A new cave-dwelling Spelaeochernes (Pseudoscorpiones: Chernetidae) from northeastern Brazil

Diego Monteiro von Schimonsky and **Maria Elina Bichuette** Laboratório de Estudos Subterrâneos, Departamento de Ecologia e Biologia Evolutiva, Universidade Federal de São Carlos, Via Washington Luís, km 235, Caixa Postal 676, CEP 13565-905, São Carlos, São Paulo, Brazil. E-mail: dmvschimonsky@gmail.com

Abstract. A new species of the pseudoscorpion genus *Spelaeochernes* Mahnert, 2001, *Spelaeochernes popeye* **sp. nov.**, is described from male, female and nymphal specimens collected in limestone caves of the Canudos supergroup in northeastern Brazil. It differs from the other *Spelaeochernes* species by the spermatheca morphology and the absence of eyespots. It exhibits marked sexual dimorphism, with an enlargement of the male pedipalp hand, which may suggest a close relationship with *S. armatus* Mahnert, 2001 and *S. dentatus* Mahnert, 2001. However, the spermathecal morphology suggests a relationship with *S. bahiensis* Mahnert, 2001. *Spelaeochernes popeye* **sp.** nov. is a guanobite, and only occurs in or near frugivorous guano piles and it was only found in subterranean domain, being considered as a troglobite.

Keywords: Arachnida, Chernetinae, guanobite, morphology, troglobite

http://zoobank.org/References/3BE1D0D5-2B8F-465D-8BFA-F0CC17672DA9

The pseudoscorpion fauna of Brazil comprises 16 families with 173 species. The family Chernetidae is the largest and is represented by 24 genera and 65 species, having the highest diversity of Neotropical region in Brazil, with ca. 26% of all species (Harvey 2013). However, since 2003 only five species have been described from Brazil, of which only one — *Attaleachernes thaleri* Mahnert, 2009—is included in the family Chernetidae. This species occurs outside karst areas, at Pantanal wetland in Central western Brazil (Mahnert 2009).

The low number of studies focusing on the taxonomy of the Brazilian pseudoscorpion fauna in the past few years is probably due to the taxonomic impediment regarding this group, where the diversity is high and the specialists are low (Marques & Lamas 2006).

The cave-dwelling chernetids in Brazil are composed of three genera: Maxchernes Feio, 1960, Spelaeochernes Mahnert, 2001 and Zaona Chamberlin, 1925 with one, eight and one named species, respectively. These genera have only been collected in caves and all were considered troglophiles by Mahnert (2001), i.e., hypogean and epigean source populations with gene flow between them, sensu Trajano (2012). The eight species of Spelaeochernes (S. altamirae Mahnert, 2001, S. armatus Mahnert, 2001, S. bahiensis Mahnert, 2001, S. dentatus Mahnert, 2001, S. dubius Mahnert, 2001, S. eleonorae Mahnert, 2001, S. gracilipalpus Mahnert, 2001, S. pedroi Mahnert, 2001), occur widely throughout caves across the country, ranging from the Xingu-Tapajos province in the north to the Atlantic province in the south (Von Schimonsky & Bichuette 2019). They occur in different lithologies such as sandstone, limestone, metamorphic sandstone and igneous, and in different biogeographical provinces (Morrone 2014) such as Cerrado and Parana forest provinces.

In this paper, we describe a new cave-dwelling species of *Spelaeochernes* from northeastern Brazil, occurring in limestone caves of the Canudos supergroup in the Caatinga and Atlantic provinces (Morrone 2014). We also discuss the conservation status and threats to the new species.

METHODS

Material examined and treatment of specimens.-The specimens examined for this study are lodged in the Museu de Zoologia da Universidade de São Paulo (MZSP). The material was prepared by immersing the specimens in 85% lactic acid at room temperature for up to 2 weeks. They were then examined by preparing temporary slide mounts with 10 mm coverslips supported by sections of nylon fish line. Specimens were examined with a Nikon SMZ660 Stereomicroscope and a Leica DMLS compound microscope, and illustrated with the aid of a camera lucida. Some images were taken with a Leica DFC 295 video camera attached to a Leica M205C with a Planapo 1.0x objective, and figures were produced from stacks of images using LAS (Leica Application Suite) v3.7. The picture of a live specimen was taken with a Canon PowerShot D20. Measurements were taken in mm at the highest possible magnification using an ocular graticule. After study, the specimens were cleaned in water and returned to 70% ethanol with the dissected parts in glass vials. Some uncoated specimens were illustrated and examined in environmental mode with a Scanning Electron Microscope (SEM, FEI Quanta 250) located in "Instituto Nacional de Ciência e Tecnologia dos Hymenoptera Parasitoides da Região Sudeste Brasileira", in São Carlos, São Paulo state, Brazil.

Terminology and mensuration.—The terminology and measurements mostly follow Chamberlin (1931). Pedipalps, legs and trichobothria terminology follow Harvey (1992) and for chelicera, Judson (2007).

Study area.—The caves are located in three different municipalities in northeastern Brazil: Paripiranga in Bahia state, and Laranjeiras and Japaratuba in Sergipe state. The region in Bahia state is situated on the edge of the Caatinga province (Morrone 2014) with an average temperature of 25.2°C, the rainy season between March and August and the dry season from September to February. The average annual rainfall is 1279.3 mm and the Köppen-Geiger Climate Classification is "As" (Santana et al. 2010). The caves are



Figure 1.—Habitat of *Spelaeochernes popeye* sp. nov. (A) Landscape of the Paripiranga region; (B) Frugivorous guano pile in Toca da Raposa cave, where specimens of *S. popeye* sp. nov. were found; (C) Cave opening in Sergipe state; (D) Exokarst in Sergipe region; E. Frugivorous guano pile with germinating seeds and a small stream, in Casa do Caboclo cave. (Photographs A–B, Jonas Eduardo Gallão; C–D, Maria Elina Bichuette; E, David C. Cardoso).

located at the supergroup Canudos, Olhos d'Água formation, formed by limestone rocks. The region in Sergipe state is in the Atlantic province (Morrone 2014) is also classified as "As", with the average temperature of 25.4°C, with the same dry and

wet seasons, with the average annual rainfall of 1368 mm (Donato et al. 2012). The caves are located in different geomorphological formations: one in the Barreiras group, another in the Sapucari member, and one in swamps and



Figure 2.-Spelaeochernes popeye sp. nov., adult male in natural habitat in Presa II Cave. (Photography: Jonas Eduardo Gallão).

mangrove deposits with its hierarchy not defined, all in limestone rocks.

In Fig. 1 we show the cave surroundings at Paripiranga municipality, Bahia state (Fig. 1A), a frugivorous guano pile (Fig. 1B), a cave entrance and outcrops in Sergipe state (Fig. 1 C, D), and frugivorous guano pile with germinating seeds in Casa do Caboclo cave (Fig. 1E).

The map was produced with the program *QuantumGis* 2.18 (QGis Open Source Geospatial Foundation). Coordinates were obtained from field trip collections to the localities with global positioning system (GPS).

RESULTS AND DISCUSSION

Mahnert (2001) reported that species of *Spelaeochernes* can be referred to two different groups, according to the shape of pedipalp femur, which was either abruptly or gradually enlarged from the pedicel. In the latter group, it is possible to recognize two other sub-groups: those with sexual dimorphism and without sexual dimorphism with chelal fingers gaping. Accordingly, the new species might be related to *S. dentatus* and *S. armatus*, as it exhibits pronounced sexual dimorphism, with an enlargement of the male hand. On the other hand, the morphology of the spermathecae might suggest a relationship with *S. bahiensis*. While *S. armatus* and *S. dentatus* occur much further south than *S. popeye* sp. nov., *S. bahiensis* is located closer, to the west, but in a different geological formation.

It is possible that individuals of *S. popeye* sp. nov. disperse by phoresy, which is consistent with that suggested by Mahnert (2001) for this genus. However, no specimens of *Spelaeochernes* (including the new one) have ever been found with bats or other animals. So, it seems that vicariance is currently the best model to explain the occurrence of the new species.

TAXONOMY

Family Chernetidae Menge, 1855 Subfamily Chernetinae Menge, 1855 Spelaeochernes Mahnert, 2001

Spelaeochernes Mahnert 2001:118-119.

Type species.—*Spelaeochernes dentatus* Mahnert, 2001, by original designation.

Diagnosis.—The genus *Spelaeochernes* is characterized by all parts fairly well sclerotized, carapace with two distinct transverse furrows, medially granulate, without central modification at the posterior margin; two weak eyespots or eyespots absent; setae clavodentate; all tergites and sternites divided, with exception of segment XI, two last tergites with lateral tactile setae; last sternite with 4 tactile setae; anal cone with 2+2 smooth setae; anterior genital operculum of male with about 10 long acuminate setae, surrounded by about 40 shorter ones, that of female with about 25 biserially arranged setae; spermatheca of female with two very short sacs, united at their base; cheliceral palm with 5–7 setae, of which 1–3 usually finely dentate; galea long, slender, with six or more rami, flagellum of four blades (one or more dentate). Pedipalps: male chelal hand of some species with an internal, more or less pronounced, setiferous protuberance at finger base, but other species with normal shape, as in female; external and internal accessory teeth present on both chelal fingers; long seta near *ist* absent; trichobothrium *ist* nearly at same level as *est*, *it* nearly at same level as *et*; *st* slightly nearer to *t* than to *sb*; venom apparatus well developed in movable finger, a very small venom duct present in fixed finger; a small number of sense-spots present between *esb* and *est*, and distad *sb*. Legs slender, femur+patella of leg IV at least 3.7 times, tibia at least 5.5. times, tarsus 6.0 times as long as deep, tarsus with a short tactile seta distad of the middle and clearly longer than breadth of tarsus, claws smooth, subterminal seta smooth, curved.

Spelaeochernes popeye sp. nov. http://zoobank.org/NomenclaturalActs/65B4CEDD-2237-46DE-AF00-0ACC3D7AEC49 Figs. 2–7

Type material.—*Holotype male.* BRAZIL: Sergipe State: Toca da Raposa cave, Laranjeiras [10.81421°S, 37.17924°W], on frugivorous bat guano piles, 20 October 2014, M.E. Bichuette, M.J.R. Costa, D.C.C. Silva, E.J. Silva, R.M. Souza (MZSP71460). *Paratypes*: BRAZIL: Sergipe State: 1 $\[mathbb{2}\]$ (allotype), same data as holotype (MZSP71461); 2 $\[mathbb{2}\]$, 3 $\[mathbb{3}\]$, same data as holotype (MZSP71462); *Bahia State:* 2 $\[mathbb{2}\]$, 1 deutonymph, 1 tritonymph, Borboletas cave, Paripiranga [10.63724°S, 37.86253°W], on frugivorous bat guano piles, 24 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (MZSP71463); 1 $\[mathbb{3}\]$, Presa II cave, Paripiranga [10.63538°S, 37.87865°W], on frugivorous bat guano piles, 23 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (MZSP71464) (Fig. 2).

Other material examined.—BRAZIL: Sergipe State: 1 9, Casa do Caboclo cave, Japaratuba [10.63255°S, 36.88309°W], on frugivorous bat guano piles, 19 October 2014, M.E. Bichuette, M.J.R. Costa, D.C.C. Silva, E.J. Silva, R.M. Souza (LES9728); 2 ♂, Aventureiros cave, Laranjeiras [10.80322°S, 37.18057°W], on frugivorous bat guano piles, 20 October 2014, M.E. Bichuette, M.J.R. Costa, D.C.C. Silva, E.J. Silva, R.M. Souza (LES9731-32). Bahia State:1 &, 1 &, Fim do Morro do Parafuso cave, Paripiranga [10.64088°S, 37.86778°W], on frugiorous bat guano piles, 22 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (LES9691); 1 9, Zumbi cave, Paripiranga [10.63639°S, 37.88527°W], on frugivorous bat guano piles, 25 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (LES9695); 1 ♂, Lola cave, Paripiranga [10.64285°S, 37.87385°W], on frugivorous bat guano piles, 26 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (LES9697); 2 &, 1 9, Fenda do Márcio cave, Paripiranga [10.63654°S, 37.87554°W], on frugivorous bat guano piles, 23 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (LES9710); 1 &, 1 ♀, 1 tritonymph, Abismo Aroeira cave, Paripiranga [10.62348°S, 37.86632°W], on frugivorous bat guano piles, 26 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (LES9698); 2 &, 1 9, 2 deutonymphs, Brilhantina cave, Paripiranga [10.63706°S, 37.86172°W], on frugivorous bat guano piles, 24 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (LES9708); 3 ♂, 1 ♀, 1 tritonymph, Presa I cave, Paripiranga



Figure 3.—*Spelaeochernes popeye* sp. nov., paratypes (MZSP71462) in dorsal and ventral view; female A–B, male C–D. (Photography: Luciana B. R. Fernandes). Scale line = 2.0 mm.

[10.63530°S, 37.87856°W], on frugivorous bat guano piles, 23 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (LES9711); 1 deutonymph, Fenda da Costura cave, Paripiranga [10.63627°S, 37.87508°W], in foliage near a frugivorous bat guano piles, 23 Nobember 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (LES9721); 1 δ , 1 tritonymph, Escondidinho cave, Paripiranga [10.63705°S, 37.87783°W], on frugivorous bat guano piles, 23 November 2014, J.E. Gallão, M. Bolfarini, M. Rosendo, R. Moreira (LES9696).

Diagnosis.—*Spelaeochernes popeye* sp. nov. differs from all other species of the genus by the spermathecae morphology which consists in two small paired sacs like withered bladders anteriorly positioned, without punctations, united, but not closed at the base, and the absence of eyespots.

Description (adults).—Pedipalps and carapace dark reddishbrown; legs reddishbrown; abdomen yellowishbrown in color (Figs. 2, 3). Vestitural setae short and clavodentate; tergal setae clavodentate and slightly longer on posterior tergites; sternal setae short and acuminate.

Pedipalps (Figs. 4A, B, E, 6A, B): robust trochanter with a dorsal hump, 1.64–2.08 (\mathfrak{P}), 1.80–1.93 (\mathfrak{J}) x, femur slightly club-shaped, 3.15–3.37 (\mathfrak{P}), 2.78–3.13 (\mathfrak{J}) x, patella 2.58–2.71 (\mathfrak{P}), 2.31–2.57 (\mathfrak{J}) x, chela (with pedicel) 3.09–3.26 (\mathfrak{P}), 2.12–2.35 (\mathfrak{J}) x, chela (without pedicel) 2.82–3.02 (\mathfrak{P}), 1.91–2.21 (\mathfrak{J}) x, hand 1.32–1.47 (\mathfrak{P}), 0.93–1.09 (\mathfrak{J}) x longer than wide; movable finger 1.00–1.18 (\mathfrak{P}), 1.01–1.18 (\mathfrak{J}) x as long as hand. Surfaces of trochanter, femur, patella, moderately granulate,





Figure 4.—*Spelaeochernes popeye* sp. nov. (A) Left pedipalpal trochanter, femur and patella, dorsal, female; (B) Left chela, lateral, female; (C) Left chela, lateral, deutonymph; (D) Left chela, lateral, tritonymph; (E) Left chela, lateral, male; (F) Left chelicera, dorsal, female; (G) Rallum female; (H) Left chelicera, dorsal, tritonymph; (I) Left chelicera, dorsal, deutonymph. Scale lines: A-E = 0.5 mm; F-H = 0.1 mm; I = 0.08 mm.



Figure 5.—*Spelaeochernes popeye* sp. nov. (A) Carapace, dorsal, female; (B) Right leg I, female; (C) Right leg IV, female; (D) Spermathecae; (E) Genital opercula, male; (F) Genital opercula, female. Scale lines: A = 0.2 mm; B-E = 0.1 mm; F = 0.08 mm.

chelal hand moderately to finely granulate and chelal fingers smooth. Fixed finger with ca. 46–58 (\mathcal{Q}), 47–52 (\mathcal{J}) marginal teeth, plus 6–10 ($\cap{2}$ and $\cap{3}$) retrolateral accessory teeth and 0–8 (9), 0-9 (3) prolateral accessory teeth; movable finger with ca. 50–54(\mathfrak{P}), 46–52 (\mathfrak{F}), marginal teeth, plus 0–7(\mathfrak{P}), 0 (\mathfrak{F}) retrolateral accessory teeth and 0-4 (\Im), 3-4 (\eth) prolateral accessory teeth. Pedipalpal setae generally slender and clavatedentate, but acuminate on fingers. Fixed finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Figs. 4E, 6A,B); esb closer to eb than to est; est slightly closer to et than to esb; isb inserted prolaterally, almost dorsally, and closer to *ist* than to *it*; *ist* closer to *ib* than to *isb*; sb closer to b than to st; st closer to t than to sb. Venom apparatus present in movable finger with nodus ramosus terminating almost midway between t and st, closer to t and a small venon duct in fixed finger; chelal fingers not gapping (Figs. 4B, E, 6A, B).

Chelicera (Figs. 4F, 6E): with 6 or 7 setae on hand; *ls*, *is*, *es*, *sbs* and *bs*', *bs*'' and *bs*''' (when present) acuminate; movable finger with 1 acuminate seta (*gs*); with 2 dorsal and 2 ventral lyrifissures. Movable finger with 3–5 teeth. Galea long and slender with 6 rami (one 3 with 5 rami and one 3 with 7 rami). Rallum (Fig. 4G) composed of 4 blades; longest blade

dentate along the distal anterior half; the second longest dentate in the half and other two shorter blades smooth. Serrula exterior with $17-21 \ (\wp, \eth)$ lamellae.

Cephalothorax: carapace (Figs. 5A, 6G) 1.23–1.34 (\mathcal{Q}), 1.30–1.37 (\mathcal{J}) x as long as broad; unicolored; eyes or eyespots absent; with 4–6 (\mathcal{Q}), 5–6 (\mathcal{J}) setae on anterior margin (Fig. 6H), with a small preocular seta, with 6–11 (\mathcal{Q}), 6–9 (\mathcal{J}) setae on posterior margin; posterior half with two moderately incised transverse furrows, anterior furrow crosses at ca. 0.49 of its length, posterior furrow nearer to posterior margin than to anterior furrow; entirely granulate (Figs. 5A, 6G, H); posterior margin gently undulate. Manducatory process with 1–2 long distal and 2–3 long subdistal setae, with 1 small sub-oral seta, remainder of maxilla with 30–39 (\mathcal{Q}), 28–37 (\mathcal{J}) setae. Chaetotaxy of coxae (Figs. 7A, B) I–IV: 14–20: 12–22: 16–26: 20–34 (\mathcal{Q}), 12–24: 12–23: 16–26: 16–30 (\mathcal{J}).

Abdomen (Fig. 7E–G): tergites I–X and sternites IV–X divided. Tergal chaetotaxy: (P) 9-12: 10–12: 10–11: 12–15: 13–17: 10–15: 11–13: 12–13: 11–13: 8–12: 8–10: 2; (a) 9-10: 9–11: 10–11: 10–13: 9–14: 9–16: 12–13: 11–12: 8–14: 12: 4–8: 2; setae restricted to posterior and lateral tergal margins. Sternal



Figure 6(A–D).—*Spelaeochernes popeye* sp. nov., scanning electron micrographs. (A) Left chela, lateral, male; (B) Left pedipalp, dorsal, female; (C) Left chela, lateral, tritonymph; (D) Left pedipalp, lateral, deutonymph. Scale lines: A, B = 0.5 mm; C = 0.4 mm; D = 0.2 mm.

chaetotaxy: (\mathfrak{P}) , ca. 29–33: 12: 6–8: 11–12: 12–15: 12–18: 13– 16: 10–13: 11: 7–8: 2; (\mathfrak{F}), ca. 42–48: 12: 8–9: 10–14: 12–14: 14– 16: 13–14: 10–11: 9–11: 6–8: 2; posterior segments with tactile setae. Pleural membrane (Fig. 7G) pointed granulate, intersegmental membrane of tergites wrinkled and of sternites undulate. Stigmatic sclerite with 3 setae on each of the first pair, and 1 seta on each of the second pair.

Genital region: Male genital operculum with 46–48 setae, medial ones long and curved (Figs. 5E, 7C). Female genital operculum (Figs. 5F, 7D) with 29–33 setae and 2 slit sensilla. Male genitalia of typical chernetid form (Vachon 1938). Female spermatheca with 2 small lateral tubes directed to anteriorly, slightly curved, fused but not closed at the base (Fig. 5D).

Legs: leg I (Fig. 5B): trochanter 1.42–1.46 (\mathcal{Q}), 1.42–1.51 (\mathcal{S}) x; femur 1.36–1.86 (\mathcal{Q}), 1.60–1.74 (\mathcal{S}) x; patella 3.64–4.10 (\mathcal{Q}), 3.35–3.70 (\mathcal{S}) x; tibia 6.22–6.46 (\mathcal{Q}), 5.67–6.33 (\mathcal{S}) x; tarsus 6.30–7.50 (\mathcal{Q}), 6.12–7.01 (\mathcal{S}) x as long as deep. Leg IV (Figs. 5C, 7H) trochanter 1.54–2.18 (\mathcal{Q}), 1.79–2.12 (\mathcal{S}) x; femur+patella 4.63–5.20 (\mathcal{Q}), 4.15–5.05 (\mathcal{S}) x; tibia 7.40–7.94 (\mathcal{Q}), 6.80–8.38 (\mathcal{S}) x; and tarsus 5.87–6.94 (\mathcal{Q}), 6.75–7.46 (\mathcal{S}) x as long as deep. Tarsus with a tactile seta in subdistal position (TS= 0.66–0.73 (\mathcal{Q}), 0.71–0.75 (\mathcal{S})), and subterminal setae smooth, curved; claws smooth, simple; arolium slightly shorter than claws. Legs I and II with an oblique junction between femur and patella.

Dimensions (mm): Male from Toca da Raposa Cave, Simão Dias, Sergipe, northeastern Brazil (MZSP71460), with other specimens in parentheses (Table 1).

Female from Toca da Raposa cave, Simão Dias, Sergipe, northeastern Brazil (MZSP71461), with other specimens in parentheses (Table 1).

Description (tritonymph).—Pedipalps and carapace reddishbrown; legs yellowish-brown; abdomen yellowish in color.

Pedipalps: trochanter 2.0 x, femur 2.89 x, patella 2.27 x, chela (with pedicel) 1.12 x, chela (without pedicel) 1.05 x, hand 1.5 x longer than wide; movable finger 1.12 x as long as hand. Fixed finger with 39 marginal teeth, plus 4 retrolateral accessory teeth and 1 prolateral accessory tooth; movable finger with 42 marginal teeth, no retrolateral accessory teeth and 1 prolateral accessory tooth. Fixed finger with 7 trichobothria, movable chelal finger with 3 trichobothria (Figs. 4D, 6C); *esb* closer to *eb* than to *est*; *est* approximately midway between *et* and *esb*; *ist* closer to *ib* than to *it*; *st* closer to *b* than to *t*. Venom apparatus present in movable finger with nodus ramosus terminating almost in the middle of the finger, between *t* and *st*, but closer to *t*.

Chelicera (Figs. 4H, 6F): with 6 setae on hand; *ls*, *is* and *es*, *sbs*, *bs*' and *bs*'' acuminate; movable finger with 1 acuminate seta (*gs*). Galea long and slender with 5 rami. Rallum composed of 4 blades; longest blade dentate along the distal anterior half; the second longest dentate in the half and other two shorter blades smooth. Serrula exterior with 17 lamellae.

Figure 6(E–H).—(E) Chelicerae, dorsal, female; (F) Left chelicera, dorsal, tritonymph; (G) Cephalothorax, dorsal, female; (H) Carapace, details of setae on anterior margin, dorsal, male. Scale lines: E = 0.2 mm; F = 0.1 mm; G = 0.5 mm; H = 0.05 mm.

| Table 1.—Measurements in mm. | of adults (male and | female), tritonymph and | deutonymph of Spelaeochern | es popeye sp. nov. |
|------------------------------|---------------------|-------------------------|----------------------------|--------------------|
| | | | | |

| | Male | Female | Tritonymph | Deutonymph |
|---|---------------------------------|---------------------------------|------------|------------|
| Body | 3.05 (2.82-4.17) | 3.35 (2.65–3.80) | 2.22 | 1.62 |
| Carapace | 0.98/0.75 (0.88-1.06/0.69-0.86) | 1.02/0.76 (0.85-1.06/0.67-0.79) | 0.71/0.53 | 0.47/0.33 |
| Pedipalp trochanter | 0.54/0.30 (0.45-0.58/0.25-0.31) | 0.52/0.28 (0.42-0.60/0.24-0.31) | 0.39/0.19 | 0.21/0.11 |
| Pedipalp femur | 0.94/0.30 (0.89-1.00/0.29-0.34) | 0.93/0.29 (0.72-1.01/0.25-0.30) | 0.60/0.20 | 0.41/0.12 |
| Pedipalp patella | 0.90/0.35 (0.78-0.96/0.31-0.37) | 0.86/0.33 (0.69-0.92/0.28-0.35) | 0.54/0.23 | 0.30/0.13 |
| Pedipalp chela (with pedicel) | 1.65/0.70 (1.52-1.77/0.61-0.79) | 1.67/0.54 (1.42-1.82/0.45-0.59) | 1.12/0.32 | 0.66/0.18 |
| Pedipalp chela (without pedicel) | 1.55 (1.40–1.72) | 1.52 (1.32–1.72) | 1.05 | 0.63 |
| Pedipalp hand length | 0.75 (0.68-0.84) | 0.73 (0.59–0.78) | 0.48 | 0.32 |
| Pedipalp movable finger length | 0.85 (0.75-0.90) | 0.81 (0.70-0.92) | 0.54 | 0.30 |
| Chelicera lenght/width | 0.31/0.16 (0.26-0.33/0.13-0.19) | 0.28/0.15 (0.26-0.32/0.12-0.17) | 0.23/0.12 | 0.16/0.08 |
| movable finger length | 0.24 (0.22-0.28) | 0.25 (0.21-0.25) | 0.16 | 0.10 |
| Leg I trochanter | 0.22/0.14 (0.20-0.22/0.13-0.16) | 0.21/0.14 (0.16-0.22/0.12-0.15) | 0.14/0.11 | 0.09/0.06 |
| Leg I femur | 0.29/0.16 (0.27-0.34/0.15-0.18) | 0.30/0.17 (0.21-0.30/0.14-0.17) | 0.19/0.12 | 0.10/0.07 |
| Leg I patella | 0.50/0.13 (0.43-0.52/0.12-0.14) | 0.50/0.13 (0.39-0.51/0.10-0.14) | 0.30/0.09 | 0.17/0.06 |
| Leg I tibia | 0.57/0.09 (0.51-0.61/0.08-1.00) | 0.56/0.09 (0.41-0.59/0.08-0.09) | 0.32/0.06 | 0.19/0.04 |
| Leg I tarsus | 0.48/0.07 (0.35-0.48/0.06-0.07) | 0.49/0.06 (0.33-0.50/0.05-0.07) | 0.29/0.05 | 0.19/0.02 |
| Leg IV trochanter | 0.31/0.16 (0.29-0.35/0.15-0.18) | 0.35/0.17 (0.22-0.36/0.13-0.19) | 0.24/0.12 | 0.14/0.07 |
| Leg IV femur patella | 0.86/0.17 (0.79-0.89/0.15-0.19) | 0.84/0.17 (0.60-0.89/0.15-0.19) | 0.55/0.12 | 0.30/0.05 |
| Leg IV tibia | 0.88/0.10 (0.71-0.89/0.09-0.12) | 0.83/0.10 (0.59-0.89/0.09-0.11) | 0.50/0.08 | 0.28/0.04 |
| Leg IV tarsus | 0.56/0.07 (0.40-0.59/0.06-0.08) | 0.57/0.09 (0.38-0.59/0.06-0.09) | 0.30/0.06 | 0.23/0.05 |
| Leg IV distance of tarsal tactile setae insertion | 0.30-0.42 | 0.28-0.39 | 0.23 | 0.14 |
| Leg IV length of tarsal tactile setae | 0.10-0.13 | 0.12 (0.11-0.13) | 0.09 | 0.07 |

Figure 7(A–D).—*Spelaeochernes popeye* sp. nov., scanning electron micrographs. (A) Cephalothorax, ventral, male; (B) Cephalothorax, ventral, female; (C) Genital region, ventral, male; (D) Genital region, ventral, female. Scale lines: A, B = 0.5 mm; C = 0.2 mm; D = 0.4 mm.

Cephalothorax: carapace 1.34 x as long as broad; unicolored; eyes or eyespots absent; with 5 setae on anterior margin, with a small preocular seta, with 8 setae on posterior margin; posterior half with two moderately incised transverse furrows, anterior furrow crosses the carapace at ca. 0.37 of its length, posterior furrow crosses at ca. 0.53 of carapace length; posterior furrow nearer to posterior margin than to anterior furrow. Manducatory process with 1 long distal and 2 long sub-distal setae, with 1 small sub-oral seta; remainder of maxilla with 16 setae. Chaetotaxy of coxae I–IV: 8: 7: 8: 11.

Abdomen: tergites I–X and sternites IV–X divided. Tergal chaetotaxy: 6: 10: 8: 8: 10: 11: 11: 9: 10: 6: 2; setae restricted to posterior and lateral tergal margins. Sternal chaetotaxy: 4: 6: 8: 8: 10: 11: 10: 8: 8: 6: 2; posterior segments with tactile setae. Stigmatic sclerite with 2 setae on each of the first pair, and 1 seta on each of the second pair.

Legs: leg I: trochanter 1.31 x; femur 1.61 x; patella 3.33 x; tibia 5.16 x; tarsus 5.8 x as long as deep. Leg IV: trochanter 2.04 x; femur+patella 4.58 x; tibia 5.88 x; tarsus 4.47 x as long as deep. Tarsus with a tactile seta in subdistal position (TS = 0.59); tarsal claws simple; arolium slightly shorter than claws. Legs I and II with an oblique junction between femur and patella.

Dimensions (mm): Tritonymph from Borboletas cave, Paripiranga, Bahia, northeastern Brazil (MZSP71463) (Table 1). **Description (deutonymph)**.—Pedipalps and carapace yellowish-brown; legs yellowish-brown; abdomen yellowish in color.

Pedipalps: trochanter 1.91 x, femur 3.41 x, patella 2.18 x, chela (with pedicel) 0.66 x, chela (without pedicel) 0.63 x, hand 1.71 x longer than wide; movable finger 0.93 x as long as hand. Fixed finger with 32 marginal teeth; movable finger with 39 marginal teeth; both fingers without external and internal accessory teeth. Fixed finger with 6 trichobothria, movable chelal finger with 2 trichobothria (Figs. 4C, 6D); *est* slightly closer to *eb* than to *et*; *ib* inserted dorsally, rather than prolaterally or retrolaterally, and closer to *ist* than to *it*; *it* almost dorsally, but slightly prolaterally. Venom apparatus present in movable finger with nodus ramosus reaching *t*.

Chelicera (Fig. 41): with 5 setae on hand; *ls, is* and *es, sbs, bs* acuminate; movable finger with 1 acuminate seta (*gs*). Galea short and slender with 4 rami. Rallum composed of 4 blades; longest blade dentate along the distal anterior half; the second longest dentate in the half and other two shorter blades smooth. Serrula exterior with 14 lamellae.

Cephalothorax: carapace 1.42 x as long as broad; unicolored; eyes or eyespots absent; with 6 setae on anterior margin, with a small preocular seta, with 6 setae on posterior margin; posterior half with two moderately incised transverse furrows, anterior furrow crosses the carapace at ca. 0.27 of its length, posterior furrow crosses at ca. 0.36 of carapace length; posterior furrow nearer to posterior margin than to anterior furrow. Manducatory process with 1 long distal and 1 long

Figure 7(E–H).—*Spelaeochernes popeye* sp. nov., scanning electron micrographs. (E) Abdomen, dorsal, female; (F) Abdomen, ventral, female; (G) Tergites VI, VII and pleural membrane, dorsal, female; (H) Tibia and tarsus IV, female. Scale lines: E, F = 1.0 mm; G, H = 0.2 mm.

sub-distal seta, with 1 small sub-oral seta; remainder of maxilla with 10 setae. Chaetotaxy of coxae I–IV: 5: 5: 5: 6.

Abdomen: tergites I–X and sternites IV–X divided. Tergal chaetotaxy: 6: 6: 7: 8: 6: 5: 6: 6: 8: 6: 6: 2; setae restricted to posterior and lateral tergal margins. Sternal chaetotaxy: 0: 4: 4: 7: 8: 8: 7: 6: 6: 2; posterior segments with tactile setae. Stigmatic sclerite with 1 seta on each of the first pair, and 1 seta on each of the second pair.

Legs: leg I: trochanter 1.34 x; femur 1.41 x; patella 2.91 x; tibia 4.08 x; tarsus 7.29 x as long as deep. Leg IV: trochanter 1.90 x; femur+patella 5.26 x; tibia 5.95 x; tarsus 4.15 x as long as deep. Tarsus with a tactile seta in subdistal position (TS = 0.59); tarsal claws simple; arolium slightly shorter than claws. Legs I and II with an oblique junction between femur and patella.

Dimensions (mm): Deutonymph from Borboletas cave, Paripiranga, Bahia, northeastern Brazil (MZSP71463) (Table 1).

Habitat and ecological status.—These animals have been found only on frugivorous bat guano piles in high abundance (dozens of specimens), which suggests strong establishment in subterranean habitats and, more specifically, the guano substrate. As observed by Mahnert & Andrade (1998) for *Maxchernes iporangae*, Mahnert & Andrade 1998, *S. popeye* sp. nov. can be considered a guanobite (*sensu* Gnaspini 1992), especially as most nymphal instars have been found with the adults. Regarding the ecological-evolutive status of *Spelaeo*-

chernes, species of this genus were considered troglophilic (Mahnert 2001), however, despite the high sampling efforts over the last 30 years (Dessen et al. 1980; Trajano 1987; Gnaspini & Trajano 1994; Pinto-da-Rocha 1995; Trajano & Bichuette 2010; Von Schimonsky 2014; Von Schimonsky & Bichuette 2019), there is still a complete lack of specimens outside caves, even with the possibility of dispersion by phoresy, but still without any record of it in this genus. Thus, the new species described herein is considered to be a troglobite, because it was only recorded inside caves, with populations well established, with nymphal stages and many specimens, representing source populations of this species in different caves, and with no representatives encountered outside caves, thus fitting the classification according to Trajano (2012). Furthermore, members of the genus Spelaeochernes possess eyespots, which is a common trait in many Chernetidae, but in the new species described herein, the absence of the eyespots could be a troglomorphic trait indicating its isolation in the subterranean realm.

Distribution.—The new species occurs in 13 caves: three caves in Sergipe State (Casa do Caboclo cave, Aventureiros cave and Toca da Raposa cave), inside the Atlantic province (Morrone 2014), near the coast and in 10 caves of Bahia State (Aroeira cave, Brilhantina cave, Presa I and Presa II caves, Borboletas cave, Escondido cave, Lola's cave, Zumbi cave, Fenda do Márcio cave and Furna do Fim do Morro do

Figure 8.—Map depicting known distribution of *Spelaeochernes popeye* sp. nov. and individual caves. The biogeographic provinces are according to Morrone (2014). The faint gray line near the top is the division of Bahia (BA) and Sergipe (SE) states.

Parafuso cave), in the Caatinga province (Morrone 2014) (Fig. 8).

Remarks.—Despite the morphology of the spermathecae and the complete absence of eyespots, the new species can be distinguished from other species by the following unique combination of characters: the number of lamellae on serrula exterior (17-19 vs. 19-20 in S. dubius, 20-21 in S. gracilipalpus, 21-22 in S. armatus); the number of galeal rami (6-7 vs. 8-10 in S. armatus); the number of setae on the posterior margin of the carapace (6-10 vs. 11-12 in S. armatus); number of marginal teeth on pedipalpal movable finger (46-54 vs. 57-68 in S. pedroi, 61-70 in S. dentatus, 62-72 in S. gracilipalpus, 63-67 in S. armatus); number of setae on the pedipalpal coxa (28-39 vs. 50 in S. dentatus); the number of setae on coxa I (12-24 vs. 8-10 in S. bahiensis); the number of setae on coxa III (16-26 vs. 9–14 in S. bahiensis, 28 in S. gracilipalpus); the number of setae on coxa IV (16-34 vs. 35 in S. pedroi, 40 in S. gracilipalpus); the total number of setae on the genital opercula (29-48 vs. 16-28 in S. altamirae for both sexes); the number of setae in the central group of the female genital opercula (19–21 vs. 16–18 in S. altamirae); the number of setae in the central group of the male genital opercula (36-38 vs. 27-32 in S. eleonorae, 28 in S. altamirae, 30 in S. gracilipalpus, 32 in S. dubius, 35 in S. armatus, S. bahiensis and S. pedroi); the

number of dentate setae on the chelicera hand (0 vs. up to 2 in *S. eleonorae*); the pedipalp femur shape (gradually enlarged vs. abruptly enlarged in *S. eleonorae*); the number of setae on the anterior III stigmatic sclerite (3, 2 and 1 in each pair of adults, tritonymph and deutonymph respectively) (1, 0, 0 in *S. dentatus*; 3, 0, 0 in *S. altamirae*; 2 in *S. bahiensis* adult).

Conservation.—Despite the abundant number of specimens of S. popeye sp. nov. and a distribution in many caves (13) and an occurrence area in Bahia state of about 4 km², and in Sergipe state of about 78 km², it is necessary to pay attention to the conservation of these caves and their fauna. There are potential threats to the cave habitat in Bahia state (Paripiranga), mainly by huge limestone mining projects and the cement industry. The localities within Sergipe state are also threatened, mainly due to loss of habitat due to oil projects and deforestation for cattle and other agricultural activities. These threats are worrisome, as in mining projects most or all of the cave habitat may be destroyed, resulting in complete loss of the habitat (Primack & Rodrigues 2001). The impact is indirect to the pseudoscorpion fauna, since S. popeye sp. nov. populations show preferences for frugivorous guano and the bats forage in the surrounding vegetation outside the caves (M.E. Bichuette, pers. obs.). Effective conservation projects are urgent in both regions.

Etymology.—The specific epithet refers to the classic Popeye comic character, created by Elzie Crisler Segar in 1929, due to the size of the male chela, which is enhanced like the muscles of the character.

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