**Research Article** 

# New records of Berothidae (Insecta: Neuroptera) from Central Brazil

Nuevos registros de Berothidae (Insecta: Neuroptera) del centro de Brasil

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**Abstract.** The species of Berothidae (Insecta: Neuroptera) collected in an area of Brazilian savannah at the Parque Nacional Chapada dos Veadeiros, Alto Paraíso de Goiás municipality, Goiás state, Brazil were documented based in a survey using Malaise traps between February 2018 and May 2019. Were captured four specimens of *Spiroberotha tocantinensis* Machado & Krolow, 2016 and one specimen of *Lomamyia trombetensis* Penny, 1983. Both species have their extension of the geographical range expanded to Goiás state.

Key words: Beaded lacewings, Berothinae, Brazilian savannah, Lomamyia, Nosybinae, Spiroberotha.

**Resumen.** Las especies de Berothidae (Insecta: Neuroptera) recolectadas en un área de sabana brasileña en el Parque Nacional Chapada dos Veadeiros, municipio de Alto Paraíso de Goiás, estado de Goiás, Brasil fueron registradas en base a una investigación desarrollada con trampas Malaise entre febrero de 2018 y mayo de 2019. Fueron capturados cuatro especímenes de *Spiroberotha tocantinensis* Machado y Krolow, 2016 y un espécimen de *Lomamyia trombetensis* Penny, 1983. Ambas especies extienden su rango de distribución geográfica al estado de Goiás.

Palabras clave: Berothinae, Lomamyia, Nosybinae, sabana brasileña, Spiroberotha.

# Introduction

Berothidae (Insecta: Neuroptera) have a cosmopolitan distribution and comprises about 120 species of 25 extant genera distributed in five subfamilies: Berothinae, Cyrenoberothinae, Nosybinae, Nyrminae and Protobiellinae (Monserrat 2006; Aspöck and Randolf 2014; Li *et al.* 2018).

In South America Berothidae is considered a rare and little known group (Penny 2002). Only two genera and two species have been previously known from Brazil (Penny 1983; Machado and Krolow 2016). Little is known about Berothidae biology (Faulkner 1992; Penny 2002; Ardila-Camacho 2013; Aspöck and Randolf 2014; Li *et al.* 2018): the larvae of some species of *Lomanyia* Banks, 1904 are associated with termite nests, where these insects inject crippling toxins in workers and suck their body fluids (Penny 2002). Adults have nocturnal or crepuscular habits and are usually attracted to light traps; they are

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polyphagous and, in their stomachs, were find pollen, small arthropods, fungal hyphae, and other materials (Oswald *et al.* 2002; Monserrat 2006).

*Spiroberotha* Adams, 1989 comprises three described species and *S. tocantinensis* Machado and Krolow, 2016 is the only known species from Brazil (Machado and Krolow 2016). Currently, little is known about the biology of this genus, except by the finding of pollen grains in guts of *S. sanctarosae* Adams, 1989 (Ardila-Camacho 2013).

*Lomamyia* includes 12 species, of which ten in North America, one in Central America and one in Brazil (Aspöck and Randolf 2014). Their larvae live in confined nests and / or galleries associated with ants and termites (Gurney 1947). There are reports of *L. hamata* (Walker, 1853) larvae feeding upon larvae of *Reticulitermes flavipes* (Kollar, 1837) (Blattodea: Rhinotermitidae) (Brushwein 1987) and of *L. latipennis* Carpenter, 1940 larvae feeding upon larvae of *Zootermopsis angusticollis* (Hagen, 1858) (Blattodea: Termopsidae) (Tauber and Tauber 1968) and *Reticulitermes hesperus* Banks, 1920 (Blattodea: Rhinotermitidae) (Johnson and Hagen 1981). *L. trombetensis* Penny, 1983 was originally described from Pará state, Brazil (Penny 1983) with a record for the Amazonas state (Faulkner 1992) and nothing is known about their biology.

In this paper, we characterize the diversity of Berothidae collected in an area of Brazilian savannah at the Parque Nacional Chapada dos Veadeiros, Alto Paraíso de Goiás municipality, Goiás state, Brazil. Two species – *L. trombetensis* and *S. tocantinensis* – are herein characterized and illustrated, their geographic distribution range are expanded, and a map with their geographical distribution range is provided.

#### Material and Methods

The specimens of Berothidae were collected in samplings occurred between February 2018 and May 2019 in an area of Brazilian savannah at the Parque Nacional da Chapada dos Veadeiros (PNCV), in Alto Paraíso de Goiás, Goiás state, Brazil. The climate at PNCV is Köpen AW type (tropical with wet summers and dry winters) with mean annual temperature of 21.7 °C and total annual rainfall of 1,792 mm with the highest rainfall occurring between October and April (CLIMATE-DATA.ORG 2019).

Were installed at the PNCV two sets of five Townes' style Malaise traps (Townes 1972) separated one of the other by about 50 m and collecting continuously over the study period. One set was located in an area of Brazilian savanna without anthropic action (14°08′36″S; 47°46′0.4″W, ~550 m above sea level [asl]) and, the other set, was located in an area of Brazilian savanna (14°07′44″S; 47°44′0.4″W, ~550 m asl) that suffered a severe fire about seven months before sampling begins, in November 2017. A 96% C<sub>2</sub>H<sub>5</sub>OH (ethanol) solution was used as a preservative in the traps and the insects were removed every two weeks. The collecting events were carried out under a Brazilian Biodiversity Information and Authorization System (SISBIO) license# 16473-1.

Berothidae specimens were separated from other Insecta in laboratory, and then they were stored in plastic vials with 96%  $C_2H_5OH$  (ethanol) solution and later air dried, and mounted on entomological pins and labeled.

Observations were made under magnification using a Leica MZ9.5 stereomicroscope and a Leica DM500 optical microscope. The color images and measurements were taken using a Leica DFC295 digital camera attached to a Leica M205C stereomicroscope with a Leica LED5000 HDI high diffuse dome illumination system, as well as with a Leica DFC295 digital camera attached to a Leica DM500 optical microscope, using the Leica Application Suite (LAS version 4.12.0) (Leica Microsystems, Germany). The images were focus-stacked using Helicon Focus version 5.3 (Helicon Soft, Kharkiv, Ukraine). The figures were prepared using Adobe Photoshop version 11.0 (Adobe Inc., California, USA).

The terminalia of the insects were separated from the rest of the abdomen, cleared in a 10% KOH (potassium hydroxide) solution for about 15 minutes and transferred, for one hour, to a 10%  $C_2H_4O_2$  (acetic acid) solution to neutralize the KOH. The cleared terminalia was stored in glycerin in glass microvials, attached in the same pin of the respective specimens.

All studied specimens were identified by the first author using the keys to the genera provided by Aspöck and Randolf (2014) and, the specific identifications were made by comparison with the works of Penny (1983), Faulkner (1992) and Machado and Krolow (2016).

The morphological terms were based on Aspöck and Aspöck (2008) and Winterton and Wang (2016). Used abbreviations are as follows: A, anal vein; CuA, anterior cubital vein; Ect, ectoproct; gx, gonocoxite; hyp, hypocauda; MA, anterior medial vein; MP, posterior medial vein; pm, maxillary palp; R, radial vein; Rs, radial sector; S, sternite; Sc, subcostal vein and T, tergite.

The collecting sites indicated on maps were based on Penny (1983), Faulkner (1992), Machado and Krolow (2016) and Machado and Martins (2019).

The information on the labels of the specimens examined was transcribed in the section of material examined as follows: the symbol backslash ( $\setminus$ ) indicates the different lines on the label and two quotation marks ("") indicate different labels on the same specimen. The museum repository is indicated in square brackets ([]).

The voucher specimens examined in this study, two males and two females of *S. tocantinensis* (LRRP #17835-17838) and one female of *L. trombetensis* (LRRP #17834) were deposited in the Entomological Collection of the Laboratório de Sistemática e Bioecologia de Predadores e Parasitoides (LRRP), of the Instituto Biológico (Ribeirão Preto, SP, Brazil).

#### Results

Were captured five specimens of beaded lacewings: a female of *L. trombetensis* and two females and two males of *S. tocantinensis*. All studied specimens were obtained in June 2018, approximately seven months after a serious fire hit the collection area.

Lomamyia trombetensis Penny, 1983 (Figs. 1-9)

**Diagnosis.** *L. trombetensis* (Figs. 1-2) are recognized by the combination of the following morphological characteristics: a. forewing elongate, apically falcate; pterostigma reddishbrown; seven Rs longitudinal veins; five radial crossveins, one directly below pterostigma; four inner gradate crossveins and two outer gradate heavily margined forming a dark patch (Fig. 3); b. hindwing with pterostigma reddish; two radial crossveins; three inner gradate crossveins and no outer gradate (Fig. 3) and, c. female terminalia (Figs. 4-8): eighth sternite narrow with a heavily sclerotized transverse band, broader laterally (Fig. 6); eighth gonocoxite small with a medial sclerotized band (Fig. 6); ninth tergite and ectoproct fused, extending ventro-anteriorly as a narrow band (Figs. 4-5); ninth gonocoxites with hypocaudae long, finger like (Fig. 7) and, bursa-copulatrix-spermatheca complex caudally swollen into sphere; short fertilization canal elongate and thin spermathecal duct (Figs. 5, 8) (Penny 1983; Faulkner 1992).

Geographical distribution (Fig. 9): *L. trombetensis* was known from Pará state, its type locality, and Amazonas state, in Brazil (Penny 1983; Faulkner 1992; Machado and Martins 2019); the new record extends its geographic distributional range about 1,700 km southeast from the type locality and about 2,000 km southeast from Amazonas state, the previous localities.

**Material examined.** "Brasil, GO, Alto Paraíso de Goiás \ Parque Nacional Chapada dos Veadeiros \ 14°07'44"S; 47°44'04"W \ Cerrado queimado, Malaise trap \ 19/VI/2018 \ RIR Lara & Perioto cols.", 1 female [LRRP]; "LRRP \ #17834".



**Figures 1-8.** Female of *Lomanyia trombetensis* Penny, 1983. 1. Habitus, lateral view. 2. Habitus, dorsal view (cut wings). 3. Fore and hindwings. 4. Abdominal apex, lateral view. 5. Abdominal apex cleared, lateral view. 6. Eighth sternite and eighth gonocoxite. 7. Ninth sternite and hypocaudae. 10. Bursa-copulatrix-spermatheca complex. Abbreviations: A, anal vein; CuA, anterior cubital vein; CuP, posterior cubital vein; Ect, ectoproct; gx, gonocoxite; hyp, hypocauda; MA, anterior medial vein; MP, posterior medial vein; R, radial vein; Rs, radial sector; S, sternite; Sc, subcostal vein; T, tergite.



**Figure 9.** Map of known distribution of *Lomamyia trombetensis* Penny, 1983 (red triangle) and *Spiroberotha tocantinensis* Machado & Krolow, 2016 (black triangle). Red and black triangles with white dot indicate new records to Goiás state, Brazil.

Spiroberotha tocantinensis Machado & Krolow, 2016 (Figs. 9, 10-16)

**Diagnosis.** *S. tocantinensis* (Fig. 10) are recognized by the combination of the following morphological characteristics: a. forewing weakly falcate, Sc and R fused on the pterostigma, one radial crossvein, three or four Rs longitudinal veins, six inner gradate crossveins and two outer gradate (Fig. 11); b. male terminalia: ectoproct with a hooklike projection on the tip; tenth gonocoxite (mediuncus) spirally coiled (Figs. 15-16); eighth sternite with a thin projection on each posteroventral corner, each projection with tip slightly curved dorsally, and bearing one strong setae on the tip (Figs. 15-16); ninth sternite with a pair

of projections on posterior margin, each projection straight with two strong setae on the tip (Figs. 15-16) and, c. female terminalia (Figs. 12-14): eighth gonocoxite extending downwards, subtriangular, with posterior margin rounded and bearing two elongate lateral tubercles (Figs. 12-13); ninth tergite and ectoproct fused with the ventral margin expanded downward with tip rounded and bearing some long setae (Figs. 12-13); ninth gonocoxite with posterior margin rounded and set with black setae and ventral margin bearing hypocaudae (Figs. 12-13); hypocaudae very long covered with elongate pale setae, mainly on the internal face (Figs. 12-13) (Machado and Krolow 2016) and, bursacopulatrix-spermatheca complex comprising a small, sclerotized ball-shaped element; a short fertilization canal and elongate spermathecal duct expanded apically (Fig. 14).

Geographical distribution (Fig. 9): *S. tocantinensis* was known only from Palmas, Tocantins state, Brazil, its type locality (Machado and Krolow 2016; Machado and Martins 2019); this new record extends its geographic distributional range about 400 km southeast from the type locality.

**Material examined.** "Brasil, GO, Alto Paraíso de Goiás \ Parque Nacional Chapada dos Veadeiros \ 14°07′44″S; 47°44′04″W \ Cerrado queimado, Malaise trap \ 5/VI/2018 \ RIR Lara & Perioto cols.", 1 female and two males [LRRP]; "LRRP \ #17835-17837"; "same data except 19/VI/2018", 1 female [LRRP]; "LRRP \ #17838".

### Discussion

Reports about the fauna of Berothidae from Brazil are scarce (Penny 1983; Faulkner 1992; Machado and Krolow 2016), which makes it difficult to discuss the obtained data.

The emergence of Berothidae seems to occur during the dry season (Adams 1989; Penny 2002; Oswald *et al.* 2002). In the Costa Rica, there are records of *Spiroberotha* Adams, 1989 between December and May (Adams 1989; Penny 2002) except for one each in March and September (Ardila-Camacho 2013); to Venezuela, in June and between January and March (Adams 1989) and, to Brazil, between June to August (Machado and Krolow 2016). Faulkner (1992) in reviewing the *Lomamyia* Banks, 1904 reported that the flight periods occurred between June and August for montane species and, between May and September for lower altitude species. *L. trombetensis* Penny, 1983, the only species of the genus from Brazil, was collected in November (Penny 1983).

During our year-long collection at PNCV, only five specimens of the two species of Berothidae were collected with Malaise traps, all of them during the dry season.

Although Berothidae are most often collected with light traps equipped with mercury, ultraviolet or fluorescent lamps (Adams 1989; Faulkner 1992; Penny 2002; Oswald *et al.* 2002; Contreras Ramos and Rosas 2014), which is expected since they are nocturnal or twilight insects, reports of their capture with Malaise traps are not uncommon. Ardila-Camacho (2013) reported the collecting of *Spiroberotha* in Colombia with Malaise traps and Machado and Krolow (2016) the collecting of *S. tocantinensis* in a typical Cerrado area during the dry season with Malaise traps.

*L. trombetensis* was erected by Penny in 1983 and later Faulkner (1992) found another specimen of this species at the Hope Museum, of the Oxford University; since then, there is no other record of the capture of this species in the literature.

Surprisingly, all studied beaded lacewings were collected in an area of Brazilian savannah that suffered a severe fire about seven months before the beginning of the sampling and we have no arguments to explain its non-capture in the studied Brazilian savanna area that did not suffer the action of fire.

This study reveals the incipient nature of the knowledge about the Berothidae and demonstrates the need of further collection effort to get a better representation of this family in Brazil.



**Figures 10-16.** *Spiroberotha tocantinensis* Machado & Krolow, 2016. **10.** Habitus, lateral view. 11. Forewing. 12. Female terminalia, lateral view. 13. Female terminalia cleared, lateral view. 14. Bursa-copulatrix-spermatheca complex. 15. Male terminalia, lateral view. 16. Male terminalia cleared, lateral view. Abbreviations: A, anal vein; CuA, anterior cubital vein; CuP, posterior cubital vein; Ect, ectoproct; gx, gonocoxite; hyp, hypocauda; MA, anterior medial vein; MP, posterior medial vein; R, radial vein; Rs, radial sector; S, sternite; Sc, subcostal vein; T, tergite; VIII, sternite eighth projection; IX, sternite ninth projection.

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