



An unexpected new species of *Isostenosmylus* Krüger, 1913 (Neuroptera: Osmylidae), from the Brazilian Northeast

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ABSTRACT

The genus *Isostenosmylus* Krüger, 1913 contains 18 species distributed in South America, especially in the Andean region and in southern Brazil and Paraguay. Herein, a new species – *Isostenosmylus derpi* sp. n. – from a specific habitat named “Brejo de Altitude” from Paraíba state, Northeast Brazil, is described and illustrated. Distribution map and an updated taxonomic key for the genus females are provided.

Introduction

Isostenosmylus Krüger, 1913 (Stenosmylinae) constitutes the most species rich genus in the family Osmylidae from the Neotropical region, receiving great attention in the last ten years, with the number of species increasing from seven to 18 (Ardila-Camacho and Noriega, 2014; Martins et al., 2016, 2019; Ardila-Camacho et al., 2020). The genus distribution ranges from Venezuela through the Andean mountain chains to Peru, Bolivia, and Argentina, and southern Brazil and Paraguay (Martins et al., 2019; Ardila-Camacho et al., 2020). A recent phylogenetic study based on morphological data rendered *Isostenosmylus* monophyletic, composed by two clades: the *pulverulentus*, with four species, and the *bifurcatus*, with 14 species, each defined by the ornamentation on the female forecoxa and the male genital morphology (Martins et al., 2019). A new species – *I. derpi* sp. n. – related to the *pulverulentus* clade was discovered in an unexpected region, the Brazilian Northeast, and

herein we aim to describe and illustrate it, increasing the number of Brazilian species to three and in the genus to 19.

Materials and methods

The two female specimens examined in this study were collected in a Malaise Trap placed in an enclave of Montane Semideciduous Seasonal Forest in Caatinga (Brazilian semi-arid scrub forest), municipality of Maturéia (Paraíba state). They are housed at the Coleção Zoológica do Maranhão, Universidade Estadual do Maranhão, Caxias, Maranhão, Brazil (CZMA) and Coleção Entomológica Padre Jesus Santiago Moure, Universidade Federal do Paraná, Curitiba, Paraná, Brazil (DZUP). The specimens were identified by dissecting the last four abdominal segments, which were cleared following the standard procedure with 10% potassium hydroxide (KOH) solution, washed with distilled water,

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10% acetic acid, and 70% ethyl alcohol; stored in microvials with glycerin and pinned together with the respective specimen. Genital structures were observed using a Zeiss Discovery V8 stereomicroscope.

Series of high-resolution images were produced by means of an AxioCam Ice1 Zeiss digital camera attached to a Zeiss SteReo Discovery V8 stereomicroscope, then the photographs were stacked and processed with the software Helicon® and Adobe Photoshop®. Drawings were vectorized from photographs using the software Adobe Illustrator CS®. Morphological terminology follows Martins et al. (2019) and Winterton et al. (2019), genital sclerites were colored with the same color used by these authors, i.e. to females: yellow to sternite 8, green to gonapophyses 9, blue to tergite 9 and orange to gonocoxite 9. Wing venation terminology was based on Breitzkreuz et al. (2017). A distribution map was produced using the website <https://www.simplemappr.net/>.

Results

Osmylidae Leach, 1815

Stenosmylinae Krüger, 1913

Isostenosmylus Krüger, 1913

Type species. *Osmylus pulverulentus* Gerstaecker, 1894: 166 (by original designation).

Generic characters. See Martins et al. (2019) and Winterton et al. (2019).

Included species. *Isostenosmylus ammirabilis* Ardila-Camacho et al., 2020, *I. angustipennis* Ardila-Camacho & Martins, 2019, *I. apaapensis* Martins et al. 2019, *I. barbatus* Martins et al. 2019, *I. bifurcatus* Ardila-Camacho et al. 2016, *I. contrerasi* Ardila-Camacho & Noriega, 2014, *I. derpi* **sp. nov.**, *I. fasciatus* Kimmins, 1940, *I. fusciceps* Kimmins, 1940, *I. inca* Martins et al. 2019, *I. irroratus* Ardila-Camacho et al. 2016, *I. jaguar* Martins et al. 2019, *I. julianae* Aspöck et al. 2016, *I. morenoi* (Navás, 1928), *I. nigrifrons* Kimmins, 1940, *I. penai* Machado et al. 2019, *I. pulverulentus* (Gerstaecker, 1894), *I. septemtrionalandinus* Ardila-Camacho & Noriega, 2014, *I. triangulatus* Ardila-Camacho et al. 2019.

Distribution. Argentina, Brazil [ES, MG, PB (**new record**), PR, RJ, RS, SC, SP], Bolivia, Colombia, Ecuador, Paraguay, Peru, and Venezuela.

***Isostenosmylus derpi* Martins, Machado & Ardila-Camacho sp. n.** (Figs 1-4)

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Etymology. The new species is named after the first author's friend, Dr. Daercio Adam de Araújo Lucena (Fig. 1a) (known as "Derp"), an entomologist expert in wasps of the family Chrysididae and who collected the specimens studied here.

Type material. Holotype: Female. **Brazil: Paraíba:** Maturéia, Pico do Jabre, Malaise 4, 07°12.092'S–37°22.853'W, 1093 m, 12.iv-08.v.2023, DAA Lucena & eq. cols. (DZUP). **Paratype:** Female. **Brazil: Paraíba:** Maturéia, Pico do Jabre, Malaise 7, 07°15.177'S–37°23.239'W, 1140 m, 12.iv-08.v.2023, DAA Lucena & eq. cols. (CZMA).

Diagnosis. This new species is placed in the clade *pulverulentus* (*I. apaapensis*, *I. irroratus*, *I. barbatus*, and *I. pulverulentus*) (Martins et al., 2019) characterized by the female forecoxae with thick and prominent setae (fig. 1c), sternite 7 with posterior margin produced (figs 2a-b), sternite 8 with anterior region concave (figs 2b, 3b), gonapophyses 9 long in lateral view with subquadrangular lobes (fig. 3). The new species has the notum with two distinct posterodorsal black and oval marks on the pronotum (fig 1b, d); gonapophyses 9 of *I. derpi* **sp. n.**, in ventral view, is Y-shaped (figs 2a-b), and in lateral view is strongly bent dorsad near mid-length (with an almost 90° angle) with apical lobes directed ventrally (fig.3). *Isostenosmylus derpi* is easily separated from *I. irroratus*, *I. barbatus*, and *I. pulverulentus* by the presence of only two apical lobes on the gonapophyses 9 (figs 2-3), the other

species have four; *I. apaapensis* shares many characteristics with the new species, nevertheless, they can be differentiated by the color of maxillary and labial palpomeres, pale amber with distal half black in the new species (fig. 1c), but completely dark brown in *I. apaapensis*, and by the gonapophyses 9, which is slightly bent dorsad, almost straight, near mid-length in *I. apaapensis* (strongly bent in the new species), without a basal projection (present in the new species) (fig. 2a), and with apical lobes directed caudally (directed ventrally in the new species).

Description. Measurements (n=2). Interocular distance: 0.8 mm; head width including compound eyes: 1.7 mm; prothorax length: 1.3 mm; prothorax width at mid-length: 0.7 mm; forewing length: 19.8–20 mm; forewing maximum width: 6–6.28 mm; forewing pterostigma length: 3.2–3.75 mm; hind wing length: 18.7–19.0 mm; hind wing maximum width: 5.67–5.75 mm; hind wing pterostigma length: 2.8–3.1 mm.

Head (figs 1b-d). Pale amber with diffuse black marks. Vertex elevated above compound eyes, rugose, with black marks, slightly raised on ocellar region. Ocelli vestigial, amber, surrounding surface of ocelli at the internal region of ocellar triangle black, with thin brown setae. Antennae filiform, scape blackish brown, pedicel black, with fine amber setae; flagellum pale amber with 29 articles 1.5 times as long as wide, all covered with long yellowish setae and microtrichia. Compound eyes sub-spherical, as wide as 0.6 of the interocular distance at antenna insertion level, black. Frons mostly pale amber with blackish marks; clypeus pale amber, entire surface with scattered, fine, long, amber setae; labrum narrow, with anterior margin concave, pale amber with amber setae. Gena with a black mark, postgena dark amber. Maxilla with cardo and stipes pale amber, galea and lacinia dark amber, maxillary palpus 5-articulate, pale amber, with distal half of last palpomere black. Labium with pale amber mentum and ligula, labial palpus 3-articulate, pale amber, with distal half of last palpomere black. Occiput dark amber, rugose.

Thorax (figs 1b-d). Prothorax elongate, narrow, sub-rectangular, cervical sclerite pale amber with blackish suffusions and set with long pale amber setae; pronotum about 1.6 times as long as wide, mostly pale amber with two broad lateral black stripes and two posterodorsal black oval marks, covered with abundant long and thick setae, setal bases raised and black, forming distinct circular marks. Prothorax ventral region pale amber. Mesonotum as long as wide, scutum pale amber with subtriangular black marks on anterior and lateral regions, with long and thick setae black or dark amber, setal bases raised; scutellum whitish amber without black marks, with a few dark amber setae on posterior region. Metanotum slightly wider than long, with scattered, fine, long, dark or pale amber setae; scutum pale amber with two large subtriangular black marks; scutellum similar to mesoscutellum. Pteropleura mostly pale amber with black suffusions below wing bases and anterior region of katepisternum, entire surface with long, hair-like, pale amber setae.

Legs (fig. 1c). Predominantly pale amber, with small black spots on the setal base, especially on tibiae. Foreleg: elongated, subcylindrical, coxa with black mark on distal part, females with a patch of thick pedicellate setae on anterior surface, entire surface with long and thin setae; trochanter and femur with long, hair-like, pale setae; femur with long and pale setae, setal bases raised and black; tibia narrow with abundant long, and thin setae, outer surface with setal bases raised and with a blackish spots composing one narrow stripes on anterior region, apical region on inner surface with abundant short, pale amber setae; two short tibial spurs; first tarsomere as long as the following three together, last tarsomere slightly shorter than basitarsus, with distal half black; all the surface with thick, long, pale amber setae; tarsal claws dark amber, arolium present. Mid and hind leg with coxa, trochanter and femur pale amber, covered with long, hair-like, pale amber setae; apical region of femur with blackish setal bases on outer surface on outer surface; tibia narrow, with abundant long and thin setae, outer

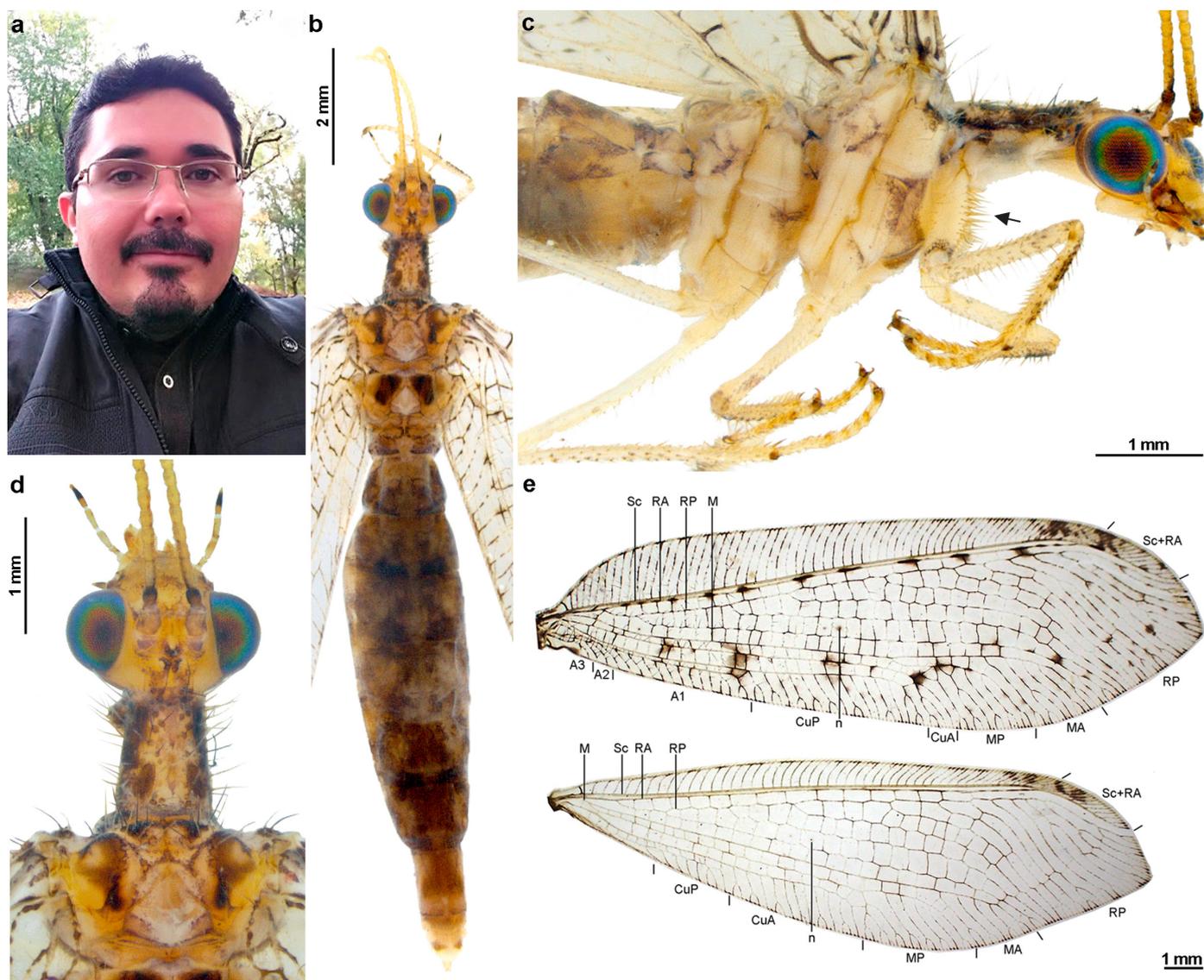


Figure 1 a) Dr. Daercio Adam de Araújo Lucena (for whom the new species was named). Holotype of *Isostenosmylus derpi* sp. n., female. b) Habitus dorsal; c) Thorax and head, lateral view (arrow indicating the coxal row of thick setae); d) Thorax and head, dorsal view; e) Wings. Abbreviations: A1-3, anal veins; CuA, cubitus anterior; CuP, cubitus posterior; MA, media anterior; MP, media posterior; n, nygma; RA, radius anterior; RP, radial posterior; and Sc, subcosta.

surface with setal bases raised and black, tibial spurs short; tarsomeres similar to that from foreleg.

Wings (fig. 1e). Forewing: elongate, broadened, posterodistal margin convex. Wing venation alternating pale- and dark greyish brown, with abundant long and fine setae of the same color as cuticle; trichosors present along wing margin except on wing base. Membrane mostly hyaline with 11 diffuse fuscous marks on crossveins of radial space extending to subcostal space, some diffuse fuscous marks on RP branches, base of MP, intracubital space, and between distal space of CuP and A1. Costal space broadened, wider basally than distally, with 73 crossveins (a few forked). Pterostigma weakly marked, greyish brown with pale amber areas, and 21 crossveins, all sinuous. Subcostal space with a single basal crossvein. Sc and RA merging at distal 1/6 of wing. Radial space with 22–24 crossveins; RP with nine branches, nygmata strongly marked, basal one located between base of RP1 and M, at RP1 fork level; distal nygma located between RP1 and RP2, slight beyond RP3 fork level. Outer gradate series distinct, inner gradate series not distinct. M vein forked at distal 1/3 length of wing; CuA bent posteriad on distal portion, slightly beyond M vein fork level, CuP running parallel to CuA,

with distal half pectinate branched, with 12 or 13 branches. A1 long, pectinate, terminating on posterior wing margin at RP2 origin level; A2 and A3 reticulate. Hind wing: elongate, shorter and narrower than forewing, with pointed apex; posterodistal margin slightly concave. Wing venation alternating pale and pale greyish brown, with abundant long, thin setae of the same color as cuticle; trichosors present along wing margin except on wing base. Membrane hyaline. Costal space slightly broadened on proximal 1/3 of wing length, narrow proximal- and distally, with 60–62 crossveins; pterostigma weakly marked with pale and greyish brown areas, composed of 16 crossveins. Subcostal space with a single basal crossvein, light amber. Radial space with 26 or 27 crossveins; RP diverging from RA near wing base, with 11 branches. Nygmata strongly marked, the basal one located between RP and M, just before the RP1 origin, distal nygma between RP1 and RP2 at RP3 origin level; outer gradates distinct, inner gradate series not distinct. M vein forked near wing base, before the origin of RP, MP forked at distal 1/3 of wing length. Cu vein forked near wing base, before M fork; distal part of CuA and CuP pectinate branched. A1 ending at the posterior wing margin opposite to RP1 origin level, A2 and A3 short.

Abdomen (fig. 1b). Tergites brown, with two darker marks, entire surface with abundant long, thin, pale brown setae. Pleural membrane brown, with abundant long, thin, pale brown setae. Sternites pale brown with dark brown areas, with abundant long, thin setae of the same color as cuticle.

Male unknown.

Female genitalia (figs 2, 3). Tergite 8 subquadrate, encircling the spiracle in lateral view, anteroventral corner ventrally projected, pointed. Sternite 7 with posterior margin subquadrate at medial region. Sternite 8, plate like, subtriangular in lateral view, anterior half with longitudinal median ridge; posterior region with a broad concavity, separated from anterior region by a transverse ridge, posterolateral corners with rounded, setose lobes. Tergite 9 narrow, ventrally projected, subrectangular, anteromedial corner with subtriangular projection, wider

than anterodorsal region, anteroventral corner rounded and setose. Gonocoxite 9 leaf-like, with anterior apex pointed, bearing two black lateral stripes: a smaller one near the base, and a larger one occupying almost the entire length of gonocoxite 9; gonostylus 9 mammilliform, setose. Gonapophyses 9 elongated and narrow, with basal projection; in lateral view strongly bent dorsad near mid-length, with an almost 90° angle, lobes subquadrate, directed ventrally; in ventral view, Y-shaped with two apical lobes anterolaterally directed, distal margin concave. Ectoprocts subtrapezoidal in lateral view, setose, dorsally fused, with black mark; callus cerci arranged in a rosette. Spermatheca ovoid.

Distribution (fig. 4). Brazil (Paraíba).

Habitat. *Isostenosmylus derpi* sp. n. was found in the municipality of Maturéia, Paraíba state, Brazilian Northeast. The type locality, "Pico do Jabre", is the highest point in Paraíba (1,208 m), Serra do Teixeira region,

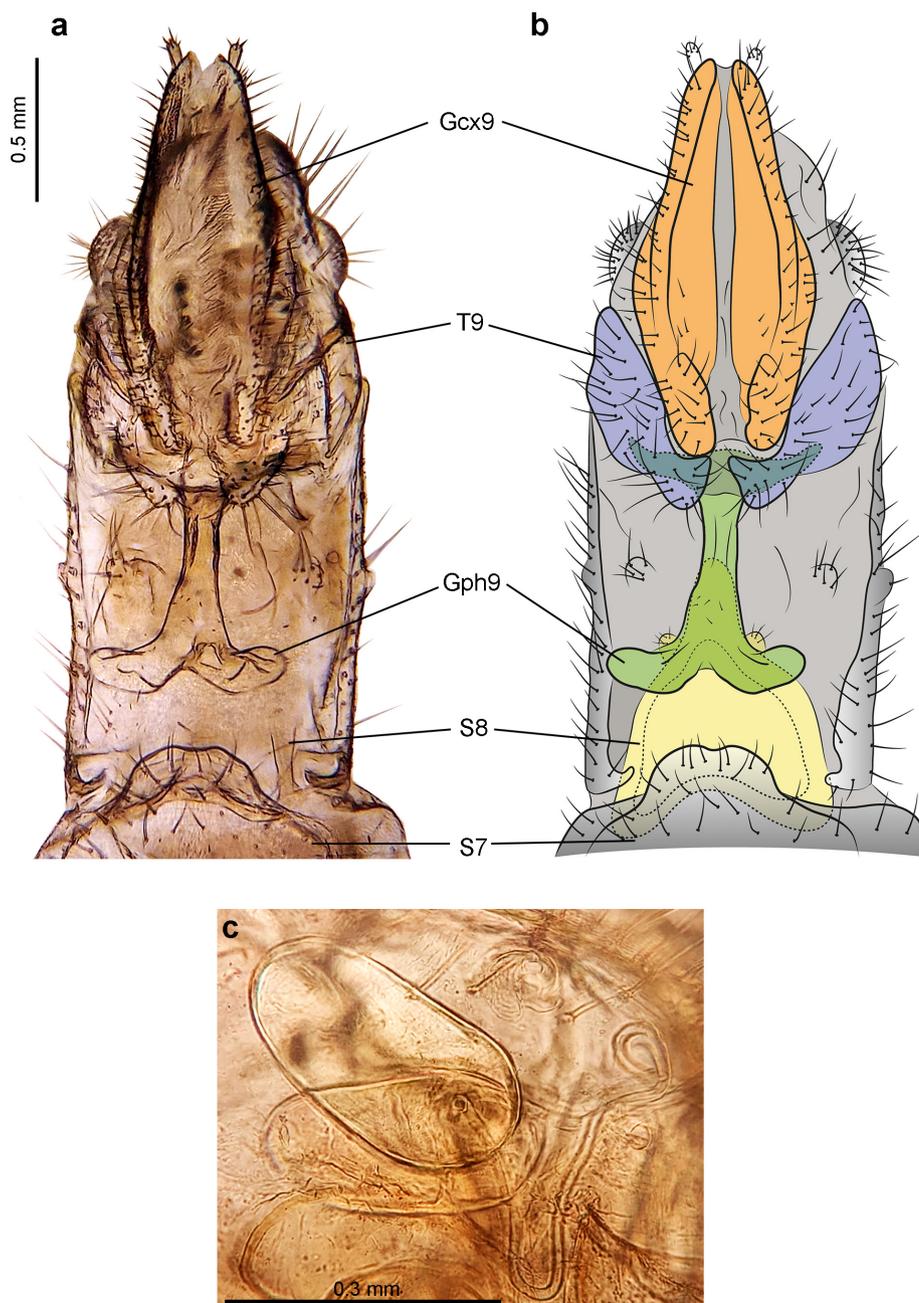


Figure 2 Holotype of *Isostenosmylus derpi* sp. n., female. a) Genitalia, ventral view; b) Morphological interpretation of genital sclerites in a; c) Spermatheca. Abbreviations: Gcx9, gonocoxites 9; Gph9, gonapophyses 9; S7, S8, sternites 7 and 8; T9, tergite 9. Colors: yellow (S8), green (Gph9), blue (T9), orange (Gcx9).

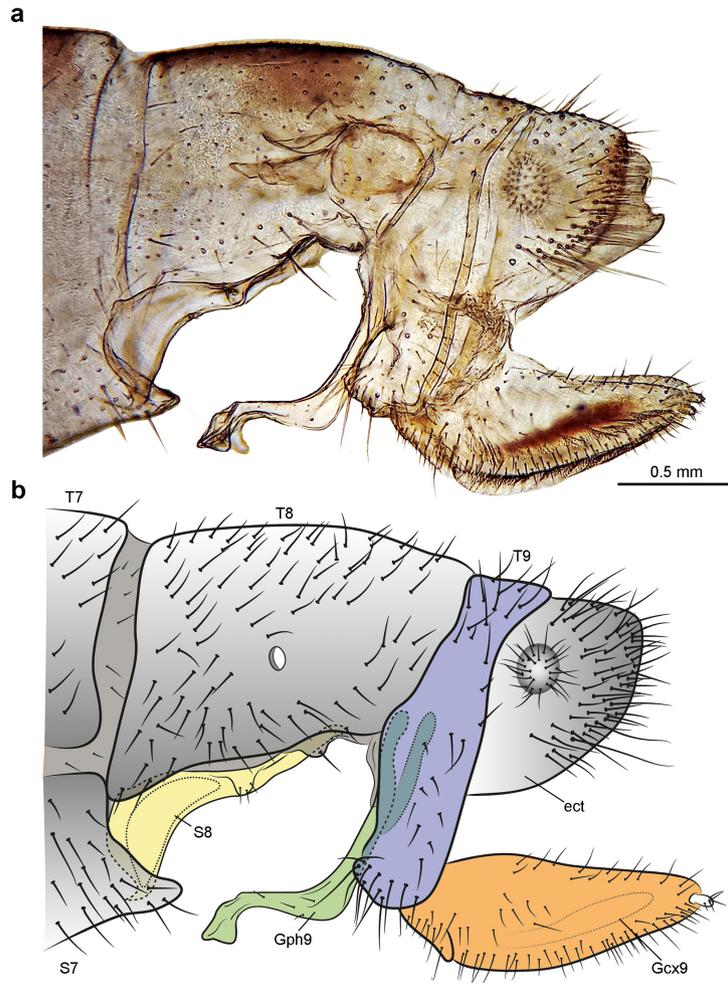


Figure 3 Holotype of *Isostenosmylus derpi* sp. n., female. a) Genitalia, lateral view; b) Morphological interpretation of genital sclerites in A. Abbreviations: ect, ectoproct; Gcx9, gonocoxites 9; Gph9, gonapophyses 9; S7, S8, sternites 7 and 8; T7-T9, tergites 7-9. Colors: yellow (S8), green (Gph9), blue (T9), orange (Gcx9).

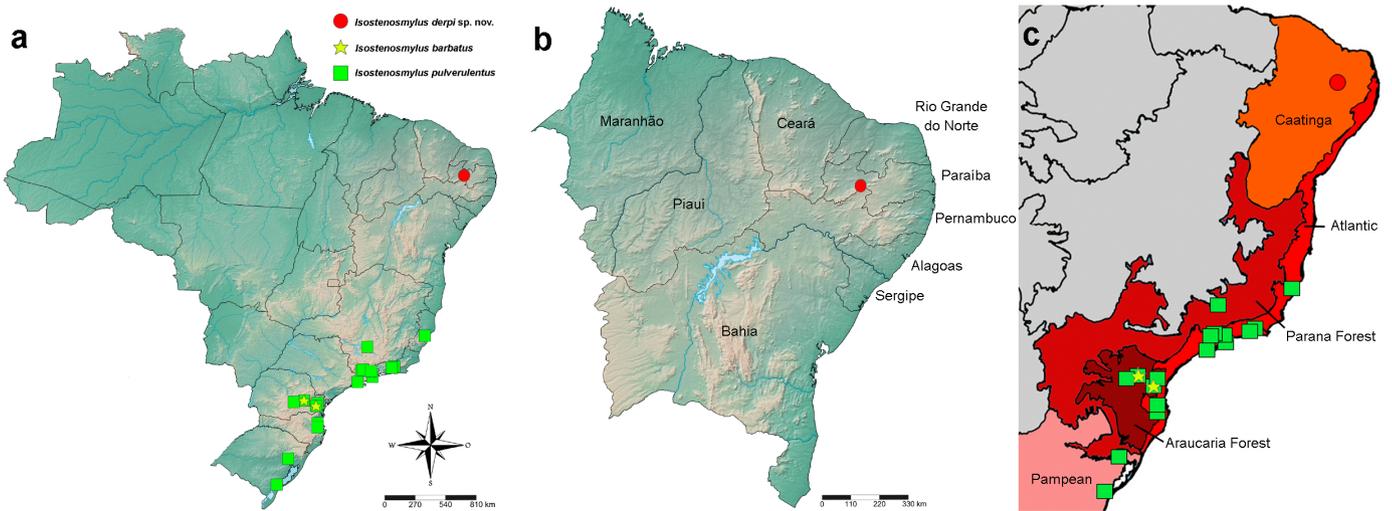


Figure 4 Distribution map of *Isostenosmylus* Krüger, 1913 (Osmylidae: Stenosmylinae) species from Brazil. a) Brazil, overview; b) Brazilian Northeast; c) Biogeographic provinces from Eastern Brazil, modified from Morrone (2014) and Löwenberg-Neto (2014).

an integral part of the Borborema Plateau. Pico do Jabre is related to a special habitat known as “Brejos de altitude” which is part of Brazilian Atlantic Forest. Brejos de Altitude areas are characterized by enclaves of Montane Semideciduous Seasonal Forest in Caatinga (Brazilian

semi-arid scrub forest), i.e. peaks with Atlantic Forest in the upper altitudes surrounded by elements of Caatinga in the lower altitudes. They are present only in Brazilian Northeast, and their existence is associated with the occurrence of plateaus, where orographic rains

guarantee precipitation levels exceeding 1200 mm/ year (Tabarelli and Santos, 2004). Recently, June 2023, the Serra do Teixeira National Park was founded, which covers 12 municipalities in Paraíba, including the type locality of the new species. The female specimens herein studied were collected at 1093 and 1140 m, a locality with high humidity all year long, and with a very strong wind during the species collection period (personal communication Daercio Lucena).

Taxonomic key to female *Isostenosmylus*

(after Martins et al., 2019; Ardila-Camacho et al., 2020)

(species not in the key: *I. bifurcatus*, *I. fusciceps*, *I. morenoi*, *I. nigrifrons*, *I. penai*)

1. Forecoxa with numerous, thick, pedicellate setae on the anterior surface (Martins et al. 2019: fig. 8d): *pulverulentus* clade..... **2**
- Forecoxa with scattered fine setae on the anterior surface (Martins et al., 2019: fig. 10d): *bifurcatus* clade..... **6**
2. Sternite 8 with medial lobes weakly developed (Martins et al., 2016: fig. 9c); gonapophyses 9 short, with distal half semitriangular with two pairs of distal short and blunt lobes, laterally on each side (Martins et al., 2016: fig. 9b) ***I. irroratus***
- Sternite 8 with medial lobes well developed (Martins et al., 2019: fig. 6d); gonapophyses 9 long with one or two distal, quadrangular lobes, laterally on each side (Martins et al., 2019: fig. 6) **3**
3. Gonapophyses 9 with one pair of distal lateral lobes (Martins et al., 2019: fig. 6) **4**
- Gonapophyses 9 with two pairs of distal lateral lobes (Martins et al., 2019: fig. 9) **5**
4. Head brown (Martins et al., 2019: fig. 5d); last maxillary and labial palpomere dark brown (Martins et al., 2019: fig. 5d); gonapophyses 9 slightly bent dorsal near mid-length, almost straight, with apical lobes directed caudally (Martins et al., 2019: figs 6a, b) ***I. apaapensis***
- Had pale amber (figs 1b-d); last maxillary and labial palpomere pale amber with distal half black (fig. 1b-c); gonapophysis 9 strongly bent dorsad near mid-length, with an almost 90° angle, with apical lobes directed ventrally (fig. 2) ***I. derpi* sp. n.**
5. Pronotum yellow with a lateral brown stripe (Martins et al., 2019: fig. 8b); gonapophyses 9 with distal lobes enlarged (Martins et al., 2019: fig. 9) ***I. barbatus***
- Pronotum yellow with dark-brown spots (Martins et al., 2019: fig. 27c); gonapophyses 9 with distal lobes shortened, dorsal ones conspicuously smaller than the ventral ones (Martins et al., 2016: fig. 26) ***I. pulverulentus***
6. Sternite 8 simple, plate-shaped, lacking prominent processes or ridges (Martins et al., 2019: fig. 13d); gonapophyses 9 short (Martins et al., 2019: figs 13, 14) **7**
- Sternite 8 elaborated, plate shaped with distinct processes or ridges (Martins et al., 2019: fig. 3d); gonapophyses 9 elongated or enlarged (Martins et al., 2019: figs 3, 11) **9**
7. Forecoxa with a dentiform process on the anterior surface (Martins et al., 2019: fig. 12d); gonapophyses 9 arrow-head shaped in ventral view (Martins et al., 2019: fig. 13d) ***I. jaguar***
- Forecoxa without processes on anterior surface (Martins et al., 2019: fig. 10d); gonapophyses 9 triangular (Martins et al., 2019: fig. 18d) or bilobed (Martins et al., 2019: fig. 11d) in ventral view **8**
8. Gonapophyses 9 with distal half triangular in ventral view, distal margin broadly concave (Martins et al., 2019: fig. 18d) ***I. triangulatus***
- Gonapophyses 9 with distal half bilobed in ventral view, distal margin with a median shallow incision (Martins et al., 2019: fig. 11d) ***I. inca***
9. Forewing narrow (Martins et al., 2019: fig. 2a); gonapophyses 9 enlarged and widened, with a median enlarged transverse ridge, apex bilobed (Martins et al., 2019: fig. 3) ***I. angustipennis***

- Forewing broadened (Martins et al., 2016: fig. 28a); gonapophyses 9 with a different shape (Martins et al., 2016: figs 18d, 28e) **10**
- 10. Gonapophyses 9 widened and X-shaped in ventral view (Martins et al., 2016: figs 12d, 15d) **11**
- Gonapophyses 9 narrow and Y-shaped in ventral view (Martins et al., 2019: figs 19d, 27d) **13**
- 11. Gonapophyses 9 with two apical lobes (Martins et al., 2016: fig. 12d) ***I. julianae***
- Gonapophyses 9 with four apical lobes (Martins et al., 2016: fig. 15d) ... **12**
- 12. Gonapophyses 9 in ventral view with apical and lateral lobes forming an angle of 45° (Martins et al., 2016: fig. 15d) ***I. contrerasi***
- Gonapophyses 9 in ventral view with apical and lateral lobes forming an angle of 90° (Ardila-Camacho et al., 2020: fig. 7) ... ***I. ammirabilis***
- 13. Forewing with numerous costal crossveins forked near costal margin (Ardila-Camacho and Noriega, 2014: fig. 2c); gonapophyses 9 with a basal enlarged lobe in lateral view (Ardila-Camacho and Noriega, 2014: fig. 3f); apex of gonapophyses 9 arms without mammilliform lobes (Martins et al., 2016: fig. 28e) ***I. septemtrionalandinus***
- Forewing with costal crossveins unforked or at least with few forks near middle of costal field (Martins et al., 2016: fig. 16b); gonapophyses 9 without basal enlarged lobe in lateral view (Martins et al., 2016: fig. 18a); apex of gonapophyses 9 arms with mammilliform lobes (Martins et al., 2016: fig. 18d) ***I. fasciatus***

Discussion

Isostenosmylus derpi sp. n. belongs to the *pulverulentus* clade – together with: *I. apaapensis* (Bolivia), *I. barbatus* (Argentina, Brazil), *I. irroratus* (Venezuela), and *I. pulverulentus* (Brazil, Paraguay) – sharing the forecoxae bearing numerous thick and prominent setae in the females, the unique synapomorphy of this group, as well as posterior margin of sternite 7 distinctly produced, anterior region of sternite 8 concave, and gonapophyses 9 long in lateral view (exceeding 3/4 of the tergite 8 length) with subquadrangular apical lobes (Martins et al., 2019). The new species seems closely related to *I. apaapensis*, both species have gonapophyses 9 with two apical lobes (four in the other three species of the clade *pulverulentus*), but *I. derpi* has the basal projection (most easily visible in lateral view), which is absent in *I. apaapensis* and present in the other three species of the clade.

Among the 18 species currently documented in *Isostenosmylus*, 14 have detailed descriptions of males. However, the females exhibit distinct diagnostic characters, particularly in their genitalia, facilitating their identification—an attribute shared by the newly discovered species. The discovery of this new species in northeastern Brazil is a surprise, since the other two species occurring in the same country – *I. pulverulentus* and *I. barbatus* – are registered only in southern and southwestern Brazil (Machado and Martins, 2022). This is by far the northernmost record of the family in Brazil, expanding its distribution by 1,444 km within the country; and the easternmost record of the family in South America, expanding its distribution by 373 km within the subcontinent. Despite the type locality of *I. derpi* being considered as part of Caatinga province (*sensu* Morrone, 2014), its type locality “Pico do Jabre” is an enclave of the Brazilian Atlantic Forest, i.e. *I. derpi* is closely related to the Atlantic province (fig. 4c). Interestingly, *I. apaapensis*, the species closest morphologically to *I. derpi*, has records at Yungas province from the South Brazilian dominion, and provinces of Chacoan dominion (Morrone, 2014) in Bolivia, separating both species. Based on previous records of the Brazilian species and this new discovery, it is possible that additional species of *Isostenosmylus* might be present in areas of the Atlantic Forest from the other northeastern Brazilian states, especially Bahia, Sergipe, Alagoas and Pernambuco.

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Conflicts of interest

The authors declare no conflicts of interest.

Author contribution statement

CCM, RJPM and AAC contributed to describing the species, analyzing the data, and writing the text. CCM prepared the images.

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