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A new species of *Neotrogla* from Brazilian caves (Psocodea: 'Psocoptera': Prionoglarididae)

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A new species of *Neotrogla* from Brazilian caves (Psocodea: 'Psocoptera': Prionoglarididae). - The recently described Brazilian genus *Neotrogla* Lienhard previously consisted of three cave-dwelling species, one from each state, Minas Gerais, Tocantins and Bahia. A fourth species, *N. curvata* n. spec., is here described from several caves in Bahia State. It is characterized by the structure of the female genitalia, in particular by the shape of the gynosome, a penis-like, probably intromittent organ associated with the spermathecal duct and present in all females of this genus. Some observations on the habitat and the biology of the new species are also presented.

Keywords: Brazil - cave fauna - female genitalia - gynosome - antennal flagellum.

INTRODUCTION

The genus *Neotrogla* Lienhard, 2010 in Lienhard *et al*. (2010) was described for three cave-dwelling species from Brazil belonging to the prionoglaridid subfamily Speleketorinae, tribe Sensitibillini. A striking autapomorphy of this genus is the presence, in the female, of a penis-like organ enclosing the distal part of the spermathecal duct. The opening of the latter is situated on the tip of this probably intromittent organ, which was termed gynosome by Lienhard *et al*. (2010). Micromorphological differences of the gynosome are the best diagnostical characters for the females of the three known species, in addition to some other features of female genitalia. The males of these species are difficult to distinguish; their genitalia are simplified and very similar to each other. The species *N. brasiliensis* Lienhard, 2010 in Lienhard *et al*. (2010) and *N. aurora* Lienhard, 2010 in Lienhard *et al*. (2010) are more closely related to each other than to *N. truncata* Lienhard, 2010 in Lienhard *et al.* (2010). The new species of *Neotrogla*, described here, belongs to the group containing the two former species but can be easily distinguished from both of them by some characters of the female subgenital plate and by the characteristically curved posterior part of the gynosome. The recent field work of the junior author enables us to present also some data on the biology of the new species.

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MATERIAL AND METHODS

The collection of the type series was performed by hand collecting in four different caves located in the municipalities of Santa Maria da Vitória and São Félix do Coribe (Bahia State, Brazil). These caves were sampled from 9 to 16 May (at the end of the wet season) and from 17 to 22 July (dry season), both in 2011. Temperature and humidity were measured inside each cave with a thermohygrometer data logger located near the areas where the psocids were found. The data loggers measured these values during 10 weeks. In October 2012 some additional material was collected in several caves of the above mentioned municipalities.

Dissection and slide-mounting followed the methods described by Lienhard (1998). The material examined is deposited in the following institutions: Universidade Federal de Lavras, Departamento de Biologia (Coleção de Invertebrados Subterrâneos), Lavras, Brazil (ISLA); Muséum d'histoire naturelle, Geneva, Switzerland (MHNG); Systematic Entomology, Hokkaido University, Sapporo, Japan (SEHU).

The following abbreviations are used in the descriptions: Ant = antenna (length); BL = body length (in alcohol); F = hindfemur (length); f1, f2, etc. = antennal flagellomeres (length); FW = forewing (length); HW = hindwing (length); IO/D = shortest distance between compound eyes divided by longitudinal diameter of compound eye in dorsal view of head; T = hindtibia (length); t1, t2, t3 = tarsomeres of hindtarsus (length, measured from condyle to condyle). Abbreviations of wing veins and cells are used according to Yoshizawa (2005).

TAXONOMY

Neotrogla curvata n. spec. Figs 1-4

HOLOTYPE: ISLA; ♀; Brazil (Bahia), São Félix do Coribe, cave PEA 380 (BA 042); 21.vii.2011; leg. Simone Soares Salgado.

PARATYPES: ISLA and MHNG; 4♂ (one of them allotype) and 5♀; same data as for holotype. – SEHU; 2♀ (one of them teneral); Brazil (Bahia), São Félix do Coribe, cave PEA 381 (BA 043); 18.vii.2011; leg. Simone Soares Salgado. – ISLA and MHNG; 1♂, 2♀, 2 nymphs (both with damaged abdomen); Brazil (Bahia), São Félix do Coribe, cave PEA 383 (BA 045); 18.vii.2011; leg. Simone Soares Salgado. – MHNG and SEHU; 1♂, 2♀ and 1 nymph (the latter lacking abdomen); Brazil (Bahia), Santa Maria da Vitória, cave PEA 343 (BA 003); 15.v.2011; leg. Simone Soares Salgado.

OTHER MATERIAL: Several additional females, males and nymphs (ISLA and SEHU) were collected in the above mentioned caves or in three other caves situated in these municipalities (caves PEA 341, 342, 378; see Distribution and habitat, below), most of them in October 2012. Some of them were used for rearing, behavioural observations or micromorphological studies of pairs *in copula*.

DIAGNOSIS: Sclerotized area of anterior part of female subgenital plate with arms forming an almost straight transverse band, in middle not separated from posterior part of subgenital plate. Basal half of median lobe of posterior part of subgenital plate with a pair of small, hemispherical, hairy lobes and medially with a bifid, dark brown sclerotization; apical half of this lobe bare, ovally rounded. Female subgenital plate different in the three other species, in particular sclerotized area of anterior part broadly V-shaped (with opening of the V directed backwards) and

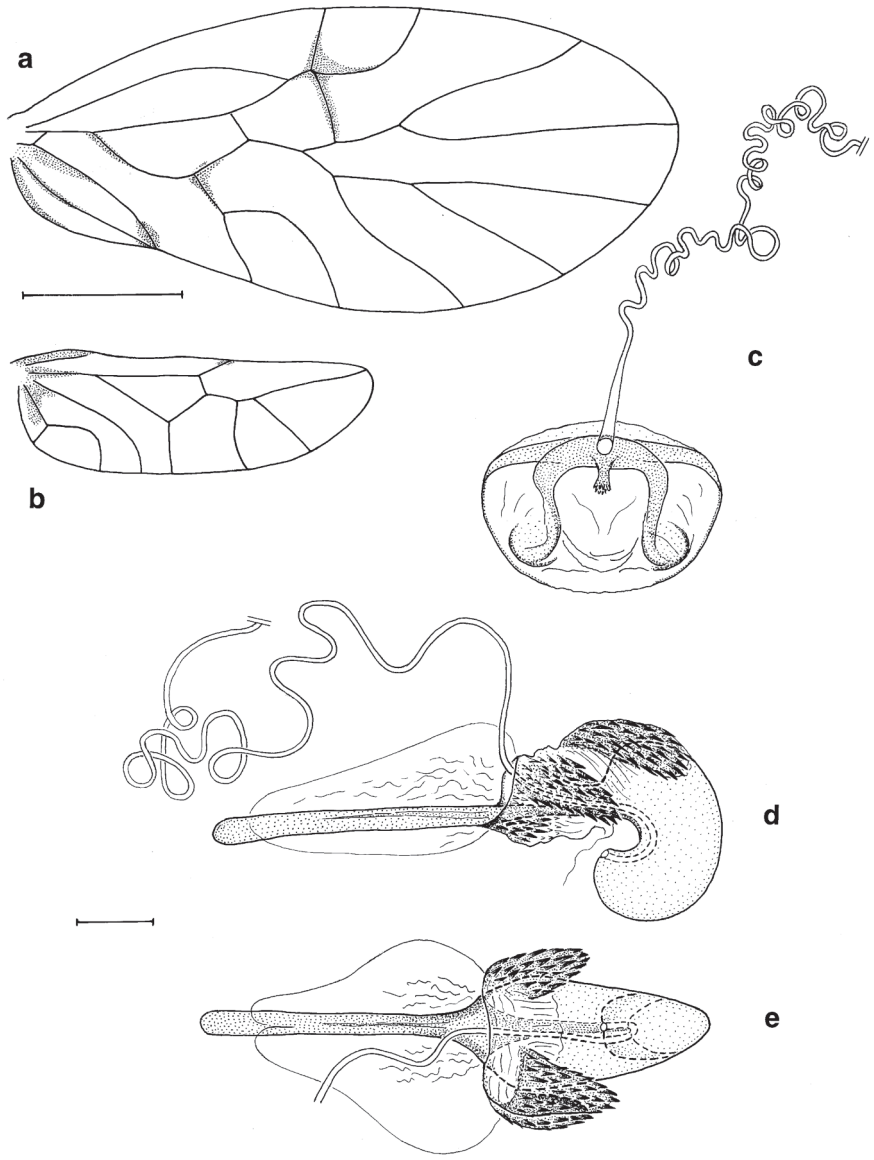

FIG. 1

Neotrogla curvata n. spec., female. (a) Forewing. (b) Hindwing. (c) Proximal part of spermathecal duct with wrinkled plate of wall of spermathecal sac (for complete length of spermathecal duct combine this figure with the next one). (d) Distal part of spermathecal duct and gynosome, lateral view; posterior part at right side of figure. (e) Gynosome, dorsal view. Scale bars: 1.0 mm for a and b; 0.1 mm for c-e.

medially separated from posterior part by an unpigmented area (see Lienhard *et al*., 2010: figs 1c, 5, 8d). In *N. curvata* n. spec. abdominal sternite anterior to subgenital plate medially with a rugose papillate area, this region smooth in the other species. Posterior sac of gynosome strongly ventrad-bent, having roughly the shape of a short and strongly bent sausage, bearing the opening of the spermathecal duct on the inner side of its broadly rounded distal end. Blister-like zone of gynosome with three strongly denticulate posteriad-directed lobes. Posterior part of gynosome (i. e. posterior sac and blister-like zone) shorter than its sclerotized anterior rod. In the other known species posterior part of gynosome longer than its anterior rod and posterior sac almost straight, only very slighty ventrad-bent in lateral view (see Lienhard *et al*., 2010: figs 2d, 2f, 6, 8c). The only characters of the male which could possibly be diagnostic are the slightly bilobed posterior thickening of the aedeagal arch and the relatively short but wide papillate channel of the endophallus (see Discussion, below).

DESCRIPTION: Habitus of adults as in Fig. 4a. Colouration and general morphology of males, females and nymphs as described for the type species *Neotrogla brasiliensis* (see Lienhard *et al*., 2010). In forewing (Fig. 1a) fused portion of Rs and M longer than basal portion of Rs, unpigmented area of pterostigma very slightly opaque. In hindwing (Fig. 1b) M2 slightly concave (bent towards wing base) and R1 distally with a tiny patch of dark pigmentation. Nymphs dorsally with short glandular hairs bearing a minute globular thickening at their tip, similar in shape to the glandular hairs known in some troctomorph psocids (see Lienhard, 1998: fig. 45g). Such hairs also present in nymphs of *N. brasiliensis*, though not mentioned in the original description.

Female terminalia: Epiproct and paraproct as described for *N. brasiliensis* by Lienhard *et al*. (2010). Subgenital plate, ovipositor valvulae and ventrolateral parts of clunium as shown in Fig. 2. Sclerotized area of anterior part of female subgenital plate with arms forming an almost straight transverse band, in middle not separated by an unpigmented area from posterior part of subgenital plate, on anterior margin medially with a short sclerotized longitudinal rod. Abdominal sternite anterior to subgenital plate medially with a rugose area bearing numerous hyaline papillae of irregular shape, mostly more or less lobate (see detail of Fig. 2). Posterior part of subgenital plate with an ovally rounded median lobe, its apical half bare, its basal half on each side with a small, hemispherical, hairy lobe (clearly visible as a proeminence in non-dissected terminalia, in lateral view), this zone medially with a characteristically bifid, dark brown sclerotization (well visible in non-dissected terminalia, in ventral view). Just dorsally of posterior lobe of subgenital plate, and basally covered by the latter, a pair of longitudinal membranous bulges. The foliaceous external gonapophysis with 13-17 short spine-like setae on ventral surface of apical half and a claw-like apical spine (dense dorsal pilosity not shown in Fig. 2, only some internal dorsomarginal setae figured). Gynosome as shown in Fig. 1d, e (length 670-680 µm, holotype and one paratype examined). Its slightly sclerotized posterior sac strongly ventrad-bent, having roughly the shape of a short and strongly bent sausage, bearing the opening of the spermathecal duct (spermapore) on the inner side of its broadly rounded distal end. In resting position tip of gynosome situated dorsally of posterior lobe of subgenital plate (analogous to the situation shown for *N. brasiliensis* in Lienhard *et al*., 2010: fig. 2d).

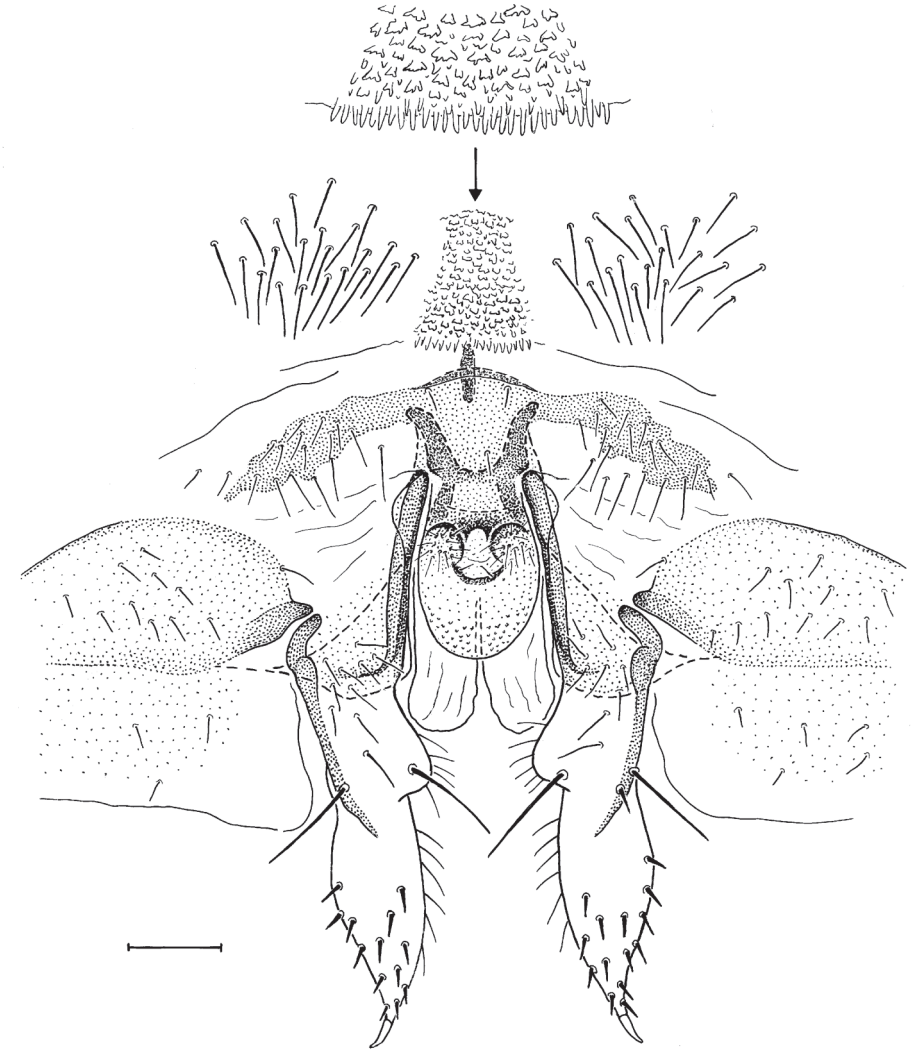

FIG. 2

Neotrogla curvata n. spec., female. Subgenital plate (with detail of posterior part of papillate area), ovipositor valvulae and ventrolateral parts of clunium, ventral view. Scale bar 0.1 mm.

Blister-like zone of gynosome with three posteriad-directed denticulate lobes (i. e. one asymmetrical dorsal lobe directed to the left and a pair of slightly ventrad-directed lateral lobes) and a pair of denticulate ventro-lateral areas (left area visible in Fig. 1d). Posterior part of gynosome (i. e. posterior sac and blister-like zone) shorter than its sclerotized anterior rod. Spermathecal duct long and irregularly curled (complete

length shown in Fig. 1c, d combined). Wall of spermathecal sac thin, bearing numerous small pores and a plate with slightly sclerotized wrinkles at origin of spermathecal duct (Fig. 1c). Spermatophores not observed.

Male terminalia: Epiproct and paraproct as described for *N. brasiliensis* (see Lienhard *et al*., 2010), hypandrium with 8th sternite distinctly sclerotized, its hind margin slightly bilobate. Phallosome as in Fig. 3; aedeagal arch apically with a slightly bilobed and weakly rugose thickening; on each side of the aedeagal arch a folded membranous bulge situated dorsally of the postero-lateral hypandrial margin. Endophallus on each side with medially bulging membranous structures; in its anterior half, near the distal end of the ejaculatory duct (Fig. 3: de, ductus ejaculatorius) a relatively wide and short longitudinal membranous channel bearing small sclerotized papillae.

MEASUREMENTS: *Female holotype*: BL = 3.3 mm; FW = 4.2 mm; HW = 2.2 mm; F = 1080 µm; T = 1620 µm; t1= 707 µm; t2 = 150 µm; t3 = 180 µm; Ant (damaged); IO/D = 2.0. – *Male allotype*: BL = 3.5 mm; FW = 4.4 mm; HW = 2.2 mm; F = 1130 µm; T = 1720 µm; t1= 740 µm; t2 = 146 µm; t3 = 183 µm; Ant (damaged; see Discussion, below); IO/D = 2.2.

ETYMOLOGY: The specific epithet (*curvatus*, *-a*, *-um*) refers to the curved posterior part of the gynosome.

DISTRIBUTION AND HABITAT: At present this species is known from seven caves situated in the municipalities of Santa Maria da Vitória (caves PEA 341, 342, 343) and São Félix do Coribe (caves PEA 378, 380, 381, 383) in Bahia State, Brazil. The limestones of the area are part of the Bambuí speleological province (upper Proterozoic). The caves of both municipalities are predominantly small, their length rarely exceeding 250 m. In Santa Maria da Vitória the caves are very small (with a length of 35 m cave PEA 341 is the biggest in this area). In São Félix do Coribe the caves are bigger and more complex, some of them being labyrinthic (cave PEA 383 has almost 300 m). Three other caves in this area were also sampled, but no *Neotrogla* specimens were found in them. The average temperature in each cave was different during the sampling period (May to July 2011); the highest values were observed in cave PEA 380 (26.27±0.39ºC), the lowest values in cave PEA 378 (21.14±0.78ºC). The average moisture in each cave was also different, with the highest values measured in cave PEA 383 (79.33±6.71% RH) and the lowest in cave PEA 342 (54.80±7.55% RH). Although the caves in which the specimens were observed are slightly different, all of them represent dry oligotrophic systems. The main resource in all caves is bat guano, especially from the insectivorous species *Carollia perspicillata* (Linnaeus) and *Peropteryx macrotis* (Wagner) and from the carnivorous species *Chrotopterus auritus* (Peters), but some piles of faeces of the rodent *Kerodon rupestris* (Wied-Neuwied), popularly known as mocó, may also be found in some areas of the caves. The main vegetation type outside the caves is pasture, with some fragmented areas of Caatinga formation. The environment outside the caves is dry and the degree of human impact is quite variable. Furthermore, some caves in which specimens were found are influenced by human activities, as cave PEA 380 (type locality), the entrance of which (Fig. 4e) is used by local residents as a shelter while fishing in the river in front of the cave (Fig. 4d).

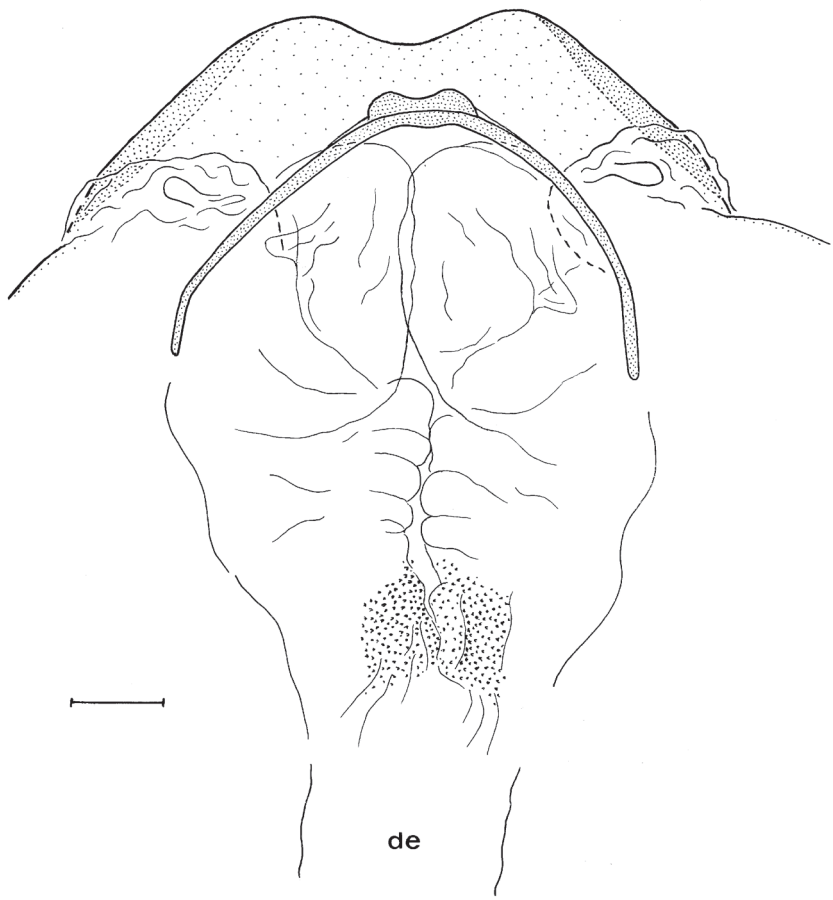

FIG. 3
Neotrogla curvata n. spec., male. Posterior margin of hypandrium (pilosity not shown), phallosome and distal end of ductus ejaculatorius (de), dorsal view. Scale bar 0.1 mm.

BIOLOGY: *N. curvata* was observed on different substrata inside the caves, mostly in deeper zones, rarely also near the entrance (e. g. in cave PEA 380, the type locality). This distribution pattern is quite different from that of the other three *Neotrogla* species, which clearly prefer areas close to cave entrance (personal observations by RLF). Adults of *N. curvata* usually were observed on the cave walls, mostly sheltered in small crevices. In contrast to this, all nymphs were observed on the cave floor, walking on the dry soil or on rocky debris. The nymphs were particularly abundant near organic resources as bat guano (Fig. 4b). Due to the presence of glandular hairs on their dorsal side, especially on abdominal tergites, nymphs were more or less well camouflaged by adherent dust particles. The presence of glandular

hairs could also be confirmed in nymphs of *N. brasiliensis* and *N. aurora*. Nymphal glandular hairs have never before been observed in the suborder Trogiomorpha (see Lienhard, 1998: 25). Adults and nymphs are probably preyed upon by spiders of the genera *Loxosceles* Heineken & Lowe (Sicariidae) and *Theridion* Walkenaer (Theridiidae), which are frequently encountered in the same caves. A freshly moulted teneral adult was observed being eaten by *Theridion* sp. in cave PEA 380 in October 2012 (Fig. 4c).

DISCUSSION

Females of *Neotrogla curvata* n. spec. are easy to distinguish from those of the three other known species of the genus (see Diagnosis, above). However, the males of all *Neotrogla* species are very similar to each other. The posterior margin of the apical thickening of the aedeagal arch is bilobed in the new species, simply rounded or almost straight in the three other species. Compared to the three previously known species, the endophallic papillate channel is shorter and wider in the new species and its papillae are smaller; the longitudinal distance between the posterior end of the papillate zone and the anterior end of the aedeagal arch is longer in the new species than in the other ones. If the hypothesis that the posterior sac of the gynosome penetrates through the papillate endophallic channel during copulation (see Lienhard *et al.*, 2010: fig. 10c) is correct, then the different constitution of the channel in *N. curvata* may be related to the relatively short but strongly curved posterior gynosomal sac of this species. However, the intraspecific variability of these male characters is not sufficiently known to affirm diagnostic significance of the above-mentioned differences.

Lienhard *et al*. (2010) suggested that the species *N. brasiliensis* and *N. aurora* are more closely related to each other than to *N. truncata*, forming a species group characterized by the presence of three denticulate lobes in the blister-like zone basally of the posterior sac of the gynosome. This synapomorphy is also present in the new species, while the blister-like zone is not lobate in *N. truncata*.

Antennae of Prionoglarididae are very long and slender. Therefore they are mostly broken in preserved material. Most antennal flagella have an abruptly broken end, only rarely a flagellum with an apically rounded tip can be observed. Lienhard (2007) and Lienhard *et al.* (2010) mentioned the surprisingly low and variable number of antennal segments in Speleketorinae and suggested that this character could constitute an autapomorphy of this subfamily (or even of the family Prionoglarididae). Counts of antennal segments were made on antennae with a seemingly intact apical flagellomere characterized by the tapering and distally rounded tip bearing a small apical sensillum. The maximal number of antennal segments (i. e. scape, pedicel and flagellomeres) observed in the subfamily Prionoglaridinae is 10 (Lienhard, 2004), in the subfamily Speleketorinae 15 (Mockford, 1984). Seeger (1975) showed for the psocid suborders Trogiomorpha and Troctomorpha that antennae broken during nymphal life can regenerate by length increase of the remaining flagellomeres. The examination of the very long and apically tapering 4-segmented antenna on one side of the allotype of *N. curvata* (total length 5.1 mm; f1 = 2.5 mm; f2 = 2.4 mm) showed that the tip of f2 of the obviously regenerated flagellum is very similar to the tip of an intact psocid antenna and clearly different from the abruptly broken end of the 5-segmented antenna

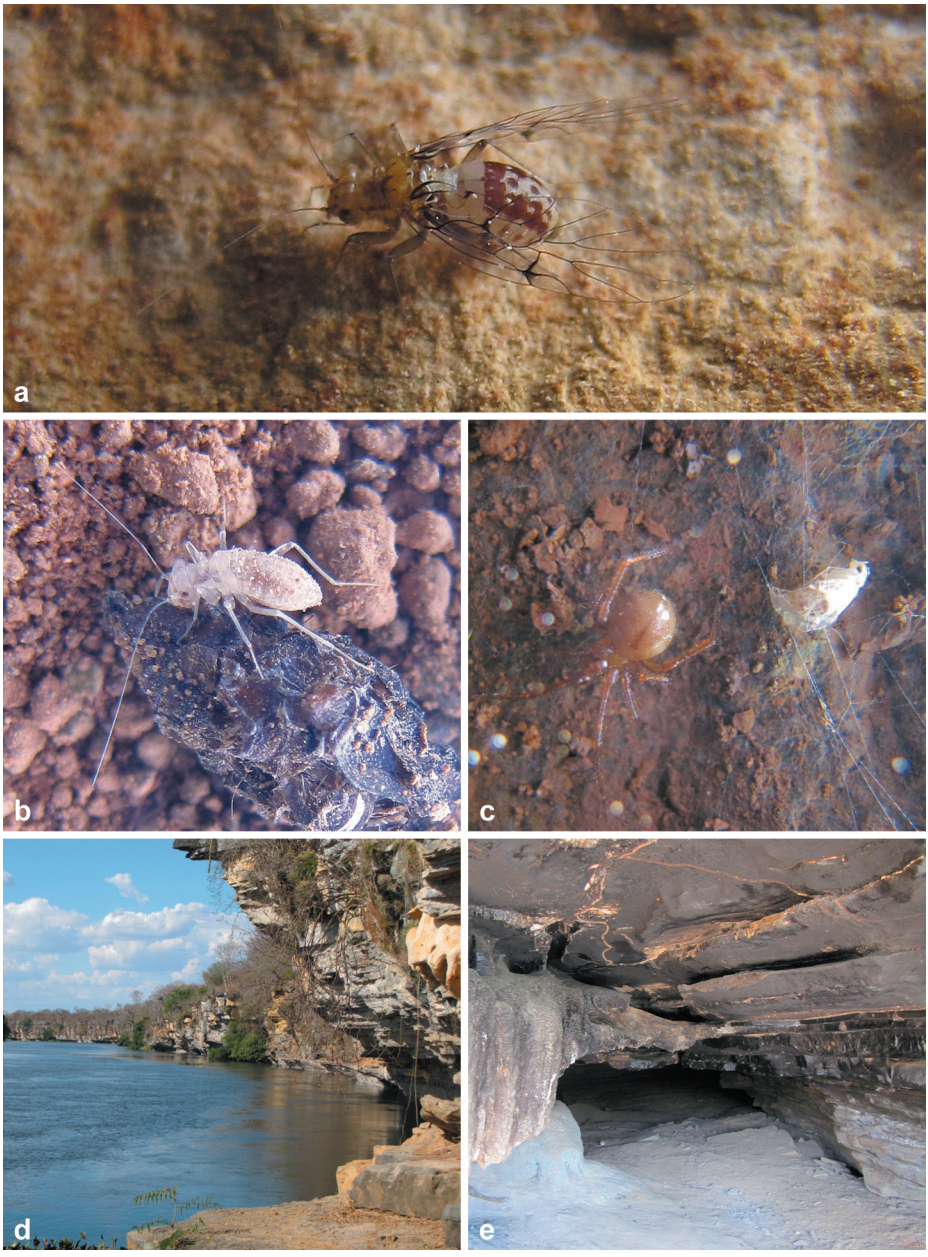

FIG. 4
Neotrogla curvata n. spec. (a) Adult specimen (sex not known), body length (without wings) 3.5 mm. (b) Nymph feeding on bat guano. (c) Teneral adult captured by *Theridion* spec. (d) Type locality; at right, in foreground, the entrance zone of cave PEA 380. (e) Entrance of cave PEA 380.

on the other side of this specimen. That second antenna was obviously damaged during adult life, as were both antennae of the holotype (8- and 9-segmented). Probably all previously observed "intact" antennae of Prionoglarididae are in fact incomplete, regenerated antennae which were damaged prior to adult life. Therefore the complete number of antennal segments remains unknown for this family. At present it cannot be confirmed that a complete antenna of Prionoglarididae has at least 20 segments, as it is normal in the suborder Trogiomorpha (Lienhard, 1998) to which this family belongs (see Yoshizawa *et al.*, 2006).

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REFERENCES

LIENHARD, C. 1998. Psocoptères euro-méditerranéens. *Faune de France* 83: XX+517 pp.

LIENHARD, C. 2004. *Siamoglaris zebrina* gen. n., sp. n., the first representative of Prionoglaridae from the Oriental Region (Insecta: Psocoptera). *Revue suisse de Zoologie* 111(4): 865-875.

LIENHARD, C. 2007. Description of a new African genus and a new tribe of Speleketorinae (Psocodea: 'Psocoptera': Prionoglarididae). *Revue suisse de Zoologie* 114(3): 441-469.

LIENHARD, C., OLIVEIRA DO CARMO, T. & LOPES FERREIRA, R. 2010. A new genus of Sensitibillini from Brazilian caves (Psocodea: 'Psocoptera': Prionoglarididae). *Revue suisse de Zoologie* 117(4): 611-635.

MOCKFORD, E. L. 1984. Two new species of *Speleketor* from southern California with comments on the taxonomic position of the genus (Psocoptera: Prionoglaridae). *Southwestern Naturalist* 29(2): 169-179.

SEEGER, W. 1975. Funktionsmorphologie an Spezialbildungen der Fühlergeissel von Psocoptera und anderen Paraneoptera (Insecta); Psocodea als monophyletische Gruppe. *Zeitschrift für Morphologie der Tiere* 81: 137-159.

YOSHIZAWA, K. 2005. Morphology of Psocomorpha (Psocodea: 'Psocoptera'). *Insecta Matsumurana, New Series* 62: 1-44.

YOSHIZAWA, K., LIENHARD, C. & JOHNSON, K. P. 2006. Molecular systematics of the suborder Trogiomorpha (Insecta: Psocodea: 'Psocoptera'). *Zoological Journal of the Linnean Society* 146: 287-299.