Boletín de la Sociedad Zoológica del Uruguay, 2022
Vol. 31 (2): e31.2.2
ISSN 2393-6940
https://journal.szu.org.uy
DOI: https://doi.org/10.26462/31.2.2

GENERA COMPOSITION OF BETHYLIDAE (HYMENOPTERA, CHRYSIDOIDEA) FROM EASTERN URUGUAY

Wilson J. Marques Jr.[1*], Gustavo K. Campos[1], Wesley D. Colombo[2*], Isabel D. C. C. Alencar[1], Nelson W. Perioto[3], Rogéria I. R. Lara[3], Enrique Castiglioni[4] & Celso O. Azevedo[2]

[1]Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo. Av. Vitória, 1729, 29040-780, Vitória, ES, Brazil.
[2]Universidade Federal do Espírito Santo, Departamento de Ciências Biológicas. Av. Fernando Ferrari, 514, 29075-910, Vitória, ES, Brazil.
[3] Instituto Biológico, Laboratório de Sistemática e Bioecologia de Predadores e Parasitoides. Av. Bandeirantes, 2419, 14030-670, Ribeirão Preto, SP, Brazil.
[4] Universidad de la República, Centro Universitario Regional del Este. Ruta Nacional nº 9 intersección con Ruta Nacional nº 15, Rocha, Uruguay.

*Corresponding authors: wilsonjmarquesj@gmail.com; wesleycolombo@gmail.com

Fecha de recepción: 21 de enero de 2022
Fecha de aceptación: 26 de setiembre de 2022

ABSTRACT

The flat wasps Bethylidae are the largest family of Chrysidoidea. Because of their undeniable ecological contribution, these insects are also important due to their potential use as biological controllers of Coleoptera and Lepidoptera that act as agricultural pests. This is the first study focused on the diversity of Bethylidae in Uruguay and the attempt to get to know the Bethylidae fauna of this country. They were collected from three environments, natural field area (NFA), pasture system area (PSA), integrated livestock production system with winter and summer agriculture (IAAa and IAAb) near Castillos, Rocha Department, Uruguay, between December 2014 and December 2016. A total of 682 bethylids were collected, representing four subfamilies and 13 genera, of which one subfamily (Scleroderminae) and eight genera (*Nothepyris*, *Plastanoxus*, *Cephalonomia*, *Allobethylus*, *Aspidepyris*, *Chlorepyris*, *Laelius* and *Dracunesia*) were first registered for Uruguay.

Key words: flat wasps, Neotropical, parasitoid wasps, South America

RESUMEN

Composición genérica de Bethylidae (Hymenoptera, Chrysidoidea) del Este del Uruguay. Las avispas planas Bethylidae son la familia más grande de Chrysidoidea. Por su innegable contribución ecológica, estos insectos también son importantes por su potencial uso como controladores biológicos de Coleoptera y Lepidoptera que actúan como plagas agrícolas. Este es el primer estudio centrado en la diversidad de Bethylidae en Uruguay. En este estudio, en un intento de conocer la fauna de Bethylidae de este país, se colectaron de tres ambientes, área de campo natural (NFA), área del sistema de pastos (PSA), sistema integrado de producción ganadera con agricultura de invierno y verano (IAAa e IAAb), cercanos a Castillos, Departamento de Rocha, Uruguay, entre diciembre de 2014 y diciembre de 2016. Se recolectaron 682 betilidos, que representan cuatro subfamilias y 13 géneros, de los cuales una subfamilia (Scleroderminae) y ocho géneros (*Nothepyris*, *Plastanoxus*, *Cephalonomia*, *Allobethylus*, *Aspidepyris*, *Chlorepyris*, *Laelius* y *Dracunesia*) fueron registraron por primera vez para Uruguay.

Palabras clave: avispas plana, avispas parasitoide, Neotropical, Sudamerica.

INTRODUCTION

Bethylidae (Hymenoptera, Chrysidoidea) are a cosmopolitan and very diverse family of parasitoid wasps, especially in tropical areas (Azevedo et al., 2018). The family has about 3,000 species, belonging to 100 genera in nine subfamilies (Azevedo et al., 2018; Colombo et al., 2020). These wasps exhibit a fascinating diversity in their parasitoid behavior, with a great uniformity for their hosts: beetle larvae

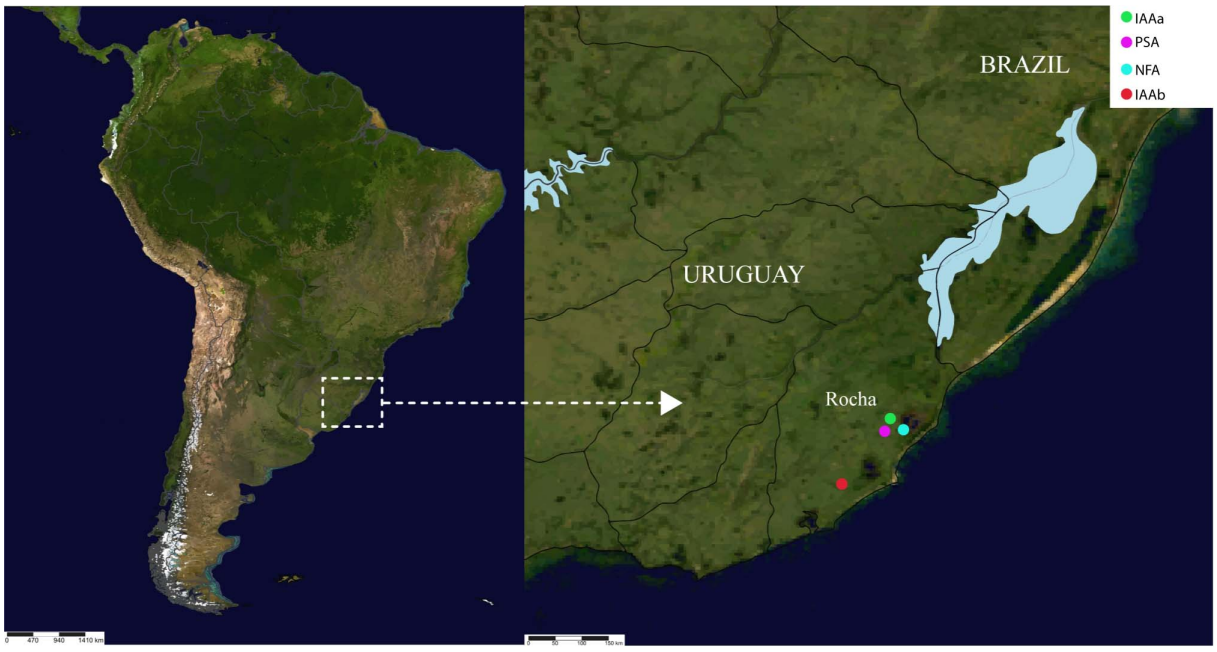

Fig. 1. Collection points in the municipality of Castillos, Rocha Department, Uruguay. A. natural field area (NFA) (blue); B. pasture system area (PSA) (purple); C. integrated livestock production system with winter and summer agriculture (IAAa) (green); integrated livestock production system with winter and summer agriculture (IAAb) (red).

(Coleoptera) are the hosts in Pristocerinae, Scleroderminae, Mesitiinae and most Epyrinae, and small moths (Lepidoptera) in Bethylinae and the remaining Epyrinae (Evans, 1964; Gauld and Bolton, 1988; Gordh and Móczár, 1990; Azevedo et al., 2018). Bethylidae could be of agricultural importance as biocontrols and have already been used successfully in limited cases – for example *Goniozus legneri* Gordh (Legner and Silveira-Guido, 1983) and *Prorops nasuta* Waterston (Infante et al., 2005) for control of navel orangeworm and coffee borer beetle, respectively.

Even though it is one of the most diverse lineages of Chrysidoidea, few studies report the abundance and richness of Bethylidae (Mugrabi et al., 2008). Studies within the Neotropical Region are mostly from Brazil: Azevedo (1991) for São Paulo; Azevedo (1996) for Mato Grosso; Azevedo and Helmer (1999) for Brasília; Azevedo et al. (2002) for Acre; Azevedo et al. (2006) for several sites in Paraná, and Mugrabi et al. (2008) for Espírito Santo. So, there exists an evident gap about the bethylids in many regions of the Neotropics.

In Uruguay, the invertebrate diversity is much less studied and known than the vertebrate fauna (Ghione et al., 2008). However, some studies were performed with Hymenoptera and a great diversity for these groups was recorded (see Zolessi et al., 1989; Castiglioni et al., 2017; Fernandes et al., 2019). The country is subject to extreme loss of habitat. In just a few decades, several regions of Uruguay have lost their natural ecosystems to agriculture (Ghione et al., 2008), and for this reason, studies focused on the local fauna are important and necessary.

For Bethylidae, a total of three subfamilies, five genera, and only seven species have been recorded for Uruguay hitherto: *Goniozus legneri* (Gordh, 1982) and *Goniozus negrifemur* (Ashmead, 1894) (Bethylinae), *Anisepyris proteus* (Evans, 1966a), *Anisepyris durini* (Barbosa and Azevedo, 2018) and *Rysepyris lautus* (Evans, 1977) (Epyrinae), *Pseudisobrachium uruguayense* (Oglobin, 1938) and *Dissomphalus connubialis* (Evans, 1966b) (Pristocerinae).

In this study, we evaluated the diversity and generic composition of Bethylidae in three environments, NFA, PSA, IAAa and IAAb. This is the first study focused on the diversity of Bethylidae in Uruguay.

MATERIALS AND METHODS

The specimens studied were collected in four localities, near Castillos, Department of Rocha, Uruguay, between December 2014 and December 2016, using Malaise traps. The studied environments

Fig. 2. Abundance of Bethylidae genera collected by subfamily: A. Pristocerinae; B. Scleroderminae; C. Epyrinae; D. Bethylinae. The sites are represented by colors: natural field area (NFA) in blue; pasture system area (PSA) in purple; C. integrated livestock production system with winter and summer agriculture (IAAa) in green); integrated livestock production system with winter and summer agriculture (IAAb) in red. Important to note each graphic is limited by the maximum number of specimens collected.

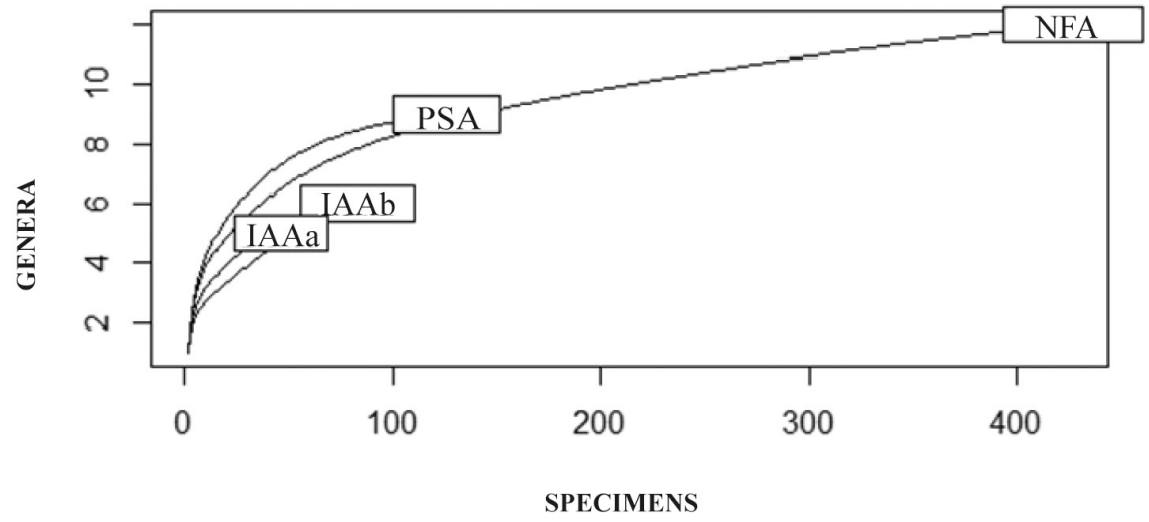

Fig. 3. Diversity of Bethylidae genera by specimens.

were: a) natural field area (NFA), 34°05'01.07"S, 53°45'43.08"W, altitude 57m; b) pasture system area (PSA), 34°05'26.08"S, 53°52'14.04"W, altitude 89m, and c) integrated agriculture area (IAA), 34°02'33.07"S, 53°50'02.07"W, altitude 26m (between December 2014 and December 2015 (IAAa) and 34°24'42.02"S, 54°08'10.05"W, altitude 18m (between January and December 2016 (IAAb)) (Fig. 1) (for more details see Fernandes et al., 2019).

The bethylids were identified to genus level under a stereomicroscope using the taxonomic keys proposed by Azevedo et al. (2018).

The genera composition of Bethylidae in each environment was performed using rarefaction curves using RStudio® (R Core Team, 2015) by the script described by Rossi (2011) and the abundance analysis was performed using Excel® (Microsoft, 2022). To verify the quality of the sampling in IAA, the data were analyzed using the number of individuals for each sampled location. The map was prepared using the free website SimpleMappr® (Shorthouse, David P.) and the graphics of abundance and diversity were edited using image edition software.

RESULTS

A total of 682 specimens of Bethylidae were collected representing 13 genera (~13% of the genera diversity of Bethylidae) and four subfamilies. Five genera of Epyrinae were obtained: *Anisepyris* Kieffer, 1905 (135 specimens/~20% of total of Bethylidae collected), *Aspidepyris* Evans (13/~2%), *Chlorepyris* Kieffer (5/~0.7%), *Laelius* Ashmead (7/~1%) and *Rysepyris* Kieffer (1/~0.1%); three of Pristocerinae: *Pseudisobrachium* Kieffer (264/~39%), *Dissomphalus* Ashmead (187/~ 27%) and *Dracunesia* Alencar & Azevedo (11/~1%); four of Scleroderminae: *Cephalonomia* Evans (15/~2%, *Allobethylus,* Kieffer (1/~0.1%), *Nothepyris* Evans (1/~0.1%) and *Plastanoxus* Kieffer (1/~0.1%) and one of Bethylinae: *Goniozus* Förster (41/~6%). *Pseudisobrachium* and *Dissomphalus* were the most abundant genera, representing ~66% of the sampled Bethylidae (Fig. 2).

Pseudisobrachium was the most abundant genus in two of the three studied locations: ~43% (184 specimens) in NFA and ~40% (50 specimens) in PSA. However, *Dissomphalus* was the most abundant in IAAb with ~7% (50 specimens) and *Goniozus* was the most abundant in IAAa, with ~3% (22 specimens) (Fig. 2).

For the genera rarefaction curve, in IAA and PSA the curve did not reach an asymptote and presented a similar diversity. For NFA, there was also a tendency to reach an asymptote (Fig. 3).

DISCUSSION

Dissomphalus and *Pseudisobrachium* were the most abundant pristocerine genera and *Anisepyris* was the most abundant Epyrinae genus, as was reported by Mugrabi et al. (2008) in Atlantic Forest areas in Brazil. Martins et al. (2020) studied the Chrysidoidea in

conventional coffee crops and agroforestry systems in Southeastern Brazil and reported *Epyris* as the most abundant bethylid genus. However, this data is not recovered here and a reason could be the taxonomic key used by Martins et al. (2020), proposed by Vargas and Terayama (2006) for genera of Bethylidae. The key in Vargas and Terayama is outdated and not suitable for identifying bethylids as the subfamily Epyrinae included Scleroderminae genera when the key was published.

The reported differences between the environments reflect the differences in the level of preservation of natural vegetation. The NFA is the most preserved area, showing the biggest abundance and diversity of the genera. The bethylids collected in the other environments (IAA and PSA) can be associated with agricultural pests. *Goniozus* was the genus most abundant in IAAa and *Dissomphalus* was the most abundant in IAAb, both areas with integrated agriculture. Previous studies (Colombo and Azevedo, 2016; Martins et al., 2020) have recorded the occurrence of these genera in areas with agriculture and less preserved vegetation. The composition of parasitoid wasps is affected by reducing the degree of preservation of habitats and, consequently, availability of hosts. Similar results have already been identified for other Hymenoptera, for example, Ichneumonoidea collected in the same areas of the present study (Fernandes et al., 2019).

Malaise traps were the only method for sampling and even with studies evaluating its efficiency in sampling for Hymenoptera (see Noyes, 1989), the result can be biased towards flying wasps. All females of Pristocerinae, and some Scleroderminae, are apterous and probably for this reason, no apterous specimens have been collected. In this sense, the generic diversity may have been affected by the adopted sampling method.

More rigorous studies are needed regarding the bethylid fauna in Uruguay. The present study resulted in the first occurrence records for eight genera of Bethylidae for that country: *Nothepyris*, *Plastanoxus*, *Cephalonomia*, *Allobethylus*, *Aspidepyris*, *Chlorepyris*, *Laelius* and *Dracunesia*. Greater sampling efforts and deeper taxonomic studies will certainly cause Uruguay's Bethylidae diversity to increase considerably, which may be able to corroborate our estimates.

ACKNOWLEDGEMENTS

The authors are grateful to anonymous reviewers and the Subject Editor for providing valuable suggestions and corrections on the final version of the manuscript. We thank Karina S. Furieri for discussion about statistical analysis and Carly M. Tribull for the English review. This contribution was supported by the Instituto Nacional de Investigación Agropecuaria of the República Oriental del Uruguay (INIA) (Proyecto FTPA 312, Convocatoria 2012), INCT-Hymenoptera Parasitoides CNPq grant #3037482018-4, FAPES PRONEM #80600417/17 FAPES #157/2020 and FAPES PRONEX #980/2022. WJMJ and GKC thanks to Instituto Federal do Espírito Santo – Campus Vitória for providing PIBIC-Jr bursary. COA is grateful for research bursary to CNPq grant #3037482018-4. WDC is grateful to FAPES/CNPq PROTAX grant #224/2021 for providing post-doctoral fellow bursary. The authors declare no conflict of interest.

REFERENCES

Ashmead, W.H. (1894). Report on the parasitic Cynipidae, part of the Braconidae, the Ichneumonidae, the Proctotrypidae, and part of the Chalcidinae. Part III. *Journal of Linnean Society of London*, *Zoology, 25*, 188-254.

Azevedo, C.O. (1991). Espécie nova e notas sobre *Bakeriella* Kieffer (Hymenoptera, Bethylidae) da região de São Carlos, SP. *Revista Brasileira de Entomologia*, *35(3)*, 535-538.

Azevedo, C.O. (1996). Sobre os Bethylidae (Hymenoptera, Chrysidoidea) da reserva indígena de Tadarimana, Rondonópolis, MT, Brasil. *Anais do VII Seminário Regional de Ecologia*, *8*, 111-119.

Azevedo, C.O., Alencar, I.D.C.C., Ramos, M.S., Barbosa, D.N., Colombo, W.D., Vargas, J.M.R. and Lim, J. (2018). Global guide of the flat wasps (Hymenoptera: Bethylidae). *Zootaxa*, *4489*(1), 1-294.

Azevedo, C.O. and Helmer, J.L. (1999). Ecologia de comunidade de Bethylidae (Hymenoptera, Chrysidoidea) da Reserva Ecológica do Roncador, Brasília, Distrito Federal, Brasil. *Revista Brasileira de Zoologia*, *16*(4), 1115-1126.

Azevedo, C.O., Helmer, J.L. and Barreto, F.C.C. (2006). Análise da fauna de Bethylidae (Hymenoptera, Chrysidoidea) de oito localidades do Paraná, Brasil. *Boletim do Museu de Biologia Mello Leitão*, *20*, 83-94.

Azevedo, C.O., Helmer, J.L. and Morato, E. (2002). Diversidade de Bethylidae (Hymenoptera) do Parque Nacional da Serra do Divisor, Acre, Brasil e seu uso no plano de manejo e conservação da área. *Acta Amazonica*, *32*(1), 71-82.

Barbosa, D.N. & Azevedo, C.O. (2018). Revision of *Anisepyris* Kieffer (Hymenoptera, Bethylidae), with description of 135 new species. *Zootaxa*, *4416*, 1-258.

Castiglioni, E., Perioto, N.W., Lara, R.I.R. and Burla, J.P. (2017). Análisis de esfuerzo de muestreo de

himenópteros parasitoides en tres ambientes del este uruguayo. *Revista del Laboratorio Tecnológico del Uruguay*, *13*, 98-105.

Colombo, W.D. and Azevedo, C.O. (2016). Review of *Dissomphalus* Ashmead, 1893 (Hymenoptera, Bethylidae) from Espírito Santo, Brazil, with description of twenty-one new species. *Zootaxa*, *4143*, 1-84.

Colombo, W.D., Perkovsky, E.E. and Azevedo, C.O. (2020). Phylogenetic overview of flat wasps (Hymenoptera, Bethylidae) reveals Elektroepyrinae, a new fossil subfamily. *Palaeoentomology*, *3*(3), 269-283.

Colombo, W.D., Tribull, C.M., Waichert, C. and Azevedo, C.O. (2022). Integrative taxonomy solves taxonomic impasses: a case study from Epyrinae (Hymenoptera, Bethylidae). *Systematic Entomology*, *47*(3), 504-529.

Evans, H.E. (1964). A synopsis of the American Bethylidae (Hymenoptera, Aculeata). *Bulletin of the Museum of Comparative Zoology*, *132*, 1-222.

Evans, H.E. (1966a). A revision of the genus *Anisepyris* Kieffer (Hymenoptera, Bethylidae). *Studia Entomologica*, *9*, 1-120.

Evans, H.E. (1966b). Further studies on neotropical Pristocerinae (Hymenoptera, Bethylidae). *Acta Hymenopterologica*, *2*, 99-117.

Evans, H.E. (1977). A revision of the genus *Holepyris* in the Americas (Hymenoptera, Bethylidae). *Transactions of the American Entomological Society*, *133*, 531-579.

Fernandes, D.R.R., Pádua, D.G., Lara, R.I.R., Perioto, N.W., Burla, J.P. and Castiglioni, E. (2019). Subfamily composition of Ichneumonidae (Hymenoptera: Ichneumonoidea) from eastern Uruguay. *Entomological Communications*, 1, ec01016.

Gauld, I.D. and Bolton, B. (1988). *Hymenoptera*. British Museum (Natural History), London, and Oxford University Press, Oxford, 332 pp.

Ghione, S., Martino, D., Aldabe, J., Bartesaghi, L., Blanco, D., Brazeiro, A., … Sención, G. (2008). Capítulo 4: Biodiversidad, p. 177-239. *In*: CLAES, PNUMA y DINAMA (Eds.). *GEO Uruguay*: informe del estado del ambiente. Montevideo: Gráfica Mosca.

Gordh, G. (1982). A new species of *Goniozus* (Hymenoptera: Bethylidae) imported into California for the biological control of the navel orangeworm. *Entomological News*, *93*, 136-138.

Gordh, G. and Móczár, L. (1990). A catalog of the world Bethylidae (Hymenoptera: Aculeata). *Memoirs of the American Entomological Institute*, *46*, 1-364.

Infante, F., Mumford, J.D., Baker, P. (2005). Life history studies of *Prorops nasuta*, a parasitoid of the coffee berry borer. *Biocontrol*, *50*, 259-270.

Legner, E.F. and Silveira-Guido, A. (1983). Establishment of *Goniozus emigratus* and *Goniozus legneri* [Hym: Bethylidae] on navel orangeworm *Amyelois transitella* [Lep: Phycitidae] in California and biological control potential. *Entomophaga, 28*, 97-106.

Martins, A.L., Lemes, J.R.A., Lopes, P.R. and Dias A.M.P. (2020). The Chrysidoidea wasps (Hymenoptera, Aculeata) in conventional coffee crops and agroforestry systems in southeastern Brazil. *Papéis Avulsos de Zoologia*, *60*, 1-7.

Microsoft Corporation. (2022). Microsoft Excel. Retrieved from <https://office.microsoft.com/excel>.

Mugrabi, D.F., Alencar, I.D.D.C., Barreto, F.C.C. and Azevedo, C.O. (2008). Os gêneros de Bethylidae (Hymenoptera: Chrysidoidea) de quatro áreas de mata atlântica do Espírito Santo. *Neotropical Entomology*, *37*(2), 158-152.

Noyes, J.S. (1989). A study of five methods of sampling Hymenoptera (Insecta) in a tropical rainforest, with special reference to the Parasitica. *Journal of Natural History*, *23*, 285-298.

Oglobin, A.A. (1938). Descripciones de Bethylidae y Dryinidae de las coleciones del Museo Argentino de Ciencias Naturales. *Anales de Museo Argentino de Ciencias Naturales*, *40*, 35-48.

Rossi, J.P. (2011). rich: an R package to analyse species richness. *Diversity*, *3*, 112-120.

RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA URL< http://www.rstudio.com/>.

Shorthouse, D.P. (2010). SimpleMappr, an online tool to produce publication-quality point maps. Retrieved from <https://www.simplemappr.net>. Accessed January 17, 2022.

Vargas-R., J.M. and Terayama, M. (2006). Familia Bethylidae, p. 427-442. *In*: Fernández, F. and Sharkey, M.J. (Eds.), *Introdución a los Hymenoptera de la Región Neotropical*. Bogotá: Sociedad Colombiana de Entomología y Universidad Nacional de Colombia.

Zolessi, L., Abenante, P. and Philippi, M. (1989). Catálogo sistemático de las especies de formícidos del Uruguay (Hymenoptera: Formicidae), pp. 40. Montevideo: ORCYT Unesco.

Editor de Sección: José Manuel Venzal