



# Taxonomic additions of the Brazilian fauna of *Prosierola* (Hymenoptera, Bethylinidae)

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**Abstract.** *Prosierola* is characterized by having a pair of conspicuous anteromedial metapostnotal foveae on the metapectal-propodeal disc. Little is known about this genus because it is rarely sampled in collections. Therefore, the main goal of this contribution is to expand the knowledge of intraspecific morphological variations and geographical distribution of its species that occur in Brazil. We sorted material from the main collections and obtained 69 specimens of *Prosierola nasalis* (Westwood) recorded for the first time from Maranhão, Minas Gerais, Pará, Rio Grande do Norte and Rio Grande do Sul; one of *Prosierola obliqua* Evans recorded for the first time from Distrito Federal; five of *Prosierola rotunda* Schiffer & Azevedo recorded for the first time from Pará; and 13 of *Prosierola rufescens* Evans recorded for the first time from Brazil (Amazonas, Bahia, Espírito Santo, Minas Gerais). The mesoscuto-scutellar foveae placed on the dorsal surface of the mesoscutellum shown to be highly variable in size, distance, and shape at both the intra- and interspecific levels.

**Keywords:** Bethylinae; Intraspecific variations; Morphology; Geographic distribution; Taxonomy.

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The subfamily Bethylinae comprises 12 genera and most of them have the well-established taxonomic frontiers (BARBOSA & MELO 2023). Among these genera, *Prosierola* is easily recognized by the presence of a pair of anteromedial metapostnotal foveae on the metapectal-propodeal disc; posterior margin of the pronotum slightly produced backward medially; the metapostnotum with a triangular area marked dorsal smooth; male genitalia with divided harpe and the female genitalia with distal region of the dorsal area of the 9 tergite enlarged. These five characters are synapomorphies for the genus (AZEVEDO 2008; AZEVEDO *et al.* 2018; RAMOS & AZEVEDO 2020). Another important feature of the *Prosierola* is a gibbous mesopleuron that, if viewed dorsally, is produced angularly or roundly. This condition is shared with its sister group, *Odontepyris* (AZEVEDO 2008; AZEVEDO *et al.* 2018; Ramos & Azevedo 2020).

The anteromedial metapostnotal foveae can vary in size (large or small), shape (elliptical, discal, circular, or oval) (AZEVEDO 2008) and can even be asymmetrical, with each one having a different size or shape. Despite being a key character for the identification of *Prosierola*, considered autapomorphic to the genus (POLASZEK & KROMBEIN 1994), it has little taxonomic value, when used to differentiate species of *Prosierola*, due to its highly plastic nature.

Currently, the genus has only seven valid species, *Prosierola cubana* Evans, *Prosierola flavicoxis* (Kieffer), *Prosierola nasalis* (Westwood), *Prosierola obliqua* Evans, *Prosierola rotunda* Schiffer & Azevedo, *Prosierola rufescens* Evans and †*Prosierola submersa* Brues, of them, three have previously been found in Brazil: *P. nasalis*, *P. obliqua* and *P. rotunda* (AZEVEDO 2008).

The genus is not commonly found in Bethylinidae samples, and little is known about its lifestyle. *Prosierola* is known to attack larvae of Lepidoptera, characteristic found in unusual uniformity in Bethylinae, with most other bethylids preferring coleoptera larvae. *P. obliqua* is known to parasitize the Hesperidae family, even showing maternal care, staying in hiding with the paralyzed larvae (MUESEBECK & WALKER 1951; EVANS 1964; MURGAS 2005, 2008; RAMOS & AZEVEDO 2020). This behavior probably protects the progenie from hyperparasitoids and the larvae from other parasitoids (multi-parasitoidism) (DOUTT 1973).

All of its taxonomic information and geographic distribution are available in the synopsis proposed by AZEVEDO (2008), and since then, there have been no studies focused on the group. Therefore, our main goal is to expand the knowledge about the geographical distribution and taxonomy of the Brazilian *Prosierola*, as well as to describe new intraspecific morphological variations.

## MATERIALS AND METHODS

We examined about 250,000 Bethylinidae specimens from various collections around the world and were able to sort only 88 specimens of Brazilian *Prosierola*, which belong to the following institutions: CPDC - Centro de Pesquisa do Cacau, CEPEC-CEPLAC (J.H.C. Delabie),

CZMA - Coleção Zoológica do Maranhão (F. Limeira-de-Oliveira), INPA - Instituto Nacional de Pesquisas na Amazônia (M.L. de Oliveira), MPEG - Museu Paraense Emílio Goeldi (O.T. Silveira), UFES - Universidade Federal do Espírito Santo (M.T. Tavares).

The specimens were captured using Malaise, Shannon, or suspended traps. Species identification follows AZEVEDO (2008) and terminology for general morphology follows LANES et al. (2020).

Photos were taken using a Leica Z16 APO stereomicroscope attached to a Leica DFC video camera with lighting dome, following the method described by KAWADA & BUFFINGTON (2016). Images were captured with extended focus using the LAS program by Leica Microsystems (Leica Application Suite v.4.3.0, Switzerland) and combined with the Helicon Focus program (v.6.3.6, Helicon Soft, Dominica).

The maps were made in the geoprocessing software QGIS, from the geographic coordinates available on the labels of each specimen studied. The cartographic base referring to Brazil biomes originates from the base of the Instituto Brasileiro de Geografia e Estatística (IBGE) available from the Geoscience website.

## RESULTS

### *Prosierola nasalis* (Westwood, 1874)

(Figures 1A-C, 2A)

Females of this species can be distinguished from other *Prosierola* species by the following characteristics: the vertex without an evident callus; the head is somewhat rounded on frontal view, and is slightly longer than it is wide; the frontal line extends to about half the length of the eyes; the mesoscuto-scutellar foveae are distant from each other by about 2.0× their diameter, with the presence or absence of a sulcus connecting them; the mesopleuron is angularly produced; the anteromedial metapostnotal foveae mainly exhibit a discal shape.

In females of this series, we observed the following variations: one female displays a testaceous-castaneous coloration; the forewings are strongly yellowish in larger specimens, while they are weakly yellowish in smaller specimens or even subhyaline; the depth of the mesoscuto-scutellar sulcus can vary from shallow to deep; the mesoscuto-scutellar foveae exhibit significant variations in distance and shape, ranging from circular, oval, to slightly elliptical, and are spaced apart by about 1.0-4.0× their diameters; the anteromedial metapostnotal foveae on the metapectal-propodeal disc can be elliptical, oval, and discal, they are asymmetrical in several specimens; the metapostnotal-propodeal carinae can be more accentuated and converge posteriorly.

Males of this species can be distinguished from other *Prosierola* species by the following characteristics: larger ocelli, which are closely located to the vertex; the frontal line extends to the anterior ocelli; the pronotal collar is carinated; the mesopleuron is roundly produced; the mesoscuto-scutellar foveae are semi-circular and separated from each other by about 1.0-2.0× their diameters, connected by an evident sulcus.

**Material examined:** BRAZIL: **Amazonas**, Manaus, 1 female, AM-010.Km.31 Embrapa, 26.ii.1992, L.P. Albuquerque, J.Binda, Arm. Shannon, C. Guaraná, Isca. Fruta, 26.ii.1992 (INPA); 2 females, Base de Instrução-2, 06.X-20.XI.1997, J.Vidal col. (INPA); 2 females, clareira, 10-20.XI.1997, arm Malaise (INPA); 1 female, mata, 21-31.VII.1997, arm. Malaise (INPA); 1 female, Reserva 1112, Lateral leste, 03.X.1984, rede, Bert Klein col.

(INPA); 1 female, Reserva 1501, Km 41, 18-30.IX.1995, arm. Malaise, (INPA); 1 female, Reserva Ducke, 24.VII.1990 Malaise, L.Ulisses col. (INPA); Novo Aripuanã, 1 female, Reserva Soka, 05°15'53"S 60°07'08"W, 17-25.VIII.1999, Arm. Malaise, J.F. Vidal & A.L. Henriques col. (INPA); Presidente Figueiredo, 1 female, 02°01'05"S, 59°49'59"W, 04-08.IX.2008, arm. Malaise, T.R Krolow & F.F. Xavier F°col. (INPA); Novo Airão, 1 female, Parq. Nac. do Jaú, Rio Jaú, Joca, 27.IV-03.V.1995, (INPA); **Bahia**, 1 female, Iguai, Faz. Monte Video, 14°42'S 40°00'W, 30.XI.2002, arm. Malaise (CPDC); 1 female, Ilhéus, CPDC/CEPEC, 31.xii.2002, (UFES 59798); 1 female, Itororó, Faz. Santa Cruz, 15°01'S 040°02'W, 24.XI.2002, arm. Malaise (CPDC); **Espírito Santo**, 1 female, Itaguaçu, Alto Lajinha, Fazenda Binda, 19°48'S 40°48'W, 22-29.ix.2008, Malaise, M.T. Tavares & eq. col. (UFES 83340); **Maranhão**, 1 female, Carolina PARNA Chapada das Mesas, Riacho Cancela 255 m, 07 06 44.2S/47 17 56.8W, armadilha Malaise, 01-15.vii.2013, JA Rafael, F Limeira-de-Oliveira, TTA Silva cols. (CZMA); 1 female, Riacho Estiva, 265m, 07°06'59.8"S/47°21'21"W, Suspensa lâmina d'água, 15-31.vii.2013, (CZMA); 1 female, Riacho Sucuruíu 240 m, 07°06'44.2"S/47°17'56.8"W, armadilha Malaise, 15-31.vii.2013, JA Rafael, F Limeira-de-Oliveira, TTA Silva cols. (CZMA); 1 female, 07°07'05"S/47°18'31.6"W, 22-01.iii.2014, (CZMA); Carolina, 240m, PARNA Chapada das Mesas, Riacho Sucuruíu, 07°07'05.6"S/47°18'31.6"W, JA Rafael, F Limeira - de - Oliveira, T.T.A. Silva, cols., 1 female, Suspensa simples (5m), 01-10.ii.2014 (CZMA); 1 female, 20-31.i.2014, JA Rafael, F Limeira-de-Oliveira, TL Rocha, S Pereira cols. (CZMA); 2 females: armadilha de Malaise, 20-31.viii.2013 (CZMA); 1 female: armadilha de Malaise, 14-30.vi.2013 (CZMA); 1 female, Carolina, PARNA, Chapada das Mesas, Riacho Sucuruíu, Arm. Malaise, 08.v.2014 (CZMA); 1 female, Caxias, Res. Ecol. Inhamum, Armadilha Malaise, 08-11.xi.05, GA Cunha col. (CZMA); 2 female, 08-11.xi.2005, GA Cunha col. (CZMA); 2 female, 11-15.xi.2005, GA Cunha col. (CZMA); 1 female, 15-19.xi.2005, GA Cunha col. (CZMA); 1 male, Zona Rural, Riacho Limpeza 04°43'05"S/ 43°15'16"W, Varredura, 24.vii.2012, JA Rafael, F Limeira-de-Oliveira, JS Pinto Junior cols (CZMA); 1 female, Mirador, Parque Estadual Mirador, Armadilha de Malaise, 1-10.xi.2013 (CZMA); 1 female, Base da Geraldina, Armadilha Suspensa, 10-20.xi.2013 (CZMA); 1 female, 419m, 06 37 25 S/45 52 08 W, Armadilha de Malaise, 01-10.x.2013, F Limeira-de-Oliveira, LLM Santos, TL Rocha cols, (CZMA); **Minas Gerais**, Marliéria, P. E. Rio Doce, Área Tereza, 19°37'S 42°34'W, arm. Malaise, JCR Fontenelle col., 2 female, 1.XI.2001 (UFES 100878, 100879); 1 female, 7.XI.2002 (UFES 102231); 1 female, 7-14.VII.2002 (UFES 102861); 1 female, 10-17.VII.2001 (UFES 100902); 1 female, 15-22.X.2005 (UFES 100764); 1 female, 18-25.X.2001 (UFES 102188); 1 female, 19-26.X.2000 (UFES 102782); 3 females, 24.X.2002 (UFES 101590, 101591, 101600); 2 female, 24-31.X.2002 (UFES 101713, 101724); 1 female, 26.X-2.XI.2003, Molecular MR1.12, (UFES 102732); 1 female, 26.X-2.XI.2003 (UFES 102733); Mata do Gambá, 1 female, 15-22.X.2005 (UFES 102929); 1 female, 28.X-4.XI.2007 (UFES 103005); Mata Vinhático, 1 female, 11-18.II.2007 (UFES 103910); 2 females, 28.X-4.XI.2007 (UFES 104337, 104346); **Pará**, 1 female, Canaã dos Carajas, mata, 26.VII.2004, arm. Malaise, R. M. Valente & E. M. Santos col. (MPEG); 1 female, prox. Igarapé fumaça, mata, 6,4°48'85"S 49,8°77'00"W, 27.XI.2005, (MPEG); Tucuruí, 1 female, Morro do Senador, 03°59'23"S 49°44'45"W, 01.XII.2001, Arm. Malaise, JA Rafael & J. F. Vidal col. (INPA); Vitória do Xingu, 1 female, Rio Xingu, Igarapé Gaioso, 12-16.VIII.2008, arm. Malaise, O.T. Silveira & equipe col. (MPEG); **Rio Grande do Norte**, 1 female, Mossoró, Fazenda Sta Julia, Caatinga, 05°01'10"S 37°22'56"W, 06.III.2007, arm. Malaise - 02, D.R.R. Fernandes e eq. col. (UFES 32125); **Rio Grande do Sul**, Morro Redondo, 101m, 31° 40'22"S 52° 35' 30"W, 09.IV.2004, arm. Malaise, R.F. Krüger col., 1 female, (UFES 30330); 1 female, 27.II.2004 (UFES 30237); 1 female, 14.II.2003 (UFES 16616); 1 female, 16.I.2004 (UFES 16624); 1 female, 19.III.2004 (UFES

16604); Pelotas, 1 female, 16m, 31°44'39"S 52°13'22"W, 11.VII.2003, arm. Malaise, R.F. Krüger col. (UFES 30280); **Roraima**, Rio Uraricoera, 1 female, Ilha Maracá, 02-13.V.1987, arm. Malaise, JA Rafael e equipe col. (INPA); 1 female, 21-30.xi.1987, JA Rafael e equipe, Armadilha de Malaise, (INPA).

**Distribution:** This species was previously known from Brazil (Acre, Amazonas, Bahia, Espírito Santo, Mato Grosso, Roraima, São Paulo, Santa Catarina), Colombia, Panama, Trinidad & Tobago, and Venezuela (AZEVEDO 2008). It has now been recorded for the first time from the Brazilian states: Maranhão, Minas Gerais, Pará, Rio Grande do Norte and Rio Grande do Sul.

#### ***Prosierola obliqua* Evans, 1974**

(Figures 1D-F, 2B)

*Prosierola obliqua* can be identified by the following characteristics: the head is wider than long; the presence of a callus on the vertex of the head; the mesoscuto-scutellar foveae are small, elliptical and far apart; the mesopleuron is angularly produced.

In this series, we observed the following variations: the distance between mesoscuto-scutellar foveae was 3-5× their diameters in the previously studied material (AZEVEDO 2008), but in the specimen reviewed, foveae are distant from each other by about 7.0× their diameters; the anteromedial metapostnotal foveae can be asymmetrical, also not showed in previous works.

**Material examined:** BRAZIL, **Distrito Federal**, Brasília, 1 female, FAL - 40 Larva 119, *Miconia albicans*, I. R. Diniz, (UFES, n°150914).

**Distribution:** This species was previously known from Panama, Bolivia, Paraguay, and Brazil (Maranhão, Pernambuco) (AZEVEDO 2008). It has now been recorded for the first time from the Brazilian state of Distrito Federal.

#### ***Prosierola rotunda* Schiffler & Azevedo, 2002**

(Figs 1G-I, 2C)

*Prosierola rotunda* can be identified by the following characteristics: the vertex without a evident callus; the head has a rounded shape on frontal view; the clipeus is semi-circular, short and flat; the mesopleuron is produced roundly, not angularly, and presenting more close to the metapectal-propodeal complex than the mesoscutellum; the anteromedial metapostnotal foveae are elliptical and very close to each other, these may be asymmetrical.

In this series, we observed the following variations: the distance between mesoscuto-scutellar foveae vary between 1-3× their diameter, the shape can be elliptical and semi-circular; the anteromedial metapostnotal foveae are mainly elliptical, but can be asymmetrical.

**Material examined:** BRAZIL: **Amazonas**, Manaus, 1 female, Base de Instrução-2, mata, Igarapé, 21-30.X.1997, arm. suspensa (INPA); 1 female, Reserva Ducke, Rod. AM 010, Km 26, mata, IX.2001, arm. Malaise, J.F. Vidal col. (INPA); 1 female, Reserva 1501, km 41, 18-30.IX.1995, arm Malaise (INPA); 1 female, Res. Soka, Nova Aripuanã, Borda, 10-13.XII.1999, Arm. Malaise, J.F. Vidal col. (INPA); **Pará**, 1 female, Melgaço, Floresta Nacional Caxiuanã, Trilha Igarapé Tijucaquara, 18.XI-24.XI.2003, Arm. Malaise 10, A.P. Aguiar & J.D. Dias, Ponto P05117 (MPEG).

**Distribution:** This species was previously known from Brazil (Amazonas) (AZEVEDO 2008), and now it is recorded for the first

time from the Brazilian state of Pará.

#### ***Prosierola rufescens* Evans, 1964**

(Figures 1J-L, 2D)

*Prosierola rufescens* can be identified by the following characteristics: the presence of a callus on the vertex of the head; the head is wider than longer; the mesoscuto-scutellar foveae are big and very close together; the mesopleuron is angularly produced.

In this series, we found the following variation: the mesoscuto-scutellar foveae can be circular or semi-circular, with their distance from each other is 1.0 to 2.0× their diameters; the anteromedial metapostnotal are elliptical or semi-circular.

**Material examined:** BRAZIL: **Amazonas**, 1 female, Manaus, Reserva 1401, Gaviao, 16-31.X.1995, arm. Malaise (INPA); **Bahia**, 1 female, Dário Meira, Faz. Maria Bonita, 14°26'S 39°55'W, 19.XI.2002, arm. Malaise (CPDC); Ubaitaba, 1 female, Faz. Casarão de Pedra, 14°18'S 39°19'W, 09.IV.2003, arm. Malaise (CPDC); 1 female, Faz. Fortaleza, 14°18'S 39°19'W, 13.XII.2003, arm. Malaise, (CPDC); Uruçuca, 1 female, Faz. Brasil, 14°33'S 39°21'W, 24.XI.2002, arm. Malaise (CPDC); 1 female, Faz. Guarany, 14°34'S 39°19'W, 23.XI.2003, arm. Malaise (CPDC); **Espírito Santo**, 1 female, Laranja da Terra, Joatuba - Faz. Betzel, 280-430, 19°50'25"S 40°49' 40"W, 05-12.x.2012, Malaise B-3, M.T. Tavares & eq. col. (UFES 134383); **Minas Gerais**, Marliéria, P.E. Rio Doce, Área Tereza, 19°37'S 42°34'W, arm Malaise, JCR. Fontenelle col. 1 female, 2-9. XI.2003 (UFES 102217); 1 female, 9-16.XI.2003 (UFES 101653); 1 female, 16.XI.2000 (UFES 102766); 1 female, 24.X.2002 (UFES 101595); 1 female, 26.X-2.XI.2003 (UFES 102731); 1 female, 27.X-2.XI.2004 (UFES 102265).

**Distribution:** This species was previously known from Colombia, Ecuador and Paraguay (AZEVEDO 2008), and now it is recorded for the first time from the Brazilian states: Amazonas, Bahia, Espírito Santo, Minas Gerais.

## DISCUSSION

Bethylid species can be found in various Brazilian biomes, ranging from rainforests (AZEVEDO & SANTOS 2000) to savannas (ARANDA & GRACIOLLI 2015). Despite this wide distribution, *Prosierola* is rarely captured, regardless of trap type or vegetation type (AZEVEDO 2008).

Studies about biological aspects and parasitoid specificity of *P. obliqua* (MURGAS 2005, 2008), show that most of the adults that emerge from the larvae are females, that could be due to a infection of the symbiotic bacteria, *Wolbachia pipientis* (Hertig), that is lethal to male parasitoids (STOUTAHAMER 1997). The presence of *Wolbachia* in DNA of Bethyilidae was reported by MARTINELLI *et al.* (2017). This, combined with the fact that *Prosierola* rarely is captured, could be the reason why so few males were found. Regardless, further studies about the biology and behavior of *Prosierola* are necessary for a more accurate answer.

Until now, the data available in the literature for *Prosierola* were based on only 82 specimens. In this study, we got an additional 88 specimens, effectively doubling the number of specimens studied.

Among the species studied, *P. nasalis* occurs in almost all Brazilian biomes, except for the Pantanal (Figure 2A), likely due to a lack of field expeditions. *Prosierola rotunda* appears to be restricted to the Amazonian Forest (Figure 2C). The type specimen was collected in Manaus, and our study identified several specimens with the same occurrence, suggesting the likely presence of more specimens in this region and others.

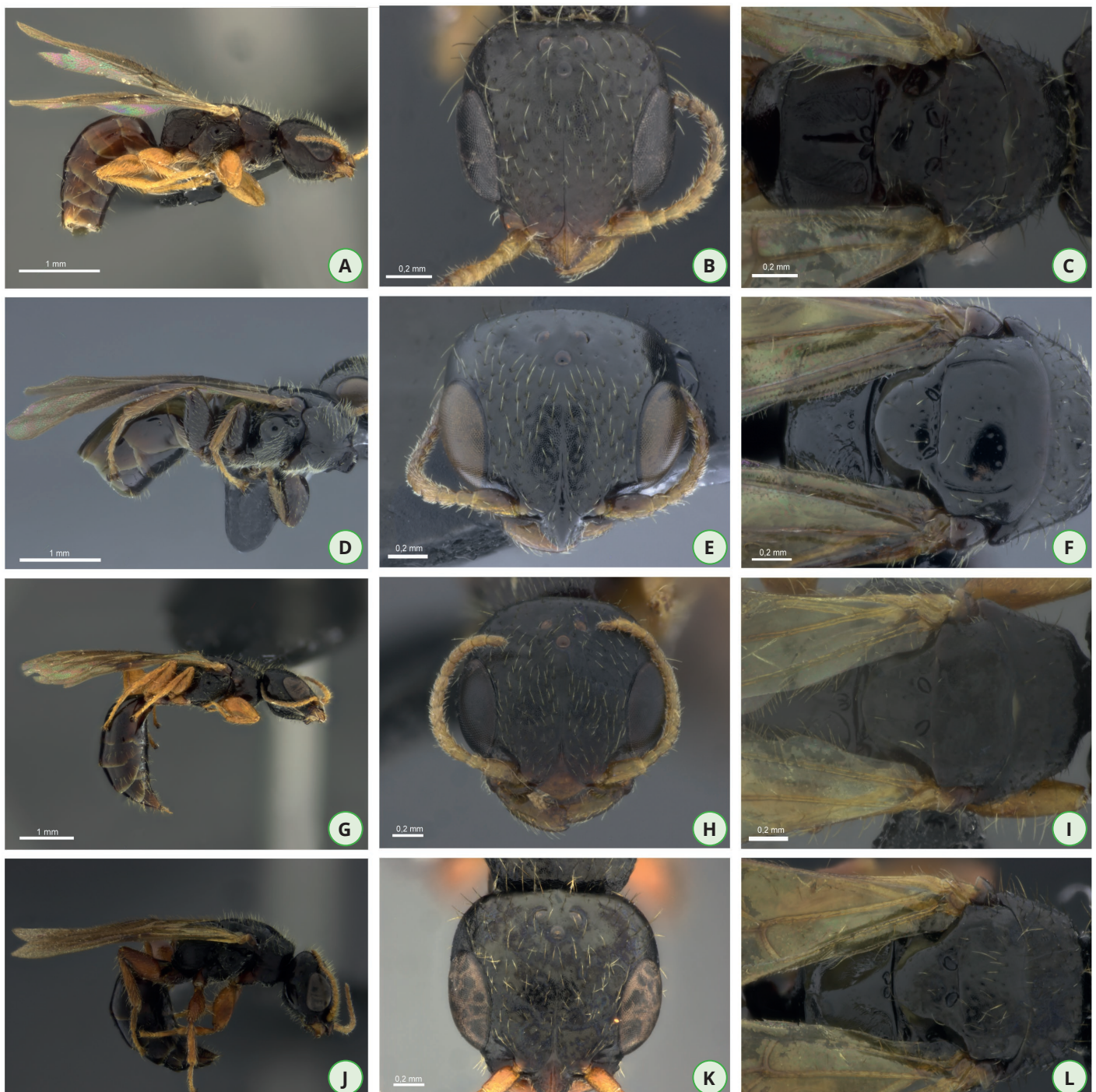


In contrast, *P. rufescens* exhibits a discontinuous distribution, occurring in both the Amazonian and Atlantic rainforests (Figure 2D). These differences may be attributed to various factors, including the use of different collection methods, so different groups and species within the same group may respond in a distinct way to trapping methods (LARSEN et al. 2014); variations in vegetation types, which can influence food sources; the presence of natural enemies (AMINAH et al. 2020); and variations in sampling efforts across different regions of the country. *Prosierola obliqua* is recorded for the first time from Distrito Federal within a Cerrado region (Figure 2B). However, it is expected to have a broader distribution in the Neotropical region, as this species has already been recorded in rainforests areas in Panama, Bolivia, Paraguay, and Brazil (Maranhão and Pernambuco).

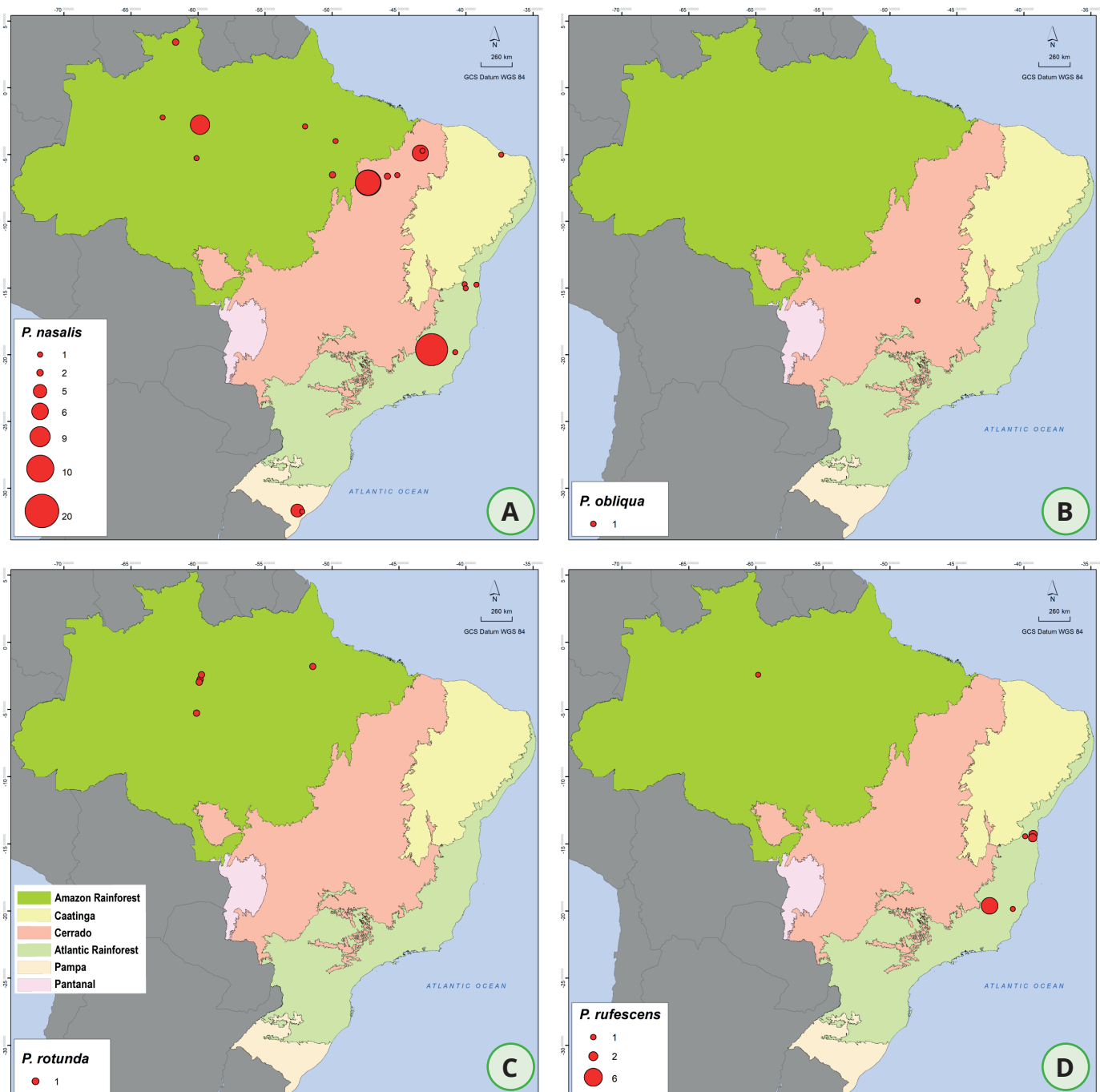
The mesoscuto-scutellar foveae are one of the main characteristics studied for the identification of *Prosierola* (AZEVEDO 2008; AZEVEDO et al. 2018). In our study, these structures

exhibited significant variation among the species, particularly concerning the distance and size between them. These differences are crucial for expanding our understanding of the genus and can contribute to future studies.

Therefore, the expansion of knowledge regarding the geographical distribution and morphological variations of *Prosierola* could help future taxonomic studies; inspire researchers to explore new collection methods and enhance sampling effort.



**Figure 1.** *P. nasalis*: A. Lateral view of mesosoma, B. Head, C. Dorsal view of mesosoma; *P. obliqua*: D. Lateral view of mesosoma, E. Head, F. Dorsal view of mesosoma; *P. rotunda*: G. Lateral view of mesosoma, H. Head, I. Dorsal view of mesosoma; *P. rufescens*: J. Lateral view of mesosoma, K. Head, L. Dorsal view of mesosoma. Photo by: Leonardo Rezeda Pereira.



**Figure 2.** Distribution of specimens in Brazilian biomes: **A.** *P. nasalis*; **B.** *P. obliqua*; **C.** *P. rotunda*; **D.** *P. rufescens*. Maps by: Matheus de Oliveira Fernandes Adão

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**REFERENCES**

Aminah, SN, T Abdullah, A Nasruddin & NA Sari, 2020. Effectiveness various kind traps for insect control based environmental friendly ways, IOP Conference Series: Earth and Environmental Science, 575. DOI: <https://doi.org/10.1088/1755-1315/575/1/012088>

Aranda, R & G Graciolli, 2015. Spatial-temporal distribution of the Hymenoptera in the Brazilian Savanna and the effects of habitat heterogeneity on these patterns. *Journal of Insect Conservation*, 19: 1173-1187. DOI: <https://doi.org/10.1007/s10841-015-9832-z>

Azevedo, CO, IDCC Alencar, MS Ramos, DN Barbosa, WD Colombo, JMR Vargas & J Lim, 2018. Global guide of the flat wasps (Hymenoptera, Bethylinidae). *Zootaxa*, 4489: 1-294. DOI: <https://doi.org/10.11646/zootaxa.4489.1.1>

Azevedo, CO & HS Santos, 2000. Perfil da fauna de himenópteros parasitóides (Insecta, Hymenoptera) em uma área de Mata Atlântica da Reserva Biológica de Duas Bocas, Cariacica, ES, Brasil. *Boletim do Museu de Biologia Mello Leitão*, 11/12: 117-126.

Azevedo, CO, 2008. Synopsis of *Prosierola* (Hymenoptera: Bethylinidae), *Zootaxa*, 1912: 45-58

Barbosa, DN & GAR Melo, 2023. Revision of Bethylinae from Dominican amber, with description of a new genus (Hymenoptera, Bethylinidae). *Journal of Hymenoptera Research*, 96: 167-180.

- Doutt, RL, 1973. Maternal care of immature progeny parasitoids. *Annals of the Entomological Society of America*, 66: 486-487. DOI: <https://doi.org/10.1093/aesa/66.2.486>
- Evans, HE, 1964. A synopsis of the American Bethylinidae (Hymenoptera, Aculeata). *Bulletin of the Museum of Comparative Zoology*, 132: 1-222.
- IBGE – Instituto Brasileiro de Geografia e Estatística, 2019. *Biomass e Sistema Costeiro-Marinho do Brasil*. Escala, v. 1, n. 250000. Available in <<https://www.ibge.gov.br/geociencias/informacoes-ambientais/estudos-ambientais/15842-biomass.html?edicao=25799>>
- Lanes, GO, R Kawada, CO Azevedo & DJ Brothers, 2020. Revisited morphology applied for Systematics of flat wasps (Hymenoptera, Bethylinidae). *Zootaxa*, 475: 1-127, DOI: <https://doi.org/10.11646/zootaxa.4752.1.1>
- Larsen, NJ, MA Minor, RH Cruickshank & AW Robertson, 2014. Optimising methods for collecting Hymenoptera, including parasitoids and Halictidae bees, in New Zealand apple orchards. *Journal of Asia-Pacific Entomology*, 17: 375-381, DOI: <https://doi.org/10.1016/j.aspen.2014.03.004>
- Kawada R & ML Buffington, 2016. A scalable and modular dome illumination system for scientific microphotography on a budget. *PLoS One*, 11: 1-20, DOI: <https://doi.org/10.1371/journal.pone.0153426>
- Martinelli, AB, Waichert C, Barbosa DN, Fagundes V, Azevedo CO, 2017. The use of Proteinase K to access genitalia morphology vouchering and DNA extraction in minutes wasps. *Anais da Academia Brasileira de Ciências*, 89: 1629-1633. DOI: <https://doi.org/10.1590/0001-3765201720160825>
- Muesebeck, CFW & LM Walkley, 1951. Family Bethylinidae, pp 726-734. In: Muesebeck, CFW, KV Krombein & HK Townes (Eds.). *Hymenoptera of America North of Mexico: Synoptic Catalog*. Agricultural Monograph. United States Department of Agriculture, Washington, D.C.
- Murgas, AS, 2005. Primer registro de *Prosierola oblicua* Evans (Hymenoptera: Bethylinidae) y aspectos bioecológicos del parasitoide de *Quadrus contubernalis* Mabille (Lepidoptera: Hesperiiidae) en Panamá. *Tecnociencia*, 7: 35-42
- Murgas, AS, 2008. Especificidad parasítica de *Prosierola oblicua* Evans, 1964 (Hymenoptera: Bethylinidae) sobre larvas de Hesperiiidae (Lepidoptera) dobladoras de hojas. *Tecnociencia*, 10: 81-93.
- Polaszek, A & KV Krombein, 1994. The genera of Bethylinae (Hymenoptera: Bethylinidae). *Journal of Hymenoptera Research*, 3: 91-105.
- Ramos, MS & CO Azevedo, 2020. Revisited phylogeny of Bethylinae (Hymenoptera: Bethylinidae) solves basal polytomy. *Insect Systematics & Evolution*, 51: 296-246, DOI: <https://doi.org/10.1163/1876312X-00002202>
- Stouthamer, R, 1997. *Wolbachia* induced parthenogenesis, pp 155-175. In: O'Neill, SL, AA Hoffmann & JH Werren, Editores. *Influential Passengers: Inherited microorganisms and invertebrate reproduction*. Oxford University Press.

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