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Description of a new *Eukoenenia* (Palpigradi: Eukoeneniidae) and *Metagonia* (Araneae: Pholcidae) from Brazilian caves, with notes on their ecological interactions

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Abstract. Palpigradi comprises the most poorly known order within the Arachnida; hence, information regarding their biology and behavior is quite scarce. We document an interaction between a palpigrade of the genus *Eukoenenia* being preyed upon by a spider of the genus *Metagonia* in the Gruta do Vale, a cave in the municipal district of Felipe Guerra (Rio Grande do Norte, Brazil). The entire prey recognition and capture process by the *Metagonia* is described in full detail. Both species involved, *Eukoenenia potiguar* n. sp. and *Metagonia potiguar* n. sp., are also described. *Metagonia potiguar* n. sp. is the first Brazilian cave-dwelling *Metagonia* to be described.

Keywords: Predation, taxonomy, morphology, Brazil, Neotropics

The order Palpigradi Thorell 1888 currently contains 85 species, among which 66 belong to the genus *Eukoenenia* Börner 1901 (Harvey 2003; Barranco & Harvey 2008; Christian 2009; Souza & Ferreira 2010). These arachnids occur in various parts of the world, inhabiting soil, litter, caves, and other endogenous environments (Condé 1996). The world distribution of the group has its geographical limits between 48°N and 40°S, most of the species being registered in Europe and Africa (Condé 1996; Mayoral & Barranco 2002). Currently only five species of Palpigradi are known from Brazil: *Eukoenenia roquetti* (Mello-Leitão & Arlé 1935) from Rio de Janeiro, *E. janetscheki* Condé 1993 from Amazonia, *E. maquinensis* Souza & Ferreira 2010 from Cordisburgo, Minas Gerais, *E. ferratilis* Souza & Ferreira 2011 from iron ore caves, Minas Gerais, and *E. spelunca* Souza & Ferreira 2011 from Vargem Alta, Espírito Santo.

The spider genus *Metagonia* Simon 1893 currently has 81 species widely distributed in South and Central America (Platnick 2010). Mexico represents the northern geographical limit, with a large number of species. In South America, there are 26 species, of which 13 species occur in Brazil. Most *Metagonia* species are leaf-dwelling, but some live in caves (Gertsch 1986; Gertsch & Peck 1992; Huber 1998), and a few are known from leaf litter habitats (Gertsch 1986; Huber et al. 2005). Some species have troglomorphic traits (Gertsch 1986; Huber 1998), and at least three species occur in cave environments as eyeless troglobites: *M. bellavista* Gertsch & Peck 1992 and *M. reederi* Gertsch & Peck 1992, both from the Galapagos Islands, and *M. debrasi* Pérez González & Huber (1999) from Cuba.

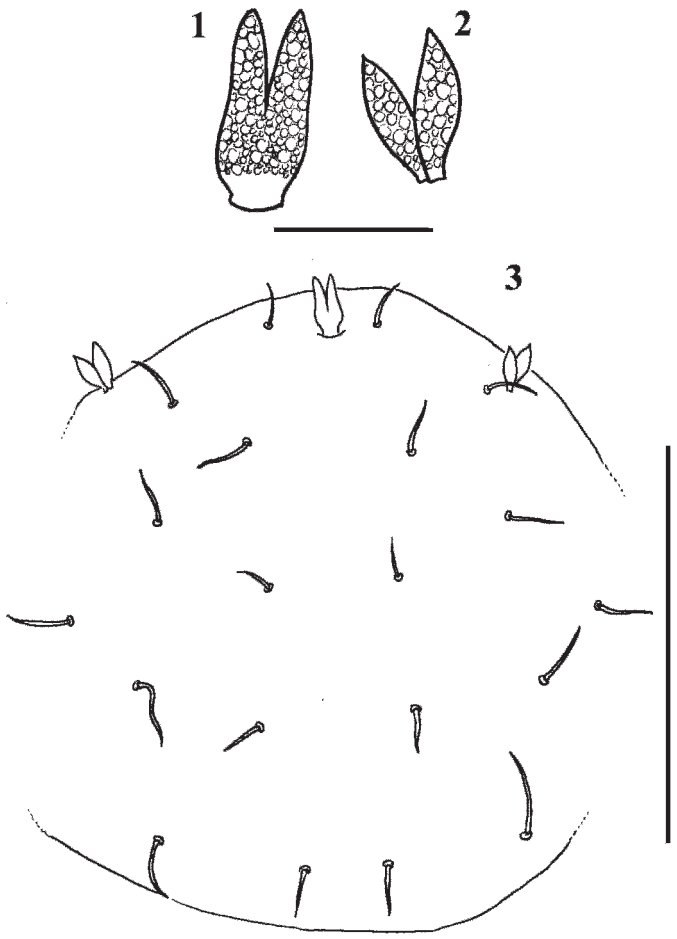
The biology of *Metagonia* species can be divided into three categories (some examples are given): leaf-dwellers, such as *M. rica* Gertsch 1986 (Gertsch 1986; Huber 1997), *M. maritaguariensis* González-Spoga 1998 (Huber 2004), *M. osa* Gertsch 1986 and *M. uvita* Huber 1997 (both in Huber & Schüte 2009); leaf litter dwellers, such as *M. paranapiacaba* Huber et al. 2005 and *M. petropolis* Huber et al. 2005 (Huber *et al.* 2005); and cave dwellers, such as *M. blanda* Gertsch 1973 (Huber 1998), *M. debrasi* Pérez González & Huber 1999 (González & Huber 1999).

Most of these papers provide general descriptions of the natural history of the species. However, Huber (1997) gives a good description of their biology, and Huber & Schüte (2009) present a complete study about their habitat preferences, web construction and prey. Little information exists on the prey consumed by some species of *Metagonia*. Furthermore, until now, documented reports of interaction of any species with individuals of the order Palpigradi have not existed, especially with respect to their potential predators. Therefore, the present work presents an account of the predation of an individual of the genus *Eukoenenia* by an individual of the genus *Metagonia* observed at the Gruta do Vale, located in the municipal district of Felipe Guerra (Rio Grande do Norte, Brazil). Both individuals, together with the other specimens of these genera found in the same cave, belong to new species that are described in the present work.

METHODS

We examined the specimens of *Eukoenenia* by clearing them in Nesbitt's solution and mounting them in Hoyer's medium on 3 × 1-inch (7.6 × 2.5 cm) glass slides using standard procedures for mites (Krantz & Walter 2009). All measurements are presented in micrometers (μm) and were taken using an ocular micrometer with a compound microscope. Body length was measured from the apex of the propeltidium to the posterior margin of the opisthosoma.

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 = relation between lengths of prosomal shield and basitarsus IV,



Figures 1–3.—*Eukoenenia potiguar* new species, paratype male: 1. Frontal organ, dorsal view; 2. Lateral organ, dorsal view; 3. Propeltidial chaetotaxy. Scale bars 20 μm (Fig. 1), 20 μm (Fig. 2), 60 μm (Fig. 3).

bta/ti = ratio between lengths of basitarsus IV and tibia IV, FI–FVIII = flagellar segments. Setal nomenclature follows that of Condé (1989, 1993).

All morphological observations and illustrations of *Metagonia* were made using a Leica MZ12 stereomicroscope with camera lucida. The epigynum was dissected and immersed in clove oil for visualization of internal structures following Levi (1965). Descriptions and measurements follow Huber (2000). Measurements are given in millimeters. The ratio tibia I length/diameter (L/d) is a measure of the robustness of the legs (Huber 2000).

The material examined was deposited in the following institutions (abbreviation and curator in parentheses): Coleção de Invertebrados Subterrâneos de Lavras, Universidade Federal de Lavras (ISLA, R.L. Ferreira) and Coleção de Artrópodes e Miriápodes, Instituto Butantan, São Paulo (IBSP, I. Knysak).

RESULTS

TAXONOMY

Order Palpigradi Thorell 1888
Family Eukoeneniidae Petrunkevitch 1955
Genus *Eukoenenia* Börner 1901

Koenenia Grassi & Calandruccio 1885:165 [junior primary homonym of *Koenenia* Beushausen 1884 (Mollusca: Bivalvia)]. *Koenenia* (*Eukoenenia*) Börner 1901:551.

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

Eukoenenia potiguar new species
(Figs. 1–19)

Types.—Holotype male (''male I''), ''Gruta do Vale'' (05°31′51″S, 37°36′58″W) Felipe Guerra, Rio Grande do Norte, Brazil, 18 July 2009, R. L. Ferreira (ISLA 1293). Paratypes: 1 male (ISLA 1294), 2 females (ISLA 1295, 1296), 1 juvenile female (ISLA 1297) and larva (ISLA 1298), collected with holotype; 1 female, ''Gruta Boca de Peixe'' (05°29′04.5″S, 37°33′29.6″W), Governador Dix Sept Rosado, Rio Grande do Norte, Brazil, 3 June 2010, D.M. Bento (ISLA 1299).

Additional material examined.—BRAZIL: *Rio Grande do Norte*: 1 ♀, Capoeira do João Carlos cave, Governador Dix Sept Rosado, 3 June 2010, D.M. Bento (IBSP 001); 1 larva, Gruta Crotes cave, 4 June 2010, D.M. Bento (IBSP 002).

Etymology.—The new species is named *potiguar* in reference to those born in the State of Rio Grande do Norte, Brazil. The name is to be treated as a noun in apposition.

Diagnosis.—*Eukoenenia potiguar* differs from all other species of the genus by the following combination of traits: two blades in the prosomal lateral organs, tergite II with two pairs and a central seta (*t, t1, t3,*) between both slender setae (*s*), tergites III–VI with three pairs of setae (*t′, t1, t3*) between both slender setae (*s*), sternites IV–VI with 2 + 2 thickened setae (a_1 and a_2) between two normal slender setae (s_1 and s_2),

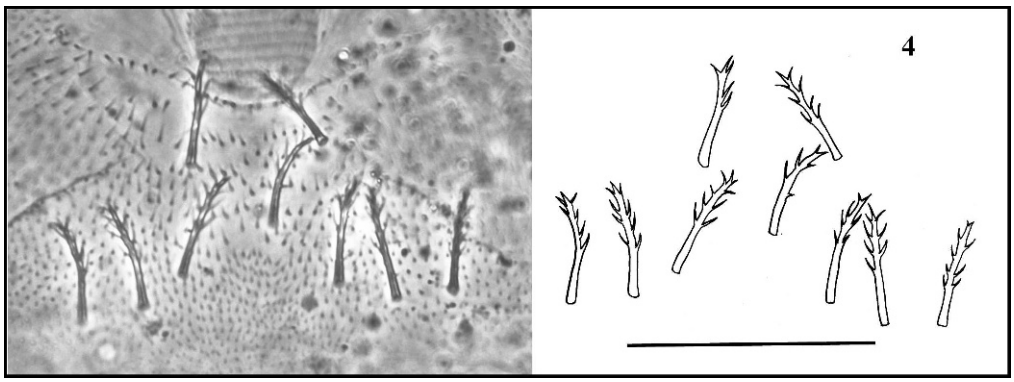
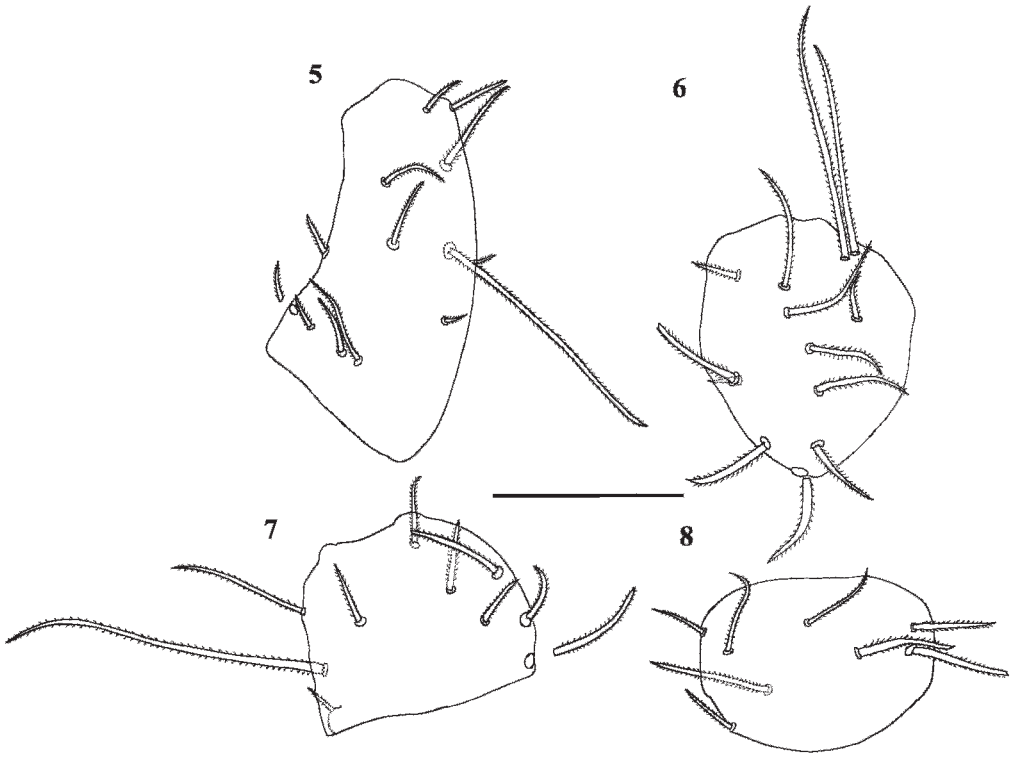
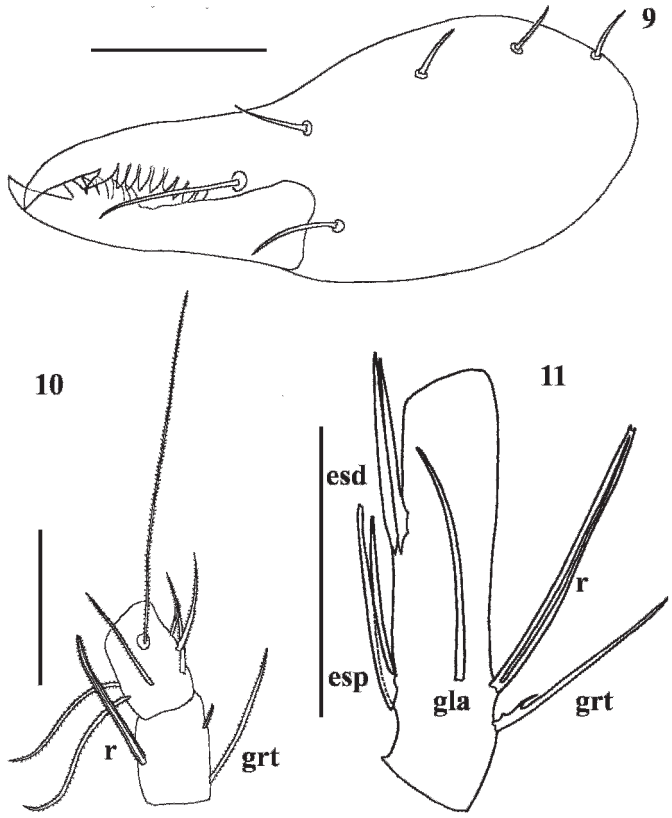


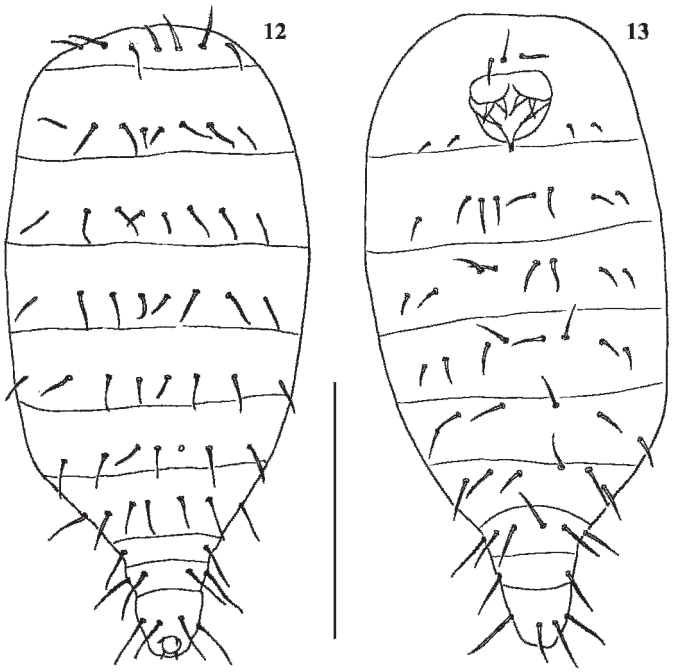
Figure 4.—*Eukoenenia potiguar* new species, paratype male: deuto-tritosternal setae. Scale bar 50 μm.



Figures 5–8.—*Eukoenenia potiguar* new species, holotype male: 5. Coxa I; 6. Coxa II; 7. Coxa III; 8. Coxa IV. Scale bar 60 μm.



Figures 9–11.—*Eukoenenia potiguar* new species, paratype male (Figs. 9, 10) and holotype male (Fig. 11): 9. Chelicerae; 10. Basitarsus 3–4 of leg I; 11. Basitarsus IV. Scale bar 60 μm.



Figures 12,13.—*Eukoenenia potiguar* new species, paratype male: 12. Opisthosoma, dorsal view; 13. Opisthosoma, ventral view. Scale bar 60 μm.

and the characteristic chaetotaxy and shape of the genitalia in females and males.

Description of adults.—*Prosoma:* frontal organ with 2 branches, pointed apically, each 4.5 times longer than wide (22.5 μm/5 μm) (Fig. 1). Lateral organ with 2 blades, each 4 times longer than wide (20 μm/5 μm) (Fig. 2). Propeltidium with 10 + 10 setae in 5 rows, outer pair on last row longer than others (Fig. 3). Metapeltidium with 3 + 3 setae (t_1, t_2, t_3), outer setae shortest (67 μm, 77 μm, 45 μm). Nine deuto-tritosternal setae in 2 rows: first with 3 setae in V arrangement and second with 6 setae in linear arrangement (Fig. 4). Male holotype with only 6 deuto-tritosternal setae.

Coxal chaetotaxy: males: coxa I with 13 setae (Fig. 5); coxa II with 3 thick and 10 normal setae (Fig. 6); coxa III with 3 thick and 7–9 normal setae (Fig. 7); coxa IV with 2 thick and 6 normal setae (Fig. 8). Females: coxa I with 15 setae; coxa II with 4 thick and 8 normal setae; coxa III with 3 thick and 8 normal setae; coxa IV with 2 thick and 8 normal setae.

Chelicerae: with 9 teeth on either finger; 4 dorsal setae and a single ventral seta inserted near third segment and single seta inserted near row of teeth of second segment (Fig. 9).

Legs: basitarsus 3 of leg I short, 1.5 times longer than wide, with 3 setae (*grt* 55 μm; *r* 52.5 μm). Seta r longer than segment (37.5 μm/52.5 μm, *t*/*r* = 0.7), inserted in proximal half and reaching distal margin of basitarsus 4 (32.5 μm/15 μm, s/er = 2.1) (Fig. 10). Basitarsus of leg IV 4.25 times longer than wide, with 7 setae (2 *esd*, 2 *esp*, *gla*, *grt* and *r*), bta/ti 0.8. Stiff seta r 1.44 times shorter than tergal edge of article (85 μm/62.5 μm,

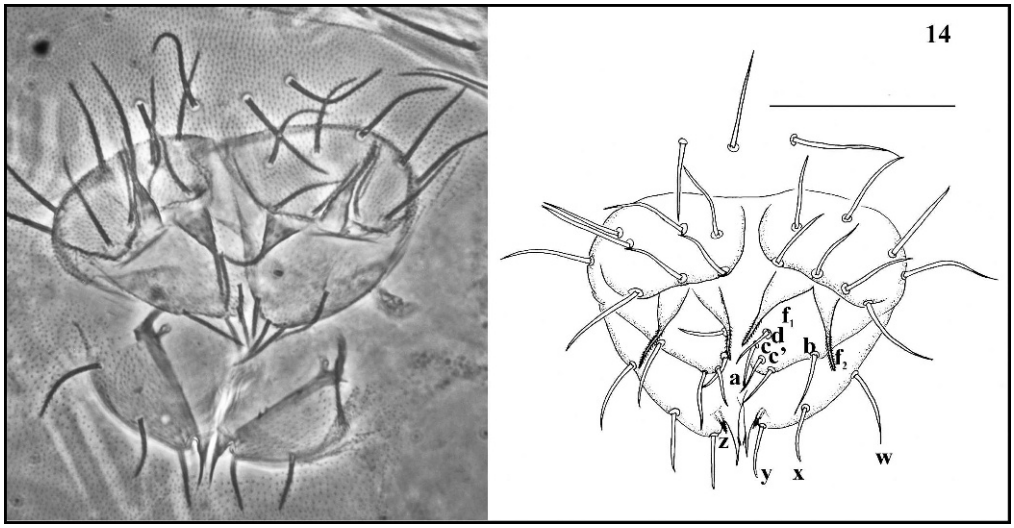


Figure 14.—*Eukoenenia potiguar* new species, holotype male (photograph) and paratype male (drawing): Male genitalia. Scale bar 60 μm.

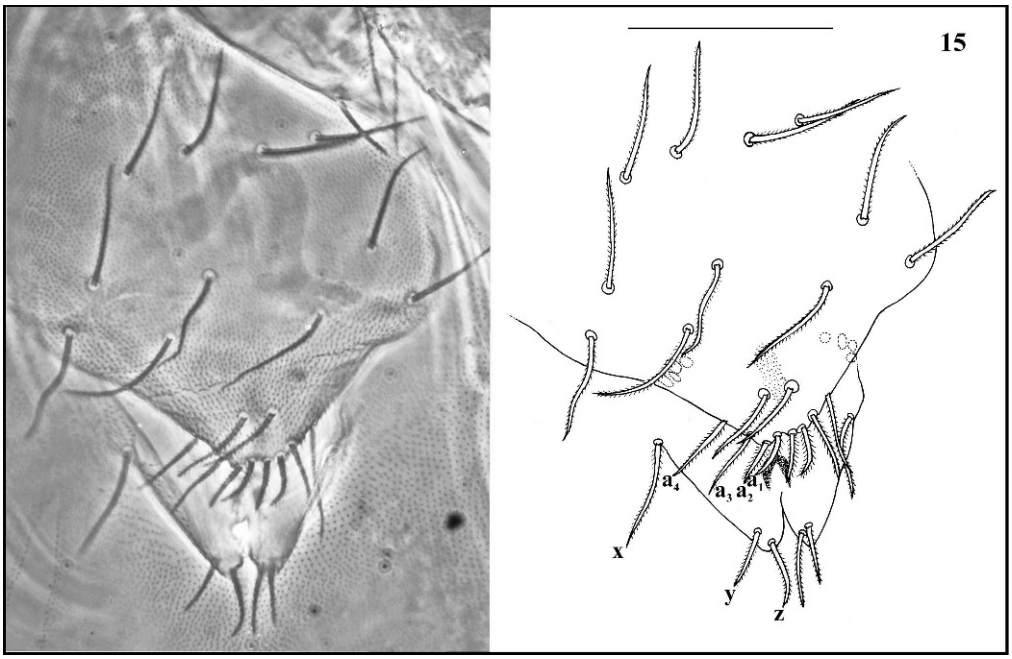


Figure 15.—*Eukoenenia potiguar* new species, female II (paratype): female genitalia. Scale bar 60 μm.

t/*r* = 1.36) and inserted in proximal third (85 μm/30 μm, *t*/*er* = 2.8). Setae *esp, grt* and *gla* in proximal half (Fig. 11).

Opisthosoma: tergite II with 3 + 1 + 3 dorsal setae, 2 pairs and a central seta (t, t_1, t_3) between both slender setae (*s*). Tergites III–VI with 4 + 4 setae, 3 pairs of setae (t', t_1, t_3) between both slender setae (*s*), central pair shortest (Fig. 12). Sternite III with 2 + 2 setae. Sternites IV–VI each with 2 + 2 (3 + 2 in the male paratype) thickened setae (a_1 and a_2) between 2 slender normal setae (s_1 and s_2) on each side (Fig. 13); a pair of glandular pores situated between a_1 setae. In one female, sternite IV only possesses one s seta and sternite VI possesses 1 more s seta (3 setae). Segments VII–XI showing some variation in the number of setae, with 13, 13–15, 8, 6–8 and 8–9 setae, respectively, in males, and with 14–15, 14–15, 8, 8 and 9–10 setae, respectively, in females.

Male genitalia: with 2 + 2 sternal setae in holotype (one asymmetrically missing in male paratype). With 40 (38 in the male II) setae distributed in 3 lobes. First lobe broad and short; with a clear separation in central region, with 9 + 9 setae in 2 rows in male holotype, proximal row with 5 + 5 setae and distal row with 4 + 4. Male II has only 8 + 8 setae in 2 rows, each with 4+4 setae. In addition, 2 pairs of fusules on distal margin; fusules short, similar in length (f_1 = 25 μm; f_2 = 27.5 μm), conical, very close to each other. Second lobe subtriangular, with a rounded apex, with 5 + 5 setae (*a, b, c, c', d*). Third lobe also in a subtriangular form, well developed, with 4 + 4 setae (w, *x, y, z*), with a large, pointed and bifurcate, apical section. In each half of third lobe, two areas can be distinguished: a glabrous inner area, and an external area that possesses micro-setae (a pubescent area) (Fig. 14).

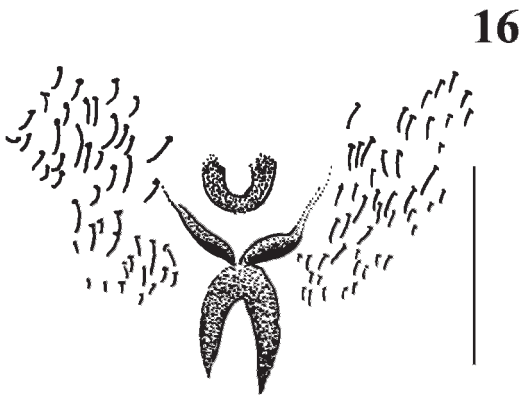
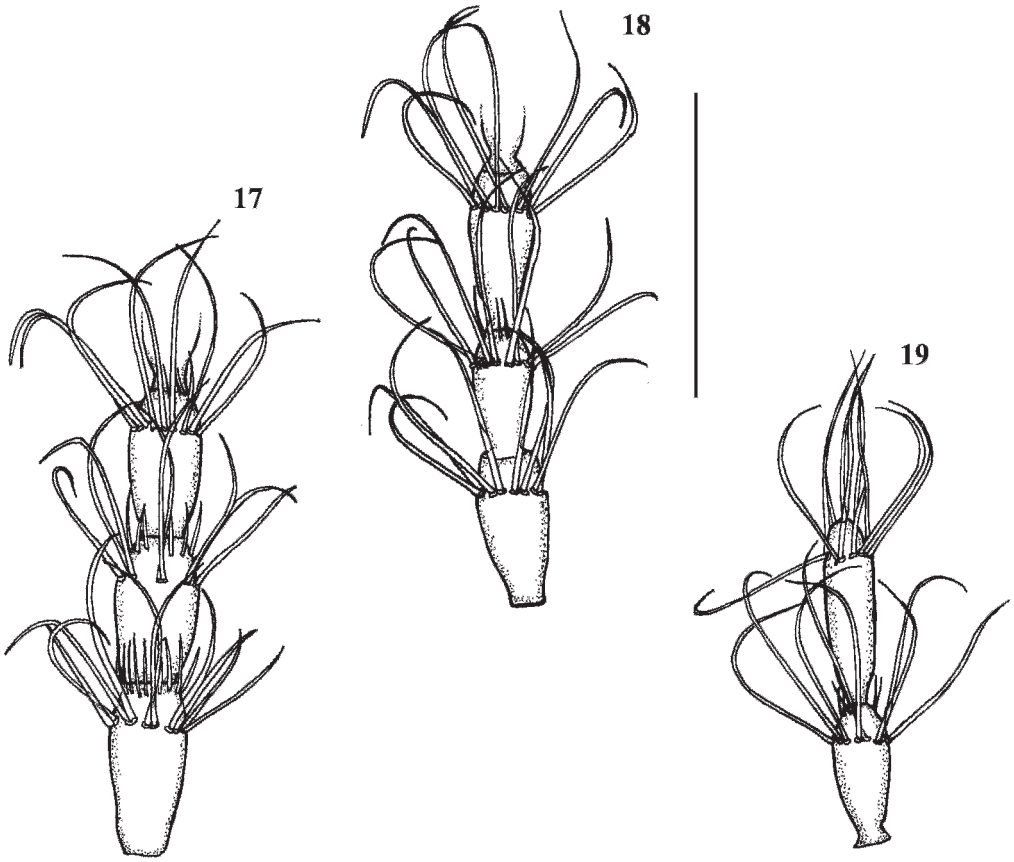


Figure 16.—*Eukoenenia potiguar* new species, female III (paratype): spermatheca detail. Scale bar 20 μm.

Female genitalia: with 2 lobes, first lobe with 10 + 11 setae (asymmetry caused by lack of regular setae): 2 + 2 sternal setae (st_1 and st_2) followed by 2 + 2, 1 + 2, 1 + 1 and 4 + 4 distal setae, of which a_1, a_2, a_3, a_4 measure 15 μm, 12.5 μm, 20 μm, and 21 μm respectively. Second lobe with 3 + 3 setae (x, y, z), measuring 31 μm, 17.5 μm, and 20 μm respectively; 4 glandular orifices (Fig. 15). Spermatheca shaped like an inverted "U," formed by 2 lobes linked at their base (Fig. 16).

Flagellum: with 8 segments in one juvenile specimen and 7 in an adult (the last flagellar segment is lacking). First segment with 9 long setae inserted in distal half. Second, third, fourth, fifth and sixth segments with 8 long setae inserted in distal half. Seventh segment with 6 long setae, respectively, inserted in distal half. Segments 1, 2, 3, 5 and 7 with an apical crown of spines.

Description of the immature stages.—*Juvenile female:* lateral organ with 2 blades. Deuto-tritosternum with 7 setae. Fingers of chelicera with 8 teeth. Chaetotaxy of propeltidium and metapeltidium complete. Tergites II–VI with 2 + 2 setae (t) between the setae s. Sternites IV–VI as in adult, except for absence of setae s_2; two gland orifices present. Segments VII–XI with 11, 12, 8, 8 and 8 setae. Primordia of genital lobes developed on segments II and III, but unfortunately it was not



Figures 17–19.—*Eukoenenia potiguar* new species, juvenile female: 17. Flagellar segments I, II and III; 18. Flagellar segments IV, V and VI; 19. Flagellar segments VII and VIII. Scale bar 60 μm.

possible to determine the number and position of the setae due to damage during slide mounting. Flagellum with 8 short segments (total length 597.5 μm). First 3 segments with 10, 8, and 9 long setae, respectively, inserted in distal half (Fig. 17). Fourth, fifth, sixth and seventh segments with 8 long setae inserted in distal half. Last segment longer than others, with 8 long setae inserted in distal half and 3 long setae inserted apically. Segments 1, 2, 3, 5 and 7 with an apical crown of spines. (Figs. 18, 19).

Larva, sex indeterminable: deuto-tritosternum with 3 setae. Chaetotaxy of propeltidium and metapeltidium complete. Coxae II–IV with 3, 3, and 0 thickened setae. Trichobothria and forked setae as in adult. Leg IV bta with setae (r and 2 esd). Tergites II–VI with 2 + 2 setae (t) between the setae s. Sternites IV–VI with setae a_1 and a_2, setae s missing. Sternite II with 2 + 2 sternal setae (st_1, st_2), sternite III with 3 + 3 (st_1, st_2, st_3).

Dimensions (μm)*:* See Table 1.

Remarks.—This species has the lateral organ formed by 2 blades, a characteristic present in only other two species of the genus *Eukoenenia*: *E. lienhardi* Condé 1989 from Sumatra (that can have 3, 2, or only 1 blade) and *E. singhi* Condé 1989 from India. *Eukoenenia lienhardi* and *E. singhi* are very similar species that share several characteristics with *E. potiguar*, such as the chaetotaxy of the opisthosomal tergites II–VI (also found in the African species *E. lawrencei* Rémy 1957), the presence of 2 + 2 setae between the two setae a in the opisthosomal sternites IV–VI, the number of setae in the basitarsus IV, and chelicerae with nine teeth. Furthermore, *E. potiguar* also shares the same number of setae in the deuto-tritosternum with *E. singhi*. However, these species can be clearly separated by the form of the genital lobes and the spermatheca of the females. It is not possible to make comparisons of the male genitalia because the two Asian species described were based only on female specimens (Condé 1989).

It is important to emphasize that the new species has quite different characteristics from those observed in the two Brazilian edaphomorphic species already described, clearly differing from *E. janetscheki* Condé 1993 (Amazonia) mainly in the chaetotaxy of the opisthosomal tergites, the number of lateral organs, the chaetotaxy, and the form of the male and female genital lobes; and from *E. roquetti* (Mello-Leitão & Arlé 1935) mainly in the number of elements that form the lateral organs and the form and chaetotaxy of the male genitalia (Mello-Leitão & Arlé 1935; Condé 1993, 1997).

The general aspect of the male genitalia of *E. potiguar* resembles that of *E. guzikae* Barranco & Harvey 2008 from Australia, in that both species have the first lobe short and wide, conical fusules, short and near each other and the second lobe with 5 pairs of setae. However, the male genitalia of *E. potiguar* differs from that of the male of *E. guzikae* mainly by having the first lobe clearly separated in two halves, the fusules without a median constriction, the second lobe with a rounded apex, and the third lobe with four pairs of setae.

Table 1.—Measurements (μm) of selected body parts of the seven type specimens of *Eukoenenia potiguar*.

Body part	Male I (Holotype)	Male II	Female I	Female II	Female III	Juvenile female	Larva
L	1085	1155	1225	1150	1220	1060	575
B	272.5	250	295	280	290	227.5	207.5
Pti	95	90	97.5	97.5	100	87.5	55
Pbta1	40	37.5	40	37.5	40	32.5	25
Pbta2	35	35	37.5	42.5	40	32.5	25
Pta1	25	30	30	50	30	25	22.5
Pta2	27.5	27.5	30	42.5	30	27.5	25
Pta3	50	45	47.5	40	52.5	42.5	40
Iti	-	110	110	110	117.5	-	65
Ibta1+2	85	87.5	85	90	87.5	82.5	55
Ibta3	37.5	37.5	40	42.5	42.5	32.5	22.5
Ibta4	40	37.5	35	45	45	32.5	25
Ita1	20	17.5	20	17.5	25	17.5	15
Ita2	30	27.5	27.5	30	32.5	25	20
Ita3	97.5	97.5	100	100	102.5	92.5	80
IVti	105	105	-	112.5	112.5	-	67.5
IVbta	85	77.5	-	102.5	92.5	-	55
IVta1	40	40	-	42.5	40	35	32.5
IVta2	50	55	-	60	52.5	45	45
A	20	20	-	20	25	-	15
Er	30	27.5	-	32.5	27.5	-	20
Grt	47.5	47.5	-	40	50	-	-
Gla	50	57.5	-	52.5	55	-	-
R	62.5	62.5	-	65	62.5	-	50
t/r	1.36	1.44	-	1.57	1.48	-	1.1
t/er	2.83	3.27	-	3.1	3.36	-	2.75
gla/grt	1.05	1.21	-	1.3	1.1	-	-
B/btaIV	3.2	2.7	-	2.7	3.1	-	3.7
btaIV/tiIV	0.8	0.85	-	0.9	0.82	-	0.8
FI	-	-	-	77.5	-	80	-
FII	-	-	-	72.5	-	65	-
FIII	-	-	-	72.5	-	80	-
FIV	-	-	-	75	-	75	-
FV	-	-	-	55	-	62.5	-
FVI	-	-	-	72.5	-	75	-
FVII	-	-	-	52.5	-	72.5	-
FVIII	-	-	-	-	-	87.5	-

Although the specimens of *E. potiguar* have only been collected in caves, the species does not show any obvious specialization linked to the cave environment because the B/btaIV and btaIV/TiIV ratio values are within the range commonly found in endogeomorphic species according to Condé (1998). It is noteworthy, however, that the conditions outside these caves, within the domain of the Caatinga (the only Brazilian semi-arid biome), are extremely restrictive. Thus, it is believed that organisms of this species are unlikely to be found in epigean or endogenous surface systems throughout the whole year. However, in the few rainy months that occur in the area, such organisms may be found closer to the surface, but this claim is certainly speculative, and this question deserves to be the target of future studies.

Order Araneae Clerck 1757
Family Pholcidae Koch 1851
Genus *Metagonia* Simon 1893

Metagonia Simon 1893:472; Gertsch 1971:82–83; Gertsch 1977:105; Gertsch 1986: 40–41; Gertsch & Peck 1992:1194–1195; Huber 1997a:342.

Anomalaia González-Sponga 1998:24.

Type species.—*Metagonia: Metagonia bifida* Simon 1893, by original designation.

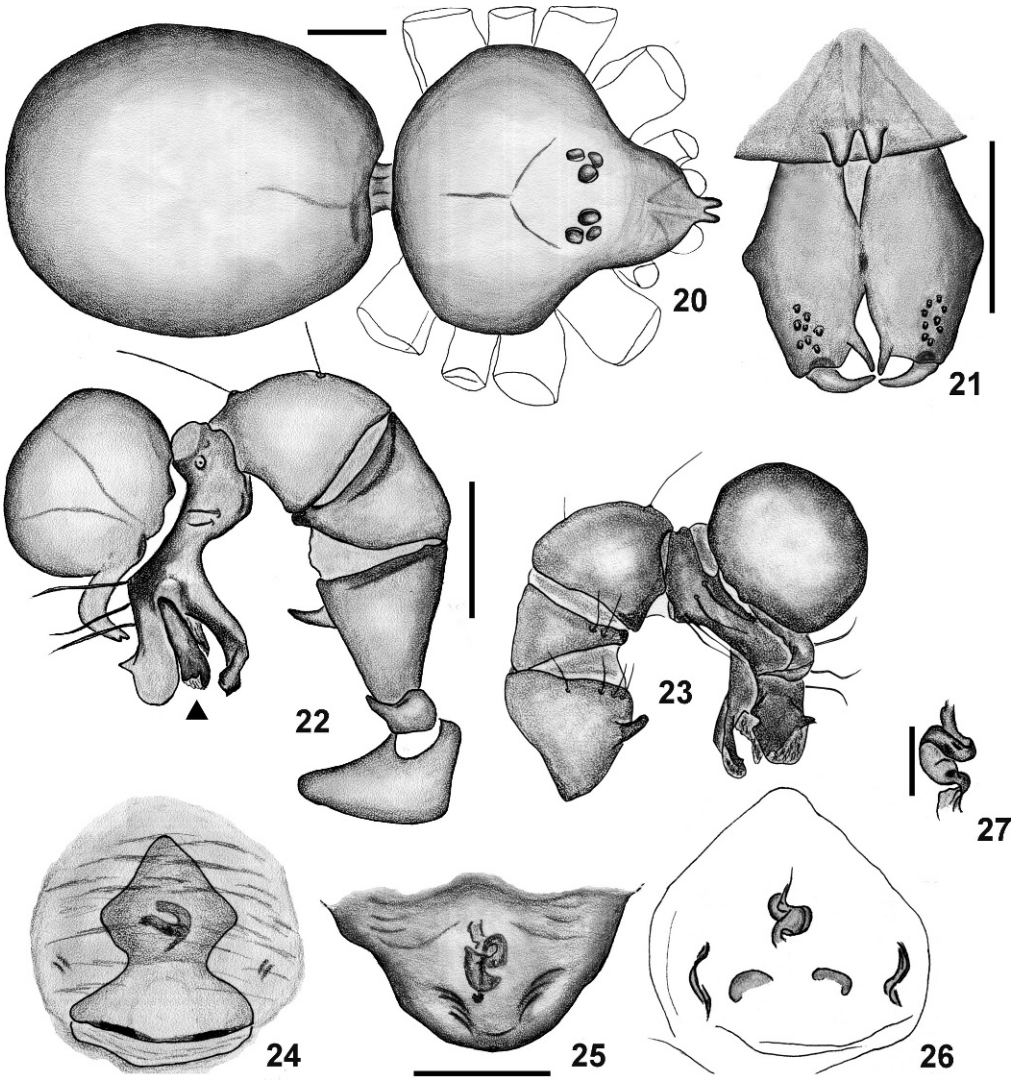
Anomalaia: Anomalaia mariguitarensis González-Sponga 1998, by original designation.

Metagonia potiguar new species
(Figs. 20–27)

Types.—Male holotype, ''Gruta do Vale'' (05°31′51″S, 37°36′58″W), Felipe Guerra, Rio Grande do Norte, Brazil, 18 July 2009, R.L. Ferreira (IBSP 145155). Paratype: 1 female, collected with holotype (IBSP 145156).

Etymology.—The new species is named *potiguar* in reference to those born in the State of Rio Grande do Norte, Brazil. The name is to be treated as a noun in apposition.

Diagnosis.—The male can be distinguished from other *Metagonia* species by the simple pair of clypeus apophyses (Figs. 20, 21), strong femoral dorsal apophysis, procursus shape with large hinged process and globular abdomen (Fig. 20). The female can be distinguished by the shape of her sclerotized ducts (Figs. 26, 27) and globular abdomen.



Figures 20–27.—*Metagonia potiguar* n. sp. (Holotype and paratype): 20. Male body, dorsal; 21. Male chelicerae, frontal; 22, 23. Male left palp; 22. Retrolateral (arrow indicates hinged process); 23. Prolateral, slightly ventral; 24–27. Female epigynum, 24. Ventral; 25. Anterior; 26. Dorsal; 27. Internal ducts. Scale bar 0.25 mm, except fig. 27: 0.10 mm.

Description.—*Male (holotype):* Total length 2.5, carapace length 0.8, width 0.8, leg I 17.4 (4.1 + 0.4 + 4.7 + 7.1 + 1.1), tibia II 3.1, tibia III missing, tibia IV 2.9; tibia I l/d 43. Body as in Fig. 20. Carapace pale yellow without stripes or spots (Fig. 20). Ocular area without color differentiation. Distance PME-ALE about 17% of PME diameter. Clypeus with a pair of small, simple, and straight apophyses (Figs. 20, 21). Sternum pale yellow. Chelicerae pale yellow, with club shaped hairs, without apophysis (Fig. 21). Palps (Figs. 22, 23) pale yellow, procursus ochre; femur with a pointed ventral apophysis; procursus split into a simple ventral projection with a twisted tip, a strong and simple dorsal projection, and a retrolateral hinged process (Fig. 22); bulb simple with a small embolus (Fig. 23). Legs yellowish, without spines, without modified hairs, retrolateral trichobothrium of tibia I at 12%, tarsus I with approximately 14 pseudosegments. Abdomen globular (Fig. 20), completely pale yellow, genital plate rectangular, light brown.

Female (paratype): Total length 2.2, carapace length 0.8, width 0.8, leg I 14.9 (3.7 + 0.4 + 4.0 + 5.7 + 1.1), tibia II 2.5, tibia III 1.8, tibia IV -. In general, very similar to male, without clypeus modification. Epigynum brown, approximately triangular with median lateral indentations (Fig. 24) and a central elevation bordered by two lateral excavations (Fig. 25). Internal genitalia with a pair of barely visible small pore fields (Fig. 26) and a system of asymmetrical, sclerotized, central ducts (Fig. 27).

Distribution.—This species is currently known only from the type locality.

Remarks.—*Metagonia potiguar* does not seem to fit convincingly within any of the five operational species-groups proposed by Huber (2000). However, it shows similarities to ''group 1'': sclerotized epigynum, ventral apophysis on the palpal femur, and bifid clypeus apophysis. The main difference lies in the globular abdomen, which is bifid in the majority of the ''group 1'' species. This trait could be due to habitat pressures, as stated in Huber *et al.* (2005). *Metagonia potiguar* represents the first record of *Metagonia* in Brazilian caves.

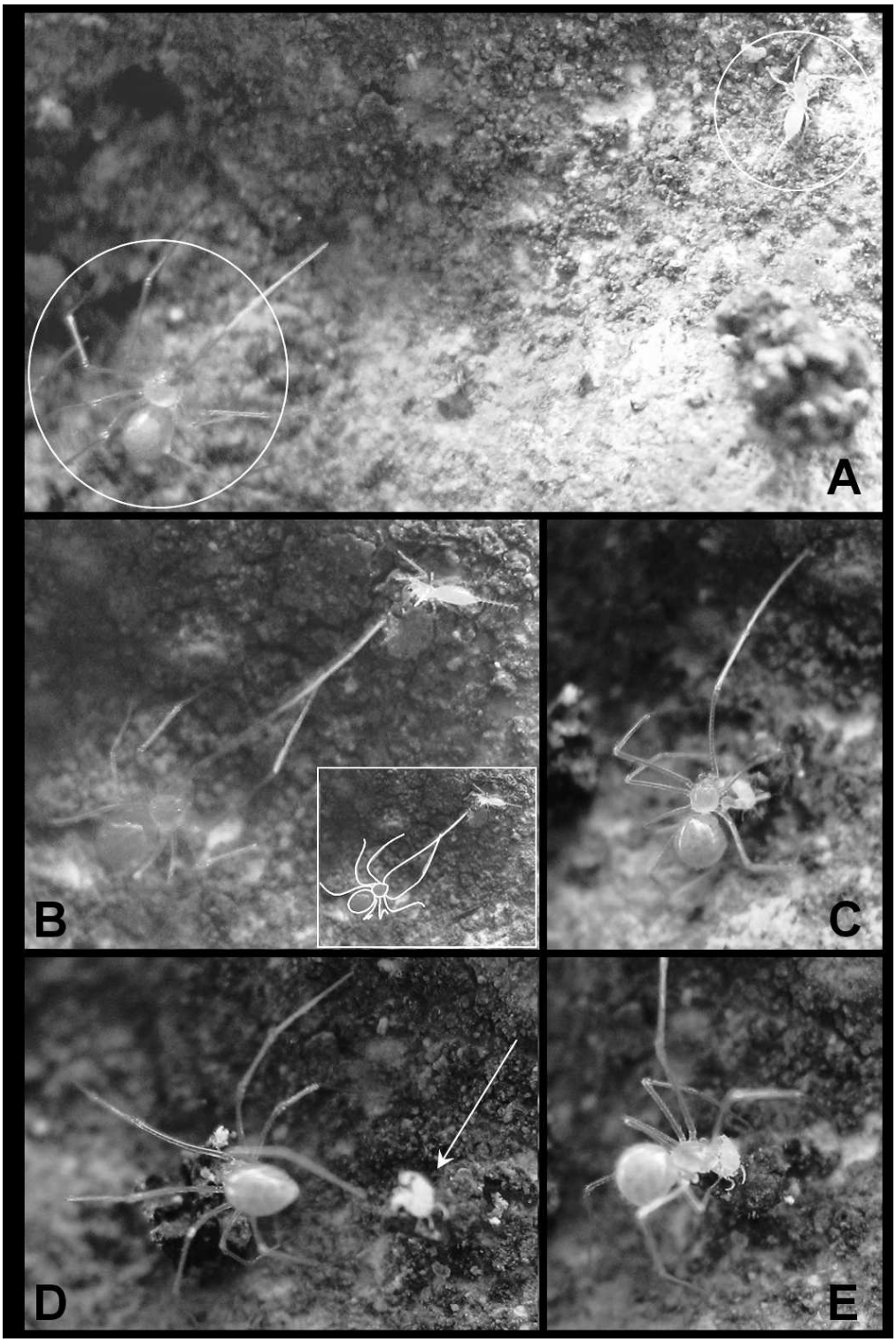


Figure 28.—Interaction repertoire: A. Individuals of *Metagonia potiguar* and *Eukoenenia potiguar* found when rock was overturned; B. *Metagonia* reaching *Eukoenenia* and touching it with a leg (in detail, white line indicating the *Metagonia*); C. *Metagonia* wrapping prey with some web filaments, holding it for some seconds, while prey struggles; D. Prey briefly abandoned; E. *Metagonia* returns and begins to feed.

DISCUSSION

Ecological interactions.—Individuals of both species, *Metagonia potiguar* and *Eukoenenia potiguar*, were under a rock fragment on the floor of the cave, in its more interior portion. The locality was aphotic. The rock, supported on earthy sediment, was located near a speleothem under a formation. The dripping made the surrounding environs more humid, including the sediment on which the rock rested. As soon as we overturned the rock, we observed the individuals. We settled the rock again on the floor, leaving the organisms visible.

When the rock was overturned, *Metagonia* remained immobile while *Eukoenenia* began moving, continually changing direction, always groping with the first pair of legs, maintaining the flagellum erect and perpendicular to the substrate, making lateral movements. *Eukoenenia* progressively began to approach *Metagonia*, until when about a centimeter away, *Metagonia* noticed its presence. Apparently *Eukoenenia* bumped into a thread of *Metagonia* web because it immediately changed position and began moving in the opposite direction from *Metagonia*, maintaining the ''random'' change of direction behavior (Fig. 28A). *Metagonia*, in turn, began moving towards *Eukoenenia*, feeling with the first pair of legs. When it finally reached *Eukoenenia* and touched it with one of its legs (Fig. 28B), it immediately jumped on *Eukoenenia,* grasping it with its chelicerae (Fig. 28C). *Metagonia* quickly wrapped the prey with some web filaments, maintaining its hold for several seconds, while the prey struggled. After immobilizing the prey, it briefly abandoned *Eukoenenia* (Fig. 28D), but after about 10 seconds, returned and began to feed (Fig. 28E). At that moment, the process was interrupted by the collection of both individuals.

Although a certain amount of attention has been drawn to the order Palpigradi in recent years (e.g., Barranco & Harvey 2008; Král et al. 2008; Christian 2009; Pepato et al. 2010), practically nothing is known of the ecological relationships exhibited by these organisms. Information regarding feeding habits, prey, predators, and more has been, until now, unknown, which makes the group even more enigmatic. The few references about possible interactions registered in the literature are almost totally speculative. This work represents the first description of an interaction involving a palpigrade in its natural habitat and the first record of *Metagonia* in Brazilian caves.

Little is known about the biology of species of *Metagonia* and of the spectrum of prey usually consumed by these spiders (Huber & Schüte 2009). A female of *M. osa* was observed feeding on an ant, and a male of the same species feeding on a cobweb spider (Theridiidae) (Huber & Schüte 2009). This study reports some new details about habitat, predation habits, one of the food items (Palpigradi) and some ethological information of *M. potiguar*. Furthermore, our study represents the documentation of a new cave-dwelling inhabitant of the genus, increasing the number of species of *Metagonia* associated with underground environments.

The order Palpigradi is one of the least known orders within Arachnida, and the large majority of publications associated with it focus on the taxonomy of the group. The small size of these arachnids hinders work on their biology and behavior, having been restricted so far to the work of Kováč et al. (2002), who was able to keep individuals of *E. spelaea* (Peyerimhoff 1902) over the course of four weeks in laboratory conditions. In spite of offering different types of prey to live specimens, Kováč et al. (2002) were unable to observe any individual capturing and feeding on them. According to Condé (1996), P. Weygoldt was able to observe laboratory-maintained palpigrades capturing small Collembola with the aid of their chelicerae. The interaction of these arachnids with other invertebrate species still remains unknown, and no ecological relationship in nature has been published.

Finally, this interaction is a clear indication that Palpigradi can be preyed upon by small spiders. The typical preference for interstitial habitats observed in many species of this group is maintained even in deep parts of caves. If this preference for such habitats were based only on the search for humid and shaded areas, one would not expect to find palpigrades sheltered under rocks in deep areas of caves, which are always aphotic and extremely humid. Therefore, the observed interaction raises the question whether the preference for interstitial microhabitats under rocks in caves may eventually be an answer to predation pressure.

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LITERATURE CITED

Barranco, P. & J.G. Mayoral. 2007. A new species of *Eukoenenia* (Palpigradi: Eukoeneniidae) from Morocco. Journal of Arachnology 35:318–324.

Barranco, P. & M.S. Harvey. 2008. The first indigenous palpigrade from Australia: a new species of *Eukoenenia* (Palpigradi: Eukoeneniidae). Invertebrate Systematics 22:227–233.

Christian, E. 2009. A new soil-dwelling palpigrade species from northern Italy (Palpigradi: Eukoeneniidae). Zootaxa 2136:59–68.

Condé, B. 1989. Palpigrades (Arachnida) endóges del'India et Sumatra. Revue Suisse de Zoologie 96:411–424.

Condé, B. 1993. Description du male de deux speces de Palpigrades. Revue Suisse de Zoologie 100:279–287.

Condé, B. 1996. Les Palpigrades, 1885–1995: acquisitions et lacunes. Revue Suisse de Zoologie, hors-série 1:87–106.

Condé, B. 1997. Description complémentaire du palpigrade brésilien *Eukoenenia janetscheki* Condé, 1993. Amazoniana 14:213–220.

Condé, B. 1998. Palpigradida. Pp. 913–920. *In* Encyclopaedia Biospeologica. Volume II. (C. Juberthie & V. Decu, eds.). Société Internationale de Biospeologie, Moulis (C.N.R.S.), France and Bucarest (Academie Rumanie), Romania.

Gertsch, W.J. 1986. The spider genus Metagonia (Araneae: Pholcidae) in North America, Central America, and the West Indies. Texas Memorial Museum, Speleological Monographs 1:39–62.

Harvey, M.S. 2003. Catalogue of the Smaller Arachnid Orders of the World: Amblypygi, Uropygi, Schizomida, Palpigradi, Ricinulei and Solifugae. CSIRO Publishing, Collingwood, Victoria, Australia.

Huber, B.A. 1997. On American '*Micromerys*' and *Metagonia* (Araneae, Pholcidae), with notes on natural history and genital mechanics. Zoologica Scripta 25:341–363.

Huber, B.A. 1998. Report of some pholcid spiders collected in Guatemala and Honduras (Araneae, Pholcidae). Revue Suisse de Zoologie 105:49–80.

Huber, B.A. 2000. New World pholcid spiders (Araneae: Pholcidae): a revision at generic level. Bulletin of the American Museum of Natural History 254:1–348.

Huber, B.A. 2004. Evidence for functional segregation in the directionally asymmetric male genitalia of the spider *Metagonia mariguitarensis* (Gonzalez-Sponga) (Pholcidae: Araneae). Journal of Zoology, London 262:317–326.

Huber, B.A., C.A. Rheims & A.D. Brescovit. 2005. Two new species of litter-dwelling *Metagonia* spiders (Araneae, Pholcidae) document both rapid and slow genital evolution. Acta Zoologica 86:33–40.

Huber, B.A. & A. Schütte. 2009. Preliminary notes on leaf-dwelling *Metagonia* spiders (Araneae: Pholcidae) in the Esquinas Rainforest near La Gamba, Costa Rica: leaf preference, mimesis, and web structure. Contributions to Natural History (Bern) 12:681–697.

Kováč, L., A. Mock, P. L'uptáčik & J.G. Palacios-Vargas. 2002. Distribution of *Eukoenenia spelea* (Peyerimhoff, 1902) (Arachnida, Palpigradida) in the Western Carpathians with remarks on its biology and behavior. Pp. 93–99. *In* Studies on Soil Fauna in Central Europe. (K. Tajovský, V. Balík & V. Pižl, eds.). Institute of Soil Biology, Academy of Science of the Czech Republic, Ĉeské Budějovice, Czech Republic.

Král, J., L. Kováč, F. Šťáhlavský, L. Lonský & P. L'uptáčik. 2008. The first karyotype study in palpigrades, a primitive order of arachnids (Arachnida: Palpigradi). Genetica 134:79–87.

Krantz, G.W. & D.E. Walter. 2009. A Manual of Acarology. Third edition. Texas Tech University Press, Lubbock, Texas.

Mayoral, J.G. & P. Barranco. 2002. Palpígrados: Grandes desconocidos (Arachnida, Microthelyphonida). Revista Ibérica de Aracnologia 5:103–109.

Mello-Leitão, C. & R. Arlé. 1935. Considerações da ordem Palpigradi com a descrição de uma nova espécie. Anais da Academia Brasileira de Cie˜ncias 7:339–343.

Pepato, A.R., C.E.F. Rocha & J.A. Dunlop. 2010. Phylogenetic position of the acariform mites: sensitivity to homology assessment under total evidence. BMC Evolutionary Biology 10:1–23.

Pérez González, A. & B.A. Huber. 1999. *Metagonia debrasi* n. sp., the first species of the genus *Metagonia* Simon in Cuba (Pholcidae, Araneae). Revue Arachnologique 13:69–72.

Platnick, N.I. 2010. The World Spider Catalog, Version 10.5. American Museum of Natural History, New York. Online at http://research.amnh.org/entomology/spiders/catalog/index.html.

Souza, M.F.V.R. & R.L. Ferreira. 2010. *Eukoenenia* (Palpigradi: Eukoeneniidae) in Brazilian caves with the first troglobiotic palpigrade from South America. Journal of Arachnology 38: 415–424.

Souza, M.F.V.R. & R.L. Ferreira. 2011a. A new species of *Eukoenenia* (Palpigradi: Eukoeneniidae) from Brazilian iron caves. Zootaxa. 2886:31–38.

Souza, M.F.V.R. & R.L. Ferreira. 2011b. A new troglobitic *Eukoenenia* (Palpigradi: Eukoeneniidae) from Brazil. Journal of Arachnology 39:185–188.

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