana faber (Wied-Neuwied, 1821)	LC	F, RP	PP, TP	1,4
Boana pombali (Caramaschi, Pimenta & Feio, 2004)	LC	F, RP	PP	1,2
Boana semilineata (Spix, 1824)	LC	F, RP	PP	1,2
Itapotihyla langsdorffii (Duméril & Bibron, 1841)	LC	F, RP	TP	1
Phyllodytes cf. *maculosus* Cruz, Feio & Cardoso, 2007†	DD	F	B	6
Phyllodytes melanomystax Caramaschi, Silva & Britto-Pereira, 1992	LC	F, RP	B	6
Phyllodytes megatympanum Marciano, Lantyer-Silva & Solé 2017†*	–	F, RP	B	6
Phyllodytes praeceptor Orrico, Dias & Marciano 2018	–	F, RP	B	6
Phyllodytes sp.	–	F, RP	B	6
Phyllodytes wuchereri (Peters, 1873)†*	LC	F	B	6
Ololygon argyreornata (Miranda-Ribeiro, 1926)*	LC	F	S	1
Ololygon strigilata (Spix, 1824)*	DD	F	S	1,2
Scinax eurydice (Bokermann, 1968)	LC	F, RP	PP, TP	1
Scinax juncae Nunes & Pombal, 2010	LC	F, RP	PP	1
Scinax x-signatus (Spix, 1824)	LC	F, RP	PP, TP	1
Trachycephalus mesophaeus (Hensel, 1867)	LC	F, RP	TP	1
Phyllomedusidae				
Hylomantis aspera (Peters, 1873)*	LC	F	TP	18
Phasmahyla timbo Cruz, Napoli & Fonseca, 2008*	DD	F	S	25
Phyllomedusa bahiana Lutz, 1925	LC	F, RP	TP	24
Pithecopus nordestinus (Caramaschi, 2006)	LC	F, RP	PP, TP	24
Pithecopus rohdei (Mertens, 1926)	LC	F, RP	PP, TP	24
Leptodactylidae				
Adenomera thomei (Almeida & Angulo, 2006)	LC	RP	LL	32
Leptodactylus macrosternum Miranda-Ribeiro, 1926	LC	F, RP	LL, S, PP, TP	11
Leptodactylus cupreus Caramaschi, Feio & São-Pedro, 2008*	DD	F	LL, TP	30
Leptodactylus fuscus (Schneider, 1799)	LC	RP	LL, TP	30
Leptodactylus mystaceus (Spix, 1824)	LC	RP	LL, TP	30
Leptodactylus vastus Lutz, 1930	LC	RP	LL, TP	11
Physalaemus camacan Pimenta, Cruz, & Silvano, 2005	LC	F, RP	LL, TP	11
Microhylidae				
Chiasmocleis cordeiroi Caramaschi & Pimenta, 2003	DD	F, RP	LL, TP	1
Chiasmocleis crucis Caramaschi & Pimenta, 2003	DD	F	LL, TP	1
Stereocyclops incrassatus Cope, 1870	LC	F, RP	LL, TP	1
Dermatonotus muelleri (Boettger, 1885)	LC	RP	TP	1
Odontophrynidae				
Macrogenioglottus alipioi Carvalho, 1946*	LC	F	LL, TP	1
Proceratophrys renalis (Miranda-Ribeiro, 1920)	LC	F	LL, S	2
Proceratophrys schirchi (Miranda-Ribeiro, 1937)*	LC	F	LL, S	2
GYMNOPHYONA				
Caeciliidae				
Siphonops annulatus (Mikan, 1820)	LC	F, RP	F	

Figure 2. Amphibians from Reserva Ecológica Michelin, Bahia State, Northeastern Brazil. **a** *Allobates olfersioides* **b** *Frostius erythrophthalmus* **c** *Rhinella hoogmoedi* **d** *Rhinella crucifer* **e** *Vitreorana eurygnatha* **f** *"Eleutherodactylus" bilineatus* **g** *Haddadus binotatus* **h** *Pristimantis paulodutrai* **i** *Pristimantis* sp. **j** *Pristimantis vinhai* **k** *Adelophryne* cf. *pachydactyla* **l** *Adelophryne mucronatus* **m** *Adelophryne* sp. **n** *Gastrotheca recava* **o** *Gastrotheca* sp.

Figure 3. Amphibians from Reserva Ecológica Michelin, Bahia State, Northeastern Brazil. **a** *Aparasphenodon brunoi* **b** *Aplastodiscus cavicola* **c** *Aplastodiscus ibirapitanga* **d** *Aplastodiscus sibilatus* **e** *Bokermannohyla capra* **f** *Dendropsophus anceps* **g** *Dendropsophus branneri* **h** *Dendropsophus decipiens* **i** *Dendropsophus elegans* **j** *Dendropsophus giesleri* **k** *Dendropsophus haddadi* **l** *Dendropsophus minutus* **m** *Dendropsophus novaisi* **n** *Dendropsophus* aff. *oliveirai* **o** *Boana albomarginata*.

Figure 4. Amphibians from Reserva Ecológica Michelin, Bahia State, Northeastern Brazil. **a** *Boana atlantica* **b** *Boana crepitans* **c** *Boana exastis* **d** *Boana faber* **e** *Boana pombali* **f** *Boana semilineata* **g** *Itapotihyla langsdorffii* **h** *Phyllodytes melanomystax* **i** *Phyllodytes praeceptor* **j** *Phyllodytes* sp. **k** *Ololygon strigilata* **l** *Scinax eurydice* **m** *Scinax juncae* **n** *Scinax x-signatus* **o** *Trachycephalus mesophaeus*.

Taxonomic and nomenclatural-remarks concerning Camurugi et al. (2010)

The previous REM checklist of anurans (Camurugi et al. 2010) included several species with taxonomic uncertainties that are revised here. Most of the following species

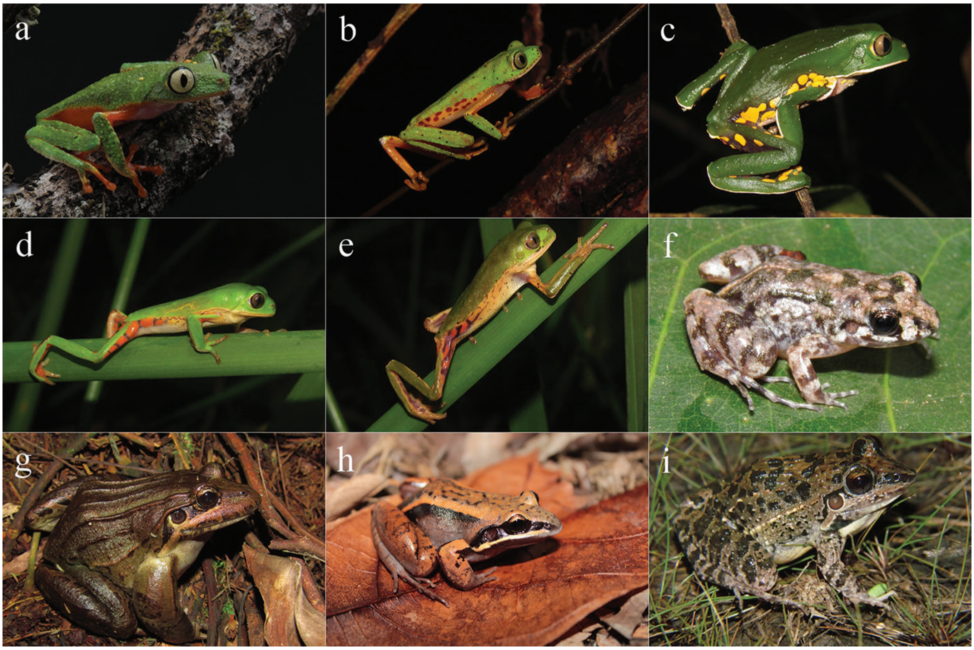

Figure 5. Amphibians from Reserva Ecológica Michelin, Bahia State, Northeastern Brazil. **a** *Hylomantis aspera* **b** *Phasmahyla timbo* **c** *Phyllomedusa bahiana* **d** *Pithecopus nordestinus* **e** *Pithecopus rohdei* **f** *Adenomera thomei* **g** *Leptodactylus macrosternum* **h** *Leptodactylus cupreus* **i** *Leptodactylus fuscus*.

show cryptic patterns that hamper their taxonomic identification. Our analysis was based on adult and larval (whenever possible) morphological characteristics and bioacoustic parameters.

Based on a study of the phylogenetic relationships within the anuran clade Terrarana (Canedo and Haddad 2012), the species referred as *Ischnocnema* by Camurugi et al. (2010) have been transferred to *Pristimantis*, with exception of *Ischnocnema bilineata* that was relocated as "*Eleutherodactylus*" *bilineatus* as *incertae sedis*. A recent nomenclature review carried out by Dubois (2017) showed that the genus *Hypsiboas* was erroneously recovered as a *Hyla* synonym by Faivovich et al. (2005), and that *Boana* as suggested by Gray (1825) is a valid generic name. Thus, species referred as *Hypsiboas* in Camurugi et al. (2010) have now been transferred to *Boana*. Based on molecular data, Duellman et al. (2016) resurrected the generic names *Ololygon* for the "*Scinax catharinae* clade" and *Phitecopus* for the "*Phyllomedusa hypochondrialis* group". Thus, *Scinax strigilatus* and *S. argyreornatus* from the list by Camurugi et al. (2010) are now referred to as *Ololygon strigilata* and *O. argyreornata*. In addition, *Phyllomedusa nordestina* and *P. rohdei* are now referred to as *Pithecophus nordestinus* and *P. rohdei*. Finally, *Phyllomedusa burmeisteri* was relocated as *P. bahiana* based on molecular data sets gathered by Barth et al. (2013) and Brunes et al. (2014).

Ischnocnema aff. *ramagii* is re-classified as *Pristimantis* sp. This species is widely distributed in the forests of southern Bahia and is currently being described (Marciano Jr.

Figure 6. Amphibians from Reserva Ecológica Michelin, Bahia State, Northeastern Brazil. **a** *Leptodactylus mystaceus* **b** *Physalaemus camacan* **c** *Chiasmocleis cordeiroi* **d** *Stereocyclops incrassatus* **e** *Dermatonotus muelleri* **f** *Macrogenioglottus alipioi* **g** *Proceratophrys renalis* **h** *Proceratophrys schirchi* **i** *Siphonops annulatus*.

et al. *in prep*). *Vitreorana* sp. was recorded by Camurugi et al. (2010) only in larval form, but adult males were collected and, using morphological and bio-acoustic traits, are identified as *Vitreorana eurygnatha*. *Scinax* aff. *alter* and *Chiasmocleis* sp. are re-classified as *Scinax juncae* and *Chiasmocleis crucis*, respectively. *Phyllodytes luteolus* as *Phyllodytes praeceptor* (Orrico et al. 2018). The species formerly classified as *Dendropsophus seniculus*, *Physalaemus signifer* and *Leptodactylus marmoratus*, are now classified as *Dendropsophus novaisi*, *Physalaemus camacan* and *Adenomera thomei*, respectively.

Discussion

The present study increases the amphibian species richness of the REM in more than 30%, increasing the total number of species for the reserve from 48 to 69. The majority (n = 43, 61.4%) of the REM species are endemic to the Atlantic Forest biome (see Haddad et al. 2013). Fourteen of the 69 recorded species (*Frostius erythrophthalmus*, "*Eleutherodactylus*" *bilineatus*, *Adelophryne* cf. *pachydactyla*, *A. mucronatus*, *Gastrotheca recava*, *Hylomantis aspera*, *Bokermannohyla capra*, *Phasmahyla timbo*, *Phyllodytes praeceptor*, *Phyllodytes wuchereri*, *Ololygon strigilata*, *Physalaemus camacan*, *Chiasmocleis cordeiroi* and *C. crucis*) are also endemic to Bahia (Angulo 2008a, Juncá and Pimenta 2004, Peixoto and Pimenta 2004, Borges-Najosa and Juncá 2004, Lourenço-de-Moraes et al. 2012, Teixeira Jr. et al. 2012, Silvano and Pimenta 2010, Napoli and Pimenta 2009, Angulo 2009, Rodrigues 2006, Juncá and Silvano 2004, Angulo 2008b, Forlani et al. 2013). The results of our study expand the known distribution of *Adelophryne mucronatus* 60 km to the north (Lourenço-de-Moraes et al. 2012, Dias et al. 2014a). Two species were recorded by collecting only a single individual per species: *Aparasphenodon brunoi*, a bromeliad species, which had its distribution recently increased from the municipality of Una to the REM (Ruas et al. 2013), and *Dermatonotus muelleri*, which is a species typically found in open areas..

Although no species has been considered threatened by ICMBio (2014), special attention should be paid to *Allobates olfersioides.* In a taxonomic review of *Allobates* from the Atlantic Forest, Verdade and Rodrigues (2007) synonymized the four previously recognized species *Allobates olfersioides* (Lutz, 1925), *A. capixaba* (Bokermann, 1967), *A. carioca* (Bokermann, 1967) and *A. alagoanus* (Bokermann, 1967) with *A. olfersioides*. However, in a recent assessment of threatened Brazilian amphibians (Haddad et al. 2016), specialists suggested that only populations from Rio de Janeiro should be recognized as *A. olfersioides* (U. Caramaschi pers. comm.) while the populations from Bahia should be assigned to *A. capixaba* or *A. alagoanus* and classified as Data deficient (DD). A recent acoustic analysis of the Atlantic Forest *Allobates* agrees with the suggestion of Haddad et al. (2016), arguing that according to the advertisement calls, populations from Bahia can be attributed to *A. capixaba* or even represent a new species (Forti et al. 2017). However, due to the lack of a recent taxonomic analysis, the species from REM is assigned to *A. olfersioides* following Verdade and Rodrigues (2007).

The two species classified as endangered (EN) in the list of threatened species of the state of Bahia (Bahia, 2017) occur in streams in the interior of forest fragments. *Phasmahyla timbo* is restricted to the state of Bahia and known only from the type locality in Serra do Timbó, municipalities of Amargosa and Santa Terezinha (Cruz et al. 2008) and from the Reserva Ecológica Michelin. *Vitreorana eurygnatha* has been reported from Amargosa (Freitas et al. 2007), Mata de São João, Jandaíra (Tinôco et al. 2008), Camacan and Almadina (Dias et al. 2014a, b), and now also from Igrapiúna, at REM.

Seven species (10.1%) are listed without a specific name or were classified as similar with other species. The formal descriptions of some of them, like *Adelophryne* sp. have already been submitted for publication. Our results add basic data on the distribution of amphibians from Bahia, and corroborate the data presented by other recent inventory studies conducted in the state (Dias et al. 2014a, b). The amphibian richness from the REM is the second-highest reported from Bahia, ranking only behind that of the RPPN Serra Bonita (80 ssp.), located along an altitudinal gradient of 200 to 950 m a.s.l. (Dias et al. 2014a). Most other Atlantic Forest sites with high amphibian diversity, such as Santa Tereza municipality (92 ssp.), the Parque Natural Municipal Nascentes de Paranapiacaba (80 ssp.), Estação Ecológica de Boracéia (67 ssp.) and Parque Estadual Carlos Botelho (65 ssp.), represent mountainous areas (Heyer et al. 1990, Forlani et al. 2010, Almeida et al. 2011, Trevine et al. 2014). Over the altitudinal gradients, changes in biotic and abiotic features increase the availability of microenvironments which are believed to promote greater species diversity. Vasconcelos et al. (2010) conducted a review in various mountainous ranges in Brazil and found that the increasing amphibian richness is related to the degree of the altitude gradient. Unlike these areas, the REM is inserted in a region classified as Dense Ombrophilous Lowland Forest (Veloso 1991), with maximum altitudes reaching 393 m above sea level.

Despite the lack of distinct altitudinal gradients, the REM is located close to 13.000 ha of forest and nested in a climatically stable region, with high moisture and availability of breeding sites. These diverse habitats provide a high diversity of breeding sites such as temporary and permanent ponds, streams, bromeliads, epiphytes and a dense leaf litter layer. This habitat heterogeneity, high temperatures and rainfall throughout the year create a hot and moist environment, which likely explains the expressive number of species recorded. Additionally, the high abundance of breeding habitats satisfies the reproductive requirements of a large number of species. According to Duellman (1988) reproductive modes play an important role in understanding anuran species diversity. Currently, there are 27 reproductive modes recognized for Atlantic Forest amphibians (Haddad et al. 2013). According to Haddad and Prado (2005), the high diversity of reproductive modes observed for the Atlantic Forest is the result of a successful utilization of the diverse humid microhabitats present in the biome. Fourteen out of the 27 reproductive modes reported for the Atlantic Forest amphibians (~52%) were recorded at the REM.

Another important factor that likely affected the results was the sampling effort. With approximately ten years of sampling this study has the highest sampling effort for northeastern Brazil to date. Long sampling periods are essential for understanding community structure and are necessary for reaching accurate values of diversity for an area. Although the present study shows an increase of 21 amphibian species in comparison to the previous study (Camurugi et al. 2010), we believe that further fieldwork may still reveal new species for the REM. Highest amphibian diversity areas in the Atlantic forest were also the result of long sampling periods. Despite the long sampling periods new species are still found in well sampled regions, as the case of *Adelophryne glandulata* and *Dendropsophus bromeliaceus*, recently described from Santa Tereza municipality (Lourenço-de-Moraes et al. 2014, Ferreira et al. 2015). Most long-term amphibian studies have been undertaken in southeastern Brazil, resulting in a much better comprehension of the amphibians of this region within the domain (Rossa-Feres et al. 2011, Campos et al. 2014). On the other hand, the recent increase in studies from other regions of the country (e.g., southern Bahia) is expanding our knowledge for these regions (Dias et al 2014a, b, present study).

Several attempts to understand the processes responsible for the high levels of species diversification of the Atlantic Rainforest have been undertaken. The consensus is that none seem to have acted isolated. The high diversity and endemism of species in southern Bahia has been associated with climate stability and forest conditions during glacial periods (Carnaval et al. 2009). According to these authors, this region was a large Pleistocene climatic refugium for amphibians. Another view of a recent research shows that suitable climatic conditions onto the emerged continental shelf probably expanded the Atlantic Forest during the last glacial period (Leite et al. 2016). Thereby, species could have expanded their distributions during the last glacial period. Thus, these long-term biogeographical processes would have promoted a high level of speciation in southern Bahia. Given the high levels of richness and endemism of amphibians in southern Bahia, future inventories in still un-sampled regions of southern Bahia are expected to recover a high diversity of amphibians, and may result in the discovery of additional new species and expand the ranges of already known species.

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Taxonomic revision of the *Graphipterus serrator* (Forskål) group (Coleoptera, Carabidae): an increase from five to 15 valid species

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Abstract

The south-west Palaearctic *Graphipterus serrator* group is revised. The systematic concept of the *G. serrator* group has undergone many changes during the last two centuries, and several different classifications have been published in recent decades. Here, the numerical taxonomy approach is used with the morphological characterization similarity level of the sympatric taxa in order to delimit allopatrically occurring taxa at the species and subspecies level. A key to the species and distribution maps are provided along with analyses of the conservation status and habitat preferences of the taxa. The *Graphipterus serrator* group currently comprises 16 taxa. Five new species are described: *Graphipterus magnus* Renan & Assmann, **sp. n.**, *Graphipterus mauretensis* Renan & Assmann, **sp. n.**, *Graphipterus piniamitaii* Renan & Freidberg, **sp. n.**, *Graphipterus sharonae* Renan & Assmann, **sp. n.**, and *Graphipterus stagonopsis* Renan & Assmann, **sp. n.** In addition, five taxa are revalidated to full species status: *Graphipterus heydeni* Kraatz, 1890, **stat. rest.** (lectotype designated), *Graphipterus multiguttatus* (Olivier, 1790), **stat. rest.** (lectotype designated), *Graphipterus peletieri* Laporte de Castelnau, 1840, **stat. rest.** (the frequently used name *lepeletieri* is an error), *Graphipterus rotundatus* Klug, 1832, **stat. rest.** (lectotype designated), and *Graphipterus valda-*

nii Guérin-Méneville, 1859 **stat. rest.**, and a full species status is proposed for *Graphipterus reymondi* Antoine, 1953, **stat. n.** One new synonymy is proposed: *Graphipterus kindermanni* Chaudoir, 1871, **syn. n**. of *Carabus multiguttatus* Olivier, 1790. Lectotype designations were made for *Graphipterus heydeni*, *Graphipterus minutus* Dejean, 1822, *Graphipterus multiguttatus,* and *Graphipterus rotundatus*. Neotype designations were made for *Graphipterus reichei* Guérin-Méneville, 1859, *Graphipterus intermedius* Guérin-Méneville, 1859, and *Graphipterus valdanii* Guérin-Méneville, 1859.

Keywords

Allopatry, conservation status, ground beetles, Harpalinae, Lebiini, species delimitation, sand dunes, sympatry

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Introduction

The ground beetles (Carabidae) constitute one of the largest animal families. They include almost 40,000 described species, distributed throughout every continent (Lorenz 2005). Harpalinae Bonelli, 1810 comprise one of the largest subfamilies of the Carabidae, whose taxonomy is poorly known due to the lack of modern revisions for most of its genera and tribes (Erwin et al. 2012). The subtribe Graphipterina Latreille, 1802 belongs to the tribe Lebiini Bonelli, 1810, which has still not been satisfactorily resolved phylogenetically (Ober and Maddison 2008) and is one of the largest tribes of the given subfamily. The nominate genus *Graphipterus* Latreille, 1802 has been previously revised four times: Chaudoir (1870); Péringuey (1896), focusing on South Africa fauna; Burgeon (1929); Basilewsky (1977). The last revision includes 116 species distributed throughout Africa except for the central Sahara desert and the tropical forest regions. Since then, only few taxonomic studies have been published (Basilewsky 1981, 1986; Werner 2003, 2007; Mawdsley 2012), including the extensive systematic and taxonomic overview of the Carabidae of the World (Lorenz 2005).

The members of the *Graphipterus serrator* (Forskål, 1775) group differ from most of the other 138 *Graphipterus* species (Lorenz 2005, Werner 2007, Mawdsley 2012) by their unique distribution. Together with *Graphipterus exclamationis* (Fabricius 1792), they are the only taxa of this genus that are distributed in and north of the Sahara. All other *Graphipterus* species have distribution ranges restricted to the arid and subtropical regions of central and southern Africa.

The systematic concept of the *G. serrator* group had undergone changes many times during the last 200 years, and numerous taxonomic publications have dealt with members of this group (e.g., Olivier 1790, Dejean 1822, Guérin-Méneville 1859, Klug 1832, Chaudoir 1870, Kraatz 1890, Péringuey 1896, Burgeon 1929, Schatzmayr 1936). During the last 40 years, several influential taxonomic publications have presented very different species classification of the *G. serrator* group (Alfieri 1976, Basilewsky 1977, Hůrka, 2003, Lorenz 2005). Basilewsky (1977), as part of his broad scope revision, recognized two species in the *G. serrator* group: *G. serrator* (Forskål, 1775), with six subspecies; and *G. minutus*, Dejean 1822, with two subspecies. However, Basilewsky's species concept strongly tended towards the "lumping" approach of taxonomy (Dayrat 2005). By choosing to re-rank six subspecies under one species, Basilewsky ignored two basic criteria that were already well accepted at his time: 1. Two or more subspecies of the same species cannot co-occur in sympatry in one location or well defined ecological habitat. 2. Subspecies are expected to share the same dominant characters (Mayr 1969). However, each of the *G. serrator* subspecies in the sense of Basilewsky does co-occur with at least one other subspecies, and they are usually characterized by different shapes of the median lobe of the aedeagus. Consequently, some modern authors have accepted at least some of "Basilewsky's subspecies" as "good" species, even though they do not recognize all co-occurring taxa of the group as species. However, Lorenz (2005) and Huber and Marggi (2017), are identical by the taxonomic ranking of taxa within the *G. serrator* group: five species, four of them polytypic ones (Huber and Marggi 2017).

Only a rigorous morphological revision of the *Graphipterus serrator* group with a critical analysis of previous classifications can solve the problems resulting from these diverging classifications. Furthermore, an approach to define a threshold for species delimitation from sympatric taxa is needed in order to cope with the general problem of treating allopatric taxa as species or subspecies.

Several species concepts are known in modern taxonomy and systematics (e.g., Claridge et al. 1997, Zachos 2016). Some of these are controversial, with potentially serious effect on the conservation of species or other biodiversity elements (May 1990). As an approach that tends to reduce the probability of overlooking species was used, an increased number of species was found in the *Graphipterus serrator* group, indicating that at least some populations and taxa require proper conservation efforts in order to ensure their long-term survival. The *Graphipterus serrator* group comprises terrestrial wingless beetles, with a highly specific habitat preference and usually distributed over limited geographical ranges. Some members of this group inhabit coastal regions of the Atlantic Ocean and the Mediterranean Sea, and thus belong to the most threatened regions in the world (Samways 1994, Brooks et al. 2002, Cuttelod et al. 2008). Consequently, the *G. serrator* group constitutes a special object for conservation efforts. Here, the new understanding of the classification and distribution patterns within the *G. serrator* species group are employed as well as ecological and conservation biological information summarized to provide the first analysis of the conservation status of these taxa.

From a general biological point of view, a taxonomic revision of the given group is needed, as numerous aspects of its biology, ecology, and morphology have already been studied. *Graphipterus serrator* (*sensu lato*) is one of the most conspicuous and familiar ground beetles in the Palaearctic region. Unusually among beetles, *G. serrator* has been the subject of many studies dealing with a wide range of topics: larval morphology (Brandmayr et al. 1993, Brandmayr et al. 1994a), adult morphology (Pocock 1902), adult anatomy (Bugnion 1933), adult and larval ecology (Paarmann 1985, Paarmann et al. 1986, Brandmayr et al. 1994b, Dinter et al. 2002), and genetics (Wahrman 1966).

The aim of the current work is to revise the south-west Palaearctic *Graphipterus serrator* group, based on objective species delimitation. The monograph presents redescriptions of eleven taxa with a new status and five new species. Moreover, an updated identification key and distribution maps for all species of the group are provided.

Materials and methods

More than 4,000 specimens were examined for this study, including all available holotypes, syntypes, and paratypes. The material is stored in the following collections:

AVTC	Augusto Vigna Taglianti, Rome, Italy, private collection
BMNH	The Natural History Museum, London, United Kingdom
CAB	Working collection Thorsten Assmann, Bleckede, Germany (part of ZSM)

CAMMZ	Cambridge University Museum of Zoology, Cambridge, United Kingdom
DWC	Working collection D.W. Wrase, Berlin, Germany (part of ZSM)
KCE	Kibbutzim College of education, Tel Aviv, Israel
NBC	Naturalist Biodiversity Center, Leiden, The Netherlands
NHMB	Naturhistorisches Museum Basel, Switzerland
NHMP	Entomology Department, Muséum National d'Histoire Naturelle, Paris, France
NMP	The National Museum, Prague, Czech Republic
RMRAC	The Royal Museum for Central Africa, Tervuren, Belgium
SDEI	Senckenberg German Entomological Institute Müncheberg (= Senckenberg Deutsches Entomologisches Institut Müncheberg), Germany
SMNHTAU	Steinhardt Museum for Natural History, Tel Aviv University, Tel Aviv, Israel
ZMHB	Zoologisches Museum, Humboldt Universität, Berlin, Germany
ZMK	Zoological Museum, University of Kiel, Kiel, Germany
ZMUC	Natural Museum of Denmark, Zoological Museum, Copenhagen, Denmark
ZSM	Zoological State Collection Munich, Munich, Germany

Images: Macrophotographs were taken with a Leica M205 C Stereomicroscope, FusionOptics – Objective Planapo 0.63× M-Serie in combination with a Leica DMC4500 digital camera LAS Montage MultiFocus. The habitus photographs were taken with a Canon D65 and the objective Canon MP-E 65 mm.

Measurements: All measurements were made with an ocular micrometer on a Leica M80 stereomicroscope. When possible, the largest, smallest and three medium sized intact specimens of both sexes for each species were chosen for measurements which include:

BL	Body length
BPW	Basal pronotum width (minimum pronotum width)
EL	Elytra length (from apical point of scutellum to apex)
EL/EW	Elytra length/width
EW	Maximum elytra width
EYL	Eye length
HW	Width of head
HW/PW	Head/pronotum width
MTAL	Metatarsus length
MTIL	Metatibia length
PL	Pronotum length (from apex to base along median impression)
PL/PW	Pronotum length/width
PW	Maximum pronotum width (Fig. 1)

Whenever in the text the words large, medium or small size appear, they are in comparison to the average of the other group species: Length, BL: small (11.9–13.5),

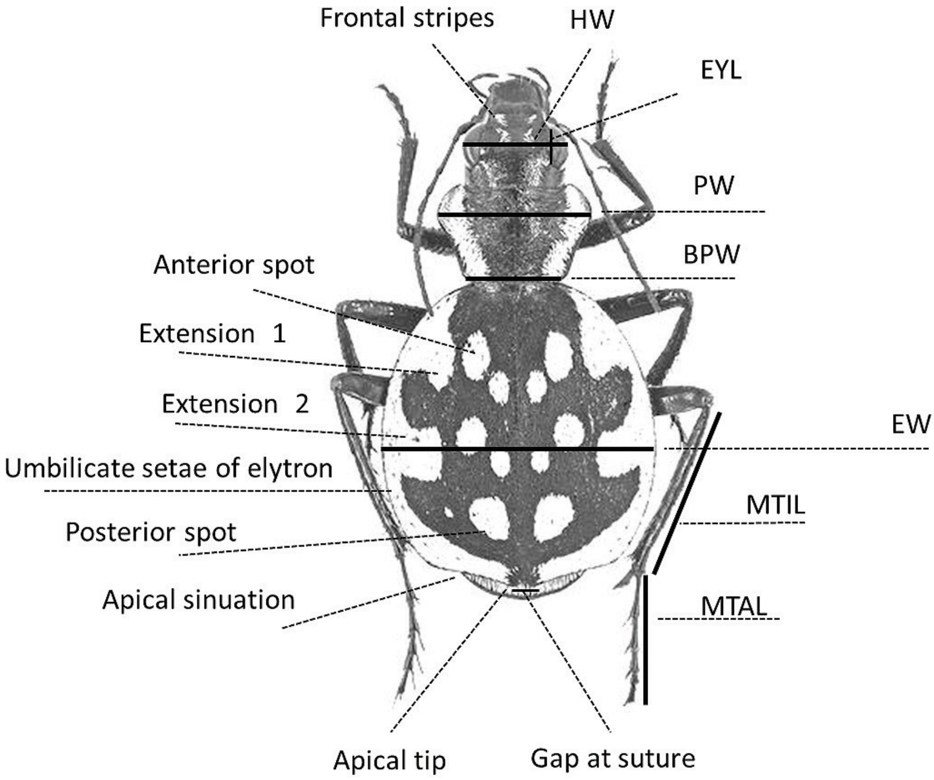

Figure 1. Patterns and morphological characters used in the descriptions (*Graphipterus serrator*).

medium (14–17.1), large (17.4–19.5); Head, HW/PW: slender (0.70–0.739), medium (0.74–0.79), wide (0.78–0.84); Legs, El/MTIL: short (1.60–1.89), medium (1.64–1.74), long (1.53–1.58). All comparative elements of the descriptions mean relative to the other species of the *Graphipterus serrator* group.

Acronyms and signs in the material examined: Aedeagus extracted (ae), unclear (uc), recent names of locations with a valid name are given in square brackets [] in addition to the original names. Original label text of type specimens appears between the symbols < >.

Scraping record: In order to examine more characters, the scraping sounds of representative males of *G. serrator* and *G. multiguttatus* were recorded and compared. We used an ultrasonic condenser microphone and a PCTape recording system (custom-made by Tübingen University) under lab conditions.

Comparison: In the comparison paragraph for each species, mainly the easily recognizable morphological characters of similar species are provided.

Distribution data: The recorded data from the species' distribution range are collected from approximately 1,400 specimen labels stored in museums and private collections (see above).

Habitat: Data on the habitats of the species are derived from surveys by the authors and colleagues.

Conservation: Threat assessments for the species are based on the distribution range of each species and the known threats to its habitat. Information about distribution ranges are given following IUCN rules (IUCN 2017).

Species delimitation: The species delimitation of the *Graphipterus serrator* group is a substantial challenge due to the more than 200 years of studies by many taxonomists, the rarity of some species, and the limited knowledge on the distribution of many group members. Our study is based on the Biological Species Concept (BSC) following Jordan (1905) and Mayr (1969), and, considering the weakness of this concept (e.g., Meier 2000), a numerical approach for species delimitation is suggested.

Numerical approaches in taxonomy date back to early taxonomic authors, but have been established mainly by Sneath and Sokal (1973). In the consecutive decades, a substantial part of taxonomic studies bases on numerical approaches as they provide objective data. It is still, also in the era of DNA approaches a useful way to delineate taxa (Sneath 1995, Jensen 2009). In ground beetles, numerical approaches are frequently used (e.g., Liebherr 1986, Baehr 1998, Liebherr and Schmidt 2004). Most of them do not have a phenetic, but a phylogenetic basis. However, a phenetic approach over a phylogenetic one is preferred as for almost all characters (e.g., body length, coloration patterns) it is not possible to polarize primitive or derived character states, even by using first and second order outgroups.

An important element of our approach is that to use sympatric taxa to determine the threshold to delineate allopatrically distributed taxa. Of course, this approach may be criticized from the point of view of other species concepts or the phylogeny. Even when we recognize that species delimitations and species limits are in many cases inherently arbitrary, the chosen approach can be applied widely in most species-rich taxa which are at least partly distributed in sympatry. Moreover, the delivery of taxonomic ranking has a high level of objectivity, consistency, and transparency (Tobias et al. 2010). To avoid both taxonomic inflation and "species" with excessive gene flow (cf. Cotterill et al. 2014), numerous authors argue for such an approach, also in recent publications (Tobias et al. 2010, Zachos et al 2013, Assmann et al. 2008).

The cases of the co-occurring taxa in the *Graphipterus serrator* group offer the option to use sympatrically distributed taxa as a reference for the extent of morphological differentiation among species. Criteria and thresholds based on the morphological characterization similarity level of the sympatric taxa are used, in order to apply them to the allopatric taxa to delimit species and subspecies.

The extreme rarity of hybrid specimens of co-occurring species supports our delimitation approach of a threshold based on a characterization similarity level of sympatric taxa. Thousands of specimens in collections and in the field were studied, but only one specimen recognized as a hybrid of *multiguttatus* and *serrator* which co-occur in the northern Negev.

In order to establish quantitative species delimitation, the threshold for delimitation according to the minimum sum of the 'diagnostic characters' of the sympatric species pairs was determined. A set of 39 characters (25 morphological and 14 ratios characters) and a matrix of all 120 pair-wise taxon comparisons was used. A diagnostic character constitutes a clear and consistent describable appearance as color pattern or aedeagus shape, or organ ratios. A quantitative measure as a diagnostic character was considered only if it showed a maximum of 5% overlapping between two taxa, or no overlapping at all. Elytral pattern and coloration are generally not well accepted as a character state by which to separate species. However, in *Graphipterus* they mirror many other characters in these states and several recent publications have based their findings mainly on those characters (e.g., Werner 2007; Mawdsley 2012). In this study, these characters were consider along with morphological shapes and measurements. Following Sneath and Sokal (1973), we decided not to give a different "weight" to a given character, as there is no objective way in which to do so.

Results

Species delimitation

Altogether, the matrix of diagnostic characters presents 120 comparison pairs with ten species living in 15 sympatric situations (Fig. 2). The number of diagnostic characters of the sympatric species pairs ranges from six to 18 (Table 1). The sympatric taxon pair *luctuosus* – *peletieri* shows the lowest value (six diagnostic characters) and therefore six was set as the threshold for the ranking of two taxa as "good" species. The allopatric taxon pair *valdanii* – *serrator* differs by six diagnostic characters. Transferring this threshold to the allopatric taxon pairs necessitated our classifying both taxa as "good" species (Fig. 2 and Table 1).

The leading sympatric taxon example is *G. serrator* and *G. multiguttatus* (eleven diagnostic characters) which co-occur in the Sinai Peninsula, Egypt, and the western Negev sand dunes in Israel. The main distinguishing morphological characters between them are: number and pattern of elytral spots and extensions, suture distinctness, elytra cross section shape, colors of spurs and claws, apex pattern and shape of median lobe of aedeagus. Moreover, we know from intensive earlier studies that the habitat preferences of the two species differ from one another (Renan in prep.). This finding provides ecological evidence for a classification based on the morphology as two "good" species.

Taking all taxa into account, the number of diagnostic characters for the pairwise comparisons ranges between four and 21. A value below the threshold of six was found only for the allopatric pair *minutus* and *goryi* and these taxa were treated as subspecies according to our species delimitation. The subspecies classification is in agreement with most other authors (e.g., Hůrka 2003, Lorenz 2005).

All other taxa that show lower values of the diagnostic characters than six (cf. Table 1) were carefully examined for further deviating characters. In none of these cases were any

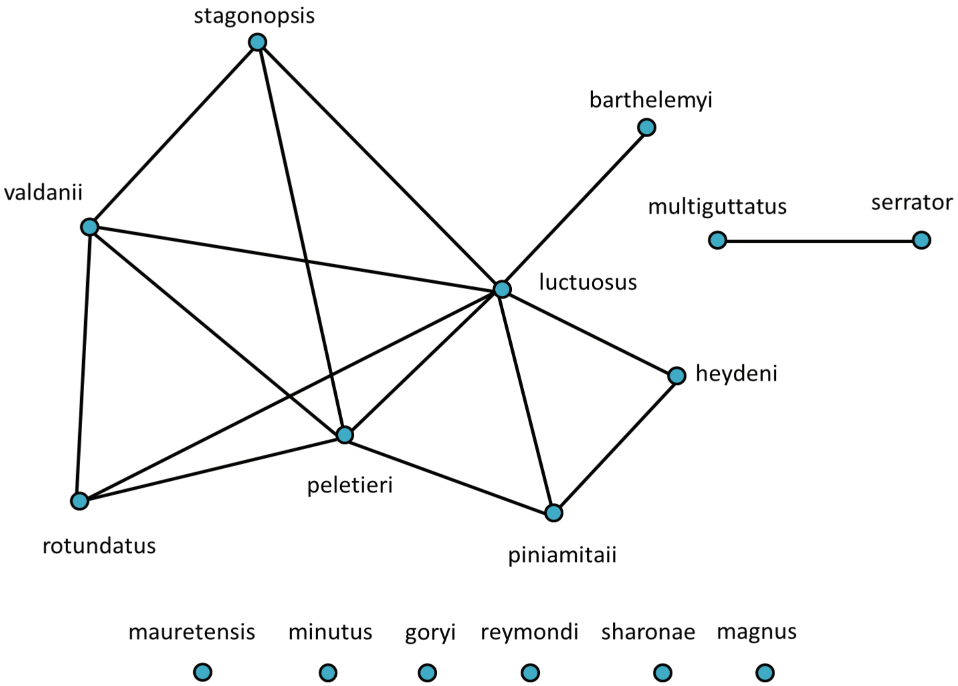

Figure 2. The ten taxa of the *Graphipterus serrator* group that occur sympatrically. Lines connect those taxa that co-occur sympatrically. Bottom row: the exclusively allopatrically occurring species.

taxonomically useful diagnostic characters found and therefore all these taxa were ranked as junior synonyms (see next chapter).

Taxonomy

Graphipterus Latreille, 1802

Stagonopterus Chaudoir, 1871 (type species: *Carabus serrator* Forskål, 1775)
Graphopterus Agassiz, 1847: 167

Type species. *Carabus variegatus* Fabricius, 1792 (= *Carabus serrator* Forskål, 1775).

Diagnosis. The *Graphipterus serrator* group is included in the genus *Graphipterus* based on the following combination of characters:

Clypeus concave at anterior margin, posteriorly well separated from front; labrum wide and short, with well-developed microsculpture and six setiferous pores. Mandibles broad at the base, sharp and strongly curved at tip; labial and maxillary palps long and slender, glabrous with exception of distal end of segments which bear a few hairs; last palpal segments slightly thicker than penultimate ones.

Table 1. Matrix of the sum of diagnostic characters for species delimitation. Bold marked are sympatric taxon pairs.

	serrator	***barthelemyi***	***heydeni***	***luctuosus***	***magnus***	***mauretensis***	***minutus***	***goryi***	***multiguttatus***	***peletieri***	***piniamitaii***	***reymondi***	***rotundatus***	***sharonae***	***stagonopsis***	***valdanii***
serrator		17	10	19	19	15	19	17	**11**	18	18	17	14	13	13	6
barthelemyi			15	**17**	15	16	15	14	14	9	14	18	14	13	11	15
heydeni				**14**	16	12	16	15	15	11	**14**	14	12	12	11	10
luctuosus					12	11	16	13	20	**6**	**8**	12	**14**	14	**13**	**18**
magnus						14	19	17	12	16	10	13	8	12	16	19
mauretensis							19	17	10	13	12	9	8	9	12	13
minutus								4	16	14	16	17	22	20	19	18
goryi									22	15	17	16	19	18	17	17
multiguttatus										17	13	15	8	7	12	15
peletieri											**9**	13	**14**	15	**14**	**16**
piniamitaii												15	10	13	12	16
reymondi													12	14	12	18
rotundatus														9	9	**11**
sharonae															10	13
stagonopsis																**10**
valdanii																

Pronotum transverse and cordiform, slightly convex, usually ornamented by colored scales at the lateral bead, disc with or without scales. Anterior and posterior angles obtuse.

Scutellum triangular, small and short, often hidden by the pronotal base. Flightless. Elytra wide and oval, slightly convex, coalesced along suture, humeri completely rounded; surface covered by dense or sparse scales, white scales creating longitudinal stripes on the radial field and spots on the disc; apex almost truncate. Pygidium not covered by elytra, last visible tergite with colored scales.

Legs long, usually black or brown, protibia with clypsetae (antenna cleaner) and dark parallel spurs, as long as ¾ of protarsomere 1. Mesotibia with two long and thin not serrated spurs, metatibia with one long and thin not serrated spur and one shorter, wide and obtuse spur. Claws of all legs long and smooth on median margin.

Graphipterus serrator group

Within the genus, the *G. serrator* group is characterized by a combination of the following characters: Antennae reaching elytral humeri; antennomere I wide and glabrous, at apex with two black erect setae; antennomere II half as wide as long and half as wide as antenonmer I, glabrous, at apex with one black erect setae; antennomere III glabrous and four times as long as antennomere II; antennomere IV pubescent in the apical two-thirds; antennomeres V–XI fully pubescent. Mentum without or with one, two, or three teeth, with or without depressions between the teeth (Fig. 3a–f).

Frons in male with two stripes of white scales attached anteriorly to each other and diverging posteriorly from each other, leaving apical frons uncovered by white scales for a section wider or slenderer than one of the given stripes (Fig. 4a–c). This scale-free section is termed an 'exposed frons', and can also be raised to form a ridge.

Pronotum strongly cordiform, wider anteriorly, narrower posteriorly; anterior margin sinuose, in the middle convex and shortly concave laterally to the protruding and rounded anterior angles; slight transverse anterior pronotal impression behind the middle of anterior margin; posterior margin concave; lateral margin sinuose. Median longitudinal impression slightly impressed medially, drawn to anterior and posterior margins, or sometimes absent. Lateral margin with white dense scales in the lateral bead, disc glabrous. Ventral side of the pronotum in males with dense white setae, in females with sparse white setae, less extended medially (Fig. 5a–b).

Elytra in most species oval, evenly rounded to drop-like shape, with isodiametric microsculpture and oval meshes, additionally covered by black or dark brown dense or sparse or white greyish scales (Fig. 6a–c). 2-6 marginal extensions of white dense scales originating from radial field posteriorly oriented and rounded toward suture, close to meet at apex. 10-40 white rounded or elongated spots on disc, in some species fused with lateral margin or with other spots to a complex pattern, umbilicate series of punctures extended with up to 15 thin bright setae (trichobotria), including the apical seta. Apical margin of each elytron sinuous to straight, posterolateral angle completely rounded, somewhat projecting; elytral apex slightly protruded, not protuberant or absent (Fig. 7a–d).

Within the genus *Graphipterus*, the stridulatory structure is a unique character for the *G. serrator* group, but does not occur in *G. minutus*. The structure consists of a serrated epipleural structure on the elytral lateral edge (Fig. 8a–b) and a carina situated on the upper side of the metafemur (Fig. 8c–d). The metatibia bears also a carina, but with some bristles. The latter ones are the reason why the metatibia does not function as part of the stridulatory structure. The carina on the metatibia occurs also in *G. minutus*, a species without the ability to stridulate, but it lacks the carina on the upper side of the metafemur. The chirping sound is created by rubbing the two hind leg femora on the elytra. The sound can be heard from a distance of several meters by the human ear.

Shape of median lobe of aedeagus occurs in four types with different variations which can be used as diagnostic features (in contrast to Basilewsky's 1977 claim). The four types are: tip sharp and ventrally bent (Fig. 9b, c, j, k, l, m, n, o, p); tip short and not bent (Fig. 9a, e, h, i), tip wide and flat (Fig. 9f, g), and tip thin and ventrally bent (Fig. 9d).

Ratios: HW/PW: 0.68–0.78, EYL/EL: 0.14–0.19. PL/PW: 0.54–0.72, BPWBPW/PW: 0.46–0.7, EL/EW: 1.08–1.29, EL/MTIL: 1.52–2.08, MTAL/MTIL: 0.72–1.28.

Taxonomic note: *Graphopterus* Agassiz, 1847 is a junior synonym of *Graphipterus* Latreille, 1802 (Basilewsky 1977; Lorenz 2005).

Species accounts

Graphipterus barthelemyi Dejean, 1830

Figs 3a, 6c, 9a, 17, 20a–b

Types. Holotype: ♂ (Blue label, black handwritten): <*Barthelemyi. Solier*/. in Barbaria. Tunis. D. Barthelemyi>. (White label with brown margin, brown letters, handwritten): <EX Musaeo/Chaudoir>. (Red label, black letters, type written): <TYPE>. Deposited in NHMP, Chaudoir collection [examined].

Diagnosis. Medium-sized species with grayish or yellowish scales usually cover the elytra and sometimes also on the pronotum. Elytra pattern rarely visible with six lateral margin extensions and 18–24 isolated white circular to elongated spots occur on elytra.

Description. BL male: 13.0–17.0 mm, average 15.8 ± 1.5 mm; BL female: 15.5–17.0 mm, average 16.3 ± 0.6 mm. Grayish with elytral white blurred spots and extensions.

Head slender: HW/PW: 0.72; EYL: 1.1-1.4 mm; EYL/EL: 0.15. Mentum without teeth (Fig. 3a). Frontal ridge reduced. In male, apical white frons stripes slenderer than exposed frons (cf. Fig. 4a).

Pronotum wide; PL/PW: 0.63; BPW/BPW/PW: 0.6; posteromedially concave and with white lateral margin, as wide as antennomere I long: white slushy scales cover disc sometimes.

Elytra wide, elytron margin almost continuously rounded from humeri to posterolateral angles; EL: 7.1–8.8 mm, average 8.2 mm; EW: 6.5–7.8 mm, average 7.3 mm; EL/EW: 1.1. Elytra longitudinally flat, usually with grayish scales, disc visible between scales (Fig. 6c); extensions and lateral margin blurred. Lateral margin nearly as wide as antennomere I long and with six extensions; extension I usually elongated; white posterior margin almost touches suture at apex. Disc with 18–24 rounded, usually elongated spots, anterior pair of spots elongate, as wide as extension I; posterior pair of spots rounded, located toward suture; round spots located posterior to third extensions laterally in imaginary lateral line as posterior spots. Apical sinuation slightly developed to straight, apex not protuberant, broadly rounded, especially medially (Fig. 7c). Suture inconspicuous.

Legs medium; MTIL: 4.5–6.5 mm, average 5.7 mm; El/MTIL: 1.7. Metatibial secondary spur brown. MTAL: 3.5–4.4 mm, average 4 mm; MTAL/MTIL: 0.8. Claws of hind legs brown at base.

Median lobe of *aedeagus* with short unbent tip (Fig. 9a).

Comparisons. Distinguished from all other species of the *G. serrator* group by white lateral margins merged at the posterior margin of the pronotum. Median lobe of aedeagus with short, straight tip.

Habitat. Unknown. The species was found exclusively in coastal dune habitats.

Co-occurring species. *Graphipterus barthelemyi* lives in sympatry with *G. luctuosus* in Tunisia.

Distribution. Restricted to north-east Tunisia (Fig. 17).

Conservation. The restricted distribution range of the endemic species and the decline of the coastal sandy habitat as a result of increasing anthropogenic pressures (e.g., tourism activities, urbanization, etc.) threaten at least the long-term survival of the species.

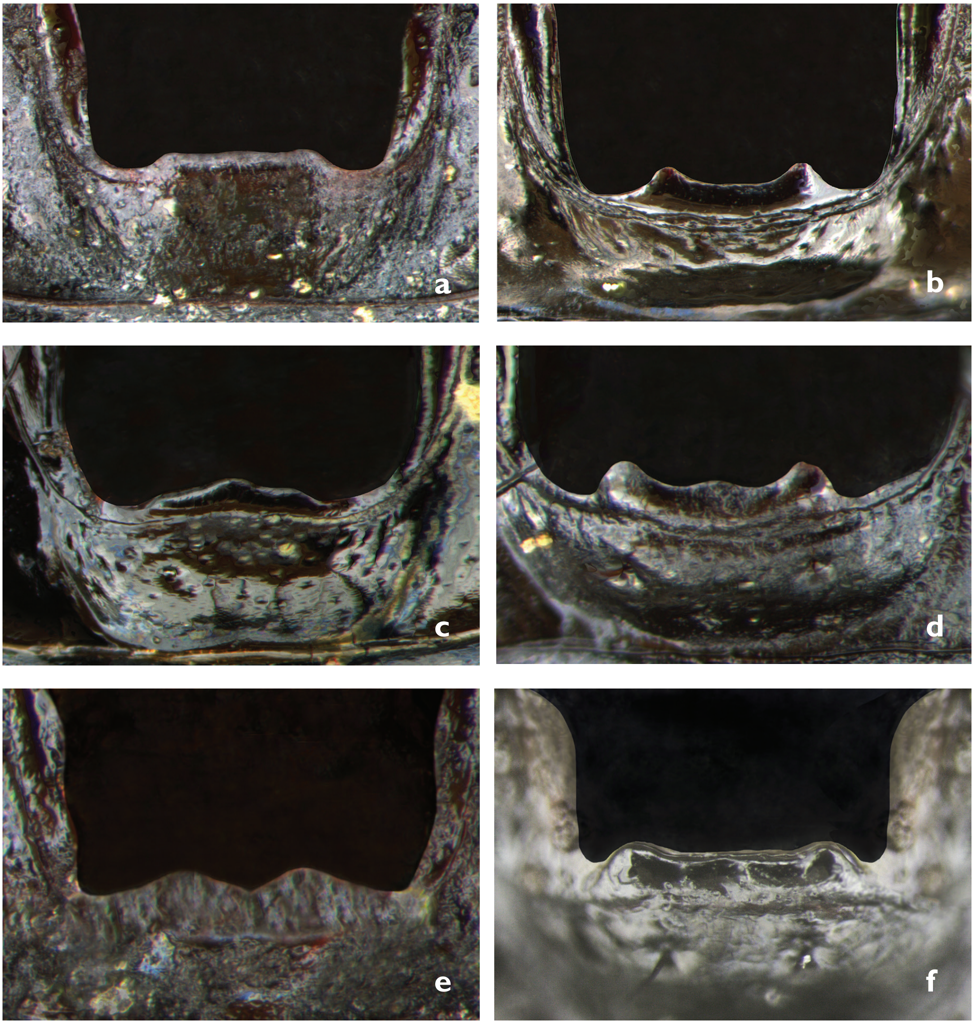

Figure 3. Mentum morphs of the *Graphipterus serrator* group: **a** No teeth (*G. barthelemyi*) **b** Two teeth with concavity between them (*G. heydeni*) **c** Two teeth as margin between them slightly convex in middle. (*G. valdanii*) **d** Three teeth (*G. peletieri*) **e** Two pronounced teeth (*G. minutus minutus*) **f** Three teeth, mid tooth very shallow (*G. serrator*).

Comments. Both Basilewsky (1977) and Lorenz (2005) note in error that *G. barthelemyi* was described by Dejean (1831).

Graphipterus heydeni **Kraatz, 1890: 77, stat. rest.**

Figs 3b, 9b, 18, 21a, c

Graphipterus luctuosus Guérin-Méneville, 1859 (nec Dejean, 1825)

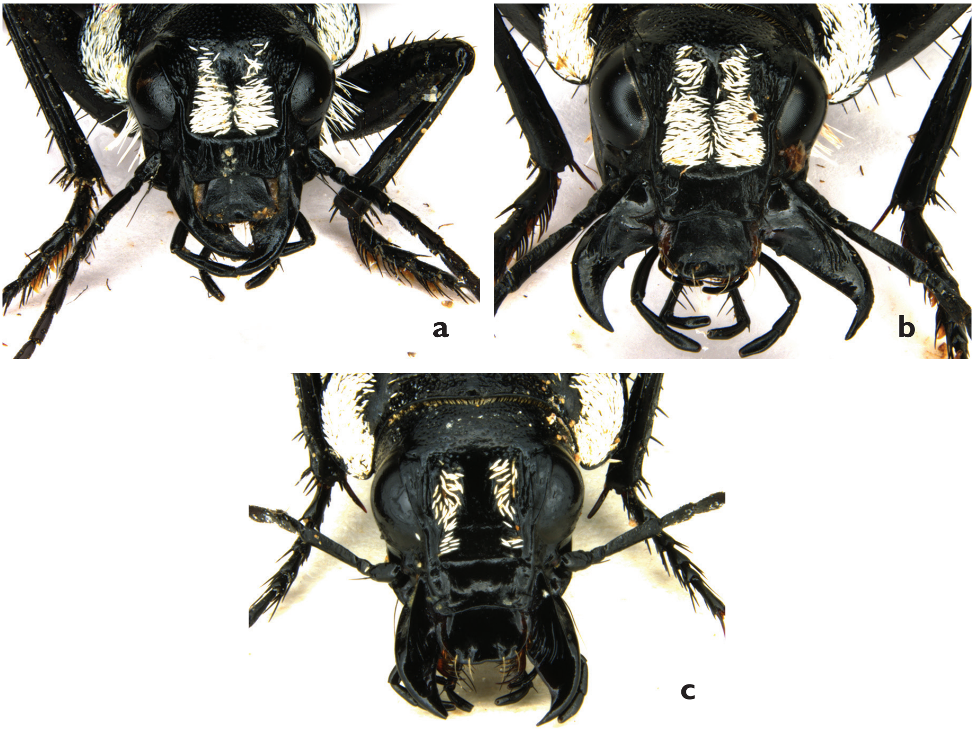

Figure 4. Frontal white stripes of white scales in both sexes: **a** Male: apical white frons stripes wider than exposed frons (*G. multiguttatus*) **b** Male: apical white frons stripes slender than exposed frons (*G. serrator*) **c** Female: sparse stripes of scales (*G. serrator*).

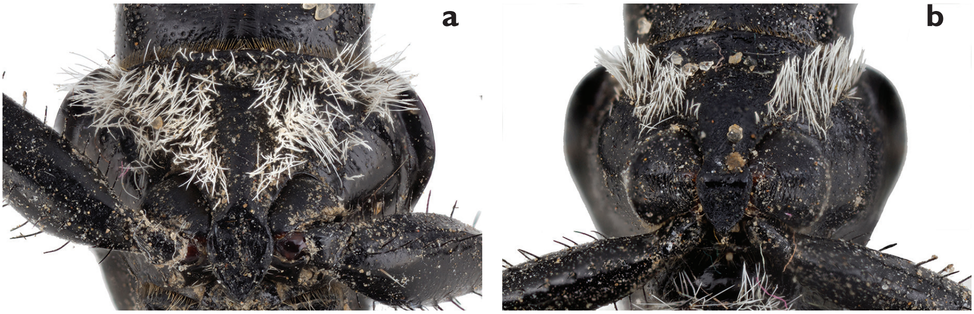

Figure 5. Ventral part of pronotum (*G. serrator*): **a** Male with dense white setae **b** Female with sparse white setae.

Types. Lectotype: ♂ (Blue label with black margin, black handwritten): <*Heydeni Krtz./luctuosus Guer./Tripolis.* Oued>. (White label, print black): <Coll. Kraatz>. (White label, black print): <Tripolis>. (White label, black print): *G. serrator*/heydeni Kr>. (Green label, black print): <Muncheberg/Col – 01309>. (White label, black print): serrator/heydeni Kz./P. Basilewsky det., 1975>. Deposited in ZSM [examined].

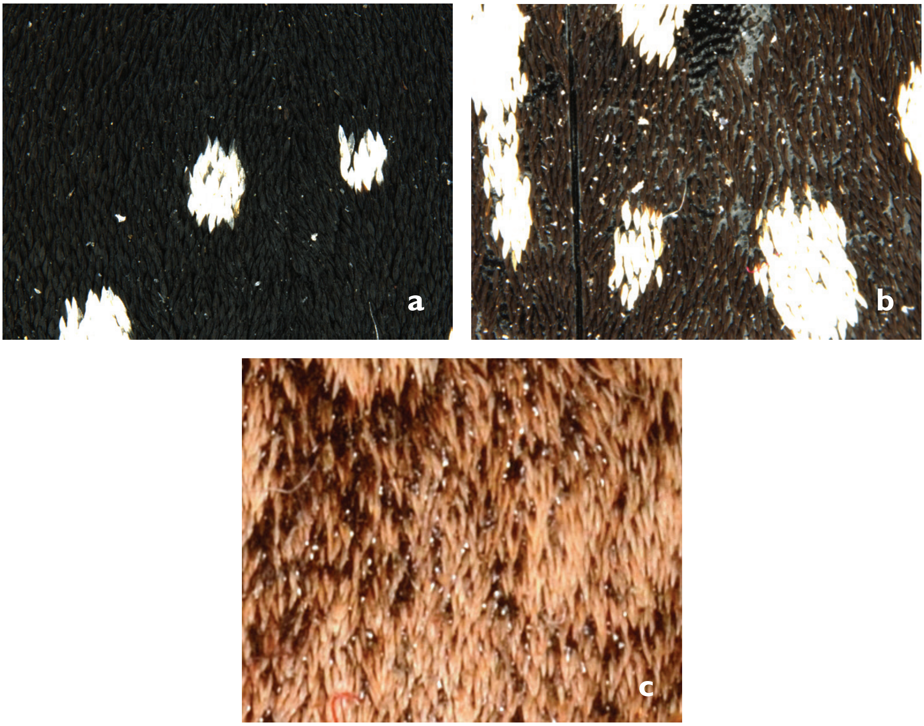

Figure 6. Elytral scale coloration: **a** Black dense scales (*G. serrator*) **b** Dark brown sparse scales (*G. reymondi*) **c** White slushy scales (*G. barthelemyi*).

Figures 7. Apical section and apices of elytra: **a** Apical sinuation strongly developed, apex protruded, almost rectangular, only slightly rounded at most distant tip (*G. rotundatus*) **b** Apical sinuation developed, apex slightly protruded, strongly rounded (*G. luctuosus*) **c** Apical sinuation slightly developed to straight, apex not protruberant, broadly rounded, especially on the median side (*G. multiguttatus*) **d** Apical sinuation and apex almost indistinct (*G. minutus goryi*).

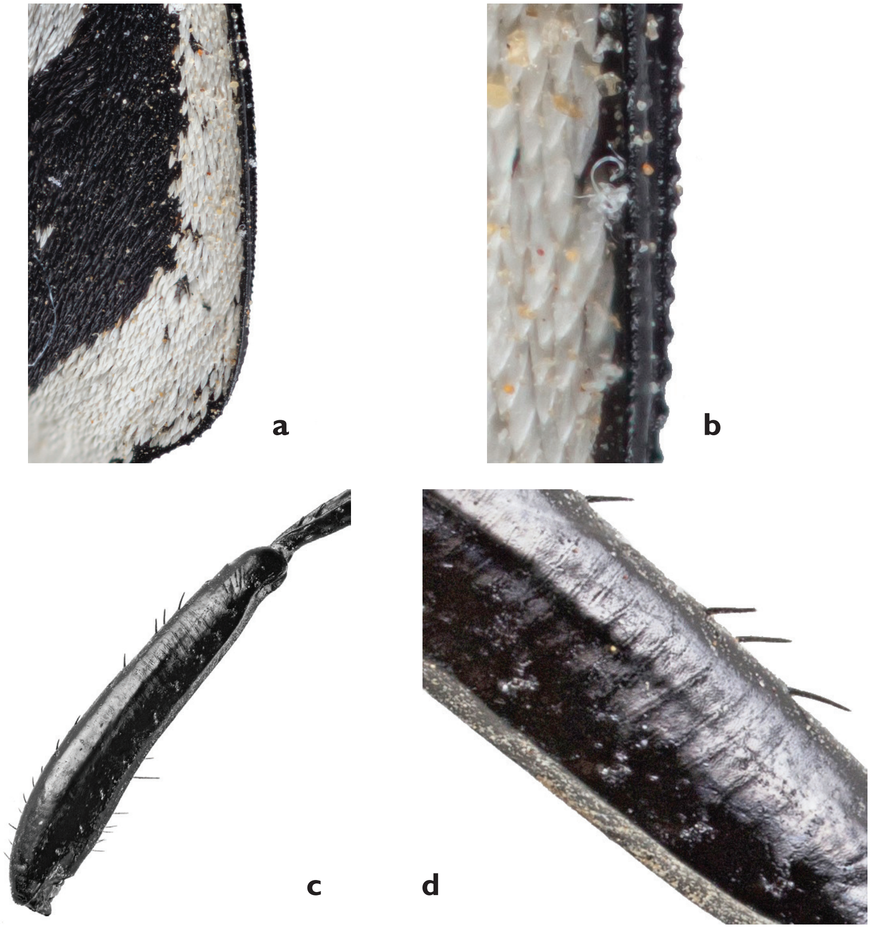

Figure 8. Stridulatory structure of *Graphipterus serrator*: **a** Serrated epipleural structure on the elytra edge **b** Magnification of a. **c** Carina on the upper side of the metafemur **d** Detail enlargement of **c**.

Paralectotype: two specimens – ♂, ♀ (White label, black black handwritten): <Tripolis>. (White label, black handwritten): <Call. Kraatz>. (White label, black handwritten): <Muncheberg/Col – 01310/01311>. Deposited in ZSM [examined]. Lectotypes and paralectotypes herewith designated.

Diagnosis. Large species with 18–26 isolated white round spots on elytra, anterior and posterior discal spots larger than other spots; four marginal extensions, anterior extension triangular; median lobe of aedeagus with ventrally bent apex.

Comparisons. *Graphipterus heydeni* resembles *G. valdanii* from which it differs mainly by the following characters: *G. heydeni*: mentum with two teeth, margin between them clearly concave; EL/EW rounded (1.24); 18-26 spots on elytra; claws of hind legs dark; metatibial secondary spur brown. In *Graphipterus valdanii*, mentum with two teeth, margin between them slightly convex in middle; EL/EW elongated (1.31); 18-26 spots on elytra; claws of hind legs brown; metatibial secondary spur dark. *Graphipterus heydeni* also resembles *G. magnus* sp. n. from which it differs mainly by the following characters:

Figure 9. Median lobes of aedeagus: **a** *G. barthelemyi* **b** *G. heydeni* **c** *G. luctuosus* **d** *G. magnus* sp. n. **e** *G. mauretensis* sp. n. **f** *G. minutus minutus* **g** *G. minutus goryi* **h** *G. multiguttatus* **i** *G. peletieri* **j** *G. piniamitai* sp. n. **k** *G. reymondi* **l** *G. rotundatus* **m** *G. serrator* **n** *G. sharonae* sp. n., **o** *G. stagonopsis* sp. n. **p** *G. valdanii*.

G. heydeni: elytra shape oval; four elytral marginal extensions; anterior and posterior elytral spots larger than all other spots; median lobe of aedeagus with stout with ventrally bent tip. *G. magnus* sp. n.: elytra shape rounded; six elytral marginal extensions; all elytral spots with similar size; median lobe of aedeagus elongated with ventrally bent tip.

Description. BL male: 17.1–20.9 mm, average 18.9 ± 1.6 mm; BL female: 18–20 mm, average 19.4 ± 1.4 mm.

Head slender; HW/PW: 0.71; EYL: 1.5–1.9 mm; EYL/EL: 0.16. Mentum with two teeth and concavity between them (Fig. 3b). Frontal ridge absent. In male, apical white frons stripes slenderer than exposed frons (Fig. 4a).

Pronotum slender; PL/PW: 0.65; BPW/PW: 0.7; posteromedially concave and without white margin; white lateral margin as wide as antennomere I long.

Elytra oval, humeri rounded; EL: 10.0–12.1 mm, average 10.9 mm; EW: 8.4–9.9 mm, average 9.16 mm; EL/EW: 1.2. Lateral cross section convex. Black scales dense, disc not visible between them (Fig. 6a). White lateral margin almost as wide as antennomere I long and with four extensions; extension I triangular with rounded angels, slightly wider at margin of elytra, slightly elongated, wider and shorter than extension II; the latter one elongated at third quarter of elytra, imaginary line connecting the media ends of the extensions I and II parallel to the suture; white posterior margin forms a gap at suture, wider than lateral margin. Disc usually with 18–26 rounded spots; anterior pair of spots rounded, as wide as extension I, usually smaller than posterior spots, larger than spots on mid disc; mid disc spots usually asymmetrically smeared. Posterior pair of spots rounded, one or two small spots located laterally to posterior spots. Apical sinuation strongly developed, apex protruded, almost rectangular, only slightly rounded at most distant tip (Fig. 7a). Suture inconspicuous.

Legs long; MTIL: 5.3–7.0 mm, average 6.5 mm; El/MTIL: 1.7. Metatibial secondary spur brown. MTAL: 4.4–5.2 mm, average 4.8 mm; MTAL/MTIL: 0.7. Claws of hind legs black at base.

Median lobe of *aedeagus* with apex bent ventrally (Fig. 9b).

Habitat. Unknown.

Co-occurring species. *Graphipterus heydeni* lives in sympatry with *G. luctuosus* around Tripoli, Libya, and might live in sympatry with *G. rotundatus* in this region. It also lives in sympatry with *G. piniamitaii* sp. n. in Nefzaoua region in Tunisia.

Distribution. Western Lybia (Tripolitania) and western Tunisia (Nefzaoua) (Fig. 18).

Conservation. The restricted distribution range of the endemic species and the decline of the coastal sandy habitat as a result of increasing anthropogenic pressures (e.g., tourism, urbanization etc.) threaten at least the long-term survival of the species.

Comments. This taxon was first described by Guérin-Méneville (erroneously as *luctuosus* Dej.). As Kraatz already noted, Guérin-Méneville's and Dejean's specimens do not belong to the same taxon, and Kraatz substituted the name *heydeni* Kraatz, 1890 as a new replacement name (nomen novum) for the already available name *luctuosus* Guérin-Méneville. However, Kraatz never fixed the holotype (Jäger, pers. comm.), following the requirement of Article 72.2 (ICZN 1999). The type series of *heydeni* comprises three individuals from Tripoli (Kraatz 1890: 77) and not seven (holotype and six paratypes) as indicated by Basilewsky (1977: 451). The beetles were collected by Quedenfeldt, as this circumstance was indicated by Kraatz in the original description. These individuals have been transferred to the DEI (Kraatz was the director of this institution) and the syntypes are still preserved there. A lectotype is designated, labeled with a handwritten card indicating the taxon’s name, the name of the location, Tripoli, and the initial letters of the collector (Fig. 21c). The above description is based primarily on the three syntypes. The misinterpretation of the type material by Kraatz led Basilewsky to an incorrect interpretation of *heydeni* Kraatz. Consequently the distribution map given by Basilewsky (1977: page 450) is also incorrect.

Graphipterus luctuosus **Dejean, 1825: 335**

Figs 7b, 9c, 16, 21b

Graphipterus reichei Guérin-Méneville, 1859: 534 (Tripoli)
Graphipterus intermedius Guérin-Méneville, 1859: 534 (Tripoli)

Types. Holotype: ♂ (Green label, black handwritten): <*Luctuosus. mihi/ h. in* Barbaria. Tripoli>. (White label, black typewritten): <P. Bedel/Visit 1905>. (White label with brown margin, brown typewritten): <EX Musaeo/Chaudoir>. (Red label, black typewritten): <TYPE>. Deposited in NHMP, Chaudoir collection [examined]. Neotype: ♂ (White label, black handwritten): <Tripolis>. (White label, black handwritten): <Coll: Kraatz>. (Green label, black handwritten): <DEI Muncheberg/ Call-01342>. (Red label, black typewritten): <Neotypus/*Graphipterus reichei*/ Guérin-Méneville, 1859/ des. I. Renan, 2018. Neotype: ♂ (White label, brown handwritten): <intermedius/♂ reichei>. (White label, brwon handwritten): <Tripolis>. (White label, black handwritten): <Call: Kraatz>. ♂ (Green label, black handwritten): <DEI Muncheberg/Call-01343>. (Red label, black typewritten): <Neotypus/*Graphipterus intermedius*/Guérin-Méneville, 1859/des. I. Renan, 2018>.

Diagnosis. Medium-sized species with 22–30 isolated white, usually elongated elytral spots, six very short marginal extensions, and a series of 8–12 elongated spots along suture form a broken line. Median lobe of aedeagus with apex slightly bent ventrally.

Comparisons. *Graphipterus luctuosus* resembles *G. peletieri* from which it differs mainly by the following characters: *G. luctuosus*: apical white frons stripes, wider than exposed frons; six elytral extensions; 8–12 elongated spots along suture of elytra; elytral suture conspicuous; white posterior margin almost attached; median lobe of aedeagus with bent tip. *G. peletieri* apical white frons stripes slenderer than exposed frons; four elytral extensions; elytral spots scattered; elytral suture not conspicuous; white posterior margin forming gap; median lobe of aedeagus with unbent tip. *Graphipterus luctuosus* resembles also *G. rotundatus* from which it differs mainly by the following characters: *G. luctuosus*: 8–12 elongated spots along suture of elytra; scales of elytral disc brown, disc visible between; metatibial secondary spur brown. *G. rotundatus*: elytral spots scattered; scales of elytral disc black, disc not visible between them; metatibial secondary spur dark, not darker than the elytral scales.

Description. BL male: 15.0–17.5 mm, average 15.8 ± 1.5 mm; BL female: 15–18 mm, average 16.3 ± 0.6 mm.

Head medium; HW/PW: 0.74; EYL: 1–1.6 mm; EYL/EL: 0.15. Mentum with two or three teeth. Frontal ridge absent. In male, apical white frons stripes wider than exposed frons, (cf. Fig. 4b).

Pronotum cordiform; PL/PW: 0.64; BPWBPW/PW: 0.61; posteromedially concave and without white margin; white lateral margin as wide as antennomere I long.

Elytra oval, humeri rounded; EL: 7.3–9.9 mm, average 8.9 mm; EW: 5.8–8.4, average 7.7 mm; EL/EW: 1.16. Lateral cross section quite flat suture conspicuous. Scales brown, disc visible between them (Fig. 6b). White lateral margin narrow, as wide as half antennomere I long and with six extensions, rarely four; extension I usually elongated, sometimes constricted at the base to the lateral margin; extension II elongated, constricted or absent; extension III elongated; white posterior margin almost as wide as the lateral margin, gap at suture smaller than lateral margin or even absent. Disc usually with 22–30 mostly elongate small spots; anterior pair of spots slightly elongate, wide as extension I, lateral spots rounded, adjacent or sometimes fused to extension II, posterior pair of spots rounded, slightly larger than others, located toward suture, round spots slightly smaller than all others, located posteriori to third extensions and laterally to posterior spots; a series of 8–12 elongated spots along the suture. Apical sinuation developed, apex slightly protruded, strongly rounded (Fig. 7b).

Legs medium; MTIL: 4.5–5.9 mm, average 5.4 mm; El/MTIL: 1.7. Metatibial secondary spur brown. MTAL: 3.4–4.7 mm, average 4.4 mm; MTAL/MTIL: 0.8. Claws of hind legs brown at base.

Median lobe of *aedeagus* with ventrally bent tip (Fig. 9c).

Habitat. Unknown.

Co-occurring species. *Graphipterus luctuosus* lives in sympatry with seven other species: *G. peletieri* in north-west Algeria, *G. heydeni* in Tripoli region, *G. valdanii* in north Algeria, *G. rotundatus* in Tunisia and Algeria, *G. stagonopsis* in the Ghardaia region, Algeria, *G. piniamitaii* sp. n. in Tunisia, and *G. barthelemyi* in north-east Tunisia.

Distribution. *Graphipterus luctuosus* presents the widest distribution range of the group: from Laghouat, more than 300 km inland Algeria to the arid and semi-arid regions of north-east Algeria, over most of the Tunisian coast and east up to Sirte on the Libyan coast (Fig. 16).

Conservation. The species does not seem to be endangered as it apparently lives in numerous habitats. Consequently, it might not be so strongly affected by human activities.

Comments. *Graphipterus reichei* and *G. intermedius* have been described by Guérin-Méneville (1859) as variants of *G. multiguttatus*. Unfortunately, the type material of both Guérin-Méneville's taxa has have been lost. Neotypes for both taxa are designated. Based on the original description and the type locality, Tripoli, the only other known species from the type locality is *G. heydeni*, which is clearly different in elytral pattern and body length. Basilewsky (1977), Huber and Marggi (2017) and Lorenz (2005) ranked both taxa as synonyms of *G. luctuosus*.

Graphipterus magnus **Renan & Assmann, sp. n.**

http://zoobank.org/EFC7478C-E761-43C8-901F-3FEE1B8A7998
Figs 9d, 19, 22a

Types. Holotype: ♂ (White label, black handwritten): <23.II 1942/Buq Buq/P.J. Gent/Egypt> (White label, black typewritten and black handwritten): <Brit. Mus./1952-180> (White label, black typewritten): <BMNH {E}/UIN989817>. (ae) Deposited in BMNH [examined].

Paratypes: (2 ♂), Egypt, Buq Buq: 14.11.1942, P.J. Gent, {E}/UIN989815 (♂); Egypt, E. of Buq Buq, 14.11.1942, P.J. Gent, {E}/UIN989815, Brit. Mus.952-180 (♂) (BMNH).

Diagnosis. Large species with 20–24 white rounded and elongated elytra spots; six white marginal extensions, extension I elongated. Elytra wide, lateral margin strongly and continuous rounded. Aedeagus elongated, thin and with apex slightly bent ventrally (Fig. 9d).

Comparisons. *Graphipterus magnus* sp. n. resembles *G. heydeni* from which it differs mainly by elytra shape and pattern, and aedeagus shape (see comparisons in *G. heydeni*).

Description. BL male: 18.3–20.1 mm, BL female: unknown. Average 19.4 ± mm.

Head slender; HW/PW: 0.72; EYL: 1.7 mm; EYL/EL: 0.17. Frontal ridge well developed. In male, apical white frons stripes slenderer than exposed frons (cf. Fig. 4a). Pronotum cordiform; PL/PW: 0.62; BPW/BPW/PW: 0.68; posteromedially concave and without white margin; white lateral margin as wide as antennomere I long.

Elytra wide, rounded, rounded-like, humeri strongly narrowed; EL: 9–10.7 mm, average 9.7 mm; EW: 8.5–9.0 mm, average 8.7 mm; EL/EW: 1.1. Lateral cross section quite flat. Scales black, disc not visible between them (cf. Fig. 6a). White lateral margin nearly as wide as antennomere I long and with six extensions; extensions I slightly elongated, wider close to the margin; extensions II and III in front of middle. White posterior margin as wide as lateral margin or wider, sutural gap slenderer than lateral margin. Disc usually with 20 (rarely up to24) spots; anterior pair of spots rounded, wider than extension I, 6–8 spots adjacent elongated and parallel to suture, posterior pair of spots rounded, additional 1–3 small spots frequently present laterally to posterior ones. Apical sinuation strongly developed, apex protruded, almost rectangular, only slightly rounded at most distant tip (Fig. 7a). Suture conspicuous.

Legs long; MTIL: 6.2–6.8, average 6.5 mm; El/MTIL: 1.53. Metatibial secondary spur brown. MTAL: 5.2mm; MTAL/MTIL: 0.8. Claws of hind legs brown at base.

Median lobe of *aedeagus* long and thin with apex hardly bent ventrally (Fig. 9d).

Etymology. The species name is derived from Latin (*magnus*) and refers to the large body size.

Habitat. Unknown.

Co-occurring species. No co-occurring species.

Conservation. Unknown.

Distribution. The only known records are from Buq Buq in north-east Egypt (Fig. 19).

Graphipterus mauretensis Renan & Assmann, sp. n.

http://zoobank.org/F3446E7A-90BB-47EA-9D08-109144005B66

Figs 9e, 16, 22b

Types. Holotype: ♂ (White label with pencil handwritten) < luctuosus/(uc)>. (White label with black typewritten and handwritten): <OFFICE NATIONAL ANTIACRI-

DIEN/Azefal Mauritania/13 Fevirer 1950/J. Leroux>. (red label): <Holotype> (ae). Deposited in Colas collection, NHMP.

Paratypes: (3 ♂, 1♀), Azefal Mauritania: 13 Fevrier 1950, J. Leroux (♂) (NHMP, Colas collection): Mauritanie [Mauritania]: Chingvetti, 3.1951, L. Dekeyser and A. Villiers (2♂ (1-ae), ♀) (MRAC).

Diagnosis. Medium-sized species with (18–) 22 white, mostly elongated spots on elytra, anterior and posterior spots larger than other spots; six marginal extensions, extension I usually triangular. Median lobe of aedeagus with short apex unbent ventrally (somewhat similar to that of *G. barthelemyi*).

Comparisons. *Graphipterus mauretensis* sp. n. resembles *G. piniamitaii* sp. n., from which it differs mainly by the following characters: *G. mauretensis* sp. n.: (18–) 22 spots on elytra; anterior and posterior elytral spots larger than all other spots; apical sinuation and apex developed and slightly protruded; median lobe of aedeagus with short bent tip. *G. piniamitaii* sp. n.: 24 spots on elytra; only posterior elytral spots larger than all other spots; apical sinuation and apex strongly developed and protruded; median lobe of aedeagus with ventrally bent tip.

Description. BL male: 15.1–17.5 mm, average 16.6 ± 1.1 mm. Females were not available.

Head medium; HW/PW: 0.76; EYL: 1.3–1.5 mm; EYL/EL: 0.16. Mentum with two teeth (cf. Fig. 3b). Frontal ridge reduced. In male, apical white frons stripes wider than exposed frons (cf. Fig. 4b).

Pronotum cordiform; PL/PW: 0.66; BPW/PW: 0.63; posteriomedially concave and without white margin; white lateral margin as wide as antennomeres I+II long.

Elytra relatively elongated oval humeri slightly narrowed; EL: 8.6–9.7 mm, average 9.2 mm; EW: 6.8–8.0 mm, average 7.4 mm; EL/EW: 1.2. Lateral cross section quite flat. Dense black scales, disc not visible between them (Fig. 6a). White lateral margin as wide as half of antennomere I long and with six extensions; extension I triangular; extension II shorter than extension III. White posterior margin as wide as lateral margin, sutural gap slenderer than lateral margin. Disc usually with 18–22 rounded to elongate spots; anterior spot elongated, as wide as extension I, anterior and posterior spots larger than all other ones, posterior one rounded. Apical sinuation developed, apex slightly protruded, strongly rounded (Fig. 7b). Suture conspicuous.

Legs long; MTIL: 5.3–5.9 mm, average 5.7 mm; El/MTIL: 1.61. Metatibial secondary spur brown at base, MTAL: 3.8–4.5 mm, average 4.2 mm; MTAL/MTIL: 0.74. Claws of hind legs brown at base.

Median lobe of *aedeagus* with short apex, unbent ventrally (Fig 9e).

Etymology. The species name is derived from ancient Latin (Mauretania, -ensis).

Habitat. Unknown.

Co-occurring species. No co-occurring species.

Distribution. As we found in all collections only nine specimens of *G. mauretensis* sp. n., our knowledge of its distribution range is limited. Known from central coast of Mauritania to more than 400 km inland to Glebat el M'Boza Adrar (Fig. 16).

Conservation. Unknown.

***Graphipterus minutus minutus* Dejean, 1822: 96**

Figs 3c, 9f, 11, 19, 23a

Types. Lectotype: ♀ (blue label, black handwritten): <minutus. m/ h. in Egypt>. (blue label, black handwritten): <Olivier>. (White label with brown margin, brown typewritten): <EX Musaeo/Chaudoir>. (Red label, black typewritten): <TYPE>. Deposited in BMNH, Chaudoir collection [examined].

Paralectotypes: ♀ (blue label, black handwritten): <*Graphipterus* {*minutus*. Ol./ minutus. Dej./Egypt. C. Olivier>. (Green circular label with black margin, black typewritten): <COLLECTION/OLIVIER/TYPE>. Deposited in BMNH, Chaudoir collection [examined]. ♀ (Green circular label with black margin, black typewritten): <COLLECTION/OLIVIER/TYPE>. Deposited in BMNH, Olivier collection [examined].

Additionally, two syntypes are deposited in Chaudoir's collection, NHMP [examined].

Diagnosis. The two subspecies of *G. minutus* are distinguished from all other species of the *G. serrator* group by smaller size, lack of the stridulatory structure, unique pronotum shape (*G. serrator* group excluding *G. minutus*: BPW/PW: 0.6-0.7, *G. minutus*: BPW/PW: 0.46) and flat tip of median lobe.

Comparisons. *Graphipterus minutus minutus* differs from *G. minutus goryi* mainly by the following characters: *G. minutus minutus*: frontal ridge not developed; 36–40 spots on elytra; two elytra marginal extensions; rounded and separated spots along median suture. *G. minutus goryi*: 28–30 spots on elytra; six elytra marginal extensions; elongated and fused spots along median suture.

Description. BL male: 10.3–13.5 mm, average 12 ± 1.2 mm; BL female: 10.5–15.2 mm, average 13.1 ± 1.9 mm;

Head wide; HW/PW: 0.77; EYL: 1–1.8 mm; EYL/EL: 0.15. Frontal ridge slightly developed. Male with two short parallel frontal stripes of white scales usually diverging apically, became wispy, not reach the level of supraorbital setiferous pores. Mentum usually with two pronounced teeth (Fig. 3e). Pronotum strongly cordiform PL/PW: 0.54; BPW/PW: 0.46; posteromedially flat and without white margin; white lateral margin as twice as antennomere II long.

Elytra almost rounded, humeri stringly rounded, lateral margin continuously rounded; EL: 5.3–7.5 mm, average 6.6; EW mm: 4.8–7.6 mm, average 6.1 mm; EL/EW: 1.16. Suture inconspicuous. Scales black, disc not visible between them (cf. Fig. 6a). Lateral cross section convex. Apical sinuation almost lacking, apex almost absent, not rounded (Fig. 7d). White lateral margin usually nearly as wide as antennomere I long and usually with two extensions; extension I elongated from humeri posteriorly; extension II usually absent, sometimes indistinct wider section of lateral margin at its middle. White posterior margin becomes narrower toward the tip, usually disappearing in front of it; gap at suture wider than lateral margin. Disc with 36–40 mostly rounded spots; usually 12, sometimes ten or 14 rounded to elongated, not fused spots located parallel to suture; anterior spot as wide as extension I. Stridulatory structure absent.

Legs short; MTIL: 2.54–4.0 mm, average 3.3 mm; El/MTIL: 1.9 mm. Metatibial secondary spur brown, MTAL length: 2.5–3.3 mm, average 2.9 mm; MTAL/MTIL: 0.85. Claws of hind legs brown at base.

Median lobe of *aedeagus* with wide and flat tip (Fig. 9f).

Habitat. Sparse populations in arid habitats with hallow sand dunes, and scant shrubs landscape (Fig. 11).

Co-occurring species. No co-occurring species.

Distribution. Syria, east and south Jordan, north Saudi Arabia, Iraq, and Iran (Fig. 19).

Conservation. The species does not seem to be endangered as it has a wide distribution range that is not strongly affected by human activities.

Comments. The type location of *G. m. minutus*, Egypt, is probably a labeling mistake. Only four specimens of this species were found with labels from Egypt; the three syntypes from Olivier's collection and one specimen deposited in BMNH, collected by Bowring. Even though Olivier had a large amount of material from Egypt and Bowring collected in Egypt, we are convinced that *G. minutus* does not occur in Egypt: all the known populations from collections and field observations are from Asia and not from Africa. Furthermore, no specimen has been ever collected in Israel, despite intensive collecting in the potential habitats. Basilewsky (1977) noted that although several researchers had contended that *G. minutus* does exist in Egypt, they were wrong, but he does not refer to the problem of types.

By applying other species concepts (e.g., Evolutionary or Phylogenetic Species Concept, Claridge et al. 1997) or by using another approach to delineate species, the two taxa *minutus* and *goryi* might be ranked as two species. However, our numerical approach to delineate species results in a value for both *minutus* and *goryi* that is clearly below the threshold of the least differentiated sympatrically occurring species of the *Graphipterus serrator* group. Therefore these two taxa must be ranked as one species. Nonetheless both taxa differ clearly from each other and are well established in the literature as subspecies (Basilewsky 1977; Lorenz 2005; Huber and Marggi 2017). Therefore we prefer a conservative taxonomic approach which avoids taxonomic inflation (cf. Zachos et al. 2013, Assmann et al. 2008) and preserve the rank of subspecies for both taxa.

Graphipterus minutus goryi Chaudoir, 1848: 127

Figs 7d, 9g, 19, 23b

Types. Holotype: ♂ (White label with brown margin, brown typewritten): <EX Musaeo/Chaudoir>. (Red label, black typewritten): <TYPE>. Deposited in BMNH, Chaudoir collection [examined].

Diagnosis. Small-sized taxon with 28–30 mostly elongated white spots, usually with several spots fused with lateral margin, and with series of usually ten elongated spots, regularly at least several are fused to each other along median suture. Two marginal extensions elongated from humeri posteriorly. Median lobe of aedeagus with wide and flat tip.

Comparisons. *Graphipterus minutus goryi* resembles *G. minutus minutus*, for further details see *Graphipterus minutus minutus*.

Description. BL male: 11.2–11.8 mm, average 11.5 ± .02 mm; BL female: 11.4–13.6 mm, average 12.2 ± 0.9 mm.

Head wide; HW/PW: 0.78; EYL: 1.1–1.3 mm; EYL/EL: 0.19. Frontal ridge absent. Male with two short parallel frontal stripes of decumbent white scales usually diverging apically became wispy, not reaching the level of supraorbital setae. Mentum with two pronounced teeth (cf. Fig. 3e).

Pronotum strongly cordiform; PL/PW: 0.57; BPW/PW: 0.5; posteriomedially flat and without white margin; white lateral margin as twice as antennomere II long.

Elytra almost rounded, humeri strongly rounded, lateral margin continuously rounded; EL: 5.9–7.3 mm, average 6.2 mm; EW: 5.2–6.8 mm, average 5.7 mm; EL/EW: 1.1. Lateral cross section convex. Scales black, disc not visible between them (cf. Fig. 6a). White lateral margin nearly as wide as antennomere I long and with six, rarely fewer, elongated extensions; extensions I elongated from humeri posteriorly; extensions II and III in front and behind the middle of lateral margin, usually much longer than lateral margin wide. White posterior margin becomes narrower toward the tip, usually disappearing in front of it; gap at suture as wide as lateral margin. Disc with 28–30 mostly elongated spots, several spots fused with lateral margin resulting in extensions II and III, a series of 10, (rarely 12–14), elongated spots fused to each other parallel to suture, anterior spot as wide as extension I. stridulatory structure absent. Apical sinuation almost lacking, apex almost absent, not rounded (Fig. 7d). Suture inconspicuous.

Legs short; MTIL: 2.5–3.3 mm, average 3.0 mm; El/MTIL: 1.9. Metatibial secondary spur brown. MTAL: 2.1–3.8 mm, average 2.9 mm; MTAL/MTIL: 0.87. Claws of hind legs brown at base.

Median lobe of *aedeagus* with wide and flat tip (Fig. 9g).

Habitat. Unknown.

Co-occurring species. No co-occurring species.

Distribution. Saudi Arabia and Iraq (Fig. 19). There are old records from Iran (Perse), but without indication of exact locality.

Conservation. The species does not seem to be endangered as it has a wide distribution range in desert regions that are not strongly affected by human activities.

Graphipterus multiguttatus (Olivier, 1790) 335, stat. rest.

Figs 4a, 7c, 9h, 10b, 12, 19, 24a

Graphipterus kindermanni Chaudoir, 1871: 299, syn. n. Alexandrie (= Alecsandria)

Types. Lectotype: ♂ (blue label, black handwritten): <Graphipterus/multiguttatus. Ol./Egypt. *G. Olivieir*> (Green circular label with black margin, black typewritten): <COLLECTION/OLIVIER/TYPE>. Deposited in NHMP, Olivier collection [examined]. Syntypes: NHMP (Olivier collection): Egypte Olivier, multiguttatus, (uc),

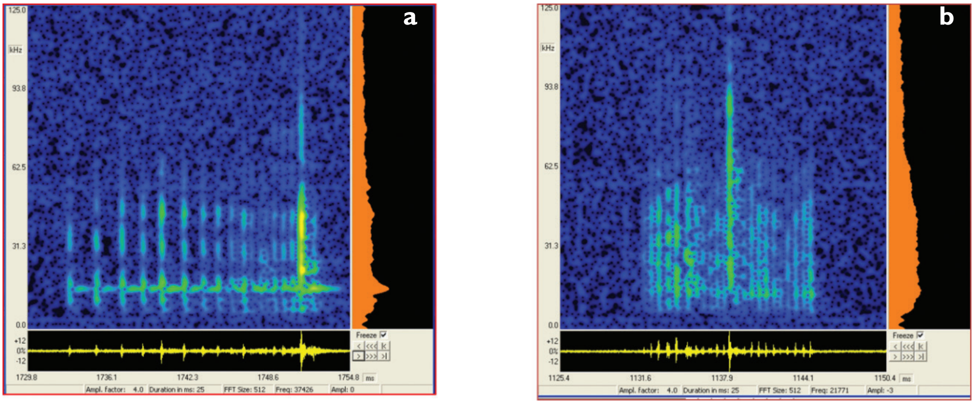

Figure 10. Spectrograms of two *Graphipterus* species: *G. serrator* and *G. multiguttatus*.

Figure 11. Habitat of *Graphipterus minutus minutus*: Shallow sand dunes in Wadi Ram, Jordan.

TYPE (♂); (Olivier collection) Collection Olivier, TYPE (♂); (General collection) Egypte Olivier, multiguttatus, Egypt, Oliv., Bedel et (uc), p. 339, 1909, vid. (♀).

Diagnosis. Small species with 16–20 white, mostly elongated spots on elytra, only posterior discal spots rounded; 4–6 marginal extensions, extension I oriented slightly posteriorly. Median lobe of aedeagus with ventrally short, unbent tip.

Comparisons. *Graphipterus multiguttatus* resembles *G. rotundatus* from which it differs mainly by the following characters: *G. multiguttatus*: average body length of 13.2 mm; El/MTIL, 1.6; all elytral spots with similar size; MTAL/MTIL, 0.84; median lobe of aedeagus with ventrally short unbent tip. *G. rotundatus*: average body length of 17.4 mm; El/MTIL, 2.08; posterior elytral spots larger than all other spots; MTAL/MTIL, 1.28; median lobe of aedeagus with longer (than *G. multiguttatus*) slightly bent tip. *Graphipterus multiguttatus* resembles also *G. sharonae* sp. n., from which it differs mainly by body length, elytral pattern, and shape of median lobe of aedeagus (see full comparisons under *G. sharonae* sp. n.).

Description. BL male: 10.0–15.0 mm, average 13.0 ± 1.3 mm; BL female: 11.5–16.0 mm, average 14.0 ± 1.2 mm.

Head wide; HW/PW: 0.76; EYL: 1.0–1.6 mm; EYL/EL: 0.17. Frontal ridge slightly developed. In male, apical white frons stripes wider than exposed frons (Fig. 4a); stripes elongate, reaching the level of supraorbital setae (populations east of the Dead Sea-Rift Valley), or being shorter (populations west of the Dead Sea-Rift Valley). Mentum with 2–3 teeth.

Pronotum cordiform; PL/PW: 0.66; BPW/PW: 0.64; posteromedially concave and without white margin; white lateral margin as wide antonomer 1 long.

Elytra oval, humeri rounded; EL: 4.5–9.1 mm, average 7.7 mm; EW: 4.1–8.0 mm, average 6.4 mm; EL/EW: 1.2. Lateral cross section quite flat. Elytra with Dense black scales, disc not visible between them (cf. Fig. 6a). White lateral margin nearly as wide as half of antennomere I long and with 6, sometimes four extensions; extension I medium long, shorter than anterior spot, but longer than extension II and shorter than extension III, which is wider than lateral margin; extension II sometimes constricted, rarely absent or fused with lateral disc spot. White posterior margin as wide as lateral margin, gap at suture smaller than lateral margin. Disc usually with 16 sometimes 18 rounded to elongate spots; anterior spot slightly elongate, longer than extension I; lateral spots rounded, adjacent, or sometimes fused to extension II, six spots forming an arch pattern anteriorly and laterally to posterior rounded larger spots. Apical sinuation slightly developed to straight, apex not protuberant, broadly rounded, especially on the medial side (Fig. 7c). Suture conspicuous.

Legs long; MTIL: 3.7–5.5 mm, average 4.7 mm; El/MTIL: 1.6. Metatibial secondary spur brown at base, MTAL: 3–4.5 mm, average 3.7 mm; MTAL/MTIL: 0.8. Claws of hind legs black at base.

Median lobe of *aedeagus* with short, unbent tip (Fig 9h).

Habitat. In the western Negev (Israel), the species shows a significant habitat preference for stabilized interdunes and for the semi-stabilized slopes. In this region it is completely absent from the crest of shifting sand dunes. On the dunes it prefers the lower part of the north-facing slope, which is the part of the dune being most humid and most vegetated by annual plants (Fig 12). Large populations inhabit the loamy and more humid region in the northern Negev. In spring, after an extremely dry winter, specimens might also be found on the margins of irrigated agriculture fields.

Figure 12. Habitat of *Graphipterus multiguttatus*: Sand rich with loess soil, relatively rich in annual plants. Western Negev sands, Israel.

Co-occurring species. *Graphipterus multiguttatus* lives in sympatry with *G. serrator* in Egypt and Israel.

Distribution. Egypt, Israel, and Jordan (Fig. 19). The only Jordanian population of which we are aware lives between Aqaba to Ma'an, and inhabits a flat sand dune area without or only slightly developed crust. In the same habitat *Anthia* (*Thermophilum*) *duodecimguttata* (Bonelli, 1813) and *Amara maindromi* Bedel, 1907 occur.

Conservation. The species does not seem to be endangered as it has a wide distribution range and it prefers habitats that are not strongly affected by human activities. However, in Israel, in the Dead Sea region and the Arava Valley, *G. multiguttatus* has been collected in the past, but no longer exists there. The latest records from these regions are Ein Gedi, 1976; Ein Husub, 1956 (leg. unknown, both specimens preserved in KCE); Sedom road, 1953; Ein-Radian, 1958 (leg. Ch. Lewinsohn, both specimens preserved in SMNHTAU). Habitats for *G. multiguttatus* on the Israeli side of the Arava valley may have disappeared. *Anthia* (*Thermophilum*) *duodecimguttata* (Bonelli, 1813), one of the co-occurring ground beetle species of the Jordanian population of *G. multiguttatus*, was last found in 2003 in Israel (coll. U. Shanas, V. Chikatunov, SMNHTAU; pers. obs.).

Comments. Specimens from Jordan and the central Negev in Israel are usually larger than those from the western Negev. Specimens from the HaBesor National Park are smaller than those from the western Negev. The latter populations of *G. multigut-*

tatus which co-occur with *G. serrator* populations (Renan et al. 2011) have individuals with intermediate body lengths.

Graphipterus kindermanni has to be ranked as a junior synonym of *G. multiguttatus.* We checked for comparison the types of Basilewsky in MRAC (but did not find the type in NHMP that Basilewsky noted he had checked there) and did not find any morphological differences, with the exception of white setae on the elytral base. Both Basilewsky (1977) and Lorenz (2005) contended that *G. kindermanni* is a synonym of *G. luctuosus*.

Biology. Seasonality and daily activity time are in the same as in *G. serrator* (see there), but the species seems to spend more time under shrubs. *Graphipterus multiguttatus* prefers stabilized and semi-stabilized sand with high vegetation. The population densities in the sympatric areas of the distribution ranges are lower than those for *G. serrator*. The beetles dig burrows between the hard crust layer and the soft sand, sometimes close to the dwarf-shrubs. Frequently, the openings do not collapse or become covered by sand. The beetles sometimes close the openings with sand from inside. Diet, intraspecific behavior including copulation and the chirping sounds produced by the stridulatory structure, are same as in *G. serrator*.

Scraping record. In comparison to the co-occurring *G. serrator*, the scraping spectrograms of *G. multiguttatus* show clear differences in pulse interval as well as in the sound pressure level (Fig. 10b).

Graphipterus peletieri **Laporte de Castelnau, 1840: 58, stat. rest.**

Figs 3e, 9i, 17, 24b

Graphipterus lepeletieri Alluaud, 1926: 17 (Tissaf)
Graphipterus discipennis Chevrolat [Unpublished name]

Types. Holotype: ♂ (Blue label, black handwritten): <*Pletieri*. Chevrolat./Oran. D.S Fargeau>. (White label, black typewritten): <P. Bedel/Visit 1905>. (White label with brown margin, brown typewritten): <EX Musaeo/Chaudoir>. (Red label, black typewritten): <TYPE>. Deposited in NHMP, Chaudoir collection [examined].

Diagnosis. Predominantly dark, medium-sized species with 18-24 small, mostly rounded white spots on elytra, four usually short marginal extensions. Median lobe of aedeagus with ventral, short, unbent tip.

Comparisons. *Graphipterus peletieri* resembles *G. luctuosus* (see comparisons in *G. luctuosus*).

Description. BL male: 13.9–14.8 mm, average 14.3 ± 0.4 mm; BL female: 11.5–16.1 mm, average 13.6 ± 1.8 mm.

Head medium; HW/PW: 0.76; EYL: 1–1.5 mm; EYL/EL: 0.17. Mentum with usually three teeth (Fig. 3d). Frontal ridge absent. In male, apical white frons stripes slenderer than exposed frons (cf. Fig. 4a).

Pronotum strongly cordiform, PL/PW: 0.63; BPW/PW: 0.6; posteromedially concave and without white margin; white lateral margin as wide as antennomere I long.

Elytra oval, humeri rounded; EL: 7.4–9.1 mm, average 8; EW: 5.7–7.9 mm, average 7.0 mm; EL/EW: 1.15. Elytra with brown scales, disc of elytra visible between scales (cf. Fig. 6b). White lateral margin wide as half antennomere I long and with four extensions; extensions often constricted; extension I elongated, shorter than extension II; sutural gap of white posterior margin wider than lateral margin. Disc usually with 18–24 mostly rounded spots; anterior pair of spots slightly elongate, as wide as extension I, lateral spots rounded, adjacent or sometimes fused to extension II, posterior pair of spots rounded, slightly larger than others, located toward suture. Lateral cross section quite flat. Apical sinuation developed, apex slightly protruded, strongly rounded (cf. Fig. 7b). Suture inconspicuous.

Legs long; MTIL: 3.8–5.3 mm, average 4.8 mm; El/MTIL: 1.7. Metatibial secondary spur brown. MTAL: 2.8–4.0 mm, average 3.5 mm; MTAL/MTIL: 0.7 (all other species of the *G. serrator* group El/MTIL: 0.8). Claws of hind legs brown at base.

Median lobe of *aedeagus* with ventrally short, not bent tip (Fig 9i).

Habitat. Unknown.

Co-occurring species. *Graphipterus peletieri* lives in sympatry with five other species in north-west Algeria: *G. luctuosus*, *G. rotundatus*, *G. valdanii*, *G. stagonopsis* sp. n., and *G. piniamitaii* sp. n.

Distribution. North-west Algeria and north Morocco (Fig. 17).

Conservation. The species does not seem to be threatened as it has a wide distribution range that appears to be mostly not strongly affected by human activities.

Comments. Alluaud (1926) initially erroneously named this species *Graphopterus lepeletieri* and since then this spelling has commonly been used by many authors (e.g., Basilewsky 1977). *Graphipterus luctuosus* was ranked as a subspecies of *G. peletieri* by Basilewsky (1977), but as a "good" species by Lorenz (2005) and Huber and Marggi (2017).

Graphipterus piniamitaii Renan & Freidberg, sp. n.

http://zoobank.org/7B3CE213-D0D6-4083-AA8E-109E72094EEE
Figs 9j, 13, 18, 25a

Types. Holotype: ♂ (White label, black handwritten): <Kebili>. (White label, black typewritten): <Ex Museo/L. Vibert>. (ae). Deposited in NHMP, general collection.

Paratypes. (20♂, 4♀). El Hammama, Tunis: (Gabès), I. 1889, Alluaud (♂) (ZMUC); Gafsa Tunis, Vibert Lyon (♂) (NMP). Kebilli, Tunis: 1906, EX Call. Maindron M., Call G. Babault 1930 (♂ae) (NHMP, General collection); 1950, Cobos Sa'nchez, (uc) (♂) (NHMP, Negre collection); L. Vibert, Ex Musaeo (♂ae) (MRAC); Call. Mus Congo, Col. P. Basilewsky (5♂) (RMRAC); Tunisia, Kebili 15 km N.W, 17.III. 1986, Zool. Mus. Copenhagen Exp. (3♂) (ZMUC); Kebili 2 km s, W. Ziegler, 30 m, Dünen, 5.3.2012, (♂, 2♀) (DWC, CAB); Douz, south

Tunisia, Zaafrane (Sahara), 02.04.1992 (♂). S. Tunisia (Kebili), Zaafrane, 12 km SW Douz, 21.IV.2007 M. Liebscher (♀); S. Tunisia (Kebili), Zaafrane, 12 km SW Douz, 21.IV.2007 M. Liebscher (♀); C. Tunisia, 2 km E. Kairouan, 23.4.2005, M. Liebscher Sammlung (♂,♀) (DWC). Oasis Gafsa: Tunis, B v. Bodemeyer (♂) (DEI Muncheberg Call- 01314); B v. Bodemeyer, O. Leonhard, (uc) (♂ae) (DEI Muncheberg Call- 01315); B v. Bodemeyer, O. Leonhard (♂) (DEI Muncheberg Call- 01316).

Diagnosis. Medium-sized species with usually 24 white large rounded and elongated spots on elytra; posterior discal spots slightly larger than other spots; six marginal extensions (Fig. 25a). Median lobe of aedeagus with slightly bent tip.

Comparisons. *Graphipterus piniamitaii* sp. n. is easily distinguished from all other species of the group by its large white spots on the elytra. The new species resembles *G. mauretensis* sp. n. (see comparisons in *G. mauretensis* sp. n.).

Description. BL male: 15.5–19.8 mm, average 17.5 ± 2.1 mm; BL female: 17–17.9 mm, average 17.5 ± 0.3 mm.

Head medium; HW/PW: 0.76; EYL: 1.5–1.8 mm; EYL/EL: 0.17. Mentum with two or three teeth. Frontal ridge absent. In male, apical white frons stripes wider than exposed frons (cf. Fig. 4b).

Pronotum cordiform; PL/PW: 0.63; BPW/PW: 0.66; posteromedially concave and without white margin; white lateral margin as wide antennomere I long.

Elytra oval, humeri rounded, but slightly protruding; EL: 8.2–11.0 mm, average 9.4 mm; EW: 6.5–9.2 mm, average 8.1 mm; EL/EW: 1.2. Lateral cross section quite flat. Suture conspicuous. Black scales dense, disc not visible between scales (cf. Fig. 6a). White lateral margin nearly as wide as 1½ antennomere I long and with six extensions; extension I triangular, slightly elongated and posteriori oriented; extensions II and III frequently constricted at base, usually wider than lateral margin. White posterior margin as wide as lateral margin or wider, not becoming narrower towards the suture; gap at suture smaller than lateral margin. Disc usually with 24 rounded to elongate, moderate large spots; anterior spot elongated, as wide as extension I, posterior discal spots slightly larger than other spots, series of six elongated spots along suture, sometimes fused to each other; posterior discal spots larger than other spots. Apical sinuation strongly developed, apex protruded, almost rectangular, only slightly rounded at most distant tip (cf. Fig. 7a).

Legs long; MTIL: 5.3–6.6 mm, average 6.1 mm; El/MTIL: 1.54. Metatibial secondary spur brown at base, MTAL: 4–5.7.0 mm, average 4.9 mm; MTAL/MTIL: 0.8. Claws of hind legs brown at base.

Median lobe of *aedeagus* with slightly bent tip (Fig. 9j).

Etymology. The species is dedicated to Pinchas (Pini) Amitai, an inspiring entomologist and mentor who wrote the first Hebrew photographed insect guide.

Habitat. The species dwells in the vicinity of Kebili on intensively grazed dunes, together with *Anthia (Thermophilum) sexmaculata* (Fabricius, 1787) and *A. venator* (Fabricius, 1792) (Fig. 13). The dunes have a diverse vegetation of shrubs and dwarf-shrubs.

Co-occurring species. *Graphipterus piniamitaii* lives in sympatry in Kebili and Gabès region in Tunisia with *G. luctuosus*, *G. peletieri*, and *G. heydeni*.

Figure 13. Habitat of *Graphipterus piniamitaii* sp. n.: Shifting sand dunes with vegetated Nebka hills, Kebili, Tunisia.

Distribution. Restricted to Central Tunisia, from the vicinity of Kebili to Gabès (Fig.18).

Conservation. The species does not seem to be endangered, as the preferred habitat is not strongly affected by human activities.

Graphipterus reymondi Antoine, 1953: 208, stat. n.

Figs 6b, 9k, 16, 25b

Types. Holotype: ♂ (White label, brown handwritten): <*Reymondi m.*/ (same label, black typewritten): Antoine det.>. (White label, black handwritten): <Inhamid/ Sahara septe./(Reymond)>. (Red label, black handwritten): <HOLOTYPE>. Deposited in NHMP, General collection, box 31[examined].

Diagnosis. Large species with 20-24 isolated white round spots on elytra, six marginal extensions, extension II short, almost triangular. Humeri very narrowed, maximum width of elytra at interior rear third. The discal elytra pattern comprises a group of 8–12 elongated spots in an order parallel to the suture. Median lobe of aedeagus with ventrally bent tip.

Comparisons. *Graphipterus reymondi* resembles *G. sharonae* sp. n., from which it differs mainly by mentum and humeri morphology, pattern, color and morphology of elytra (see full comparisons under *G. sharonae* sp. n.). *Graphipterus reymondi* resembles also *G. stagonopsis* sp. n., from which it differs mainly by mentum morphology, pattern, and morphology of elytra, and color of claws and spurs (see full comparisons under *G. stagonopsis* sp. n.).

Description. BL male: 17–18, average 17.6 ± 0.4 mm; BL female: 17.4–21.4, average 19.3 ±2 mm.

Head medium; HW/PW: 0.76; EYL: 1.6–1.8 mm; EYL/EL: 0.17. Mentum with three teeth (cf. Fig. 3d). Frontal ridge absent. In male, apical white frons stripes wider than exposed frons (Fig. 4b).

Pronotum wide; PL/PW: 0.72; BPW/PW: 0.63; posteromedially concave and without white margin; white lateral margin as wide as antennomere I long.

Elytra with strongly narrowed humeri; EL: 9.4–10.3 mm, average 9.75 mm; EW: 8.0–8.5, average 8.3 mm; EL/EW: 1.2. Lateral cross section convex. Suture conspicuous. Scales brown, disc visible between them (Fig. 6b). White lateral margin nearly as wide as antennomere I long and with six extensions; extension I triangular with rounded tip, slightly more elongated than in *G. serrator*, wider and shorter than extensionII; the latter one elongated, at third quarter of elytra. White posterior margin commonly slightly wider than lateral margin, gap at suture smaller than lateral margin, usually with a small, indistinct tip anteriorly. Disc usually with 20–24 (rarely 18), mainly rounded spots; anterior pair of spots rounded, wide as extension I, usually smaller than posterior spots, but larger than spots on central disc; central disc spots usually asymmetrically smeared; posterior pair of spots rounded; one or two small additional spots adjacent laterally to the posterior ones. Apical sinuation strongly developed, apex protruded, almost rectangular, only slightly rounded at most distant tip (Fig. 7a).

Legs long; MTIL: 5.8–6.1 mm, average 5.9 mm; El/MTIL: 1.6. Metatibial secondary spur brown. MTAL length: 4.2–5, average 4.7 mm; MTAL/MTIL: 0.8. Claws of hind legs black at base.

Median lobe of *aedeagus* with ventrally bent tip (Fig. 9k).

Habitat. Unknown.

Co-occurring species. No co-occurring species.

Distribution. Morocco (Fig. 16).

Conservation. Unknown.

Graphipterus rotundatus Klug, 1832: 7, stat. rest.

Figs 7a, 9l, 18, 26a

Types. Lectotype: ♀ (blue label, black handwritten): <rotundatus/Klug*/x.118-21./Bir Hamam El Eherenberg> (White label, black handwritten): <Zwischen Bir-Lebuck/and Bir Hamam/(Libye)> (White label, black typewritten): <Type> (White label, black typewritten): <Hist. –Coll. (Coleoptera)/Nr. 1299/ *Graphipterus rotundatus*/ Klug*/Bir Hamam El Eherenberg/Zool. Mus. Berlin>. Deposited in ZMHB [examined]. Paralectotype: ♂ (Red label, black typewritten): <Type> (White label, black handwritten): <1299> (white label, black typewritten): <Hist.–Coll. (Coleoptera)/Nr. 1299/*Graphipterus rotundatus*/Klug*/Bir Hamam El Eherenberg/Zool. Mus. Berlin>. Deposited in ZMHB [examined].

Diagnosis. Small species with large distribution range, high variation in size (15–19 mm) and variation in elytra pattern (4–6 extensions, 16–22 spots). posterior discal spots larger than other spots; six spots usually forming an arc pattern anterior and lateral to posterior spots; Median lobe of aedeagus with short, slightly bent tip.

Comparisons. *Graphipterus rotundatus* resembles *G. multiguttatus* (see comparisons in *G. multiguttatus*) and *G. luctuosus* (see comparisons in *G. luctuosus*).

Description. BL male: 15.0–19.0 mm, average 17.4 ± 1.5 mm; BL female: 15.4–17.1 mm, average 16.1 ± 1.3 mm.

Head slender; HW /PW: 0.72; EYL: 1.4–1.7 mm; EYL/EL: 0.16. Mentum with 2–3 teeth. Frontal ridge slightly developed. In male, apical white frons stripes wider than exposed frons (Fig. 4b).

Pronotum cordiform; PL/PW: 0.65; BPW/PW: 0.69; posteromedially concave and without white margin; white lateral margin as wide antonomer 1 long.

Elytra oval, humeri rounded; EL: 8.9–11.0 mm, average 9.7 mm; EW: 7.0–8.7 mm, average 7.8 mm; EL/EW: 1.25. Lateral cross section quite flat. Dense black scales, disc not visible between scales (Fig. 6a). White lateral margin nearly as wide as half antennomere I long and with six, sometimes fouor extensions; extension I triangular to slightly elongated; extension II absent or only weakly developed, rarely fused with lateral disc spot. White posterior margin becomes narrower towards the suture, gap at suture smaller than lateral margin. Disc usually with 18, sometimes 16 or 22 rounded to weakly elongate spots; anterior spot slightly elongated, wide as extension I, six spots usually forming an arc pattern anterior and lateral to posterior rounded, larger spots. Apical sinuation strongly developed, apex protruded, almost rectangular, only slightly rounded at most distant tip (Fig. 7a). Suture conspicuous.

Legs long; MTIL: 4.3–5.2 mm, average 4.7 mm; El/MTIL: 1.63. Metatibial secondary spur dark at base, MTAL: 5.4–6.9 mm, average 6 mm; MTAL/MTIL: 0.8. Claws of hind legs brown at base.

Median lobe of *aedeagus* with slightly bent tip (Fig 9l).

Habitat. Unknown.

Co-occurring species. *Graphippterus rotundatus* lives in sympatry with G. *luctuosus, G. peletieri,* and *G. valdanii* in Algeria and Tunisia.

Distribution. Algeria, Tunisia, and the coastal region of west Libya (Fig. 18).

Conservation. The species does not seem to be endangered as it has a wide distribution range which is not strongly affected by human activities.

Comments. On the label of the *Graphipterus rotundatus* type, “Libye” is written; however, as far as it is known, C.G. Ehrenberg never succeeded in reaching Libya (Baker, 1997). There is only a very small chance that any other entomologist had collected *Graphipterus* in Lybia earlier than 1830.

Biology. The three larval stages develop during the summer inside ant nests. The first larval instar is nearly 4 mm long and creeps into nests of large ant species, digs there a chamber, preys on the ant’s brood and pupates within the nest. When the first larval instar tries to enter nests of small ants, it is attacked by the ants (Paarmann 1985; Dinter et al. 2002). The larval instars have a mandibular suctorial tube to suck hemolymph from their prey (Brandmayr 1994a, 1994b). Four specimens from the species studied by Wilfried Paarmann, Pietro Brandmayr, and their co-workers were examined; the material belongs to *G. rotundatus* and not to *G. serrator* as noted in their publications.

Graphipterus serrator **(Forskål, 1775): 77**

Figs 1, 3f, 4b, 4c, 5, 6a, 7, 9m, 10a, 14, 19, 26b, 28b, c, d

Carabus serrator Forskål, 1775: 77 (Aegypten)
Carabus variegatus Fabricius, 1781: 501 (Orient)
Carabus variegatus Fabricius, 1792: 147 (Orient)
Graphipterus serrator lobatus Alfieri, 1976: 15 [unavailable name]
Graphipterus serrator sexguttatus Alfieri, 1976: 15 [unavailable name]

Type material of *Carabus serrator*. Holotype: ♀ (White label with blue margin, black handwritten): <*Graphipterus* Latr./*serrator* Forsk./Aegypten>. Deposited in ZMUC [examined].

Type material of *Carabus variegatus*. Holotype: gender unknown (only fragments of a beetle preserved). (White label with black margin, black handwritten): < variegatus/ 824>. Deposited in ZMK [examined] (Fig. 28d).

Diagnosis. Large species with 10–12 isolated white round spots on elytra: anterior and posterior discal spots larger than other spots, six smaller spots near suture form circular pattern on disc; four white marginal extensions present, extension I triangular. Median lobe of aedeagus with ventrally bent tip.

Comparisons. *Graphipterus serrator* resembles *G. valdanii* from which it differs mainly by the following characters: *G. serrator*: mentum with three teeth, mid tooth shallow; PL/PW (0.72); BPW/HW (0.8); EL/EW rounded (1.18); elytra lateral margin wide as antennomere I long; Claws of hind legs dark. *G. valdanii*: mentum with three teeth, merges shallow and mid tooth bolt; PL/PW (0.64); BPW/HW (1); EL/EW elongated (1.3); elytra lateral margin wide as half antennomere I long; Claws of hind legs brown.

Description. BL male: 17–18 mm, average 17.6 ± 0.4 mm; BL female: 17.4–21.4 mm, average 19.3 ± 2 mm.

Head medium; HW/PW: 0.76; EYL: 1.6–1.8.0 mm; EYL/EL: 0.16. Mentum with three teeth, mid tooth shallow (Fig. 3f). Frontal ridge absent. In male, Apical white frons stripes slenderer than exposed frons (Fig. 4b). Pronotum wide; PL/PW: 0.58; BPW/PW: 0.65; posteromedially concave and without white margins; white lateral margin as wide as antennomere I long.

Elytra oval, humeri rounded; EL: 9.3–11.3 mm, average 10.3 mm; EW: 7.0–9.8 mm, average 8.4 mm; EL/EW: 1.2. Lateral cross section convex. Elytra with dense black scales, disc of elytra not visible between scales (Fig. 6a). White lateral margin nearly as wide as antennomere I long and with four extensions; extension I triangular with rounded angels, margin of elytra wider and shorter than extension II; the latter one elongated; at third quarter of elytra, imaginary line connecting the medial ends of the extension I and I parallel to the suture. White posterior margin forming gap at suture which is wider than lateral margin. Disc usually with 10, sometimes 12 round spots; anterior pair of spots circular to slightly elongate, narrower than extension I, larger than the six central spots forming a circular pattern; anterior and posterior pair of spots circular rounded, larger than other spots; small additional spots frequently present laterally to the posterior spots. Apical sinuation strongly developed, apex protruded, almost rectangular, only slightly rounded at most distant tip (Fig. 7a). Suture inconspicuous.

Legs long; MTIL: 4.8–7.4 mm, average 6.1 mm; El/MTIL: 1.7. Metatibial secondary spur dark. MTAL: 4.0–5.3 mm, average 4.6 mm; MTAL/MTIL: 0.8. Claws of hind legs black at base. Median lobe of aedeagus with ventrally bent tip (Fig. 9m).

Habitat. Very common in arid sandy habitats, it shows a significant habitat preference for the crest of shifting sand dunes (Fig. 14). It avoids stabilized interdunes and half-stabilized dune slopes (Renan et al. 2011). The sandy habitat in the western Negev sand dunes is poor in perennial woody plants with maximal coverage of 10–15% (Perry 2008; Siegal et al. 2013). The dominant perennial plants are *Retama raetam* (Fabaceae) and *Stipagrostis scoparia* (Poaceae).

Co-occurring species. *Graphipterus serrator* lives in sympatry with *G. multiguttatus* in Egypt and Israel.

Distribution. North-east Egypt (incl. Sinai) and Israel. In Israel it is restricted to the western Negev sand dunes (Fig. 19).

Conservation. The sand dunes in the western Negev suffer from two major threats: agricultural development that has caused a significant loss of the sands' range (Ben David and Avni 2013), and a stabilizing process of the shifting sand resulting from a bio-crust (Kidron and Abeliovich 2009). In the Sinai Peninsula, a lack of shrubs as a result of overgrazing threats the population.

Comments. The female holotype of *Carabus serrator* has been considered lost (Basilewsky 1977), but it was recently found by us in ZMUC (Fig. 28b–c). After studying the type material, we agree with Hůrka (2003), Lorenz (2005) and Huber and Marggi (2017), that *variegatus* (Fabricius 1792) falls within the morphological variability of *serrator*. Therefore *variegatus* is confirmed as a junior synonym of *serrator* (Fig. 28d). *Graphipterus serrator lobatus* and *G. serrator sexmaculatus* were considered by Alfieri (1976) as variations of *G. serrator*. Following the ICZN (1999, Article 45.6.3), a taxon that is described as a variation after 1960 is not valid. Moreover, no holotype has been designated. Therefore, both *lobatus* Alfieri and *sexmaculatus* Alfieri are not available names. One specimen from the western Negev sands was found with intermediate characters of *G. serrator serrator* and *G. multiguttatus*, and this specimen seems to be a hybrid between them: ♂ Israel, Holot Agur, May 2012, leg. I. Renan.

Biology. Adults emerge immediately after the first significant rainfall and inhabit sandy dunes or sand and loess plains and edges of salt lakes. In the spring following an average rainy winter, the species can densely populate the dunes (one observer

Figure 14. Habitat of *Graphipterus serrator*: Shifting sand dunes in the Western Negev Sands, Israel.

can locate up to 40 individuals within one hour). Their diet is based mainly on ants and occasionally on other small insects, as well as on dead insects and dead reptiles. Activity is limited by temperature: it begins at a soil temperature of approximetly 18 °C, and ceases at a soil temperature of approximetly 39 °C. By moving between sun-exposed microhabitats and the shadow of dwarf-shrubs can prolong the activity period. Strong wind halts activity due to the beetle's sensitivity to dehydration. Some activity also occurs in the afternoon, but it is significantly lower than in the morning peak hours.

Prior to commencing inactivity, the beetle digs a short burrow with a narrow elliptic cross-section into the dune's slope. The digging is performed mainly with the hind legs and secondarily with the middle legs. The well-developed, spoon-shaped metatibial spurs (see fig. 4a in Assmann et al. 2015) seem to function as a shovel. The burrow's opening usually collapses behind the beetle or is covered by shifting sand. In the burrow, a few centimeters below the sand surface, the beetle is relatively protected from predation and can probably still detect the outside temperature and light conditions. In enclosure experiments with individual markings and variation in population density, one of us found that even during the peak activity season, most of the specimens spend most of the days without displaying epigeic activity. An encounter between two individuals of any gender immediately develops into a short, hasty, bite battle and the escape of the loser. In some regions, shade is a limited resource and the battle occurs mainly under bushes and dwarf-shrubs. An encounter between male and female starts with an aggressive fight. The persistent male will then mount the back of the female. His forelegs grasp the female between the basal part of the pronotum and the elytral humeri, while the female tries to grab the male with her hind legs. The copulation lasts for approximately 30 minutes and occurs mostly beneath perennial vegetation. During the fight, the beetles stridulate. This sound is produced when the beetles are threatened by other individuals or by potential predators (Renan unpublished data, based on field observations and arena experiments).

Scraping record. Comparing *G. serrator*'s scraping spectrograms with those from its co-occurring species, *G. multiguttatus*, reveals clear differences in pulse intervals as well as in the sound pressure level (Fig. 10).

Graphipterus sharonae Renan & Assmann, sp. n.

http://zoobank.org/64BF5A31-99ED-4C75-A88F-3FB3144618B1
Figs 9n, 15, 19, 27a

Types. Holotype, ♂ (White labe, black typewritten): <51780 ISRAEL/ Karmiya N.P/ 7.4.2011/ I. Renan>. (red label): <Holotype>(ae). Deposited in SMNHTAU [examined].

Paratypes: (79♂, 70♀): All material collected in Israel. Ashdod: 6.V.2015, I. Renan (7♂, 14♀); 5.XII.2014, I. Renan (6♂, 3♀); 16.III.2011, (♂) (CAB); 3.IV.1998, H. Ackerman (♂) (SMNHTAU); 16.III.2011 leg. Th. Assmann, (♂,♀), W. Starke leg. (♂,♀) (CAB). Ashkelon [Ashqelon]: 7.IV.2017, I. Renan (6♂, 4♀) (SMNHTAU). Avshalom: 24.III.2012, M. Bologna (2♂) (AVTC). Ayalon: 1.IV.1943 (♂) (KCE). Bat Yam: 14.III.1940, Bytinski- Salz (3♂); 24.III.1940, Bytinski- Salz (2♂); 23.IV.1959, J. Wahrman (2♂, 2♀) (SMNHTAU). Bene' Berack [Bene Beraq]: 26.II.1954 (♂) (SMNHTAU). 'En Sarid: 22.IV.2015, I. Renan (2♀) (SMNHTAU). Holon: 14. IV.1981, A. Freidberg (♂) (SMNHTAU). Jaffa [Yafo]: 21.I.1900 (♀) (BMNH). Jaffa-Rehoboth [Rehovot]: 14.VII.1913, S.G.J. Aharoni (♂) (RMRAC). Karmiyya N.P: 07.IV.2011, I. Renan (4♂, 2♀) (SMNHTAU). MiqWeYisra'el: 14. IV.1934, F.S. Bodenheimer (♂, 3♀); 11.IV.1946, J. Wahrman (♀); 20. IV.1934, F.S. Bodenheimer (♂) (SMNHTAU). Nachalat Jischack, Palestina [Tel Aviv, Nahalat Yizhaq], 5.VI.1942, Housk (4♂) (NMP). Netanya: III.-IV. 1996, R. Rod (♀) (DWC); 15.II.1955, S. Nothiltz (♂); 11. IV.1957, J. Machlis (♂, ♀); 03.V.1997, R. Hoffman (♂, ♀); 04. IV.2010, I. Renan (5♂, 1ae, ♀) (SMNHTAU); III.IV.1996, leg. R. Rod (♀) (CWD); III.2016, leg. Th. Assmann (3♂, 4♀) (CAB). Nizzanim N.P: 29. IV.2015, Renan I. (14♂, 10♀); 19.V.2009, I. Renan (3♂,2ae, ♀); 15.V.2009, I. Renan (5♂, 2ae, 4♀,) 7.4.2011, I. Renan (♂ae) (SMNHTAU). 22.III.2012, M. Bologna (♂) (AVTC). 25.II.2009, L. Friedman (♀) (BMNH); 07.VI.2007, leg. J. Buse (♀) (CAB). Palmahim: 25.III.1978, Tedeschi (3♂, 1♀) (AVTC). Porat: 22.I.2015, I. Renan (♂); 09.IV.2014, I. Renan (5♂); 19.IV.2015, I. Renan (2♂); 22.IV.2015, I. Renan (8♂, 8♀) (SMNHTAU). Ra'ananna: 11.IV.1947, Bytinski-Salz

(♂) (SMNHTAU). 13.VI.1940, Bytinski-Salz (♀) (SMNHTAU). Rafha [Rafiah]: (♂) (ae) (BMNH). Rishon Leziyyon: 17.III.2003, M. Yogev (♂) (BMNH); 10.III.1942, Bytinski-Salz (♀); 29.VI.1979, D. Furth (♂); 1.III.1938 (♂) (SMNHTAU). Tel Aviv: 11.I.1900 (♂) (BMNH); 2.I.1900 (♂) (KCE). Ziqim N.P: 4.VI.2015, I. Renan (2♂, 4♀); 5.V.2015, I. Renan (♂, ♀); 7.IV.2011, I. Renan (2♂, 1♀) (SMNHTAU).

Diagnosis. Medium-sized species with 12–18 white elytral spots; the anterior and central ones usually elongated, the posterior ones rounded; six marginal extensions, extension II triangular. Median lobe of aedeagus with bent tip.

Comparisons. *Graphipterus sharonae* sp. n. resembles *G. multiguttatus*, from which it differs mainly by the following characters: *G. sharonae* average body length 13mm; extension slightly elongated 1; median lobe of aedeagus short, unbent tip. *G. multiguttatus* average body length 17.05 mm; extension I triangular; median lobe of aedeagus with bent tip. *Graphipterus sharonae* resembles also *G. reymondi*, from which it differs mainly by the following characters: *G. sharonae* sp. n. mentum with two teeth, humeri rounded, 12–18 spots on elytra, widest line of elytra located at middle, elytra disc not seen, and elytra scales black while *G. reymondi* has the mentum with three teeth, humeri narrowed, 20–24 spots on elytra, widest line of elytra located at interior rear third, elytra disc seen, and elytra scales brown.

Description. BL male: 15.0–18.0 mm, average 16.5 ± 0.8 mm; BL female: 16.0–193 mm., average 17.6 ± 0.8 mm;

Head medium; HW/PW: 0.74 mm; EYL: 1.2–1.7 mm; EYL/EL: 0.15. Mentum with two teeth and shallow depression between (cf. Fig. 3b). Frontal ridge slightly developed. In male, apical white frons stripes wider than exposed frons (Fig. 4b).

Pronotum cordiform; PL/PW: 0.66; BPW/PW: 0.66; posteromedially concave and without white margin; white lateral margin as wide as antennomere I long.

Elytra oval, humeri rounded; EL: 8.1–10.3 mm, average 9.2 mm; EW: 6.2–8.8 mm, average 7.8 mm, (EL/EW: 1.3). Lateral cross section flat. Dense black scales, disc not visible between scales (Fig. 6a). White lateral margin as wide as half antennomere I long and with six extensions; extension I triangular with rounded angels, as wide as or wider than elytra margin, wider and shorter than extension III; extension II smaller and usually shorter than two other ones; extension III often constricted at base. White posterior margin almost continuously rounded, only slightly becoming narrower, gap at suture smaller than lateral margin. Disc with 14, sometimes 12 or 18 spots; most anterior pair of spots slightly elongate to rounded, usually wide as extension I, second anterior pair of spots strongly elongate, nearly two times as long as wide; the two lateral pairs of spots rounded, adjacent or sometimes fused to extension II; the tow to four posterior pairs of spots rounded; the medial, most posterior pair of spots larger than all other spots; the outer most posterior pair of spots much smaller than the latter one. Apical sinuation slightly developed to straight, apex not protuberant, broadly rounded, especially on the medial side (Fig. 7c). Suture conspicuous.

Legs long; MTIL: 4.9–6.1 mm, average 5.6 mm; El/MTIL: 1.7. Metatibial secondary spur brown. MTAL: 4.0–5.0 mm, average: 4.5 mm; MTAL/MTIL: 0.8. Claws of hind legs black at base.

Median lobe of *aedeagus* with bent tip (Fig. 9n).

Etymology. The species is dedicated to Sharon Renan, biologist, conservationist, and the first author's wife.

Habitat. In sand dunes and on calcareous sandstone habitats along the coast. Low, mostly vegetated and stabilized sand dunes are the preferred habitat (Ramot 2008). Individuals are active as far as 50 meters from the shoreline, but seem to be more common further inland. The average annual rainfall in the coastal plain is approxemetly 450 mm (I.M.S, 2016). The dominant perennials of the habitats in Israel are *Artemisia monosperma* and *Helianthemum stipulatum* (Fig. 15).

Co-occurring species. No sympatrically occurring species.

Distribution. Endemic to the Mediterranean coastal plains from north-east Sinai (El Arish) to central Israel south of Nahal Alexander (Fig. 19).

Conservation. The coastal plain sand dunes of Israel form the largest part of the entire distribution range of *G. sharonae* sp n. As a result of land use changes and urbanization, less than 25% of the Israel sandy habitats remain and a further decline can be expected. In addition, the remaining dune habitats are under extreme anthropogenic disturbance and highly fragmented (Achiron-Frumkin et al. 2003). The following records are examples of sites that were populated by *G. sharonae* sp. n. in the past, but where their populations no longer exist: Kefar Bilu, Rehovot, Nes Ziyyona, Bat Yam, Holon, Tel Aviv, Ramat Gan, Bene Beraq, Ra'ananna, Yafo (based on SMNHTAU collection and the authors' experience).

Despite having no precise data, the habitats in the Gaza Strip and north-eastern Egypt seem also to have declined as these areas feature a strong increase in human population density. In a faunistic survey of the ground beetles of the Sinai Peninsula, Abdel-Dayem et al. (2004) did not record *Graphipterus* from El-Arish, where it had been present nearly a century ago (records in London, cf. Schatzmayr 1936). El Surtasi et al. (2012) demonstrated the negative effect of urbanization on *G. serrator* population in Egypt. Both the restricted distribution range of the endemic species *G. sharonae* sp. n. and the decline in coastal sandy habitats threaten the long-term survival of the species.

Biology. Seasonal and daily activity time, as well as diet, intraspecific behavior, including copulation and the chirping sounds produced by the stridulatory structure, are as in *G. serrator*. *Graphipterus sharonae* sp. n. prefers stabilized sands with high vegetation cover, and its population density is higher than that of *G. serrator*.

Graphipterus stagonopsis Renan & Assmann, sp. n.

http://zoobank.org/435E6626-47B0-4701-A57C-45E23959B7AD

Figs 18, 27b

Types. ***Holotype***. ♂ (White label, black handwritten): <Beni Abbes/23.III.48 F. Pierre>. (red label): <Holotype> (ae). Deposited in NHMP [examined].

Paratypes. (11♂, 3♀), NHMP (Colas collection): Gardhaia (Ghardaia), Sahara, G. Mahoux, 19.5.60 (2♂); Beni Abbes, 23.3.48, F. Paiu (2♂, 1- ae). (Negre collection):

Figure 15. Habitat of *Graphipterus sharonae* sp. n.: Stabilized sand dunes with rich vegetation. Nizzanim, Israel.

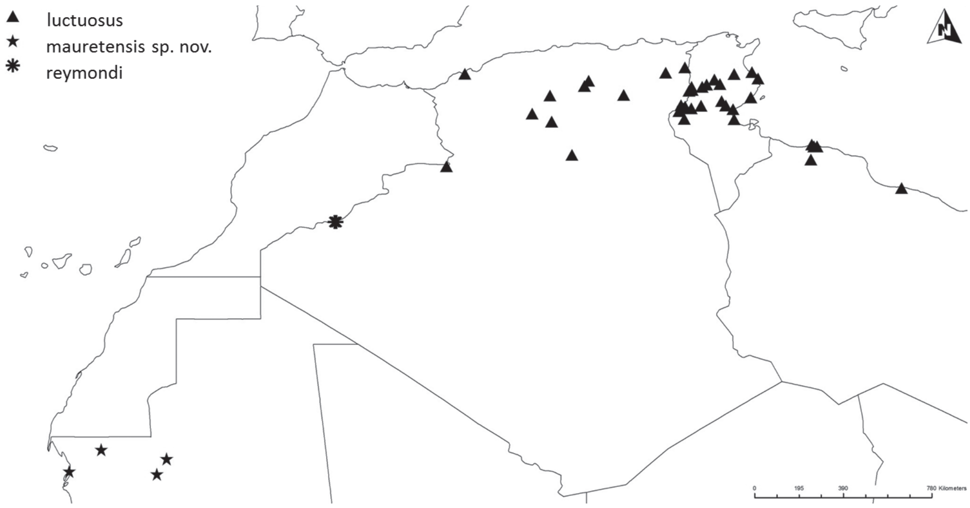

Figure 16. Distributional records of *G. luctuosus*, *G. mauretensis* sp. n., and *G. reymondi*.

Beni Abbes, Sahara argelino, J. Mateu (3♀). (Antoine collection): Beni Abes, south Algerien (reymondi) (♂ae). ZMUC Algerie, Beni Abbes, 11.3.1984, Tilg. 4-12.1948, Tentens-Nielsen [*G. serrator valdani* Guer. P. Basilewsky 1985] ♂. NMP: Algeria, Igli,

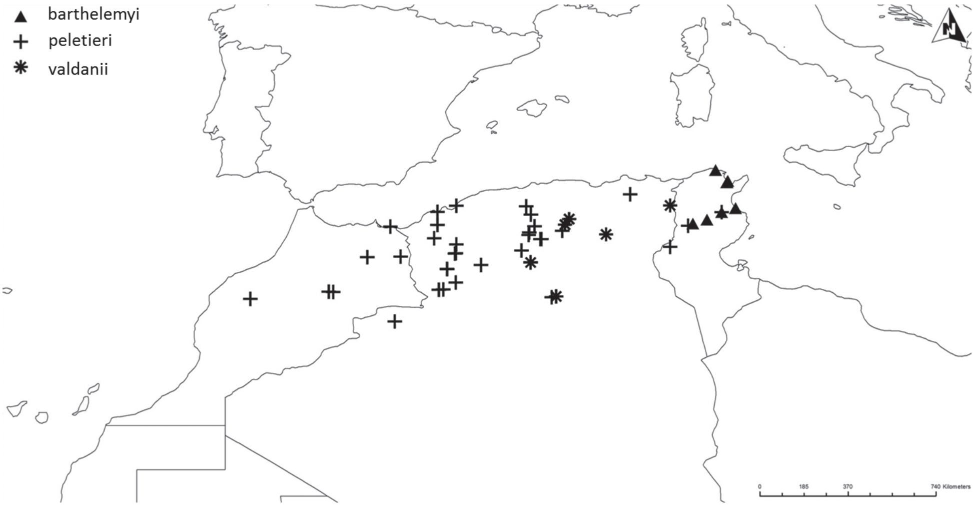

Figure 17. Distributional records of *G. barthelemyi*, *G. peletieri,* and *G. valdanii.*

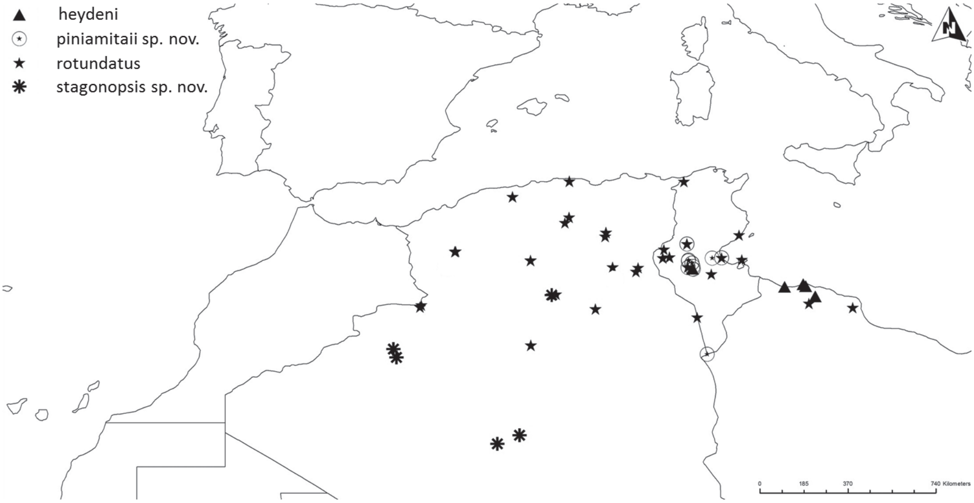

Figure 18. Distributional records of *G. heydeni*, *G. piniamitaii* sp. n., *G. rotundatus,* and *G. stagonopsis,* sp. n.

12.IV. 1988, Igt. Kepler, 11/1988. Ex call. M. Dvorak, National Museum, Prague, Czech Republlic. MRAC: Aoulel el Arab Tidicelt Sahara Cen., J. Mateu (♂); Pozo zug (R.O.) Sa’hara espanol, J. Mateu (2♂); Oasis de la-Salah Tidikelt Sahara Cen, J. Mateu (3♂).

Diagnosis. Large species with 16 white rounded to elongated spots on elytra, anterior and posterior pair of spots larger than others; six marginal extensions, extension

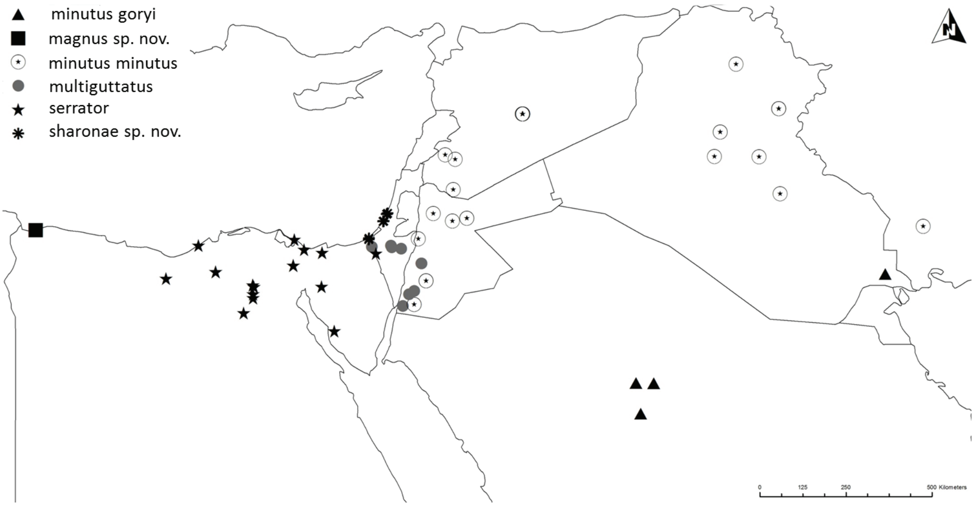

Figure 19. Distributional records of *G. minutus minutus*, *G.minutus goryi*, *G. magnus* sp. n., *G. multiguttatus*, *G. serrator,* and *G. sharonae* sp. n.

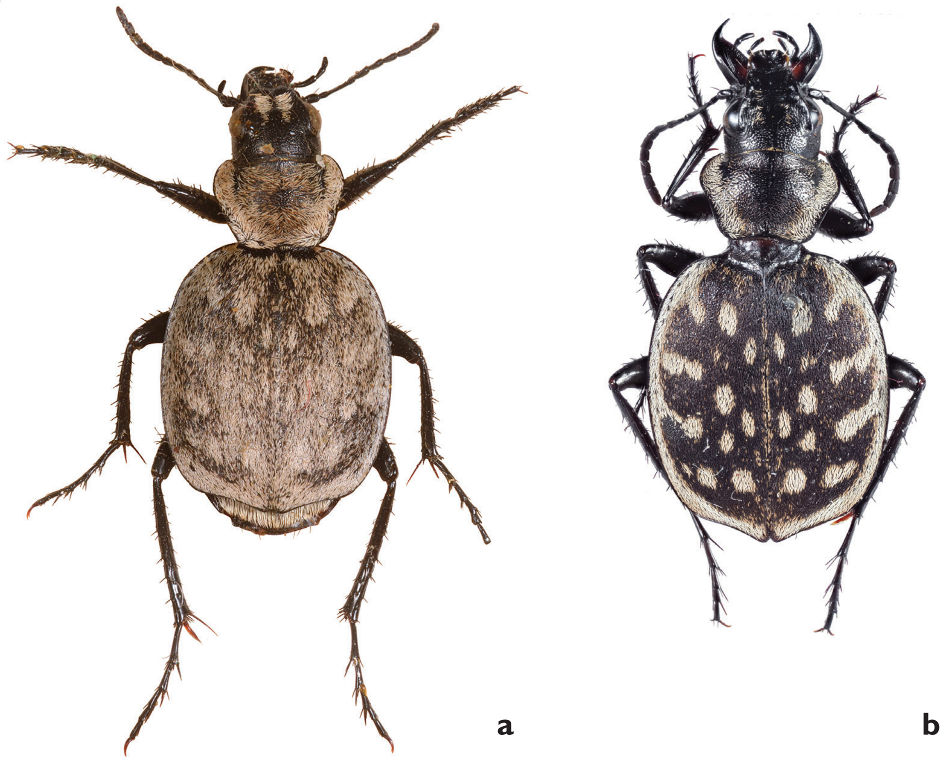

Figure 20. Dorsal habitus of *Graphipterus*: **a** *G. barthelemyi* with greyish scales phase **b** *G. barthelemyi* without grayish scales.

Coll. Krautz

Tripolis

Heydeni Krtz
luctuosus Guer
Tripolis. Aud

G. serrator
heydeni Kr.

serrator
heydeni Kr.
P. Basilewsky det., 1975

DEI Müncheberg
Col - 01309

Figure 21. Dorsal habitus of *Graphipterus*: **a** *G. heydeni* **b** *G. luctuosus* **c** *G. heydeni* lectotypes' lables (ZSM).

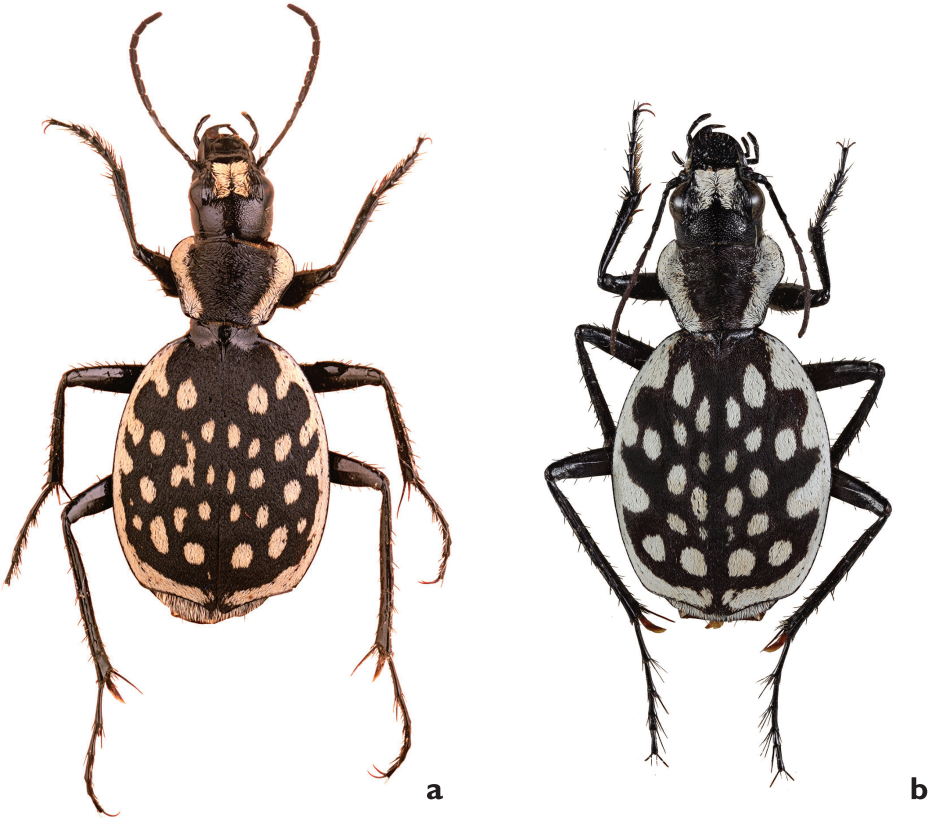

Figure 22. Dorsal habitus of *Graphipterus*: **a** *G. magnus* sp. n. **b** *G. mauretensis* sp. n.

I triangular, extension I and II elongated. Elytra widest at interior rear third, drop-like shape. Median lobe of aedeagus with slightly bent tip.

Comparisons. *Graphipterus stagonopsis* sp. n. resembles *G. reymondi* from which it differs mainly by the following characters: G. *stagonopsis* sp. n.: mentum with two teeth; eight spots on elytra; scales of elytral disc brown; claws of hind legs and metatibial secondary spur dark . *G. reymondi*: mentum with three teeth; 10–12 spots on elytra; scales of elytral disc black; claws of hind legs and metatibial secondary spur brown .

Description. BL male: 17.2–20.1 mm, average 18.8 ± 1 mm; BL female: 18.4–19.8 mm, average 18.9 ± 0.6 mm.

Head slender; HW/PW: 0.7; EYL 1.1–1.7 mm; EYL/EL: 0.16. Mentum with two teeth (Fig. 3b). Frontal ridge slightly developed. Male, apical white frons stripes wider than exposed frons (Fig. 4b).

Pronotum strongly cordiform; PL/PW: 0.66. BPW/PW: 0.64; posteromedially concave and without white margin; white lateral margin as wide as antennomere I long.

Elytra droplet-like, humeri strongly narrowed; EL: 9.1–11.1 mm, average 8.4 mm; EW: 7.5–9.0 mm, average 8.4 mm; EL/EW: 1.1–1.5. Lateral cross section convex.

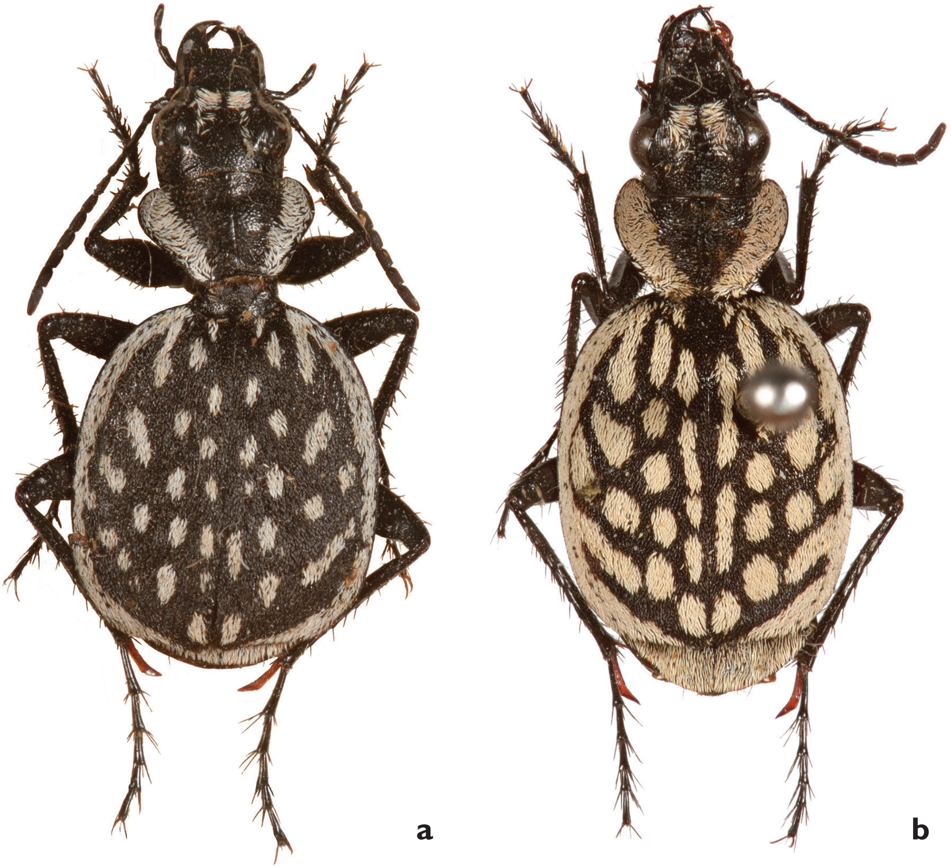

Figure 23. Dorsal habitus of *Graphipterus*: **a** *G. minutus minutus* **b** G. *minutus goryi.*

Dense black scales, disc not visible between them (Fig. 6a). White lateral margin nearly as half wide as antennomere I long and with six extensions; extension I triangular with rounded angels, as wide as lateral margin, posteriorly oriented; extension II small, often constricted at base, as wide as lateral margin; extension III large, elongated, posteriorly oriented. White posterior margin becomes narrower towards suture; gap at suture wider than lateral margin. Disc usually with 16 spots; anterior pair of spots elongate, as wide as extension I; posterior pair of spots rounded and larger than other ones; six spots forming arch pattern anterior and lateral to posterior rounded larger spots. Apical sinuation slightly developed to straight, apex not protuberant, broadly rounded, especially on the median side (Fig. 7c). Suture inconspicuous.

Legs long; MTIL: 6.0–7.0 mm, average 6.5 mm; El/MTIL: 1.6. Metatibial secondary spur black. MTAL: 4.7–5.3 mm, average 4.9 mm; MTAL/MTIL: 0.8. Claws of hind legs black at base.

Median lobe of *aedeagus* with bent tip (Fig. 9o).

Etymology. The name is derived from ancient Greek (*σταγών*, *όψις*) and means ”drop-like” which refers to the shape of the elytra.

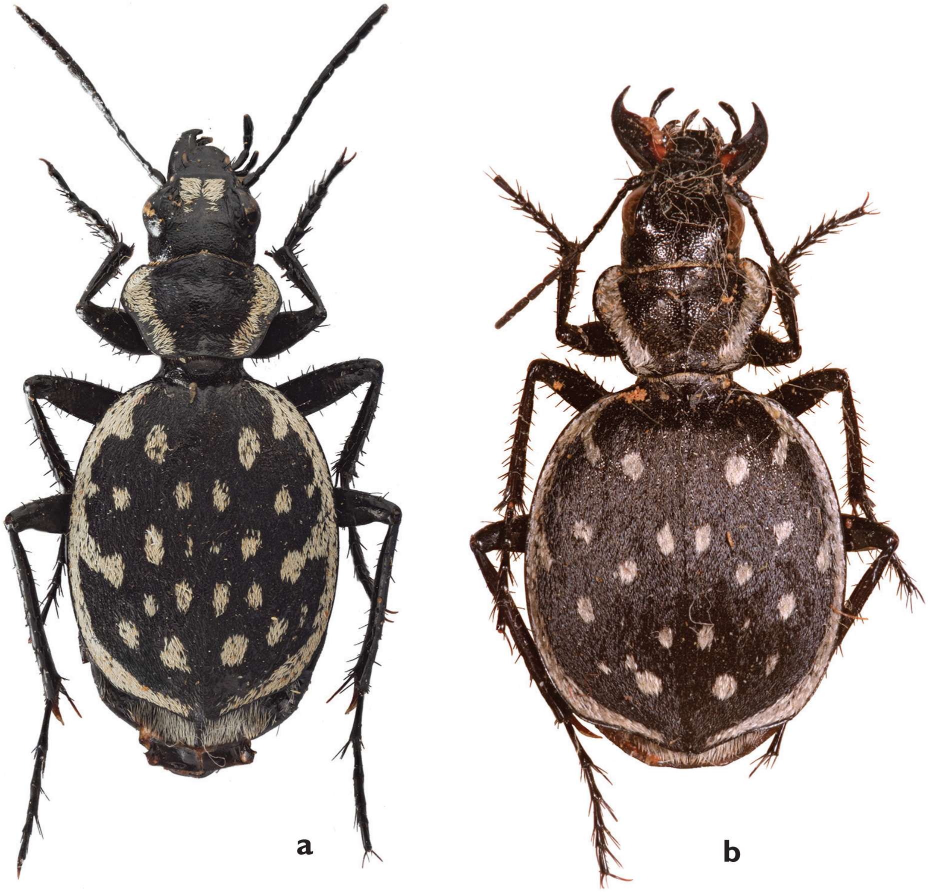

Figure 24. Dorsal habitus of *Graphipterus* **a** *G. multiguttatus* **b.** *G. peletieri.*

Habitat. Unknown.

Co-occurring species. *Graphipterus stagonopsis* lives in sympatry with *G. luctuosus, G. peletieri,* and *G. valdanii* in Ghardaia, Algeria.

Distribution. Central and west Algeria (Fig. 18).

Conservation. Unknown.

Graphipterus valdanii Guérin-Méneville, 1859: 534, stat. rest.

Figs 3a, 17, 28a

Types. ***Neotype.*** ♂ (White label, black handwritten): < Bou saada/ Oherthur R.>. (ae). Deposited in NHMP, General collection. (Red label, black typewritten): < Neotypus *Graphipterus valdanii* Guérin-Méneville, 1859/ des. I. Renan, 2018>.

Neoparatypes. NHMP (General collection): Baniou, Vibert L. (♂,♀); Bou saada, 1875, Oberthur R. (2♂); Bou saada, Oberthur R. (♂); Bou saada, Dr Martin (♂). (Negre collection): Algeria (♂); Bou Saada (♂); Bou Saada, Dr Martin (♀); BMNH:

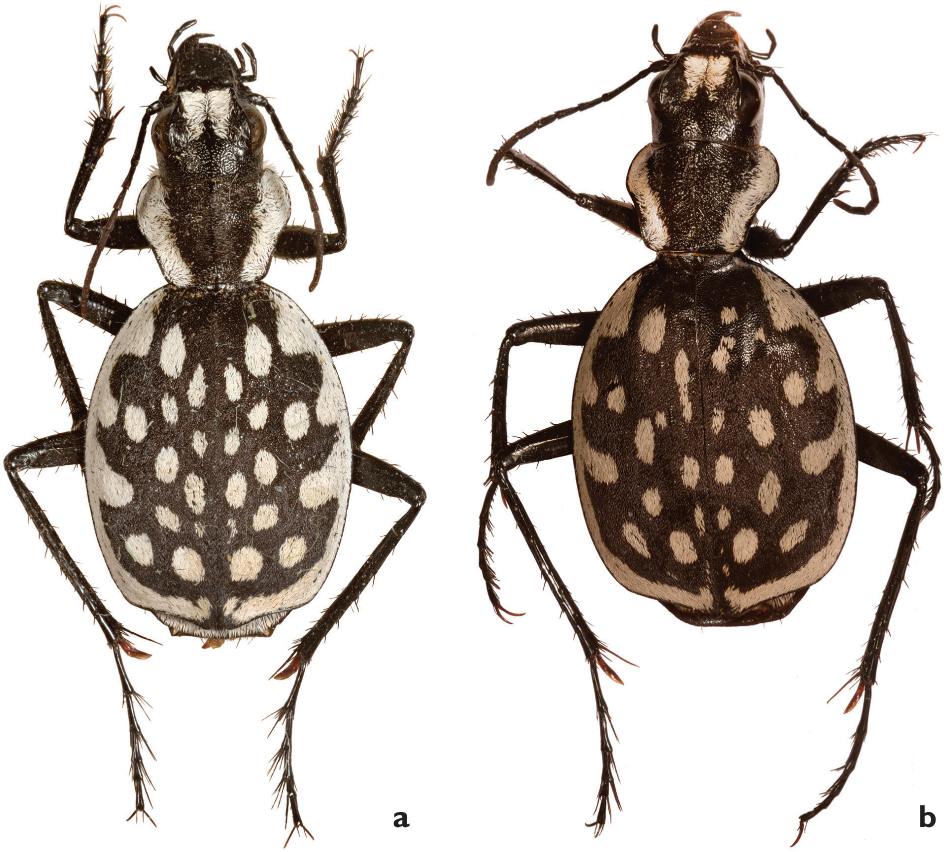

Figure 25. Dorsal habitus of *Graphipterus*: **a** *G. piniamitaii* sp. n. **b** *G. reymondi.*

Bou-Saada, 1875, Oberthur R. (2♂). MRAC: Bou Saada, P. Basilewsky (♂); Bou saada, Dr Martin (♂). DEI: Bou Saada, O. Leonhard / Dr Martin (♂); ZMUC: Bou Saada, 28.4.1927 (♀); (uc) (♂);

Diagnosis. Large species with 10–16 white round spots on elytra; anterior and posterior discal spots larger than other spots; four white marginal extensions, oval elytra, extension I triangular. Median lobe of aedeagus with bent tip.

Comparisons. *Graphipterus valdanii* resembles *G. serrator* (see comparisons in *G. serrator*) and *G. heydeni* (see comparisons in *G. heydeni*).

Description. BL male: 14.8–19.0 mm, average 17.1 ± 1.7 mm; BL female: 18.6–20.5 mm, average 18.6 ± 1.9 mm.

Head slender; HW/PW: 0.71; EYL: 1.4–1.8 mm; EYL/EL: 0.15. Mentum with mentum with two teeth as margin between them slightly convex in middle (Fig. 3c). Frontal ridge slightly developed. In male, apical white frons stripes slenderer than exposed frons (Fig. 4a).

Pronotum cordiform; PL/PW: 0.64; BPW/PW: 0.7; posteromedially concave and without white margin; white lateral margin as wide as antennomere I long.

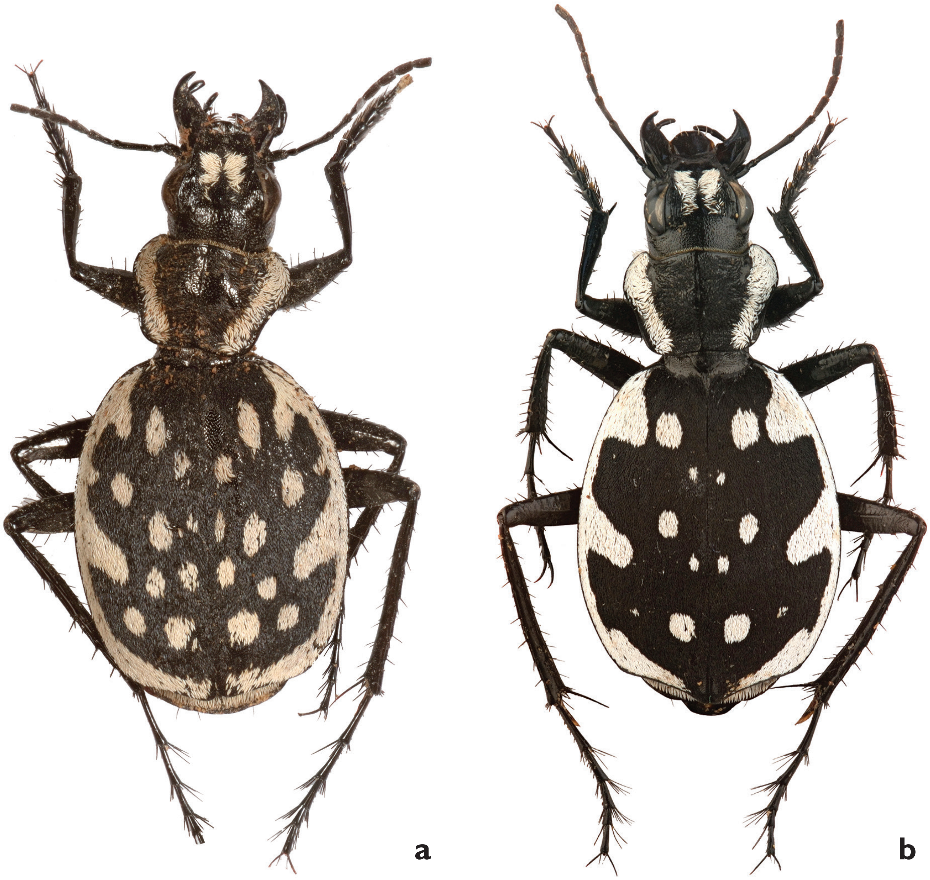

Figure 26. Dorsal habitus of *Graphipterus*: **a** *G. rotundatus* **b** *G. serrator.*

Elytra oval, relatively elongated, humeri rounded; EL: 8.1–12 mm, average 10.6 mm; EW: 6.5–9.1 mm, average 8.0 mm; EL/EW: 1.3. Lateral cross section convex. Dense black scales, disc not seen between scales (Fig. 6a). White lateral margin as wide as half antennomere I long and with four extensions; extension I triangular with rounded angels, much wider than lateral margin, but shorter than extensionII; the latter one elongated, positioned at second third of elytra. Apical sinuation strongly sinuated, apex strongly protruded, forming almost a rectangular. White posterior margin evenly rounded, not becoming narrower towards the suture; gap at suture wider than lateral margin. Disc with (10–) 14 (–16) spots; anterior pair of spots rounded to slightly elongate, much smaller than extension I; anterior and posterior pair of spots round, larger than other spots; small additional spots located medially to extension II and laterally to posterior spots. Apical sinuation strongly developed, apex protruded, almost rectangular, only slightly rounded at most distant tip (Fig. 7a). Suture inconspicuous.

Legs long; MTIL: 4.9-7.0 mm, average 6.3 mm; El/MTIL: 1.7. Metatibial secondary spur dark. MTAL: 5.4-6.9 mm, average 6.0 mm; MTAL/MTIL: 0.72. Claws of hind legs brown at base.

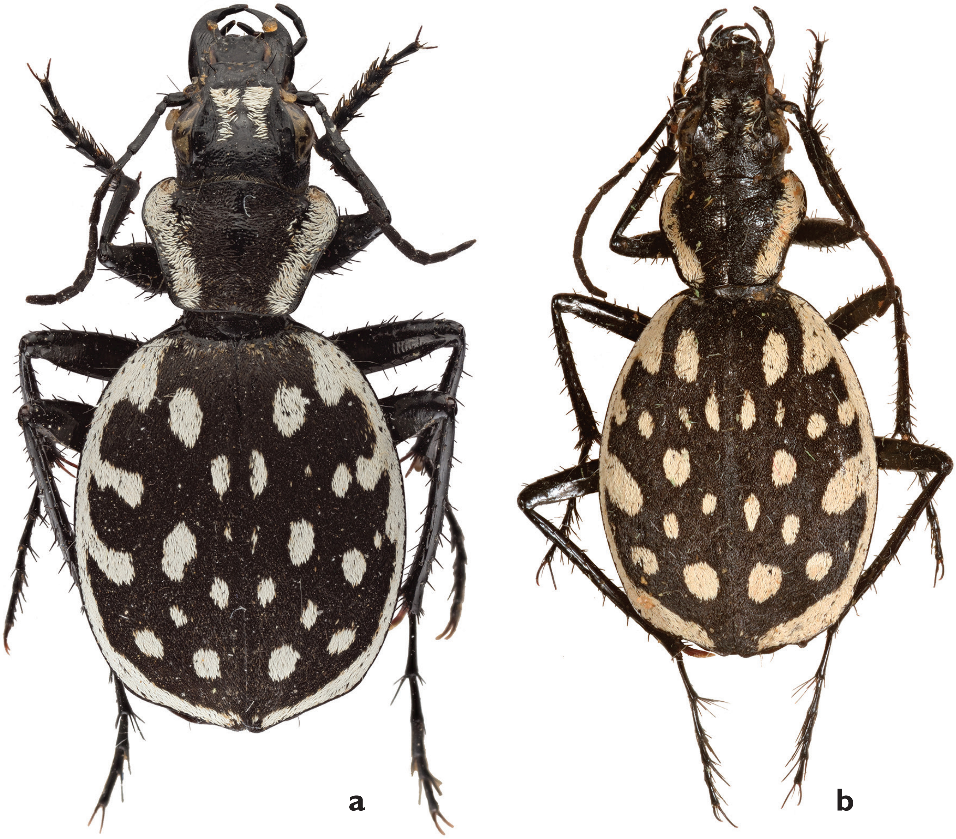

Figure 27. Dorsal habitus of *Graphipterus*: **a** *G. sharonae* sp. n. **b** *G. stagonopsis* sp. n.

Median lobe of *aedeagus* with bent tip (Fig. 9p).

Habitat. Unknown.

Co-occurring species. *Graphipterus valdanii* lives in sympatry with *G. peletieri*, *G. luctuosus*, *G. rotundatus*, and *G. stagonopsis* in Algeria.

Distribution. The arid and semi-arid regions of north-east Algeria from Ghardaia, to Bou-Saada and Tebessa (Fig. 17).

Conservation. Unknown.

Comments. Guérin-Méneville described *G. valdanii* as a new species in 1859. Chaudoir (1870: 296), having seen the types that had been collected in Algeria and compared them with *G. serrator* from Egypt, contending that they differed in elytral shape and were a local variation of *G. serrator.*

The type of *valdanii* is lost. Our attempts to find any specimen from the typical series in several museums (incl. NHMP) was unsuccessful, as Guèrin's collection was sold and his material appears to be unavailable (Thierry Deuve pers. comm.). Chaudoir (1870) used *G. valdanii*, but Guérin-Méneville introduced the species as *G. valdani* (sic). Since then, Chaudoir's spelling has appeared in most of the literature that deals with this species.

Graphipterus Latr.
serrator Forsk
Aegypten F.S.

Figure 28. Dorsal habitus of *Graphipterus*: ***a*** *G. valdanii* **b** *G. serrator* holotype (ZMUC) **c** *G. serrator* holotypes' label **d** *Graphipterus variegatus* holotype (ZMUC).

Identification key

1 Stridulatory structure (ventrolaterally on elytral margin and carina on inner side of metafemur) present; pronotum posteriorly concave; median lobe of aedeagus with long curved tip or short, not curved tip (Fig. 9a–f, i–p)........**2**

– Stridulatory structure absent; pronotum posteromedially not concave; median lobe of aedeagus with wide and flat tip (Fig. 9f, g) **15**

2 White scales on pronotum restricted to lateral margin (Figs 20–24 except 20a, 20b); elytra and pronotum without grayish or yellowish scales; elytra with white spots and extensions well contrasted to the dark background.....**3**

– Pronotum with white scales extending medially, sometimes to median line (Fig. 20a, b); elytra and pronotum often with grayish or yellowish scales; white spots and extensions on elytra not well contrasted to the dark background. Distribution: north-east Tunisia..............................***G. barthelemyi***

3 Distribution: Egypt and eastwards. **4**

– Distribution: Libya and westwards...**7**

4 Lateral margin of elytra with six extensions; anterior and posterior spots not larger than others; suture conspicuous; apical gap at suture smaller than elytral lateral margin.......... **5**

– Lateral margin of elytra with four extensions; anterior and posterior spots larger than others; no conspicuous suture; apical gap at suture wider than elytral lateral margin .... ***G. serrator***

5 Elytra with 20-24 spots; aedeagus long and thin, with slightly bent tip (Fig. 9d). Distribution: west of the Nile (exclusively known from the north-west Egyptian coast, perhaps also in north-east Libya) ....***G. magnus* sp. n.**

– Elytra with 12-18 spots; aedeagus with strongly bent or unbent tip (Fig. 9 except 9d, f, g). Distribution: east of the Nile **6**

6 Extension I triangular; aedeagus with strongly bent tip (Fig. 9n). Distribution: exclusively in the sandy coastal plain of Israel and north-east Egypt, perhaps also in Gaza Strip..........***G. sharonae* sp. n.**

– Extension I elongated; aedeagus short with unbend tip (Fig. 9h). Distribution: Sinai Peninsula, Israel, and Jordan ....***G. multiguttatus***

7 Distribution: Morocco, Mauritania.......... **8**

– Distribution: Algeria, Tunisia, Libya **9**

8 Mentum with three teeth (Fig. 3d); elytra wider at rear; humeri strongly narrowed; anterior and posterior spots not larger than others; elytra with dark-brown scales; disc of elytra visible between the scales; aedeagus with bent tip.......... ***G. reymondi***

– Mentum with two teeth (Fig. 3b); elytra relatively elongated oval; humeri slightly narrowed; anterior and posterior spots larger than others; elytra with black scales; disc of elytra not visible between scales; aedeagus short, with unbent tip (Fig. 9e)..........***G. mauretensis* sp. n.**

9 Elytra with dark brown scales, disc of elytra visible between them (Fig. 6b); elytral extension I elongated.......... **10**

– Elytra with black scales, disc of elytra not visible between them (Fig. 6a); elytral extension I triangular.......... **11**

10 Three marginal extensions; series of 8-12 elongated spots along suture, forming a broken line; suture conspicuous; apex gap at suture thinner than elytral lateral margin; aedeagus with bent tip (Fig. 9d) .... ***G. luctuosus***

– Two marginal extensions; small isolating spots scattered on disc, generally a black beetle; suture not conspicuous; apical gap at suture wider than elytral lateral margin; aedeagus short unbent tip (Fig. 9i) ....***G. peletieri***

11 Elytra widest at the posterior third of the elytra, drop-like shape, humeri narrowed; apical sinuation slightly developed.......... ***G. stagonopsis* sp. n.**

– The widest horizontal line of the elytra is at the middle of the elytra, creates an orb form, humeri rounded; subapical sinuation well developed.......... **12**

12 Anterior and posterior spots larger than others; apical gap at suture wider than elytral lateral margin; suture not conspicuous **13**

– Only posterior spots larger than others; apical gap at suture thinner than elytral lateral margin; suture conspicuous.......... **14**

13 Elytra with 18–26 spots; mentum with two teeth with concavity between them (Fig. 3b); frontal ridge absent. Distribution: vicinity of Tripoli, Libya.. .... ***G. heydeni***

– Elytra with 10–16 spots; mentum with two teeth as margin between them slightly convex in middle (Fig. 3c); frontal ridge slightly developed. Distribution: Algeria.. ***G. valdanii***

14 Elytra with 24 spots; most spots wider than lateral margin; lateral cross section quite flat. Distribution: central Tunisia, from the vicinity of Kebili to Gabès.. ***G. piniamitaii* sp. n.**

– Elytra with 16–22 (usually 18) spots; most spots thinner than lateral margin; lateral cross section convex. Distribution: Algeria, Tunisia and the coastal region of west Libya.. ***G. rotundatus***

15 Elytra with 36–40, mostly rounded white spots, including a series of 10–14 round spots along median suture; lateral margin of elytra with two extensions. Distribution: Syria, Jordan, Saudi Arabia, Iraq and western Iran .... ***G. minutus minutus***

– Elytra with approx. 30, mostly elongated white spots, usually with several spots fused with lateral margin, and with a series of 10 elongated spots, usually fused to each other along median suture; lateral margin of elytra with six extensions. Distribution: Iraq and Iran .... ***G. minutus goryi***

Discussion

Species delimitation

The *Graphipterus serrator* group shows a high divergence that is exceeded by only a few other species groups of the genus *Graphipterus* (e.g., *G. sennariensis* group, Lorenz 2005). The results of the present study now re-divide the previously "polytypic species" *Graphipterus serrator* from comprising one species with six subspecies, as classified by Basilewsky (1977), the author of the last revision of this genus, into 14 species. Some of Basilewsky's subspecies have been accepted by Lorenz (2005) and Huber and Marggi (2017) as species. However, these authors did not show any methodological procedure for their decisions (cf. Assmann et al. 2008) and they still accept *Graphipterus serrator* as one species with an extraordinarily large distribution range from Morocco to the southern Levant. The strong increase in species number suggests that the overall number of all insect species, especially beetles, is still underestimated, also in the western Palaearctic. This finding corresponds with other recent findings regarding beetle diversity: e.g., the remarkable increase in beetle species numbers from the western Palaearctic demonstrated by Hendrich et al. (2015), who used DNA barcoding and found numerous overlooked species, even in Central Europe. A macroecological approach suggested that many species from certain parts of the Palaearctic region have been overlooked and an underestimated species number is also assumed for less studied regions (see Schuldt et al. 2009).

Furthermore, the remarkable re-division since the time of Basilewsky (1977) from one species to 14 includes eight re-rankings of historically described species while only five taxa are new to science. Although the total species number of this species group seems to be high, it should be taken into account that the authors do not know of any other wingless Palaearctic ground beetle species that covers a distribution range with a linear expansion of at least ca. 5,500 km, as does *G. serrator* (sensu lato) according to Basilewsky (1977), Lorenz (2005) and Huber and Marggi (2017). In general, the distribution range of flightless ground beetle species is much smaller (cf. Homburg et al. 2013, Homburg et al. 2014). Nearly two-thirds of the western Palaearctic carabid species are endemics, with distribution ranges smaller than ca. 6 × 105 km^2 (Schuldt and Assmann 2009). Almost all are flightless as the species of the *Graphipterus serrator* group. The distribution ranges of the species as classified after our numerical taxonomic approach fall mostly into the range indicated by Schuldt and Assmann (2009).

One of the weaknesses of both classical and modern taxonomy lies in the definition of an objective decision by which to delimit species, although there seems to be a common ground across many species concepts as to what a species means (Hey 2006). In some cases an increase of species numbers occurs due to the application of different species concepts, as recently discussed for several mammalian taxa (e.g., Zachos 2013). This so-called taxonomic inflation is also known from ground beetles, especially in those cases where allopatric taxa have been elevated from subspecies to species level without the provision of any new findings or a discussion of the reasons for these decisions (Assmann et al. 2008). However, the re-division of the *Graphipterus serrator* group is the only reasonable response to Basilewsky's previous "lumping" approach. Our decisions were based on a consistent consequence of the application of our threshold value derived from the number of diagnostic characters of sympatrically occurring taxa (Table 1). This approach constitutes an objective method for species delimitation decisions; and one that we propose also be applied for further taxonomic analyses with both sympatric and allopatric taxa.

The decision not to give a different "weight" to pattern and morphological diagnostic characters was based on the problem of defining the "exact right weight". However, it is important to emphasize the characteristics of the pairs with the lowest diagnostic characters in the matrix: the sympatric pair *luctuosus* and *peletieri* which has been defined as the threshold for delimiting a "good" species, are diagnostic with six characters, five of which are pattern characters, but the shape of the median lobe of aedeagus differs in both species. Another pair with a low diagnostic character number is the allopatric species *serrator* and *valdanii*, also with six characters. However, four of these characters are morphological. The taxa *minutus* and *goryi* are ranked as subspecies as they differ from one another by only four diagnostic characters. No sympatric *Graphipterus* species pair of the *serrator* group is known to have so small morphological and coloration differentiation.

Endangered taxa in the *Graphipterus serrator* group

Our approach revealed several threatened species, both sympatric and allopatric. Some of them show very small distribution ranges and their habitats have undergone strong losses and fragmentation, such as those of the coastal dune habitats in the southern Levant. For those taxa, the relevant countries, as for example Israel, have special responsibility for their protection as the taxa do not occur anywhere else than in the given country. The coastal plain in Israel, for example, is inhabited by 30 endemic and 118 red list species of vascular plants (Shmida et al. 2011). *Graphipterus sharonae* sp. n., along with the weevil *Achradidius ochraceus* (Tournier, 1874) are the only insect species that have been studied and classified as endemics of the given region, but future studies will probably find additional ones (Friedman pers. comm.).

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CHECKLIST

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Amphibians and reptiles of the state of San Luis Potosí, Mexico, with comparisons with adjoining states

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Abstract

A summary of the species of amphibians and reptiles of the state has been compiled, including their geographic distributions, habitats, and conservation statuses. The herpetofauna of San Luis Potosí consists of 41 species of amphibians and 141 species of reptiles. San Luis Potosí shares the highest number of species with Hidalgo and Tamaulipas, and the least number of species with Nuevo León. In San Luis Potosí, there are several taxa of particular conservation concern including salamanders, emydid and trionychid turtles, anguid and xenosaurid lizards, and natricid and colubrid snakes.

Keywords

Checklist, Chihuahuan Desert, conservation status, herpetofauna, shared species, Sierra Madre Oriental

Introduction

San Luis Potosí is a relatively small state (surface area = 63,068 km^2, 3.1% of the surface area of Mexico) located in the north-central part of Mexico, between 24°29' and 21°10'N and 98°20' and 102°18'W (see Figure 1; INEGI 2009). The climate of San Luis Potosí varies from the temperate, dry high plains to the warm, relatively humid coast (Lemos-Espinal and Dixon 2013). Several distinctive habitats are found within the boundaries of the state, including the Chihuahuan Desert in the western half and tropical perennial

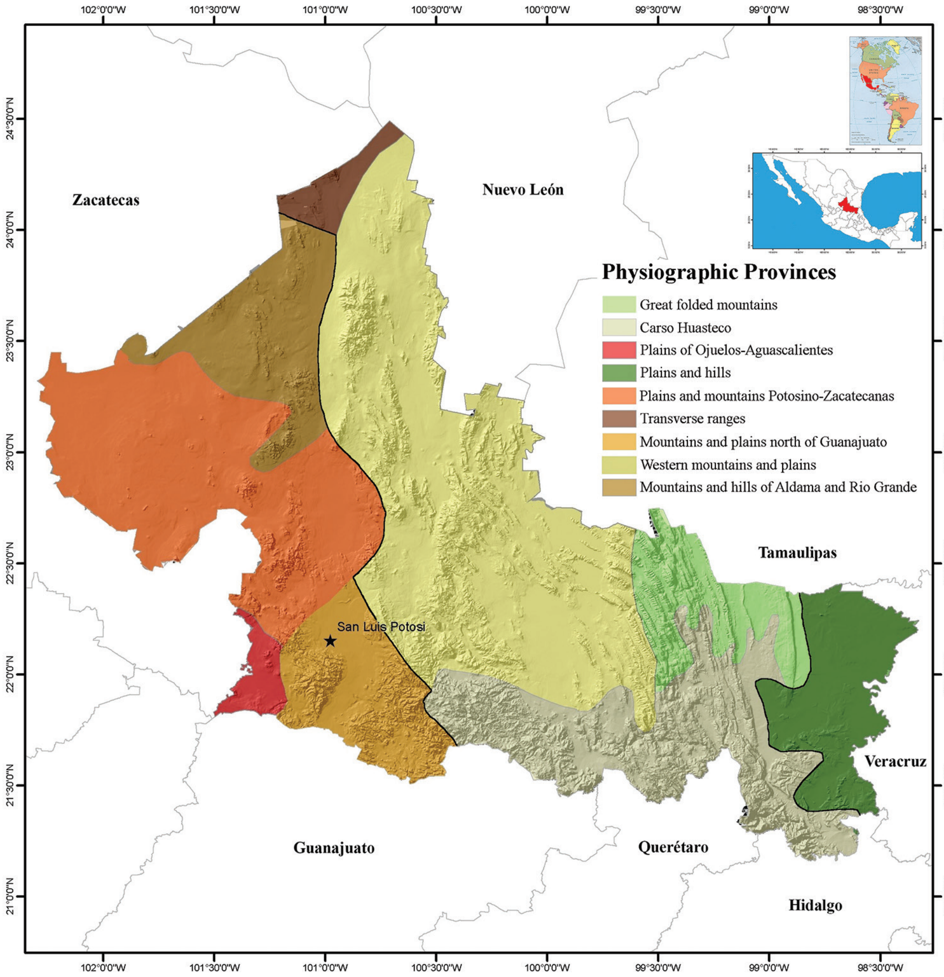

Figure 1. Topographical map with physiographic provinces of the state of San Luis Potosí, Mexico. The thicker black lines delineate the major habitat types found in San Luis Potosí (from west to east): Central Plateau, Sierra Madre Oriental, and North Gulf Coastal Plains (INEGI 2009). Maps modified from Cervantes-Zamora et al. (1990); http://www.gifex.com/fullsize/2009-09-17-3/Mapa-de-Amrica.html; García E – Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (2008).

forests in the southeastern portion (= Huasteca Potosina). Three physiographic provinces that vary in their temperature and the moisture retention of their soils (INEGI 2009; Lemos-Espinal and Dixon 2013) are found in San Luis Potosí: the Sierra Madre Oriental, the North Gulf Coastal Plains, and the Central Plateau (Figure 1). The Tropic of Cancer crosses the northern part of the state, and to the east San Luis Potosí nearly reaches the Gulf of Mexico to the east. The elevation of San Luis Potosí varies from about 50 m above sea level to about 3,180 m in Cerro Grande (INEGI 2009). The variation in climate (Figure 2) and physiography of the state have created a mosaic of habitat and vegetation types in San Luis Potosí (Figure 3) that most likely affect the distribution and

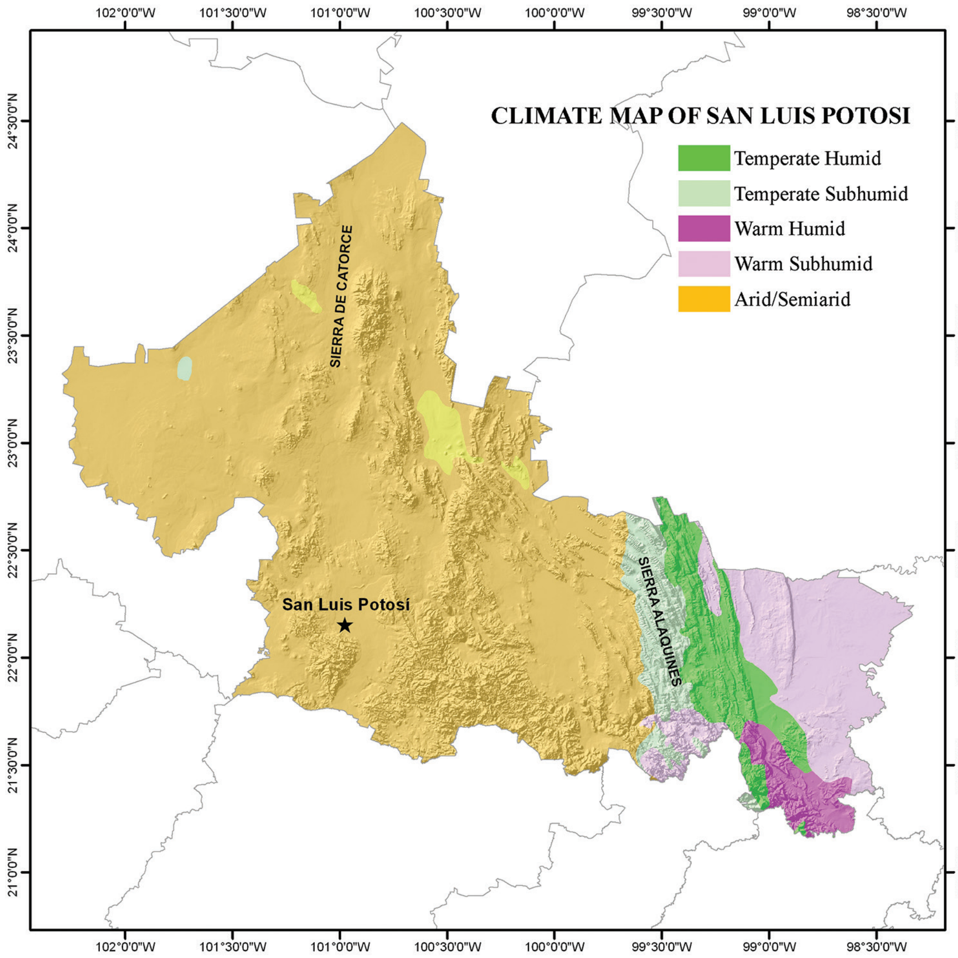

Figure 2. Climate map of the state of San Luis Potosí, Mexico (modified from García – CONABIO 1998).

presence of amphibians and reptiles in the state (see Lemos-Espinal and Dixon 2013 for detailed description of these habitats and vegetation types).

Our understanding of the herpetofauna of San Luis Potosí still remains somewhat limited (see Lemos-Espinal and Dixon 2013 for a review of previous herpetological studies in San Luis Potosí). Our intent with this paper is to encourage others to continue studying the herpetofauna of the state by providing a summary of the species of amphibians and reptiles of the state, their geographic distributions, habitat, and conservation status. By placing all this information into one, easily accessible place, we hope to provide a starting place for further research on the herpetofauna of San Luis Potosí. In addition, a comparison of the amphibian and reptile species lists to those in the neighboring states is provided in an effort to identify unique aspects of the herpetofauna of San Luis Potosí, as well as shared species, with the aim to understand the potential conservation or management needs at the state or regional level.

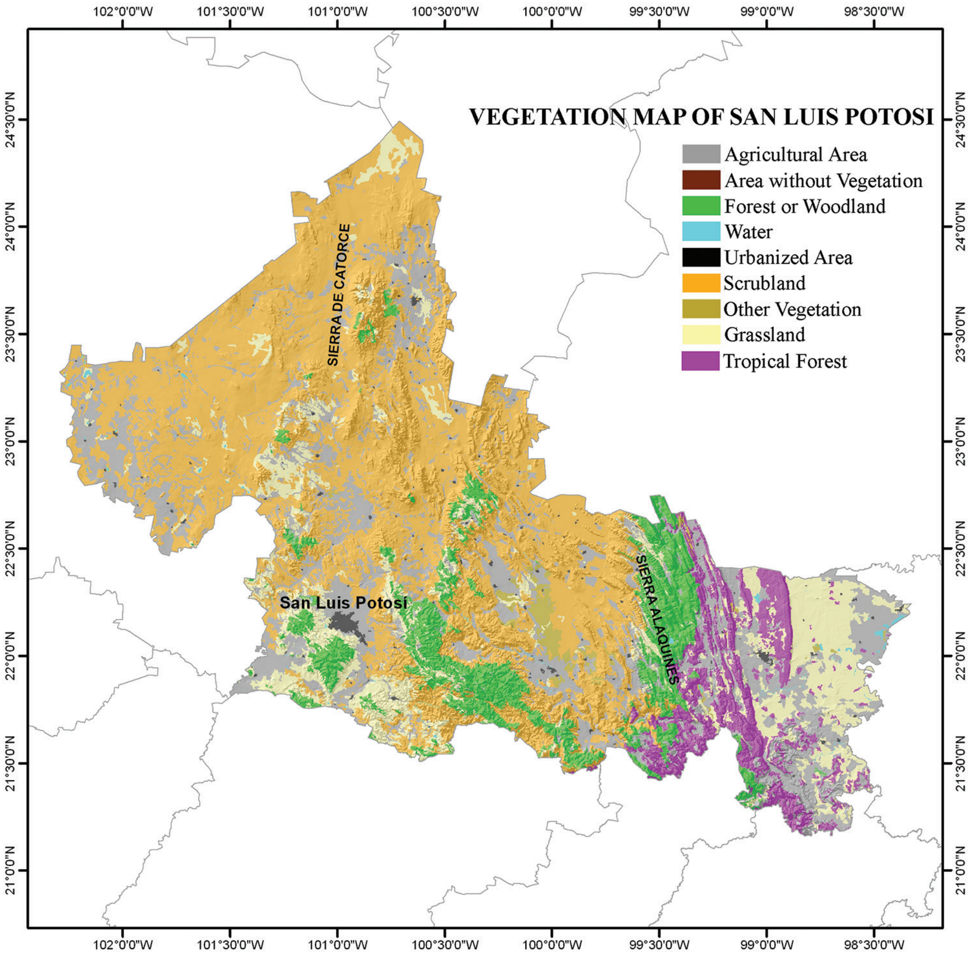

Figure 3. Vegetation type map of the state of San Luis Potosí, Mexico (modified from Dirección General de Geografía – INEGI 2005).

Materials and methods

This list of amphibians and reptiles of the state of San Luis Potosí was compiled from the following sources: (1) our own field work; (2) specimens from the Laboratorio de Ecología – UBIPRO (**LEUBIPRO**) collections; (3) a thorough examination of the available literature on amphibians and reptiles of the state; and (4) databases from the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (National Commission for the Understanding and Use of Biodiversity; **CONABIO**), including records from the following 30 collections:

AMNH	Collection of Herpetology, Herpetology Department, American Museum of Natural History
ANSP	Collection of Herpetology, Herpetology Department, Academy of Natural Sciences of Philadelphia

BMNH	Collection of Herpetology, Zoology Department, The Natural History Museum, British Museum (Natural History)
CAS	Collection of Herpetology, Herpetology Department, California Academy of Sciences
CMNH	Collection of Herpetology, Amphibians and Reptiles Section, Carnegie Museum of Natural History – Pittsburgh
CNAR	Colección Nacional de Anfibios y Reptiles, Instituto de Biología UNAM
EALC	Ernest A. Liner Collection of Herpetology
ENCB	Colección Herpetológica, Departamento de Zoología, Escuela Nacional de Ciencias Biológicas
ENEPI	Colección Herpetológica, Departamento de Biología Experimental, Escuela Nacional de Estudios Profesionales, Unidad Iztacala, UNAM
FMNH	Division of Amphibians and Reptiles, Field Museum of Natural History
FSM-UF	Collection of Herpetology, Florida State Museum, University of Florida
FWMSH	Fort Worth Museum of Sciences and History
LACM	Collection of Herpetology, Herpetology Section, Natural History Museum of Los Angeles County
LSUMZ	Collection of Herpetology, Museum of Zoology, Biological Sciences Division, Louisiana State University
MCZ	Collection of Herpetology, Museum of Comparative Zoology, Harvard University Cambridge
MNHUK	Museum of Natural History, Division of Herpetology, University of Kansas
MZFC-UNAM	Colección Herpetológica, Museo de Zoología "Alfonso L. Herrera", Facultad de Ciencias UNAM
MVZ	Collection of Herpetology, Museum of Vertebrate Zoology, Division of Biological Sciences, University of California Berkeley
SDNHM	Collection of Herpetology, Herpetology Department, San Diego Natural History Museum
TCWC	Collection of Herpetology, Texas Cooperative Wildlife Collection, Texas A&M University
TNHC	Collection of Herpetology, Texas Natural History Collection, University of Texas Austin
TU	Collection of Herpetology, Biology Department, Tulane University, New Orleans
UAZ	Amphibians and Reptiles Collection, University of Arizona
UCM	Collection of Herpetology, University of Colorado Museum
UIMNH	Collection of Herpetology, University of Illinois Museum of Natural History
UIUC	Collection of Herpetology, Museum of Natural History, University of Illinois at Urbana-Champaign
UMMZ	Collection of Herpetology, Museum of Zoology, University of Michigan Ann Arbor

USNM	Collection of Herpetology, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution
UTAMM	Merriam Museum, University of Texas Arlington
UTEP	Collection of Herpetology, Laboratory of Environmental Biology, Biological Sciences Department, University of Texas - El Paso

Amphibian names follow Frost (2017) and AmphibiaWeb (2017) (http://amphibiaweb.org) and reptile names follow Uetz and Hošek (2017). Species were included in the list if they had confirmed records, either by direct observation or through documented museum records or vouchers. Species accumulation curves were created for the total herpetofauna, amphibians, and reptiles using the year of the first recorded observation for each species. Such species accumulation curves are likely to serve as good estimators of the potential species richness of amphibians and reptiles (see Raxworthy et al. 2012). In addition, the conservation status of each species was recorded based on three sources: 1) the IUCN Red List 2017; 2) Environmental Vulnerability Scores from Wilson et al. (2013a,b) and Johnson et al. (2015); 3) listing in SEMARNAT (2010).

The number of overlapping species with those neighboring states for which a recent checklist exists (Hidalgo: Lemos-Espinal and Smith 2015, Lemos-Espinal and Dixon 2016; Nuevo León: Lemos-Espinal et al. 2016; Tamaulipas: Farr 2015, Terán-Juárez et al. 2016; Querétaro: Dixon and Lemos-Espinal 2010) was determined, and hierarchical clustering analyses with single linkage and Euclidean distances using Systat 13 software (SYSTAT software, Chicago, IL) used to examine the similarities among the herpetofaunas of San Luis Potosí and its neighboring states (see Enderson et al. 2009 for a similar analysis). Lists were updated for Hidalgo (substituting *Lampropeltis polyzona* for *L. triangulum*, Ruane et al. 2014, Uetz and Hošek 2017); Nuevo León (adding *Chiropterotriton miquihuanus*, Campbell et al. 2014; *Crotalus morulus,* Bryson et al. 2014, Uetz and Hošek 2017; and substituting *Lampropeltis annulata* for *L. triangulum*, Ruane et al. 2014, Uetz and Hošek 2017); Querétaro (substituting substituting *L. annulata* for *L. triangulum*, Ruane et al. 2014, Uetz and Hošek 2017; adding *Amastridium sapperi*, Calzada-Arciniega 2014). The neighboring states of Guanajuato, Veracruz, and Zacatecas do not have recent, comprehensive checklists of amphibians and reptiles available so were not included in comparisons.

Results and discussion

San Luis Potosí is home to 182 species of amphibians and reptiles which represent 33 families and 98 genera (Table 1). These include 41 species of amphibians (six salamanders, 35 anurans) and 141 of reptiles (one crocodilian, seven turtles, 48 lizards, 85 snakes). The herpetofaunal account for the state published by Lemos-Espinal and Dixon (2013) listed a total of 181 species of amphibians and reptiles, including Dennis' Chirping Frog (*Eleutherodactylus dennisi*), a species not included in this paper since the only record for this species (ENCB-14250 – *E. dennisi*; collected on August 13th, 1989. 1 km N of Apetz-

Table 1. Checklist of amphibians and reptiles of San Luis Potosí providing Global Distribution (0 = Introduced; 1 = Endemic to Mexico; 2 = Distributed in the United States and Mexico; 3 = Distributed from Mexico and south of Mexico; 4 = Distributed from the United States to Central or even South America; 5 = Distributed from Canada to Mexico or south of Mexico), the habitat type (CD = Chihuahuan Desert, SMO = Temperate Forests of the Sierra Madre Oriental, SBT = Subtropics of the Sierra Madre Oriental; GEN = Generalist – occupies more than one habitat type), IUCN Status (DD = Data Deficient; LC = Least Concern, VU = Vulnerable, NT = Near Threatened; EN = Endangered; CE = Critically Endangered; NL = not listed), population trend (+ = Increasing, = = Stable, - = Decreasing, ? = Unknown) according to the IUCN Red List (The IUCN Red List of Threatened Species, Version 2016.3; www.iucnredlist.org; accessed 1 March 2017), Environmental Vulnerability Score (EVS; the higher the score the greater the vulnerability; NE = not evaluated) from Wilson et al. (2013a,b) and Johnson et al. (2015a), and conservation status in Mexico according to SEMARNAT (2010) (P = in danger of extinction, A = threatened; Pr = subject to special protection, NL – not listed). Source denotes whether the species was observed in the field by the authors (A), documented in the CONABIO data base and/or museum collections (C/M), or found in the literature (citation of source). N/A = not applicable due to being non-native.

Taxa	**GD**	**Habitat type**	**IUCN**	**Population Trend**	**EVS**	**SEMARNAT**	**Source**
CLASS AMPHIBIA							
ORDER CAUDATA							
Ambystomatidae (1 genus, 1 species)							
Ambystoma velasci (Dugès, 1888)	1	**CD**	**LC**	?	**10**	**Pr**	**A**
Plethodontidae (3 genera, 4 species)							
Bolitoglossa platydactyla (Gray, 1831)	1	**SBT**	**NT**	–	**15**	**Pr**	**C/M**
Chiropterotriton magnipes Rabb, 1965	1	**SMO**	**CE**	–	**16**	**Pr**	**C/M**
Chiropterotriton multidentatus (Taylor, 1938)	1	**SMO**	**EN**	–	**15**	**Pr**	**C/M**
Isthmura bellii (Gray, 1850)	1	**SMO**	**VU**	–	**12**	**A**	**C/M**
Salamandridae (1 genus, 1 species)							
Notophthalmus meridionalis (Cope, 1880)	2	**SBT**	**EN**	–	**12**	**Pr**	**C/M**
ORDER ANURA							
Bufonidae (3 genera, 6 species)							
Anaxyrus cognatus (Say, 1823)	5	**CD**	**LC**	?	**9**	**NL**	**A**
Anaxyrus debilis (Girard, 1854)	2	**CD**	**LC**	=	**7**	**Pr**	**A**
Anaxyrus punctatus Baird & Girard, 1852	2	**CD**	**LC**	=	**5**	**NL**	**A**
Incilius nebulifer Girard, 1854	2	**GEN**	**LC**	=	**6**	**NL**	**A**
Incilius occidentalis Camerano, 1879	1	**CD**	**LC**	=	**11**	**NL**	**A**
Rhinella horribilis (Linnaeus, 1758)	4	**GEN**	**NL**	?	**NE**	**NL**	**A**
Craugastoridae (1 genus, 3 species)							
Craugastor augusti (Dugès, 1879)	2	**SMO**	**LC**	=	**8**	**NL**	**A**
Craugastor berkenbuschii (Peters, 1870)	1	**CD**	**NT**	–	**14**	**Pr**	**C/M**
Craugastor decoratus (Taylor, 1942)	1	**SMO**	**VU**	?	**15**	**Pr**	**C/M**
Eleutherodactylidae (1 genus, 5 species)							
Eleutherodactylus cystignathoides (Cope, 1878)	2	**GEN**	**LC**	–	**12**	**NL**	**A**
Eleutherodactylus guttilatus (Cope, 1870)	2	**GEN**	**LC**	?	**11**	**NL**	**C/M**
Eleutherodactylus leprus (Cope, 1879)	3	**SMO**	**VU**	–	**12**	**NL**	**C/M**
Eleutherodactylus longipes (Baird, 1869)	1	**SBT**	**VU**	?	**15**	**NL**	**C/M**
Eleutherodactylus verrucipes Cope, 1865	1	**GEN**	**VU**	–	**16**	**Pr**	**C/M**
Hylidae (7 genera, 9 species)							
Hyla arenicolor Cope, 1886	2	**GEN**	**LC**	=	**7**	**NL**	**A**

Taxa	GD	Habitat type	IUCN	Population Trend	EVS	SEMARNAT	Source
Hyla eximia Baird, 1854	1	**GEN**	**LC**	=	**10**	**NL**	**A**
Hyla plicata Brocchi, 1877	1	**SMO**	**LC**	=	**11**	**A**	**C/M**
Rheohyla miotympanum (Cope, 1863)	1	**SBT**	**NT**	–	**9**	**NL**	**A**
Sarcohyla arborescandens (Taylor, 1939)	1	**SBT**	**EN**	–	**11**	**Pr**	**C/M**
Scinax staufferi (Cope, 1865)	3	**GEN**	**LC**	=	**4**	**NL**	**A**
Smilisca baudinii (Duméril & Bibron, 1841)	4	**SBT**	**LC**	=	**3**	**NL**	**A**
Tlalocohyla picta (Günther, 1901)	3	**SBT**	**LC**	+	**8**	**NL**	**A**
Trachycephalus typhonius (Linnaeus, 1758)	3	**SBT**	**LC**	=	**4**	**NL**	**A**
Leptodactylidae (1 genus, 2 species)							
Leptodactylus fragilis (Brocchi, 1877)	4	**SBT**	**LC**	=	**5**	**NL**	**A**
Leptodactylus melanonotus (Hallowell, 1861)	3	**SBT**	**LC**	=	**6**	**NL**	**A**
Microhylidae (2 genera, 2 species)							
Gastrophryne olivacea (Hallowell, 1857)	2	**SBT**	**LC**	=	**9**	**Pr**	**C/M**
Hypopachus variolosus (Cope, 1866)	4	**GEN**	**LC**	=	**4**	**NL**	**A**
Ranidae (1 genus, 5 species)							
Rana berlandieri Baird, 1859	4	**GEN**	**LC**	=	**7**	**Pr**	**A**
Rana catesbeiana Shaw, 1802	0	**N/A**	**N/A**	N/A	**N/A**	**N/A**	**C/M**
Rana johni Blair, 1965	1	**SBT**	**EN**	–	**14**	**Pr**	**C/M**
Rana montezumae Baird, 1854	1	**GEN**	**LC**	–	**13**	**Pr**	**A**
Rana neovolcanica Hillis & Frost, 1985	1	**CD**	**NT**	–	**13**	**A**	**A**
Rhinophrynidae (1 genus, 1 species)							
Rhinophrynus dorsalis Duméril & Bibron, 1841	4	**SBT**	**LC**	=	**8**	**Pr**	**A**
Scaphiopodidae (2 genera, 2 species)							
Scaphiopus couchii Baird, 1854	2	**GEN**	**LC**	=	**3**	**NL**	**A**
Spea multiplicata (Cope, 1863)	2	**GEN**	**LC**	=	**6**	**NL**	**A**
CLASS REPTILIA							
ORDER CROCODYLIA							
Crocodylidae (1 genus, 1 species)							
Crocodylus moreletii Duméril & Bibron, 1851	3	**SBT**	**LC**	=	**13**	**Pr**	**C/M**
ORDER TESTUDINES							
Emydidae (2 genera, 2 species)							
Terrapene mexicana (Gray, 1849)	1	**SBT**	**NL**	?	**19**	**NL**	**C/M**
Trachemys venusta (Gray, 1855)	3	**GEN**	**NL**	?	**13**	**NL**	**C/M**
Kinosternidae (1 genus, 4 species)							
Kinosternon herrerai Stejneger, 1925	1	**GEN**	**NT**	–	**14**	**Pr**	**A**
Kinosternon hirtipes (Wagler, 1830)	2	**GEN**	**LC**	–	**10**	**Pr**	**A**
Kinosternon integrum LeConte, 1854	1	**GEN**	**LC**	=	**11**	**Pr**	**A**
Kinosternon scorpioides (Linnaeus, 1766)	3	**SBT**	**NL**	?	**10**	**Pr**	**A**
Trionychidae (1 genus, 1 species)							
Apalone spinifera (Lesueur, 1827)	5	**SBT**	**LC**	–	**15**	**Pr**	**C/M**
ORDER SQUAMATA							
SUBORDER LACERTILIA							
Anguidae (4 genera, 5 species)							
Abronia taeniata (Wiegmann, 1828)	1	**GEN**	**VU**	–	**15**	**Pr**	**A**
Barisia ciliaris (Smith, 1942)	1	**GEN**	**NL**	?	**15**	**NL**	**A**

Taxa	GD	Habitat type	IUCN	Population Trend	EVS	SEMARNAT	Source
Gerrhonotus infernalis Baird, 1859	2	GEN	LC	=	13	NL	A
Gerrhonotus ophiurus Cope, 1866	1	GEN	LC	?	12	NL	A
Ophiosaurus incomptus (McConkey, 1955)	1	SBT	DD	?	15	Pr	C/M
Corytophanidae (2 genera, 2 species)							
Corytophanes hernandesii (Wiegmann, 1831)	3	SBT	LC	=	13	Pr	A
Laemanctus serratus Cope, 1864	3	SBT	LC	=	8	Pr	A
Crotaphytidae (1 genus, 1 species)							
Crotaphytus collaris (Say, 1823)	2	CD	LC	=	13	A	A
Dactyloidae (1 genus, 2 species)							
Anolis petersii Bocourt, 1873	3	SBT	NL	?	9	NL	C/M
Anolis sericeus Hallowell, 1856	3	SBT	NL	?	8	NL	A
Dibamidae (1 genus, 1 species)							
Anelytropsis papillosus Cope, 1885	1	GEN	LC	–	10	A	C/M
Eublepharidae (1 genus, 1 species)							
Coleonyx elegans Gray, 1845	3	SBT	LC	=	9	A	C/M
Gekkonidae (2 genera, 3 species)							
Gehyra mutilata (Wiegmann, 1834)	0	N/A	N/A	N/A	N/A	N/A	C/M
Hemidactylus frenatus Schlegel, 1836	0	N/A	N/A	N/A	N/A	N/A	A
Hemidactylus turcicus (Linnaeus, 1758)	0	N/A	N/A	N/A	N/A	N/A	A
Iguanidae (1 genus, 1 species)							
Ctenosaura acanthura (Shaw, 1802)	1	SBT	NL	?	12	Pr	A
Phrynosomatidae (4 genera, 19 species)							
Cophosaurus texanus Troschel, 1852	2	CD	LC	=	14	A	A
Holbrookia approximans Baird, 1859	1	CD	NL	?	14	NL	A
Phrynosoma cornutum (Harlan, 1824)	2	CD	LC	=	11	NL	A
Phrynosoma modestum Girard, 1852	2	CD	LC	=	12	NL	A
Phrynosoma orbiculare (Linnaeus, 1758)	1	GEN	LC	=	12	A	A
Sceloporus cautus Smith, 1938	1	GEN	LC	–	15	NL	A
Sceloporus cowlesi Lowe & Norris, 1956	2	CD	NL	?	13	NL	A
Sceloporus dugesii Bocourt, 1873	1	CD	LC	=	13	NL	A
Sceloporus goldmani Smith, 1937	1	CD	EN	–	15	NL	C/M
Sceloporus grammicus Wiegmann, 1828	2	GEN	LC	=	9	Pr	A
Sceloporus minor Cope, 1885	1	CD	LC	=	14	NL	A
Sceloporus olivaceus Smith, 1934	2	CD	LC	=	13	NL	A
Sceloporus parvus Smith, 1934	1	GEN	LC	=	15	NL	A
Sceloporus poinsettii Baird & Girard, 1852	2	CD	LC	=	12	NL	A
Sceloporus scalaris Wiegmann, 1828	1	CD	LC	=	12	NL	A
Sceloporus serrifer Cope, 1866	4	GEN	LC	=	6	NL	A
Sceloporus spinosus Wiegmann, 1828	1	CD	LC	=	12	NL	A
Sceloporus torquatus Wiegmann, 1828	1	GEN	LC	=	11	NL	A
Sceloporus variabilis Wiegmann, 1828		GEN	LC	=	5	NL	A
Scincidae (2 genera, 5 species)							
Plestiodon dicei (Ruthven & Gaige, 1933)	1	SMO	NL	?	7	NL	A
Plestiodon lynxe (Wiegmann, 1834)	1	GEN	LC	=	10	Pr	A
Plestiodon obsoletus Baird & Girard, 1852	2	CD	LC	=	11	NL	C/M
Plestiodon tetragrammus Baird, 1859	2	GEN	LC	=	12	NL	A
Scincella caudaequinae (Smith, 1951)	1	GEN	NL	?	NE	NL	A

Taxa	GD	Habitat type	IUCN	Population Trend	EVS	SEMARNAT	Source
Teiidae (2 genera, 3 species)							
Aspidoscelis gularis (Baird & Girard, 1852)	2	CD	LC	=	9	NL	A
Aspidoscelis inornatus (Baird, 1859)	2	CD	LC	–	14	NL	A
Holcosus amphigrammus (Smith & Laufe, 1945)	1	GEN	NL	?	12	NL	A
Xantusiidae (1 genus, 4 species)							
Lepidophyma gaigeae Mosauer, 1936	1	GEN	VU	–	13	Pr	A
Lepidophyma micropholis Walker, 1955	1	SBT	VU	?	15	A	C/M
Lepidophyma occulor Smith, 1942	1	SBT	LC	=	14	Pr	A
Lepidophyma sylvaticum Taylor, 1939	1	SMO	LC	–	11	Pr	A
Xenosauridae (1 genus, 1 species)							
Xenosaurus newmanorum Taylor, 1949	1	SBT	EN	–	15	Pr	A
ORDER SQUAMATA							
SUBORDER SERPENTES							
Boidae (1 genus, 1 species)							
Boa imperator Daudin, 1803	3	SBT	NL	?	NE	NL	A
Colubridae (22 genera, 36 species)							
Arizona elegans Kennicott, 1859	2	CD	LC	=	5	NL	A
Coluber constrictor Linnaeus, 1758	5	SBT	LC	=	10	A	C/M
Conopsis lineata (Kennicott, 1859)	1	SMO	LC	=	13	NL	A
Conopsis nasus Günther, 1858	1	SMO	LC	=	11	NL	A
Drymarchon melanurus (Duméril, Bibron, & Duméril, 1854)	4	GEN	LC	=	6	NL	A
Drymobius chloroticus (Cope, 1886)	3	SBT	LC	?	8	NL	C/M
Drymobius margaritiferus (Schlegel, 1837)	4	GEN	NL	?	6	NL	A
Ficimia hardyi Mendoza-Quijano & Smith, 1993	1	CD	EN	–	13	NL	C/M
Ficimia olivacea Gray, 1849	1	SBT	NL	?	9	NL	C/M
Ficimia streckeri Taylor, 1931	2	GEN	LC	=	12	NL	C/M
Gyalopion canum (Cope, 1861)	2	CD	LC	=	9	NL	C/M
Lampropeltis annulata Kennicott, 1861	2	CD	NL	?	NE	NL	C/M
Lampropeltis mexicana (Garman, 1884)	1	CD	LC	=	15	A	A
Lampropeltis polyzona Cope, 1860	1	GEN	NL	?	11	NL	A
Lampropeltis splendida (Baird & Girard, 1853)	2	CD	NL	?	NE	NL	C/M
Leptophis mexicanus Duméril & Bibron, 1854	3	GEN	LC	=	6	A	A
Masticophis flagellum (Shaw, 1802)	2	CD	LC	=	8	A	A
Masticophis mentovarius (Duméril, Bibron, & Duméril, 1854)	3	GEN	LC	?	6	A	C/M
Masticophis schotti Baird & Girard, 1853	2	CD	LC	=	13	NL	A
Mastigodryas melanolomus (Cope, 1868)	3	SBT	LC	=	6	NL	C/M
Oxybelis aeneus (Wagler, 1824)	4	SBT	NL	?	5	NL	C/M
Pantherophis emoryi (Baird & Girard, 1853)	2	CD	LC	=	13	NL	A
Phrynonax poecilonotus (Günther, 1858)	3	SBT	NL	?	NE	NL	CM
Pituophis catenifer Blainville, 1835	5	GEN	LC	=	9	NL	A
Pituophis deppei (Duméril, 1853)	1	CD	LC	=	14	A	A
Pseudoelaphe flavirufa (Cope, 1867)	3	SBT	NL	?	10	NL	C/M
Rhinocheilus lecontei Baird & Girard, 1853	2	CD	LC	=	8	NL	A

Taxa	GD	Habitat type	IUCN	Population Trend	EVS	SEMARNAT	Source
Salvadora grahamiae Baird & Girard, 1853	2	**CD**	**LC**	=	**10**	**NL**	**A**
Senticolis triaspis (Cope, 1866)	4	**GEN**	**LC**	=	**6**	**NL**	**A**
Spilotes pullatus (Linnaeus, 1758)	3	**SBT**	**NL**	?	**6**	**NL**	**A**
Tantilla atriceps (Günther, 1895)	2	**CD**	**LC**	=	**11**	**A**	**C/M**
Tantilla bocourti (Günther, 1895)	1	**CD**	**LC**	?	**9**	**NL**	**C/M**
Tantilla rubra Cope, 1876	3	**SBT**	**LC**	?	**5**	**Pr**	**C/M**
Tantilla shawi Taylor, 1949	1	**SBT**	**EN**	?	**15**	**Pr**	**C/M**
Tantilla wilcoxi Stejneger, 1902	2	**CD**	**LC**	=	**10**	**NL**	**C/M**
Trimorphodon tau Cope, 1870	1	**CD**	**LC**	?	**13**	**NL**	**C/M**
Dipsadidae (14 genera, 22 species)							
Adelphicos quadrivirgatum (Jan, 1862)	3	**SBT**	**LC**	?	**10**	**Pr**	**C/M**
Amastridium sapperi (Werner, 1903)		**SBT**	**LC**	=	**10**	**NL**	**Calzada-Arciniega (2014)**
Chersodromus rubriventris (Taylor, 1949)	1	**SBT**	**EN**	–	**14**	**Pr**	**C/M**
Coniophanes fissidens (Günther, 1858)	3	**SBT**	**NL**	?	**7**	**NL**	**C/M**
Coniophanes imperialis (Baird, 1859)	4	**SBT**	**LC**	=	**8**	**NL**	**C/M**
Coniophanes piceivittis Cope, 1869	3	**SBT**	**LC**	=	**7**	**NL**	**C/M**
Diadophis punctatus (Linnaeus, 1766)	5	**CD**	**LC**	=	**4**	**NL**	**A**
Geophis latifrontalis Garman, 1883	1	**CD**	**DD**	?	**14**	**Pr**	**C/M**
Geophis mutitorques (Cope, 1885)	1	**SBT**	**LC**	=	**13**	**Pr**	**C/M**
Heterodon kennerlyi Kennicott, 1860	2	**CD**	**NL**	?	**11**	**NL**	**C/M**
Hypsiglena jani (Dugès, 1865)	2	**CD**	**NL**	?	**6**	**NL**	**A**
Hypsiglena tanzeri Dixon & Lieb, 1972	1	**CD**	**DD**	?	**15**	**NL**	**C/M**
Imantodes cenchoa (Linnaeus, 1758)	3	**SBT**	**NL**	?	**6**	**Pr**	**A**
Leptodeira maculata (Linnaeus, 1758)	1	**GEN**	**LC**	=	**7**	**Pr**	**A**
Leptodeira septentrionalis (Kennicott, 1859)	3	**GEN**	**NL**	?	**8**	**NL**	**C/M**
Ninia diademata Baird & Girard, 1853	3	**SBT**	**LC**	=	**9**	**NL**	**A**
Pliocercus elapoides Cope, 1860	3	**SBT**	**LC**	=	**10**	**NL**	**A**
Rhadinaea decorata (Günther, 1858)	3	**SBT**	**NL**	?	**9**	**NL**	**A**
Rhadinaea gaigeae Bailey, 1937	1	**GEN**	**DD**	?	**12**	**NL**	**A**
Rhadinaea marcellae Taylor, 1949	1	**SBT**	**EN**	–	**12**	**Pr**	**C/M**
Tropidodipsas fasciata Günther, 1858	3	**SBT**	**NL**	?	**13**	**NL**	**C/M**
Tropidodipsas sartorii Cope, 1863	3	**GEN**	**LC**	=	**9**	**Pr**	**A**
Elapidae (1 genus, 1 species)							
Micrurus tener Baird & Girard, 1853	2	**GEN**	**LC**	=	**11**	**NL**	**A**
Leptotyphlopidae (1 genus, 3 species)							
Rena dulcis Baird & Girard, 1853	2	**GEN**	**LC**	?	**13**	**NL**	**C/M**
Rena myopica (Garman, 1884)	1	**GEN**	**LC**	=	**13**	**NL**	**C/M**
Rena segrega (Klauber, 1939)	2	**CD**	**NL**	?	**NE**	**NL**	**C/M**
Natricidae (3 genera, 12 species)							
Nerodia rhombifer (Hallowell, 1852)	2	**GEN**	**LC**	=	**10**	**NL**	**C/M**
Storeria dekayi (Holbrook, 1939)	5	**SMO**	**LC**	=	**7**	**NL**	**A**
Storeria hidalgoensis Taylor, 1942	1	**SMO**	**VU**	–	**13**	**NL**	**A**
Storeria storerioides (Cope, 1866)	1	**SMO**	**LC**	=	**11**	**NL**	**A**
Thamnophis cyrtopsis (Kennicott, 1860)	4	**GEN**	**LC**	=	**7**	**A**	**A**
Thamnophis eques (Reuss, 1834)	2	**GEN**	**LC**	=	**8**	**A**	**A**
Thamnophis marcianus (Baird & Girard, 1853)	4	**GEN**	**LC**	?	**10**	**A**	**A**

Taxa	GD	Habitat type	IUCN	Population Trend	EVS	SEMARNAT	Source
Thamnophis melanogaster (Wiegmann, 1830)	1	CD	EN	–	15	A	A
Thamnophis proximus (Say, 1823)	4	SBT	LC	=	7	A	C/M
Thamnophis scalaris Cope, 1861	1	SMO	LC	=	14	A	C/M
Thamnophis scaliger (Jan, 1863)	1	SMO	VU	–	15	A	C/M
Thamnophis sumichrasti (Cope, 1866)	1	SMO	LC	?	15	A	A
Viperidae (4 genera, 10 species)							
Agkistrodon taylori Burger & Robertson, 1951	1	SMO	LC	?	17	A	Lemos-Espinal and Dixon (2013)
Atropoides nummifer (Rüppell, 1845)	1	SBT	LC	=	13	A	Lemos-Espinal and Dixon (2013)
Bothrops asper (Garman, 1883)	3	SBT	NL	?	12	NL	Lemos-Espinal and Dixon (2013)
Crotalus aquilus Klauber, 1952	1	GEN	LC	–	16	Pr	A
Crotalus atrox Baird & Girard, 1853	2	CD	LC	=	9	Pr	A
Crotalus lepidus (Kennicott, 1861)	2	CD	LC	=	12	Pr	A
Crotalus molossus Baird & Girard, 1853	2	CD	LC	=	8	Pr	A
Crotalus pricei Van Denburgh, 1895	2	SMO	LC	=	14	Pr	Lemos-Espinal and Dixon (2013)
Crotalus scutulatus (Kennicott, 1861)	2	CD	LC	=	11	Pr	A
Crotalus totonacus Gloyd & Kauffeld, 1940	1	SBT	NL	?	17	NL	A

co, municipality of Xilitla, SLP), seems to be a misidentified *E. longipes*. *Amastridium sapperi* was added based on Calzada-Arciniega (2014). *Sceloporus cowlesi* was substituted for *S. consobrinus* based on Leaché (pers. comm.), *Scincella silvicola* for *S. caudaequinae* based on Linkem et al. (2011) and Uetz and Hošek (2017), and *Holcosus undulatus* for *H. amphigrammus* based on Meza-Lázaro and Nieto-Montes de Oca (2015). *Lampropeltis triangulum* was substituted for *L. annulata* and *L. polyzona* based on Ruane et al. (2014) and Uetz and Hošek (2017). *Xenosaurus newmanorum* was regarded as endemic to Mexico but not to San Luis Potosí based on Nieto Montes de Oca et al. (2017). No species is endemic to the state, and four are introduced: the American Bullfrog (*Rana catesbeiana*), the Common Four-clawed Gecko (*Gehyra mutilata*), the Common House Gecko (*Hemidactylus frenatus*), and the Mediterranean House Gecko (*H. turcicus*).

A list of 17 species (nine amphibians, eight reptiles) potentially occurring in San Luis Potosí was compiled (Table 2), based on species for which undocumented observations in San Luis Potosí exist but for which museum or other records are not available, and on species that have not been recorded or observed in the state, but whose distributional ranges come close to the borders of San Luis Potosí.

The species accumulation curves for all species, amphibians, and reptiles suggest that the current list of species is close to being the likely species richness for San Luis Potosí (Figure 4). These curves show a dramatic increase in documents herpetofaunal species during the 1940's and 1950's, primarily associated with the work of Edward Taylor and Hobart Smith (Smith 1939, Smith and Taylor 1945, 1950; Taylor 1949, 1950, 1952, 1953). Taken together with the relatively limited number of potential additions to the herpetofauna of San Luis Potosí (see Table 2), it seems likely that, barring the discovery of multiple cryptic species, that this is a fairly complete list of the herpetofauna of San Luis Potosí.

General distribution

Seventeen of the 41 species of Amphibians that inhabit San Luis Potosí are endemic to Mexico, two of which are restricted to small areas in the Sierra Madre Oriental around southeastern San Luis Potosí (Table 1). Eight more are distributed mainly in eastern Mexico (Table 1). The remaining seven endemic amphibians are widely distributed in central, eastern, and even western Mexico (Table 1). Of the 24 amphibian species not endemic to Mexico that inhabit San Luis Potosí, one is an introduced species, eleven more are found in the United States and Mexico, the remaining 12 species have a wide distribution from Canada to Central America, from the United States to Central or South America, or from Mexico to Central or South America (Table 1).

Morelet's Crocodile (*Crocodylus moreletii*), is widely distributed from Tamaulipas to Central America. Three of the seven species of turtles that inhabit San Luis Potosí are endemic to Mexico, two of them to eastern Mexico and another is widely distributed in western and central Mexico (Table 1). The four non-endemic species of turtles are found from southern Canada to the Balsas River of Guerrero, from the United States to Mexico, or from Mexico to South America (Table 1). Twenty-five of the 48 species of lizards that occur in the state are endemic to Mexico, two more have a narrow distribution in northern San Luis Potosí and southern Tamaulipas (*Ophisaurus incomptus* and *Lepidophyma micropholis*) one is found from southern Tamaulipas to northern Hidalgo (*Xenosaurus newmanorum*), another to a small area in Coahuila, Nuevo León, and San Luis Potosí (*Sceloporus goldmani*), one more to northern Querétaro and adjacent San Luis Potosí (*Lepidophyma occulor*), and another to a small area in San Luis Potosí, Querétaro, and Hidalgo (*Lepidophyma gaigeae*). Most of the remaining 19 lizards endemic to Mexico are distributed mainly in eastern or central Mexico, in northern Mexico (*Holbrookia approximans*), or in western and eastern Mexico (Table 1). The remaining 23 species of lizards that inhabit San Luis Potosí are not endemic to Mexico; 13 of the non-endemic are species found in the United States and Mexico; two are found from southern United States to Central America; five are distributed from Mexico to Central America; and three are introduced to San Luis Potosí (Table 1). Twenty-eight

Table 2. List of amphibian and reptile species that potentially occur in San Luis Potosí.

CLASS AMPHIBIA	
ORDER CAUDATA	
Plethodontidae	
Aquiloeurycea cephalica (Cope, 1869)	Likely to occur in south-southeastern SLP (credible but not documented or published records exist)
Bolitoglossa rufescens (Cope, 1869)	Reported by Taylor (1949) without museum record
ORDER ANURA	
Bufonidae	
Incilius marmoreus (Wiegmann, 1833)	Likely to occur in southeastern SLP
Incilius valliceps (Wiegmann, 1833)	Likely to occur in southeastern SLP
Craugastoridae	
Craugastor rhodopis (Cope, 1867)	Reported by Taylor (1949) without museum record
Eleutherodactylidae	
Eleutherodactylus dennisi (Lynch, 1970)	Likely to occur in southeastern SLP
Eleutherodactylus nitidus (Peters, 1870)	Likely to occur in southeastern SLP
Hylidae	
Sarcohyla bistincta (Cope, 1877)	Likely to occur in southeastern SLP
Ranidae	
Rana spectabilis Hillis & Frost, 1985	Likely to occur in southeastern SLP
CLASS REPTILIA	
ORDER TESTUDINES	
Testudinidae	
Gopherus berlandieri (Agassiz, 1857)	Reported by Taylor (1949) without museum record
ORDER SQUAMATA	
SUBORDER LACERTILIA	
Anguidae	
Gerrhonotus farri Bryson & Graham, 2010	Likely to occur in central-eastern SLP
Phrynosomatidae	
Sceloporus aeneus Wiegmann, 1828	Likely to occur in southeastern SLP
Scincidae	
Scincella gemmingeri (Cope, 1864)	Likely to occur in southeastern SLP
Teiidae	
Aspidoscelis neomexicanus (Lowe & Zweifel, 1952)	Reported by Taylor (1949) without museum record
ORDER SQUAMATA	
SUBORDER SERPENTES	
Colubridae	
Lampropeltis ruthveni Blanchard, 1920	Likely to occur in southern SLP
Dipsadidae	
Rhadinaea montana Smith, 1944	Likely to occur in central-eastern SLP
Leptotyphlopidae	
Epictia goudotti (Duméril & Bibron, 1844)	Likely to occur in southeastern SLP

of the 85 species of snakes are endemic to Mexico (Table 1). Twenty-three snake species that are found in San Luis Potosí are distributed from the United States to Mexico; another 22 species range from Mexico to Central or even South America; eight more species are found from central or southern United States to Central or South America; and four more range from Canada to Mexico or even Central America (Table 1).

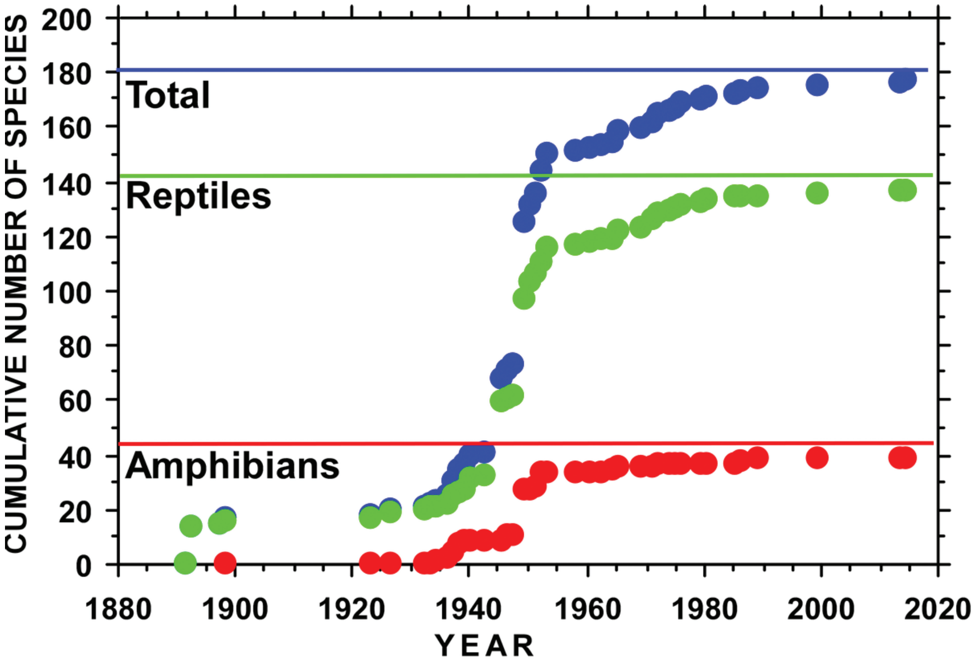

Figure 4. Species accumulation curves for the total herpetofauna, amphibians, and reptiles from San Luis Potosí. Horizontal lines are estimated asymptotes for the species accumulation curves.

Habitat types

When considering all the species of amphibians and reptiles in San Luis Potosí, the number of species in the Chihuahuan Desert, the subtropics of the Sierra Madre Oriental, and generalist habitat types are about equal with 30% of the species occurring in each of these habitat types (Table 3) The temperate forests of the Sierra Madre Oriental has much fewer species (Table 3); however, this overall pattern is primarily a function of the distribution of reptile species, since all reptile groups tend to follow this pattern, with the number of reptile species found only in the temperate forests of the Sierra Madre Oriental being particularly low compared to the other habitat types (Table 3). For amphibians, the pattern is more complicated. Anurans have a higher number of species using the subtropics of the Sierra Madre Oriental and are generalists more than either the Chihuahuan Desert and the temperate forests of the Sierra Madre Oriental (Table 3). On the other hand, 50% of salamander species are found in the temperate forests of the Sierra Madre Oriental (Table 3). These patterns of distribution for amphibians likely parallel their need for moist habitats.

At the family level, some families appear to be primarily associated with specific habitat types whereas others are found across habitat types. Bufonidae, Phrynosomatidae, and Teiidae are primarily associated with the Chihuahuan Desert; Plethodontidae is primarily found in the Sierra Madre Oriental; Hylidae is primarily found in the subtropics of the Sierra Madre Oriental; Colubridae and Dipsadidae are often found

Table 3. Summary of the number of native species (% in parentheses) in different taxonomic groups found in different habitat types in San Luis Potosí, Mexico (see Table 2 for abbreviations).

Taxa	CD	SMO	SBT	GEN
Amphibia	7 (17.5)	7 (17.5)	13 (32.5)	13 (32.5)
Caudata	1 (16.7)	3 (50)	2 (33.3)	0 (0)
Anura	6 (17.6)	4 (11.8)	11 (32.4)	13 (32.5)
Reptilia	48 (34.8)	12 (8.7)	37 (26.8)	41 (29.7)
Crocodylia	0 (0)	0 (0)	1 (100)	0 (0)
Testudines	0 (0)	0 (0)	3 (42.8)	4 (57.1)
Squamata	48 (36.9)	12 (9.2)	33 (25.4)	37 (28.5)
Lacertilia	16 (35.6)	2 (4.4)	10 (22.2)	17 (37.8)
Serpentes	32 (37.6)	10 (11.8)	23 (27.0)	20 (23.5)
Total	55 (30.9)	19 (10.7)	50 (28.1)	54 (30.3)

in the Chihuahuan Desert and the subtropics of the Sierra Madre Oriental, but few of their species are found in the Sierra Madre Oriental; and Viperidae are found in all three habitat types.

Comparisons with neighboring states

Overall, San Luis Potosí shares the most species with Hidalgo and Tamaulipas, and shares the least number of species with Nuevo León (Table 4). It is particularly interesting to note that for most taxa Hidalgo shares the highest proportion of species with San Luis Potosí whereas Tamaulipas shares the highest proportion of lizard species by a large margin and Nuevo León shares a very high proportion (≈ 90%) of phrynosomatid species (Table 4). It is likely that this reflects the more arid nature of Tamaulipas and Nuevo León (i.e., Chihuahuan Desert), compared to the more mountainous Querétaro and Hidalgo. Thus, the numbers and types of shared species among San Luis Potosí and its neighboring states reflects the pattern of habitat and vegetation types found in each neighboring state (see also Smith and Lemos-Espinal 2015, Lemos-Espinal and Smith 2016, Lemos-Espinal et al. 2017). However, the results of the cluster analysis are somewhat different. The cluster analysis found that San Luis Potosí is clustered with the pair of Hidalgo and Querétaro for all species together and reptiles (Figure 5A). In contrast, for amphibians San Luis Potosí clusters with Querétaro, and this pair clusters with the pair of Nuevo León and Hidalgo (Figure 5B). Thus, it appears that amphibians and reptiles show different affinities among these states, again perhaps reflecting the available habitats or environments in each state. It therefore appears that in addition to state-specific conservation and management plans, more integrated habitat specific conservation plans that allow inter-state efforts would be the best approach to preserve the herpetofauna of San Luis Potosí and its neighboring states. In addition, the results of the cluster analysis suggest that amphibians and reptiles will each require different inter-state collaborations (i.e., the states involved in such collaborations might differ between amphibians and reptiles based on the different patterns of clustering between these taxa).

Table 4. Summary of the numbers of species shared between San Luis Potosí and neighboring Mexican states (not including introduced species). The percent of species from San Luis Potosí shared by a neighboring state are given in parentheses. – indicates either San Luis Potosí or the neighboring state has no species in the taxonomic group, thus no value for shared species is provided.

Taxa	San Luis Potosí	Hidalgo	Querétaro	Nuevo León	Tamaulipas
Class Amphibia	40	35 (87.5)	26 (65)	17 (42.5)	29 (72.5)
Order Caudata	6	5 (83.3)	4 (66.7)	0 (0)	4 (66.7)
Ambystomatidae	1	1 (100)	1 (100)	0 (0)	–
Plethodontidae	4	3 (75)	3 (75)	0 (0)	3 (75)
Salamandridae	1	1 (100)	–	–	1 (100)
Order Anura	34	30 (88.2)	22 (64.7)	17 (52)	25 (73.5)
Bufonidae	6	4 (67)	4 (67)	5 (83.3)	5 (83.3)
Craugastoridae	3	3 (100)	2 (67)	1 (33)	2 (67)
Eleutherodactylidae	5	3 (60)	3 (60)	3 (60)	4 (80)
Hylidae	9	9 (100)	6 (67)	2 (22.2)	5 (55.6)
Leptodactylidae	2	2 (100)	–	1 (50)	2 (100)
Microhylidae	2	1 (50)	1 (50)	2 (100)	2 (100)
Ranidae	4	4 (100)	3 (75)	1 (25)	2 (50)
Rhinophrynidae	1	1 (100)	1 (100)	–	1 (100)
Scaphiopodidae	2	2 (100)	2 (100)	2 (100)	2 (100)
Class Reptilia	138	98 (71.0)	92 (66.7)	75 (54.3)	100 (72.5)
Order Crocodylia	1	1 (100)	0 (0)	0 (0)	1 (100)
Crocodylidae	1	1 (100)	–	–	1 (100)
Order Testudines	7	5 (71.4)	3 (42.8)	2 (28.6)	5 (71.4)
Emydidae	2	1 (50)	–	0 (0)	1 (50)
Kinosternidae	4	4 (100)	3 (75)	1 (25)	3 (75)
Trionychidae	1	–	–	1 (100)	1 (100)
Order Squamata	130	92 (70.8)	73 (56.2)	73 (56.2)	94 (72.3)
Suborder Lacertilia	45	25 (55.6)	22 (48.9)	27 (60.0)	36 (80.0)
Anguidae	5	3 (60)	1 (20)	2 (40)	5 (100)
Corytophanidae	2	1 (50)	1 (50)	–	1 (50)
Crotaphytidae	1	–	–	1 (100)	1 (100)
Dactyloidae	2	2 (100)	1 (50)	–	1 (50)
Dibamidae	1	1 (100)	1 (100)	–	1 (100)
Eublepharidae	1	–	–	–	–
Iguanidae	1	1 (100)	–	–	1 (100)
Phrynosomatidae	19	9 (47.4)	10 (52.6)	17 (89.5)	15 (78.9)
Scincidae	5	3 (60)	3 (60)	4 (80)	5 (100)
Teiidae	3	2 (66.7)	2 (66.7)	2 (66.7)	3 (100)
Xantusiidae	4	2 (50)	3 (75)	1 (25)	2 (50)
Xenosauridae	1	1 (100)	0 (0)	–	1 (100)
Suborder Serpentes	85	67 (78.8)	51 (60.0)	46 (54.1)	58 (68.2)
Boidae	1	1 (100)	1 (100)	–	1 (100)
Colubridae	36	24 (66.7)	22 (61.1)	23 (63.9)	27 (75)
Dipsadidae	22	19 (86.4)	13 (59.1)	6 (27.3)	14 (63.6)
Elapidae	1	1 (100)	1 (100)	1 (100)	1 (100)
Leptotyphlopidae	3	2 (66.7)	1 (33.3)	2 (66.7)	2 (66.7)
Natricidae	12	12 (100)	7 (58.3)	7 (58.3)	6 (50)
Viperidae	10	8 (80)	6 (60)	7 (70)	7 (70)
TOTAL	**178**	**133 (74.8)**	**118 (66.3)**	**92 (51.7)**	**129 (72.5)**

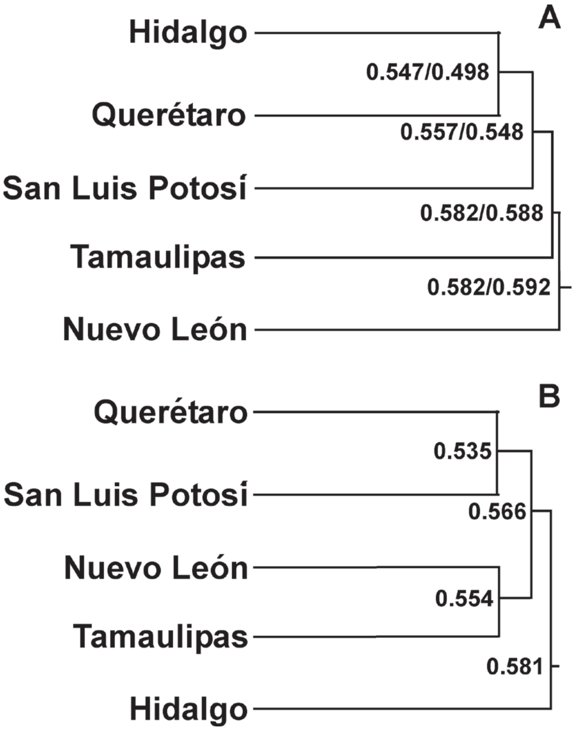

Figure 5. Results of cluster analysis of the herpetofaunas of San Luis Potosí and its neighboring states (Hidalgo, Nuevo León, Querétaro, and Tamaulipas). The distances provided are Euclidean distances for **A** the entire herpetofauna and reptiles only, respectively and **B** amphibians only.

Conservation status

Nearly 82% of the amphibians and reptile species that have been evaluated by the IUCN falls in the Least Concern category (does not include DD species; Table 5, Figure 6). However, only 60% are not listed by SEMARNAT (Table 5, Figure 6). The discrepancy between the IUCN and SEMARNAT listings are greater for reptiles than amphibians (Figure 6). The average EVS for all herpetofaunal species in San Luis Potosí that have been evaluated is 10.67. These overall numbers tend to obscure the presence of particular groups, or even individual species, that occur in San Luis Potosí that are at potential risk and that may warrant special attention. Some taxa of particular concern, based on their IUCN listing, SEMARNAT category, or their EVS include the salamanders in general, and Plethodontidae and Salamandridae in particular; the emydid and trionychid turtles, anguid and xenosaurid lizards, and natricid and colubrid snakes. These taxa reflect assessments at the global or country-level scale. It may be, and indeed it is likely, that there are multiple species of amphibians and reptiles that are more or less threatened at the state level than these larger scale assessments suggest. However, given the relative paucity of population-level studies and assessments on the herpetofauna of San Luis Potosí, such conservation or management needs are unknown.

Table 5. Summary of native species present in San Luis Potosí by family, order or suborder, and class. Status summary indicates the number of species found in each IUCN conservation status in the order DD, LC, V, NT, E, CE (see Table 1 for abbreviations; in some cases species have not been assigned a status by the IUCN and therefore these may not add up to the total number of species in a taxon). Mean EVS is the mean Environmental Vulnerability Score, scores > 14 are considered high vulnerability (Wilson et al., 2013a,b) and conservation status in Mexico according to SEMARNAT (2010) in the order NL, Pr, A, P (see Table 1 for abbreviations).

Class	Order/ Suborder	Family	Status Summary	Mean EVS	SEMARNAT
Amphibia	Caudata		0,1,1,1,1,1	13.33	0,4,1,1
		Ambystomatidae	0,1,0,0,0,0	10	0,1,0,0
		Plethodontidae	0,0,1,1,1,1	14.5	0,3,1,0
		Salamandridae	0,0,0,0,1,0	12	0,0,0,1
	Anura		0,24,4,3,2,0	8.93	22,9,2,1
		Bufonidae	0,5,0,0,0,0	7.6	5,1,0,0
		Craugastoridae	0,1,1,1,0,0	12.33	1,2,0,0
		Eleutherodactylidae	0,2,3,0,0,0	13.2	4,1,0,0
		Hylidae	0,7,0,1,1,0	7.44	7,1,1,0
		Leptodactylidae	0,2,0,0,0,0	5.5	2,0,0,0
		Microhylidae	0,2,0,0,0,0	6.5	1,1,0,0
		Ranidae	0,2,0,1,1,0	11.75	0,2,1,1
		Rhynophrynidae	0,1,0,0,0,0	8	0,1,0,0
		Scaphiopodidae	0,2,0,0,0,0	4.5	2,0,0,0
	Subtotal		0,25,5,4,3,1	9.59	22,13,3,2
Reptilia	Crocodylia		0,1,0,0,0,0	13	0,1,0,0
		Crocodylidae	0,1,0,0,0,0	13	0,1,0,0
	Testudines		0,3,0,1,0,0	13.14	2,5,0,0
		Emydidae	0,0,0,0,0,0	16	2,0,0,0
		Kinosternidae	0,2,0,1,0,0	11.25	0,4,0,0
		Trionychidae	0,1,0,0,0,0	15	0,1,0,0
	Squamata		4,84,5,0,7,0	10.82	80,26,22,1
	Lacertilia		1,29,3,0,2,0	11.84	28,10,6,1
		Anguidae	1,2,1,0,0,0	14	3,1,0,1
		Corytophanidae	0,1,0,0,0,0	10.5	0,2,0,0
		Crotaphytidae	0,1,0,0,0,0	13	0,0,1,0
		Dactyloidae	0,0,0,0,0,0	8.5	2,0,0,0
		Dibamidae	0,1,0,0,0,0	10	0,0,1,0
		Eublepharidae	0,1,0,0,0,0	9	0,0,1,0
		Iguanidae	0,0,0,0,0,0	12	0,1,0,0
		Phrynosomatidae	0,16,0,0,1,0	12	16,1,2,0
		Scincidae	0,3,0,0,0,0	10.0	4,1,0,0
		Teiidae	0,2,0,0,0,0	11.7	3,0,0,0
		Xantusiidae	0,2,2,0,0,0	13.25	0,3,1,0
		Xenosauridae	0,0,0,0,1,0	15	0,1,0,0
	Serpentes		3,55,2,0,5,0	10.29	52,16,16,0
		Boidae	0,0,0,0,0,0		1,0,0,0
		Colubridae	0,25,0,0,2,0	9.42	27,2,6,0
		Dipsadidae	3,10,0,0,2,0	9.73	14,8,0,0
		Elapidae	0,1,0,0,0,0	11	1,0,0,0
		Leptotyphlopidae	0,2,0,0,0,0	13	3,0,0,0
		Natricidae	0,9,2,0,1,0	11	4,0,8,0
		Viperidae	0,8,0,0,0,0	12,9	2,6,2,0
	Subtotal		4,88,5,1,7,0	10.95	82,32,22,1
TOTAL			4,109,10,4,10,1	10.64	105,45,25,3

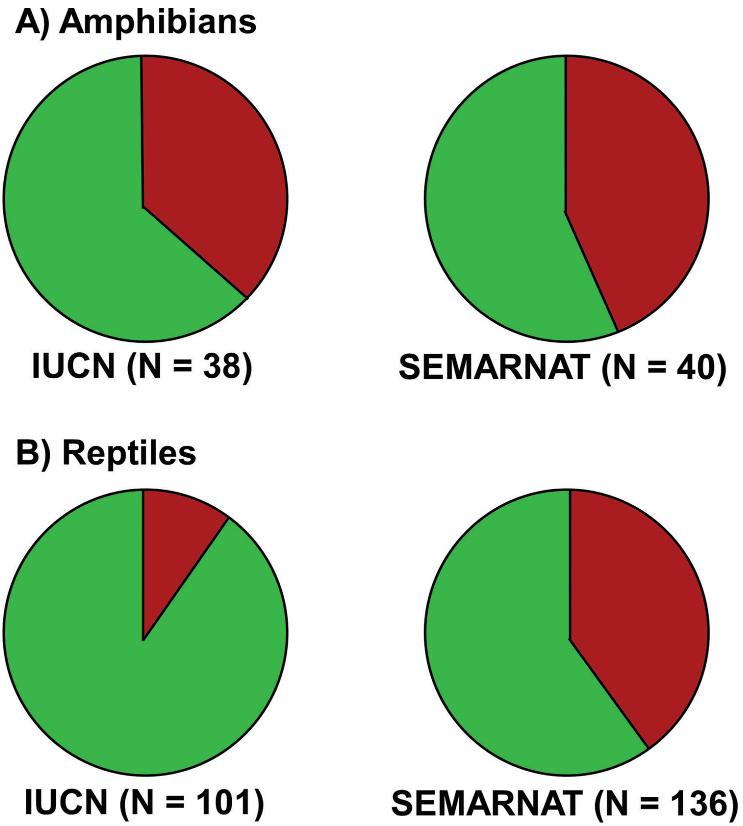

Figure 6. Percent of **A** amphibians and **B** reptiles listed in protected categories on the IUCN Red List and SEMARNAT. Green is percent in Least Concern (IUCN) or Not Listed (SEMARNAT), Red is percent in protected categories. N is the total number of species assessed by each agency.

The conservation status of the reptiles and amphibians in each habitat type was examined. For amphibians, the percentage of species in protected IUCN categories (VU, NT, EN, CE) varied among the habitat types. Twenty-nine percent of amphibians in the Chihuahuan Desert were listed in IUCN categories, 72% in the Sierra Madre Oriental, 46% in the subtropics of the Sierra Madre Oriental, and 8% of the generalists. For SEMARNAT categories, 57% of amphibians in the Chihuahuan Desert, 72% in the Sierra Madre Oriental, 46% of the subtropics of the Sierra Madre Oriental, and 23% of the generalists were listed. Thus, for amphibians, species found in the Sierra Madre Oriental are the most threatened whereas the generalists were least threatened. Reptiles showed a slightly different pattern. For the IUCN listings, all habitat types had relatively few species in the protected categories (Chihuahuan Desert, 8%; Sierra Madre Oriental, 18%; subtropics of the Sierra Madre Oriental, 10%; and generalists, 9%). However, for SEMARNAT, 28% of reptiles in the Chihuahuan Desert, 50% from the Sierra Madre Oriental, 50% from the subtropics of the Sierra Madre Oriental, and 42% of the generalist species were in the protected categories. For reptiles, the conservation status of the species in each habitat type is more evenly distributed across the habitat types than in amphibians.

Hopefully, by establishing this list of herpetofaunal species with their global and country-level conservation statuses will prompt further investigations into the amphibians and reptiles of this state, which could provide the needed information to allow for state specific, or even habitat type, conservation measures to be undertaken. Specific threats known to be present in San Luis Potosí are deforestation and habitat loss (Miranda-Aragón et al. 2012, Reyes Hernández et al. 2013, Ramos-Lara and Koprowski 2014), industrial pollutants and heavy metals (Alcalá-Jáuregui et al. 2014, Pérez-Vázquez et al. 2016a, b), mining (Razo et al. 2004, Chapa-Vargas et al. 2010, Espinosa-Reyes et al. 2014), and overexploitation of water resources (Esteller et al. 2012).

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Three new species of the spider genus *Plato* and the new genus *Cuacuba* from caves of the states of Pará and Minas Gerais, Brazil (Araneae, Theridiosomatidae)

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Abstract

Three new species of the genus *Plato* from caves in the states of Pará and Minas Gerais, Brazil, are described. *P. novalima* **sp. n.,** from Minas Gerais, is the first record of the genus in the southeastern region of Brazil. *P. ferriferus* **sp. n.** and *P. striatus* **sp. n.**, from Carajás, Pará, north of Brazil, are also described. The former is an extremely abundant species, whereas the latter has only one known male specimen**.** *Cuacuba* **gen. n.** is proposed and represented by two new species, *C. mariana* **sp. n.** (type species) and *C. morrodopilar* **sp. n.**, both from the state of Minas Gerais. Morphology of genitalia in *Cuacuba* **gen. n.** is similar to other Theridiosomatidae genera and is herein discussed. None of the proposed species presents troglomorphic adaptations. They are widespread, abundant inside caves in different and large karst areas, and each genus prefers different lithologies.

Keywords

biospeleology, Neotropical region, taxonomy

Introduction

The family Theridiosomatidae Simon 1881 is currently represented by 18 genera and 111 species worldwide (World Spider Catalog 2017). Specimens of this family differ from others by the presence of pits on the anterior margin of the sternum (except in *Chthonos* Coddington, 1986), connate spermathecae in female genitalia (except in *Coddingtonia* Miller, Griswold & Yin, 2009 and *Tagalogonia* Labarque & Griswold, 2014) and tibial dorsal trichobothria, usually 2 to 4 times longer than tibial diameter (shorter only in *Wendilgarda* Keyserling, 1886) (Coddington 1986).

Theridiosomatidae is divided into four subfamilies (Coddington 1986), which include the following Neotropical genera: Epeirotypinae Coddington, 1986, with *Epeirotypus* O. Pickard-Cambridge, 1894 and *Naatlo* Coddington, 1986; Ogulninae Coddington, 1986, only with *Ogulnius* O. Pickard-Cambridge, 1882; Theridiosomatinae Coddington, 1986, with *Theridiosoma* O. Pickard-Cambridge, 1879, *Baalzebub* Coddington, 1986, *Epilineutes* Coddington, 1986 and *Wendilgarda*; Platoninae Coddington, 1986, with *Chthonos* and *Plato* Coddington, 1986. Representatives of the subfamily Platoninae differ from other Theridiosomatidae due to the following characteristics: cubic eggsacs suspended from a single long wire; male palp with paracymbium T-shaped; margin of cymbium and distal alveoli punctuated or bifid medially; medial apophysis with a long and curved tip; and conductor with a thick ventral apophysis (Coddington 1986).

The diagnostic characteristics that differentiate *Plato* from other genera in Theridiosomatidae are the presence of a median projection in the female epigynum base, grooves in the distal or mesal area of the cymbium, and a strong, curved ventral apophysis in the conductor of male palp (Coddington 1986). *Plato* includes six species: the type species *Plato troglodita* Coddington 1986, from Ecuador; *Plato bicolor* (Keyserling 1986), from the Amazonian region in Brazil; *Plato bruneti* (Gertsch 1960), from Trinidad and Tobago; *Plato guacharo* and *Plato miranda*, both described by Brignoli (1972), from Venezuela; and *Plato juberthiei* Lopez 1996, from French Guiana (World Spider Catalog 2017). Their distribution is currently limited to South America and, so far, only *P. bicolor* has been described from Brazil. Specimens of *Plato* are found in caves, near stream passages, or on the wall, next to water bodies, preying on small flying insects (Fig. 3B; Trajano and Bichuette 2010).

Two species were collected from the Carajás region, *Plato ferriferus* sp. n. and *Plato striatus* sp. n. *Plato novalima* sp. n. was collected in the Iron Quadrangle region and surrounding cave areas in the state of Minas Gerais. Besides *Plato*, other Theridiosomatidae genera are also commonly found inside caves, such as *Baalzebub*, also from the state of Minas Gerais (Prete et al. 2016), and *Wendilgarda* (Trajano 1987; Gnaspini and Trajano 1994) and *Epilineutes* (Gnaspini and Trajano 1994), both from the state of São Paulo.

Furthermore, two new species are described and included in the newly proposed genus, *Cuacuba* gen. n. Specimens of this genus were recorded in the literature as unidentified *Plato* sp. from the caves Lapa Encantada (Pinto-da-Rocha 1995) and Morena (Gnaspini and Trajano 1994), both in the state of Minas Gerais. While reexamining the material currently deposited in the IBSP collection, we detected diagnostic characters, mainly in the genital structures, that allow us to propose a new genus to include the type species *Cuacuba mariana* sp. n. and *Cuacuba morrodopilar* sp. n., both from caves of Iron Quadrangle formation. The species of this genus have a set of characteristics that do not place them into any Theridiosomatidae genus. Males are diagnosed by having a bifid conductor with two long apophyses: the posterior one involving a long embolus and the anterior one distally ornamented. Females present an epigynal plate with a projected posterior margin. Relationships among the new genus and other Theridiosomatidae still need to be evaluated phylogenetically as the morphological characters of genitalia in this genus do not allow it to be placed within any of the current subfamilies.

Materials and methods

A total of 3868 adult specimens of five species from 1007 different caves was analyzed. The examined material was collected between 1984 and 2015 and deposited in the following taxonomic collections (curators between parentheses): IBSP, Instituto Butantan, São Paulo (A.D. Brescovit); ISLA, Coleção de Invertebrados Subterrâneos de Lavras, Universidade Federal de Lavras, Lavras (R.L. Ferreira); MPEG, Museu Paraense Emilio Goeldi, Belém (A.B. Bonaldo); MZSP, Museu de Zoologia da Universidade de São Paulo, São Paulo (R. Pinto da Rocha).

Spiders were collected in different karst areas throughout the states of Minas Gerais and Pará in Brazil. Iron and carbonate formations are the most representative among the explored areas. All samples were manually collected.

The material was studied using a stereomicroscope Nikon SMZ 745T. Multifocal photos were taken using a stereomicroscope Leica DFC500 and the Leica Application Suite v3.3.0 software. Scanning Electron Microscopy (SEM) images of the left palp of males (as is standard in arachnological studies) were made using a FEI Quanta 250 microscope from Laboratório de Biologia Celular of Instituto Butantan.

Genitalia were dissected and illustrations were made using a Leica MZ12 stereomicroscope with an attached camera lucida. Descriptions of species follow Coddington (1986). All measurements are presented in millimeters (mm). Maps were produced using GPS Track Maker-PRO and edited in GIMP v2.8.14 and Inkscape v0.48.4. Graphics and tables were made in Microsoft Office Excel 2013.

Abbreviations:

ALE	anterior lateral eyes,
AME	anterior median eyes,
MF	multifocal photo
PLE	posterior lateral eyes,
PME	posterior median eyes,
SEM	scanning electron microscopy.

Collecting sites

Five new species of Theridiosomatidae were found inside caves in the states of Pará and Minas Gerais, Brazil. The species' distributions are mainly restricted to two karst areas of great economic and mineral interest. One of them is the region of Carajás, state of Pará, an important speleological area in Brazil. Its iron formation has a great potential for forming cavities, as it concentrates one of the largest iron reserves in the world. These caves have a singular biological evolution (Ab'Sáber 1986; Piló and Auler 2009), in which a series of discontinuous mountains and hills are separated by wide valleys of iron ore that emerge above the forested plateau with elevations of 600 to 800 m. The main elevations are the northern and southern mountains (Serra Norte e Serra Sul) (Cunha Jr. et al. 2007).

The second area is in the Iron Quadrangle, located in the central part of the state of Minas Gerais, and covers approximately 7,200 km^2. During the evolution of the area`s relief, small erosion surfaces were formed, distributed at different altitudes and with a clear lithostructural control. This region is a unique landscape when compared to the other southeastern geological patterns in Brazil (Varajão 1991).

Taxonomic part

Family Theridiosomatidae
Subfamily Platoninae

Genus *Plato* Coddington, 1986

Type species. *Plato troglodita* Coddington, 1986, by original designation.

Plato ferriferus sp. n.

http://zoobank.org/3C5D2399-EB83-4572-964A-6EF7058C4C9C
Figures 1, 2, 3, 16

Types. Male holotype and female paratype from Cave N4E_0079 (6°02'00"S, 50°09'07"W), Parauapebas, Pará, Brazil, 19/II–4/III/2010, deposited in IBSP 173283. Paratypes: male and female from Cave N5S_0037 (6°06'23"S, 50°07'59"W), 15–21/IX/2009 (MPEG 32028); male and female from Cave N5S_0012 (6°06'13"S, 50°07'33"W), 14–23/X/2009 (MPEG 32027); male and female from Cave N5S_0030 (6°05'20"S, 50°07'12"W), 14–16/XII/2010 (MZSP 70929); male and female from Cave N5S_0028 (6°05'19"S, 50°07'33"W), 10–19/V/2011 (MZSP 70930), all from Parauapebas, Pará, Brazil, R. Andrade & I. Cizauskas et al. coll.

Other material examined. BRAZIL. **Pará**: Parauapebas, FLONA de Carajás, Cave NV_01 (6°28'36"S, 49°54'13"W), 1♀ (IBSP 55373); Cave NV_03 (6°28'43"S, 49°54'10"W), 1♀ (IBSP 55385); Cave NV_05 (6°28'43"S, 49°54'9"W), 1♀ (IBSP 55369); Cave NV_06 (6°28'48"S, 49°54'26"W), 1♀ (IBSP 55380); Cave NV_07 (6°28'41"S, 49°54'20"W), 1♀ (IBSP 55386), all collected on 22–28/II/2005 by R. Andrade et al.; Cave N5E_0001 (6°4'25"S, 50°7'5"W), 1♀ (IBSP 55786); Cave N5E_0008 (6°4'54"S, 50°7'50"W), 2♀ (IBSP 55379); Cave N5E_0009 (6°4'54"S, 50°7'43"W), 1♀ (IBSP 55383); Cave N5E_0010 (6°4'50"S, 50°7'42"W), 2♀ (IBSP 55377); Cave N5E_0011 1♀ (IBSP 55374); Cave N5E_0013, 1♀ (IBSP 55368); Cave N5E_0014, 2♀ (IBSP 55370); Cave N5E_0015 1♀ (IBSP 55378); Cave N5E_0016 2♀ (IBSP 55375), all collected on 22/III–03/IV/2005 by R. Andrade et al.; Cave N5E_0004 (6°5'11"S, 50°7'47"W), 1♂ 2♀, 03–13/V/2005 (IBSP 55376), collected by R. Andrade et al.; Cave N4E_0017 (6°2'7"S, 50°9'37"W), 2♀ (IBSP 174998); Cave N4E_0027 (6°2'15"S, 50°10'4"W), 1♀ (IBSP 175039); Cave N4E_0028 (6°2'15"S, 50°10'3"W), 2♀ (IBSP 175040); Cave N4E_0030 (6°2'25"S, 50°9'41"W), 3♀ (IBSP 175041); Cave N4E_0032 (6°2'24"S, 50°9'40"W), 1♂ 1♀, (IBSP 175049); Cave N4E_0034 (6°2'24"S, 50°9'39"W), 2♀ (IBSP 175065); Cave N4E_0035 (6°2'20"S, 50°9'39"W), 1♂ 2♀ (IBSP 175067); Cave N4E_0036 (6°2'10"S, 50°9'37"W), 1♀ (IBSP 175071); 1♀, 18/VIII–03/IX/2009 (IBSP 173197); Cave N4E_0038 (6°2'6"S, 50°9'39"W), 1♀ (IBSP 175073); Cave N4E_0040 (6°2'1"S, 50°9'45"W), 2♀ (IBSP 175074); Cave N4E_0041 (6°2'0"S, 50°9'43"W), 3♀ (IBSP 175076); 3♀, 24–30/VII/2009 (IBSP 173209); Cave N4E_0061 (6°2'22"S, 50°10'5"W), 1♂ 3♀ (IBSP 175078); 7♀, 24–30/VII/2009 (IBSP 173216, IBSP 173217, IBSP 173218, IBSP 173219), all collected by R. Andrade et al.; Cave N4E_0010 (6°2'22"S, 50°9'40"W), 2♀ (IBSP 174967, IBSP 174971), 1♂ 1♀, 20/IV–04/V/2010 (IBSP 173323, IBSP 173324), 3♀, 20/X–01/XI/2006 (IBSP 174966); Cave N4E_0022 (6°2'3"S, 50°10'5"W) 1♀ (IBSP 175017); 7♀, 20/IV–04/V/2010 (IBSP 173344–IBSP 173347); 1♂ 9♀, 20/X–01/XI/2006 (IBSP 175013); Cave N4E_0026 (6°2'16"S, 50°10'4"W), 7♀ (IBSP 175027); 1♂ 19♀, 08–12/II/2007 (IBSP 175026); 2♂ 16♀, 18/VIII–03/IX/2009 (IBSP 173187–IBSP 173192); Cave N4E_0033 (6°2'26"S, 50°9'38"W), 1♂ 3♀ (IBSP 175059); 1♂ 15♀, 08–12/II/2007 (IBSP 175054); 2♂ 7♀, 15–22/IX/2009 (IBSP 173200–IBSP 173203); Cave N4E_0068 (6°1'56"S, 50°9'4"W), 3♂ 2♀ (IBSP 175081); 3♀, 19/II–04/III/2010 (IBSP 173252, IBSP 173253); 1♂ 2♀, 24–30/VII/2009 (IBSP 173146, IBSP 173147); Cave N4E_0092 (6°2'24"S, 50°9'32"W), 3♀ (IBSP 175082); 2♂ 5♀, 19/II–04/III/2010 (IBSP 173297–IBSP 173300); 11♀, 24–30/VII/2009 (IBSP 173180–IBSP 173184); Cave N4E_0095 (6°2'25"S, 50°9'33"W), 1♂ 6♀ (IBSP 175085, IBSP 175086); 2♂ 7♀, 19/II–04/III/2010 (IBSP 173303–IBSP 173305); 1♂ 13♀, 24–30/VII/2009 (IBSP 173166–IBSP 173169) all collected by R. Andrade et al.; Cave N4E_0039 (6°1'60"S, 50°9'40"W), 1♂ 3♀ (IBSP 173206–IBSP 173208); Cave N4E_0062 (6°2'2"S, 50°9'14"W), 1♀ (IBSP 173138); Cave N4E_0082 (6°2'0"S, 50°9'23"W), 4♀ (IBSP 173143, IBSP 173144) all collected on 24–30/VII/2009 by R. Andrade et al.; Cave N4E_0031 (6°2'26"S, 50°9'41"W), 1♂ 1♀ (IBSP 173195); Cave N4E_0085 (6°2'4"S, 50°9'27"W), 4♀ (IBSP 173193, IBSP 173194); 1♀, 19/II–04/III/2010 (IBSP 173289); Cave N4E_0087 (6°1'58"S, 50°9'2"W), 1♀ (IBSP 173185,

IBSP 173186); 1♀, 20/IV–04/V/2010 (IBSP 173290, IBSP 173291) all collected by R. Andrade et al.; Cave N4E_0075 (6°1'54"S, 50°9'3"W), 1♂ 5♀ (IBSP 173204, IBSP 173205); 2♂ 6♀, 19/II–04/III/2010 (IBSP 173274, IBSP 173275, IBSP 173276, IBSP 173277) collected by I. Cizauskas; Cave N4E_0043 (6°1'56"S, 50°9'52"W), 2♀ (IBSP 173220); Cave N4E_0044 (6°1'56"S, 50°9'51"W), 1♂ 3♀ (IBSP 173221, IBSP 173222); 2♀, 24–30/VII/2009 (IBSP 173210, IBSP 173211); Cave N4E_0045 (6°2'27"S, 50°9'42"W), 2♀ (IBSP 173224); Cave N4E_0046 (6°2'17"S, 50°9'38"W), 1♂ 2♀ (IBSP 173232–IBSP 173234); Cave N4E_0048 (6°2'17"S, 50°9'38"W), 2♀ (IBSP 173235, IBSP 173239); Cave N4E_0050 (6°2'11"S, 50°9'37"W), 1♀ (IBSP 173225); Cave N4E_0051 (6°2'24"S, 50°9'40"W), 2♀ (IBSP 173236); 1♂ 1♀, 24–30/VII/2009 (IBSP 173212); Cave N4E_0054 (6°2'2"S, 50°10'9"W), 2♀ (IBSP 173226, IBSP 173227); Cave N4E_0055 (6°1'56"S, 50°10'1"W), 1♀ (IBSP 173229); 1♀ 24–30/VII/2009 (IBSP 173213); Cave N4E_0057 (6°1'57"S, 50°9'50"W), 3♀ (IBSP 173230, IBSP 173231); 1♂ (IBSP 173214); Cave N4E_0059 (6°2'13"S, 50°10'5"W), 1♂ 1♀ (IBSP 173237, IBSP 173238); Cave N4E_0060 (6°2'13"S, 50°10'6"W), 1♀ (IBSP 173228); 1♀ (IBSP 173215); Cave N4E_0063 (6°2'3"S, 50°9'17"W), 2♀ (IBSP 173223); Cave N4E_0065 (6°1'59"S, 50°9'6"W), 3♀ (IBSP 173243, IBSP 173244); Cave N4E_0066 (6°1'53"S, 50°9'5"W), 1♂ 2♀ (IBSP 173245, IBSP 173246); Cave N4E_0067 (6°1'56"S, 50°9'4"W), 6♀ (IBSP 173247–IBSP 173250); 2♂ 3♀ (IBSP 173139, IBSP 173140); Cave N4E_0069 (6°1'56"S, 50°9'11"W), 3♀ (IBSP 173254); 4♀ (IBSP 173155–IBSP 173158); Cave N4E_0070 (6°1'57"S, 50°9'12"W), 1♂ 5♀ (IBSP 173255–IBSP 173258); 3♂ 15♀ (IBSP 173148–IBSP 173152); Cave N4E_0071 (6°1'58"S, 50°9'14"W), 1♀ (IBSP 173259); 1♂ 5♀ (IBSP 173141, IBSP 173142); Cave N4E_0072 (6°1'58"S, 50°9'14"W), 7♀ (IBSP 173260–IBSP 173263); 9♀ (IBSP 173162–IBSP 173164); Cave N4E_0073 (6°1'58"S, 50°9'15"W), 13♀ (IBSP 173264–IBSP 173268, IBSP 173273); 2♂ 3♀ (IBSP 173175–IBSP 173179); Cave N4E_0074 (6°2'0"S, 50°9'22"W), 12♀ (IBSP 173269–IBSP 173272); 7♀ (IBSP 173133–IBSP 173137); Cave N4E_0076 (6°2'1"S, 50°9'5"W), 2♀ (IBSP 173278, IBSP 173279); Cave N4E_0077 (6°1'59"S, 50°9'4"W), 1♂ 1♀ (IBSP 173280, IBSP 173281); 3♀ (IBSP 173131, IBSP 173132); Cave N4E_0078 (6°1'59"S, 50°9'6"W), 2♀ (IBSP 173282); 3♀ (IBSP 173159–IBSP 173161); Cave N4E_0079 (6°1'60"S, 50°9'7"W), 3♀ (IBSP 173284–IBSP 173286); 1♀ (IBSP 173165); Cave N4E_0081 (6°2'0"S, 50°9'22"W), 2♂ 4♀ (IBSP 173240–IBSP 173242); 2♂ 1♀ (IBSP 173170, IBSP 173171); Cave N4E_0083 (6°2'0"S, 50°9'24"W), 1♀ (IBSP 173251); Cave N4E_0084 (6°2'2"S, 50°9'15"W), 2♀ (IBSP 173287, IBSP 173288); 2♀ (IBSP 173145); Cave N4E_0088 (6°1'56"S, 50°9'4"W), 4♀ (IBSP 173290, IBSP 173291); 1♂ 4♀ (IBSP 173185, IBSP 173186); Cave N4E_0089 (6°2'0"S, 50°9'8"W), 2♂ 5♀ (IBSP 173292, IBSP 173293, IBSP 173294); 2♀ (IBSP 173153, IBSP 173154); Cave N4E_0090 (6°2'2"S, 50°9'6"W), 1♀ (IBSP 173295); Cave N4E_0091 (6°2'2"S, 50°9'16"W), 2♀ (IBSP 173296); Cave N4E_0093 (6°2'24"S, 50°9'32"W), 5♀ (IBSP 173301 IBSP 173302); 1♂ 6♀ (IBSP 173172–IBSP 173174) all collected on 24–30/VII/2009 by R. Andrade et al.; Cave N4E_0064 (6°1'57"S, 50°9'5"W), 1♂

3♀ (IBSP 173306, IBSP 174319, IBSP 177221, IBSP 184741); 1♂ 1♀, 18/VIII–03/IX/2009 (IBSP 173198); Cave N4E_0086 (6°2'7"S, 50°9'39"W), 1♀ (IBSP 173307); 3♀, 18/VIII–03/IX/2009 (IBSP 173196) all collected on 14/III–04/IV/2010 by R. Andrade et al.; Cave N4E_0001 (6°2'26"S, 50°9'41"W), 3♀ (IBSP 173308, IBSP 173309); 1♂ 8♀ (IBSP 174935); Cave N4E_0002 (6°2'26"S, 50°9'40"W), 2♂ 2♀ (IBSP 173310, IBSP 177222, IBSP 184738, IBSP 174938); Cave N4E_0003 (6°2'26"S, 50°9'40"W), 1♀ (IBSP 173311); 2♀ (IBSP 174943); Cave N4E_0004 (6°2'27"S, 50°9'41"W), 2♀ (IBSP 173312); Cave N4E_0005 (6°2'24"S, 50°9'39"W), 1♂ 4♀ (IBSP 173313, IBSP 174317); 5♀ (IBSP 174948); Cave N4E_0006 (6°2'23"S, 50°9'37"W), 2♂ (IBSP 177223, IBSP 184740); Cave N4E_0007 (6°2'22"S, 50°9'37"W), 1♀ (IBSP 173314); 1♀ (IBSP 174951); Cave N4E_0008 (6°2'22"S, 50°9'37"W), 1♂ 3♀ (IBSP 173318–IBSP 173320); 1♂ 3♀ (IBSP 174963); Cave N4E_0009 (6°2'23"S, 50°9'38"W), 1♀ (IBSP 173322); Cave N4E_0011 (6°2'21"S, 50°9'40"W), 2♀ (IBSP 173325, IBSP 173326); 1♂ (IBSP 174973); Cave N4E_0012 (6°2'18"S, 50°9'39"W), 2♀ (IBSP 173327, IBSP 174318); Cave N4E_0013 (6°2'19"S, 50°9'39"W), 3♀ (IBSP 173328, IBSP 173329); 1♀ (IBSP 174977); Cave N4E_0014 (6°2'19"S, 50°9'39"W), 3♀ (IBSP 173330–IBSP 173332); 1♂ 2♀ (IBSP 174988); Cave N4E_0015 (6°2'11"S, 50°9'37"W), 4♀ (IBSP 173315, IBSP 173316, IBSP 173317); 2♀ (IBSP 174992); Cave N4E_0016 (6°2'7"S, 50°9'39"W), 2♀ (IBSP 173333, IBSP 173334); 1♂ (IBSP 174995); Cave N4E_0018 (6°2'6"S, 50°9'39"W), 1♂ (IBSP 177224, IBSP 184739); Cave N4E_0019 (6°2'5"S, 50°9'39"W), 1♀ (IBSP 173335); 5♀ (IBSP 175002); Cave N4E_0020 (6°2'3"S, 50°9'37"W), 1♂ 1♀ (IBSP 173336, IBSP 173337); Cave N4E_0021 (6°2'3"S, 50°9'38"W), 2♂ 6♀ (IBSP 173338–IBSP 173343); 4♀ (IBSP 175009); Cave N4E_0023 (6°2'3"S, 50°10'9"W), 1♂ 4♀ (IBSP 173348–IBSP 173350); 1♂ 3♀ (IBSP 175022); Cave N4E_0025 (6°2'3"S, 50°10'9"W), 1♀ (IBSP 173321), all collected on 20/X–01/XI/2006 by R. Andrade et al.; Cave N5S_0008 (6°6'21"S, 50°7'57"W), 2♀ (IBSP 174522, IBSP 174525); 3♂ 14♀, 14–23/X/2009 (IBSP 172714–IBSP 172718, IBSP 174502); Cave N5S_0010 (6°6'21"S, 50°7'53"W), 2♀ (IBSP 174527); 13♀, 14–23/X/2009 (IBSP 172722–IBSP 172728); Cave N5S_0011 (6°6'18"S, 50°7'47"W), 1♂ 1♀ (IBSP 174530); 1♂ 19♀, 14–23/X/2009 (IBSP 172729–IBSP 172736); Cave N5S_0021 (6°5'15"S, 50°7'34"W), 4♀ (IBSP 174535, IBSP 174539, IBSP 174540); 1♂ 9♀, 25/VIII–03/IX/2009 (IBSP 172659–IBSP 172664), all collected by R. Andrade et al.; Cave N5S_0050 (6°6'26"S, 50°8'1"W), 1♂ 1♀ (IBSP 172652); 1♀, 14/III-04/IV/2010 (IBSP 172769); Cave N5S_0017 (6°5'17"S, 50°7'12"W), 6♀ (IBSP 172665, IBSP 172666); Cave N5S_0018 (6°5'11"S, 50°7'39"W), 1♀ (IBSP 172673); Cave N5S_0019 (6°5'13"S, 50°7'37"W), 4♀ (IBSP 172671, IBSP 172672); Cave N5S_0020 (6°5'16"S, 50°7'37"W), 8♀ (IBSP 172654, IBSP 172655, IBSP 172656, IBSP 172658); Cave N5S_0022 (6°5'16"S, 50°7'33"W), 2♀ (IBSP 172643); Cave N5S_0047 (6°6'26"S, 50°8'2"W), 1♀ (IBSP 172642); Cave N5S_0059 (6°6'29"S, 50°7'58"W), 1♂ 4♀ (IBSP 172641, IBSP 172763, IBSP 172790); Cave N5S_0069 (6°6'4"S, 50°8'8"W), 2♀ (IBSP 172674), all collected on 25/VIII–03/IX/2009 by R. Andrade et al.; Cave N5S_0039 (6°6'21"S, 50°8'2"W), 1♀ (IBSP 174503); Cave

N5S_0040 (6°6'20"S, 50°8'2"W), 1♀ (IBSP 172756); Cave N5S_0061 (6°6'20"S, 50°8'5"W), 6♀ (IBSP 172684, IBSP 172791, IBSP 172792); Cave N5S_0062 (6°6'19"S, 50°8'8"W), 1♀ (IBSP 172685); Cave N5S_0066 (6°6'13"S, 50°8'9"W), 5♀ (IBSP 172690, IBSP 174504); Cave N5S_0080 (6°6'9"S, 50°8'15"W), 2♂ 3♀ (IBSP 172688, IBSP 172689, IBSP 174505), all collected on 15–21/IX/2009 by R. Andrade & I. Cizauskas et al.; Cave N5S_0001 (6°5'27"S, 50°7'31"W), 1♀ (IBSP 172737); Cave N5S_0002 (6°5'33"S, 50°7'33"W), 3♀ (IBSP 172748); Cave N5S_0003 (6°6'18"S, 50°8'4"W), 3♀ (IBSP 172708–IBSP 172710); Cave N5S_0004 (6°6'21"S, 50°8'4"W), 3♀ (IBSP 172705–IBSP 172707); Cave N5S_0005 (6°6'21"S, 50°8'1"W), 1♀ (IBSP 172702); Cave N5S_0006 (6°6'21"S, 50°8'2"W), 3♂ 2♀, (IBSP 172703, IBSP 172704); 1♂ 5♀, 15–21/IX/2009 (IBSP 172691–IBSP 172694); Cave N5S_0007 (6°6'22"S, 50°8'1"W), 1♀ (IBSP 172701); Cave N5S_0009 (6°6'22"S, 50°7'53"W), 6♀ (IBSP 172749–IBSP 172752); Cave N5S_0012 (6°6'13"S, 50°7'33"W), 15♀ (IBSP 172738–IBSP 172743, IBSP 172745–IBSP 172747); Cave N5S_0013 (6°6'19"S, 50°8'2"W), 4♀ (IBSP 172711–IBSP 172713); Cave N5S_0014 (6°6'21"S, 50°8'2"W), 2♀ (IBSP 172720, IBSP 172721); Cave N5S_0016 (6°6'21"S, 50°8'1"W), 2♀ (IBSP 172719), all collected on 10–19/V/2011 by R. Andrade et al.; Cave N5S_0036 (6°6'24"S, 50°7'54"W), 1♀ (IBSP 172753); Cave N5S_0037 (6°6'23"S, 50°7'59"W), 3♀ (IBSP 172754); 2♀, 15–21/IX/2009 (IBSP 172755); Cave N5S_0041 (6°6'20"S, 50°8'3"W), 3♀ (IBSP 172758, IBSP 172759); 1♀, 15–21/IX/2009 (IBSP 172757); Cave N5S_0042 (6°6'22"S, 50°8'4"W), 4♀, 25/VIII–03/IX/2009 (IBSP 172760); 1♀ (IBSP 172761); Cave N5S_0044 (6°6'26"S, 50°8'3"W), 1♂ 1♀ (IBSP 172778); 1♀ (IBSP 172777); Cave N5S_0045 (6°6'25"S, 50°8'2"W), 2♀ (IBSP 172762, IBSP 172764); 3♀ (IBSP 172679); Cave N5S_0049 (6°6'27"S, 50°8'1"W), 3♀ (IBSP 172765, IBSP 172767 IBSP 172768); 2♀ (IBSP 172678, IBSP 172766); Cave N5S_0051 (6°6'28"S, 50°8'1"W), 2♀ (IBSP 172776); 1♀ (IBSP 172775); Cave N5S_0052 (6°6'29"S, 50°7'60"W), 7♀ (IBSP 172770–IBSP 172774); 1♀ (IBSP 172677); Cave N5S_0054 (6°6'29"S, 50°8'0"W), 1♂ (IBSP 172780); 2♀, 25/VIII–03/IX/2009 (IBSP 172779); Cave N5S_0055 (6°6'29"S, 50°7'58"W), 1♀ (IBSP 172781); 2♂ 1♀ (IBSP 172653, IBSP 172782); Cave N5S_0056 (6°6'29"S, 50°7'59"W), 2♀ (IBSP 172784, IBSP 172785); 1♂ 1♀ (IBSP 172636, IBSP 172783); Cave N5S_0057 (6°6'29"S, 50°7'59"W), 2♂ 5♀ (IBSP 172786, IBSP 172787); 1♂ 9♀ (IBSP 172637– IBSP 172640); Cave N5S_0058 (6°6'29"S, 50°7'59"W), 1♂ 4♀ (IBSP 172788, IBSP 172789); Cave N5S_0063 (6°6'14"S, 50°8'9"W), 13♀ (IBSP 172793–IBSP 172802); 1♂ 10♀, 15–21/IX/2009 (IBSP 172695–IBSP 172700); Cave N5S_0068 (6°6'5"S, 50°8'8"W), 1♀ (IBSP 172804); 1♂ 4♀, 25/VIII–03/IX/2009 (IBSP 172803, IBSP 174322); Cave N5S_0070 (6°6'7"S, 50°8'5"W), 2♀ (IBSP 172805, IBSP 172806); 4♀ 25/VIII–03/IX/2009 (IBSP 172657, IBSP 172667, IBSP 172668); Cave N5S_0071 (6°6'4"S, 50°8'8"W), 1♀ (IBSP 172808); 1♂, 25/VIII–03/IX/2009 (IBSP 172807); Cave N5S_0072 (6°6'4"S, 50°8'7"W), 1♀ (IBSP 172809); 1♀, 25/VIII–03/IX/2009 (IBSP 172644); Cave N5S_0073 (6°6'3"S, 50°8'6"W), 5♀ (IBSP 172812, IBSP 172813); 4♀, 25/VIII–03/IX/2009 (IBSP 172675, IBSP 172676); Cave N5S_0074 (6°6'3"S,

50°8'6"W), 1♂ (IBSP 172814); 2♀, 25/VIII–03/IX/2009 (IBSP 172669, IBSP 172670); Cave N5S_0075 (6°6'3"S, 50°8'2"W), 1♂ 2♀ (IBSP 172810, IBSP 172811); 2♂ 1♀, 25/VIII–03/IX/2009 (IBSP 172649–IBSP 172651); Cave N5S_0078 (6°6'9"S, 50°8'15"W), 4♀ (IBSP 172815, IBSP 172816, IBSP 174324); 1♀, 15–21/IX/2009 (IBSP 172686); Cave N5S_0079 (6°6'10"S, 50°8'14"W), 3♀ (IBSP 172817, IBSP 177562); 1♂ 6♀, 15–21/IX/2009 (IBSP 172680, IBSP 172681, IBSP 172682, IBSP 174320); Cave N5S_0081 (6°6'10"S, 50°8'14"W), 3♀ (IBSP 172818); Cave N5S_0082 (6°6'11"S, 50°8'14"W), 2♀ (IBSP 174506); Cave N5S_0083 (6°6'20"S, 50°8'13"W), 2♀ (IBSP 172819, IBSP 172820); 1♂ 2♀, 15–21/IX/2009 (IBSP 172687); Cave N5S_0085 (6°5'13"S, 50°7'36"W), 7♀ (IBSP 172821–IBSP 172825); 5♀, 25/VIII–03/IX/2009 (IBSP 172645–IBSP 172648), all collected on 14/III–04/IV/2010 by R. Andrade et al.; Cave N5S_0025 (6°5'13"S, 50°7'40"W), 1♀ (IBSP 172835); 2♀, 14–16/XII/2010 (IBSP 172826); Cave N5S_0028 (6°5'19"S, 50°7'33"W), 2♀ (IBSP 172836); 1♀ (IBSP 172827); Cave N5S_0030 (6°5'20"S, 50°7'12"W), 6♀ (IBSP 172838–IBSP 172841); 4♀ (IBSP 172829–IBSP 172831); Cave N5S_0032 (6°5'35"S, 50°7'10"W), 1♂ 6♀ (IBSP 172842–IBSP 172844); Cave N5S_0033 (6°6'14"S, 50°7'33"W), 4♀ (IBSP 172845, IBSP 172846); 1♀ (IBSP 172833); Cave N5S_0035 (6°6'21"S, 50°7'50"W), 1♀ (IBSP 172847); 1♀ (IBSP 172832); Cave N5PSE_01 (6°6'15"S, 50°9'6"W), 1♀ (IBSP 172851); Cave N5PSE_02 (6°6'14"S, 50°9'6"W), 2♀ (IBSP 172852); 1♀, 11–13/XII/2010 (IBSP 172848); Cave N5PSE_04 (6°6'21"S, 50°9'7"W), 1♀ (IBSP 177777); Cave N5PSE_05 (6°6'21"S, 50°9'8"W), 1♂ 7♀ (IBSP 172853–IBSP 172855); 2♂ 6♀ (IBSP 172849, IBSP 172850); Cave N5PSE_06 (6°6'4"S, 50°9'6"W), 1♂ (IBSP 172856); Cave N5PSL_01 (6°4'8"S, 50°8'41"W), 1♀ (IBSP 177778); Cave N5PSL_02 (6°3'45"S, 50°7'54"W), 1♀ (IBSP 172857); Cave N5PSL_03 (6°3'45"S, 50°7'54"W), 1♂ (IBSP 177779) all collected on 11–13/XII/2010 by I. Cizauskas et al.; Cave N4WS_0011 (6°4'9"S, 50°11'38"W), 3♂ 4♀ (IBSP 174772); Cave N4WS_0012 (6°4'0"S, 50°11'46"W), 2♂ (IBSP 174775); Cave N4WS_0014 (6°3'54"S, 50°11'21"W), 2♀ (IBSP 174784) all collected 20/X–01/XI/2006 by R. Andrade et al.; Cave N4WS_0008 (6°5'22"S, 50°11'41"W), 1♀ (IBSP 174800); 2♀, 10–19/V/2011 (IBSP 173497, IBSP 173498); 1♂ 3♀, 18/XI–01/XII/2010 (IBSP 173420–IBSP 173423); Cave N4WS_0015 (6°3'59"S, 50°11'22"W), 5♂ 6♀ (IBSP 174807, IBSP 174815); 1♂ 21♀, 20/IV–04/V/2010 (IBSP 173400–IBSP 173414); 1♂ 16♀, 20/X–01/XI/2006 (IBSP 174792), all collected by R. Andrade et al.; Cave N4WS_0050 (6°4'44"S, 50°11'36"W), 1♀ (IBSP 172769); 1♂ 1♀, 25/VIII–03/IX/2009 (IBSP 172652); Cave N4WS_0067 (6°4'23"S, 50°11'31"W), 1♀ (IBSP 177563); 1♀ 20/IV–04/V/2010 (IBSP 184745); Cave N4WS_0076 (6°4'29"S, 50°11'20"W), 1♂ (IBSP 174325) all collected 14/III–04/IV/2010 by F. P. Franco et al.; Cave N4WS_0013 (6°3'59"S, 50°11'23"W), 4♀ (IBSP 173398, IBSP 173399); 1♀ 20/X–01/XI/2006 (IBSP 174781); Cave N4WS_0017 (6°3'54"S, 50°11'44"W), 1♂ 2♀ (IBSP 173415, IBSP 173416); 1♂ 8♀ 20/X–01/XI/2006 (IBSP 174797), all collected by F. P. Franco et al.; Cave N4WS_0022 (6°3'48"S, 50°11'34"W), 2♂ 3♀ (IBSP 173478); Cave N4WS_0026 (6°3'56"S, 50°11'28"W), 2♀ (IBSP 173424);

Cave N4WS_0027 (6°3'56"S, 50°11'29"W), 2♀ (IBSP 173445); Cave N4WS_0029 (6°3'49"S, 50°11'30"W), 1♀ (IBSP 173442); Cave N4WS_0042 (6°4'24"S, 50°11'41"W), 1♀ (IBSP 173449); Cave N4WS_0044 (6°4'23"S, 50°11'43"W), 1♀ (IBSP 173450); Cave N4WS_0046 (6°4'30"S, 50°11'40"W), 1♀ (IBSP 173451); Cave N4WS_0047 (6°4'32"S, 50°11'40"W), 2♀ (IBSP 173426, IBSP 173427); Cave N4WS_0054 (6°5'15"S, 50°11'42"W), 1♂ 1♀ (IBSP 173465); Cave N4WS_0056 (6°4'35"S, 50°11'29"W), 1♀ (IBSP 173428); Cave N4WS_0061 (6°4'37"S, 50°11'40"W), 1♂ 2♀ (IBSP 173479); Cave N4WS_0068 (6°4'24"S, 50°11'31"W), 1♀ (IBSP 173458); Cave N4WS_0074 (6°4'20"S, 50°11'23"W), 1♂ (IBSP 173460), all collected 18/XI–01/XII/2010 by F. P. Franco et al.; Cave N4WS_0001 (6°3'46"S, 50°11'32"W), 1♀ (IBSP 173480); 2♂ 2♀, (IBSP 173429, IBSP 173430, IBSP 173431); Cave N4WS_0002 (6°4'22"S, 50°11'40"W), 1♂ 3♀ (IBSP 173481, IBSP 173482); Cave N4WS_0003 (6°4'21"S, 50°11'41"W), 3♀ (IBSP 173483, IBSP 173484); 2♀ (IBSP 173417); Cave N4WS_0004 (6°4'21"S, 50°11'43"W), 10♀ (IBSP 173485–IBSP 173489, IBSP 177775, IBSP 177776); 8♀ (IBSP 173432–IBSP 173436, IBSP 177774); Cave N4WS_0005 (6°4'27"S, 50°11'40"W), 1♀ (IBSP 173490); 1♀ (IBSP 173437); Cave N4WS_0009 (6°5'22"S, 50°11'41"W), 1♂ 3♀ (IBSP 173499, IBSP 173500) 2♂ 9♀, (IBSP 173466–IBSP 173470); Cave N4WS_0010 (6°5'23"S, 50°11'42"W), 1♂ 8♀ (IBSP 173501–IBSP 173505); 7♀ (IBSP 173474–IBSP 173477); Cave N4WS_0020 (6°4'29"S, 50°11'0"W), 6♀ (IBSP 173507–IBSP 173509); 1♂ (IBSP 173473); Cave N4WS_0024 (6°3'49"S, 50°11'31"W), 1♂ 1♀ (IBSP 172834, IBSP 173511); Cave N4WS_0035 (6°5'7"S, 50°10'56"W), 2♀ (IBSP 173515, IBSP 173516); 1♂ 2♀, (IBSP 173443, IBSP 173444); Cave N4WS_0037 (6°6'45"S, 50°10'56"W), 1♂ 2♀ (IBSP 173517, IBSP 173518); 1♂ 1♀, (IBSP 173446, IBSP 173447); Cave N4WS_0041 (6°4'24"S, 50°11'42"W), 4♀ (IBSP 173519, IBSP 173520); 1♀ (IBSP 173448); Cave N4WS_0043 (6°4'23"S, 50°11'42"W), 3♀ (IBSP 173521); Cave N4WS_0058 (6°4'25"S, 50°11'41"W), 2♀ (IBSP 173529); Cave N4WS_0063 (6°4'23"S, 50°11'47"W), 3♂ 7♀ (IBSP 173530–IBSP 173532); 1♂ 6♀ (IBSP 173479, IBSP 173454–IBSP 173457); Cave N4WS_0064 (6°4'53"S, 50°11'45"W), 3♀ (IBSP 173533–IBSP 173535) 3♀ (IBSP 173471, IBSP 173472); Cave N4WS_0065 (6°5'55"S, 50°11'27"W), 3♀ (IBSP 173536); Cave N4WS_0069 (6°4'19"S, 50°11'40"W), 2♀ (IBSP 173537); 1♀ (IBSP 173459); Cave N4WS_0073 (6°4'26"S, 50°11'39"W), 1♂ 3♀ (IBSP 173538, IBSP 174378); 1♂ 2♀ (IBSP 173462, IBSP 173463); Cave N4WS_0075 (6°4'29"S, 50°11'23"W), 1♀ (IBSP 173541); 1♀ (IBSP 173464); Cave N4WS_0078 (6°4'22"S, 50°11'23"W), 1♀ (IBSP 173539); Cave N4WS_0079 (6°4'34"S, 50°11'28"W), 1♀ (IBSP 173540); Cave N4WS_0080 (6°4'34"S, 50°11'28"W), 1♀ (IBSP 173542); 1♀ (IBSP 173461), all collected 18/XI–01/XII/2010 by F. P. Franco et al.; Cave N4WS_0006 (6°4'36"S, 50°11'36"W), 3♀ (IBSP 173491, IBSP 173492); 3♀ (IBSP 173418, IBSP 173419); Cave N4WS_0007 (6°5'22"S, 50°11'41"W), 6♀ (IBSP 173493–IBSP 173496); 1♂ 3♀ (IBSP 173438–IBSP 173440); Cave N4WS_0018 (6°4'35"S, 50°11'38"W), 1♀ (IBSP 173506); 1♀ (IBSP 173441); Cave N4WS_0021 (6°3'59"S, 50°11'24"W), 1♀

(IBSP 173510); Cave N4WS_0031 (6°4'1"S, 50°11'26"W), 3♀ (IBSP 173512); Cave N4WS_0032 (6°4'5"S, 50°11'33"W), 2♀ (IBSP 173513, IBSP 173514) 1♀ (IBSP 173425); Cave N4WS_0049 (6°4'39"S, 50°11'39"W), 1♂ 1♀ (IBSP 173522, IBSP 173523); Cave N4WS_0055 (6°4'51"S, 50°11'46"W), 1♂ 5♀ (IBSP 173524–IBSP 173528) 1♂ 1♀ (IBSP 173452, IBSP 173453), all collected 18/XI–01/XII/2010 by F. P. Franco et al.; Cave N4WS_0040 (6°3'59"S, 50°11'37"W), 2♀ (IBSP 181381, IBSP 181382), Equipe Carste coll.; Cave N5SM1_0005 (6°6'42"S, 50°8'8"W), 1♂ 2♀ 01/IX/2010 (IBSP 176988); Cave N5SM1_0031 (6°6'20"S, 50°8'19"W), 2♀ 21/II/2011 (IBSP 177007); Cave N5SM1_0032 (6°6'19"S, 50°8'19"W), 2♀ 07–12/X/2008 (IBSP 176982, IBSP 177011); 1♂, 07/II/2011 (IBSP 184732), all collected by R. Zampaulo et al.; Cave N5SM1_0009 (6°6'27"S, 50°8'2"W), 6♀ (ISLA 14823); Cave N5SM2_0001 (6°8'32"S, 50°8'1"W), 1♂ 5♀ (ISLA 14691, ISLA 14718); Cave N5SM2_0002 (6°8'31"S, 50°8'3"W), 3♀ (ISLA 14654, ISLA 14759); Cave N5SM2_0003 (6°8'31"S, 50°8'6"W), 1♂ 3♀ (ISLA 14698, ISLA 14730); Cave N5SM2_0004 (6°8'28"S, 50°8'5"W), 5♀ (ISLA 14660, ISLA 14727); Cave N5SM2_0005 (6°8'27"S, 50°8'8"W), 8♀ (ISLA 14706, ISLA 14732); Cave N5SM2_0006 (6°8'28"S, 50°8'9"W), 6♀ (ISLA 14692); Cave N5SM2_0007 (6°8'27"S, 50°8'11"W), 1♂ 5♀ (ISLA 14657, ISLA 14724); Cave N5SM2_0008 (6°8'27"S, 50°8'9"W), 3♀ (ISLA 14758); Cave N5SM2_0009 (6°8'29"S, 50°8'14"W), 2♀ (ISLA 14734); Cave N5SM2_0010 (6°8'24"S, 50°8'17"W), 1♀ (ISLA 14668); Cave N5SM2_0011 (6°8'21"S, 50°8'17"W), 2♀ (ISLA 14714); Cave N5SM2_0012 (6°8'18"S, 50°8'18"W), 1♂ 2♀ (ISLA 14663); Cave N5SM2_0013 (6°8'16"S, 50°8'10"W), 1♂ 4♀ (ISLA 14666); Cave N5SM2_0014 (6°8'18"S, 50°8'0"W), 2♂ 1♀ (ISLA 14701); Cave N5SM2_0015 (6°8'17"S, 50°8'1"W), 2♀ (ISLA 14669, ISLA 14671); Cave N5SM2_0016 (6°8'17"S, 50°7'59"W), 3♀ (ISLA 14688); Cave N5SM2_0017 (6°8'19"S, 50°8'2"W), 2♀ (ISLA 14655, ISLA 14744); Cave N5SM2_0018 (6°8'18"S, 50°8'2"W), 2♀ (ISLA 14751); Cave N5SM2_0020 (6°7'59"S, 50°7'52"W), 1♀ (ISLA 14726); Cave N5SM2_0021 (6°7'58"S, 50°7'52"W), 7♀ (ISLA 14708, ISLA 14778); Cave N5SM2_0022 (6°8'8"S, 50°8'7"W), 3♀ (ISLA 14771); Cave N5SM2_0024 (6°8'8"S, 50°8'6"W), 1♂ 4♀ (ISLA 14680, ISLA 14763); Cave N5SM2_0025 (6°8'9"S, 50°8'6"W), 1♀ (ISLA 14746); Cave N5SM2_0026 (6°8'9"S, 50°8'6"W), 6♀ (ISLA 14681, ISLA 14749); Cave N5SM2_0027 (6°8'6"S, 50°8'12"W), 1♂ 9♀ (ISLA 14679, ISLA 14745); Cave N5SM2_0028 (6°8'4"S, 50°8'15"W), 1♀ (ISLA 14697); Cave N5SM2_0029 (6°8'5"S, 50°8'9"W), 1♂ (ISLA 14674); Cave N5SM2_0032 (6°8'3"S, 50°8'9"W), 1♀ (ISLA 14713); Cave N5SM2_0033 (6°8'3"S, 50°8'8"W), 1♂ (ISLA 14686); Cave N5SM2_0034 (6°8'2"S, 50°8'8"W), 2♀ (ISLA 14747); Cave N5SM2_0035 (6°8'2"S, 50°8'6"W), 1♂ 4♀ (ISLA 14650, ISLA 14752); Cave N5SM2_0036 (6°7'60"S, 50°8'4"W), 1♀ (ISLA 14757); Cave N5SM2_0037 (6°7'59"S, 50°8'5"W), 3♀ (ISLA 14651, ISLA 14753); Cave N5SM2_0038 (6°7'58"S, 50°8'5"W), 2♀ (ISLA 14725); Cave N5SM2_0039 (6°7'58"S, 50°8'6"W), 1♀ (ISLA 14768); Cave N5SM2_0040 (6°7'58"S, 50°8'12"W), 5♀ (ISLA 14659); Cave N5SM2_0041 (6°7'58"S, 50°8'12"W), 1♂ (ISLA 14777); Cave N5SM2_0042 (6°7'57"S, 50°8'11"W), 1♂ 4♀

(ISLA 14694); Cave N5SM2_0043 (6°7'56"S, 50°8'10"W), 1♂ 2♀ (ISLA 14682, ISLA 14779); Cave N5SM2_0044 (6°7'56"S, 50°8'6"W), 4♀ (ISLA 14723, ISLA 14770); Cave N5SM2_0045 (6°7'55"S, 50°8'6"W), 1♂ 7♀ (ISLA 14705, ISLA 14782); Cave N5SM2_0046 (6°7'54"S, 50°8'6"W), 8♀ (ISLA 14693, ISLA 14775); Cave N5SM2_0049 (6°7'52"S, 50°8'5"W), 1♂ 6♀ (ISLA 14658, ISLA 14739); Cave N5SM2_0050 (6°7'51"S, 50°8'6"W), 1♂ 1♀ (ISLA 14704, ISLA 14767); Cave N5SM2_0051 (6°7'51"S, 50°8'5"W), 1♂ 2♀ (ISLA 14675, ISLA 14743); Cave N5SM2_0052 (6°7'51"S, 50°8'5"W), 1♂ (ISLA 14750); Cave N5SM2_0053 (6°7'49"S, 50°8'5"W), 2♀ (ISLA 14703, ISLA 14719); Cave N5SM2_0054 (6°7'48"S, 50°8'4"W), 5♀ (ISLA 14667, ISLA 14738); Cave N5SM2_0056 (6°7'47"S, 50°8'5"W), 1♂ 5♀ (ISLA 14773); Cave N5SM2_0057 (6°7'47"S, 50°8'5"W), 1♂ 20♀ (ISLA 14687, ISLA 14760); Cave N5SM2_0058 (6°7'46"S, 50°8'5"W), 3♀ (ISLA 14656); Cave N5SM2_0059 (6°7'45"S, 50°8'5"W), 2♀ (ISLA 14672, ISLA 14699); Cave N5SM2_0060 (6°7'43"S, 50°8'9"W), 1♀ (ISLA 14676); Cave N5SM2_0061 (6°7'43"S, 50°8'6"W), 2♂ 4♀ (ISLA 14677, ISLA 14766); Cave N5SM2_0063 (6°7'42"S, 50°8'5"W), 2♀ (ISLA 14781); Cave N5SM2_0064 (6°7'43"S, 50°8'7"W), 5♀ (ISLA 14695, ISLA 14774); Cave N5SM2_0065 (6°7'41"S, 50°8'8"W), 1♀ (ISLA 14683); Cave N5SM2_0067 (6°7'39"S, 50°8'12"W), 1♂ 7♀ (ISLA 14664, ISLA 14772); Cave N5SM2_0068 (6°7'34"S, 50°8'15"W), 1♀ (ISLA 14685); Cave N5SM2_0069 (6°7'39"S, 50°7'55"W), 1♂ (ISLA 14649); Cave N5SM2_0070 (6°7'31"S, 50°7'55"W), 2♀ (ISLA 14769); Cave N5SM2_0071 (6°7'31"S, 50°7'55"W), 1♂ 1♀ (ISLA 14737); Cave N5SM2_0072 (6°7'31"S, 50°7'54"W), 1♂ (ISLA 14741); Cave N5SM2_0074 (6°7'32"S, 50°7'56"W), 2♀ (ISLA 14729); Cave N5SM2_0075 (6°7'32"S, 50°7'55"W), 1♂ 7♀ (ISLA 14670, ISLA 14712, ISLA 14755); Cave N5SM2_0076 (6°7'31"S, 50°7'54"W), 2♂ 6♀ (ISLA 14696, ISLA 14762); Cave N5SM2_0077 (6°7'28"S, 50°7'52"W), 2♀ (ISLA 14716); Cave N5SM2_0078 (6°7'23"S, 50°7'49"W), 3♂ 17♀ (ISLA 14673, ISLA 14756); Cave N5SM2_0079 (6°7'23"S, 50°7'50"W), 2♂ 1♀ (ISLA 14715); Cave N5SM2_0080 (6°7'20"S, 50°7'47"W), 1♂ 11♀ (ISLA 14689, ISLA 14711); Cave N5SM2_0081 (6°7'19"S, 50°7'44"W), 4♀ (ISLA 14662, ISLA 14740); Cave N5SM2_0082 (6°7'20"S, 50°7'43"W), 1♀ (ISLA 14731); Cave N5SM2_0084 (6°7'20"S, 50°7'41"W), 1♀ (ISLA 14710); Cave N5SM2_0086 (6°7'16"S, 50°7'47"W), 3♀ (ISLA 14653); Cave N5SM2_0087 (6°7'16"S, 50°7'43"W), 1♂ 3♀ (ISLA 14665); Cave N5SM2_0088 (6°7'15"S, 50°7'44"W), 5♂ 9♀ (ISLA 14690, ISLA 14733); Cave N5SM2_0089 (6°7'15"S, 50°7'44"W), 11♀ (ISLA 14684, ISLA 14754, ISLA 14761, ISLA 14765); Cave N5SM2_0090 (6°7'14"S, 50°7'45"W), 4♀ (ISLA 14700, ISLA 14721); Cave N5SM2_0091 (6°7'14"S, 50°7'46"W), 2♀ (ISLA 14717); Cave N5SM2_0092 (6°7'17"S, 50°7'55"W), 3♀ (ISLA 14722); Cave N5SM2_0093 (6°7'17"S, 50°7'56"W), 6♀ (ISLA 14678, ISLA 14735); Cave N5SM2_0094 (6°7'10"S, 50°7'54"W), 2♀ (ISLA 14702, ISLA 14776); Cave N5SM2_0095 (6°7'6"S, 50°7'54"W), 4♀ (ISLA 14764); Cave N5SM2_0096 (6°8'6"S, 50°8'12"W), 2♂ 5♀ (ISLA 14661, ISLA 14742); Cave N5SM2_0097 (6°7'42"S, 50°8'9"W), 1♀ (ISLA 14652); Cave N5SM2_0098 (6°8'28"S, 50°8'3"W), 2♂ 2♀ (ISLA 14736); Cave N5SM2_0100 (6°7'17"S, 50°7'55"W), 3♀ (ISLA 14707, ISLA 14728); Cave N5SM2_0101 (6°7'16"S, 50°7'54"W), 5♀ (ISLA 14780); Cave N5SM2_0102 (6°7'17"S, 50°7'52"W), 3♀ (ISLA 14720); Cave GEM-1747, 2♀ (ISLA 14709), all collected on 2010-2011 by Equipe Carste; Cave PPOR_0001 (6°3'53"S, 50°4'56"W), 5♀, 03–17/IV/2013 (IBSP 173903, IBSP 173904, IBSP 173905, IBSP 173906); 1♀, 26/IX–17/X/2012 (IBSP 173897); Cave PPOR_0002 (6°3'24"S, 50°4'49"W), 1♀, 26/IX–17/X/2012 (IBSP 173898); Cave PPOR_0003 (6°3'2"S, 50°5'57"W), 1♀, 26/IX–17/X/2012 (IBSP 173899) all collected by Equipe Carste; Cave N2_0005 (6°3'10"S, 50°14'32"W), 1♀ (IBSP 173357); Cave N2_0012 (6°3'10"S, 50°14'32"W), 1♀ (IBSP 173358); Cave N3_0008 (6°1'48"S, 50°12'4"W), 1♂ (IBSP 173704); Cave N3_0014 (6°1'59"S, 50°12'21"W), 1♂ 1♀ (IBSP 173711, IBSP 173712); Cave N3_0018 (6°1'44"S, 50°12'2"W), 3♀ (IBSP 173714, IBSP 173715); Cave N3_0025 (6°2'30"S, 50°13'6"W), 1♂ 1♀ (IBSP 173727, IBSP 173728); Cave N3_0058 (6°2'31"S, 50°13'24"W), 4♀ (IBSP 173731, IBSP 173757, IBSP 173758); Cave N3_0059 (6°2'30"S, 50°12'52"W), 1♀ (IBSP 173759); Cave N3_0060 (6°2'27"S, 50°13'8"W), 1♂ 2♀ (IBSP 173760, IBSP 173761) all collected on 26/IX–17/X/2012 by Equipe Carste coll.; Cave N3_0001 (6°1'47"S, 50°12'5"W), 2♂ (IBSP 173763, IBSP 173764); 2♀ (IBSP 173697); Cave N3_0002 (6°1'45"S, 50°12'4"W), 1♀ (IBSP 173698); 2♀ (IBSP 173765); Cave N3_0003 (6°1'45"S, 50°12'4"W), 5♀ (IBSP 173766–IBSP 173770); 1♂ 1♀ (IBSP 173699); Cave N3_0004 (6°1'46"S, 50°12'4"W), 1♀ (IBSP 173771); 3♀ (IBSP 173700–IBSP 173702); Cave N3_0005 (6°1'47"S, 50°12'5"W), 1♀ (IBSP 173772); Cave N3_0007 (6°1'48"S, 50°12'4"W), 2♀ (IBSP 173773); 1♀ (IBSP 173703); Cave N3_0009 (6°1'47"S, 50°12'4"W), 1♀ (IBSP 173774); Cave N3_0011 (6°1'49"S, 50°12'2"W), 3♀ (IBSP 173775, IBSP 173776); 4♀ (IBSP 173705–IBSP 173707); Cave N3_0013 (6°2'1"S, 50°12'5"W), 3♀ (IBSP 173777, IBSP 173778); 1♂ 2♀ (IBSP 173708–IBSP 173710); Cave N3_0016 (6°2'3"S, 50°12'42"W), 1♀ (IBSP 173780); Cave N3_0017 (6°2'2"S, 50°12'49"W), 3♀ (IBSP 173781–IBSP 173783); 1♀ (IBSP 173713); Cave N3_0019 (6°1'43"S, 50°12'2"W), 2♀ (IBSP 173784, IBSP 173785); 1♀ (IBSP 173716); Cave N3_0020 (6°2'6"S, 50°12'34"W), 1♂ 11♀ (IBSP 173786–IBSP 173792); 12♀ (IBSP 173717–IBSP 173726); Cave N3_0026 (6°2'33"S, 50°13'7"W), 4♀ (IBSP 173798–IBSP 173801); 2♀ (IBSP 173729, IBSP 173730); Cave N3_0027 (6°2'41"S, 50°13'14"W), 1♂ (IBSP 173802); Cave N3_0033 (6°2'43"S, 50°13'14"W), 2♀ (IBSP 173803, IBSP 173804); Cave N3_0036 (6°2'47"S, 50°13'15"W), 3♀ (IBSP 173805, IBSP 173806); 1♀ (IBSP 173732); Cave N3_0037 (6°2'46"S, 50°13'15"W), 2♀ (IBSP 173807, IBSP 173808); 1♂ 11♀ (IBSP 173733–IBSP 173739); Cave N3_0039 (6°2'25"S, 50°13'23"W), 1♀ (IBSP 173809); 2♀ (IBSP 173740, IBSP 173741); Cave N3_0041 (6°2'24"S, 50°13'16"W), 1♂ 4♀ (IBSP 173810–IBSP 173813); 1♂ 7♀ (IBSP 173742–IBSP 173748); Cave N3_0042 (6°2'23"S, 50°13'16"W), 10♀ (IBSP 173814–IBSP 173818); 8♀ (IBSP 173749–IBSP 173753); Cave N3_0043 (6°2'14"S, 50°13'6"W), 3♀ (IBSP 173819–IBSP 173821); 1♀ (IBSP 173754); Cave N3_0045 (6°2'1"S, 50°12'22"W), 1♀ (IBSP 173822); Cave N3_0057 (6°2'33"S, 50°13'23"W), 2♂ 2♀ (IBSP 173824, IBSP

178965); Cave N3_0055 (6°2'30"S, 50°13'8"W), 1♂ (IBSP 173823); 1♂ 1♀ (IBSP 173755, IBSP 173756), all collected on 26/IX–17/X/2012 by Equipe Carste; Cave N2_0001 (6°3'17"S, 50°14'25"W), 2♀ (IBSP 173373); 2♀ (IBSP 173352, IBSP 173353); Cave N2_0003 (6°3'17"S, 50°14'41"W), 7♀ (IBSP 173374–IBSP 173379); 3♀ (IBSP 173354, IBSP 173355); Cave N2_0004 (6°3'10"S, 50°14'35"W), 3♀ (IBSP 173380, IBSP 173381); 1♀ (IBSP 173356); Cave N2_0007 (6°3'15"S, 50°14'23"W), 3♀ (IBSP 173382–IBSP 173384); Cave N2_0008 (6°3'15"S, 50°14'23"W), 1♀ (IBSP 173385); Cave N2_0009 (6°3'15"S, 50°14'23"W), 1♀ (IBSP 173386); Cave N2_0013 (6°3'10"S, 50°14'34"W), 3♀ (IBSP 173387, IBSP 173359); Cave N2_0014 (6°3'2"S, 50°14'57"W), 1♀ (IBSP 173388); Cave N2_0015 (6°3'3"S, 50°14'56"W), 1♀ (IBSP 173389); Cave N2_0016 (6°3'10"S, 50°14'35"W), 1♀ (IBSP 173390); 1♂ 3♀ (IBSP 173360–IBSP 173363); Cave N2_0017 (6°3'7"S, 50°14'40"W), 1♂ 1♀ (IBSP 173391); Cave N2_0022 (6°3'1"S, 50°15'3"W), 2♀ (IBSP 173392); 2♂ 3♀ (IBSP 173364–IBSP 173367); Cave N2_0026 (6°2'5"S, 50°12'34"W), 7♀ (IBSP 173393–IBSP 173397); 1♂ 7♀ (IBSP 173368–IBSP 173372); Cave N3_0015 (6°2'7"S, 50°12'29"W), 1♀ (IBSP 173779); Cave N3_0032 (6°2'39"S, 50°13'12"W), 1♀ (IBSP 173827); Cave N3_0049 (6°2'26"S, 50°13'38"W), 1♀ (IBSP 173836); Cave N3_0050 (6°2'25"S, 50°13'40"W), 1♀ (IBSP 173842); Cave N3_0071 (6°2'38"S, 50°13'52"W), 1♂ 1♀ (IBSP 173864, IBSP 173865); Cave N3_0073 (6°2'38"S, 50°13'47"W), 2♀ (IBSP 173868, IBSP 173869); Cave N3_0072 (6°2'38"S, 50°13'51"W), 2♀ (IBSP 173866, IBSP 173867); Cave N3_0078 (6°2'37"S, 50°13'44"W), 2♀ (IBSP 173872); Cave N3_0067 (6°2'31"S, 50°13'36"W), 1♂ 3♀ (IBSP 173855–IBSP 173857); 1♀ (IBSP 173762); Cave N3_0068 (6°2'30"S, 50°13'35"W), 2♂ 7♀ (IBSP 173858–IBSP 173862); Cave N3_0064 (6°2'29"S, 50°13'37"W), 1♀ (IBSP 173853); Cave N3_0065 (6°2'28"S, 50°13'37"W), 1♂ (IBSP 173854); Cave N6_0003 (6°8'9"S, 50°10'5"W), 1♂ 1♀ (IBSP 173900, IBSP 173901); Cave N6_0004 (6°7'31"S, 50°10'12"W), 1♀ (IBSP 173902), all collected on 26/IX–17/X/2012 by Equipe Carste; Cave N3_0024 (6°2'28"S, 50°13'7"W), 2♀ (IBSP 173873, IBSP 173874) 6♀ 05–17/III/2013 (IBSP 173793–IBSP 173797); Cave N3_0038 (6°2'22"S, 50°13'29"W), 1♂ 1♀ (IBSP 173875, IBSP 173876); 1♂ 03–17/IV/2013 (IBSP 173828); Cave N3_0070 (6°2'40"S, 50°13'50"W), 1♂ (IBSP 173889); 3♀ 03–17/IV/2013 (IBSP 173863); Cave N3_0051 (6°2'39"S, 50°13'33"W), 1♀ (IBSP 173882); Cave N3_0056 (6°2'38"S, 50°13'32"W), 1♂ (IBSP 173887); 2♂ 4♀, 03–17/IV/2013 (IBSP 173845–IBSP 173848); Cave N3_0074 (6°2'37"S, 50°13'51"W), 3♀ (IBSP 173890–IBSP 173892); 2♀, 05–17/III/2013 (IBSP 173825, IBSP 173826); Cave N3_0063 (6°2'33"S, 50°13'36"W), 1♂ 2♀ (IBSP 173888); 6♀, 03–17/IV/2013 (IBSP 173849, IBSP 173850–IBSP 173852); Cave N3_0076 (6°2'30"S, 50°13'37"W), 1♂ 3♀ (IBSP 173893–IBSP 173896); 3♀, 03–17/IV/2013 (IBSP 173870, IBSP 173871); Cave N3_0047 (6°2'28"S, 50°13'41"W), 5♀ (IBSP 173877–IBSP 173881); 2♂ 1♀, 03–17/IV/2013 (IBSP 173829–IBSP 173835); Cave N3_0052 (6°2'27"S, 50°13'44"W), 1♂ 4♀ (IBSP 173883–IBSP 173885); 6♀, 03–17/IV/2013 (IBSP 173837–IBSP 173841); Cave N3_0054 (6°2'27"S, 50°13'43"W), 1♀ (IBSP 173886); 1♂ 3♀, 03–17/IV/2013 (IBSP 173843, IBSP 173844); Cave

N5W_0001 (6°4'47"S, 50°8'0"W), 5♀ (IBSP 172858–IBSP 172860); Cave N5W_0002 (6°4'48"S, 50°8'1"W), 2♀ (IBSP 172861); Cave N5W_0003 (6°4'52"S, 50°8'4"W), 1♂ 7♀ (IBSP 172862–IBSP 172868); Cave N5W_0007 (6°4'52"S, 50°8'4"W), 1♀ (IBSP 172869); Cave N5W_0008 (6°4'54"S, 50°8'4"W), 1♂ 4♀ (IBSP 172870–IBSP 172874) all collected on 02–23/VIII/2013 by Equipe Carste; Cave N6_0005 (6°7'22"S, 50°10'28"W), 1♀ (IBSP 181310); Cave N6_0006 (6°8'8"S, 50°10'3"W), 1♀ (IBSP 181311); Cave N8_0028 (6°10'33"S, 50°9'29"W), 2♀ (IBSP 181329, IBSP 181330); Cave N8_0021 (6°10'7"S, 50°9'28"W), 1♀ (IBSP 181328); Cave N8_0012 (6°10'7"S, 50°9'29"W), 1♀ (IBSP 181327); 1♀ 24/II–13/III/2015 (IBSP 181547); Cave N8_0002 (6°10'5"S, 50°9'35"W), 1♀ (IBSP 181312); Cave N8_0031 (6°9'54"S, 50°9'30"W), 6♀ (IBSP 181331–IBSP 181334), all collected on 16/VII–06/VIII/2014 by Equipe Carste; Cave N8_0017 (6°10'7"S, 50°9'27"W), 2♀ (IBSP 181386, IBSP 181387); Cave N8_0004 (6°10'7"S, 50°9'29"W), 1♀ (IBSP 181472), collected by Equipe Carste; Cave N8_0019 (6°10'11"S, 50°9'27"W), 1♀ (IBSP 181544); Cave N8_0010 (6°10'10"S, 50°9'35"W), 2♀ (IBSP 181545, IBSP 181546); 3♀, 16/VII–06/VIII/2014 (IBSP 181324–IBSP 181326); Cave N8_0018 (6°10'8"S, 50°9'28"W), 1♂ 1♀ (IBSP 181551, IBSP 181552); Cave N8_0011 (6°10'8"S, 50°9'29"W), 1♀ (IBSP 181547); Cave N8_0009 (6°10'8"S, 50°9'36"W), 3♀ (IBSP 181541, IBSP 181542, IBSP 181543); 2♂ 7♀, 16/VII–06/VIII/2014 (IBSP 181316–IBSP 181323); Cave N8_0023 (6°10'8"S, 50°9'30"W), 2♀ (IBSP 181555); Cave N8_0008 (6°10'7"S, 50°9'34"W), 1 (IBSP 181532–IBSP 181540); 2♀, 16/VII–06/VIII/2014 (IBSP 181314, IBSP 181315); Cave N8_0014 (6°10'7"S, 50°9'31"W), 1♀ (IBSP 181550); Cave N8_0022 (6°10'6"S, 50°9'30"W), 2♀ (IBSP 181553, IBSP 181554); Cave N8_0007 (6°10'6"S, 50°9'36"W), 1♂ 3♀ (IBSP 181528–IBSP 181531); Cave N8_0003 (6°10'6"S, 50°9'32"W), 1♀ (IBSP 181525); 1♂ 1♀, 04/IX–06/X/2014 (IBSP 181383, IBSP 181384); Cave N8_0005 (6°10'6"S, 50°9'32"W), 1♀ (IBSP 181526); Cave N8_0013 (6°10'6"S, 50°9'31"W), 2♀ (IBSP 181548, IBSP 181549); 1♀, 04/IX–06/X/2014 (IBSP 181385); Cave N8_0006 (6°10'5"S, 50°9'38"W), 1♂ (IBSP 181527); 1♀, 16/VII–06/VIII/2014 (IBSP 181313); Cave N8_0036 (6°10'1"S, 50°9'13"W), 1♂ 1♀ (IBSP 181559, IBSP 181560); Cave N8_0033 (6°10'0"S, 50°9'16"W), 2♀ (IBSP 181556, IBSP 181557); Cave N8_0035 (6°9'59"S, 50°9'14"W), 3♀ (IBSP 181558); 1♀, 16/VII–06/VIII/2014 (IBSP 181335), all collected by Equipe Carste; Cave N1_0002 (6°2'26"S, 50°16'13"W), 2♀ (IBSP 174650); Cave N1_0004 (6°2'25"S, 50°16'14"W), 3♂ 7♀ (IBSP 174653, IBSP 174654); 4♀, 16/VII–06/VIII/2014 (IBSP 181276–IBSP 181279); Cave N1_0008 (6°2'21"S, 50°16'15"W), 2♀ (IBSP 174658, IBSP 174659); 3♀, 11/VI–02/VII/2014 (IBSP 181240–IBSP 181242); 1♀, 24/II–13/III/2015 (IBSP 181445); Cave N1_0014 (6°2'4"S, 50°16'21"W), 3♀ (IBSP 174661); 1♀, 03–17/XII/2014 (IBSP 181388); 2♀, 11/VI–02/VII/2014 (IBSP 181243); Cave N1_0015 (6°2'3"S, 50°16'17"W), 5♀ (IBSP 174666); 3♀, 11/VI–02/VII/2014 (IBSP 181244, IBSP 181245); 3♀, 24/II–13/III/2015 (IBSP 181446–IBSP 181448); Cave N1_0018 (6°2'3"S, 50°16'19"W), 3♀ (IBSP 174670); 2♀, 07–28/I/2015 (IBSP 181420, IBSP 181421); 1♂ 1♀, 11/VI–02/VII/2014 (IBSP 181246, IBSP 181247); Cave N1_0022

(6°1'58"S, 50°16'20"W), 5♀ (IBSP 174736); 1♀, 07–28/I/2015 (IBSP 181429); 1♀, 16/VII–06/VIII/2014 (IBSP 181283); Cave N1_0025 (6°1'54"S, 50°16'21"W), 1♂ 5♀ (IBSP 174684, IBSP 174686); 2♂ 1♀, 02–29/IV/2015 (IBSP 181481, IBSP 181482); 1♂ 2♀, 04/IX–06/X/2014 (IBSP 181337, IBSP 181338); Cave N1_0037 (6°1'51"S, 50°16'29"W), 2♀ (IBSP 174687); Cave N1_0039 (6°1'48"S, 50°16'16"W), 3♀ (IBSP 174689); 1♀, 02–29/IV/2015 (IBSP 181484); 1♀, 04/IX–06/X/2014 (IBSP 181344); Cave N1_0072 (6°1'15"S, 50°17'19"W), 8♀ (IBSP 174693, IBSP 174696); Cave N1_0075 (6°1'16"S, 50°16'50"W), 2♂ 5♀ (IBSP 174701, IBSP 174703); Cave N1_0116 (6°0'41"S, 50°18'52"W), 3♀ (IBSP 174710); Cave N1_0119 (6°1'17"S, 50°18'8"W), 5♀ (IBSP 174713); 1♀, 02–29/IV/2015 (IBSP 181503); 2♀, 16/VII–06/VIII/2014 (IBSP 181294, IBSP 181295); Cave N1_0143 (6°1'38"S, 50°17'29"W), 1 (IBSP 174717, IBSP 174719); Cave N1_0170 (6°1'25"S, 50°17'60"W), 1♂ 6♀ (IBSP 174722, IBSP 174723); 1♀, 03–17/XII/2014 (IBSP 181402); Cave N1_0173 (6°1'29"S, 50°17'57"W), 3♀ (IBSP 174725); 1♀, 07–28/I/2015 (IBSP 181440); 1♀, 16/VII–06/VIII/2014 (IBSP 181307); Cave N1_0176 (6°1'30"S, 50°18'4"W), 2♀ (IBSP 174729); Cave N1_0180 (6°2'35"S, 50°16'26"W), 1♀ (IBSP 174732); Cave N1_0212 (6°1'49"S, 50°18'3"W), 1♀ (IBSP 174735), all collected by R. Andrade et al.; Cave N1_0074 (6°1'18"S, 50°16'51"W), 1♀ (IBSP 181257); Cave N1_0084 (6°1'8"S, 50°17'2"W), 1♀ (IBSP 181258); Cave N1_0104 (6°0'34"S, 50°18'3"W), 1♀ (IBSP 181259); Cave N1_0114 (6°0'49"S, 50°18'24"W), 1♂ 2♀ (IBSP 181260, IBSP 181261); Cave N1_0149 (6°2'32"S, 50°16'30"W), 2♀ (IBSP 181264, IBSP 181265); 1♀, 24/II–13/III/2015 (IBSP 181462); Cave N1_0156 (6°2'42"S, 50°16'23"W), 1♀ (IBSP 181267); Cave N1_0237 (6°1'17"S, 50°16'27"W), 1♀ (IBSP 181271); Cave N1_0228 (6°1'11"S, 50°17'3"W), 1♀ (IBSP 181270), all collected on 11/VI–02/VII/2014 by Equipe Carste; Cave N1_0186 (6°2'38"S, 50°16'35"W), 1♀ (IBSP 181309); 1♀, 24/II–13/III/2015 (IBSP 181464), all collected by Equipe Carste; Cave N1_0016 (6°1'11"S, 50°16'42"W), 1♂ (IBSP 181336); Cave N1_0031 (6°1'47"S, 50°16'21"W), 1♂ (IBSP 181339); Cave N1_0033 (6°1'52"S, 50°16'30"W), 1♀ (IBSP 181340); Cave N1_0035 (6°1'51"S, 50°16'30"W), 1♀ (IBSP 181341); Cave N1_0043 (6°1'51"S, 50°16'34"W), 1♀ (IBSP 181346); Cave N1_0044 (6°1'14"S, 50°16'43"W), 1♀ (IBSP 181347); 1♀ (IBSP 181451); Cave N1_0045 (6°1'45"S, 50°16'33"W), 1♀ (IBSP 181348); 1♀ (IBSP 181452); Cave N1_0049 (6°1'42"S, 50°16'33"W), 1♀ (IBSP 181349); Cave N1_0052 (6°1'38"S, 50°16'34"W), 1♀ (IBSP 181350); 1♀ (IBSP 181454); Cave N1_0067 (6°1'44"S, 50°17'22"W), 2♀ (IBSP 181352, IBSP 181353); Cave N1_0088 (6°1'3"S, 50°17'6"W), 1♀ (IBSP 181354); Cave N1_0138 (6°1'34"S, 50°16'32"W), 1♀ (IBSP 181357); Cave N1_0160 (6°2'36"S, 50°16'25"W), 1♀ (IBSP 181358); Cave N1_0178 (6°2'24"S, 50°17'29"W), 2♀ (IBSP 181360, IBSP 181361); 1♀ (IBSP 181463); Cave N1_0198 (6°2'48"S, 50°17'27"W), 1♀ (IBSP 181362); 2♀ (IBSP 181467); Cave N1_0199 (6°2'54"S, 50°17'29"W), 1♀ (IBSP 181363); 1♀ (IBSP 181468); Cave N1_0203 (6°2'43"S, 50°16'43"W), 3♀ (IBSP 181364, IBSP 181365); Cave N1_0204 (6°2'43"S, 50°16'37"W), 1♀ (IBSP 181366); 1♀ (IBSP 181469); Cave N1_0205 (6°2'43"S, 50°16'37"W), 1♀ (IBSP 181367); 1♀ (IBSP 181470); Cave N1_0214

(6°2'27"S, 50°17'51"W), 1♀ (IBSP 181368); Cave N1_0230 (6°2'25"S, 50°17'32"W), 1♂ 1♀ (IBSP 181373, IBSP 181374); 1♀ (IBSP 181471); Cave N1_0218 (6°2'9"S, 50°17'23"W), 1♀ (IBSP 181369); Cave N1_0221 (6°1'50"S, 50°18'3"W), 1♀ (IBSP 181370); Cave N1_0240 (6°1'20"S, 50°16'28"W), 6♀ (IBSP 181376, IBSP 181377, IBSP 181378, IBSP 181379), all collected on 24/II–13/III/2015 by Equipe Carste coll.; Cave N1_0017 (6°2'3"S, 50°16'23"W), 2♀ (IBSP 181389, IBSP 181390); Cave N1_0154 (6°2'43"S, 50°16'22"W), 1♀ (IBSP 181391); 2♀, 11/VI–02/VII/2014 (IBSP 181266); Cave N1_0158 (6°2'40"S, 50°16'24"W), 1♀ (IBSP 181392); 2♀, 11/VI–02/VII/2014 (IBSP 181268, IBSP 181269); Cave N1_0168 (6°1'18"S, 50°18'6"W), 2♂ 6♀ (IBSP 181393–IBSP 181399); Cave N1_0169 (6°1'25"S, 50°18'1"W), 1♂ 1♀ (IBSP 181400, IBSP 181401); Cave N1_0171 (6°1'19"S, 50°18'5"W), 1♂ 6♀ (IBSP 181403–IBSP 181409); 1♂, 4♀, 16/VII–06/VIII/2014 (IBSP 181303–IBSP 181306); Cave N1_0239 (6°1'20"S, 50°16'28"W), 1♀ (IBSP 181416); Cave N1_0236 (6°1'17"S, 50°16'26"W), 2♀ (IBSP 181412, IBSP 181413); Cave N1_0238 (6°1'16"S, 50°16'26"W), 2♀ (IBSP 181414, IBSP 181415); 2♀, 11/VI–02/VII/2014 (IBSP 181272, IBSP 181273); Cave N1_0232 (6°1'16"S, 50°16'23"W), 1♂ (IBSP 181411); Cave N1_0247 (6°1'15"S, 50°16'24"W), 2♀ (IBSP 181417, IBSP 181418); 1♀ (IBSP 181275); Cave N1_0231 (6°1'15"S, 50°16'23"W), 1♀ (IBSP 181410), all collected by Equipe Carste coll.; Cave N1_0013 (6°2'4"S, 50°16'17"W), 1♀ (IBSP 181419); Cave N1_0019 (6°2'2"S, 50°16'19"W), 2♀ (IBSP 181422, IBSP 181423); Cave N1_0020 (6°1'59"S, 50°16'19"W), 2♂ 2♀ (IBSP 181424, IBSP 181425, IBSP 181426, IBSP 181427); 1♀ ,16/VII–06/VIII/2014 (IBSP 181281); Cave N1_0021 (6°1'59"S, 50°16'20"W), 1♀ (IBSP 181428); 1♀, 16/VII–06/VIII/2014 (IBSP 181282); Cave N1_0054 (6°1'15"S, 50°17'12"W), 1♀ (IBSP 181430); Cave N1_0055 (6°1'13"S, 50°16'47"W), 1♀ (IBSP 181431); Cave N1_0056 (6°1'13"S, 50°16'45"W), 1♀ (IBSP 181432); Cave N1_0060 (6°1'14"S, 50°16'43"W), (IBSP 181433); 1♀, 11/VI–02/VII/2014 (IBSP 181256); Cave N1_0096 (6°1'10"S, 50°17'1"W), 1♀ (IBSP 181434); Cave N1_0118 (6°0'42"S, 50°18'54"W), 1♀ (IBSP 181435); Cave N1_0125 (6°0'16"S, 50°17'17"W), 2♂ (IBSP 181436, IBSP 181437); 1♂, 11/VI–02/VII/2014 (IBSP 181262); Cave N1_0141 (6°2'36"S, 50°16'34"W), 1♀ (IBSP 181438); 1♂ 7♀, 16/VII–06/VIII/2014 (IBSP 181296–IBSP 181300); Cave N1_0145 (6°2'35"S, 50°16'30"W), 1♀ (IBSP 181439); 1♂ 1♀, 16/VII–06/VIII/2014 (IBSP 181301, IBSP 181302); Cave N1_0174 (6°1'29"S, 50°17'55"W), 3♀ (IBSP 181441, IBSP 181442); 1♀ 16/VII–06/VIII/2014 (IBSP 181308); Cave N1_0210 (6°1'30"S, 50°17'52"W), 1♀ (IBSP 181443) all collected by Equipe Carste coll.; Cave N1_0005 (6°2'24"S, 50°16'12"W), 1♀ (IBSP 181444); Cave N1_0029 (6°1'49"S, 50°16'21"W), 2♀ (IBSP 181449); Cave N1_0032 (6°1'52"S, 50°16'30"W), 1♀ (IBSP 181450); Cave N1_0046 (6°1'44"S, 50°16'33"W), 1♂ (IBSP 181453); Cave N1_0076 (6°1'16"S, 50°16'50"W), 2♀ (IBSP 181456, IBSP 181457); Cave N1_0077 (6°1'16"S, 50°16'54"W), 1♀ (IBSP 181455); Cave N1_0085 (6°1'8"S, 50°17'2"W), 1♀ (IBSP 181458); Cave N1_0098 (6°1'11"S, 50°17'7"W), 1♀ (IBSP 181459); Cave N1_0101 (6°1'9"S, 50°16'48"W), 2♀ (IBSP 181460, IBSP 181461); Cave N1_0187 (6°2'39"S, 50°16'35"W), 3♀ (IBSP 181465); Cave N1_0188 (6°2'43"S, 50°16'34"W), 1♀ (IBSP 181466), all collected on 24/II–13/III/2015 by Equipe Carste coll.; Cave N1_0010 (6°1'12"S, 50°16'44"W), 1♀ (IBSP 181474); 1♀, 16/VII–06/VIII/2014 (IBSP 181280); Cave N1_0024 (6°1'54"S, 50°16'22"W), 1♂ 5♀ (IBSP 181475–IBSP 181480); 1♀, 11/VI–02/VII/2014 (IBSP 181248–IBSP 181255); Cave N1_0038 (6°1'50"S, 50°16'19"W), 1♀ (IBSP 181483); 2♀, 04/IX–06/X/2014 (IBSP 181342, IBSP 181343); Cave N1_0041 (6°1'46"S, 50°16'10"W), 1♀ (IBSP 181485); 1♀, 04/IX–06/X/2014 (IBSP 181345); Cave N1_0051 (6°1'50"S, 50°16'14"W), 2♀ (IBSP 181486); Cave N1_0059 (6°1'12"S, 50°16'46"W), 1♂ 1♀ (IBSP 181487); Cave N1_0062 (6°1'11"S, 50°16'46"W), 2♀ (IBSP 181488, IBSP 181489) 1♀ 04/IX–06/X/2014 (IBSP 181351); Cave N1_0073 (6°1'10"S, 50°16'47"W), 9♀ (IBSP 181490–IBSP 181497); 1♂ 9♀, 16/VII–06/VIII/2014 (IBSP 181284–IBSP 181293); Cave N1_0091 (5°59'57"S, 50°17'58"W), 2♀ (IBSP 181498, IBSP 181499); Cave N1_0092 (6°0'43"S, 50°18'16"W), 1♀ (IBSP 181500); Cave N1_0105 (6°0'37"S, 50°18'10"W), 2♀ (IBSP 181501, IBSP 181502); Cave N1_0129 (6°0'37"S, 50°17'30"W), 2♀ (IBSP 181504, IBSP 181505); 1♀, 11/VI–02/VII/2014 (IBSP 181263); Cave N1_0134 (6°1'5"S, 50°17'30"W), 1♀ (IBSP 181506); Cave N1_0137 (6°1'33"S, 50°16'31"W), 1♂ 2♀ (IBSP 181507, IBSP 181508); 2♀, 04/IX–06/X/2014 (IBSP 181355, IBSP 181356); Cave N1_0147 (6°2'34"S, 50°16'28"W), 2♀ (IBSP 181509, IBSP 181510); Cave N1_0148 (6°2'33"S, 50°16'27"W), 1♀ (IBSP 181511); Cave N1_0165 (6°1'10"S, 50°18'28"W), 1♀ (IBSP 181512); 2♀, 04/IX–06/X/2014 (IBSP 181359); Cave N1_0181 (6°2'24"S, 50°17'29"W), 1♀ (IBSP 181513); Cave N1_0213 (6°2'4"S, 50°17'55"W), 1♀ (IBSP 181514); Cave N1_0225 (6°2'18"S, 50°16'4"W), 1♀ (IBSP 181516); 1♀, 04/IX–06/X/2014 (IBSP 181372); Cave N1_0242 (6°1'52"S, 50°16'12"W), 2♀ (IBSP 181519, IBSP 181520); 1♀, 04/IX–06/X/2014 (IBSP 181380); Cave N1_0233 (6°1'16"S, 50°16'24"W), 3♀ (IBSP 181517, IBSP 181518); 1♀, 04/IX–06/X/2014 (IBSP 181375); Cave N1_0222 (6°0'36"S, 50°17'28"W), 1♀ (IBSP 181515); 1♀, 04/IX–06/X/2014 (IBSP 181371); Cave N1_0245 (6°0'32"S, 50°18'8"W), 1♀ (IBSP 181522); 1♂, 11/VI–02/VII/2014 (IBSP 181274); Cave N1_0246 (6°0'31"S, 50°18'7"W), 2♀ (IBSP 181523, IBSP 181524); Cave N1_0244 (6°0'26"S, 50°18'17"W), 1♀ (IBSP 181521), all collected by Equipe Carste coll.; Canaã dos Carajás, Cave CRIS_002 (6°27'35"S, 49°41'3"W), 1♀ (IBSP 174552); Cave CRIS_007 (6°27'9"S, 49°40'43"W), 3♀(IBSP 174561); Cave CRIS_010 (6°26'56"S, 49°41'9"W), 2♀ (IBSP 174571); Cave CRIS_014 (6°26'51"S, 49°40'59"W), 1♀ (IBSP 174583); Cave CRIS_015 (6°26'51"S, 49°40'58"W), 1♂ (IBSP 174585); Cave CRIS_018 (6°26'4"S, 49°41'13"W), 1♂ (IBSP 174593); Cave CRIS_024 (6°27'33"S, 49°42'44"W), 1♀ (IBSP 174604); Cave CRIS_025 (6°27'35"S, 49°42'40"W), 5♀ (IBSP 174606); Cave CRIS_026 (6°27'35"S, 49°42'40"W), 1♀ (IBSP 174616); Cave CRIS_028 (6°27'33"S, 49°42'35"W), 1♀ (IBSP 174623); Cave CRIS-033 (6°27'38"S, 49°42'26"W), 3♀ (IBSP 174636); Cave CRIS_035 (6°27'34"S, 49°42'18"W), 1♂ (IBSP 174639); Cave CRIS_036 (6°27'34"S, 49°42'18"W), 2♂ 4♀ (IBSP 174641); Cave CRIS_038 (6°27'33"S, 49°42'14"W), 2♀ (IBSP 174646), all collected on 29/VII–06/VIII/2008 by R. Andrade et al.; Cave

CRIS_016 (6°26'21"S, 49°40'57"W), 2♂ 6♀ 22/II/2011 (IBSP 175226, IBSP 175227, IBSP 175951, IBSP 175952); Cave CRIS_017 (6°26'22"S, 49°40'56"W), 4♀ 22/II/2011 (IBSP 175228–IBSP 175230); 4♀, 23/II/2011 (IBSP 175953–IBSP 175955) collected by R. Andrade & V. Felice; Cave SB_0021 (6°18'36"S, 50°0'11"W), 1♂ (IBSP 173682); 1♀, 29/VIII–27/IX/2012 (IBSP 173601); Cave SB_0022 (6°18'26"S, 50°0'7"W), 1♀ (IBSP 173683); 1♀, 10–31/I/2013 (IBSP 173638) collected by C. A. R. Souza & J. Mascarenhas, Cave SB_0159 (6°20'44"S, 49°50'29"W), 1♀ (IBSP 173592); Cave SB_0147 (6°18'5"S, 49°49'40"W), 1♀ (IBSP 173595); Cave SB_0158 (6°20'44"S, 49°50'29"W), 2♀ (IBSP 173593); Cave SB_0002 (6°19'1"S, 49°59'36"W), 1♀ (IBSP 173603); Cave SB_0005 (6°17'9"S, 49°55'39"W), 1♀ (IBSP 173604); Cave SB_0042 (6°18'56"S, 49°53'41"W), 1♀ (IBSP 173607); Cave SB_0087 (6°17'36"S, 49°56'32"W), 1♂ 1♀ (IBSP 174379); Cave SB_0094 (6°18'2"S, 49°57'29"W), 1♂ (IBSP 173606) all collected on 29/VIII–27/IX/2012 by C. A. R. Souza et al.; Cave SB_0034 (6°19'0"S, 49°53'45"W), 1♀ (IBSP 173545); 1♀, 29/VIII–27/IX/2012 (IBSP 173596); Cave SB_0035 (6°18'59"S, 49°53'48"W), 1♀ (IBSP 173546); Cave SB_0036 (6°19'1"S, 49°53'42"W), 1♀ (IBSP 173547); Cave SB_0038 (6°18'52"S, 49°53'1"W), 1♀ (IBSP 173548); Cave SB_0041 (6°18'56"S, 49°52'55"W), 1♂ 6♀ (IBSP 173549–IBSP 173552); 3♀, 29/VIII–27/IX/2012 (IBSP 173618); Cave SB_044 (6°18'60"S, 49°53'42"W), 1♀ (IBSP 173553); 2♀, 20/IX–01/X/2011 (IBSP 173590, IBSP 173591); Cave SB_0046 (6°18'59"S, 49°53'42"W), 2♀ (IBSP 173554); 1♂ 2♀, 29/VIII–27/IX/2012 (IBSP 173612–IBSP 173614); Cave SB_0060 (6°18'45"S, 49°52'59"W), 1♀ (IBSP 173555); Cave SB_0062 (6°18'45"S, 49°52'59"W), 1♀ (IBSP 173556); Cave SB_0063 (6°16'38"S, 49°55'5"W), 1♀ (IBSP 173557); 1♂, 29/VIII–27/IX/2012 (IBSP 173610); Cave SB_0067 (6°16'35"S, 49°55'5"W), 1♀ (IBSP 173558); Cave SB_0071 (6°16'35"S, 49°55'7"W), 4♀ (IBSP 173578, IBSP 173579); 2♀, 29/VIII–27/IX/2012 (IBSP 173631, IBSP 173632); Cave SB_0074 (6°18'41"S, 49°52'6"W), 1♀ (IBSP 173559); 1♂, 29/VIII–27/IX/2012 (IBSP 173630); Cave SB_0085 (6°18'40"S, 49°54'43"W), 1♀ (IBSP 173560); 1♀, 29/VIII–27/IX/2012 (IBSP 173615); Cave SB_0086 (6°18'40"S, 49°54'43"W), 1♀ (IBSP 173562); Cave SB_0107 (6°18'53"S, 49°56'17"W), 2♀ (IBSP 173561) all collected on 17/I–02/II/2012 by C. A. R. Souza et al.; Cave SB_0007 (6°18'44"S, 50°0'0"W), 1♀ (IBSP 173568); Cave SB_0008 (6°18'47"S, 50°0'3"W), 1♀ (IBSP 173569); Cave SB_0009 (6°18'47"S, 50°0'3"W), 1♀ (IBSP 173577); Cave SB_0040 (6°18'59"S, 49°52'52"W), 2♀ (IBSP 173574, IBSP 173575); 2♀ (IBSP 173616, IBSP 173617); Cave SB_0047 (6°18'48"S, 49°52'51"W), 1♂ (IBSP 173566); Cave SB_0048 (6°18'51"S, 49°52'51"W), 1♂ (IBSP 173567); 1♀ (IBSP 173609); Cave SB_0050 (6°18'52"S, 49°52'51"W), 2♀ (IBSP 173571); Cave SB_0054 (6°18'35"S, 49°53'8"W), 1♂ 1♀ (IBSP 173580, IBSP 173581); Cave SB_0055 (6°16'36"S, 49°54'53"W), 1♀ (IBSP 183456); 2♀ (IBSP 173619, IBSP 173620); Cave SB_0056 (6°16'37"S, 49°54'53"W), 1♀ (IBSP 174326); Cave SB_0065 (6°18'6"S, 49°53'11"W), 1♀ (IBSP 173589); Cave SB_0066 (6°18'5"S, 49°53'10"W), 2♀ (IBSP 173587, IBSP 173588); Cave SB_0069 (6°16'36"S, 49°55'5"W), 6♀ (IBSP 173583–IBSP 173585); Cave SB_0070 (6°16'35"S, 49°55'6"W), 1♀ (IBSP 173563); Cave SB_0072 (6°16'53"S, 49°55'40"W), 3♀ (IBSP 173572, IBSP 173573, IBSP 173586); 1♂ 2♀ (IBSP 173598–IBSP 173600); Cave SB_0073 (6°16'55"S, 49°55'41"W), 1♀ (IBSP 173582); 1♀ (IBSP 173636); Cave SB_0075 (6°17'47"S, 49°53'59"W), 2♀ (IBSP 173564); Cave SB_0082 (6°18'6"S, 49°55'27"W), 1♀ (IBSP 173576); 1♀ (IBSP 173635); Cave SB_0083 (6°18'5"S, 49°55'26"W), 1♂ (IBSP 173565); 1♀ (IBSP 173611); Cave SB_0100 (6°16'3"S, 49°57'4"W), 1♀ (IBSP 173570); 1♀ (IBSP 173597) all collected on 29/VIII–27/IX/2012 by C. A. R. Souza et al.; Cave SB_0161 (6°20'10"S, 49°51'0"W), 3♀ (IBSP 173629); 1♀, 28/I–05/II2013 (IBSP 173677); Cave SB_0138 (6°19'13"S, 49°49'54"W), 2♀ (IBSP 173634); Cave SB_0023 (6°19'24"S, 49°59'3"W), 1♀ (IBSP 173621); all collected on 18–26/X/2012 by C. A. R. Souza et al.; Cave SB_0152 (6°20'54"S, 49°50'30"W), 1♀ (IBSP 173657); Cave SB_0155 (6°20'46"S, 49°50'29"W), 2♀ (IBSP 173652, IBSP 173653); 1♀, 29/VIII–27/IX/2012 (IBSP 173594); Cave SB_0156 (6°20'45"S, 49°50'29"W), 1♀ (IBSP 173651); Cave SB_0135 (6°19'25"S, 49°49'58"W), 1♀ (IBSP 173656); 1♀, 18–26/X/2012 (IBSP 173633); Cave SB_0137 (6°19'13"S, 49°49'54"W), 3♀ (IBSP 173658, IBSP 173659, IBSP 173660); 2♀, 18–26/X/2012 (IBSP 173622, IBSP 173623); Cave SB_0139 (6°19'13"S, 49°49'53"W), 4♀ (IBSP 173670–IBSP 173672); 2♀, 29/VIII–27/IX/2012 (IBSP 173624); Cave SB_0001 (6°18'47"S, 49°59'47"W), 2♀ (IBSP 173679); 1♀, 29/VIII–27/IX/2012 (IBSP 173605); Cave SB_0006 (6°17'9"S, 49°55'37"W), 1♀ (IBSP 173675); Cave SB_0010 (6°18'42"S, 50°0'8"W), 1♀ (IBSP 173665); Cave SB_0011 (6°19'0"S, 49°59'37"W), 1♂ 1♀ (IBSP 173666, IBSP 173681); Cave SB_0013 (6°19'36"S, 49°58'26"W), 1♀ (IBSP 173667); 1♂, 28/I–05/II2013 (IBSP 173678); Cave SB_0017 (6°18'47"S, 49°59'56"W), 1♀ (IBSP 173668); 6♀, 28/I–05/II2013 (IBSP 173661–IBSP 173664); 1♀, 29/VIII–27/IX/2012 (IBSP 173602); Cave SB_0018 (6°18'45"S, 49°59'59"W), 2♀ (IBSP 173637); 1♀, 28/I–05/II2013 (IBSP 173640); Cave SB_0026 (6°18'49"S, 49°53'35"W), 1♀ (IBSP 173676) 1♀, 17/I–02/II/2012 (IBSP 173543); 5♀ 29/VIII–27/IX/2012 (IBSP 173625–IBSP 173628); Cave SB_0030 (6°18'51"S, 49°53'34"W), 1♀ (IBSP 173639); 1♀, 17/I–02/II/2012 (IBSP 173544); Cave SB_0080 (6°18'23"S, 49°56'46"W), 1♀ (IBSP 173642); Cave SB_0090 (6°18'5"S, 49°57'28"W), 1♂ 3♀ (IBSP 173647–IBSP 173650); Cave SB_0091 (6°18'5"S, 49°57'51"W), 1♀ (IBSP 173644); 1♀, 29/VIII–27/IX/2012 (IBSP 173608); Cave SB_0093 (6°18'43"S, 49°57'23"W), 1♀ (IBSP 173654); Cave SB_0096 (6°18'20"S, 49°56'47"W), 1♀ (IBSP 173643); Cave SB_0097 (6°18'18"S, 49°56'49"W), 1♀ (IBSP 173645); Cave SB_0106 (6°15'50"S, 49°58'38"W), 1♀ (IBSP 173646); Cave SB_0115 (6°21'14"S, 49°58'39"W), 1♀ (IBSP 173641); Cave SB_0117 (6°21'13"S, 49°58'43"W), 1♀ (IBSP 173655) all collected on 10–31/I/2013 by C. A. R. Souza & J. Mascarenhas et al.; Cave SB_0160 (6°20'12"S, 49°51'4"W), 1♀ (IBSP 173673); Cave SB_0134 (6°19'59"S, 49°50'55"W), 1♀ (IBSP 173680); Cave SB_0133 (6°18'54"S, 49°50'14"W), 1♀ (IBSP 173674); Cave SB_0039 (6°18'49"S, 49°52'56"W), 2♀ (IBSP 173669); all collected on 28/I–05/II2013 by C. A. R. Souza et al.; Cave SB_0227 (6°21'33"S, 49°59'35"W), 2♀ (IBSP 185237); Cave SB_0224 (6°21'32"S, 49°59'35"W), 1♀ (IBSP 185236); 1♀, 12–22/X/2013 (IBSP

181588); Cave SB_0222 (6°21'30"S, 49°59'36"W), 1♂ 1♀ (IBSP 185235); Cave SB_0187 (6°20'43"S, 49°58'22"W), 1♀ (IBSP 185223); Cave SB_0217 (6°20'43"S, 49°58'30"W), 1♀ (IBSP 185234); 1♀, 12–22/X/2013 (IBSP 181586); Cave SB_0186 (6°20'41"S, 49°58'18"W), 2♀ (IBSP 174381, IBSP 185222); Cave SB_0212 (6°20'25"S, 49°57'39"W), 1♂ 2♀ (IBSP 185231); 8♀ (IBSP 181578–IBSP 181582); Cave SB_0210 (6°20'22"S, 49°57'36"W), 1♀ (IBSP 185229); 2♀ (IBSP 181576, IBSP 181577); Cave SB_0208 (6°20'21"S, 49°57'36"W), 1♀ (IBSP 185227); Cave SB_0209 (6°20'21"S, 49°57'36"W), 1♀ (IBSP 185228); Cave SB_0193 (6°20'8"S, 49°57'28"W), 2♀ (IBSP 185225, IBSP 185226); 3♀ (IBSP 181574); Cave SB_0192 (6°20'3"S, 49°57'29"W), 2♀ (IBSP 185224); Cave SB_0183 (6°19'4"S, 49°57'55"W), 1♂ (IBSP 185221); Cave SB_0164 (6°19'3"S, 49°58'45"W), 3♀ (IBSP 185206, IBSP 185207); Cave SB_0169 (6°19'3"S, 49°58'44"W), 3♀ (IBSP 185211, IBSP 185212); 1♂ 2♀ (IBSP 181569, IBSP 181570); Cave SB_0168 (6°19'2"S, 49°58'45"W), 1♀ (IBSP 185210); 1♂ 4♀ (IBSP 181565–IBSP 181568); Cave SB_0167 (6°19'1"S, 49°58'45"W), 4♀ (IBSP 185208, IBSP 185209); 4♀ (IBSP 181563, IBSP 181564); Cave SB_0173 (6°18'52"S, 49°52'47"W), 1♀ (IBSP 185213); 1♀ (IBSP 181572); Cave SB_0175 (6°18'52"S, 49°52'49"W), 3♀ (IBSP 185215, IBSP 185216); Cave SB_0176 (6°18'51"S, 49°52'50"W), 5♀ (IBSP 185217, IBSP 185218); 1♀ (IBSP 181573); Cave SB_0174 (6°18'51"S, 49°52'48"W), 1♀ (IBSP 185214); Cave SB_0178 (6°18'49"S, 49°52'50"W), 1♀ (IBSP 185219); Cave SB_0179 (6°18'45"S, 49°52'50"W), 3♀ (IBSP 185220); Cave SB_0163 (6°18'44"S, 49°58'43"W), 1♀ (IBSP 185205); 1♂ (IBSP 181561); Cave SB_0216 (6°18'14"S, 49°58'33"W), 1♀ (IBSP 185233); Cave SB_0214 (6°18'14"S, 49°58'33"W), 1♂ 1♀ (IBSP 185232) all collected on 10–20/IX/2013 by C. A. R. Souza et al.; Cave SB_0112 (6°21'12"S, 49°58'37"W), 2♀ (IBSP 185238); Cave SB_0114 (6°21'12"S, 49°58'39"W), 1♀ (IBSP 185239); Cave SB_0125 (6°21'17"S, 49°59'11"W), 1♀ (IBSP 185240); Cave SB_0127 (6°21'16"S, 49°59'12"W), 1♀ (IBSP 185241) all collected on 20–26/VI/2013 by C. A. R. Souza et al.; Cave SB_0200 (6°20'43"S, 49°57'50"W), 1♀ (IBSP 181575); 1♂, 13–23/II/2014 (IBSP 181597); Cave SB_0166 (6°18'60"S, 49°58'45"W), 1♂ (IBSP 181562) 2♀ 13–23/II/2014 (IBSP 181593); Cave SB_0172 (6°18'50"S, 49°52'46"W), 1♀ (IBSP 181571) all collected on 10–20/IX/2013 by C. A. R. Souza et al.; Cave SB_0199 (6°20'43"S, 49°56'57"W), 1♀ (IBSP 181584); Cave SB_0218 (6°20'43"S, 49°58'31"W), 1♀ (IBSP 181587); Cave SB_0241 (6°20'41"S, 49°54'14"W), 1♀ (IBSP 181591); 2♀ (IBSP 181609, IBSP 181610); Cave SB_0239 (6°20'40"S, 49°54'13"W), 1♂ 1♀ (IBSP 181589, IBSP 181590); 1♂ 3♀ (IBSP 181604–IBSP 181607); Cave SB_0197 (6°20'37"S, 49°57'10"W), 1♀ (IBSP 181583); Cave SB_0243 (6°20'2"S, 49°54'20"W), 1♀ (IBSP 181592); Cave SB_0206 (6°18'26"S, 49°57'23"W), 1♀ (IBSP 181585); 2♀ (IBSP 181599); Cave SB_0205 (6°19'39"S, 49°59'3"W), 3♀ (IBSP 181611, IBSP 181612) all collected on 13–23/II/2014 by C. A. R. Souza et al.; Cave SB_0240 (6°20'40"S, 49°54'13"W), 2♀ (IBSP 181608); Cave SB_0238 (6°20'36"S, 49°54'16"W), 1♀ (IBSP 185243); Cave SB_0230 (6°20'36"S, 49°59'44"W), 1♀ (IBSP 174380); Cave SB_0235 (6°20'33"S, 49°54'18"W), 1♀ (IBSP 181603); Cave SB_0194 (6°20'31"S, 49°57'13"W), 2♂ 1♀

(IBSP 174323, IBSP 181595, IBSP 181596); Cave SB_0233 (6°20'29"S, 49°54'19"W), 3♀ (IBSP 181602, IBSP 185242); Cave SB_0213 (6°20'27"S, 49°57'40"W), 1♀ (IBSP 181601); Cave SB_0211 (6°20'25"S, 49°57'37"W), 1♀ (IBSP 181600); Cave SB_0188 (6°20'25"S, 49°57'55"W), 1♀ (IBSP 181594); Cave SB_0201 (6°20'25"S, 49°57'59"W), 1♀ (IBSP 181598) all collected on 13–23/II/2014 by C. A. R. Souza et al.; Cave CAV_02 (6°29'40"S, 51°9'46"W), 2♀ (IBSP 173908); 1♀, 20–29/VI/2012 (IBSP 173929); Cave CAV-03 (6°29'39"S, 51°9'48"W), 1♀ (IBSP 173911); Cave CAV_04 (6°29'39"S, 51°9'47"W), 6♀ (IBSP 173918, IBSP 174382); 6♀, 20–29/VI/2012 (IBSP 173930); Cave CAV_05 (6°29'58"S, 51°9'44"W), 2♀ (IBSP 173921); Cave CAV_07 (6°30'2"S, 51°9'41"W), 4♀, 08–15/III/2012 (IBSP 173913, IBSP 173923); 3♀, 20–29/VI/2012 (IBSP 173933); Cave CAV_09 (6°30'2"S, 51°9'41"W), 1♂ 5♀ (IBSP 173909, IBSP 173910, IBSP 173912); 1♀, 20–29/VI/2012 (IBSP 173928); Cave CAV_10 (6°30'8"S, 51°9'40"W), 1♀, 08–15/III/2012 (IBSP 173919); Cave CAV_13 (6°29'53"S, 51°9'44"W), 2♂ (IBSP 173907); 2♀, 20–29/VI/2012 (IBSP 173925); Cave CAV_14 (6°30'2"S, 51°9'41"W), 1♀ (IBSP 173922); 1♀, 20–29/VI/2012 (IBSP 173934); Cave CAV_15 (6°29'50"S, 51°9'32"W), 1♀(IBSP 173914); Cave CAV_16 (6°29'56"S, 51°9'43"W), 1♂ 4♀ (IBSP 173916); 1♂ 7♀, 20–29/VI/2012 (IBSP 173927); Cave CAV_17 (6°29'50"S, 51°9'32"W), 1♀ 08–15/III/2012 (IBSP 173915); 2♀, 20–29/VI/2012 (IBSP 173932); Cave CAV_18 (6°29'50"S, 51°9'31"W), 3♀ (IBSP 173920); 3♀, 20–29/VI/2012 (IBSP 173926); Cave CAV_20 (6°30'1"S, 51°9'41"W), 1♂ (IBSP 173917); 2♀, 20–29/VI/2012 (IBSP 173935); Cave CAV_21 (6°29'60"S, 51°9'41"W), 1♀ (IBSP 173924) all collected on 08–15/III/2012 by Equipe Carste coll.; Cave CAV_08 (6°29'52"S, 51°9'43"W), 1♀ 20–29/VI/2012 (IBSP 173931); collected by Equipe Carste; Cave S11A_0003 (6°21'1"S, 50°27'4"W), 1♀ (IBSP 174402); Cave S11A_0007 (6°21'7"S, 50°26'37"W), 3♀ (IBSP 174409); Cave S11A_0012 (6°19'54"S, 50°27'6"W), 2♀ (IBSP 174412); Cave S11A_0026 (6°18'28"S, 50°26'57"W), 2♂ 4♀(IBSP 174419, IBSP 174422); Cave S11B_0013 (6°21'17"S, 50°24'42"W), 1♀ (IBSP 174438); Cave S11B_0023 (6°20'45"S, 50°24'36"W), 2♀ (IBSP 174444); Cave S11B_0024 (6°20'45"S, 50°24'35"W), 1♀(IBSP 174447), all collected on 23/VIII–02/IX/2007 by R. Andrade et al.; Cave S11D_0048 (6°24'40"S, 50°18'56"W), 2♀ (IBSP 172483, IBSP 172484); Cave S11D_0005 (6°24'4"S, 50°21'1"W), 1♀ (IBSP 172520); Cave S11D_0100 (6°23'46"S, 50°20'28"W), 2♀ (IBSP 172466, IBSP 172467); Cave S11D_0101 (6°23'24"S, 50°21'50"W), 1♂ 2♀ (IBSP 172459, IBSP 172460, IBSP 172461); Cave S11D_0015 (6°23'47"S, 50°21'26"W), 1♀ (IBSP 172486); Cave S11D_0018 (6°24'14"S, 50°22'28"W), 1♀ (IBSP 172475); Cave S11D_0019 (6°24'17"S, 50°22'16"W), 1♀ (IBSP 172487); Cave S11D_0034 (6°24'42"S, 50°20'37"W), 1♂ 2♀ (IBSP 172510, IBSP 172511); Cave S11D_0035 (6°24'41"S, 50°20'36"W), 3♀ (IBSP 172514, IBSP 172515, IBSP 172516); Cave S11D_0036 (6°24'41"S, 50°20'36"W), 2♀ (IBSP 172505); Cave S11D_0038 (6°23'51"S, 50°20'27"W), 4♀ (IBSP 172500); Cave S11D_0040 (6°24'40"S, 50°19'31"W), 1♂ 2♀ (IBSP 172512, IBSP 172513); 3♀, 23/VIII–02/IX/2007 (IBSP 174477); Cave S11D_0044 (6°25'3"S, 50°18'56"W), 1♀ (IBSP 172485); Cave S11D_0046

(6°24'55"S, 50°19'0"W), 2♀ (IBSP 172506, IBSP 172507); Cave S11D_0051 (6°24'26"S, 50°19'16"W), 1♀ (IBSP 172482); Cave S11D_0059 (6°24'28"S, 50°18'47"W), 1♀ (IBSP 172481); Cave S11D_0062 (6°23'33"S, 50°18'49"W), 1♀ (IBSP 172494); Cave S11D_0065 (6°23'27"S, 50°18'50"W), 2♀ (IBSP 172491); Cave S11D_0068 (6°23'35"S, 50°19'9"W), 2♀ (IBSP 172497, IBSP 172498); Cave S11D_0070 (6°23'35"S, 50°19'10"W), 1♀ (IBSP 172499); Cave S11D_0073 (6°23'34"S, 50°19'8"W), 1♂ 5♀ (IBSP 172451, IBSP 173684); Cave S11D_0076 (6°23'34"S, 50°19'1"W), 2♀ (IBSP 172452, IBSP 172453); Cave S11D_0078 (6°23'34"S, 50°18'59"W), 1♂ 2♀ (IBSP 172457, IBSP 173685); 6♀, 23/VIII–02/IX/2007 (IBSP 174492, IBSP 174493); Cave S11D_0081 (6°23'35"S, 50°18'54"W), 3♀ (IBSP 172462–IBSP 172464); Cave S11D_0084 (6°23'50"S, 50°19'26"W), 3♀ (IBSP 172473, IBSP 172474); Cave S11D_0087 (6°23'47"S, 50°19'24"W), 1♀ (IBSP 172458); Cave S11D_0091 (6°23'45"S, 50°19'20"W), 1♀ (IBSP 172472); Cave S11D_0094 (6°23'42"S, 50°19'19"W), 2♀ (IBSP 172454, IBSP 172455); Cave S11D_0099 (6°23'46"S, 50°20'28"W), 1♂ 1♀ (IBSP 172469), all collected on 13–30/I/2010 by R. Andrade et al.; Cave S11D_0003 (6°24'3"S, 50°21'1"W), 1♂ (IBSP 173686); Cave S11D_0020 (6°24'45"S, 50°21'38"W), 1♀ (IBSP 172526); Cave S11D_0021 (6°24'45"S, 50°21'36"W), 1♂ 1♀ (IBSP 173687); Cave S11D_0023 (6°24'48"S, 50°21'34"W), 2♀ (IBSP 172529); Cave S11D_0025 (6°24'50"S, 50°21'45"W), 1♀ (IBSP 172530); Cave S11D_0028 (6°24'41"S, 50°21'7"W), 1♀ (IBSP 172539); Cave S11D_0029 (6°24'42"S, 50°20'45"W), 4♀ (IBSP 172540, IBSP 172541); Cave S11D_0037 (6°24'48"S, 50°21'32"W), 3♀ (IBSP 172542, IBSP 172543); Cave S11D_0027 (6°24'44"S, 50°21'11"W), 1♂ 6♀ (IBSP 172536, IBSP 172537, IBSP 172538), all collected on 19–22/II/2010 by R. Andrade et al.; Cave S11_0006 (6°26'21"S, 50°17'34"W), 2♀ (IBSP 172559); Cave S11_0019 (6°26'37"S, 50°17'31"W), 1♀ (IBSP 172560); Cave S11_0020 (6°26'39"S, 50°17'31"W), 1♀ (IBSP 172561); Cave S11_0029 (6°26'33"S, 50°17'34"W), 1♀ (IBSP 172564), all collected on 19–22/III/2010 by R. Andrade et al.; Cave S11_0001 (6°24'28"S, 50°14'54"W), 3♀ (IBSP 172544, IBSP 172545); Cave S11_0012 (6°25'12"S, 50°15'1"W), 1♀ (IBSP 172551); Cave S11_0013 (6°25'13"S, 50°15'2"W), 2♀ (IBSP 172550); Cave S11_0014 (6°25'13"S, 50°15'2"W), 1♀ (IBSP 172552); Cave S11_0018 (6°26'10"S, 50°17'45"W), 1♂ 1♀ (IBSP 172555, IBSP 172556); Cave S11_0023 (6°25'25"S, 50°18'0"W), 2♀ (IBSP 172546, IBSP 172547); Cave S11_0024 (6°25'23"S, 50°18'5"W), 1♀ (IBSP 172548), all collected on 24/II–04/III/2010 by R. Andrade & I. Cizauskas; Cave CAV_0002 (6°24'46"S, 50°20'9"W), 1♀ (IBSP 172568); Cave CAV_0003 (6°24'43"S, 50°20'6"W), 1♂ 3♀ (IBSP 172569–IBSP 172571); Cave CAV_0007 (6°24'41"S, 50°19'59"W), 1♀ (IBSP 172575); Cave CAV_0023 (6°24'56"S, 50°21'41"W), 3♀ (IBSP 172583); Cave CAV_0024 (6°24'22"S, 50°21'58"W), 1♂ (IBSP 172584); Cave CAV_0025 (6°24'56"S, 50°21'41"W), 1♀ (IBSP 172585); Cave CAV_0022 (6°24'24"S, 50°22'11"W), 1♀ (IBSP 172582); Cave CAV_0032 (6°25'37"S, 50°19'27"W), 1♀ (IBSP 172586); Cave CAV_0040 (6°24'57"S, 50°21'50"W), 1♂ 3♀ (IBSP 172590); Cave CAV_0041 (6°24'57"S, 50°21'52"W), 3♀ (IBSP 172591, IBSP 172592); Cave CAV-08B

(6°24'43"S, 50°19'52"W), 2♀ (IBSP 172576), all collected on 22–31/V/2010 by R. Andrade et al.; Cave S11D_0047 (6°24'40"S, 50°18'56"W), 1♀ (IBSP 172521) 1♀ 13–30/I/2010 (IBSP 172614); Cave S11D_0055 (6°24'24"S, 50°19'14"W), 1♀ (IBSP 172488–IBSP 172490); 1♂ 3♀, 13–30/I/2010 (IBSP 172615); 1♀, 23/VIII–02/IX/2007 (IBSP 174483, IBSP 174486); Cave S11D_0060 (6°23'35"S, 50°18'43"W), 1♀ (IBSP 172492, IBSP 172493); 3♀, 13–30/I/2010 (IBSP 172616); Cave S11D_0069 (6°23'36"S, 50°19'9"W), 2♀ (IBSP 172617); 2♀, 13–30/I/2010 (IBSP 172495, IBSP 172496); Cave S11D_0071 (6°23'35"S, 50°19'10"W), 1♀ (IBSP 172593); 1♀, 13–30/I/2010 (IBSP 172450); Cave S11D_0077 (6°23'34"S, 50°19'0"W), 1♀ (IBSP 172456); 3♀, 13–30/I/2010 (IBSP 172594); Cave S11D_0080 (6°23'35"S, 50°18'58"W), 1♀ (IBSP 174376); 2♀, 13–30/I/2010 (IBSP 172465); Cave S11D_0088 (6°23'46"S, 50°19'24"W), 3♀ (IBSP 172595, IBSP 172596); 1♀, 13–30/I/2010 (IBSP 172468); 1♀, 23/VIII–02/IX/2007 (IBSP 174496); Cave S11D_0089 (6°23'46"S, 50°19'22"W), 1♀ (IBSP 172597); 2♀, 13–30/I/2010 (IBSP 172470, IBSP 172471); Cave S11D_0096 (6°23'39"S, 50°19'28"W), 6♀ (IBSP 172598–IBSP 172601); 8♀, 13–30/I/2010 (IBSP 172476–IBSP 172480); 7♀, 23/VIII–02/IX/2007 (IBSP 174497), all collected on 01–14/VII/2010 by R. Andrade et al.; Cave S11_0007 (6°27'22"S, 50°14'31"W), 1♀ (IBSP 172557, IBSP 172558); 3♀, 24/II–04/III/2010 (IBSP 172631); Cave S11_0008 (6°25'14"S, 50°17'12"W), 1♀ (IBSP 172549); 2♀, 24/II–04/III/2010 (IBSP 172632); Cave S11_0015 (6°25'12"S, 50°15'2"W), 1♀ (IBSP 172553, IBSP 172554); 4♀, 24/II–04/III/2010 (IBSP 172633); Cave S11_0021 (6°26'41"S, 50°17'30"W), 1♀ (IBSP 172562, IBSP 172563); 3♀ 19–22/III/2010 (IBSP 172634); Cave S11_0025 (6°25'19"S, 50°18'20"W), 1♀ (IBSP 172635); Cave S11D_0022 (6°24'47"S, 50°21'35"W), 3♀ (IBSP 172531, IBSP 172532, IBSP 172533, IBSP 172534); 5♀, 19–22/II/2010 (IBSP 172602); Cave S11D_0024 (6°24'48"S, 50°21'17"W), 2♀ (IBSP 172527, IBSP 172528); 3♀, 19–22/II/2010 (IBSP 172603 IBSP 172604); Cave S11D_0026 (6°24'50"S, 50°21'19"W), 1♀ (IBSP 172535, IBSP 172536, IBSP 172537, IBSP 172538); 2♂ 6♀, 19–22/II/2010 (IBSP 172605); Cave S11D_0033 (6°24'41"S, 50°20'38"W), 1♂ 4♀ (IBSP 172501–IBSP 172504); 6♀ (IBSP 172606, IBSP 172607, IBSP 172608); 2♀, 23/VIII–02/IX/2007 (IBSP 174468, IBSP 174470); Cave S11D_0039 (6°23'48"S, 50°20'28"W), 2♀ (IBSP 172522–IBSP 172525); 4♀ (IBSP 173688); Cave S11D_0041 (6°23'33"S, 50°19'10"W), 2♀ (IBSP 172609); Cave S11D_0043 (6°24'49"S, 50°19'19"W), 1♂ 2♀ (IBSP 172517, IBSP 172518, IBSP 172519); 5♀, (IBSP 172610–IBSP 172612) 4♀ 23/VIII–02/IX/2007 (IBSP 174479); Cave S11D_0045 (6°24'57"S, 50°19'0"W), 3♀ (IBSP 172508, IBSP 172509); 5♀ (IBSP 172613) all collected on 13–30/I/2010 by R. Andrade et al.; Cave CAV_0001 (6°24'43"S, 50°20'7"W), 4♀ (IBSP 172565, IBSP 172566, IBSP 172567) 1♂ 5♀, 22–31/V/2010 (IBSP 172618–IBSP 172620); Cave CAV_0005 (6°24'42"S, 50°20'3"W), 1♀ (IBSP 172621); 2♀, 22–31/V/2010 (IBSP 172572, IBSP 172573); Cave CAV_0006 (6°24'41"S, 50°19'59"W), 1♀ (IBSP 172622); 1♀, 22–31/V/2010 (IBSP 172574); Cave CAV_0010 (6°24'40"S, 50°19'42"W), 1♀ (IBSP 172625); 1♂, 22–31/V/2010 (IBSP 172579); Cave CAV_0012 (6°24'40"S, 50°19'40"W), 1♀

(IBSP 172626); 1♂ 2♀, 22–31/V/2010 (IBSP 172580, IBSP 172581); Cave CAV_0028 (6°24'32"S, 50°22'9"W), 1♂ 1♀ (IBSP 174321); Cave CAV_0034 (6°24'10"S, 50°22'58"W), 1♀ (IBSP 172628); Cave CAV_0036 (6°24'33"S, 50°22'10"W), 1♀ (IBSP 172630); Cave CAV_0009 (6°25'21"S, 50°19'33"W), 2♀ (IBSP 172623, IBSP 172624); 4♀, 22–31/V/2010 (IBSP 172577, IBSP 172578); Cave CAV_0018 (6°24'25"S, 50°22'10"W), 2♀ (IBSP 174377); Cave CAV_0019 (6°24'22"S, 50°22'9"W), 1♀ (IBSP 172627); Cave CAV_0035 (6°24'24"S, 50°23'8"W), 2♂ (IBSP 172629); 2♂ 4♀, 22–31/V/2010 (IBSP 72587–IBSP 172589), all collected by R. Andrade et al.; Cave S11D_0116 (6°25'19"S, 50°19'0"W), 1♀ (IBSP 173696); 3♀, 30/VII–02/IX/2011 (IBSP 173690, IBSP 173691); Cave S11D_0112 (6°24'47"S, 50°21'16"W), 1♀ (IBSP 173695); 1♀, 30/VII–02/IX/2011 (IBSP 173689); Cave S11D_0104 (6°23'51"S, 50°22'0"W), 2♀ (IBSP 173693); 5♀, 30/VII–02/IX/2011 (IBSP 173692); Cave S11D_0111 (6°23'50"S, 50°20'29"W), 1♀ (IBSP 173694) all collected by R. Andrade et al.; Curionópolis, Cave SL_0074 (5°57'58"S, 49°37'56"W), 1♀ (IBSP 174771); Cave SL_0075 (5°57'56"S, 49°37'57"W), 4♀ (IBSP 174749); Cave SL_0089 (5°57'33"S, 49°38'9"W), 2♀ (IBSP 174768) all collected on 17–24/X/2008 by R. Andrade et al.; Cave GEM-2076, 2♀ 2010–11 (ISLA 14818); Cave SL_0002 (5°57'59"S, 49°38'59"W), 3♀ (ISLA 14806, ISLA 14797); Cave SL_0003 (5°57'51"S, 49°38'59"W), 1♀ (ISLA 14811); Cave SL_0004 (5°57'49"S, 49°38'59"W), 8♀ (ISLA 14786, ISLA 14783); Cave SL_0005 (5°57'49"S, 49°38'59"W), 1♀ (ISLA 14785); Cave SL_0009 (5°58'4"S, 49°38'59"W), 1♂ 1♀ (ISLA 14801); Cave SL_0016 (5°58'13"S, 49°38'52"W), 2♀ (ISLA 14804); Cave SL_0024 (5°58'16"S, 49°38'43"W), 1♂ 3♀ (ISLA 14787, ISLA 14798); Cave SL_0026 (5°58'21"S, 49°38'41"W), 5♀ (ISLA 14816); Cave SL_0029 (5°58'21"S, 49°38'37"W), 1♂ (ISLA 14810); Cave SL_0030 (5°58'21"S, 49°38'38"W), 5♀ (ISLA 14795, ISLA 148190); Cave SL_0033 (5°58'11"S, 49°38'37"W),, 1♀ (ISLA 14814); Cave SL_0035 (5°58'33"S, 49°38'17"W), 4♀ (ISLA 14822); Cave SL_0041 (5°58'37"S, 49°37'58"W), 1♀ (ISLA 14790); Cave SL_0042 (5°58'42"S, 49°37'57"W), 5♀ (ISLA 14807, ISLA 14796); Cave SL_0043 (5°58'36"S, 49°37'55"W), 2♀ (ISLA 14799); Cave SL_0045 (5°58'53"S, 49°38'9"W), 3♀ (ISLA 14820); Cave SL_0046 (5°58'56"S, 49°38'7"W), 1♀ (ISLA 14805); Cave SL_0050 (5°58'51"S, 49°37'52"W), 5♀ (ISLA 14794); Cave SL_0057 (5°58'36"S, 49°37'32"W), 8♀ (ISLA 14808); Cave SL_0060 (5°58'46"S, 49°37'22"W), 1♀ (ISLA 14803); Cave SL_0062 (5°58'46"S, 49°37'19"W), 3♀ (ISLA 14817, ISLA 14813); Cave SL_0067 (5°58'53"S, 49°37'14"W), 1♀ (ISLA 14793); Cave SL_0069 (5°59'3"S, 49°37'14"W), 3♀ (ISLA 14800); Cave SL_0071 (5°58'19"S, 49°37'29"W), 2♀ (ISLA 14809, ISLA 14802); Cave SL_0075 (5°57'56"S, 49°37'57"W), 1♂ 8♀ (ISLA 14788, ISLA 14789, ISLA 14784, ISLA 14791); Cave SL_0077 (5°58'0"S, 49°38'33"W), 1♀ (ISLA 14812); Cave SL_0079 (5°57'52"S, 49°38'18"W), 3♂ 5♀ (ISLA 14792); Cave SL_0086 (5°57'32"S, 49°38'10"W), 1♂ 1♀ (ISLA 14815); Cave SL_0092 (5°57'34"S, 49°38'39"W), 2♀ (ISLA 14821), all collected on 2010-2011 by Equipe Carste; Altamira, Cave Abrigo do Sismógrafo (3°18'0"S, 52°13'39"W), 1♀, 11/IV/2009 (IBSP 151442); Cave Abrigo Queda d'Água (3°15'18"S, 52°8'60"W), 8♂ 24♀, IV/2011

(IBSP 151391) collected by M. E. Bichuette coll.; Vitória do Xingu, Cave Abrigo Kararaô (3°8'33"S, 51°49'8"W), 2♀, XII/2010 (IBSP 151419); Cave Gruta do China (3°8'32"S, 51°49'8"W), 4♀, XII/2010 (IBSP 151404, IBSP 151407, IBSP 151409), all collected by M. E. Bichuette; São Geraldo do Araguaia, Cave SI-05 (4°58'35"S, 48°39'40"W), 1♂, 22/II–02/III/2011 (IBSP 175231); Cave SI-07 (6°22'2"S, 48°23'38"W), 1♂ 2♀, 22/II–02/III/2011 (IBSP 179480, IBSP 179481); Cave SI-08 (6°22'2"S, 48°23'38"W), 1♀, 22/II–02/III/2011 (IBSP 179482), all collected on 2010–2011 by F. P. Franco & B. F. Takano.

Etymology. The specific name is a masculine noun in apposition and refers to the word *ferro*, which means iron in Portuguese. This name describes the type of lithology where the species is found in abundance.

Diagnosis. Male resembles *P. novalima* sp. n. in the rounded tegulum, posterior portion of conductor hyaline and partially overlapping the embolus, and longer than larger bulb; it can be distinguished by the bifid conductor with a long and digitiform distal projection and rounded basal projection, and median apophysis with a single small tip (Fig. 1C–F). Female resembles *P. novalima* sp. n. in the large epigynal plate (Fig. 2B–C) and canoe-shaped sclerotized internal plate surrounding the spermathecae (Fig. 2C) but differs in the ample and rounded curvature of the copulatory ducts (Fig. 2C).

Description. Male (Holotype, IBSP 173283). Cephalothorax brown, wider than longer. Sternum brown. Endite and labium slightly lighter than sternum. Chelicerae brown. Legs brown. Abdomen grayish, covered by dispersed bristles (Fig. 1A). Total length 1.85. Carapace 0.91 long. Clypeus 0.21 high. Sternum 0.45 long, 0.43 wide. Eye measurements: AME 0.07; ALE-PLE contiguous, 0.06 each; PME-PME separated by diameter of PME (0.07 each). Legs: I femur 0.99/ patella 0.39/ tibia 0.9/ metatarsus 0.6/ tarsus 0.25/ total 3.13. II 0.8/ 0.36/ 0.72/ 0.54/ 0.51/ 2.93. III 0.62/ 0.3/ 0.51/ 0.39/ 0.37/ 2.19. IV 0.7/ 0.3/ 0.57/ 0.42/ 0.37/ 2.36. Palp: pointed cymbium. Conductor robust, hyaline in the distal region, covering embolus tip. Embolus large, with two mesal embolic apophyses (see Coddington 1986: 12) pointing down, usually partially covered by hyaline membrane (Fig. 1C–G). Abdomen: 0.9 long.

Female (paratype IBSP 173283). Color and body as in male, except for the slightly longer than wide cephalothorax (Fig. 1B). Total length: 2.4. Carapace. 0.96 long. Sternum 0.56 long, 0.52 wide. Abdomen 1.5 long. Eye measurements: AME 0.08; ALE-PLE contiguous, 0.07 each; PME-PME separated by the diameter of PME (0.07 each). Clypeus 0.2 high. Legs I femur 1.2/ patella 0.45/ tibia 0.9/ metatarsus 0.68/ tarsus 0.51/ total 3.74. II 1/ 0.4/ 0.74/ 0.56/ 0.54/ 3.24. III 0.65/ 0.33/ 0.54/ 0.43/ 0.44/ 2.39. IV 0.95/ 0.35/ 0.7/ 0.53/ 0.44/ 2.97. Epigynal plate wider than long, posterior margin very sclerotized, with wrinkles near the posterior margin, covered by disperse bristles. Internally with glandular ducts in the middle of the curve of ducts. Ovoid spermathecae (Fig. 2A–C).

Variation. Ten males: total length 1.75–1.95; carapace 0.75–0.91; femur I 0.9–1.15. 10 females: total length 2–2.8; carapace 0.9–1; femur I 1–1.25**.**

Distribution. Canaã dos Carajás, Parauapebas, Curionópolis, Altamira and São Geraldo do Araguaia, Pará, Brazil (Fig. 16).

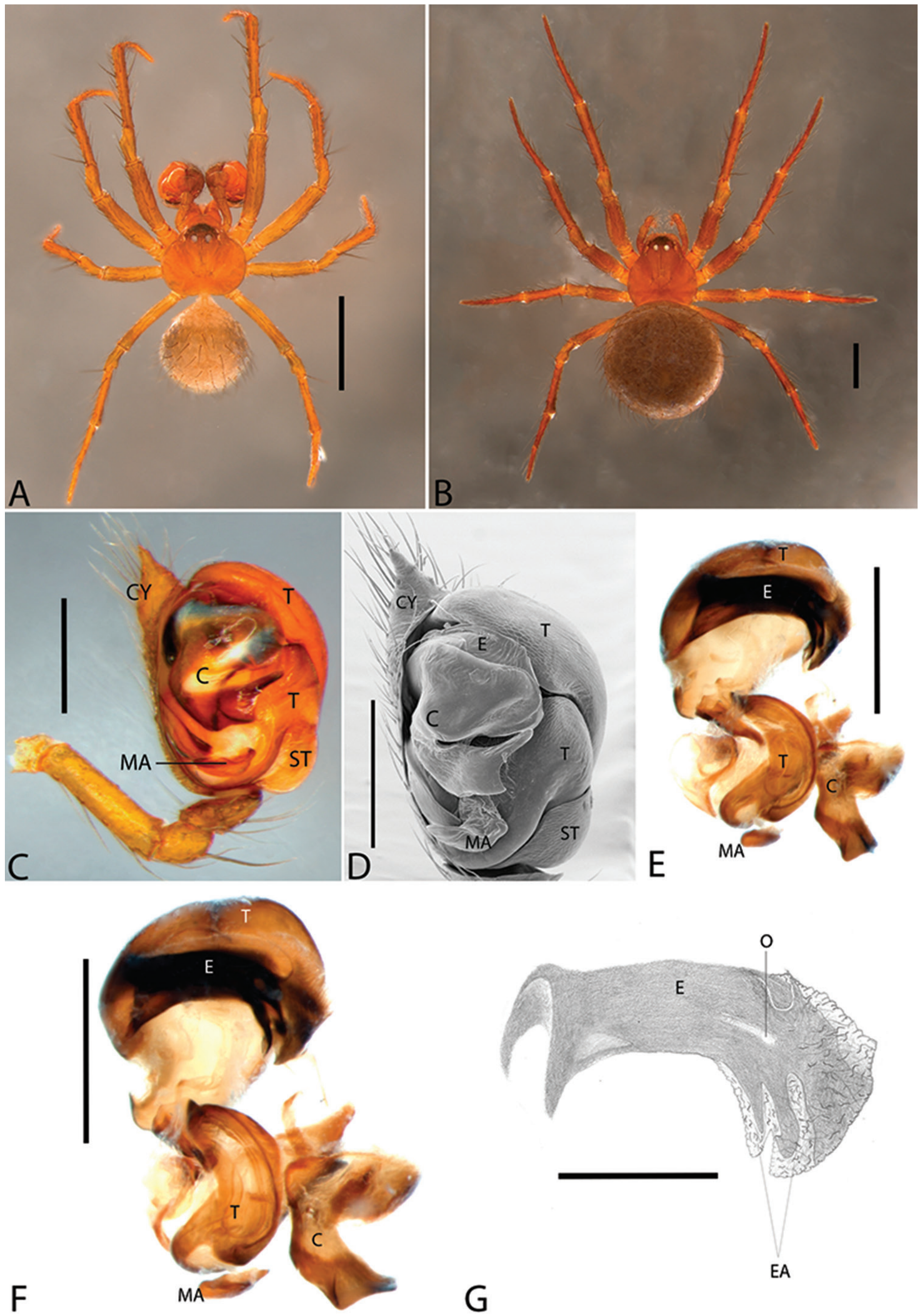

Figure 1. *Plato ferriferus* sp. n. **A** male, dorsal view **B** female, dorsal view **C** male palp, ventral view **D** male palp, ventral view (SEM) **E–F** male palp, ventral view, expanded and with conductor removed **G** embolus, illustration. Abbreviations: **C** conductor; **CY** cymbium; **E** embolus; **EA** mesal embolic apophysis; **MA** median apophysis; **O** embolic opening; **ST** subtegulum; **T** tegulum. Scale bars: **A** 1.1; **B** 1; **C–F** 0.3; **G** 0.15 mm.

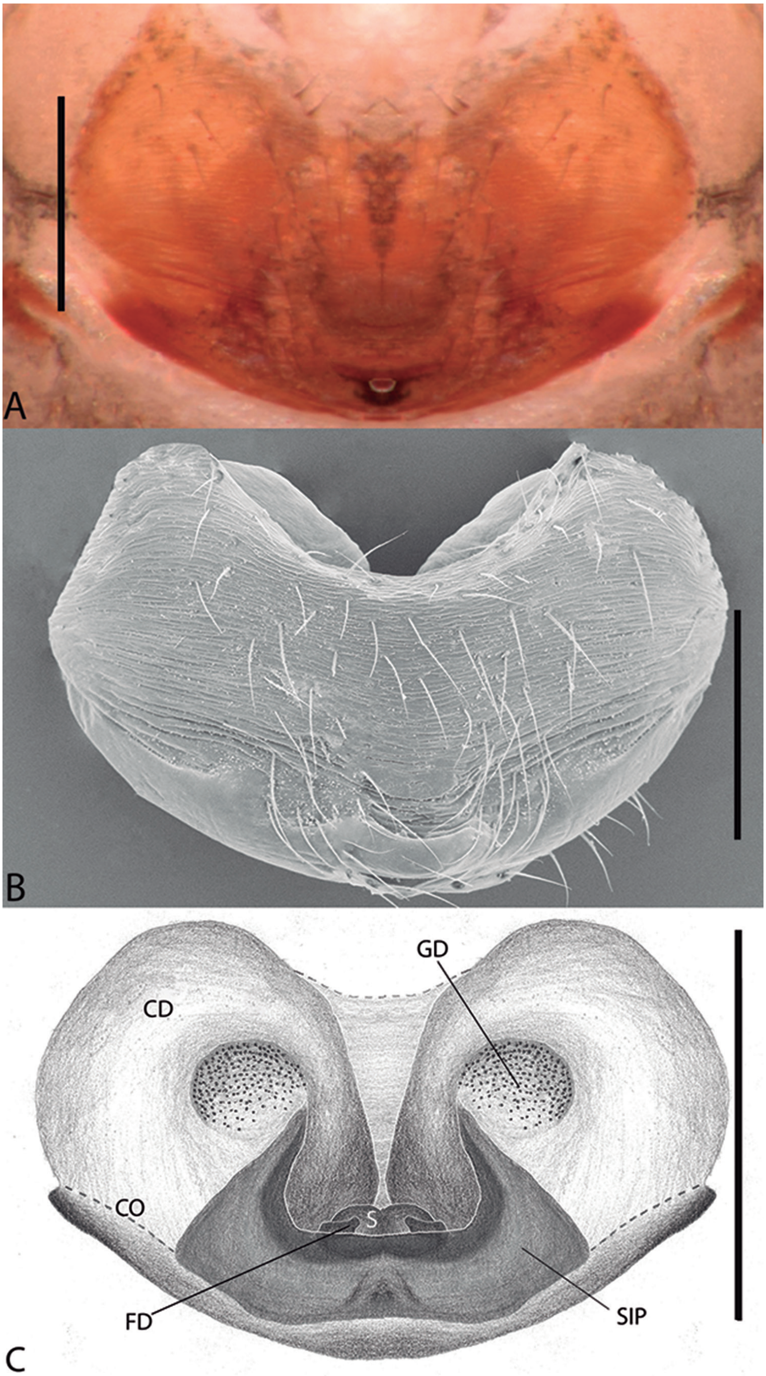

Figure 2. *Plato ferriferus* sp. n. **A** female epigynum, ventral view (LM) **B** female epigynum, ventral view (SEM) **C** female epigynum, dorsal view (drawing). Abbreviations: **CD** copulatory ducts; **CO** copulatory opening; **FD** fertilization ducts; **GD** glandular ducts; **S** spermathecae; **SIP** sclerotized internal plate. Scale bars: **A** 0.17; **B** 0.2; **C** 0.5 mm.

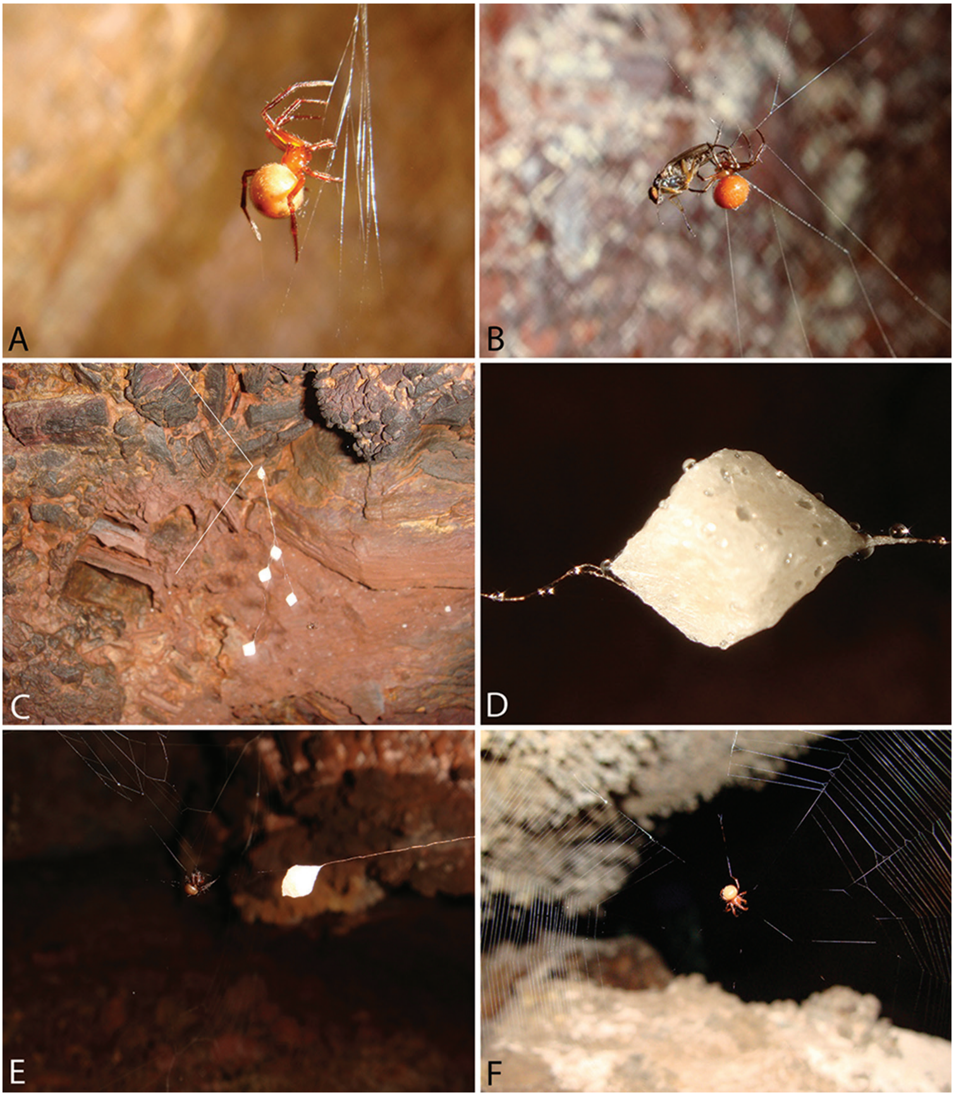

Figure 3. A *Plato ferriferus* sp. n. on its web **B** *Plato ferriferus* sp. n. preying on fly **C, D** *Plato ferriferus* sp. n. egg sacs **E** *Plato novalima* sp. n. on its web, building its egg sac **F** *Cuacuba mariana* sp. n. on its web; Photos **A–D** were taken in caves in Parauapebas, PA, Brazil. Photo E was taken in Mariana, Minas Gerais, Brazil. Photo **F** was taken in Matozinhos, Minas Gerais, Brazil. (I. Cizauskas).

Natural history. All specimens were collected in caves in iron formations. Most specimens were collected in the middle of orbicular webs, usually in the twilight zone (Fig. 3A–D). Egg sacs had a cubic shape and were fixed on cave walls (Fig. 3D). In some cases, more than four egg sacs were found in a single guide wire (Fig. 3C). The number of eggs per egg sac varied from eight to seventeen. They were recorded on different types of prey, and the most common prey items were winged species of orders Diptera (Fig. 3B) and Lepidoptera.

Plato striatus sp. n.

http://zoobank.org/9372DF43-4C6D-44A4-A2A4-D7A2C17C0E75

Figures 4, 16

Types. Male holotype from Cave GEM_1786 (6°06'19"S, 44°08'18"W), Parauapebas, Pará, Brazil, 07/II/2011, R. Zampaulo et al., deposited in IBSP 176982.

Etymology. The specific name is a masculine noun in apposition and means "striped" in Latin, referring to the darkened stripes on the male`s fourth pair of legs.

Diagnosis. *Plato striatus* sp. n. resembles *P. guacharo* in the twisted projection of the conductor (see Brignoli 1972: fig. 22), and *P. novalima* sp. n. and *P. ferriferus* sp. n. in the rounded tegulum, posterior portion of conductor hyaline and partially overlapping the embolus, and longer than large bulb. It differs from these three species in the proximal portion of the conductor simple, arrow-shaped, twisted and pointing upwards, embolus with proximal apophysis elongated, distal apophysis fused to the membrane (Fig. 4C–E) and fourth pair of legs with dark stripes on the articulations (Fig. 4A).

Description. Male (Holotype, IBSP 176982). Cephalothorax brown, longer than wide. Sternum brown with darkened edges. Endite, labium, and chelicerae brown. Legs yellowish, stripes on articulations of the fourth pair. Abdomen dark grayish, longer than wide. Total length: 1.5. Carapace 0.6 long. Clypeus height: 0.2. Sternum: 0.3 long; 0.3 wide. Eye measurements: AME 0.1; ALE-PLE: grouped, 0.05 each; PME-PME: separated by 1 PME (0.07 each). Legs: I femur 0.6/ patella 0.21/ tibia 0.4/ metatarsus 0.3/ tarsus 0.28/ total 1.79; II 0.45/ 0.2/ 0.35/ 0.22/ 0.25/ 1.47; III 0.32/ 0.15/ 0.2/ 0.17/ 0.2/ 1.04; IIII 0.4/ 0.17/ 0.3/ 0.2/ 0.2/ 1.27. Palp: cymbium pointed; conductor covering most of the embolus. Embolus large, with rounded embolic opening between the mesal embolic apophysis (Fig. 4B–E; Coddington 1986: 12). Abdomen: 0.8 long.

Female. Unknown.

Distribution. Known only from the type locality, a cave in Parauapebas, state of Pará, Brazil (Fig. 16).

Plato novalima sp. n.

http://zoobank.org/1A1653F3-0C7D-4C07-A000-FFE0F2DEDA7F

Figures 3E, 5, 6, 16

Plato sp.: Pinto-da-Rocha, 1995: 74 (examined, now in IBSP 56068, IBSP 56075, and IBSP 56081).

Types. Holotype: male from Cave VG_28 (20°07'00"S, 43°53'57"W), Nova Lima, Minas Gerais, Brazil, 29/III-1/IV/2011, V. Felice coll., deposited in IBSP 175196. Paratypes: male and female from Cave RF_15 (19°55'19"S, 43°29'43"W), Barão de Cocais, Minas Gerais, Brazil, 10–21/III/2009, R. Andrade coll. (MZSP70927);

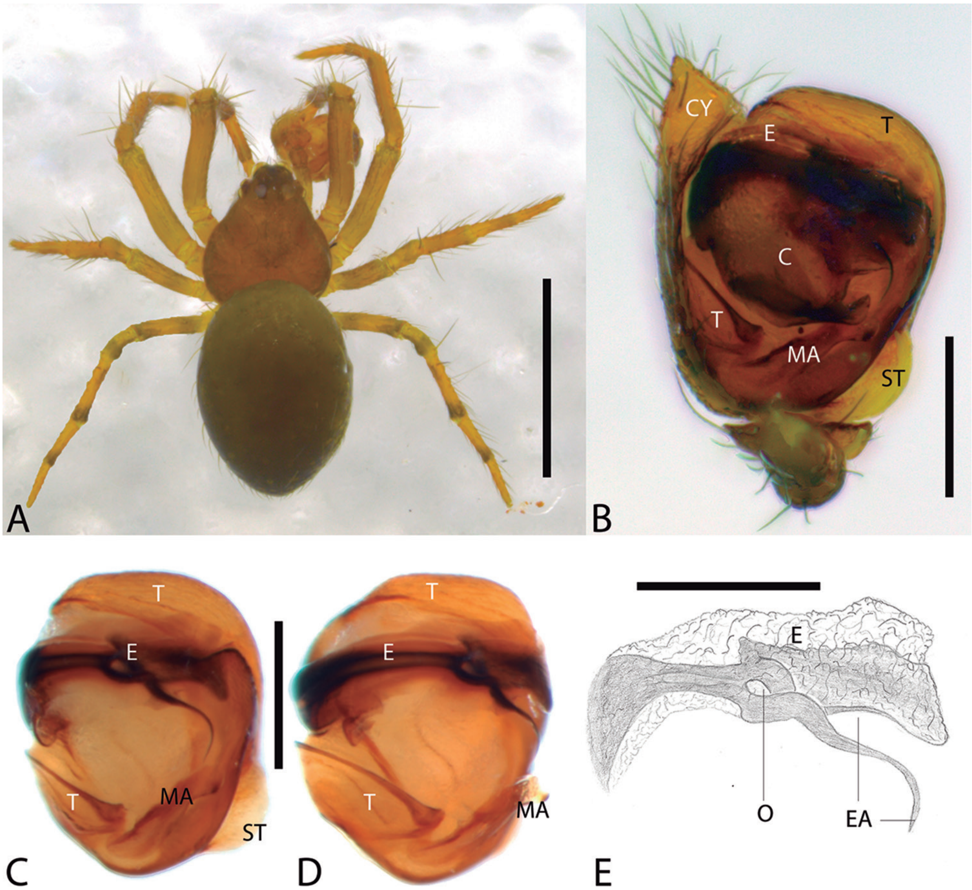

Figure 4. *Plato striatus* sp. n. **A** male, dorsal view **B** male palp, ventral view **C, D** male palp, ventral view with conductor removed **E** embolus, illustration. Abbreviations: **C** conductor; **CY** cymbium; **E** embolus; **EA** mesal embolic apophysis; **MA** median apophysis; **O** embolic opening; **ST** subtegulum; **T** tegulum. Scale bars: **A**, 0.8; **B–D** 0.1; **E** 0.05 mm.

Male from Cave VG_28 (20°07'00"S, 43°53'57"W), Nova Lima, Minas Gerais, Brazil, 02-10/VIII/2011, Andrade et al. coll. (MZSP70926); Female from Cave VG_26 (20°07'00"S, 43°53'57"W), Nova Lima, Minas Gerais, Brazil, 29/III-01/IV/2011, G.P. Perroni coll. (MPEG 32024); Male from Cave VL_10 (20°17'9"S, 43°56'44"W), Itabirito, Minas Gerais, Brazil, 18-25/IV/2007, R. Andrade coll. (MPEG 32023); Female from Cave VL_09 (20°17'9"S, 43°56'47"W), Itabirito, Minas Gerais, Brazil, 18-25/IV/2007, R. Andrade coll. (MPEG 32025).

Other material examined. BRAZIL. **Minas Gerais**: Barão de Cocais, Cave Mina Gongo Soco, 4♀ 02–24/XI/2007 (IBSP 127615, IBSP 127618) collected by R. Andrade coll.; Cave RF_05 (19°55'3"S, 43°29'10"W), 2♀ (IBSP 181157); 3♀, 10–21/III/2009 (IBSP 181144); Cave RF_07 (19°55'5"S, 43°29'13"W), 1♀ (IBSP 181134); Cave RF_09 (19°55'6"S, 43°29'13"W), 1♀ (IBSP 181137); Cave

RF_13 (19°55'18"S, 43°29'28"W), 1♂ 1♀ (IBSP 181136); 4♀ (IBSP 181140); Cave RF_14 (19°55'19"S, 43°29'41"W), 1♀ (IBSP 181147); 2♀ (IBSP 181135); Cave RF_19 (19°55'19"S, 43°29'48"W), 1♀ (IBSP 181139, IBSP 181155); Cave RF_20 (19°55'21"S, 43°29'50"W), 1♀ 10–21/III/2009 (IBSP 181149); Cave RF_25 (19°55'26"S, 43°29'57"W), 1♀ (IBSP 181133); Cave RF_38 (19°55'42"S, 43°30'30"W), 3♂ 14♀ (IBSP 181146, IBSP 181132, IBSP 181138, IBSP 181142); Cave RF_46 (19°55'46"S, 43°30'36"W), 3♂ 8♀ (IBSP 181156, IBSP 181141); 2♀ (IBSP 181150); Cave RF_52 (19°56'5"S, 43°31'8"W), 1♂ 1♀ (IBSP 181145); Cave RF_55 (19°56'10"S, 43°31'23"W), 1♀ (IBSP 181151); Cave RF_57 (20°1'34"S, 43°41'8"W), 1♀ (IBSP 181153); Cave RF_59 (19°56'2"S, 43°31'58"W), 2♀ (IBSP 181152, IBSP 181158); Cave RF_72 (19°55'8"S, 43°28'19"W), 1♂ 14♀ (IBSP 181154, IBSP 181148), all collected on 10–21/III/2009 by R. Bessi et al.; Caeté; Cave AP_46 (20°2'28"S, 43°40'44"W), 1♀ (IBSP 175143); 3♀ (IBSP 175150, IBSP 175151); Cave AP_47 (20°1'39"S, 43°40'52"W), 3♀ (IBSP 175144–IBSP 175146) 4♀ (IBSP 175152–IBSP 175154); Cave AP_49 (20°2'8"S, 43°41'29"W), 1♀ (IBSP 175149); 1♂ 2♀ (IBSP 175175); Cave AP_55 (20°1'35"S, 43°40'47"W), 2♀ (IBSP 175148); 1♀ (IBSP 175156); Cave E_47 (20°2'10"S, 43_41'31"W), 1♀ (IBSP 175147); Cave E_71, 1♀ (IBSP 175142), all collected on 13–17/IV/2010 by R. Bessi et al.; Cave APOL_12 (20°0'11"S, 43°40'8"W), 1♀, 21–25/XI/2011 (IBSP 175169); 1♀, 30/VI–15/VII/2011 (IBSP 175166); Cave APOL_18 (20°3'7"S, 43°42'10"W), 1♀, 02–07/I/2012 (IBSP 175171); 1♀, 30/VI–15/VII/2011 (IBSP 175160); Cave APOL_29 (20°2'36"S, 43°41'56"W), 1♀, 30/VI–15/VII/2011 (IBSP 175161); Cave APOL_31 (20°0'11"S, 43°40'8"W), 1♀ 30/VI–15/VII/2011 (IBSP 175162); 2♀, 21–25/XI/2011 (IBSP 175170), all collected by G. P. Perroni et al.; Cordisburgo, Cave Morena (19°10'5"S, 44°20'20"W), 2♀ IV/1986, F. Chaimowicz coll. (IBSP 56075); 1♂ 12♀, 12–13/X/2007 (IBSP 132151, IBSP 132152, IBSP 132160, IBSP 132157, IBSP 132161), all collected by G. R.S. Ruiz & E. O. Machado; Curvelo, Cave Lapa do Mosquito (18°37'59"S, 44°24'37"W), 1♀, IV/1986 (IBSP 56068); 1♀, 30/XI/1992 (IBSP 56081) collected by F. Chaimowicz coll.; Itabirito, Cave VL_10 (20°17'9"S, 43°56'44"W), 1♂ 1♀, 18–25/IV/2007 (IBSP 115744,); Cave VL_12 (20°17'46"S, 43°56'47"W), 2♀, 18–25/IV/2007 (IBSP 115737); 3♀, 18–25/IV/2007 (IBSP 115740, IBSP 115756); 1♂ 12♀, 03–20/XI/2007 (IBSP 128821, IBSP 128844, IBSP 128822); 2♂ 2♀, IV/2008 (IBSP 128841, IBSP 128842), all collected by R. Andrade et al.*;* Lima Duarte, Parque Estadual de Ibitipoca, Cave Gruta dos Coelhos (19°5'11"S, 43°56'12"W), 3♀, 08/X/2002, F. Tulio coll. (IBSP 39723); Cave A, 3♀, 07/III/2006 (IBSP 117707); Cave B, 2♀, 07/III/2007 (IBSP 117702, IBSP 117698), all collected by M. E. Bichuette & F. P. Franco; Mariana, Cave CH_07 (20°14'35"S, 43°31'1"W), 4♀, 28–30/IV/2009 (IBSP 145929); Cave CH_20 (20°13'43"S, 43°31'4"W), 1♀, 28–30/IV/2009 (IBSP 146001); Cave CH_25 (20°13'37"S, 43°31'4"W), 1♀, 23–30/IX/2008 (IBSP 146031), all collected by F. P. Franco et al.; Cave FN_01 (20°13'39"S, 43°25'49"W), 9♀, 05–09/V/2008 (IBSP 146108, IBSP 146134, IBSP 146142); Cave FN_04 (20°13'18"S, 43°26'3"W), 1♀, 05–09/V/2009 (IBSP 146127); Cave FN_06 (20°13'7"S, 43°25'50"W), 4♂ 11♀, 05–09/V/2009 (IBSP 146154, IBSP

146156, IBSP 146165, IBSP 146171, IBSP 146161, IBSP 146169); Cave FN_09 (20°12'27"S, 43°26'19"W), 3♀, 16–21/I/2009 (IBSP 146185, IBSP 146188); Cave FN_10 (20°12'27"S, 43°26'19"W), 1♂ 2♀, 05–09/V/2009 (IBSP 146197); Cave FN_12 (20°12'29"S, 43°26'19"W), 1♂ 4♀, 16–21/I/2009 (IBSP 146218); Cave FN_13 (20°12'26"S, 43°26'18"W), 8♀, 05–09/V/2009 (IBSP 146225); Cave FN_14 (20°12'27"S, 43°25'58"W), 1♀, 05–09/V/2009 (IBSP 146247); Cave FN_23 (20°12'30"S, 43°26'22"W), 1♀, 01–02/IX/2010 (IBSP 175209); Cave FN_27 (20°13'25"S, 43°26'15"W), 1♀, 01–02/IX/2010 (IBSP 175210); 1♀, 03–07/II/2011 (IBSP 175211), all collected by R. Andrade et al.; Cave GS-12 (20°10'53"S, 43°31'8"W), 3♀ (IBSP 175177, IBSP 175178); Cave GS_19 (20°11'17"S, 43°30'31"W), 1♀ (IBSP 175176); Cave GS_22 (20°14'46"S, 43°28'48"W), 1♀ 06–16/VI/2011 (IBSP 175183); Cave GS_26 (20°13'0"S, 43°29'34"W), 1♀ (IBSP 175181); Cave GS_33 (20°12'31"S, 43°29'45"W), 1♀ (IBSP 175182); Cave GS_35 (20°10'47"S, 43°30'39"W), 1♂ 3♀ (IBSP 175179, IBSP 175180), all collected on 16/I–11/II/2011 by R. Bessi et al.*;* Matozinhos, Cave Gruta dos Irmãos Piriá (19°10'58"S, 44°6'35"W), 2♀, 30/XI/1992, F. Chaimowicz coll. (IBSP 56082); Cave MOC_70/71 (19°32'47"S, 44°0'50"W), 2♀, 28/VI–01/VII/2011, F. P. Franco & C. A. R. Souza et al. (IBSP 181131)*;* Nova Lima, Cave VG_02 (20°9'30"S, 43°49'8"W), 1♀, 29/III–01/IV/2011 (IBSP 175187); Cave VG_07 (20°6'6"S, 43°53'44"W), 1♀, 29/III–01/IV/2011 (IBSP 175188); 2♀, 02–10/VIII/2011 (IBSP 175199); Cave VG_20 (20°7'24"S, 43°54'4"W), 1♀ 02–10/VIII/2011 (IBSP 175200); 2♀, 29/III–01/IV/2011 (IBSP 175189); Cave VG_26 (20°6'60"S, 43°53'55"W), 7♀, 02–10/VIII/2011 (IBSP 175203); 2♀, 29/III–01/IV/2011 (IBSP 175194, IBSP 175201, IBSP 175202); 6♀, 29/III–01/IV/2011 (IBSP 175191–IBSP 175193); Cave VG_28 (20°6'59"S, 43°53'56"W), 6♀, 02–10/VIII/2011 (IBSP 175206, IBSP 181130, IBSP 175205); 1♂ 2♀, 29/III–01/IV/2011 (IBSP 175195, IBSP 175197); Cave VG-40 (20°8'60"S, 43°52'28"W), 1♀, 02–10/VIII/2011 (IBSP 175208); 1♀, 29/III–01/IV/2011 (IBSP 175198), all collected by R. Andrade et al.*;* Pedro Leopoldo, Cave Gruta do Nei (19°37'45"S, 44°0'30"W), 4♀, 05–06/X/2009 (IBSP 175249, IBSP 175250); 2♀, 12–15/I/2009 (IBSP 175239, IBSP 175240), F. P. Franco et al.; Cave Gruta do Sufoco (19°37'46"S, 44°0'35"W), 10♀, 05–06/X/2009 (IBSP 175241–IBSP 175246, IBSP 175248); 2♂ 28♀, 12–15/I/2009 (IBSP 175235–IBSP 175238), all collected by F. P. Franco et al.; Rio Acima, Cave AP_09 (20°1'33"S, 43°40'54"W), 1♂ 4♀, 19–23/VII/2008 (IBSP 175215–IBSP 175217); Cave AP_10 (20°1'33"S, 43°40'55"W), 2♀, 19–23/VII/2008 (IBSP 175222); 1♂ 3♀, 14–21/XI/2008 (IBSP 175220); Cave AP_13 (20°1'40"S, 43°40'51"W), 2♀, 19–23/VII/2008 (IBSP 175218); Cave AP_15 (20°1'40"S, 43°40'52"W), 1♀, 19–23/VII/2008 (IBSP 175219); Cave AP_19 (20°1'43"S, 43°40'57"W), 1♀, 14–21/XI/2008 (IBSP 175221); Cave AP_21 (20°1'41"S, 43°40'53"W), 2♀ 14–21/XI/2008 (IBSP 175223, IBSP 175224); 1♂, 19–23/VII/2008 (IBSP 175214); Cave AP_36 (20°2'28"S, 43°40'44"W), 1♀, 14–21/XI/2008 (IBSP 175213); 2♀, 19–23/VII/2008 (IBSP 175212) all collected by R. Bessi et al.; Santa Bárbara, Cave APOL_10 (19°59'58"S, 43°39'55"W), 4♀, 21–25/XI/2011 (IBSP 175167, IBSP 175168); 9♀, 30/VI–15/VII/2011 (IBSP 175164, IBSP 175163); Cave APOL_11 (20°0'3"S, 43°39'57"W), 1♀, 30/VI–15/VII/2011 (IBSP 175165); Cave APOL_17 (20°3'9"S, 43°42'4"W), 1♀, 09–13/I/2012 (IBSP 175172); 3♀, 30/VI–15/VII/2011 (IBSP 175157–IBSP 175159); Cave SG_10 (20°3'17"S, 43°41'8"W), 2♀, 02–07/I/2012 (IBSP 175155, IBSP 175174); 3♀, 26–30/IX/2011 (IBSP 175173), all collected by G. P. Perroni et al.; Vazante, Cave P_04 (17°55'13"S, 46°48'37"W), 1♀ (IBSP 175185); 1♀ (IBSP 175184); Cave V_02 (17°55'36"S, 46°49'34"W), 1♀ (IBSP 175186), all collected on 16–19/VIII/2012 by A.P. Bueno.

Etymology. The specific name is a noun in apposition from the type locality.

Diagnosis. Male resembles *P. ferriferus* sp. n. and *P. striatus* sp. n. in the rounded tegulum, posterior portion of conductor hyaline and partially overlapping the embolus, and longer than larger bulb. It can be distinguished by the proximal portion of the conductor with an elongated tip and a prickly projection (Fig. 5C–F) and median apophysis with a single long rounded tip (Figs 5D). The female resembles *P. ferriferus* sp. n. in the larger than long epigynal plate, with a sclerotized canoe-shaped internal plate surrounding the spermathecae, but is distinguished by the smoothly projected posterior edge (Fig. 6A–B) and straight curvature of copulatory ducts (Fig. 6C).

Description. Male (holotype IBSP 175196). Cephalothorax brown. Sternum dark brown, slightly longer than wide. Endite, labium, and chelicerae slightly darker than sternum. Legs brown. Abdomen ovoid, grayish, covered with bristles (Fig. 5A). Total length 2.1. Carapace 1.24 long. Clypeus: height 0.27. Sternum 0.66 long, 0.59 wide. Eye measurements: AME 0.09; ALE-PLE: grouped, 0.08 each; PME-PME: separated by diameter of 1 PME (0.08 each). Legs: I femur 1.55/ patella 0.65/ tibia 1.3/ metatarsus 1/ tarsus 0.78/ total 5.28. II 1.42/ 0.55/ 1.15/ 0.8/ 0.72/ 4.64. III 0.88/ 0.45/ 0.81/ 0.61/ 0.59/ 3.34. IV 1.15/ 0.45/ 0.94/ 0.64/ 0.52/ 3.7. Palp: cymbium pointed. Robust and sclerotized conductor, except posterior region, hyaline, covering the embolus. Embolus covered by the conductor. Flattened and darkened embolus, with rounded opening and two small mesal embolic apophyses (Fig. 5C–G; Coddington 1986:,12). Abdomen: 1.2 long.

Female (paratype IBSP 175204). Color as in male, except for lightly brown sternum and yellowish abdomen (Fig. 5B). Total length 2.79. Carapace 0.96 long. Clypeus: height: 0.28. Sternum 0.74 long, 0.68 wide. Eye measurements: AME 0.1. ALE-PLE: grouped, 0.09 each. PME-PME: separated by 0.1 (PME: 0.1 each). Legs: I femur 1.84/ patella 0.67/ tibia 1.39/ metatarsus 1.02/ tarsus 0.9/ total 5.82. II 1.6/ 0.68/ 1.25/ 0.9/ 0.86/ 5.29. III 1.25/ 0.45/ 0.88/ 0.65/ 0.67/ 3.9. IV 1.42/ 0.54/ 1.02/ 0.78/ 0.61/ 4.37. Epigynal plate large. Sclerotized posterior border, bristles disperse but concentrated in the median region. Internally, spermathecae ovoid, covered by sclerotized internal plate. Glandular ducts in the middle of copulatory duct (Fig. 6A–C). Abdomen: 1.75 long.

Variation. 10 males: total length: 2.1–2.5; carapace: 1.15–1.28; femur I: 1.55–1.75. 10 females: total length: 2.5–3.1; carapace: 0.96–1.45; femur I: 1.25–1.84.

Distribution. Common in the Iron Quadrangle, state of Minas Gerais, Brazil (Fig. 16).

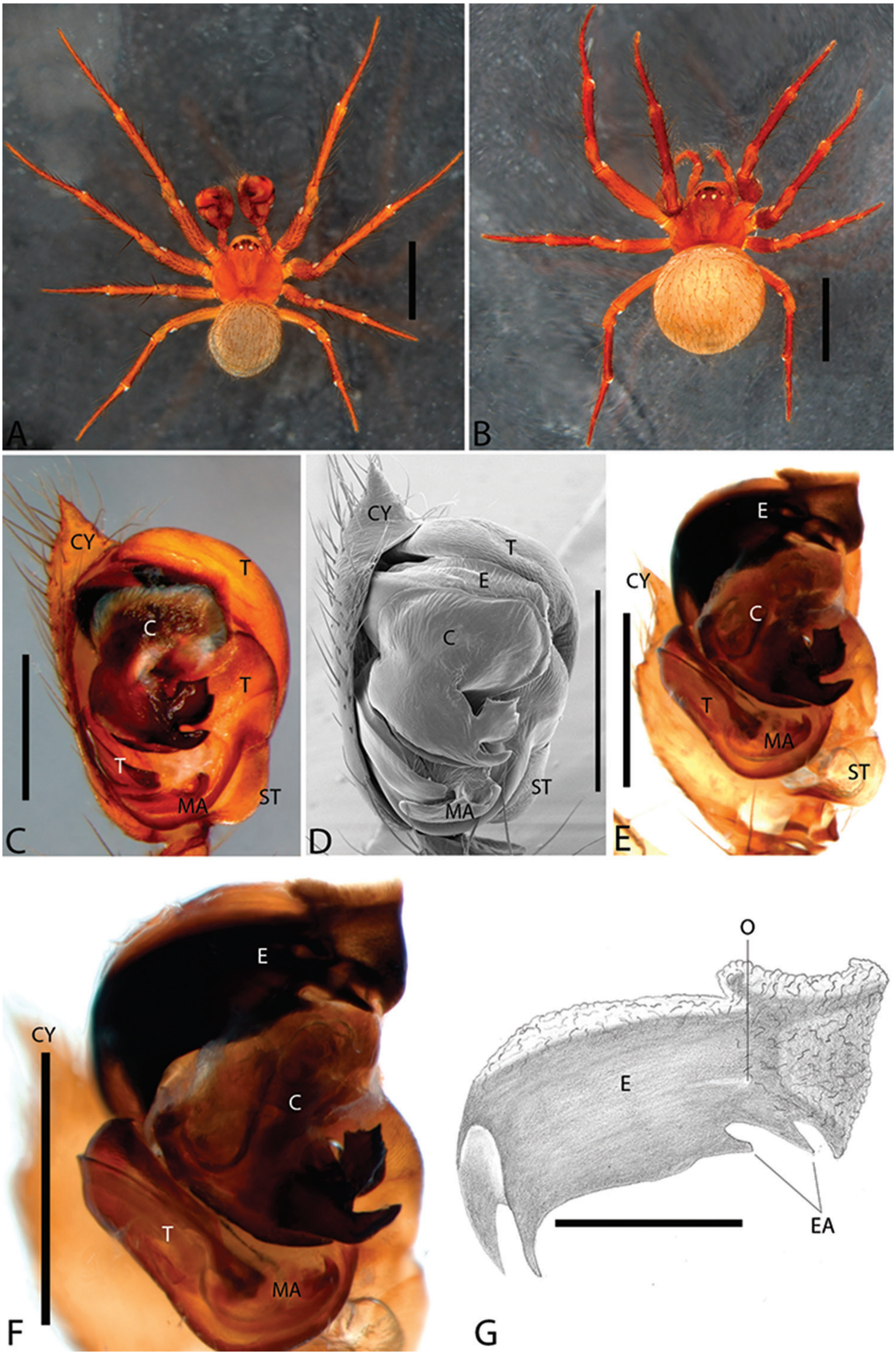

Figure 5. *Plato novalima* sp. n. **A** male, dorsal view **B** female, dorsal view **C** male palp, ventral view **D** male palp, ventral view (SEM) **E, F** male palp, ventral view with conductor removed **G** embolus, illustration. Abbreviations: **C** conductor; **CY** cymbium; **E** embolus; **EA** mesal embolic apophysis; **MA** median apophysis; **O** embolic opening; **ST** subtegulum; **T** tegulum. Scale bars **A, B** 1.8; **C–F** 0.45; **G** 0.21 mm.

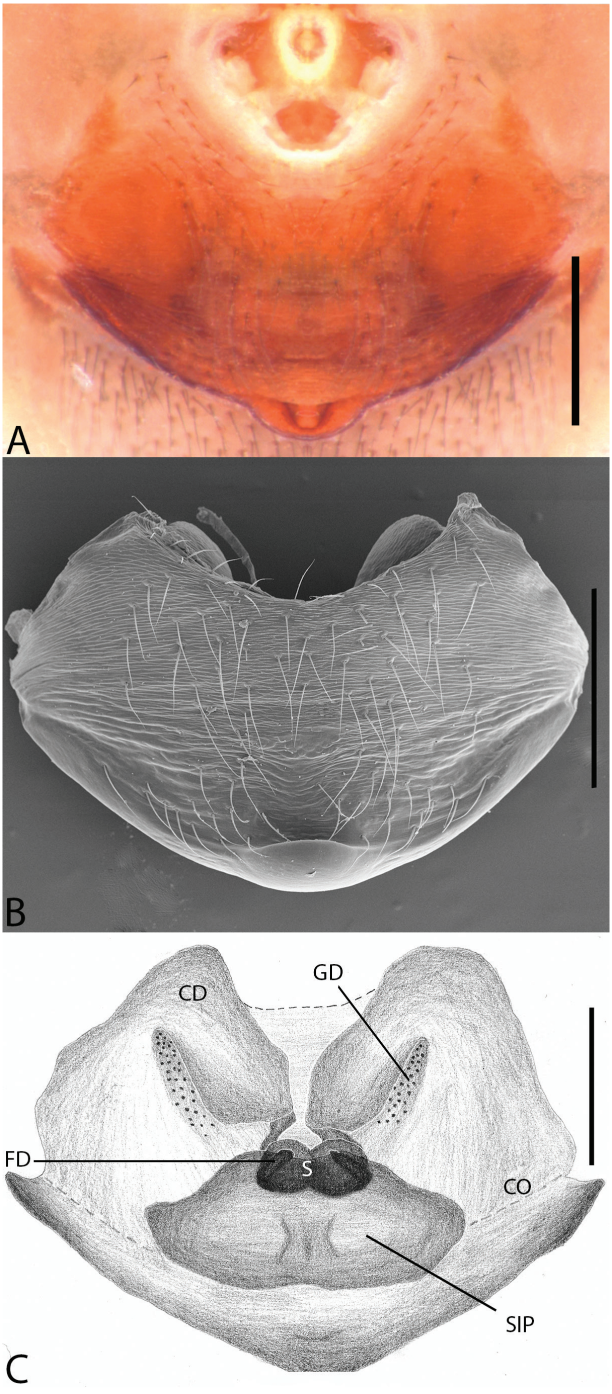

Figure 6. *Plato novalima* sp. n. **A**, female epigynum, ventral view **B** female epigynum, ventral view (SEM) **C** female epigynum, dorsal view, illustration. Abbreviations: **CD** copulatory ducts; **CO** copulatory opening; **FD** fertilization ducts; **GD** glandular ducts; **S** spermathecae; **SIP** sclerotized internal plate. Scale bars 0.3 mm.

Natural history. Most specimens were collected in caves in iron formations, in the middle of their orbicular webs and usually in the twilight zone (Fig. 3E). Egg sacs had a cubic shape and were fixed on the walls of caves. In some cases, more than one egg sac was observed on a single guide wire.

Cuacuba gen. n.

http://zoobank.org/3F30135D-3C0A-40D7-B90C-F848CAF87BA8

Type species. *Cuacuba mariana* sp. n.

Etymology. The generic name "*Cuacuba*" means *hidden* in the native language of the South American indigenous tribe Tupi. It refers to the embolus of the male palp.

Monophyly. This genus has at least three putative synapomorphies: C-shaped conductor with a posterior apophysis covering the embolus (Fig. 11C–E), anterior apophysis with filamentous structures (Fig. 9D), and cuneiform tegulum (Fig. 9B).

Diagnosis. Males of *Cuacuba* gen. n. can be distinguished from the other males in the family by the C-shaped conductor, split into anterior and posterior apophysis (Fig. 9B–C). The anterior apophysis has distal filamentous ornaments (Figs 9D, 14E) and the posterior one covers the embolus (Figs 9B, 11C–E). Resembles the genus *Sinoalaria* Zhao & Li, 2012 in the morphology of the conductor covering the embolus and in not having an embolic division (see Lin et al. 2014: fig. 6A). Females of *Cuacuba* gen. n. are similar to females of *Sinoalaria* in the curves of the copulatory ducts, and in position and shape of spermathecae (see Lin et al. 2014: figs 10A–B), but can be distinguished by the lack of scapus, and by having epigynum with salient posterior margin, distally notched in the transversal groove (Figs 10B, 15C–D).

Description. Total length 1.3–3 mm. Cephalothorax longer than wide, thoracic groove inconspicuous. Clypeus 3 times AME diameter. Eyes: anterior row recurved, posterior row straight. PME separated by its diameter. Sternum: rounded posteriorly. Legs long, formula: 1243. Tibia with a single row of 4-5 trichobothria, relatively short when compared to other genera (not as short as in *Wendilgarda*) (Fig. 7D). Tarsi with three claws. Paired claws with approximately five teeth. Unpaired claw long (Fig. 7E). Abdomen ovoid, larger than wide, with disperse and short bristles. Colulus a single flattened plate with a pair of bristles (Fig. 8D). Six spinnerets. Anterior lateral spinnerets larger than posterior lateral ones. Posterior median spinnerets smaller than others (Fig. 8C, E, F). Male palp with rounded cymbium (Fig. 9A–B). Paracymbium wing-shaped (Fig. 9F). Subtegulum transparent over fundus (Fig. 11D). Tegulum massive, scaled, and cuneiform, almost half the size of the bulb (Fig. 11C). Median apophysis large, conical, with dark tip (Figs 11D, 14F). Conductor C-shaped with posterior apophysis large, covering the embolus, and anterior apophysis narrow, generally with ornament-like accessory structures on the tip (Fig. 11C). Embolus long, flageliform, with large base, pars pendula, mesal embolic apophysis (Fig. 12A–B), and filamentous distal tip. Embolus covered by conductor up to the embolic opening (Fig. 12D), showing only tip of the embolus (Figs 11D–E, 14F–H). Female with epigynal plate sclerotized, without central pit, covered by short bristles, posterior margin triangular or rounded, distally notched (Figs 13A, 15A). Internally with long and coiled copulatory ducts, distally sclerotized, inserts laterally into the spermathecae, basal area with glandular ducts (Figs 13C–D, 15B, E). Two basal oval and connate spermathecae, longer than fertilization ducts (Figs 13C–D, 15B, D, E).

Natural history. *Cuacuba* gen. n. was found only in caves. The species is a troglophile, as its specimens do not lack pigmentation nor have modified eyes (Fig. 3F).

Cuacuba mariana sp. n.

http://zoobank.org/E7F94F33-4051-4788-B113-59E7D00A3C34
Figures 3F, 7, 8, 9 10, 11, 12, 13, 17

Plato sp.: Pinto-da-Rocha 1995: 74 (now in IBSP 56084).

Types. Male holotype from Cave SG_07 (20°02'58"S, 43°41'4"W), Santa Bárbara, Minas Gerais, Brazil, 26-30/IX/2011, Equipe Carste, deposited in IBSP 175141. Paratypes: male and female from Cave ICPA_697 (20°22'20"S, 45°36'14"W), Pains, Minas Gerais, Brazil, 26-30/IX/2011, A. P. Bueno et al coll. (MZSP 70925); male from Cave MOC_10 (19°33'6"S, 44°1'11"W), Matozinhos, Minas Gerais, Brazil, 28/VI–01/VII/2011, C.A.R. Souza et al. coll. (MPEG 32022); female from Cave MOCN_10 (19°33'19"S, 44°00'56"W), Matozinhos, Minas Gerais, Brazil, 04–15/IV/2011, C.A.R. Souza et al. coll. (MPEG 32021).

Other material examined. BRAZIL. **Minas Gerais**: Mirabela, Cave Gruta Vaca Voadora, 1♀, VII/1984, F. Chaimowicz coll. (IBSP 3810); Montes Claros, Cave Lapa Encantada (16°19'48"S, 43°59'24"W), 1♀, X/1985 (IBSP 56084), F. Chaimowicz coll.; Lima Duarte, Cave Gruta dos Manequins, 3♀, X–XI/2000 (IBSP 39768), F. Tulio coll.; Cordisburgo, Cave Morena (19°10'7"S, 44°20'21"W), 1♀, 12/IX/2001 (IBSP 71835), R. L. Ferreira coll.; Mariana, Cave CH_07 (20°14'35"S, 43°31'1"W), 1♂ 5♀, 23–30/IX/2008 (IBSP 145930); Cave CH_17 (20°14'30"S, 43°31'6"W), 1♀, 28–30/IV/2009 (IBSP 145977); Cave CH_18 (20°14'30"S, 43°31'7"W), 1♂ 2♀, 23–30/IX/2008 (IBSP 145988); Cave CH_19 (20°14'32"S, 43°30'59"W), 1♀, 28–30/IV/2009 (IBSP 145994); 4♀, 23–30/IX/2008 (IBSP 145997); Cave CH_20 (20°13'43"S, 43°31'4"W), 2♀, 23–30/IX/2008 (IBSP 146002); Cave CH_21 (20°13'55"S, 43°31'5"W), 1♂ 2♀, 23–30/IX/2008 (IBSP 146009, IBSP 146010); 3♀, 28–30/IV/2009 (IBSP 146012); Cave CH_22 (20°13'55"S, 43°31'5"W), 1♀, 28–30/IV/2009 (IBSP 146023), all collected by F. P. Franco *et al.*; Cave GS_03 (20°9'16"S, 43°30'58"W), 2♀, 05/I/2011 (IBSP 174909, IBSP 174910); Cave GS_06 (20°10'10"S, 43°31'0"W), 1♀, 16/I–11/II/2011 (IBSP 174911); 1♀, 06–16/VI/2011 (IBSP 174912); Cave GS_09 (20°10'10"S, 43°31'0"W), 1♀, 06–16/VI/2011 (IBSP 174913); Cave GS_10 (20°10'6"S, 43°30'57"W), 2♀, 06–16/VI/2011 (IBSP 174914) all collected by R. Bessi *et al.*; Cave Gruta Furnas I (20°12'36"S, 43°12'36"W), 2♀, IX/2002 (IBSP 39733); 1♀, IX/2002 (IBSP 39734); 1♀, 14/VII/2002 (IBSP 39772),

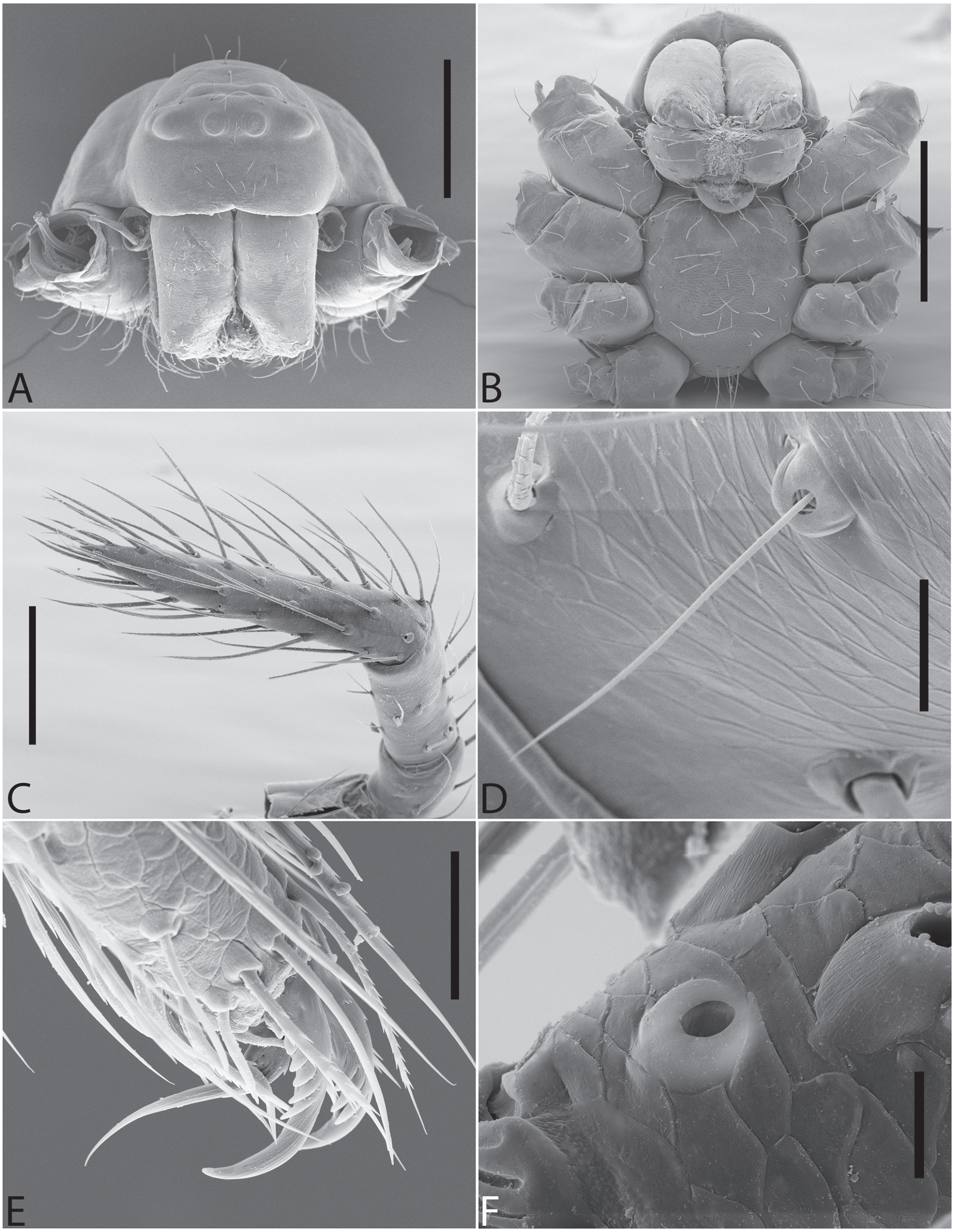

Figure 7. *Cuacuba mariana* sp. n. (IBSP 181212, 181214). **A** female prosoma, frontal view **B** female prosoma, ventral view **C** female left palp **D** detail of tibial trichobothria, female **E** detail of tarsal claws on leg 2, female **F** tarsal organ on leg 1, female. All SEM images. Scale bars: **A** 0.4; **B** 0.5; **C** 0.2; **D** 0.05; **E** 0.03; **F** 0.01 mm.

all collected by F. Tulio; Piumhi, Cave ICCA_014 (20°20'44"S, 45°50'53"W), 1♂ (IBSP 181216); Cave ICCA_018 (20°20'44"S, 45°50'54"W), 1♂ 3♀ (IBSP 181201, IBSP 181212, IBSP 181231); Cave ICCA_020 (20°20'44"S, 45°50'56"W), 1♂, 13–

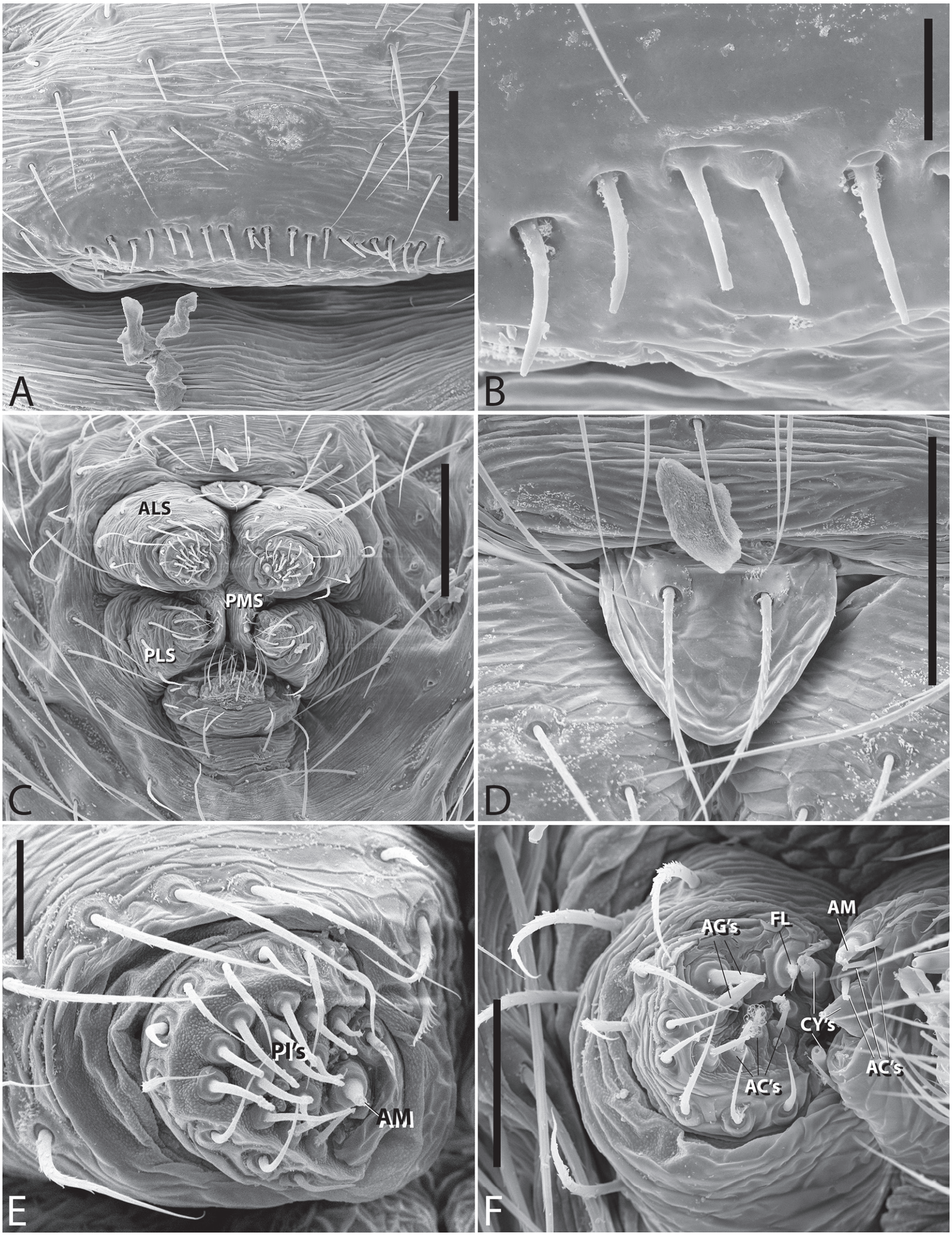

Figure 8. *Cuacuba mariana* sp. n. (IBSP 18118, 174911). **A** male epiandrous **B** male epiandrous, detail **C** male spinnerets **D** male colulus **E** male anterior lateral spinneret, detail **F** male posterior lateral spinneret and posterior median spinneret, detail. Abbreviations: **AC** aciniform spigots; **AG** aggregate gland spigots; **ALS** anterior lateral spinnerets; **AM** ampullate spigot; **CY** cylindrical gland spigots; **FL** flagelliform gland spigot; **PI** piriform gland spigots; **PLS** posterior lateral spinneret; **PMS** posterior median spinneret. Scale bars: **A** 0.05; **B** 0.01; **C** 0.1; **D** 0.05; **E** 0.02; **F** 0.03 mm.

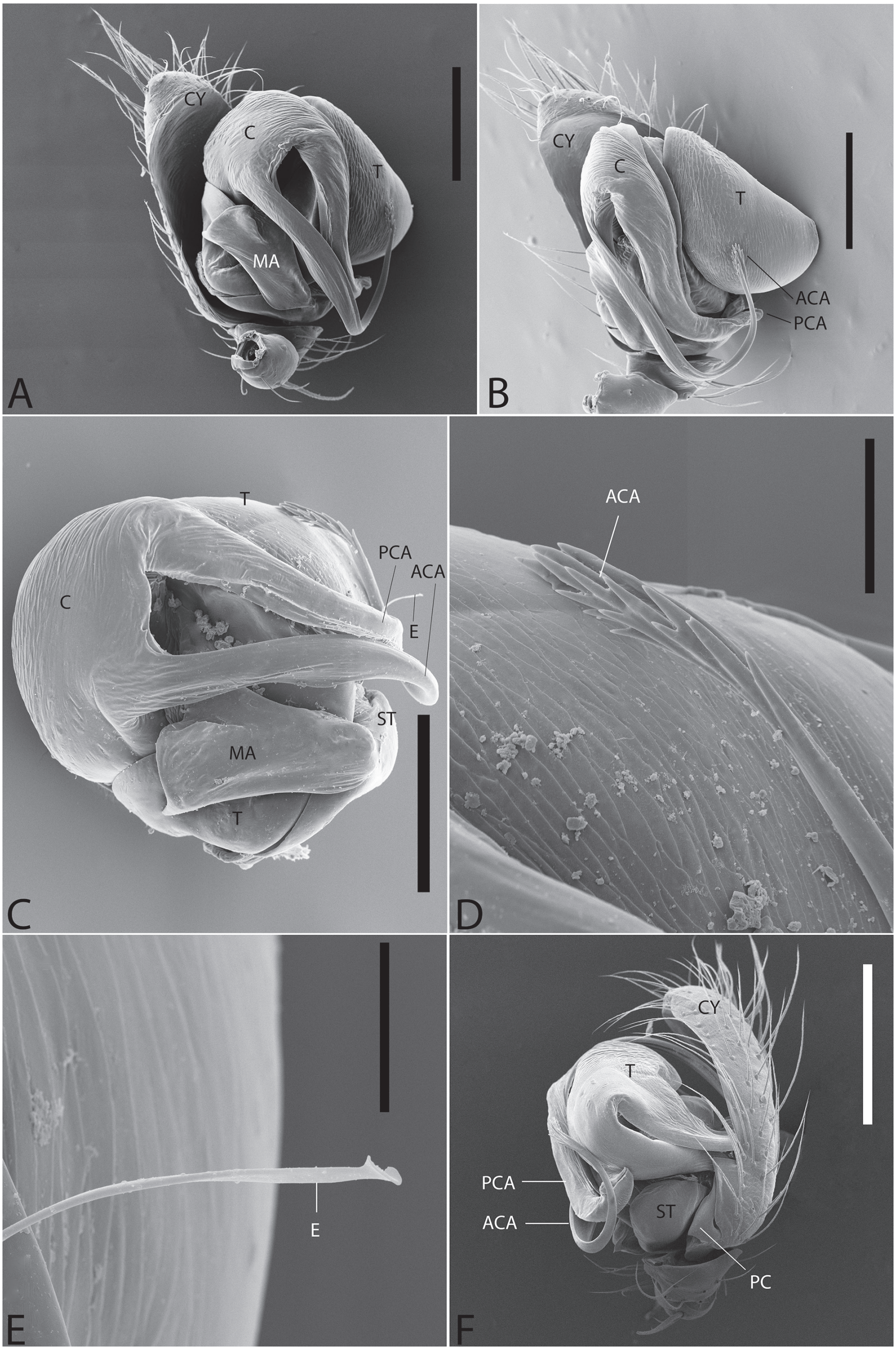

Figure 9. *Cuacuba mariana* sp. n. (IBSP 18118, 174911). **A** male palp, ventral view **B** male palp, ventral view **C** male palp, ventral view **D** anterior conductor apophysis tip, detail **E** posterior conductor apophysis tip, detail **F** male palp, retrolateral view. Abbreviations: **ACA** anterior conductor apophysis; **C** conductor; **CY** cymbium; **MA** median apophysis; **PC** paracymbium; **PCA** posterior conductor apophysis; **ST** subtegulum; **T** tegulum. Scale bars: **A–C**, 0.2; **D** 0.05; **E** 0.02; **F** 0.3 mm.

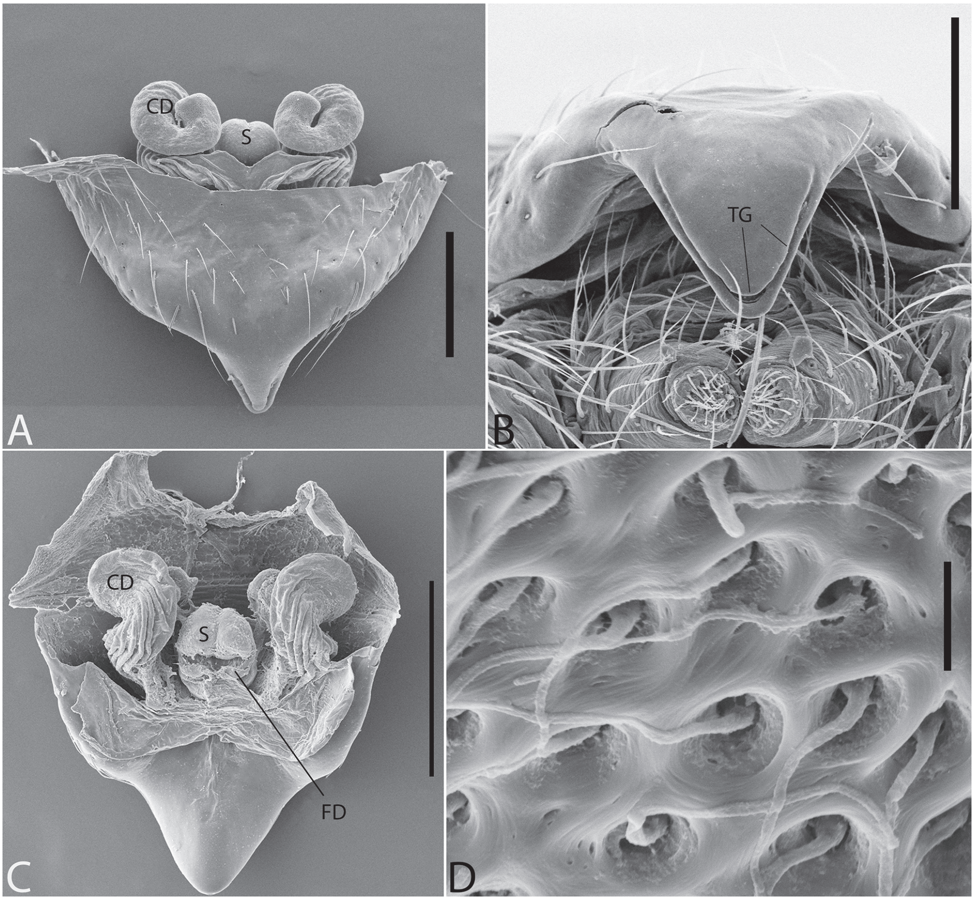

Figure 10. *Cuacuba mariana* sp. n. (IBSP 181212, 181214) **A** female epigynum, ventral view **B** female epigynum, detail of posterior margin **C** female epigynum, dorsal view **D** detail of glandular ducts. Abbreviations: **CD** copulatory ducts; **TG** transversal groove; **FD** fertilization ducts; **S** spermathecae. Scale bars: **A** 0.2; **B** 0.15; **C** 0.3; **D** 0.01 mm.

21/I/2014 (IBSP 181217); Cave ICCA_022 (20°20'42"S, 45°50'55"W), 1♂ 2♀ (IBSP 181227, IBSP 181230); Cave ICCA_026 (20°20'44"S, 45°50'56"W), 1♂ (IBSP 181205); Cave ICCA_035 (20°20'45"S, 45°50'55"W), 1♂ 2♀ (IBSP 181199, IBSP 181229); Cave ICCA_037 (20°20'45"S, 45°50'55"W), 1♀ (IBSP 181226); Cave ICCA_041 (20°20'46"S, 45°50'53"W), 1♂ 2♀, 4–22/XI/2013 (IBSP 181208, IBSP 181233); Cave ICCA_046 (20°20'50"S, 45°50'54"W), 1♀ (IBSP 181200); Cave ICCA_052 (20°20'48"S, 45°50'57"W), 2♀ (IBSP 181228, IBSP 181235); Cave ICCA_053 (20°20'49"S, 45°50'56"W), 1♀ (IBSP 181223); Cave ICCA–068 (20°20'50"S, 45°50'52"W), 1♀ (IBSP 181237); Cave ICCA_072 (20°20'51"S, 45°50'54"W), 1♂ (IBSP 181209); Cave ICCA–079 (20°20'52"S, 45°50'52"W), 1♂ 1♀ (IBSP 181220); Cave ICCA_081 (20°20'52"S, 45°50'52"W), 2♀ (IBSP 181211, IBSP 181213); Cave ICCA_082 (20°20'51"S, 45°50'55"W), 1♀ (IBSP 181210);

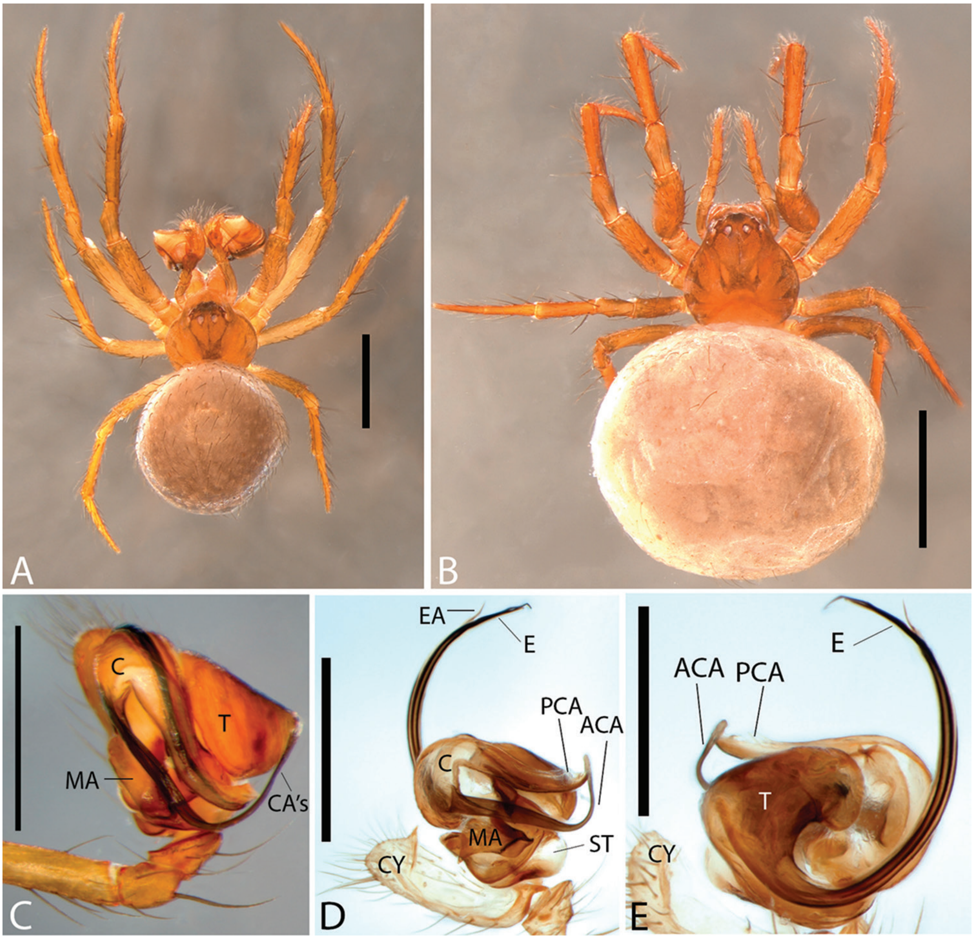

Figure 11. *Cuacuba mariana* sp. n. **A** male, dorsal view **B** female, dorsal view **C** male palp, ventral view **D** male palp, expanded, retrolateral view **E** male palp, expanded, dorsal view. Abbreviations: **ACA** anterior conductor apophysis; **C** conductor; **CA** conductor apophysis; **CY** cymbium; **E** embolus; **EA** mesal embolic apophysis; **MA** median apophysis; **PCA** posterior conductor apophysis; **ST** subtegulum; **T** tegulum. Scale bars: **A** 0.9; **B** 1.1; **C–E** 0.2 mm.

Cave ICCA_103 (20°20'54"S, 45°50'46"W), 1♂ (IBSP 181196); Cave ICCA_129 (20°21'3"S, 45°50'35"W), 3♀, 4–22/XI/2013 (IBSP 181203, IBSP 181219, IBSP 181232); Cave ICCA_139 (20°20'56"S, 45°50'42"W), 1♂ 3♀, 4–22/XI/2013 (IBSP 181198, IBSP 181207, IBSP 181224); Cave ICCA–141 (20°20'53"S, 45°50'42"W), 2♀ (IBSP 181202); Cave ICCA_142 (20°20'54"S, 45°50'36"W), 1♂ 1♀ (IBSP 181214, IBSP 181236); Cave ICCA_158 (20°20'59"S, 45°50'35"W), 1♀, 13–21/I/2014 (IBSP 181218); Cave ICCA_187 (20°21'3"S, 45°50'34"W), 1♀ (IBSP 181239); Cave ICCA_208 (20°20'59"S, 45°50'41"W), 1♂ (IBSP 181234); Cave ICCA–209 (20°21'3"S, 45°50'27"W), 1♂ 1♀ (IBSP 181225); Cave ICCA_211 (20°21'2"S, 45°50'27"W), 2♀ (IBSP 181222); Cave ICCA_247 (20°21'3"S,

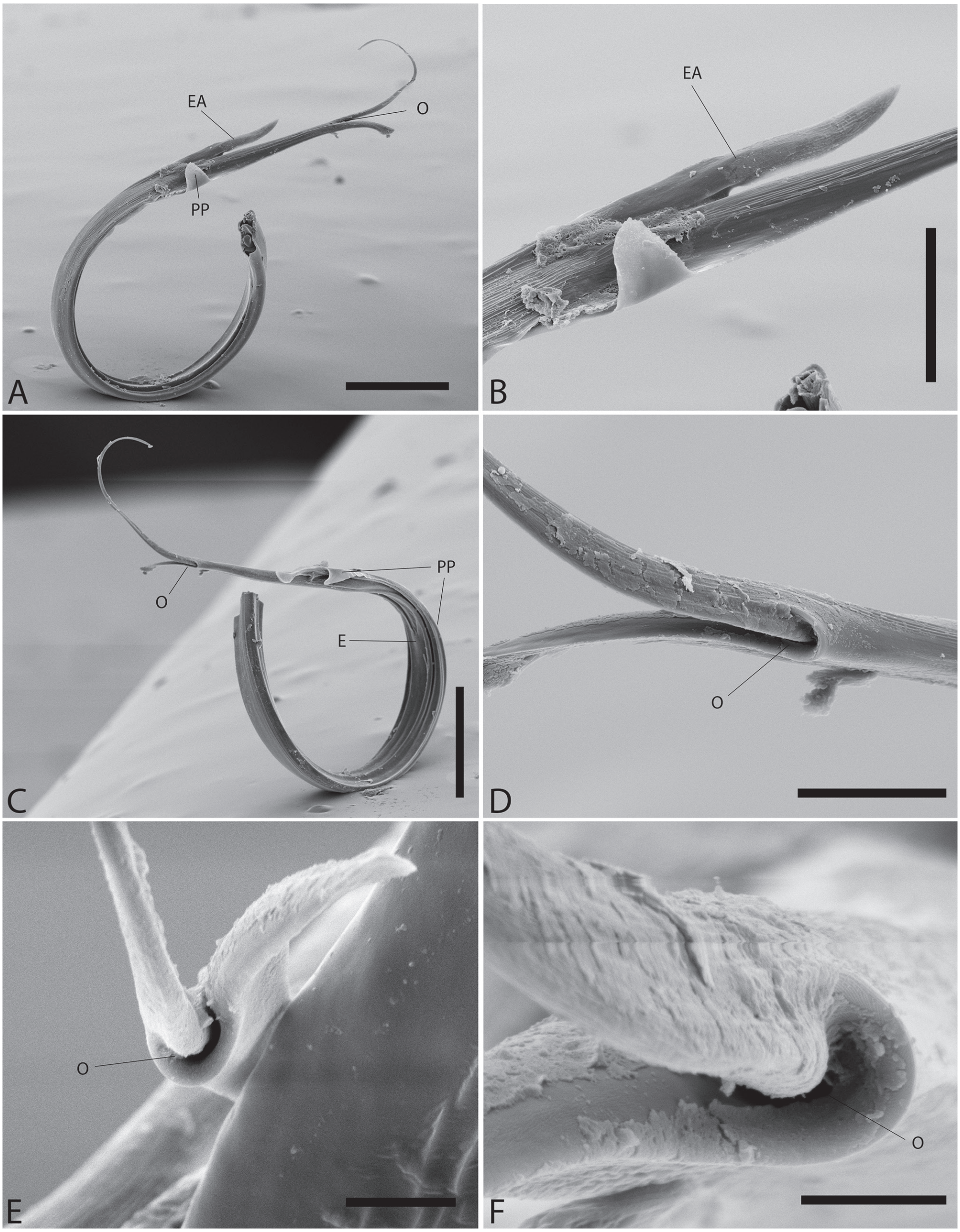

Figure 12. *Cuacuba mariana* sp. n. **A** embolus, cut out **B** same, detail of embolic apophysis **C** same, cut out **D** same, detail of embolic opening **E** same, detail of embolic opening **F** same, detail of embolic opening. Abbreviations: **E** embolus; **EA** embolic apophysis; **O** embolic opening; **PP** pars pendula. Scale bars: **A** 0.1; **B** 0.05; **C** 0,1 **D** 0.02; **E** 0.01; **F** 0.005 mm.

45°50'23"W), 1♀, 13–21/I/2014 (IBSP 181206); Cave ICCA_353 (20°21'5"S, 45°50'18"W), 1♀ (IBSP 181221); Cave ICCA_355 (20°21'6"S, 45°50'21"W), 1♂ (IBSP 181238); Cave ICCA–531 (20°20'58"S, 45°50'26"W), 1♂ (IBSP 181215);

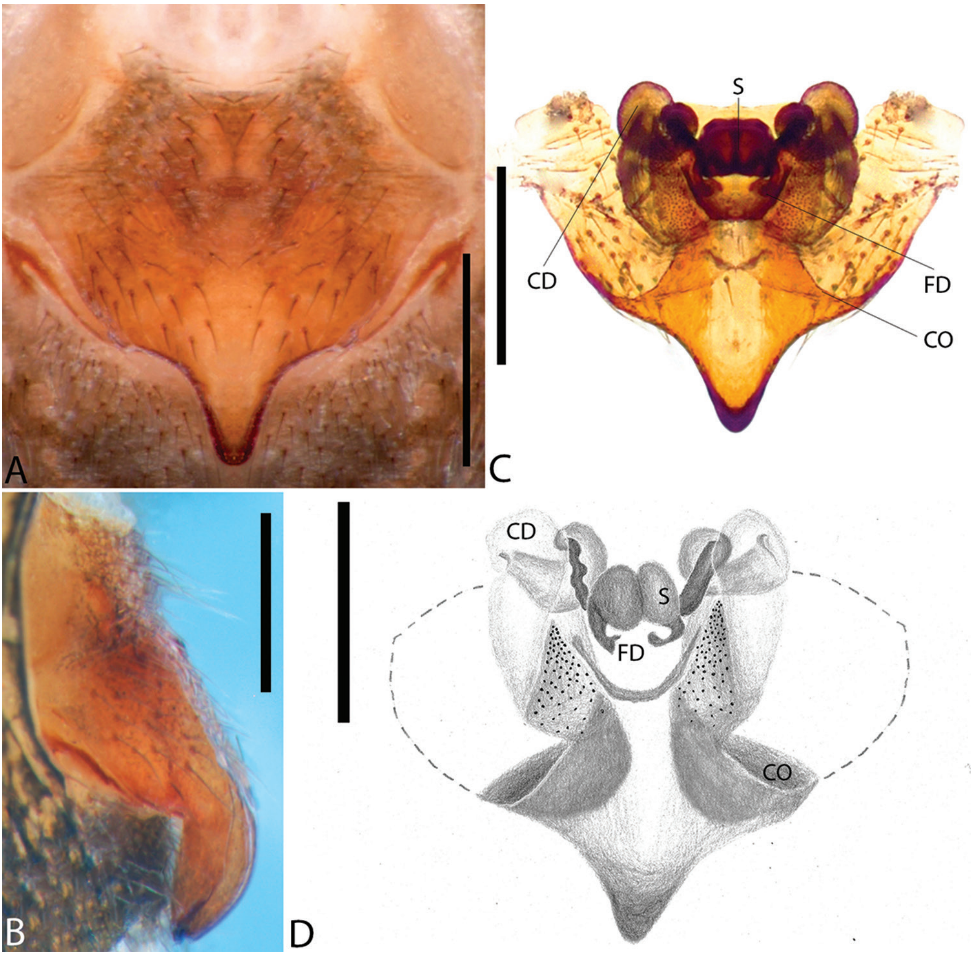

Figure 13. *Cuacuba mariana* sp. n. **A** female epigynum, ventral view **B** female epigynum, lateral view **C** female epigynum, dorsal view, clarified **D** female epigynum, dorsal view, illustration. Abbreviations: **CD** copulatory ducts; **CO** copulatory opening; **FD** fertilization ducts; **S** spermathecae. Scale bars: **A, C, D** 0.27; **B** 0.22 mm.

Cave ICCA_533 (20°20'58"S, 45°50'26"W), 2♀ (IBSP 181195); Cave ICCA_566 (20°20'42"S, 45°50'55"W), 1♀, 13–21/I/2014 (IBSP 181194); Cave ICCA_568 (20°20'50"S, 45°50'56"W), 1♀, 13–21/I/2014 (IBSP 181197); Cave ICCA_574 (20°21'6"S, 45°50'20"W), 1♀ (IBSP 181204), all collected between 4–22/XI/2013 by A. P. Bueno *et al.*; Pains, Cave Ressurgência da Loca D'Água (20°25'48"S, 45°41'24"W), 9♀, 07/IX/2001 (IBSP 71854, IBSP 71856), P. Gnaspini coll.; Cave Gruta do Topo (20°21'36"S, 45°40'12"W), 1♀, 01/XI/2005 (IBSP 71901) M.E. Bichuette coll.; Cave Gruta Arcaica, 2♀, 25/I/2008 (IBSP 118679); Cave Gruta Sem Fim, 7♂ 10♀, 24–25/I/2008 (IBSP 118670, IBSP 118673, IBSP 118693, IBSP 118682, IBSP 118698, IBSP 118705), E.O. Machado & J.P.P.P. Barbosa coll.; Cave ICPA_031 (20°22'37"S, 45°36'32"W), 1♂ (IBSP 181163); Cave ICPA_041 (20°22'12"S, 45°36'23"W), 1♀ (IBSP 181159); Cave ICPA_144 (20°22'17"S, 45°36'39"W), 2♀, 24–27/IV/2012 (IBSP 174926); 1♀, 28–29/XI/2012 (IBSP 174928); Cave ICPA_146 (20°22'16"S, 45°36'42"W), 1♀, 28–29/XI/2012 (IBSP 174927); Cave ICPA_631 (20°22'25"S, 45°36'16"W), 1♀ (IBSP 181160); Cave ICPA_636 (20°22'14"S, 45°36'10"W), 1♀ (IBSP 181189); Cave ICPA_639 (20°22'14"S, 45°36'7"W), 2♀ (IBSP 181167); Cave ICPA_665 (20°22'25"S, 45°36'17"W), 1♀ (IBSP 181188); Cave ICPA_671 (20°22'15"S, 45°36'18"W), 1♀ (IBSP 181179); Cave ICPA_685 (20°22'39"S, 45°36'29"W), 1♀ (IBSP 181170); Cave ICPA_692 (20°22'11"S, 45°36'17"W), 2♀ (IBSP 181171, IBSP 181184); Cave ICPA_693 (20°22'14"S, 45°36'10"W), 1♀ (IBSP 181191); Cave ICPA_697 (20°22'20"S, 45°36'14"W), 2♀ (IBSP 181172, IBSP 181175); Cave ICPA_699 (20°22'25"S, 45°36'11"W), 3♀(IBSP 181177, IBSP 181175); Cave ICPA_700 (20°22'24"S, 45°36'29"W), 1♂ (IBSP 181193); Cave ICPA_710 (20°22'37"S, 45°36'15"W), 1♂ (IBSP 181161); Cave ICPA_711 (20°22'27"S, 45°36'19"W), 1♀ (IBSP 181176); Cave ICPA_731 (20°22'29"S, 45°36'31"W), 3♀ (IBSP 181162, IBSP 181165); Cave ICPA_731 (20°22'29"S, 45°36'31"W), 1♀ (IBSP 181165); Cave MV_014 (20°22'22"S, 45°36'11"W), 2♀ (IBSP 181185, IBSP 181186); Cave MV_018 (20°22'26"S, 45°36'14"W), 1♂ (IBSP 181180); Cave MV_019 (20°22'27"S, 45°36'14"W), 1♀ (IBSP 181168); Cave MV_025 (20°22'22"S, 45°36'14"W), 1♀ (IBSP 181169); Cave MV_027 (20°22'25"S, 45°36'13"W), 1♀ (IBSP 181187); Cave MV_036 (20°22'24"S, 45°36'11"W), 1♀ (IBSP 181192); Cave MV_037 (20°22'25"S, 45°36'12"W), 1♀ (IBSP 181181); Cave MV–044 (20°22'17"S, 45°36'9"W), 2♀ (IBSP 181174); Cave MV_090 (20°22'28"S, 45°36'27"W), 1♀ (IBSP 181166); Cave MV_16 (20°22'25"S, 45°36'11"W), 1♀ (IBSP 181190); Cave MV_27 (20°22'25"S, 45°36'13"W), 1♂ (IBSP 181178); Cave MV_33 (20°22'17"S, 45°36'16"W), 2♂ (IBSP 181183); Cave MV_44 (20°22'17"S, 45°36'9"W), 1♀ (IBSP 181164), all collected on 18/II–9/III/2013 by A. P. Bueno *et al.*; Matozinhos, Cave MOC_113/114 (19°33'18"S, 44°1'13"W), 2♀, 04–15/IV/2011 (IBSP 174831, IBSP 174832); Cave MOC_118 (19°32'53"S, 44°1'4"W), 2♀, 04–15/IV/2011 (IBSP 174835, IBSP 174836); Cave MOC_120 (19°33'5"S, 44°1'7"W), 2♀, 04–15/IV/2011 (IBSP 174839); 1♀, 29–30/VIII/2011 (IBSP 174852); Cave MOC_123 (19°33'13"S, 44°1'9"W), 2♀, 04–15/IV/2011 (IBSP 174840); Cave MOC_131 (19°33'2"S, 44°0'49"W), 2♀, 04–15/IV/2011 (IBSP 174833, IBSP 174834); Cave MOC_133 (19°33'3"S, 44°0'49"W), 2♀, 04–15/IV/2011 (IBSP 174841); Cave MOC_135 (19°33'16"S, 44°0'20"W), 2♂ 3♀, 04–15/IV/2011 (IBSP 174842, IBSP 174843, IBSP 174853); Cave MOC_16 (19°33'9"S, 44°1'5"W), 2♀, 08–18/II/2011 (IBSP 174818); Cave MOC_17 (19°33'9"S, 44°1'6"W), 1♀, 08–18/II/2011 (IBSP 174819); Cave MOC_18 (19°33'10"S, 44°1'6"W), 1♀, 08–18/II/2011 (IBSP 174820); Cave MOC_19 (19°33'7"S, 44°1'13"W), 16♀, 08–18/II/2011 (IBSP 174821–IBSP 174825); 1♂ 5♀, 28/VI–01/VII/2011 (IBSP 174846–IBSP 174848); Cave MOC_30 (19°33'2"S, 44°1'6"W), 1♂ 1♀, 08–18/II/2011 (IBSP 174829, IBSP 174830); Cave MOC_32 (19°33'12"S, 44°1'4"W), 1♂ 6♀, 08–18/II/2011 (IBSP 174826–IBSP 174828); 4♀, 28/VI–01/VII/2011 (IBSP 174849, IBSP 174850); Cave MOC_N8 (19°33'18"S, 44°0'59"W), 3♀, 04–15/IV/2011 (IBSP 174837, IBSP 174838); 1♀, 01–08/VIII/2011 (IBSP 174851), all collected by C. A. R. Souza *et al.;* Cave Gruta Periperi II (19°31'12"S, 44°3'36"W), 2♀, 26/XI/1992 (IBSP 56071); Cave Gruta do Tombo (19°30'0"S, 44°0'36"W), 1♂ 3♀, 29/XI/1992 (IBSP 56067), F. Chaimowicz coll.; Morro do Pilar, Cave MP_01A (19°9'15"S, 43°24'13"W), 14♀, 12–24/IX/2011 (IBSP 174864–IBSP 174867, IBSP 174869–IBSP 174873); 2♂ 8♀, 28/II/2012 (IBSP 174891–IBSP 174898,); Cave MP_01B (19°9'15"S, 43°24'13"W), 16♀, 28/II/2012 (IBSP 174899–IBSP 174908); 1♂ 9♀, 12–24/IX/2011 (IBSP 174868, IBSP 174874–IBSP 174876, IBSP 174878, IBSP 174879, IBSP 174881); 4♀, 12–24/IX/2011 (IBSP 174877, IBSP 174880); Cave MP_10 (19°9'28"S, 43°23'29"W), 2♀, 13–17/II/2012 (IBSP 174882); Cave MP_13 (19°7'5"S, 43°26'1"W), 4♀, 12–24/IX/2011 (IBSP 174854–IBSP 174856); 1♀, 13–17/II/2012 (IBSP 174883); Cave MP_14 (19°8'15"S, 43°24'19"W), 5♀, 13–17/II/2012 (IBSP 174885–IBSP 174887); 7♀, 12–24/IX/2011 (IBSP 174857–IBSP 174861); Cave MP_18 (19°10'14"S, 43°23'47"W), 1♀, 13–17/II/2012 (IBSP 174888); Cave MP_19 (19°9'45"S, 43°23'29"W), 3♀, 13–17/II/2012 (IBSP 174889); Cave MP_20 (19°10'2"S, 43°23'37"W), 3♀, 12–24/IX/2011 (IBSP 174862, IBSP 174863); Cave MP_21 (19°8'56"S, 43°25'45"W), 1♀, 13–17/II/2012 (IBSP 174890); Santa Barbara, Cave SG_02 (20°2'56"S, 43°40'56"W), 9♀, 05–09/XII/2011 (IBSP 174920–IBSP 174923); 9♀, 26–30/IX/2011 (IBSP 174916–IBSP 174918, IBSP 175225); Cave SG_07 (20°2'58"S, 43°41'4"W), 3♀, 05–09/XII/2011, (IBSP 174924, IBSP 174925), all collected by I. Cizauskas *et al.*; Cave SPD_38 (20°3'43"S, 43°40'14"W), 1♀, 09–13/I/2012, J. Mascarenhas coll. (IBSP 174915).

Etymology. The specific name is a feminine noun in apposition and refers to one of the cities where the species is found. This city suffered one of the worst mining accidents in Brazilian history, in 2015.

Diagnosis. Males of *Cuacuba mariana* sp. n. differ from *C. morrodopilar* sp. n. in the distal area of the anterior conductor apophysis with a group of thorns (Fig. 9B, D) and median apophysis without protruding tips (Figs 9A, C, 11D). Females can be distinguished by the conical salient posterior margin of the epigynal plate, with accentuate curvature in the distal region (Fig. 13A–B).

Description. Male (holotype IBSP 175141). Cephalothorax yellowish brown. Chelicerae, endites, labium, and sternum red to brown. Legs orange. Abdomen grayish. Total length 2.25. Carapace 0.82 long. Clypeus high 0.26. Sternum 0.47 long, 0.48 wide. Eye measurements: AME 0.07; ALE-PLE: grouped, 0.07 each; PME-PME: separated by diameter of 1 PME (0.06 each). Legs: I femur 0.92/ patella 0.39/ tibia 0.82/ metatarsus 0.64/ tarsus 0.47/ total 3.25. II 0.9/ 0.35/ 0.72/ 0.52/ 0.45/ 2.94. III 0.63/ 0.27/ 0.45/ 0.38/ 0.35/ 2.08. IV 0.75/ 0.3/ 0.59/ 0.43/ 0.34/ 2.41. Palp: short median apophysis (Fig. 11D), anterior conductor apophysis longer and thinner than posterior one (Fig. 11C). Abdomen: 1.4 long.

Female (paratype IBSP 174919). Coloration as in male, except for brown cephalothorax and legs. Total length 3. Carapace 0.94 long. Clypeus high 0.21. Sternum 0.56 long, 0.58 wide. Eye measurements: AME 0.07; ALE-PLE: grouped, 0.07 each;

PME-PME: separated by 0.07 (PME: 0.07 each). Legs: I femur 1.16/ patella 0.46/ tibia 0.82/ metatarsus 0.64/ tarsus 0.57/ total 3.65. II 1.15/ 0.45/ 0.81/ 0.59/ 0.55/ 3.55. III 0.68/ 0.32/ 0.52/ 0.43/ 0.44/ 2.39. IV 0.92/ 0.37/ 0.68/ 0.52/ 0.47/ 2.96. Epigynal plate with posterior margin darkened at the tip (Fig. 13A, C). Epigynum with glandular ducts in the basal third of the copulatory ducts, spermathecae connate, and fertilization ducts smaller than spermathecae (Fig. 13C–D). Abdomen: 2.57 long.

Variation. Five males: total length 1.8–2.25; carapace 0.82–1; femur I: 0.92–1.2. 8 females: total length 2–3; carapace 0.8–1.15; femur I: 1–1.3**.**

Distribution. Found in caves near the Iron Quadrangle, state of Minas Gerais, Brazil (Fig. 17).

***Cuacuba morrodopilar* sp. n.**

http://zoobank.org/709CAEE8-D109-4A9A-BC3D-0BF2DCA64054

Figs 14, 15, 17

Types. Male holotype and female paratype from Cave MP_07 (19°15'30"S, 43°22'35"W), Morro do Pilar, Minas Gerais, Brazil, 12-24/IX/2011, Equipe Carste coll., deposited in IBSP 174389; Paratypes: male and female (IBSP 174387); one female (MZSP 70928); one female (MPEG 32026), 13-17/II/2012, all with same of data of holotype.

Other material examined. Brazil, Minas Gerais: Morro do Pilar, Cave MP_06 (19°14'58"S, 43°21'09"W), 3♀, 12-24/IX/2011 (IBSP 174383-174384); 3♀, 12-24/IX/2011, J. Mascarenhas coll. (IBSP 174385, IBSP 174394); 1♂ 3♀, 13-17/II/2012 (IBSP 174395, IBSP 174400); Cave MP_07 (19°15'30"S, 43°22'35"W), 2♂ 8♀, 12-24/IX/2011 Equipe Carste coll. (IBSP 174387–IBSP174392); 15♀, 13-17/II/2012, (IBSP 174396-174399) all collected by Equipe Carste; 1♂ 7♀, 12-24/IX/2011, J. Mascarenhas coll. (IBSP 174386–IBSP 174389, IBSP 174393).

Etymology. The specific name is a noun in apposition taken from the type locality.

Diagnosis. Male of *C. morrodopilar* sp. n. differs from *C. mariana* sp. n. by the anterior conductor apophysis with flattened tip (Fig. 14D–E) and by the median apophysis with protruding and recurve tip, darkened (Fig. 14D, F, H). Females can be distinguished by the posterior margin of epigynal plate in "U" shape, with very remarkable distally notched transversal groove (Fig. 15A–E).

Description. Male (holotype IBSP 174389). Cephalothorax and sternum brown. Chelicerae, endites and labium brownish. Legs light brown. Abdomen grayish. Total length: 1.68. Carapace: 0.91 long. Clypeus 0.18 high. Sternum 0.4 long, 0.33 wide. Eye measurements: AME: 0.06; ALE-PLE: grouped, 0.06 each; PME-PME: separated by 1 PME (0.06 each). Legs: I femur 0.77/ patella 0.35/ tibia 0.67/ metatarsus 0.48/ tarsus 0.44/ total 2.7. II 0.75/ 0.33/ 0.65/ 0.38/ 0.4/ 2.51. III 0.48/ 0.26/ 0.36/ 0.32/ 0.31/ 1.73. IV 0.63/ 0.28/ 0.46/ 0.35/ 0.3/ 2.02. Anterior conductor apophysis longer and thinner than posterior one (Fig. 14C–H). Abdomen: 0.81 long.

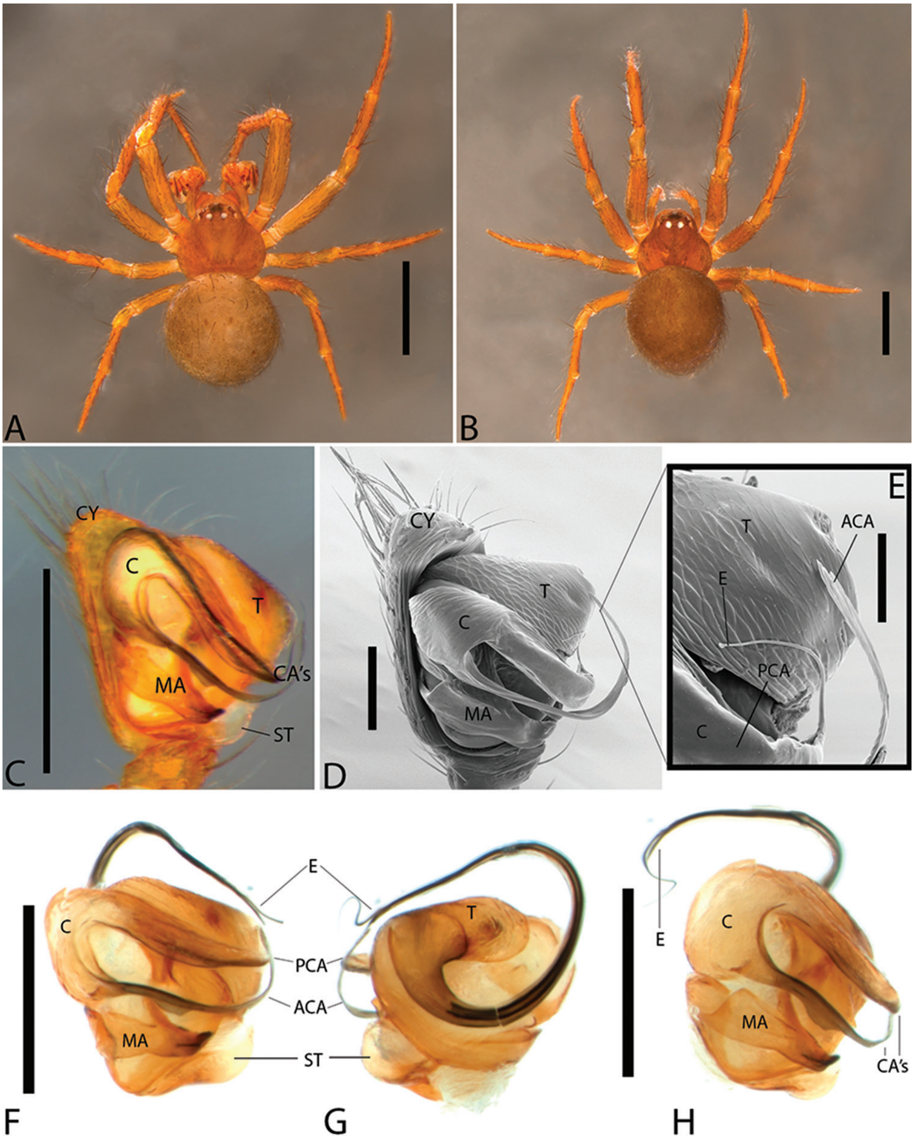

Figure 14. *Cuacuba morrodopilar* sp. n. **A** male, dorsal view **B** female, dorsal view **C** male palp, ventral view **D** male palp, ventral view (SEM) **E** detail of the lower conductor apophysis tip (SEM) **F, G, H** male palp, expanded (**F**, ventral view **G** dorsal view, **H**, retrolateral view). Abbreviations: **ACA** anterior conductor apophysis; **C** conductor; **CA** conductor apophysis; **E** embolus; **EA** embolic apophysis; **MA** median apophysis; **O** embolic opening; **PCA** posterior conductor apophysis; **ST** subtegulum; **T** tegulum. Scale bars: **A** 0.9; **B** 1.1; **C, F–H** 0.2; **D** 0.1; **E** 0.04 mm.

Female (paratype IBSP 174389). Coloration as in male. Total length: 1.8. Carapace: 0.9 long. Clypeus 0.18 high. Sternum 0.51 long, 0.48 wide. Eye measurements: AME: 0.07; ALE-PLE: grouped, 0.06 each; PME-PME: separated by 1 PME (0.07 each). Legs: I femur 1.07/ patella 0.45/ tibia 0.75/ metatarsus 0.61/ tarsus 0.48/ total

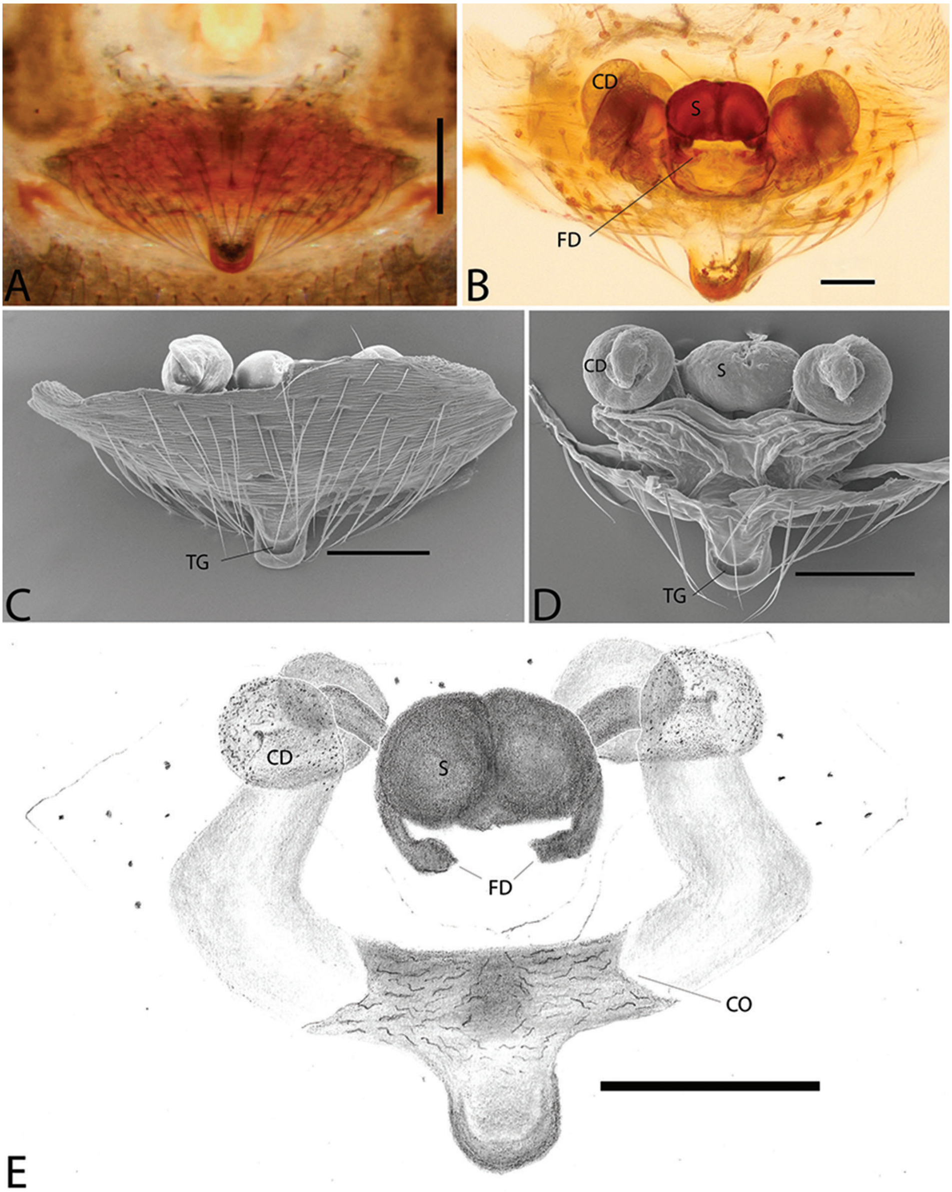

Figure 15. *Cuacuba morrodopilar* sp. n. **A** female epigynum, ventral view **B** female epigynum, dorsal view, clarified (LM) **C** female epigynum, ventral view (SEM) **D** female epigynum, ventral view with plate removed (SEM) **E** female epigynum, dorsal (drawing). Abbreviations: **CD** copulatory ducts; **CO** copulatory opening; **TG** transversal groove**; FD** fertilization ducts; **S** spermathecae. Scale bars: **A**, 0.9; **B** 0.13; **C, D** 0.1; **E** 0.25 mm.

3.36. II 0.92/ 0.46/ 0.61/ 0.45/ 0.44/ 2.88. III 0.58/ 0.3/ 0.42/ 0.37/ 0.36/ 2.03. IV 0.76/ 0.3/ 0.54/ 0.44/ 0.35/ 2.39. Epigynal plate larger than long, with long bristles (Fig. 14A–D). Spermathecae connate (Fig. 15B, D–E). Abdomen: 1.24 long.

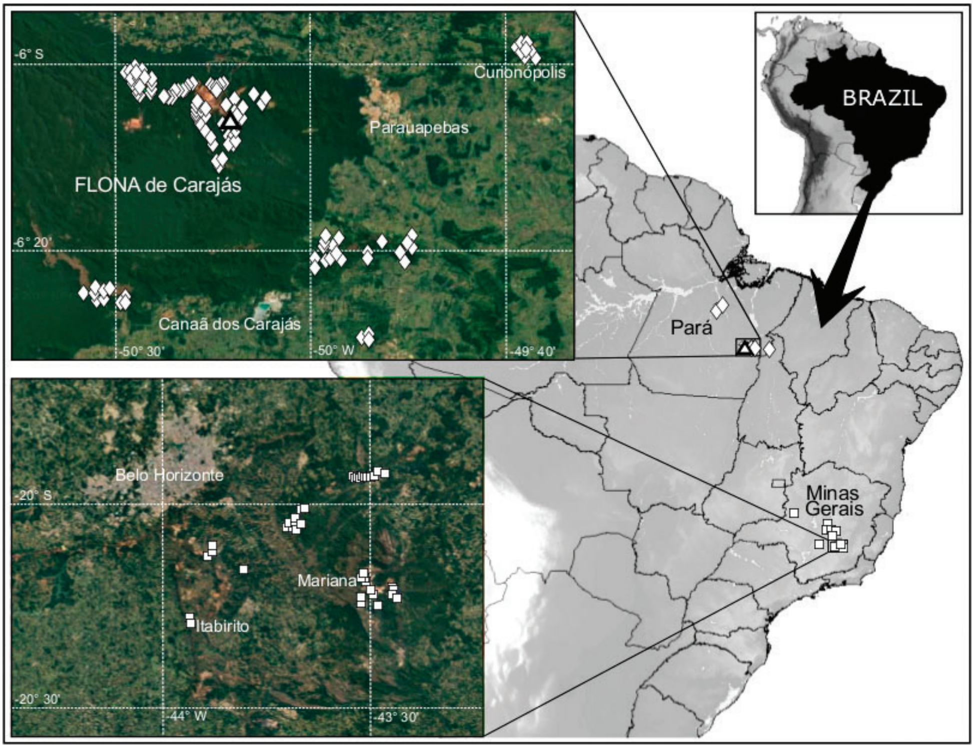

Figure 16. Distribution maps of *Plato ferriferus* sp. n. (diamond), *P. striatus* sp. n. (triangle) and *P. novalima* sp. n. (square) in states of Pará and Minas Gerais, Brazil.

Variation. 2 males: total length: 1.3–1.7; carapace: 0.75–0.91; femur 1: 0.77–0.9; 10 females: total length: 1.78–2.8; carapace: 0.75–1.05; femur I: 1–1.25.

Distribution. Known only from the type locality, Morro do Pilar, Minas Gerais, Brazil (Fig. 17).

Discussion

Relationships

Among the results obtained with the genus *Plato*, the three new species have the five putative synapomorphies indicated for Platoninae (see Coddington 1986: 18–19). A phylogenetic analysis is necessary to establish the relationships among all species of the genus. On the other hand, the peculiar characteristics of *Cuacuba* gen. n. genitalia make it difficult to insert the genus into any of the current four Theridiosomatidae subfamilies (Coddington 1986; Labarque and Griswold 2014). The same occurs even if we consider the two subfamilies proposed by Wunderlich (2011), Luangnaminae Wunderlich (with two tribes, and the genus type synonymized with *Coddingtonia* La-

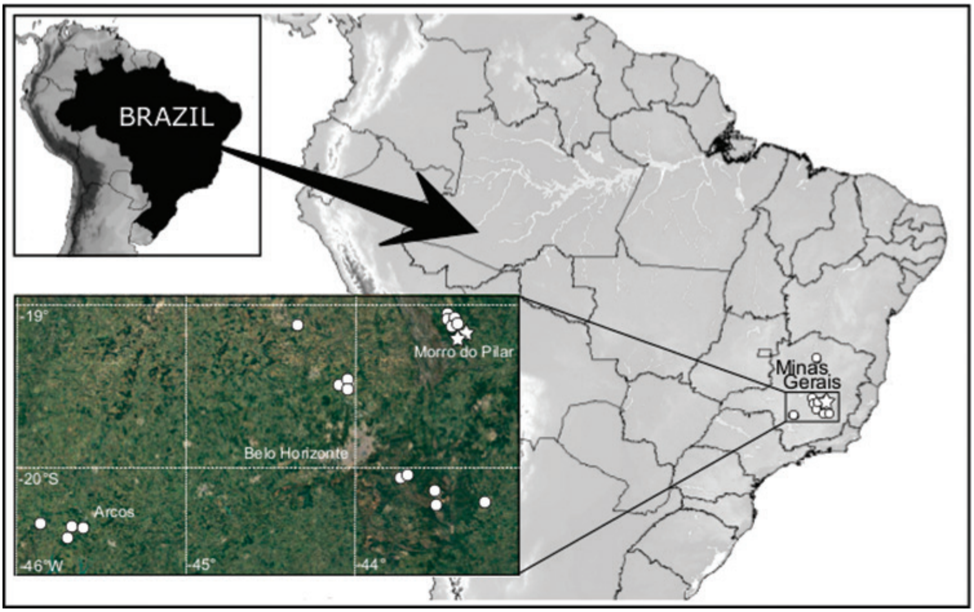

Figure 17. Distribution maps of *Cuacuba mariana* sp. n. (circle) and *C. morrodopilar* sp. n. (star) in state of Minas Gerais, Brazil.

barque & Griswold 2014) and Theridiosomatinae Simon (with five tribes), a classification that was ignored by the recent authors.

Cuacuba gen. n. can be distinguished from the other genera of Theridiosomatidae by at least three putative synapomorphies, all located in the male palp: conductor C-shaped with a posterior apophysis covering the embolus (Fig. 11C–E), filamentous structures on the anterior apophysis (Fig. 9D) and cuneiform tegulum (Fig. 9B).

Cuacuba gen. n. is similar to the Asian species of the genus *Sinoalaria* Zhao & Li, 2012 in structures of the male genitalia. The long and thin embolus of *Cuacuba* gen. n. as well as the absence of an embolic division resemble the palp of the *Sinoalaria* males, which are also involved by a broad conductor. However, in *Sinoalaria*, the conductor does not present the peculiar C-shape (Figs 9A–B, 11C) nor the distal filamentous projections (Fig. 9D), which appear to be exclusive of *Cuacuba* gen. n.

As in *Plato*, *Cuacuba* gen. n. has a mesal embolic apophysis (Figs 1G, 12A) that differs it from the other genera of Theridiosomatidae. In the latter, the apophysis normally originates from the embolic division. Nevertheless, by their morphology, this mesal embolic apophysis does not appear to be homologous in *Plato* and *Cuacuba* gen. n. In addition, the palp of *Cuacuba* gen. n. resembles *Tagalogonia* Labarque & Griswold, 2014, *Coddingtonia* Miller, Griswold & Yin, 2009 and *Ogulnius* in the conductor covering the long and thin embolus.

The female genitalia in *Sinoalaria* resemble that of *Cuacuba* gen. n. in the route of the copulatory ducts and morphology of the connate spermathecae. However, differently from *Cuacuba* gen. n., the route of the copulatory duct seems to have little variation among the species of the former genus. *Sinoalaria bicornis* Lin, Li & Jäger, 2014 has the same route of the copulatory ducts as in *Cuacuba* gen. n. (see Lin et al. 2014: fig. 13E). The main difference between the female genitalia in the two genera is in the scape, as *Cuacuba* gen. n. has no scape, only a marked prolongation of the posterior region of the epigynal plate. Both genera have a transverse groove in the posterior area of the epigynum.

The female genitalia of *Ogulnius* and *Tagalogonia* also resemble those of *Cuacuba* gen. n. in the curves of the copulatory ducts. *Ogulnius* females have connate spermatheca, wide and sinuous copulatory ducts and a transverse groove. *Cuacuba* gen. n. (Figs 10A–B, 13D) has more complex curves in the copulatory ducts, more similar to those of *Tagalogonia*, besides presenting the posterior margin of the elongated and accentuated epigyinal plate. In addition, *Sinoalaria* females share the twisted routes of the coupling ducts with *Coddingtonia*, *Tagalogonia*, *Ogulnius*, Theridiosomatinae, and *Cuacuba* gen. n.

In general, the internal morphology of genitalia of Theridiosomatidae is conservative within each genus. The median spermathecae is present in most genera, usually paired, globular, connate or with little distance between them, in addition to coiled or enveloped ducts, peripheric to the spermathecae, generally varying more in width than length (Figs 2C, 6C, 13D, Coddington 1986: figs 26, 51, Labarque and Griswold 2014: figs 3F, 6F). Although *Sinoalaria* was well characterized by the authors, it has not been formally included in any subfamily. It was, however, considered a probable member of the Epeirotypinae or Platoninae subfamilies, due to the distal embolic opening and absences of apophysis and embolic division (Labarque and Griswold 2014).

Cuacuba gen. n. is very similar in external morphology and in general habits to *Plato*, so they can be easily confused (Pinto-da-Rocha 1995). In addition, some similarities in the genitalia are similar to *Sinoalaria*, *Tagalogonia* and *Ogulnius*. *Cuacuba* gen. n. resembles *Ogulnius* in the long and tapered embolus covered by the conductor, in addition to the female characteristics mentioned above; however, it does not present the diagnostic characteristics of Ogulninae Coddington, 1986, such as the abdomen greatly overlapping cephalothorax, leg IV longer than leg I and reduced body size. Important synapomorphies of Platoninae (probable subfamily to which *Sinoalaria* belongs) such as pointed cymbium, T-shaped paracymbium and median apophysis recurved with long-tip, are absent in *Cuacuba* gen. n. Thus, *Cuacuba* gen. n. shares general characteristics with different subfamilies and does not currently fit into any known subfamily. Without an extensive analysis of the intrageneric family relationships, the new genus cannot be allocated to any of the current subfamilies, nor can we confirm it is a sister group of *Sinoalaria*.

Distribution and associated lithologies

Even with the development of biospeleology in Brazil, undersampled or even nonsampled areas (Trajano and Bichuette 2010) and large mappings of this fauna are ex-

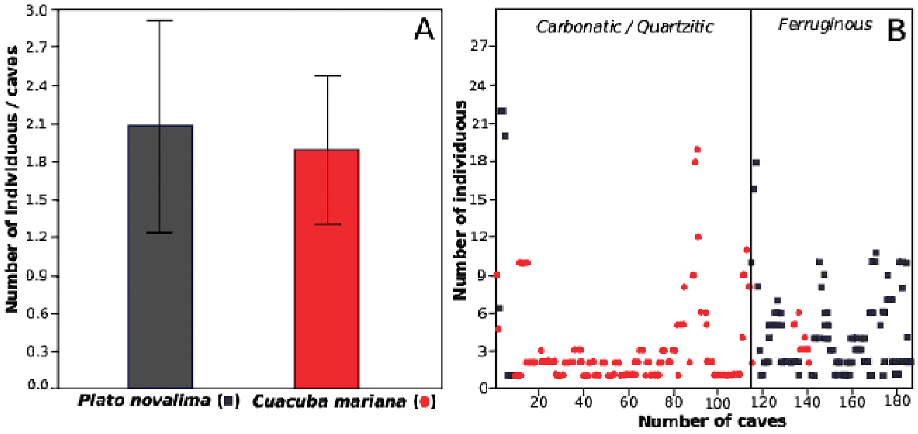

Figure 18. A Mean value of individuals collected per cave **B** Number of individuals collected per cave in their respective lithologies.

Table 1. Number of individuals collected and number of caves studied per lithology. Key: *Capture frequency = N total individuals / N total caves by lithology.

Specie	Ferruginous caves	Capture frequency*	Limestone / Quartzitic caves	Capture frequency*
Cuacuba mariana sp. n.	33 ind. / 7 caves	0.45	312 ind. / 109 caves	3.00
Plato novalima sp. n.	306 ind. / 68 caves	4.19	85 ind. / 7 caves	0.82

tremely scarce. In this work, we identified 3868 adult spiders distributed in 1007 caves, and observed that the spider species in *Plato* and *Cuacuba* gen. n. are highly related to cave environments. They are troglophile aerial spiders that build orbicular webs but do not present troglomorphic characteristics. They mostly occur in dark environments and may occupy dysphotic environments, twilight regions and cave entrances. According to Coddington (1986), all described *Plato* species were located in cryptic habitats and/or in caves, corroborating the observed for species included in this work. This characteristic behavior was also observed for species of *Cuacuba* gen. n., which were sometimes confused with *Plato* (Pinto-da-Rocha 1995).

The species of *Plato*, *Baalzebub* Coddington, 1986 and *Cuacuba* gen. n. are the most frequent theridiosomatides in Brazilian caves. *Plato ferriferus* sp. n. is one of the spiders most commonly found in the ferruginous caves located in FLONA Carajás and surrounding regions, in the state of Pará. *Plato novalima* sp. n., and *Cuacuba mariana* sp. n., together with *Baalzebub acutum* Prete, Cizauskas & Brescovit, 2016 are the most frequently observed species in caves in the state of Minas Gerais. *Plato novalima* sp. n. is mainly found in the karst region of the Iron Quadrangle.

Due to the high abundance of individuals collected, we evaluated the frequency of capture of the species recorded in this study. We observed that the species of *Plato* are mostly located in caves in iron formations, whereas those of *Cuacuba* gen. n. are usually found in other lithologies, such as carbonates. *Plato ferriferus* sp. n., the most abundant species in this study (3098 adult spiders collected), was observed in 816 caves, 809 of which (99% of the records) were inserted in ferruginous rock outcrops. The sole representative of *Plato striatus* sp. n. was also collected in a ferruginous cave in FLONA de Carajás.

A more detailed analysis was performed on *Plato novalima* sp. n. and *Cuacuba mariana* sp. n., as they are the only species herein studied living in sympatry inside caves (n = 2) of the region of Iron Quadrangle in the state of Minas Gerais. *Cuacuba morrodopilar* sp. n. was collected only in two quartzite caves. Table 1 shows the number of individuals collected and from how many caves. For both species, the mean number of individuals collected per well was approximately two (Fig. 18A). However, when we evaluated the cave environment where the specimens were captured we observed that there is a preference for caves inserted in different lithologies (Fig. 18B).

Acknowledgments

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CORRIGENDA

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In our recently published illustrated key to the genera and checklist of the species of Chinese Eumeninae, we overlooked the paper by Kurzenko (1977). This was part of a series on the Insects of Mongolia, and contains important distributional information about Eumeninae in China. It was kindly brought to our attention by Dr A.V. Fateryga and we are glad to correct the omissions here and are grateful to use some additional comments by Dr Fateryga.

The following couplets should be changed or added to accommodate two missing genera:

23 Tergum I with two transverse carinae (23a) or with one (23a') **24A**
– Tergum I without transverse carinae (23aa)..**27**
24A Propodeal dorsum without extending horizontal area (24Aa)....................**24**
– Propodeal dorsum extending horizontally, forming shelf-like area behind metanotum (24Aaa). [pregetular carina present] **25**

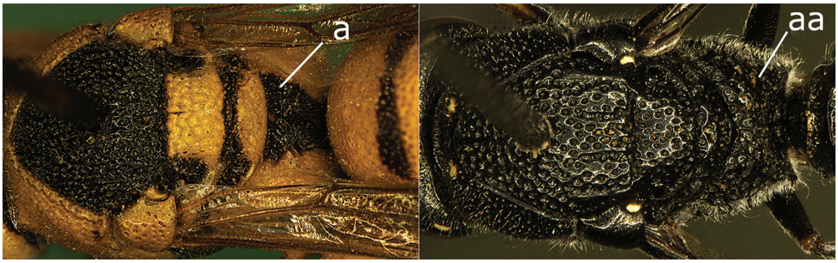

Figure 1. Mesosoma in dorsal view (**a, aa**). **a** *Jucancistrocerus* (*Eremodynerus*) *atrofasciatus* (Morawitz) **aa** *Pseudonortonia abbreviaticornis* Giordani Soika.

24 Tegula densely punctate, sieve-like, surpassing parategula posteriorly (24a); pretegular carina absent (24b); pronotal anterior carina complete laterally, humeri angular or pointed (24c); carina of tergum I at anterior narrow part of tergum [and carina indistinct in some species] (24d) ....***Jucancistrocerus* Blüthgen**
– Tegula usually finely punctate (24aa); pretegular carina present (24bb); pronotal anterior carina partly absent laterally, humeri rounded (24cc); carina of tergum I at about middle of tergum (24dd) .....***Stenancistrocerus* de Saussure**

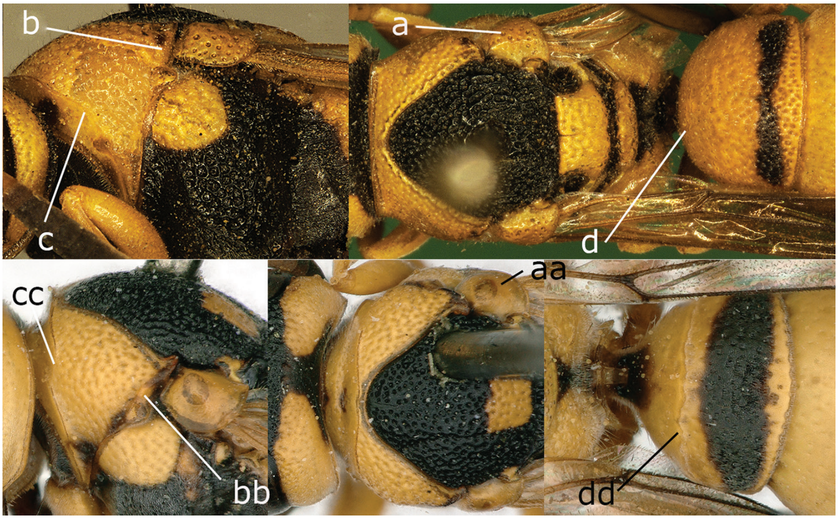

Figure 2. Mesosoma in lateral view (**c b, cc,** and **bb**) and in dorsal view (**a, aa**), tergum I in dorsal (**d, dd**). **a-d.** *Jucancistrocerus* (*Eremodynerus*) *atrofasciatus* (Morawitz); **aa-dd.** *Stenancistrocerus alluaudi* (Dusmet).

46 Metanotum between horizontal and vertical area with hemi-circular carina (46a) .... ***Antodynerus* de Saussure**

– Metanotum between areas without hemi-circular shaped carina (46aa) .. 46A

46A Body mainly yellow with few black spots; pronotum anterior vertical plane usually without hyaline carina, with its anterior face densely punctate laterally (46Aa); cephalic fovea remaining far from occipital carina (46Ab) .... ***Chlorodynerus* Blüthgen**

– Body mainly black with yellow patches; pronotum anterior vertical plane with hyaline carina, with its anterior face sparsely punctate laterally (46Aaa); cephalic foveae close to occipital carina (46Abb) .....***Euodynerus* Dalla Torre**

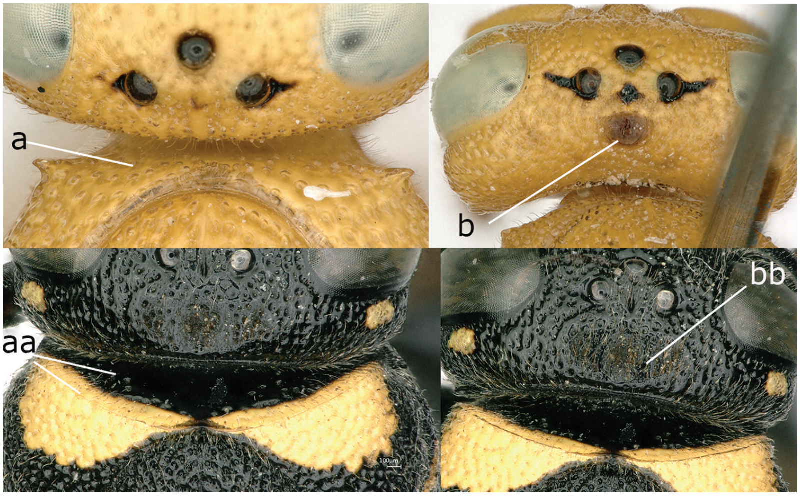

Figure 3. Pronotum anterior vertical plane (a, aa), head in dorsal view (b, bb). **a-b.** *Chlorodynerus diglaensis* (Blüthgen) **aa-bb.** *Euodynerus* sp.

The following species and subspecies should be added to the checklist. The omitted genera are *Cholordynerus* and *Stenancistrocerus*.

[*Ancistrocerus* Wesmael, 1836]

Ancistrocerus oviventris oviventrus (Wesmael, 1836)
Ancistrocerus raddei (Kostylev, 1940)
Ancistrocerus scoticus scoticus (Curtis, 1826)
Ancistrocerus tenellus (Kostylev, 1935)

[*Antepipona* de Saussure, 1855]

Antepipona tylocifica Kurzenko, 1977

***Chlorodynerus* Blüthgen, 1951**

Chlorodynerus Blüthgen, 1951, Boll. Soc. Entomol. Ital. 81: 67 (key), 75. Type species: *Odynerus chloroticus* Spinola, 1838, by original designation.

Chlorodynerus arenicolus (Kostylev, 1935)

[*Eumenes* Latreille, 1802]

Eumenes coarctatus ordubadensis Blüthgen, 1938

Eumenes mongolicus Morawitz, 1889

[*Euodynerus* Dalla Torre, 1904]

Euodynerus (*Euodynerus*) *dantici dantici* (Rossi, 1790)

Euodynerus (*Euodynerus*) *semisaecularis macedonicus* Blüthgen, 1951

[*Katamenes* Meade-Waldo, 1910]

Katamenes radoszkovskii Blüthgen, 1962 (*fide* Dr A.V. Fateryga: probably a synonym of *K. dimidiatus montanus* (Nurse, 1904))

Katamenes sichelii fulvus (Eversmann, 1854)

[*Leptochilus* de Saussure, 1853]

Leptochilus (*Lionotulus*) *habyrganus* Kurzenko, 1977

Leptochilus (*Lionotulus*) *kozlovi* Kurzenko, 1977

[*Onychopterocheilus* Blüthgen, 1955]

Onychopterocheilus (*Ghilarocheilus*) *turovi* (Kostylev, 1937)

[*Pseudepipona* de Saussure, 1856]

Pseudepipona (*Deuterepipona*) *herzi kozlovi* (Kostylev, 1937)

Pseudepipona (*Pseudepipona*) *herrichii mongolica* Giordani Soika, 1970

Pseudepipona (*Pseudepipona*) *kozhevnikovi* (Kostylev, 1927)

Pseudepipona (*Pseudepipona*) *tricarinata* (Kokujev, 1912)

Note. The species listed in the checklist belong all to the subgenus *Pseudepipona* de Saussure.

[*Pterocheilus* Klug, 1805]

Pterocheilus (*Pterocheilus*) *heptneri* Kostylev, 1940

Pterocheilus (*Pterocheilus*) *mandibularis* Morawitz, 1889

Pterocheilus (*Pterocheilus*) *quaesitus* (Morawitz, 1895)

Pterocheilus (*Pterocheilus*) *sibiricus sibiricus* (Morawitz, 1867)

***Stenancistrocerus* de Saussure, 1863**

Stenancistrocerus de Saussure, 1863, Mém. Soc. Phys. Hist. Nat. Genève 17 (1): 216. Type species: *Odynerus atropos* Lepeletier, 1841.

Stenancistrocerus (Paratropancistrocerus) transcaspicus (Kostylev, 1935)

[*Symmorphus* Wesmael, 1836]

Symmorphus allobrogus (de Saussure, 1855) (Dr A.V. Fateryga *in litt*.: reported as *S. bifasciatus* in Kurzenko (1977); true *S. bifasciatus* was reported as *S. mutinensis*)

Symmorphus crassicornis (Panzer, 1798)

Correction (by Dr A.V. Fateryga):

Brachyodynerus perrarus (not "*perarrus*") Kurzenko, 1977

Acknowledgement

We thank Dr Alexander V. Fateryga (Feodosiya, Crimea) for his extremely kind support in improving our key and checklist of the Chinese Eumeninae.

Reference

Kurzenko NV (1977) Eumenid wasps (Hymenoptera, Eumenidae) of the Mogolian People's Republic and adjacent regions of China and Southern Siberia. Nasekomye Mongolii [Insects of Mongolia] 5: 537–582. [In Russian]

ZooKeys 753: 169–170 (2018)
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CORRIGENDA

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Corrigenda: Han S-Y, Kim J-K, Kai Y, Senou H (2017) Seahorses of the *Hippocampus coronatus* complex: taxonomic revision, and description of *Hippocampus haema*, a new species from Korea and Japan (Teleostei, Syngnathidae). ZooKeys 712: 113–139. https://doi.org/10.3897/zookeys.712.14955

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Several typing errors need attention and correction:

Accession numbers in Table 1, page 119:

In the cyt *b* row of *H. coronatus*, 'KT167545–KP167548' should be: KT167545–KT167548.

In the 16S rRNA row of *H. coronatus*, 'KT167549–KP167552' should be: KT167549–KT167552.

In the 12S rRNA row of *H. coronatus*, 'KT167553–KP167556' should be: KT167553–KT167556.

In the cyt *b* row of *H. sindonis*, 'KT167539–KP167540' should be: KT167539–KT167540.

In the 16S rRNA row of *H. sindonis*, ‘KT167541–KP167542’ should be: KT167541–KT167542.
In the 12S rRNA row of *H. sindonis*, ‘KT167543–KP167544’ should be: KT167543–KT167544.

Table 2, page 121: The first “Lourie et al. (1999)” column under *H. sindonis* should be moved under *H. coronatus*.

Material examined of *H. sindonis*, page 127, line 36: ‘FAKU 137339, 1 93.0 mm’ should be: FAKU 137339, 1, 93.0 mm.

Description of *H. sindonis*, page 128, line 15: ‘CoT, 5’ should be: CoT 5.

Paratypes of *H. haema*, page 130, line 4: Size range of paratype series should be: 15.9–113.9 mm SL. **Page 130, line 13:** ‘PKU 9713–9717, 9719–9720, 7, 61.6–85.1 mm SL’ should be: PKU 9713–9720, 8, 49.5–85.1 mm SL. **Page 130, line 25:** ‘PKU 11170–11180, 11, 74.2–102.4 mm SL’ should be: PKU 11169–11180, 12, 74.2–102.4 mm SL.

Discussion, page 134, line 16: ‘Overfishing could potentially threat *H. haema*’ should be: Overfishing could potentially threaten *H. haema*.

Acknowledgements, page 135, line 11: ‘Haecheonma’ should be: Haechunma Co., Ltd.