

## Taxonomic and faunistic study of four almost unknown Brazilian Meloidae (Coleoptera)

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### ABSTRACT

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The Brazilian fauna of Meloidae is poorly studied, even though it includes more than 160 species. In this paper, we aimed at widening the knowledge on four species of blister beetles from this country. Specifically, we defined the uncertain range of *Tetraonyx angulicollis*, as extended in south-eastern Brazil rather than in Mexico, and implemented the description of the species with figures. We studied the taxonomy and distribution of three almost unknown species of *Nemognatha* from Brazil, São Paulo State, providing descriptions and figures of sexual characters and colour variability of *N. beauregardii*, to which is probably referable as a junior synonym of *N. plaumanni*, of *N. rufoscutellaris* and of *N. cfr. gounellei*. Moreover, we assigned these three species to the subgenus *Pauronemognatha*, recently recorded from South America.

### Introduction

Meloidae is a widely distributed family of beetles including about 3000 species characterized by: (1) the production of Cantharidin; (2) a hypermetabolic larval development except in the basal subfamily Eleticinae and (3) the biology of the first instar larvae which can be predators of Hymenoptera, Apoidea or Orthoptera, Acrididae (Bologna, 1991). At the imaginal stage, blister beetles are quite heterogeneous but are characterized by an elongated body, a narrow “neck”, due to a marked constriction of the postocciput, and a ventral blade on the claws (Bologna, 1991; Bologna et al., 2010). Among all the instar larvae, only the first one, the triungulin, is well known for most of the species (Bologna et al., 2010). Triungulins are well sclerotized, highly mobile, and campodeiform larvae, and represent the dispersal and food finding phase (Bologna et al., 2010). In some species, triungulins attain the food directly by crawling, while in others they show morphological adaptations to phoresy (Bologna, 1991; Bologna et al., 2010). The other phases, up to the pupal stage, are responsible for: feeding and body growth (First Grub), enduring periods of cold or dryness (Coarctate), and preparing the pupal chamber (Second Grub) (Bologna et al., 2010; Bologna & Di Giulio, 2011).

Three subfamilies are currently recognized: Eleticinae, Nemognathinae and Meloinae (Bologna and Pinto, 2001; Bologna et al., 2008; Ricciari et al., 2022, Ricciari et al., 2023).

The blister beetle fauna of Brazil is still scarcely studied, even if it includes many species (more than 160: see Denier, 1935a, 1935b, 1940; unpublished records from studied collections).

Among the Neotropical Meloidae, only the subfamily Eleticinae was revised at the genus level (Selander, 1966) together with some monotypic genera of Meloinae, or those including very few species. As for the more speciose genera of Meloinae, only some groups of species of *Epicauta* Redtenbacher, 1845 were partially analysed (Adams and Selander, 1979; Selander, 1981; Campos Soldini and Roig-Juñent, 2015; Campos Soldini et al., 2018). The genus *Tetraonyx* Latreille, 1805 shows its larger diversity in Brazil (at least 55 species over 102), but the only study of the species remains the late monograph of Haag-Rutenberg (1879). After that revision, only a catalogue of the New World (mostly Neotropical) tribe Tetraonycini was published (Selander, 1983), with additional contributions focused on the other three monotypic genera of this tribe (Selander, 1965, 1983, 1985; Bologna and Pinto, 2007), one study on the Argentinian species of *Tetraonyx* (Selander and Martinez, 1984; Selander and Selander, 1992), and a faunistic study on the Brazilian State of Rio de Janeiro (Quintino and Monné, 2009).

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A contribution to the monotypic genus *Meloetyphlus* Waterhouse, 1872 was recently published (Di Giulio et al., 2023).

The Nemognathinae subfamily, recently explored with a molecular phylogenetic approach considering their whole range (Ricciari et al., 2023), is insufficiently studied in the Neotropical Region, especially as concern the Brazilian fauna. The allocation of the species within the described genera still requires further investigations (Pinto and Bologna, 1999; Bologna and Pinto, 2002). Such an undefined taxonomic situation is so deep that Denier (1935a) in his catalogue of American blister beetles, erroneously considered the genus *Nemognatha* Illiger, 1807 as a synonym of *Zonitis* Fabricius, 1775. The Neotropical species of *Nemognatha* were never revised, even if Ricciari et al. (2023) pointed out that in South America are distributed some of the Nearctic subgenera studied by Enns (1956), together with other unknown intrageneric lineages. Moreover, the value of the genus *Zonitolytta* Pic, 1927 is questionable and it was considered by Selander (1991) as a subgenus of *Nemognatha*, but because he did not provide an explanation for this transfer, we continue to treat *Zonitolytta* at the generic level (Pinto and Bologna, 1999). Also, in the genus *Zonitis*, some species appear well distinct and possibly referable to new genera (Pinto and Bologna, 1999; Bologna, unpubl.), or a few others have been referred to the genus *Pseudozonitis* Dillon, 1952 (Pinto, 2019) or *Rhyphonemognatha* Enns, 1956 (Pinto and Bologna, 2016). Recently, García-París et al. (2014) studied in detail one species of *Nemognatha* from Venezuela which was described from south-eastern Brazil (see below). A revisional work of the southern America Nemognathinae could permit to assess the generic status of the Neotropical species and to describe new species and synonymies. In particular, at least 10 species of *Nemognatha* were recorded from Brazil, and a few additional, as *N. claveri* Pic, 1914, probably belong to other genera.

In this nebulous context, this paper is aimed at taxonomically studying four species of almost unknown Meloidae from the São Paulo State, in Brazil, one belonging to the genus *Tetraonyx* and three to the genus *Nemognatha*.

## Material and methods

The examen of numerous specimens from the Museu de Zoologia, Universidade de São Paulo, collected in a few localities of the São Paulo State, allowed to conduct this study. The examined material includes four specimens of *Tetraonyx angulicollis* Haag-Rutenberg, 1879 [one now in the Marco A. Bologna collection (MAB) at Roma Tre University], 61 of *Nemognatha beauregardii* Pic, 1910 (five now in MAB), 53 of *N. rufoscutellaris* Pic, 1910 (five now in MAB), and 7 of *N. cfr. gounellei* Pic, 1910 (one now in MAB).

Morphological study was carried out using an Olympus SZX 12 stereomicroscope. Photographs were taken with Visionary Digital LK Lab System (Visionary Digital, Palmyra, VA) equipped with a Canon EOS 6D mark II dSLR camera and an MP-E 65mm f/2.8 1–5× lens (Canon, Tokio, Japan). This device allowed the automatic capture of stacks of images on different focal planes, which were combined with the Helicon Focus 7 software.

## Results

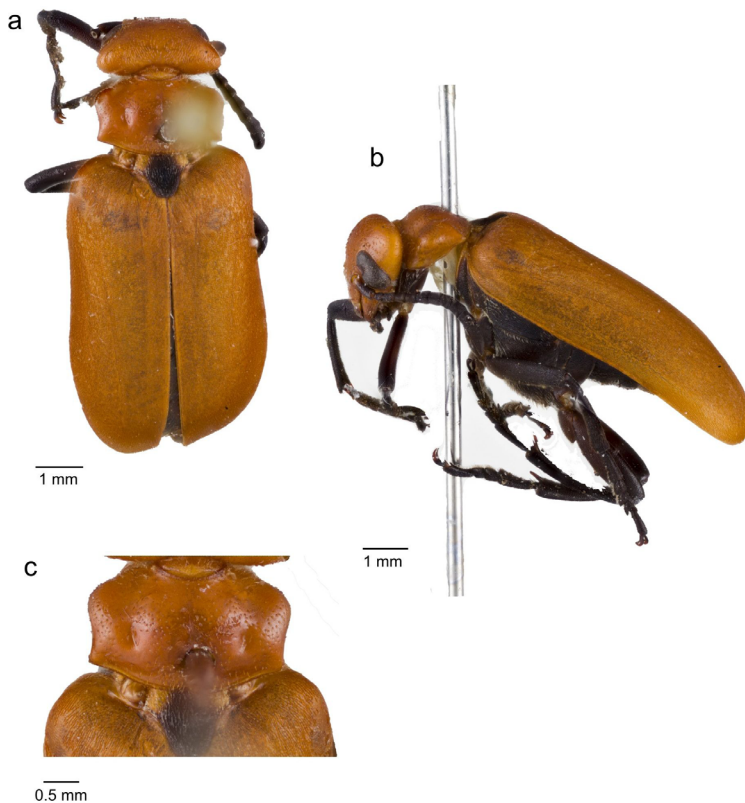
### *Tetraonyx angulicollis* Haag-Rutenberg, 1879

*Tetraonyx angulicollis* Haag-Rutenberg, 1879: 253, 270; Champion, 1892: 392; Selander, 1983: 279; García-París et al., 2007: 242.

Figures 1a-c.

*Material examined.* 4 exx., "Faz. (= Fazenda) Sta. (= Santa) Carlota, Cajuru, SP, BR", with different dates (1 ex. 25.X.1988; 1 ex. 10.10.1989; 1 ex. 29.III.1991; 1 ex. without date).

*Taxonomy.* The description of this species made by Haag-Rutenberg (1879) is clear and permitted the identification of our specimens. The genus *Tetraonyx* includes two described subgenera, the nominate and the monotypic *Paratetraonyx* Kaszab, 1959 (Pinto and Bologna, 1999).



**Figure 1** *Tetraonyx angulicollis* a. body dorsally; b. body laterally; c. pronotum.

The nominate subgenus was divided by Haag-Rutenberg into two lineages: one (A) characterized by the sides of pronotum concave in middle and with more marked angles; the second (B) with pronotum not incised medially and obtuse angles. According to the shape of pronotum (Figure 1c), *T. angulicollis* belongs to the lineage A and it is the only species with the dorsal body colour totally ochre-brown (Figure 1a).

Among the examined specimens, the abdomen could be entirely black or with the last three ventrites orange; meso- and metapleures totally or partially black; mesosternum orange or partially black; antennae black and antennomeres similar in both sexes.

**Remarks.** Haag-Rutenberg (1879) cited "Mexico?" as type locality of *T. angulicollis*, but expressed doubts about it. Subsequently, this uncertain range was quoted in all papers and catalogues in which the species was mentioned (Champion, 1892; Borchmann, 1917; Denier, 1935a; Blackwelder, 1945; Selander, 1983; García-París et al., 2007). Nevertheless, none of these authors examined the type or additional specimens and, after the examination of the new material, we can define that the range of *T. angulicollis* certainly includes the south-eastern Brazil (São Paulo State) rather than Mexico.

***Nemognatha (Pauronemognatha) beauregardii* Pic, 1910**

*Nemognatha atra* Beauregard, 1890: 465, note 1, *nomen praeoccupatum* by *atra* Dugès, 1889.

*Nemognatha beauregardii* Pic, 1910b: 7.

Figure 2a-f

**Material examined.** 27 exx., "Faz. (= Fazenda) Sta. (= Santa) Carlota, Cajuru, SP, BR" with different dates (1 ex. 1986; 1 ex. 12.III.1987; 2 exx. 2.III.1988; 2 exx. 16.III.1988; 1 ex. 14.IV.1988; 1 ex. 1989; 1 ex. 17.III.1989; 1 ex. 19.III.1989; 1 ex. 27.III.1989; 1 ex. 10.IV.1989; 1 ex. 3.V.1989; 1 ex., 13.II.1990; 1 ex. 15.II.1990; 1 ex. 26.III. 1990; 1 ex. 23.IV.1990; 1 ex. 24. IV.,1990; 1 ex. 30.IV.1990; 1 ex. 16.X.1990; 1 ex. 12.X.1990; 1 ex. 23.X.1990; 1 ex. 23.II.1998; 1 ex. 25.IX.1999; 3 exx. without date).

8 exx., "Faz. (= Fazenda) Cambuhy, Matão, SP, BR", with different dates (1 ex. 1986; 1 ex. 30.I.1996; 1 ex. 25.X.1996; 4 exx. 1997; 1 ex. 4.II.1997).

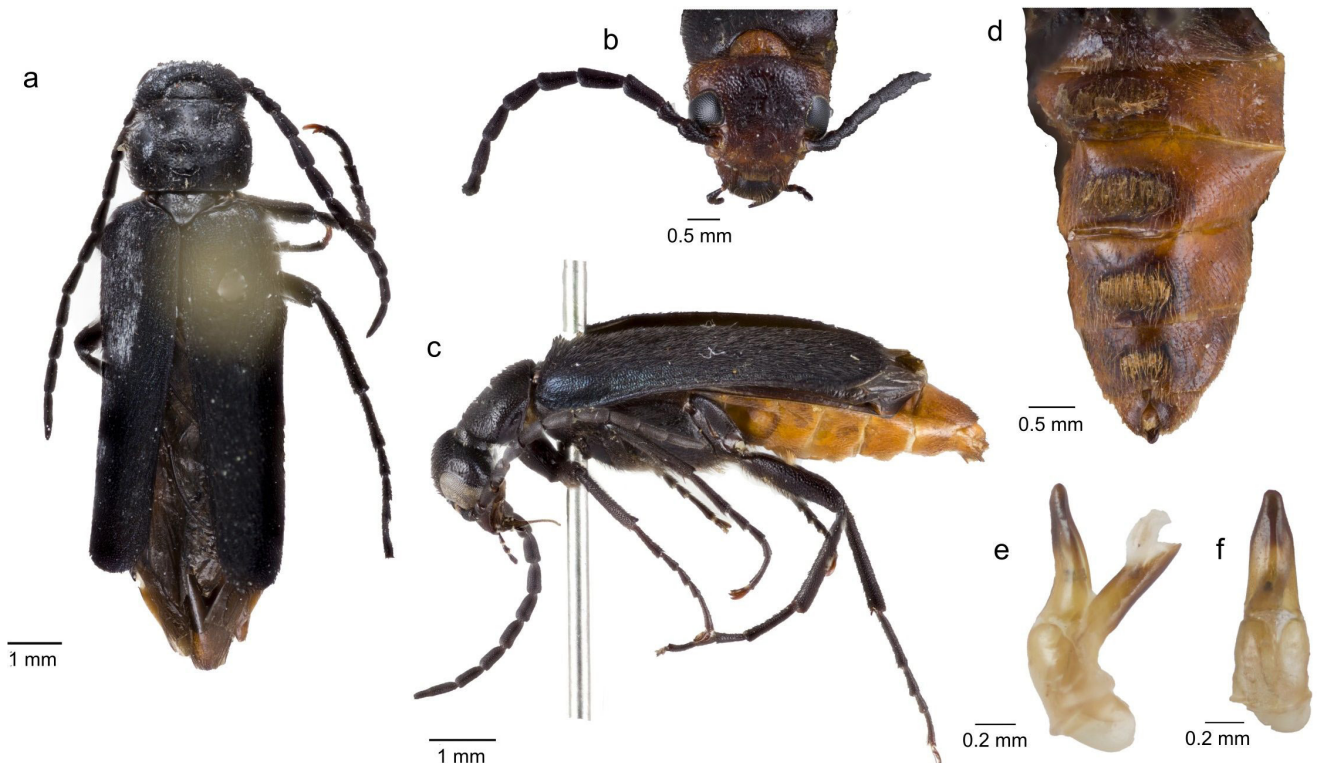
8 exx., "Serra do Japi, Jundalaí, SP, BR", with different dates (1 ex. 1986; 1 ex. 14.IX.1995; 1 ex. 2.X.1995; 1 ex. 14.X.1995; 1 ex. 14.XI.1995; 1 ex. 27.IV.1995; 1 ex. 16.XI.1995; 1 ex. 1996).

18 exx., "Est. (= Estação) Ecol. (= Ecológica) dos Caetatus, Gália, SP, BR, 22°22.51' - 49°40.26'", with different dates (1 ex. 23.II.2007; 1 ex. 14.III.2007; 1 ex. 28.III.2007; 1 ex. V.2007; 1 ex. 23.V.2007; 1 ex. 29.V.2007; 1 ex. 1.VI.2007; 1 ex. 23.VI.2007; 1 ex. 25.VI.2007; 1 ex. 15.X.2007; 1 ex. 28.X.2007; 1 ex. 8.XI.2007; 1 ex. 10.XI.2007; 2 exx. 19.XI.2007; 1 ex. 24.XI.2007; 1 ex. 30.XII.2007; 1 ex. 3.XII.2009).

**Taxonomy.** Also in this species, as in other *Nemognatha* from South America (*N. chrysoloides*) and North America (e.g., *N. lurida* LeConte, 1858, *N. lutea* LeConte, 1853), exists a great variability in the body colour and this condition produced several taxonomic errors. Usually the body is black with elytra dark blue-violet metallic and the abdomen orange (Fig. 2a/c), but with the following variation: males (except two) have orange shiny abdomen, while ca. one third of females have the abdomen black or at least distinctly dark; the head is black, but very few specimens have temples and genae partially orange (Fig. 2b); one single specimen shows the head almost completely reddish and the pronotum dark-reddish.

As the other two following species, the head is very short and galeae are quite short, differently than in most *Nemognatha*, reaching the lateral-anterior angle of the eye. The male modified areas are present on ventrites II-V (see below; Fig. 2d) and are represented by scarcely depressed, sub-oval surface, with a distinct and denser punctuation and dense different setae; male genitalia as in Fig. 2e/f.

**Remarks.** This species is recorded only from Brazil. Beauregard (1890) described it as *N. atra* using the name found on a specimen of the Brussels' Museum collections, but this name was preoccupied by *N. atra* Dugès, 1889 from Mexico (now *Zonitis (Parazonitis) dugesi* Selander, 1954). Consequently, the name was changed by Pic (1910b) as *N. beauregardii*. After Pic's paper this species has never been studied. Erroneously, *N. atra* and *N. beauregardii* were included by García-París et al.



**Figure 2** *Nemognatha beauregardii* a. body dorsally; b. head variant; c. body laterally; d. ventrites ventrally; e. male genitalia laterally; f. male genitalia ventrally.



(2007) among the synonyms of *N. chrysomeloides* (Linnaeus, 1763), a species widely spread from Mexico to Argentina, which belongs to another lineage and is greatly distinct at least because of the ventrites not modified and galeae extremely elongate.

According to the classification of *Nemognatha* proposed by Enns (1956), very few South American species have been assigned to one of the four Nearctic subgenera. Riccieri et al. (2023) referred tentatively *N. nigrotarsata* (Fairmaire et Germain, 1861) from Chile and NW Argentina to the nominate subgenus, and *N. mimula* Borchmann, 1952 from Ecuador and Peru to the subgenus *Pauronemognatha* Enns, 1956, while they did not place in none of the described subgenera both *N. chrysomeloides* and *N. nigronotata* (Pic, 1914). We confirm the arrangement in *Pauronemognatha* of the first two species and refer to it also *N. beauregardii*, which shows modified areas on ventrites II-V (Figure 2d).

García-París et al. (2014) recorded for the first time *N. plaumanni* Borchmann, 1942 from Venezuela. This species was described from south-eastern Brazil, Santa Catarina, Nova Teutonia [erroneously considered by Borchmann (1942) as in the Rio Grande do Sul State], not far from the localities of *N. beauregardii* we studied in the São Paulo State. As noted above, García-París et al. (2014), who examined topotypic specimens of *N. plaumanni* in the Budapest' Museum, erroneously considered *N. beauregardii* as a variation of *N. chrysomeloides* and did not compare *N. plaumanni* with *N. beauregardii*. According to the figures of the topotypic *N. plaumanni* published by these authors, this species seems extremely similar to *N. beauregardii* and we suggest their possible synonymy. We cannot confirm this co-specificity without the examination of the male structures (ventrites and genitalia) of *N. plaumanni*, and because García-París et al. (2014) stated that this species cannot be referred to any described subgenera, while in

*N. beauregardii* the modified ventral areas and the hind spurs typical of *Pauronemognatha* are clearly detectable.

Léo Correia da Rocha Filho communicated to us (pers. comm. II.2023) that specimens of *N. beauregardii* have been collected in the nests of *Tetrapedia diversipes* Friese, 1899 (Hymenoptera, Apidae), and those of *N. rufoscutellaris* and *N. cfr. gounellei* (see below) in the nest of *Tetrapedia* spp. Parasitization of *T. diversipes* was ascertained also in *N. rufoscutellaris* and in the species which probably corresponds to *N. gounellei* (Rocha-Filho and Garofalo, 2016).

***Nemognatha (Pauronemognatha) rufoscutellaris* Pic, 1910**

*Nemognatha rufoscutellaris* Pic, 1910: 115; Denier, 1935b: 28.

*Nemognatha subparallela* Pic, 1927: 29.

Figure 3a-h

**Material examined.** 20 exx., "Faz. (= Fazenda) Sta. (= Santa) Carlota, Cajuru, SP, BR" with different dates (1 ex. 1986; 1 ex. 17.II.1988; 1 ex. 23.II.1988; 1 ex. 3.III.1988; 1 ex. 6.II.1989; 1 ex. 1990; 1 ex. 12.III.1990; 1 ex. 5.III.1990; 1 ex. 6.III.1990; 1 ex. 19.III.1990; 1 ex. 5.IV.1990; 1 ex. 8.IV.1990; 1 ex. 17.X.1990; 2 exx. 23.X.1990 (1 with exuvia); 1 ex. 23.X.1991; 1 ex. 1997; 1 ex. 8.III.1998; 2 exx. without date).

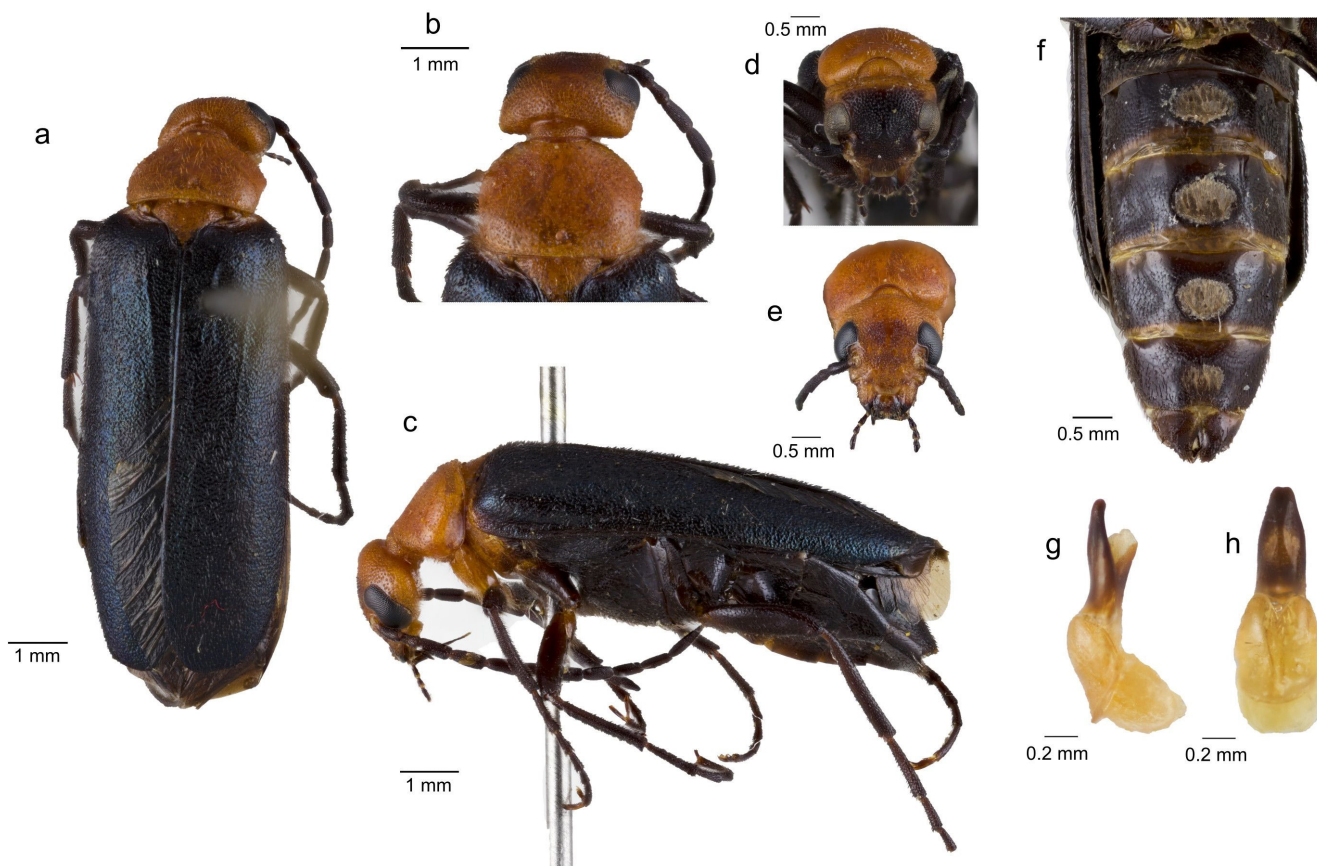
1 ex., "Serra do Japi, Jundalaí, SP, BR", 1 ex. 3.XI.1995.

2 exx., "Est. (= Estação) Ecol. (= Ecológica) dos Caetatus, Gália, SP, BR, 22°22.51' - 49°40.26'", with different dates (1 ex. 2.II.2007; 1 ex. 19.XI.2007).

4 exx., "Reserva Ecológica Pedregulho, SP; BR", with different dates (1 ex. 25.X. 1991; 1 ex. 21.X.1991; 2 exx. 3.XI.1991).

3 exx., "Est. (= Estação) Ecol. (= Ecológica) de Jataí, L. (=Luiz) Antonio, SP, BR", with different dates (1 ex. 9.X.1991; 1 ex. 25.X.1991; 1 ex. 29.X.1991).

1 ex., "Faz. (= Fazenda) Feder. (= Federal) (illegible), SP, BR", (illegible) (without date).



**Figure 3** *Nemognatha rufoscutellaris* a. body dorsally; b. pronotum; c. body laterally; d. head variant black; e. head variant orange; f. ventrites ventrally; g. male genitalia laterally; h. male genitalia ventrally.

22 exx., "Faz. (= Fazenda) Ecol. (= Ecológica) Santa Cecilia, Patrocínio Paulista, SP, BR", with different dates (1 ex. 4.IV.2001; 1 ex. 29.III.2002; 1 ex. 1.XI.2002; 1 ex. 27.XI.2002; 1 ex. 22.III.2003; 1 ex. 1.III.2003; 5 exx. 21.X.2003; 1 ex. 27.X.2003; 4 exx. 22/23.X.2003; 2 exx. 26.X.2003; 1 ex. 27.X.2003; 1 ex. 31.X.2003; 1 ex. 10.II.2004; 1 ex. 25.X.2004).

**Taxonomy.** This species is black with elytra dark black-violet metallic, head, pronotum, procoxae and abdomen usually orange (Fig. 3a/b/c). The colour variation of the examined specimens is large and could support the hypothesis of co-specificity with other Brazilian taxa. First, the head colour could be totally orange (Fig. 3e) or with a black frontal area, present in almost 14% of the individuals, usually rectangular, extended from the suture to the middle of interocular space or totally covering the frons until the posterior margin of eye (Fig. 3d). The antennomeres are black, but in two specimens antennomeres I-II are orange as the base of III. Elytra in a few individuals are blue-violet or green-violet. The abdomen is orange, especially in males, but in about 38% of individuals is black or rarely dark reddish.

As in both other *Nemognatha* object of this study, the head is very short and galeae are quite short, reaching at most the anterior ventral angle of the eye. The modified ventral areas, which allow to refer for the first time this species to the subgenus *Pauronemognatha*, are depicted in Fig. 3f, and male genitalia in Fig. 3g/h.

**Remarks.** Both *N. rufoscutellaris* and *N. subparallela* Pic, 1927 have been described generically from Brazil and afterwards recorded also from Bolivia and Argentina. According to the description, they look very similar to each other, except for the head colour, black in the first and orange/red in the second species. We agree with Denier (1935b) who considered *N. subparallela* as a chromatic variation of *N. rufoscutellaris* with the head orange/red, rather than black. For instance, Martinez (1992) considered these two taxa as distinct, based on the unpublished opinion of R. B. Selander. Another species, *N. pallidicollis* Beaufort, 1890, which was compared by Pic (1910a) to *N. rufoscutellaris*, could be referred to the intraspecific variation of this complex, but we did not examine it. If the synonymy between the two species will be confirmed, the name *N. pallidicollis* should have the priority.

For information about the bee host see above.

***Nemognatha (Pauronemognatha) cfr. gounellei* Pic, 1910**

*Nemognatha gounellei* Pic, 1910: 115

Fig. 4aA-f

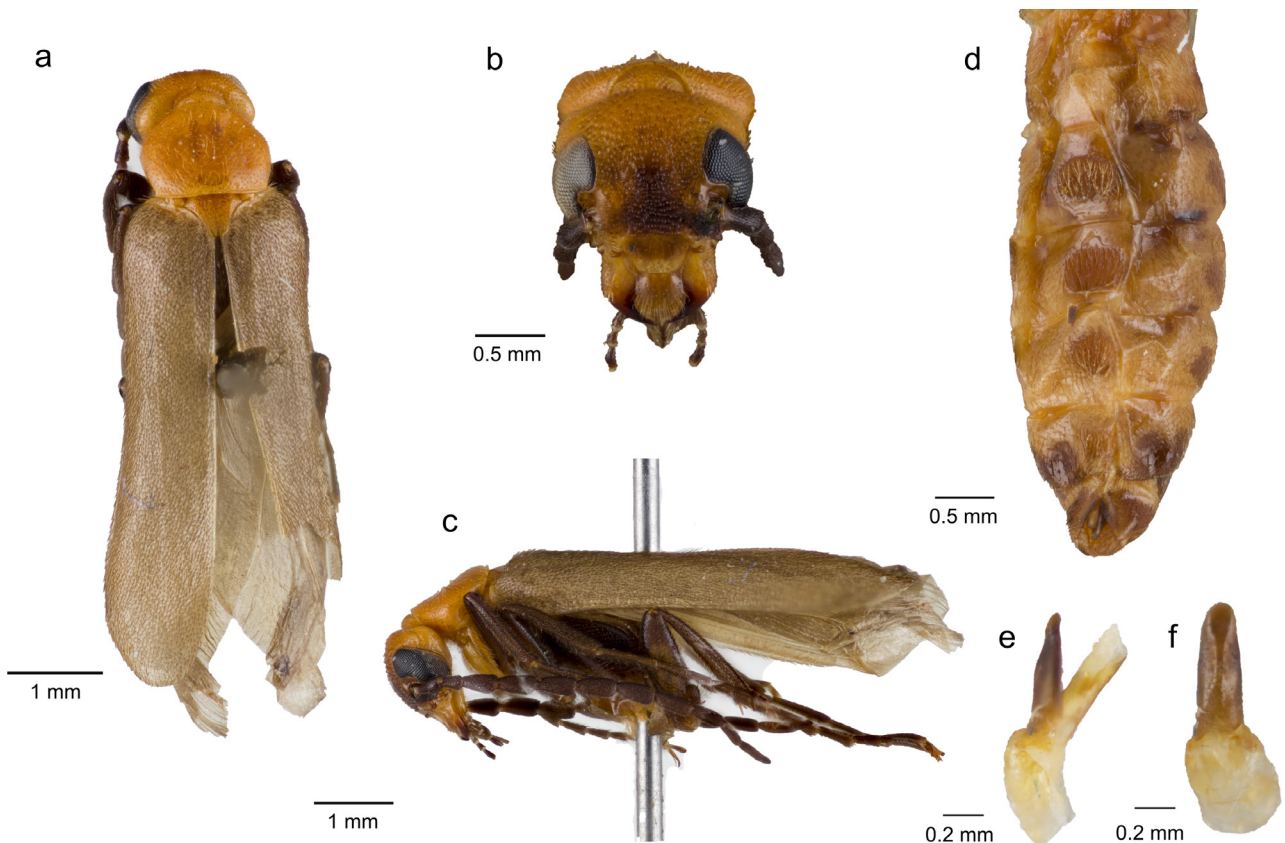
**Material examined.** 4 exx., "Faz. (= Fazenda) Sta. (= Santa) Carlota, Cajuru, SP, BR" with different dates (2 ex. 12.X.1990; 1 ex. 23.X.1990; 1 ex. 16.X.1991).

2 exx., "Serra do Japi, Jundalaí, SP, BR" with different dates (1 ex. 26.IX.1995; 1 ex. 22.V.1996).

1 ex., "Faz. (= Fazenda) Ecol. (= Ecológica) Santa Cecilia, Patrocínio Paulista, SP, BR", 1.X.1993.

**Taxonomy.** This species (Fig. 4a/c) is black with the elytral colouration brown-hazelnut, variable at apex, as it could be metallic violet on the apical third-fourth (50% of the specimens; three localities) or apically only infuscate without distinct violet colouration, but this might be related to the scarce sclerotization being the individuals extracted from the nests of their hosts (37%; one of the previous localities). In one specimen elytra are completely broken posteriorly. Both head and pronotum are red (Fig. 4a/b), but in three specimens the head is black, and in one of them also the pronotum is dark. The abdomen is usually orange.

As in the previous two species, the head is very short and galeae are quite short, reaching at most the anterior ventral angle of the eye. The modified ventral areas (Fig. 4d), permit to assign for the first time this species to the subgenus *Pauronemognatha*. Male genitalia are represented in Fig. 4e/f.



**Figure 4** *Nemognatha* cfr. *gounellei* a. body dorsally; b. head; c. body laterally; d. ventrites ventrally; e. male genitalia laterally; f. male genitalia ventrally.



**Remarks.** Until now, this species was recorded only from Brazil. We refer tentatively the examined specimens to *N. gounellei* because of the correspondence of most of the description (Pic, 1910a). Doubts are due to the lack of a small violet spot at the base of the elytra, but since the great variability in colouration of the Brazilian *Nemognatha*, numerous specimens should be examined to define their variation.

For information about the bee host see above.

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### Conflicts of interest

The authors declare no conflicts of interest associated with this publication.

### Author contribution statement

MAB contributed to the study design. AR produced the photographs. Both authors contributed equally to the taxonomic analysis and have read and approved the manuscript.

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