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Source: Journal of Arachnology, 39(1):185-188. 2011.

Published By: American Arachnological Society

DOI: 10.1636/Ha10-43.1

URL: <http://www.bioone.org/doi/full/10.1636/Ha10-43.1>

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## SHORT COMMUNICATION

A new troglobitic *Eukoenia* (Palpigradi: Eukoeniidae) from Brazil

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**Abstract.** A new Brazilian species of the genus *Eukoenia* is described from a single male specimen collected within the Archimedes Passini cave, a marble cave located in the municipal district of Vargem Alta, Espírito Santo. *Eukoenia spelunca*, sp. nov., has six blades on the prosomal lateral organs and a unique shape of the genital lobes. Some morphometric parameters demonstrate the specialization of this new species to the cave environment.

**Keywords:** Neotropics, taxonomy, caves, troglomorphic

Palpigradi is one of the least known of the arachnid orders, and its phylogenetic position is problematic (Pepato et al. 2010). Historically, various authors (Hansen & Sørensen 1897; Petrunkevitch 1955; Weygoldt and Paulus 1979; van der Hammen 1982) have proposed different relationships with other groups of arachnids, but there is no consensus.

Within the Palpigradi, the most distinctive troglomorphisms are found in species of the genus *Eukoenia* Börner 1901, which is also the most diverse and widely distributed genus. Representatives of the genera *Allokoenia* Silvestri 1913, *Koeniodes* Silvestri 1913, and *Prokoenia* Börner 1901 sometimes have been found in caves, but in none of the cases have the species expressed adaptations related to the subterranean environment (Condé 1996).

Despite being one of the smallest arachnid orders (Harvey 2007), new palpigrade species are being regularly discovered and described (e.g., Moreno 2006; Barranco & Harvey 2008; Christian 2009). In recent years researchers have uncovered a variety of Palpigradi in several Brazilian caves (Souza & Ferreira 2010). Most of these species are new, and many are currently under study to determine their affinities. In the present work, a new Brazilian species of the genus *Eukoenia* with troglomorphic traits is described from an adult male found walking on a speleothem in a marble cave in the municipal district of Vargem Alta, Espírito Santo.

## METHODS

The specimen was examined by clearing it in Nesbit's solution and mounting it in Hoyer's medium on 3 × 1-inch glass slides using standard procedures developed for mites (Krantz & Walter 2009). All measurements are presented in micrometers (μm) and were taken using an ocular micrometer with a phase contrast microscope. Body length was measured from the apex of the propeltidium to the posterior margin of the opisthosoma. The areoles in some drawings represent the insertions of setae.

The following abbreviations were utilized, based on Barranco & Mayoral (2007): L, total body length (without flagellum); B, dorsal shield length; P, pedipalpus; I and IV, legs I and IV; ti, tibia; bta1, basitarsus 1; bta2, basitarsus 2; bta3, basitarsus 3; bta4, basitarsus 4; ta1, tarsus 1; ta2, tarsus 2; ta3, tarsus 3; a, width of basitarsus IV at level of seta r; er, distance between base of basitarsus IV and insertion of seta r; grt, tergal seta length; gla, lateral seta length; r, stiff seta length; t/r, ratio between length of basitarsus IV and stiff seta length; t/er, ratio between basitarsus IV length and distance to insertion of stiff seta; gla/grt, ratio between lengths of lateral and tergal setae; B/bta, ratio between lengths of prosomal shield and basitarsus IV; bta/ti, ratio between lengths of basitarsus IV and tibia IV. Setal

nomenclature follows that of Condé (1974a, 1974b, 1981, 1984, 1988, 1989, 1992, 1993, 1994).

The specimen is lodged in the Coleção de Invertebrados Subterrâneos de Lavras, Departamento de Biologia, Universidade Federal de Lavras, Lavras, Minas Gerais (ISLA).

## TAXONOMY

Family Eukoeniidae Petrunkevitch 1955

Genus *Eukoenia* Börner 1901

*Koenenia* Grassi & Calandruccio 1885:165 [junior primary homonym of *Koenenia* Beushausen 1884 (Mollusca: Bivalvia)].

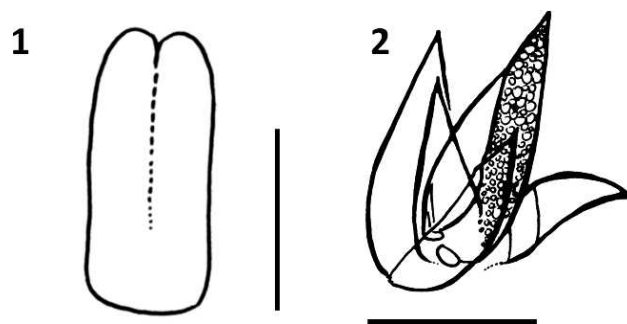
*Koenenia* (*Eukoenia*) Börner 1901:551.

**Type species.**—*Koenenia mirabilis* Grassi & Calandruccio 1885, by monotypy.

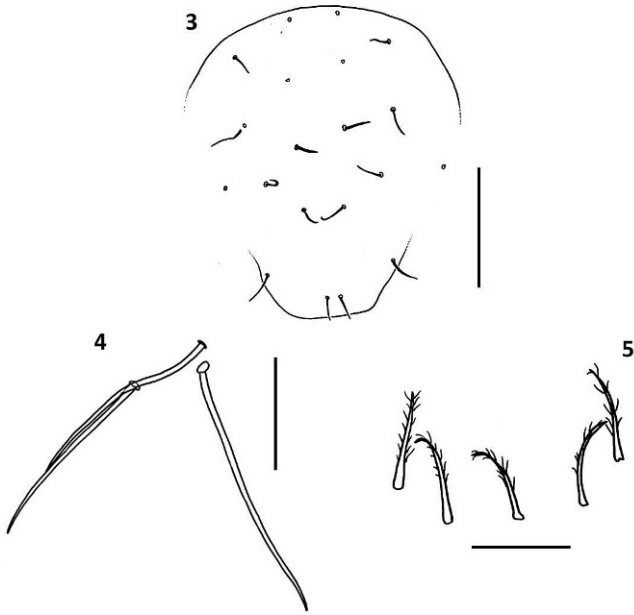
*Eukoenia spelunca* new species  
(Figs. 1–15)

**Material examined.**—Brazil: *Espírito Santo*: Holotype adult male, Archimedes Passini cave (collected from a speleothem), Vargem Alta (UTM 285168,01; 7711062,66), 15 September 2005, R.L. Ferreira (ISLA 850).

**Diagnosis.**—*Eukoenia spelunca* differs from all other species of the genus by the following combination of characters: prosomal lateral organs with 6 blades; six setae on the basitarsus IV with a single proximal sternal seta; opisthosomal sternites IV–VI with 2 + 2 thickened setae ( $a_1$ ,  $a_2$ ) in middle of the opisthosoma between both normal slender setae ( $s$ ); and male genitalia with 11 + 11 setae on first



Figures 1, 2.—*Eukoenia spelunca* new species, holotype male: 1. Frontal organ, dorsal view; 2. Lateral organ, dorsal view. Scale bars 20 μm (Fig. 1), 20 μm (Fig. 2).



Figures 3–5.—*Eukoenia spelunca* new species, holotype male: 3. Propeltidial chaetotaxy; 4. Metapeltidial setae; 5. Deuto-tritosternal setae. Scale bars 100  $\mu$ m (Fig. 3), 40  $\mu$ m (Fig. 4), 20  $\mu$ m (Fig. 5).

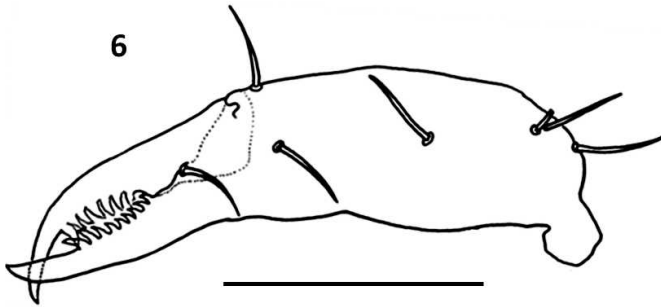
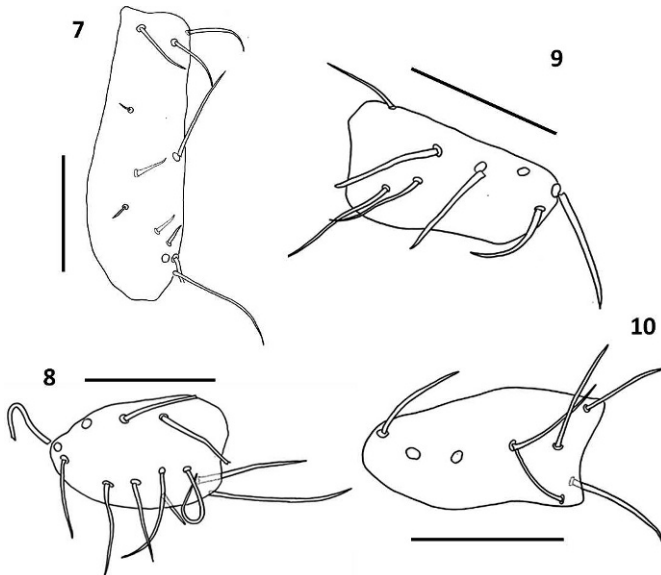
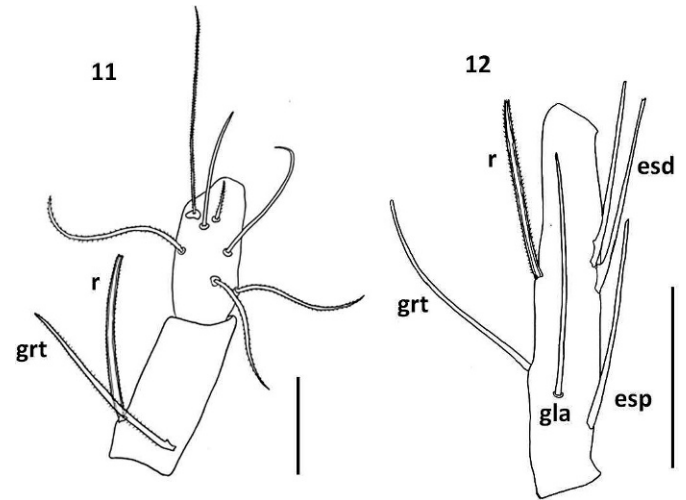


Figure 6.—*Eukoenia spelunca* new species, holotype male: 6. Chelicerae. Scale bar 100  $\mu$ m.



Figures 7–10.—*Eukoenia spelunca* new species, holotype male: 7. Coxa I; 8. Coxa II; 9. Coxa III; 10. Coxa IV. Scale bars 60  $\mu$ m.



Figures 11, 12.—*Eukoenia spelunca* new species, holotype male: 11. Basitarsus 3–4 of leg I; 12. Basitarsus IV. Scale bars 40  $\mu$ m (Fig. 11), 60  $\mu$ m (Fig. 12).

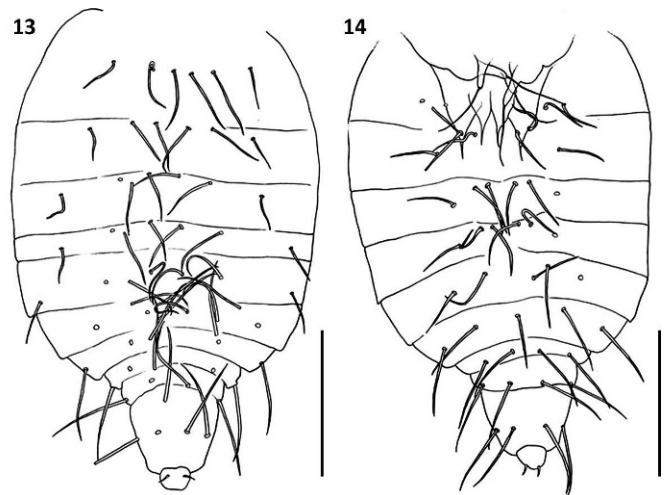
lobe (and 2 + 2 sternal setae), 4 + 4 setae on second lobe, and 4 + 4 setae on third lobe.

**Description.**—*Prosoma*: frontal organ with two branches, blunt apically and each 4.4 times longer than wide (27.5  $\mu$ m/6.25  $\mu$ m) (Fig. 1). Lateral organ with 6 pointed parallel blades, each 6.5 times longer than wide (32.5  $\mu$ m/5  $\mu$ m) (Fig. 2).

Propeltidium with 10 + 10 setae (Fig. 3). Metapeltidium with 3 + 3 setae ( $t_1$ ,  $t_2$ ,  $t_3$ ) each of different length, inner seta shortest (65  $\mu$ m, 75  $\mu$ m, and 67.5  $\mu$ m) (Fig. 4). Deutotritosternum with 5 setae in U-shaped arrangement (Fig. 5).

*Chelicerae*: with 9 teeth on each finger; 4 dorsal setae, 1 lateral seta, and 1 seta inserted near the row of teeth of the second segment (Fig. 6).

*Legs*: chaetotaxy of coxae I–IV: 11, 8, 12 and 8 (Figs. 7–10). Basitarsus 3 of leg I 2.3 times longer than wide, with 2 setae (*grt* 67.5  $\mu$ m; *r* 77.5  $\mu$ m). Seta *r* longer than segment (65  $\mu$ m/77.5  $\mu$ m,  $t/r = 0.8$ ), inserted in proximal half and surpassing hind edge (27.5  $\mu$ m/60  $\mu$ m,  $s/er = 0.45$ ) (Fig. 11). Basitarsus of leg IV 5.6 times longer than wide, with 6 setae (2 *esd*, *esp*, *gla*, *grt* and *r*),  $btalti$  0.91. Stiff seta



Figures 13, 14.—*Eukoenia spelunca* new species, holotype male: 13. Opisthosoma, dorsal view; 14. Opisthosoma, ventral view. Scale bar 150  $\mu$ m.

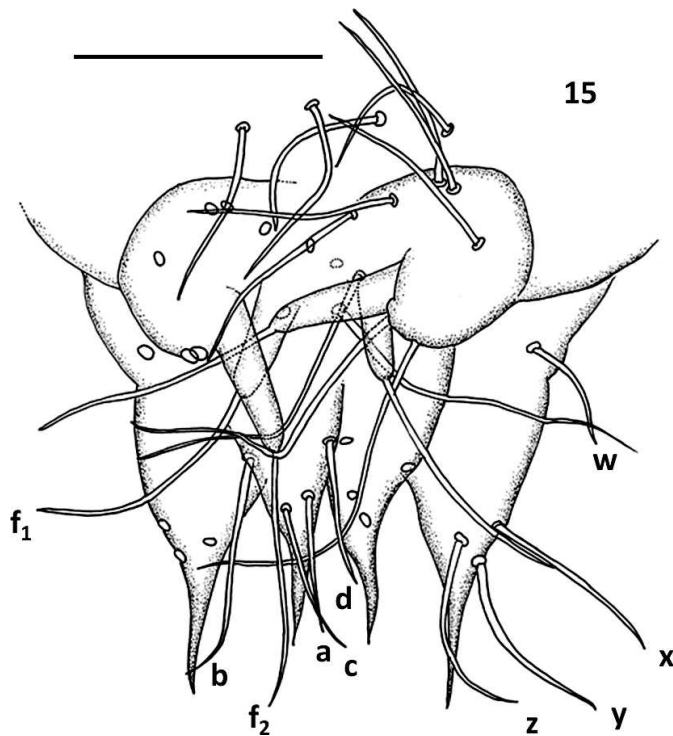


Figure 15.—*Eukoenia spelunca* new species, holotype male: 15. Male genitalia. Scale bar 60  $\mu\text{m}$ .

*r* 2.2 times shorter than tergal edge of article (127.5  $\mu\text{m}/57.5 \mu\text{m}$ , *t/r* = 2.2) and inserted in its distal half (127.5  $\mu\text{m}/72.5 \mu\text{m}$ , *t/ler* = 1.75). Seta *esp* proximally inserted, followed by *gla* and *grt*, more or less at the same level, all of them in proximal half (Fig. 12).

**Opisthosoma:** tergites II–VI with 3 + 3 setae each, 2 pairs of setae (*t*<sub>1</sub>, *t*<sub>3</sub>) between both slender setae (*s*). Tergites VII–VIII each with 2 + 2 setae (Fig. 13). Sternite III with 2 + 2 setae. Sternite IV–VI each with 2 + 2 thickened setae (*a*<sub>1</sub>, *a*<sub>2</sub>) in middle of the opisthosoma between both normal slender setae (*s*). Sternites VII–VIII with 2 + 2 setae and 2 + 1 + 2 setae respectively. Segments IX–XI each with 8 setae (Fig. 14).

**Genitalia:** with 2 + 2 external setae (*st*<sub>1</sub> and *st*<sub>2</sub>) and 38 setae distributed in 3 lobes that form the genitalia of the male. First lobe with a rounded aspect, not being possible to identify a clear separation in the central region; with 11 + 11 setae (including 2 + 2 fusules in the distal margin); *f*<sub>1</sub> = 80–85  $\mu\text{m}$ ; *f*<sub>2</sub> = 100–95  $\mu\text{m}$ . Second lobe subtriangular, with a simple and sharp apex (without bifurcation), with 4 + 4 setae (*a*, *b*, *c*, *d*). Third lobe also in a subtriangular form, well developed, with 4 + 4 setae (*w*, *x*, *y*, *z*), with a large, sharp and simple acute apical region (Fig. 15).

**Dimensions ( $\mu\text{m}$ ):** See Table 1.

**Etymology.**—Name given in apposition as a reference to the Corsican word *spelunca* meaning “cave.”

**Habitat.**—Archimedes Passini cave is formed within marble and is located in the municipal district of Vargem Alta (Espírito Santo). This cave possesses approximately 150 m of linear development. Its topography is irregular and the more interior portion of the cave harbors a small drainage. The only individual of *E. spelunca* collected was walking on a stalagmitic floor, about 40 m from the only cave entrance. This area is isolated from the surrounding epigeal environment, comprising a conduit with a low ceiling (about 1 m high) and a more stable microclimate. The surface of the stalagmitic floor where the palpigra was collected was quite humid. The cave is located in the domain of the Brazilian Atlantic forest, but the area has been quite altered by anthropogenic activities, deforestation being very frequent in the area.

Table 1.—Measurements ( $\mu\text{m}$ ) of selected body parts of the two type specimens of *Eukoenia spelunca*.

Body part	Holotype
L	720
B	245
Pti	115
Pbta1	52.5
Pbta2	62.5
Pta1	32.5
Pta2	40
Pta3	50
Iti	117.5
Ibta1+2	100
Ibta3	65
Ibta4	62.5
Ita1	15
Ita2	32.5
Ita3	120
IVti	140
IVbta	127.5
IVta1	50
IVta2	57.5
A	22.5
Er	72.5
Grt	75
Gla	77.5
R	575
<i>t/r</i>	2.21
<i>t/ler</i>	1.75
<i>gla/grt</i>	1.03
B/btaIV	1.92
btaIV/ti	0.91

## DISCUSSION

Among the species of Palpigra found in South America, *Eukoenia improvisa* Condé 1979 from French Guiana (Condé 1979a) has characteristics most in common with *E. spelunca*. Such characteristics include the presence of 6 setae on the basitarsus of leg IV (presence of only a seta *esp*), the chaetotaxy of the opisthosomal sternites IV–VI (2 + 2 thickened setae between both slender setae) and of the opisthosomal tergites II–VI (3 + 3 setae, two pairs of seta *t* between both seta *s*), presence of 5 setae in the deutotritosternum, and seta *r* inserted in the distal half of the basitarsus IV. However, some characteristics distinguish *E. improvisa* from *E. spelunca* such as the lateral organs formed by 4 elements, the disposition of the setae of the deutotritosternum, and the body dimension values. Although *E. improvisa* has a larger body size, *E. spelunca* has longer segments that form the pedipalp and legs I and IV, the former characteristic of edaphomorphic species and the latter with troglobitic species. Unfortunately, the characteristics of the genitalia cannot be compared, since the male of *E. improvisa* is not known (Condé 1979a). Despite these similarities with *E. improvisa*, a better knowledge of the intertropical species is necessary, based on males and females, so that it is possible to group them or to phylogenetically associate them.

The chaetotaxy of the opisthosomal sternites IV–VI of *E. spelunca* is also similar to that of *E. thais* Condé 1988 and *E. lyrifer* Condé 1992 (Condé 1988, 1992). In addition, the occurrence of 6 setae of the IV bta due to the presence of only one seta *esp* is also observed in *E. pauli* Condé 1979 (Condé 1979c).

The presence of 6 elements forming the lateral organs in *E. spelunca* is shared with other species found in caves such as *E. spelaea* (Peyerimhoff 1902) (5–6), *E. remyi* Condé 1974 (4–6), *E. maroccana* (6) and *E. maquinensis* Souza & Ferreira 2010 (6) (Peyerimhoff 1902; Condé 1974; Souza & Ferreira 2010).

The male genitalia of *E. spelunca* has 38 setae (11 + 11 on the first lobe, 4 + 4 on the second, 4 + 4 on the third), this being a characteristic also found in *E. bonadonai* Condé 1979 and *E. pretneri* Condé 1977 (Condé 1977, 1979b). However, in spite of having the same number of setae, the lobes of the genitalia of these three species have a completely different shape and distribution of the setae. *Eukoenia spelunca* has fusules on moderately dilated processes, as in *E. pauli*, *E. lawrencei* Rémy 1957 from South Africa and Papua New Guinea, *E. grassii* (Hansen 1901) from South America, and *E. janetscheki* Condé 1993 from Brazil, as discussed by Barranco and Mayoral (2007).

Although the only known individual of *E. spelunca* has a moderately reduced body size (only 720 µm), the value of the bta IV/ti ratio (0.91) is closer to the troglobitic species average (0.95) than to the endogeic species (0.79) (Condé 1996). The value of the propeltidium/bta IV ratio (1.92) suggests prolongation of the appendages, being similar to that of troglobitic species, which is always less than 2 (Condé 1998). Finally, the bta IV is 5.6 times longer than wide at the level of the seta r, being in the range found for cave species, which varies between 3.22 in *E. pretneri* and 10.22 in *E. naxos* (Condé 1998).

The description of a new species of troglobitic Palpigradi for Brazil is very important, keeping in mind the fact that few described species exist not only in the country, but also in the Neotropics region as a whole (Harvey 2003).

Furthermore, in Brazil, the presence of an endemic troglobitic species assures the preservation of the cave in which it was found. Until 2009, all Brazilian caves were protected by law. However, unfortunately, the legislation was altered, and the Brazilian caves now can be destroyed by different anthropogenic activities (especially mining). With the intention of defining which caves can be eliminated and which should be preserved, government officials created categories (based on biological and geological parameters) that define the status of each cave. To assure the preservation of a cave in Brazil, it is necessary, from a biological point of view, that it possesses at least an endemic troglobitic or rare species. Therefore, the description of *E. spelunca*, besides contributing to the knowledge of Palpigradi diversity in the Neotropics, ensures the preservation of a cave and its surroundings.

#### ACKNOWLEDGMENTS

The authors would like to thank Marconi Souza Silva for his assistance with the fieldwork, Critical Ecosystem Partnership Fund (CEPF), Conservação Internacional (CI), ICMBIO – CECAV, and Fundação S.O.S Mata Atlântica. We would also like to thank Paulo Rebelles Reis (EPAMIG-CTS/M/EcoCentro Lavras) for the use of the phase contrast microscope and the entire staff of the Laboratory of Underground Ecology of the Section of Zoologia of the Federal University of Lavras (UFLA) for their efforts in the collection.

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