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O PRIMEIRO REGISTRO DE ADELOSGRYLLUS MESA & ZEFA, 2004 (ORTHOPTERA: GRYLLOIDEA: PHALANGOPSIDAE) PARA CAVERNAS, COM A DESCRIÇÃO DE UMA NOVA ESPÉCIES PARA O BRASIL.

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The first record of *Adelosgryllus* Mesa & Zefa, 2004 (Orthoptera: Grylloidea: Phalangopsidae) from caves, with the description of a new species from Brazil.

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Abstract

The first species for the genus *Adelosgryllus* Mesa & Zefa, 2004 recorded in caves is herein described. We used the morphology of the phallic complex as the main criteria to differentiate this species from the congeneric ones. In addition, we discussed the natural history of the new species, some aspects of its association to the cave habitats, and the intraspecific variation of the right tegmen observed in two populations of this new species.

Key words: Ensifera; Taxonomy; Crickets; Cave

Resumo

A primeira espécie para o gênero *Adelosgryllus* Mesa & Zefa, 2004 registrada em cavernas é descrita. Utilizamos a morfologia do complexo fálico como principal critério para a diferenciação desta espécie em relação às espécies congenéricas. Além disso, discutimos a história natural da nova espécie, alguns aspectos de sua associação ao modo de vida subterrâneo e as variações intraespecíficas da tégmina direita observadas em duas populações desta nova espécie.

Palavras-chave: Ensifera; Taxonomia; Grilos; Caverna

Introduction

The colonization of subterranean environments represents an ecological achievement for crickets living in epigean environments (Desutter 1993), and new taxa are being continuously discovered in caves. The Phalangopsidae family presents several species pre-adapted to cave environments, thus several species from this family are frequently reported in these habitats (Desutter-Grandcolas 1998; Deharveng & Bedos 2018; Heads 2010). Both epigean and hypogean environments lack biological studies aiming to fill basic knowledge gaps regarding their species, with deficits in Linnaean (taxonomic) and Wallacean (distribution) knowledge (Ficetola 2019). This problem certainly includes the crickets occurring in these environments, with many species only sporadically recorded.

Adelosgryllus Mesa & Zefa 2004 presents six nominal species, all described in the last 16 years. Such species are distributed in different regions of South America (Cigliano et al. 2020), covering forested areas in different biomes, such as the Amazon Forest, Atlantic Forest and Cerrado (Brazilian Savanna) (Corrêa et al. 2018). However, the disjunct distribution of the known species allows to infer that the species number and the genus distribution are still underestimated (Corrêa et al. 2018).

Individuals from this genus present nocturnal habits, being found in forests, litter, cracks in the soil and/or rocks, under fallen trunks, in armadillos' burrows, in termite nests (Mesa & Zefa 2004; Gorochov 2011; Corrêa et al. 2018; Gorochov 2019) and even close to urban areas (Mesa & Zefa 2004). *Adelosgryllus* species present a blackish body, contrasting with a red, brown or orange head, with antennal flagella divided into three long bands of black, white and black (Mesa & Zefa 2004; Gorochov 2011; Corrêa 2017; Corrêa et al. 2018; Gorochov 2019), which makes their identification in nature quite easy when compared to other phalangopsids. Furthermore, some females present brachypteral or macropteral wings (Mesa & Zefa 2004; Corrêa 2017), and, for some species, only females with long wings are known (Gorochov 2011; Corrêa 2017; Gorochov 2019).

The first species described for the genus, *Adelosgryllus rubricephalus* Mesa & Zefa, 2004, was found in the Iguaçu National Park, Paraná state, Southern Brazil. However, as noted by Mesa & Zefa (2004), this species is also distributed in the Brazilian states of São Paulo, Goiás, and possibly Pernambuco (only immatures were found for the latter location). Subsequently, two new species were described, *Adelosgryllus spurius* Gorochov, 2011 and *Adelosgryllus phaeocephalus* Gorochov, 2011, both collected in primary forests in the Province

of Atalaya, Department of Ucayali, Peru (Gorochov 2011). In recent years, *Adelosgryllus similis* Corrêa & Zefa, 2018 and *Adelosgryllus cruscastaneus* Corrêa & Zefa, 2018, both found in litter and soil in the Araripe-Apodi National Forest, Ceará state, Northeastern Brazil, have been described. The last species to be described, *Adelosgryllus parasimilis* Gorochov, 2019, was collected in a primary forest in the Ashaninka Communal Reserve, Satipo Province, Department of Junin, Peru.

The main criterion used to distinguish species in this genus has been the adult male genitalia (phallic complex), although the morphology of the copulatory papilla and body color can be used as a complement in the group's taxonomy (Mesa & Zefa 2004; Gorochov 2011; Gorochov, 2019; Corrêa et al. 2018).

Herein, we described a new species of *Adelosgryllus*, the first recorded for caves. We used the morphology of the phallic complex as the main taxonomic criterion, although we have also described the right tegmen, the copulatory papilla and the body color. In addition, we present information about the natural history of the new species and highlight the intraspecific variation observed for the right tegmen.

Methodology

Study area

Specimens were collected in two caves, Gruta dos Morcegos and Onça Morta caves, both located within the domains of the Caatinga biome (Olson et al. 2001), in the state of Piauí, northeastern Brazil. Both caves are located in refuges of humid forests, inserted in the arid phytophysiognomy of the region. The Onça Morta Cave is located in the Sete Cidades National Park (Fig. 1). Both caves are inserted in sandstones from the Canindé geological group, formed between the Mesodevonian and Eocarboniferous (Auler 2019).

Collection and examination

The field trips were carried out on 21.i.2019 and 23.ix.2019. The specimens were collected by active search and immediately fixed in 70% ethanol. In the laboratory, phallic sclerites and copulatory papillae were dissected with the aid of entomological forceps and pins. Subsequently, the male genitalia was treated with an aqueous solution of potassium hydroxide (KOH) in a concentration of 10%, for about 10 minutes to remove membranous and muscle tissues. The phallic sclerites and copulatory papilla of each individual were stored in vials containing 70% ethanol together with the other parts of the specimen.

Body, tegmen and phallic complex morphology were analyzed through a Stemi 2000 (ZEISS) stereomicroscope; measurements and photographs were obtained under an Axio Zoom

V16 (ZEISS) stereomicroscope. Male phallic sclerites and copulatory papilla terminology were based on Desutter (1987, 1988), modified by Desutter-Grandcolas (2003) and the terminology used by Corrêa et al. (2018).

Depository. Holotype and 11 paratypes of *Adelosgryllus lucifugus* n. sp. (9♂♂ and 3♀♀) were deposited in the "Collection of Subterranean Invertebrates of Lavras" (ISLA), Center for Studies in Subterranean Biology, Department of Ecology and Conservation, Federal University of Lavras, Minas Gerais state, Brazil.

Abbreviations: **Male genitalia**: **Ps.m.l**, pseudepiphallic median lophy; **PsP1**, pseudepiphallic paramere 1; **Ps.P1.p,** inner projection of pseudepiphallic papamere 1; **PsP2**, pseudepiphallic paramere 2; **Ps.M.Pr**, pseudepiphallic median projection; **Ec.Ap**, ectophallic apodeme; **Ec.Arc**, ectophallic arch; **Ec.F**, ectophallic fold; **End.Sc**, endophallic sclerite; **Ec.Pr**, ectophallic projection; **R**, rami. **Venation**: **L**, medium-longitudinal vein; **DV**, diagonal vein; **Cu1**, cubital 1; **M**, medial; **R**, radial; **Sc**, subcostal; **3A**, anal 3; **2A**, anal 2; **1A**, anal 1; **Cu2***, *pars stridens* (stridulatory file); **Hcv**, harp cross-vein; **Mcv**, mirror cross-vein. **Legs**: **S.S. Int.** and **S.S. Ext,** subapical spurs in internal and external view respectively; **a**, **b**, **c**, **d**, **e**, **f** and **g**, apical spurs.

Results

***Adelosgryllus lucifugus* n. sp.**

(Figures 2–7, 8–15, 16–18, Table 1)

Material examined. Holotype ♂, code ISLA 66149, Brazil, Piauí state, Piripiri municipality, Morcego cave (04° 25’44.056’’ S; 41° 40’ 14.044” W), 21.i.2019, Ferreira R. L. leg. Holotype condition: right tegmen and legs detached, kept in the holotype tube. **Paratypes,** 6 ♂♂ (ISLA 66144, 66146, 66147, 66150, 66151, 66152) and 2 ♀♀ (ISLA 66145* and 66148), (* = nymph stage), same data and locality of holotype; 2 ♂♂ (ISLA 66162 and 66164) and 1 ♀♀ (ISLA 66163), Onça Morta cave (04° 05’ 12.314’’ S 41° 41’ 25.034” W), Piracuruca municipality, Piauí state, Brazil.

Distribution. Known for two caves, the Morcego cave (04° 25’ 44.056’’ S; 41° 40’ 14.044” W - Piripiri municipality), and the Onça Morta cave (04° 05’ 12.314’’ S; 41° 41’ 25.034” W - Piracuruca municipality), associated with the speleological unit of Canindé (Fig. 1).

Etymology. The specific epithet “lucifugus” refers to the evasive behavior of the specimens in the presence of light. From the Latin *luci* = light, *fugus* = escape.

Diagnosis. Combination of the following characters: pseudoepiphallic paramere 1 well developed, C-shaped, very similar to *A. spurius*, but in this new specie the Ps.P1 parameres are

far from each other and flattened horizontally (Figs 2 and 3), apex dilated and curved inward (Ps.P1.p, Figs 2–5); ectophallic fold sclerotized, linear-shaped, with the lateral border more sclerotized than that interior base, central part slightly convex at the top and bottom borders (Ec.F, Fig. 3); endophallus circular-shaped and vertically elongated, forming a short ventral crest (End.Sc), connected to the ectophallic fold by an inverted U-shaped membrane (End.Sc, Fig. 3).

Description, male holotype. General Coloration. Body dark brown with orange head (*in vivo*) (head pale yellow after fixation in ethanol 70%) (Figs 8–15); **Head.** slightly pubescent and with long bristles between scapes (Fig. 8), few of them are present around the eyes and at the posterior margin and occiput of the head (apparently many were lost after fixation), occiput region is slightly darkened behind the eyes (Fig. 9); **Eyes.** compound eyes with black ommatidia rounded by a margin of depigmented ommatidia, and a superior region more depigmented near the scape insertion (Fig. 9); vestigial ocelli (Fig. 8); **Mouthparts.** clypeus and labrum whitish, mandibles dark outlined (Figs 8 and 9); maxillary and labial palps lightly darkened between articulations, with distal region outlined in white (maxillary palp) and whitish (labial palp) (Figs 8 and 9); maxillary palp slightly pubescent, elongated, with five articulations; the first and second palpomeres of same size and shorter than the others; the third and fourth of same sized and bigger than the first two; fifth palpomere is longer than the third and fourth, claviform, dilated in distal portion (Figs 8 and 9); labial palps with three articulations of increasing size, third palpomere claviform (Figs 8 and 9); **Antennae.** scape pubescent, whitish brown coloration, oval shaped and dilated, with long bristles on interior distal portion; pedicel whitish black, narrow, cylindrical and slightly compressed on median portion; antennomeres lightly pubescent, twice shorter than the pedicel; antennomeres with darkened base, distal region slightly whitish, darkened flagel with a median white band. **Thorax.** pronotum pubescent, darkened brown, marked with a vertical median white stripe; dorsal disc wider than long, lateral lobe rounded, with long bristles at the posterior margin (Fig. 10). **Legs.** Leg I: femur whitish at the proximal part becoming darkened distally; tibia darkened and with two subequal apical spurs, oval tympanum present at the internal proximal face; first tarsomere twice bigger than the second and third together, second tarsomere with one quarter of the third tarsomere length, all tarsomeres darkened between the articulations (Fig. 18). Leg II: similar to leg I, with tibial apical spurs longer than in leg I, tympanum absent. Leg III: similar to leg I and II, however, the femur is developed, proximal and median region whitish, with reddish-brown coloration at the articulation between femur and tibia, with black spots at basilateral inner and outer regions,

distal portion darkened; tibia darkened, with three inner (S.S. Int., Fig. 17) and three outer subapical spurs (S.S. Ext., Fig. 16), and four inner (d, e, f and g, Fig. 17;) and three outer apical spurs (a, b and c, Fig. 16), first tarsomere developed with two apical spurs, the inner slightly bigger than the outer (Figs. 16 and 17), tarsomeres II and III broken.

Right tegmen. Darkened brown, covering the first four abdominal tergites (Fig. 11). **Lateral field** (in lateral view) with a diagonal vein (**DV**) poorly marked in its distal portion and with two little ramifications at the lateral margin of the wing extending parallelly to the subcostal vein (**Sc**) reaching one-third of the length of the lateral field; subcostal (**Sc**), radial (**R**) and medial (**M**) veins parallelly distributed in the lateral field; **Sc** with a ramification well marked at the lateral margin with a cross-vein well marked connecting with **R** at the middle of the wing; **R** with a small cell undeveloped right after the cross-vein with **Sc**, two little reticulated veins poorly marked can be observed at subapical region; between the parallel veins **M** and **R** can be seen some cross-vein poorly marked (four or more); **Field** (in ventral view, Fig. 19): anal area, chordal area, harp area and the mirror area well developed; anal region with veins anal 1 (**1A**), anal 2 (**2A**) and anal 3 (**3A**) poorly demarked; chordal area with veins **1A**, **2A** poorly marked and cubital 2 (**Cu2**) well marked; **Cu2*** modified in stridulatory file; harp with a median-longitudinal vein (**L**), and three crossed veins (**Hcv**), two connecting **Cu2** to **Cu1** towards the lateral field, and one connecting **Cu2** to **Cu1** at the dorsal proximal portion, forming five cells well marked, the cell above the mirror presents five reticular veins; mirror triangular oval, with a crossed vein (**Mcv**) well marked at the center and one poorly marked vein at distal region, forming three cells, proximal cell with four reticular veins; stridulatory file with 100 teeth. **Abdomen:** tergites pubescent, darkened brown (Figs 14 and 11); sternites pubescent, slightly whiter than the tergites (Fig. 11); subgenital plate darkened, pubescent, quadrangular shape, distal and lateral margins with long bristles, distal central region with a slightly indentation (Fig. 13); supra-anal plate slightly whitish comparing to the subgenital plate, pubescent, trapezoidal shaped, with small lateral projections, rounded by two white spots at latero-median portion from structure, distal portion rounded and with long bristles (Fig. 15); cerci reddish-brown and whitish at the base, subapical region slightly darkened (Fig. 14).

Observations in Paratypes. Male phallic sclerites (paratype ISLA 66144, Figs 2–6) **Pseudepiphallus:** median projection curved inward, lobular shape, slightly acuminated at the base, slightly sclerotized (Ps.M.Pr, Figs 2, 4 and 6); pseudepiphallic median lophy claviform and thin (compared with *A. similis* and *A. cruscastaneus*), acuminated apex with bristles and flattened, (Ps.m.l, Figs 3, 4 and 6); Paramere 1 well developed, C-shaped (very similar to *A. spurius*) apex dilated and curved inward (Ps.P1.p, Figs 2–5); Paramere 2 connected to Paramere

1 by membranous tissue, little protruding and escrerotized in this specie (Ps.P2, Figs 4 and 5); Rami less elongated and sclerotized (compared to *A. rubricephalus, A. similis, A. cruscastaneus, A. parasimilis*), dilated, curved inside and triangular shaped at the tip (R, Figs 3, 4 and 6). **Ectophallic invagination**: ectophallic sclerite H-shaped shortened (similar to *A. spurius*) (Figs 2 and 3), with a apodeme in the distal region (Ec.Ap) weakly sclerotized and slightly dilated to the outer edge of the sclerito (Figs 2 and 3) apex of posterior projections quadrangular-shaped in ventral view, dilated and weakly sclerotized, connected to the pseudepiphallic paramere 1 by membranous tissue (Ec.Pr, Figs 2, 3, 4 and 6); ectophallic arc slightly longer as wider (Ec.Arc, Figs 2 and 3); ectophallic fold sclerotized, linear-shaped, with the lateral border more sclerotized than that interior base, central part slightly convex at the top and bottom borders (Ec.F, Fig. 3). **Endophallus**: circular-shaped and vertically elongated, with a short ventral crest (End.Sc), connected to the ectophallic fold by an inverted U-shaped membrane (End.Sc, Fig. 3).

Female (Figs 27–33**,** ISLA 66148) Body color similar to holotype (Fig. 27), body size bigger than the holotype (13.797 mm); small wings triangular-shaped (Fig 27); supranal plate more whitish than tergites, trapezoidal-shaped elongated, with small lateral projections, surrounded by two white spots on the latero-median region, apex rounded and with long bristles (Figs 28–29); subgenital plate dark, short, V-shaped, apex with a slight concavity (Fig. 28); ovipositor thin and elongated (5.917 mm), proportional to tibia III size, sword format at apex (Figs 31–33).

Copulatory Papilla: well sclerotized, circular-shaped, with a large membranous opening area, reaching 2/3 of the structure in dorsal view (Fig. 7a); lateral face sclerotized in all its extension (Fig. 7a, 7b and 7c), apex slightly concave, with a ventral indentation followed by a less sclerotized region (in white), base with a membranous opening of triangular shape in ventral view (Fig. 7c).

Variations in male's tegmens of the Paratypes

Male right tegmen (ISLA 66149, 66146, 66151, 66152, 66162, 66164, n = 5). Mirror: presents a slight variation, mainly in the proximal shape of the mirror (at apex) can be tri-oval shaped (Figs 22, 23, 24 and 25) or oval-quadrangular shaped (Figs 21 and 26); three (Figs 25 and 26) to four cells (Figs 21 and 24) well marked with cross vein; the first proximal cell (Fig. 23), or the first two proximal cells can be present reticular veins (Figs 21, 22, 24, 25 and 26); the first distal cell can be divided with poorly marked veins, in two (Figs 21, 22, 24 and 26) or three cells (Figs 23 and 25); one poorly marked diagonal vein can be present in left (Figs 21,

22, 25), or in the center (Fig. 23) in the first distal cell; the vein Mcv can have different placements in some cases (Figs 24, 25 and 26). **Harp:** with the conservative cell number, equal to four cell and three well marked cross vein for all material examined; first distal cell without ramifications (Fig. 26), or with one poorly marked diagonal vein, connecting Cu1 and Cu2, forming one small cell in the anal region (Figs 22, 23, 24 and 25), or also with one branch connecting to Hcv, forming two small anal cells in the same region (Fig. 21); reticular veins can be present in the first distal cell (Figs 21, 22, 24, 25 and 26); the second and third distal cells could have poorly marked veins (Figs 21, 22, 24, 25 and 26); stridulatory file with 96 ± 4.741 teeth (92–100, n = 5, ISLA 66149, 66144, 66146, 66147, 66151).

Ecological Remarks (Figs 34–39). Specimens of *Adelosgryllus lucifugus* **n. sp.** were found in Gruta dos Morcegos cave, located in the municipality of Piripiri, in northern Piauí state, Brazil. The region is located within the limits of the Caatinga formation, the unique Brazilian semi-arid biome. The area presents, according to the Köppen's climate system, a tropical climate with dry summer (AS), with a dry period frequently reaching 6 months of drought. The average temperature is 25°C, and the annual rainfall is around 1000 mm (Alvares *et al*. 2013). The Gruta dos Morcegos cave comprises a sandstone cave with approximately 200 meters of linear projection. The cave presents at least three entrances: one horizontal, which corresponds to the main entrance (Fig. 34) and other two vertical entrances (skylights, Fig. 35). Furthermore, its main conduit is trespassed by a stream, which springs through the main entrance. The cave terrestrial habitats are variable, although several collapsed blocks predominate in the cave floor. Near the main entrance, roots from external vegetation constitute the main organic resource observed. No specimens of *A. lucifugus* **n. sp.** were found in this area, although several specimens of another cricket (*Uvaroviella* sp.) were quite abundant. In the inner chambers, the main organic resource was the guano from insectivorous bats. The large bat colony inhabiting the cave (the cave´s name – Gruta dos Morcegos – means "bat cave", in Portuguese language), produces huge guano deposits, which literally covers large portions of the cave floor, including collapsed blocks. Specimens of *A. lucifugus* **n. sp.** were mainly found in this area, although some specimens were also associated to areas devoid of guano (Figs 36 and 37). Individuals of *A. lucifugus* **n. sp.** are extremely evasive, quickly escaping in the first contact with light. In most cases, they shelter themselves under collapsed blocks, preventing any detailed observation of their behavior. Despite their escaping behavior, it was possible to attest that the population seems not to be small, since dozens of specimens were observed. The external area surrounding the cave is partially preserved, presenting a small-forested area. However, anthropized areas,

especially crops, occurs not far from the cave. Around 30 km towards north from the Gruta dos Morcegos cave, there is a National park (Sete Cidades National Park, Fig. 39), which presents several small sandstone caves. Such caves were sampled during both dry and rainy period in 2019 and a single specimen of *A. lucifugus* **n. sp.** was observed in one of the caves (Toca da Onça Morta cave, Fig. 38). Hence, the species seems to be relatively widespread in the area. However, since no external samplings were conducted during this work, we have no information on the actual distribution and habitat extent of this species, which certainly merit further research.

Discussion

Comparative morphology between Adelosgryllus species

Although coloration has been used as a taxonomic character for *Adelosgryllus* species, we cannot fail to highlight the discoloration caused by the specimens' fixation in 70% ethanol (Corrêa et al. 2018). The species *A. rubricephalus*, *A. similis*, *A. cruscastaneus* and *A. parasimilis* present a reddish head, while in *A. phaeocephalus* the head is brownish. In *A. spurius* and *A. lucifugus* **n. sp.** the heads have a reddish orange color.

In *A. rubricephalus*, the type species of the genus, there is no discussion regarding a possible discoloration caused by the specimen's fixation in ethanol. However, it is likely that the species has been described based on *in vivo* coloration, with specimens being further fixed in ethanol for structures conservation. Subsequently, *A. spurius* and *A. phaeocephalus* were described based on dry specimens apparently (Gorochov 2011); therefore, changes in color are probably negligible, since the specimens were not fixed in ethanol. The authors of the description indicated a color change in the head of *A. similis* and *A. cruscastaneus,* which heads were at first reddish and that after fixation in ethanol, they became yellowish. However, it is important to highlight that in *A. similis* and *A. cruscastaneus* the color used in the description was obtained *in vivo* (Corrêa et al. 2018).

There are similarities regarding the color of *A. lucifugus* **n. sp.** in comparison with other species of the genus (Cigliano et al. 2020). However, the color of the head of this species also suffered depigmentation due to the fixation in ethanol, being initially reddish orange (*in vivo*) and currently pale yellow (fixed). Accordingly, it is highly recommendable that only the coloration of living specimens (or those recently fixed) must be used as diagnostic character in taxonomy. Thus, we emphasize that caution is required when using body color as a criterion for species differentiation (Corrêa et al. 2018).

Regarding the phallic sclerites, the new species presents the male genitalia shape similar to *A. spurius*. In both species (*A. lucifugus* **n. sp.** and *A. spurius*) the paramere 1 is C-shaped, and has an internal projection, but in new species such projections are far from each other. However, in the new species, the inner projections of the paramere 1 do not overlap. In the other species (*A. rubricephalus*, *A. parasimilis*, *A. similis*, *A. cruscastaneus*) the Ps.P1 is continuous, without internal projections, and of lamellar aspect.

The rami (R) cover the ectophallic apodemes in all species. However in *A. lucifugus* **n. sp.** and *A. spurius* the rami are undeveloped, differently from other species (*A. rubricephalus*, *A. parasimilis A. similis* and *A. cruscastaneus*), which exhibit a much more elongated rami.

The ectophallic fold (Ec.F) in *A. lucifugus* **n. sp.** and *A. spurius* exhibits a linear-shaped. In other species (*A. rubricephalus*, *A. parasimilis*, *A. similis* and *A. cruscastaneus*), this structure is U-shaped. Already the Endophallus (End.Sc) of the new species, is more similar to the shape present in *A. similis* (Fig. 21, pg 102, Corrêa et al. 2018), although it is more squat and circular for *A. lucifugus* **n. sp.**

The species *A. phaeocephalus* was described based only in a female, so we must pay special attention to structures such as the ovipositor and the copulatory papilla, since in this case the description of the ovipositor was used to differentiate the species. Despite presenting a usually simplified morphology, the copulatory papilla may be eventually used to differentiate species from some cave groups of Phalangopsidae (e.g. *Eidmanacris* Chopard, 1956; *Phalangopsis* Serville, 1831). However, since four *Adelosgryllus* species were described without any mention to the copulatory papilla (*A. rubricephalus*; *A. spurius*; *A. phaeocephalus* and *A. parasimilis*) it is currently impossible to determine whether all the species of this genus could be distinguished using only this structure. Although, it is interesting to note that the circular-shaped of the copulatory papilla is the first to be registered within *Adelosgryllus* through this study.

Is the male's right tegmen a problematic trait for taxonomy?

The male's right tegmen are usually considered, along with other structures, as an important character used in taxonomic descriptions, since they present considerable subsets of characteristics (e.g. pattern of veins distribution in harp and mirror), that allow to differentiate many species. However, variations existing within the same species bring questions on the effectiveness of using tegmina as a species-differentiation attribute. Such limitation in the use of right tegmen for species differentiation has already been discussed for other genera of Phalangopsidae, such as *Endecous* (Castro-Souza et al. 2020).

The right tegmen from individuals of *A. lucifugus* **n. sp.** from two different populations (Morcego's cave and Onça Morta cave) were analyzed, showing the existence of considerable variations. Furthermore, when comparing the right tegmen of different specimens of *A. rubricephalus*, it was possible to observe variations in the diagonal vein of the lateral field (VDCL), which could be present or absent, and, when present, it varied in number. The number of harp cross-vein also varied among specimens, along with the number of mirror cross-veins. Thus, as for other genera of the family, the differentiation of species based only on the variations existing in the right tegmen is not recommended for *Adelosgryllus*.

Concluding remarks

The description for *Adelosgryllus lucifugus* **n. sp.**, besides contributing to the increase of the knowledge for the genus, brings new information regarding the taxonomy of this group. In addition, since it is the first species of the genus to be recorded in caves, its description expands the ecological knowledge of the taxon, also contributing to the preservation of the caves where the species occurs. However, further studies are still required to increase the knowledge on both ecological and phylogenetic aspects of other species within the genus.

Even considering that a specimen from the new species was found in a cave located at the Sete Cidades National Park, it is important to highlight that the largest population of *A. lucifugus* **n. sp.** was observed in the Gruta dos Morcegos cave, which is located out of the limits of the National Park. Therefore, this cave is currently unprotected, and we must highlight the importance of preserving it to guarantee the preservation of the largest known population of this species.

The number of inventoried caves in Brazil is still small when compared to the potential number of caves existing in the country (CECAV 2019). Thus, several new species, as well as many aspects of their ecology are likely unknown. Thus, investments in formation of taxonomists and bio-speleological surveys are imperative to reduce these gaps.

As emphasized by Fianco et al. (2018), studies that investigate the behavior of crickets from the Phalangopsidae are still scarce. In addition, for some Phalangopsidae genera described in the past, nothing is known beyond their morphological descriptions, often based on very limited type series. Thus, any aspects of the natural history and ecology of new species should always be included in the taxonomic descriptions, since such information are always important for analyses regarding the degree of threat of a given species. Hence, we must emphasize the need for studies on the population ecology, behavior and interactions of species of this family (highlighting *Adelosgryllus*), especially considering the scarcity of information about this genus.

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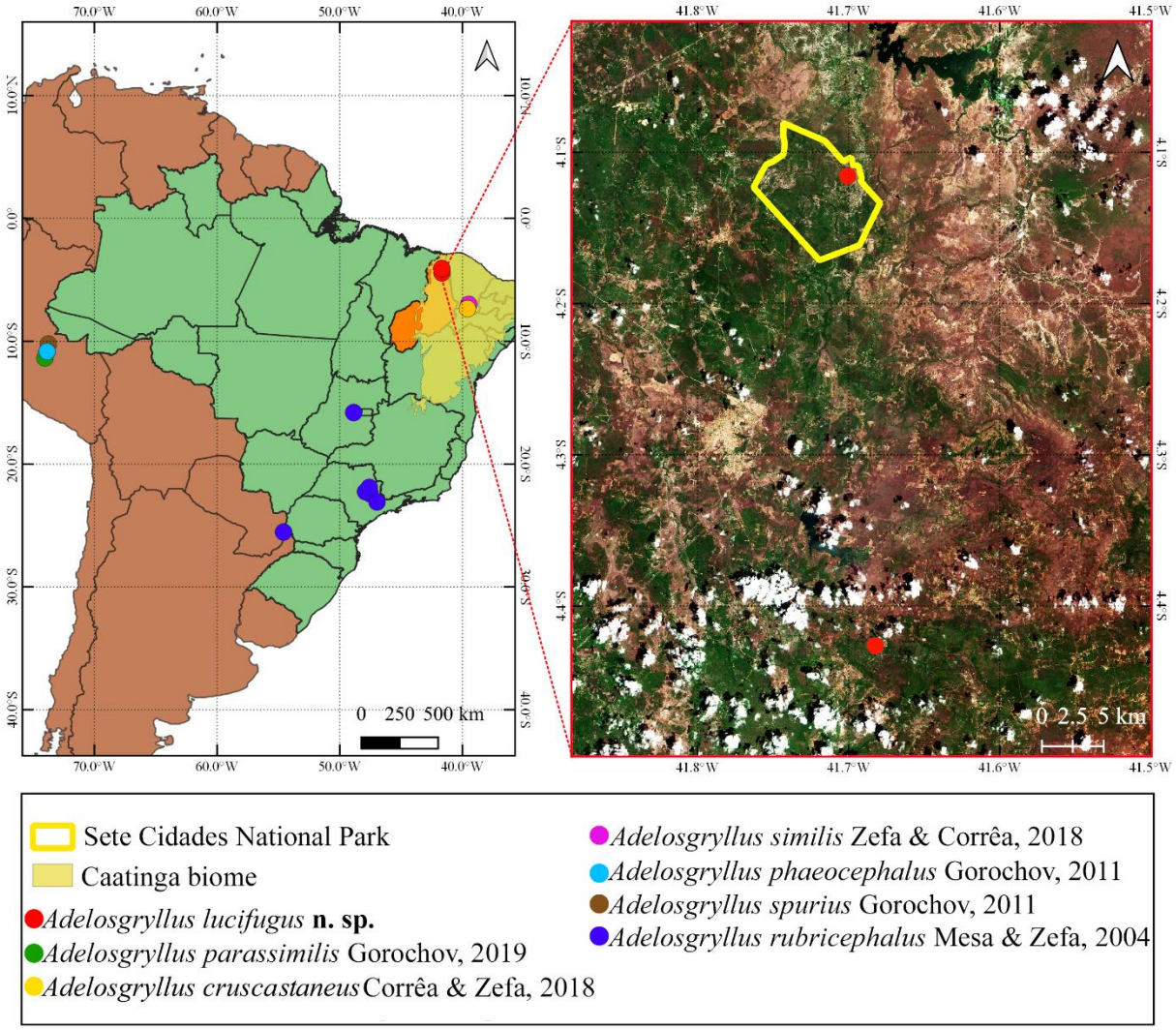
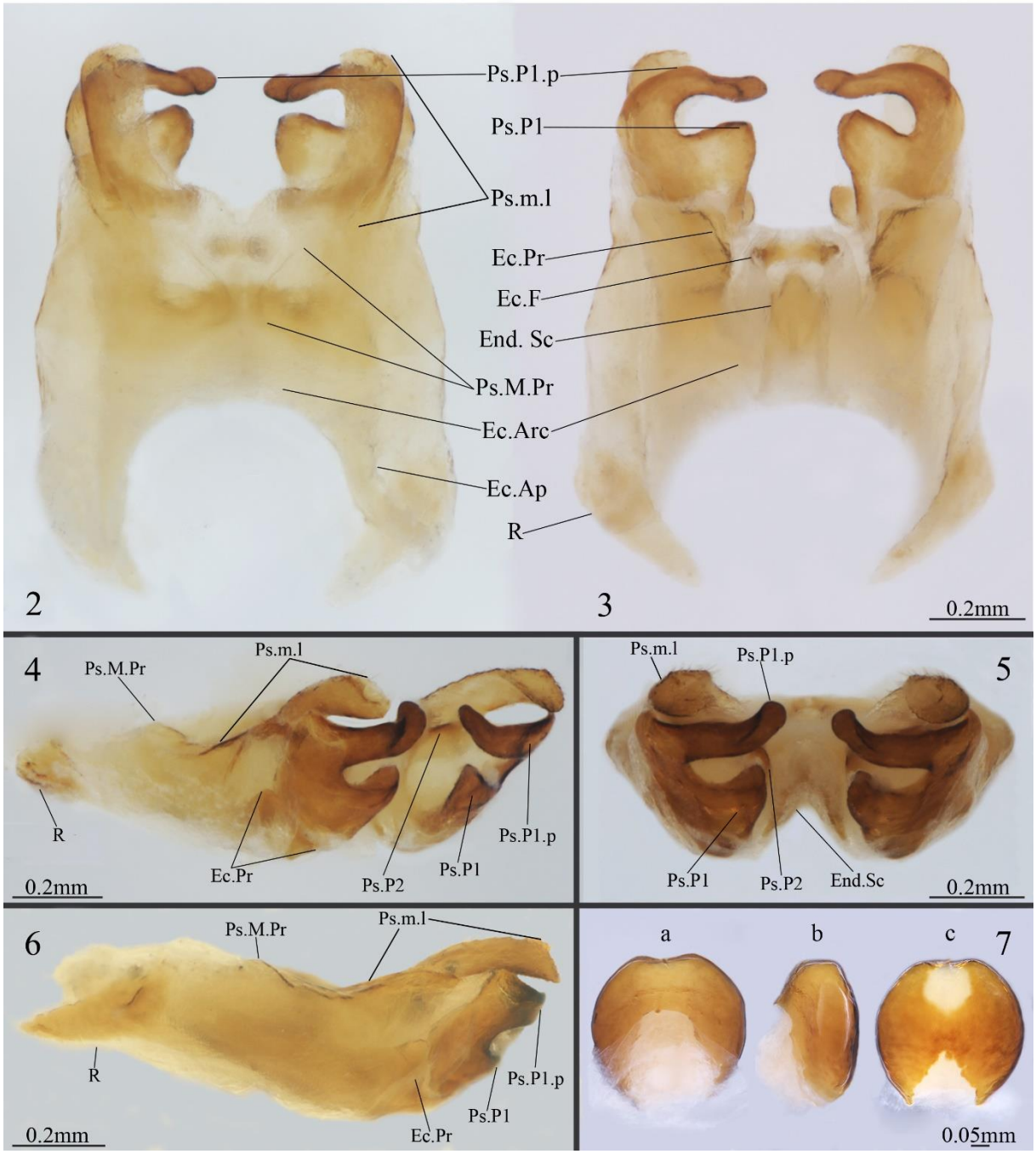
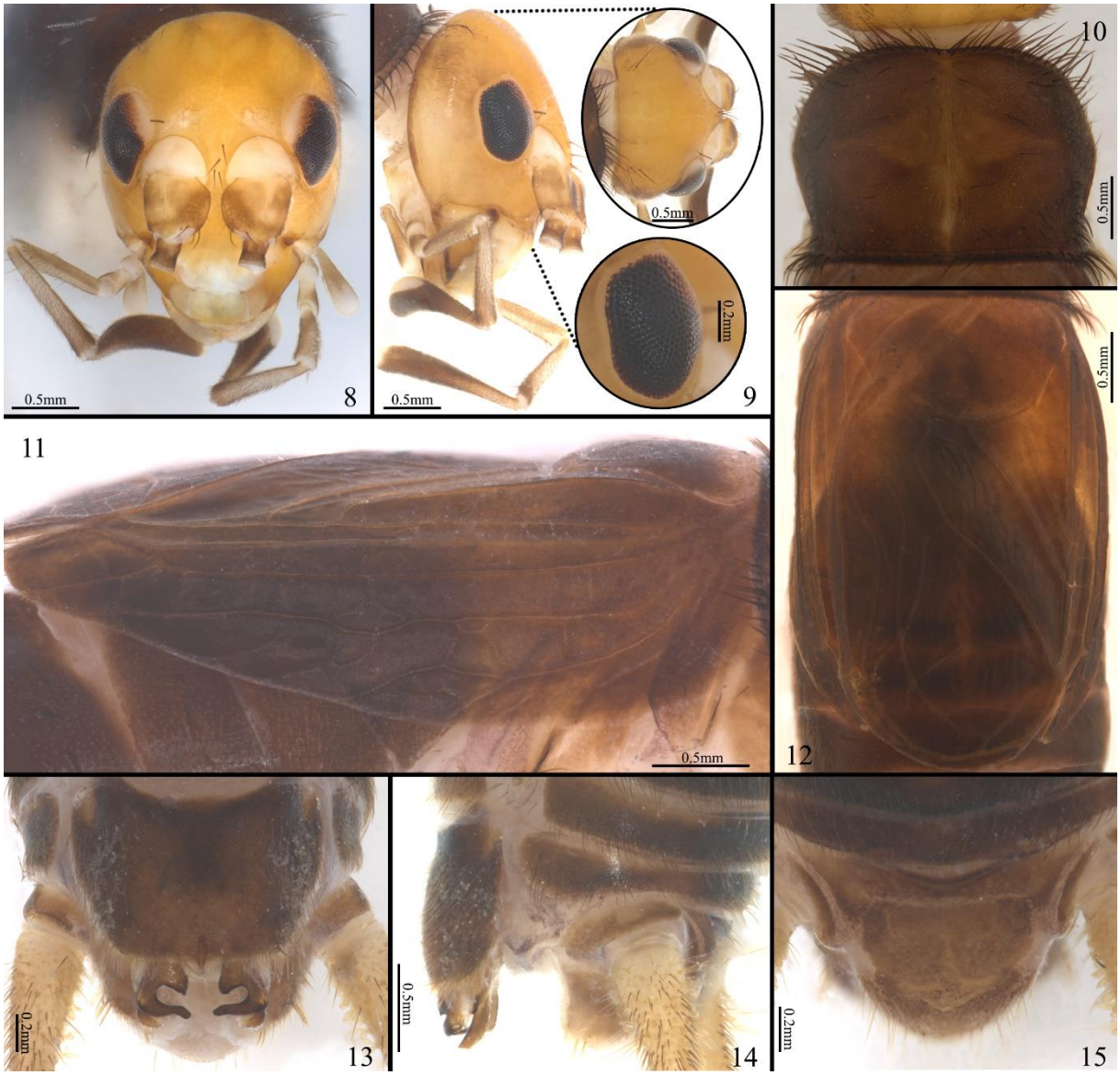


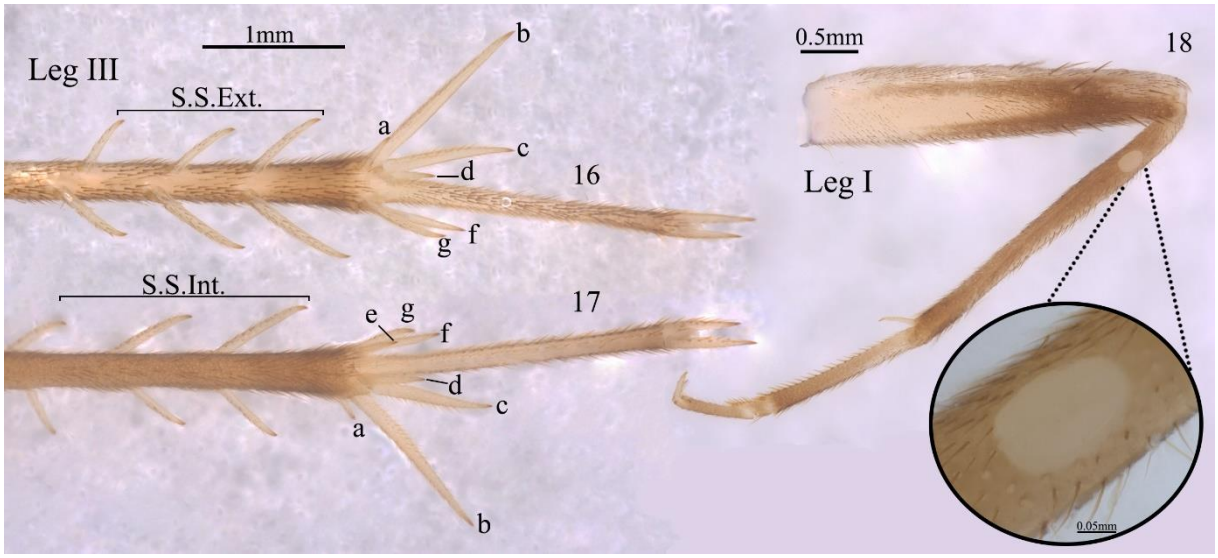
FIGURE 1. Distribution of genus *Adelosgryllus* Mesa & Zefa, 2004.



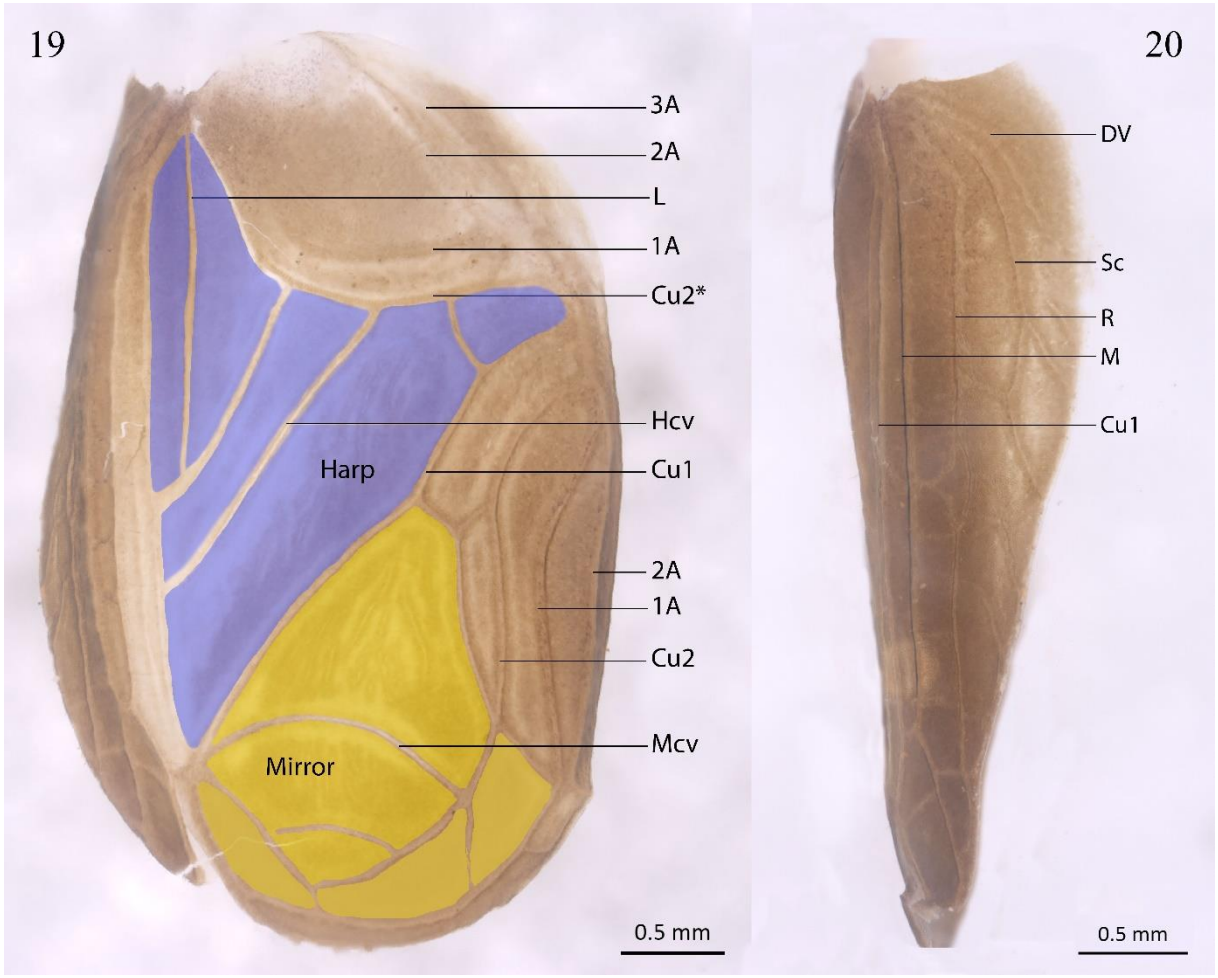
FIGURES 2–7. *Adelosgryllus lucifugus* **n. sp.** phallic sclerite and copulatory papilla of the paratypes ♂ (ISLA 66144) and ♀ (ISLA 66148); 2— dorsal view; 3—ventral view, 4—diagonal view; 5— frontal view; 6—lateral view; 7—copulatory papilla. a, dorsal view; b, lateral view; c, ventral view. *Abbreviations*: **Male genitalia**: **Ps.m.l**, pseudepiphallic median lophy; **PsP1**, pseudepiphallic paramere 1; **Ps.P1.p,** inner projection of pseudepiphallic papamere 1; **PsP2**, pseudepiphallic paramere 2; **Ps.M.Pr**, pseudepiphallic median projection; **Ec.Ap**, ectophallic apodeme; **Ec.Arc**, ectophallic arch; **Ec.F**, ectophallic fold; **End.Sc**, endophallic sclerite; **Ec.Pr**, ectophallic projection; **R**, rami.



FIGURES 8–15. *Adelosgryllus lucifugus* **n. sp.** holotype morphology. 8—head in frontal view; 9—head in lateral and superior view; 10—pronotum in dorsal view; 11—right tegmen in lateral view; 12—right tegmen in dorsal view; 13—subgenital plate, ventral view; 14—subgenital and supranal plates, lateral view; 15—supranal plate, dorsal view.

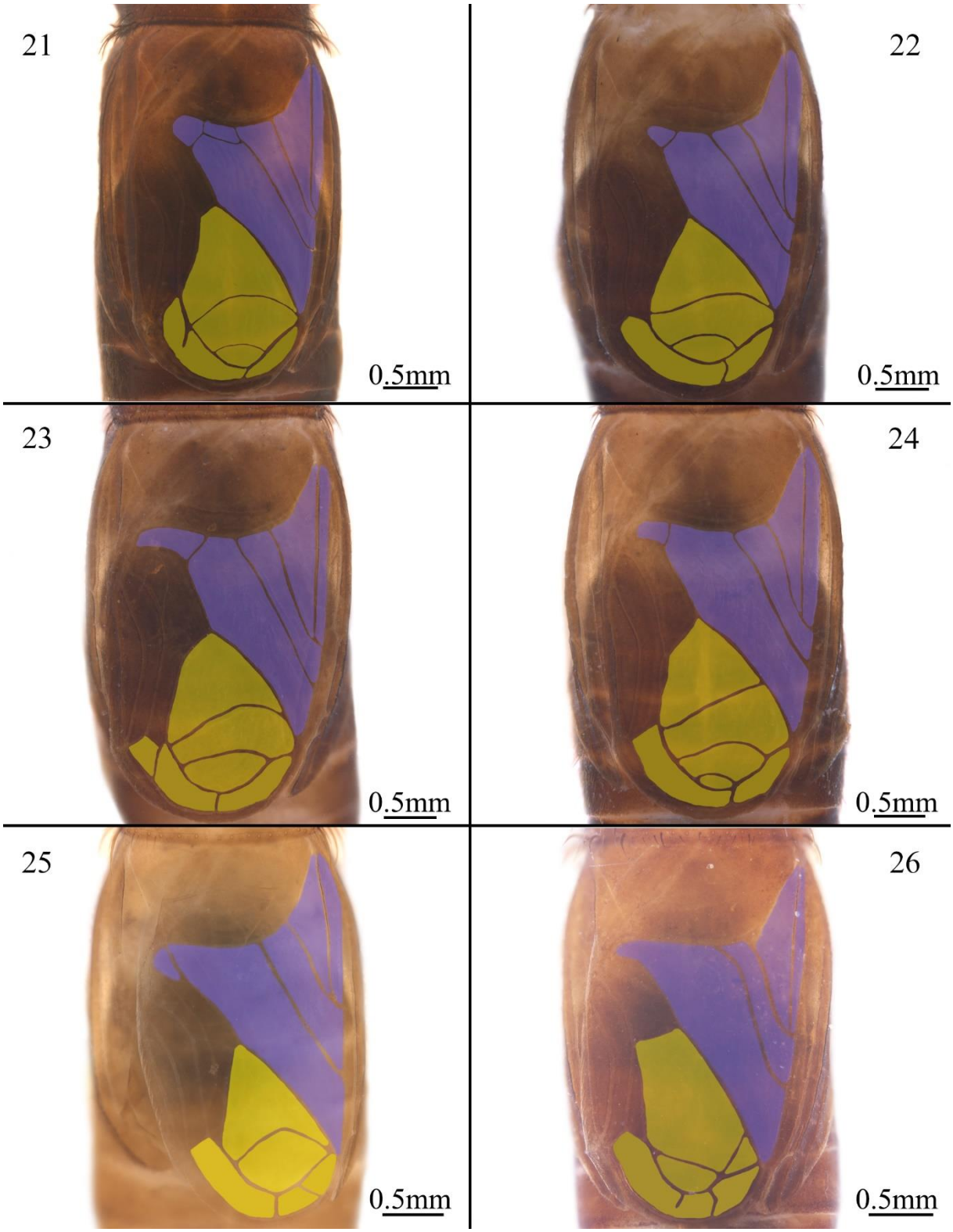


FIGURES 16–18. *Adelosgryllus lucifugus* **n. sp.** holotype's legs III and I morphology. 16—tibia III, subapical spurs (S.S) and apical spurs (a, b, c, d, f, g), external view; 17—tibia III, subapical spurs (S.S) and apical spurs (a, b, c, d, e, f, g), internal view; 18—leg I and auditory tympanum, inner view.

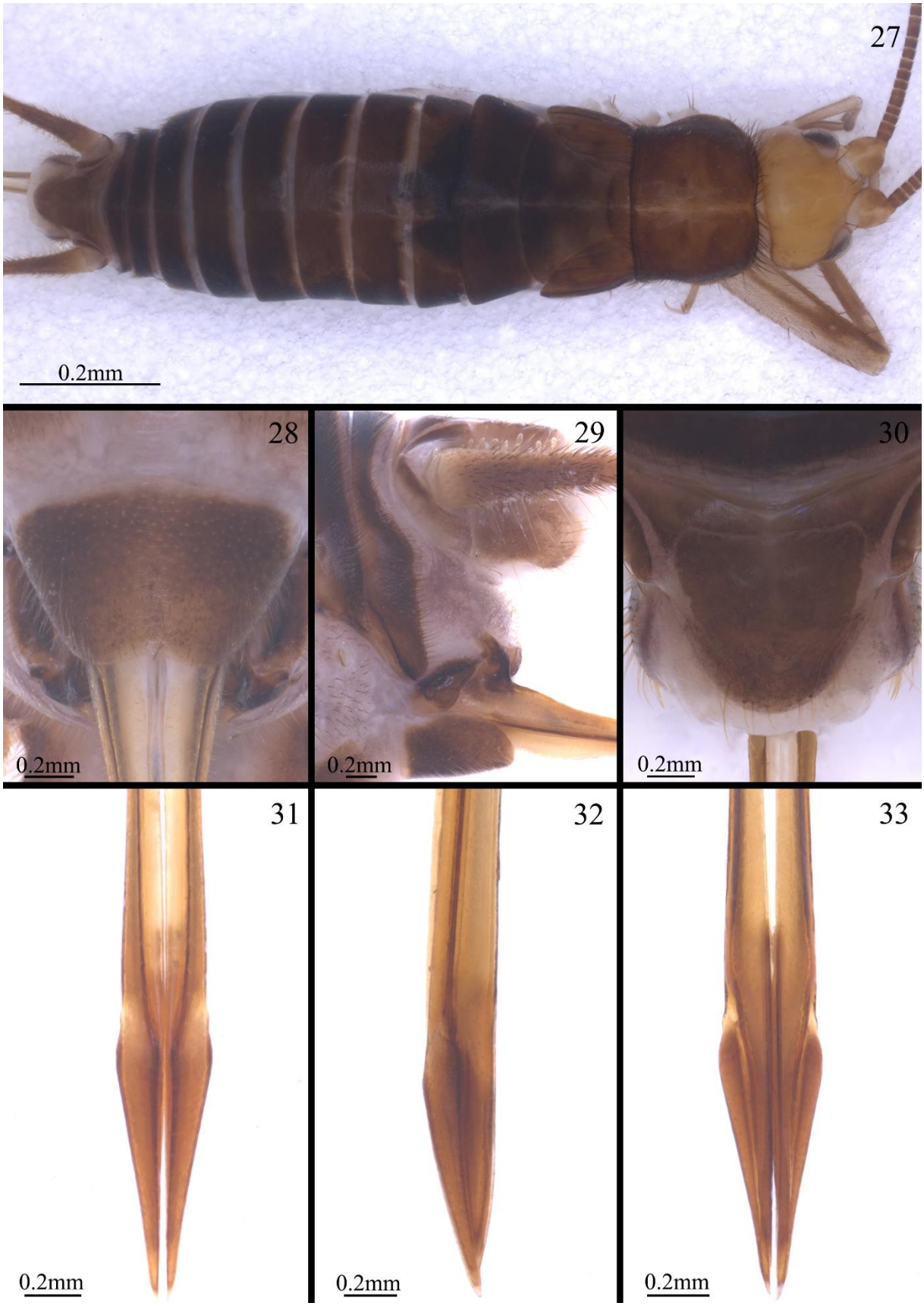


FIGURES 19–20. *Adelosgryllus lucifugus* **n. sp.** Holotype right tegmen, ventral and lateral view, respectively. *Abbreviations:* medium-longitudinal vein (L); diagonal vein (DV); cubital 1 (Cu1); medial (M); radial (R);

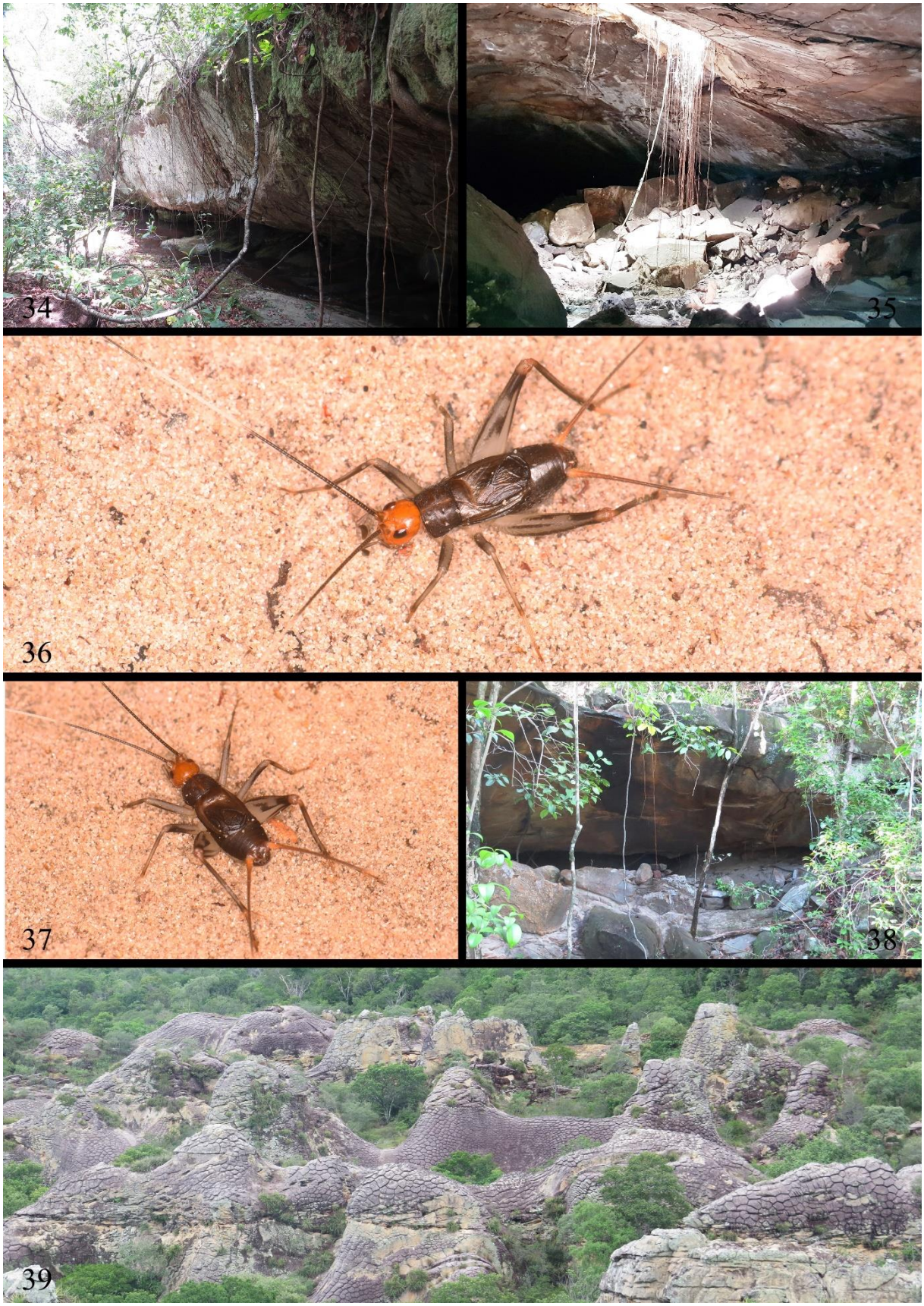
subcostal (Sc); anal 3 (3A); anal 2 (2A); anal 1 (1A); *pars stridens* (Cu2*) (stridulatory file); harp cross-vein (Hcv); mirror cross-vein (Mcv).



FIGURES 21—26. Right tegmen of the paratypes the *Adelosgryllus lucifugus* **n. sp.** in dorsal view. 21— ISLA 66149 (holótipo); 22— ISLA 66146; 23— ISLA 66151; 24— ISLA 66152; 25— ISLA 66162; 26— ISLA 66164.



FIGURES 27—33. *Adelosgryllus lucifugus* **n. sp.** female morphology (ISLA 66148). 27— Bodydorsal; 28— subgenital plate; 29— subgenital and supranal plates, lateral view; 30—supranal plate; 31, 32 and 33— ovipositor apex, dorsal, lateral and ventral view, respectively.



FIGURES 34—39. Study area and habitats of *Adelosgryllus lucifugus* **n. sp.** 34—Morcego cave's entrance; 35—skylight in the Morcego cave's; 36 and 37—Male of *Adelosgryllus lucifugus* **n. sp.** in overview; 38—Onça Morta cave's entrance; 39— Sete Cidades National Park region.

TABLE 1: *Adelosgryllus lucifugus* **n. sp.** morphological measurements (mm), mean (Med.) and standard deviation (D.P.) of 9 specimens examined from Piauí state.

♂	66144	66146	66147	66149	66150	66151	66152	Med.	D.P.
Head width	1.547	1.667	1.528	1.610	1.531	1.614	1.915	1.630	0.136
Head length	2.340	2.483	2.007	2.413	2.209	2.116	2.447	2.288	0.181
Intraocular	0.990	0.935	0.916	0.965	0.921	0.925	0.994	0.941	0.035
Femur III	6.597	6.503	5.909	6.363	6.181	5.773	5.966	6.185	0.315
Tibia III	5.878	5.460	5.176	5.518	5.328	4.921	5.196	5.354	0.305
Body	13.450	13.487	11.526	12.835	10.948	10.958	11.891	12.156	1.101
Pronotum width	2.681	2.564	2.235	2.424	2.291	2.134	2.302	2.376	0.192
Pronotum length	1.754	1.601	1.528	1.538	1.336	1.479	1.524	1.537	0.126
Wing width	2.905	2.234	2.213	2.500	2.477	2.202	2.397	2.418	0.248
Wing length	4.872	4.398	3.873	4.414	4.243	3.667	3.997	4.209	0.402
stridulatory file	103.8	92.8	92.4	99.6	–	95.5	–	96.82	4.845

♀	66148	66162	Med.	D.P.
Head width	1.796	1.508	1.652	0.204
Head length	2.543	2.181	2.362	0.256
Intraocular	1.068	0.920	0.994	0.105
Femur III	6.377	5.517	5.947	0.608
Tibia III	5.826	5.045	5.436	0.552
Body	13.797	11.136	7.467	8.953
Pronotum width	2.459	2.011	2.235	0.317
Pronotum length	1.811	1.366	1.589	0.315
Ovopositor	5.917	5.661	5.789	0.181