Research Article

# *Nonnus niger* (Brullé, 1846) (Hymenoptera: Ichneumonidae: Nesomesochorinae) in eastern Uruguay: new records and comments about phenology

*Nonnus niger* (Brullé, 1846) (Hymenoptera: Ichneumonidae: Nesomesochorinae) en el este de Uruguay: nuevos registros y comentarios sobre su fenología

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**Abstract.** The genus *Nonnus* Cresson, 1874 (Hymenoptera: Ichneumonidae: Nesomesochorinae) contains 20 species distributed in the New World and so far, no species of this genus has been recorded for Uruguay. Thus, the objective of this work was to investigate the occurrence, abundance and sex ratio of *Nonnus niger* (Brullé, 1846) in three different phytophysiognomies in eastern Uruguay.

**Key words:** Darwin wasps; Ichneumonoidea; Neotropical region; parasitoids.

**Resumen.** El género *Nonnus* Cresson, 1874 (Hymenoptera: Ichneumonidae: Nesomesochorinae) contiene 20 especies distribuidas en el Nuevo Mundo y hasta el momento no se ha registrado ninguna especie de este género para Uruguay. Así, el objetivo de este trabajo fue investigar la presencia, abundancia y proporción de sexos de *Nonnus niger* (Brullé, 1846) en tres diferentes fitofisonomías en el este de Uruguay.

**Palabras clave:** Avispa de Darwin; Ichneumonoidea; región Neotropical; parasitoides.

## Introduction

Insects are present in practically all environments, from extremely hot places to regions with low temperatures (Camargo *et al*. 2015) and are involved in numerous biological processes important for the maintenance of life on the planet (Ruppert *et al*. 2005; Vasconcellos *et al*. 2010).

Despite its importance, the diversity of insects in Uruguay has a lower degree of knowledge when compared to the fauna of birds and tetrapods. However, some important advances have been made with some groups such as Hymenoptera (Zolessi *et al*. 1989; Aldabe *et al*. 2008; Castiglioni *et al*. 2017), Hemiptera (Martínez & Bianchi 2010), Coleoptera (Háva 2011), Orthoptera (Miguel *et al*. 2014), Lepidoptera (Castiglioni *et al*. 2016; Burla *et al*. 2019) and Mantodea (Trillo *et al*. 2021).

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The Hymenoptera have different ecological roles, such as pollinators, seed dispersers, and regulators of other arthropod populations, acting as predators and parasitoids (natural enemies) (Fernandes *et al*. 2018). Among these, Darwin wasps (Ichneumonidae) constitute one of the largest families, with about 25,000 valid species, distributed in 1,601 genera and 44 subfamilies (Yu *et al*. 2016; Klopfstein *et al*. 2019). In the Neotropical region alone, more than 435 genera are registered (Yu *et al*. 2016). As for the fauna of this group of insects in Uruguay, very little is known, and so far only 19 subfamilies and 62 genera are recorded, of which only 53 nominal species are formally registered for this country (Yu *et al*. 2016; Fernandes *et al*. 2019; Pádua *et al*. 2020).

Nesomesochorinae is a very small subfamily of Darwin wasps, having only four genera: *Bina* Shimizu & Alvarado, 2020, *Chriodes* Förster, 1869, *Klutiana* Betrem, 1932 and *Nonnus* Cresson, 1874, totaling 62 described species (Yu *et al*. 2016; Shimizu & Alvarado 2020).

The subfamily can be distinguished from the other Ichneumonidae by a set of characters such as the presence of an areolet on the forewing, more or less straight inner facial orbits (never strongly notched opposite the antennal socket), laterally compressed metasoma, medially curved bristle fringe on the inner surface of the posterior tibia, and the reduced number of maxillary palps (*i.e*., usually four segments) (Townes 1970; Bennett *et al*. 2019).

To date, their biology is unknown, but it is believed that they are possibly koinobiont endoparasitoids of Lepidoptera larvae (Shimizu & Alvarado 2020). Its distribution is more abundant in the tropics and known in the Afrotropical, Palearctic, Eastern and Neotropical regions (Yu *et al*. 2016).

Among the genera of Nesomesochorinae, *Nonnus* Cresson, 1874, has 20 species distributed in the New World (Townes & Townes 1966; Wahl & Bennett 2020; Yu *et al*. 2016). *Nonnus niger* (Brullé, 1846) is a species originally described from Brazil, where it appears to be quite abundant in the southern and southwestern regions of the country (Townes & Townes 1966; Yu *et al*. 2016; Onody *et al*. 2021).

So far, no nominal species of *Nonnus* has been recorded for Uruguay, and the generic record is the only information about this subfamily in this country. Thus, the objective of this work was to investigate the occurrence, abundance and sex ratio of *N. niger* in three different phytophysiognomies in eastern Uruguay.

## Material and Methods

The material is from samples carried out in four locations which represent three different environments: Natural Field Area (NFA), Pasture System Area (PSA) and Integrated Agriculture Area (IAA), to the east of Uruguay (Fig. 1) (Castiglioni *et al*. 2017). Sampling was carried out fortnightly from December 2014 to December 2016 with two Malaise traps, separated from each other by about 100 m. Ethanol (ETOH 95° GL) was used for the preservation of captured insects. The traps remained active throughout the study period in three environments near the city of Castillos, Rocha Department, Uruguay. The environments studied were: a) Natural Field Area (NFA), with low grazing intensity by cattle - Don Bosco / Bosque - field; 34°05'1.07''S, 53°45'43.08''W, 57 m above sea level; b) Pasture System Area (PSA), area under production with cattle and sheep grazing - Cardoso / natural field; 34°05'26.8''S, 53°52'14.4''W, 89 m above sea level, and c) Integrated Agriculture Area (IAA), areas under an integrated livestock production system with winter and summer - Branaa; 34°02'33.7''S, 53°50'02.7''W, 26 m above sea level (between December 2014 and December 2015) and Llambi; 34°24'42.2''S, 54°08'10.5''W, 18 m above sea level (between January and December 2016).

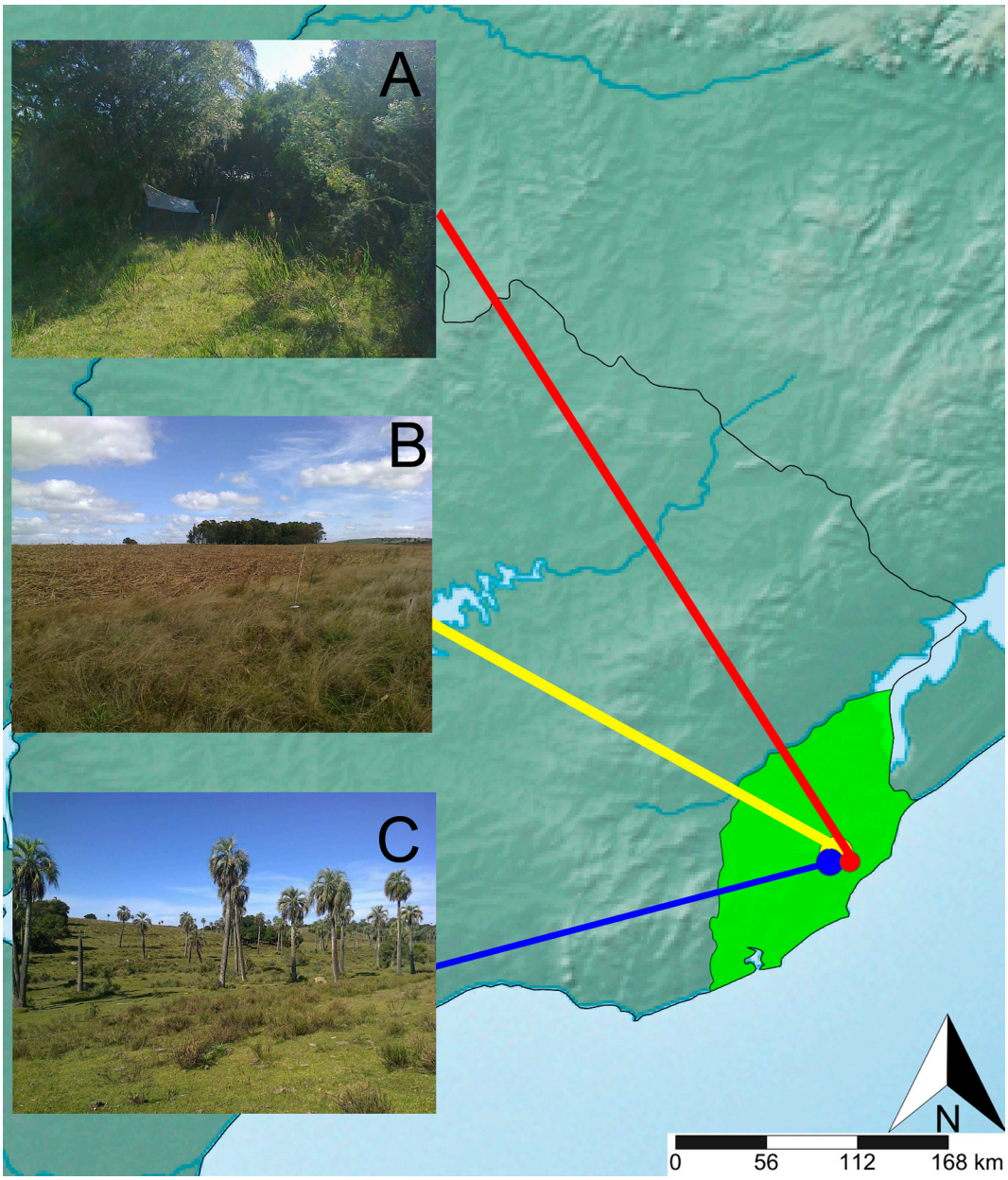


**Figure 1. A-C.** Collection area in the city of Castillos, Rocha Department, Uruguay. **A.** Natural Field Area (NFA) – Don Bosco (red). **B.** Integrated Agriculture Area (IAA) – Branaa (yellow). **C.** Pasture System Area (PSA) – Cardoso (blue). / Área de recolección en la ciudad de Castillos, Departamento de Rocha, Uruguay. **A.** Área de Campo Natural (ACN) – Don Bosco (rojo). **B.** Área de Agricultura Integrada (AAI) – Branaa (amarillo). **C.** Área de Sistema Pastoril (ASP) – Cardoso (azul).

The studied specimens were deposited in the Invertebrate Collection of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil (M. L. Oliveira, curator). Additional material from the collection of the American Museum of Natural History (AMNH), New York (J. Carpenter, curator) was also studied.

For data on the sex ratio of the individuals collected, that is, the number of males or females in relation to the total number of specimens, it was compared using the chi-square

test ($x^2$) at a significance level of 5% ($p \leq 0.05$). Statistical analyzes were performed with the help of the "R" program (R Development Core Team 2021).

The map was prepared using the on-line site SimpleMappr (www.simplemappr.net) (Shorthouse 2010).

## Results and Discussion

### *Nonnus niger* (Brullé, 1846)

*Atractodes albitarsis* Brullé 1846: 166 [original designation]; Townes & Townes 1966: 141 [synonymy]. Holotype male, Brazil (MNHN).

*Atractodes niger* Brullé 1846: 168 [original designation]; Krieger 1903: 291 [synonymy]. Holotype female, Brazil (MNHN).

*Nonnus biannulatus* Cameron 1911: 178 [original designation]; Townes & Townes 1966: 141 [synonymy]. Holotype female, Guyana (BMNH).

**Material examined.** 13 females, 79 males. URUGUAY, Rocha, Castillos, Don Bosco – Bosque campo 34°05'1.07" S 53°45'43.08" W, Arm. Malaise 2, 29.XII.2014 E. Castiglioni e eq. cols. (11 males, INPA); same, except 1, 12.I.2015 (5 males, INPA); same, except 2, 12.I.2015 (9 males, INPA); same, except 1, 28.I.2015 (1 males, INPA); same, except 2, 28.I.2015 (8 males, INPA); same, except 1, 11.II.2015 (2 males, INPA); same, except 2, 11.II.2015 (10 males, INPA); same, except 1, 13.X.2015 (2 males, INPA); same, except 1, 27.X.2015 (1 female, INPA); same, except 2, 14.I.2016 (1 male, INPA); same, except 2, 28.I.2016 (2 males, INPA); same, except 2, 12.II.2015 (1 male, INPA); same, except Cardoso – campo natural 34°05'26.8"S 53°52'14.4"W, 2, 10.IV.2015 (1 female, INPA); same, except 1, 27.IV.2015 (1 female, INPA); same, except 2, 27.IV.2015 (1 female, INPA); same, except 1, 12.V.2015 (1 female, INPA); same, except 1, 10.VII.2015 (1 male, INPA); same, except 2, 28.IX.2015 (1 male, INPA); same, except Branaa – pasto agricultura 34°02'33.7"S, 53°50'02.7"W, 1, 13.XI.2015 (1 male, INPA); Cerro Largo, Sierra de Vaz, Rio Tacuari, 20 Km SE Melo, 23-26.III.1963, JK Bouseman collector (4 females, AMNH); Tacuarembó, 40 Km Nw Tacuarembó, 10-16.II.1963, JK Bouseman collector (4 males, AMNH); same data except 2-9.II.1963 (8 males, AMNH).

**Geographic distribution.** Panama, Guiana, Peru, Bolivia, Brazil and Uruguay (**new record**) (Fig. 2G).

The 60 specimens of *N. niger* analyzed were collected in three phytophysiognomy of Uruguay, namely: NFA in Don Bosco with 53 specimens, PSA in Cardoso with six and IAA in Branaa with just one.

Males and females of this species have similar morphology, being easily recognized by the following characteristics: body completely black, robust and slightly leathery (Figs. 2A-B); mesoscutum punctuated (Fig. 2C); propodeum with transverse striations in the center and with a heavily raised posterior carina centrally and laterally (Fig. 2F); tarsal claws pectinate completely (Fig. 2D); notaulus weak present anteriorly (Fig. 2E).

As for the sex ratio, there was a significant sampling only in the Don Bosco area, with the presence of 52 males for 1 female ($X^2 = 49{,}075$, $p < 0.001$). Due to the low abundance in the areas of Cardoso (PSA), Branaa (IAA) and Llambi (IAA), these were excluded from the analysis.

Onody *et al.* (2021) carried out a study in different phytophysiognomies of the Estação Ecológica de Jataí reserve, Luiz Antônio, São Paulo, Brazil, where a total of 219 specimens of *N. niger* were collected, and the sex ratio observed by them was five males for one female ($X^2 = 72.924$, $p < 0.0001$) in the gallery forest and approximately nine males for one female

($X^2$ = 39.361, p <0.0001) in the "Cerradão", this abundance of male in the study can be compared with the abundance of males that occurred in this research in the Don Bosco area.

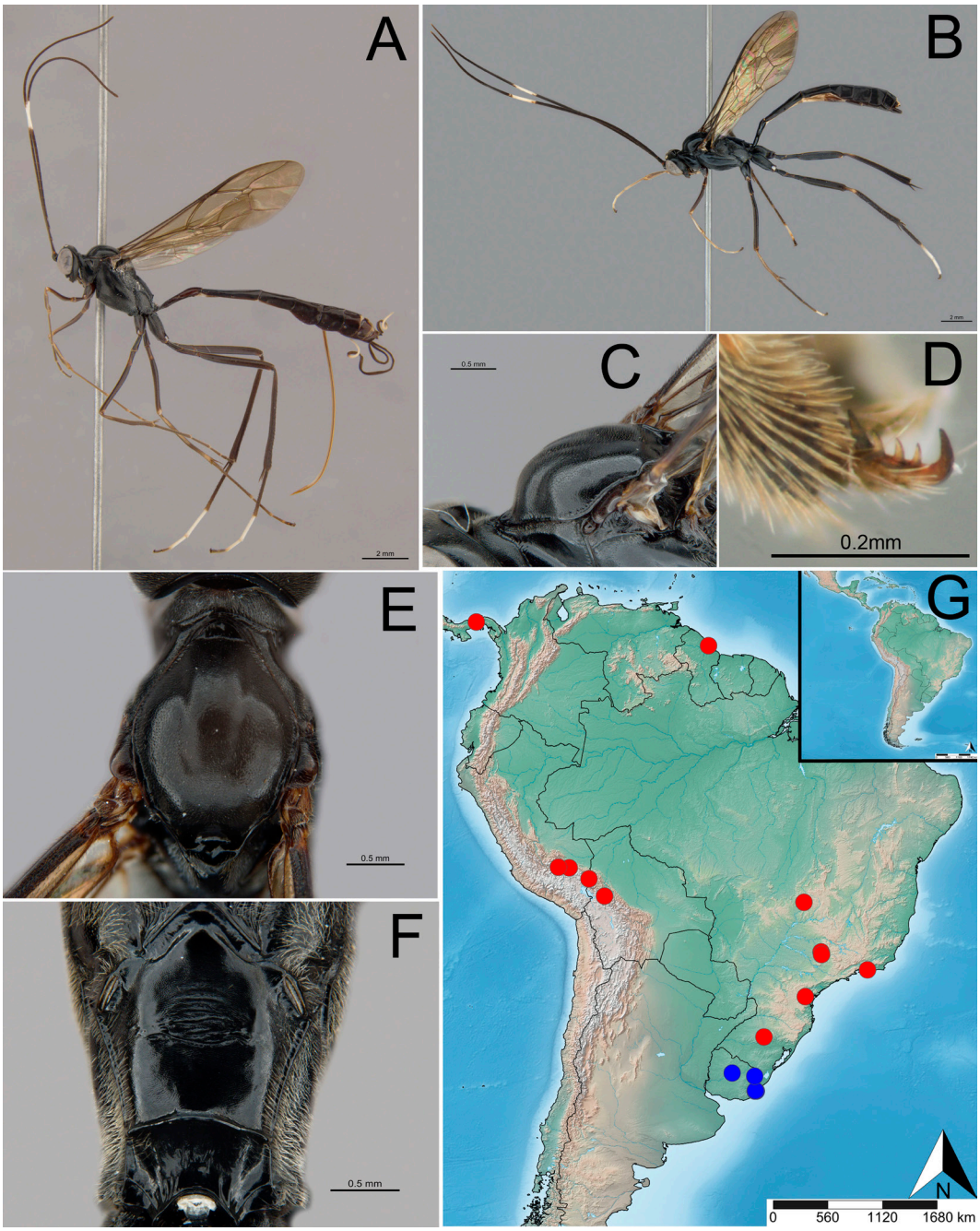


**Figure 2.** *Nonnus niger* (Brullé, 1846). **A.** *Habitus* female. **B.** *Habitus* male. **C.** Mesoscutum, lateral view. **D.** Tarsal claws, ventral view. **E.** Mesoscutum, dorsal view. **F.** Propodeum, dorsalview. **G.** Distribution map, where the red dots are the previous records, and the blue dot are the new records. / **A.** *Habitus* hembra. **B.** *Habitus* macho. **C.** Mesoscuto, vista lateral. **D.** Garra tarsal, vista ventral. **E.** Mesoscuto, vista dorsal. **F.** Propodeo, vista dorsal. **G.** Mapa de distribución, donde los puntos rojos son registros previos, y los puntos azules los nuevos registros.

Onody *et al*. (2021) also reported that females can spend most of their time looking for hosts in soils and foliage. However, other reasons associated with the biology and behavior of the species cannot be rejected. Fox *et al*. (1990) studied the interaction between the cabbage plant (*Brassica oleracea* var. *acephala*), cruciferous moths (DBM, *Plutella xylostella* (Linnaeus, 1758)) (Yponomeutidae) and its parasitoid wasp *Diadegma insulare* (Cresson, 1865) (Ichneumonidae), in addition, a rate of parasitism and sex ratio of *D. insulare* was observed, which concluded that the parasitoids are sensitive to the quality of the plant and the host, thus understanding that the higher proportion of females is a direct response to the high quality of the hosts.

Regarding the time of occurrence, we verified that the peak of abundance occurred from October to February, with the rest of the months without the capture of individuals (Fig. 3). This may have occurred due to factors that can affect the timing of the reconciliation of insect populations, such as the temporal availability of their resources (Dixon 2003; Freire *et al*. 2014), in addition to environmental heterogeneity (Sutcliffe *et al*. 1996), variation climate and the presence of natural enemies and predators (Wallner 1987; Wolda 1988). This is because parasitoid insects are specialized and operate at higher trophic levels (Shaw 2006).

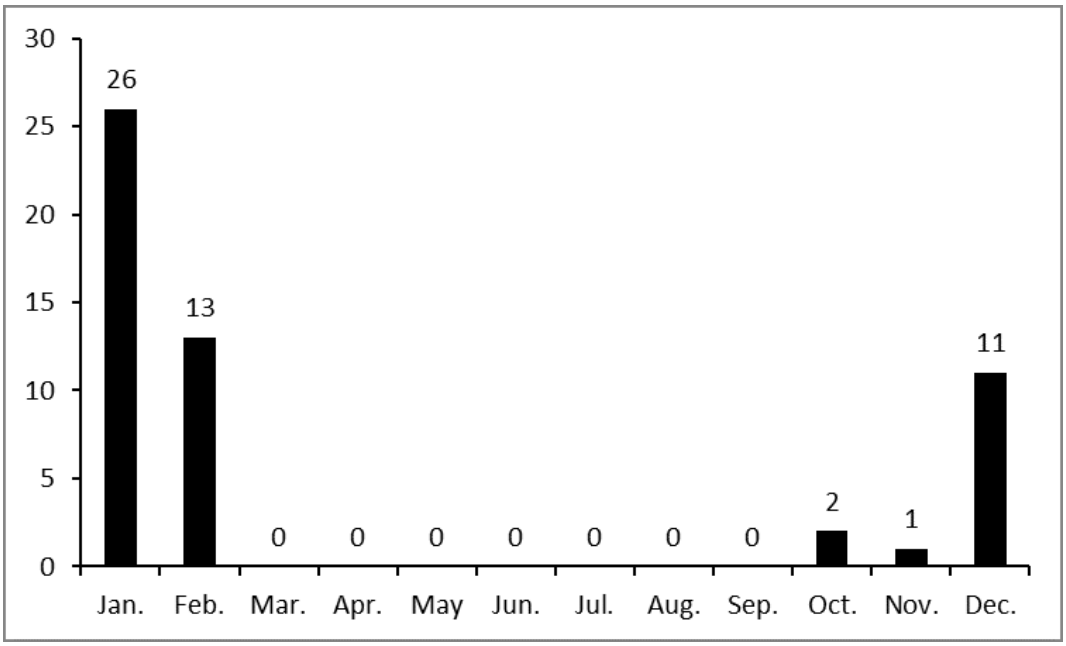


**Figure 3.** Total number of individuals of *Nonnus niger* (Brullé) collected per month in a natural field area in Don Bosco, Uruguay, in the years 2014 to 2016. / Número total de individuos de *Nonnus niger* (Brullé) recolectados por mes en el área de campo natural Don Bosco, Uruguay, años 2014 a 2016.

For a more robust sampling, long-term studies and successive samplings can be an effective strategy for collecting insects that have a well-defined temporal occurrence, as in this case of *N. niger*. In Malaise trap surveys, some long-term sampling in the same sampling area has been shown to be effective in capturing species of unusual families of parasitoid Hymenoptera such as Chrysididae, Dryinidae, Monomachidae, Pelecinidae and Sclerogibbidae (Lucena *et al*. 2012; Lara & Perioto 2014; Versuti *et al*. 2014; Perioto *et al*. 2016; Fernandes *et al*. 2017).

Thus, in the area of Don Bosco (NFA), it was possible to observe a significant sampling for the abundance of males, this may have occurred by the collection method used, the

Malaise trap, this result corroborates the studies of Aguiar & Santos (2010) and Onody *et al*. (2021). Aguiar & Santos (2010) reported in their study that some groups of Ichneumonidae can be collected with Malaise traps in a different way, being able to collect individuals of a certain sex, in addition to being effective in intercepting flight, thus, explaining the greater capture of males. This report was repeated in the work by Onody *et al*. (2021) in which the abundance of males was significant, in addition, they carried out a long-term work using the Malaise trap collection method, which was active without interruption, where it was possible to obtain a large sample of individuals collected in the phytophysiognomy localities of the Cerrado biome in São Paulo (Brazil).

Therefore, the present research showed that a long-term study in different phytophysiognomies of Uruguay was important to know more about the *N. niger* fauna in the locality because it was possible to observe that there was a deviation in the sex ratio of males that were significant in the natural field area of Don Bosco and that there was a sampling void of collections in the period from March to September, this may have occurred due to climatic variation of the place or food resource.

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## Literature Cited

**Aguiar, A.P. & Santos, B.F. (2010)** Discovery of potent, unsuspected sampling disparities for Malaise and Möricke traps, as shown for Neotropical Cryptini (Hymenoptera, Ichneumonidae). *Journal of Insect Conservation*, *14*: 199-206. https://doi.org/10.1007/s10841-009-9246-x

**Aldabe, J., Bartesaghi, L., Blanco, D., Brazeiro, A., Calvar, M., García, G., Tagliani, L.G., González, E.M., Rivas, M., Scarlato, G. & Soutullo, A. (2008)** Capítulo 4: Biodiversidad. *In*: CLAES, PNUMA y DINAMA (Eds.). *GEO Uruguay: informe del estado del ambiente*, pp. 1-352. Montevideo: Gráfica Mosca.

**Bennett, A.M.R., Cardinal, S., Gauld, I.D. & Wahl, D.B. (2019)** Phylogeny of the subfamilies of Ichneumonidae (Hymenoptera). *Journal of Hymenoptera Research*, *71*: 1-156. https://doi.org/10.3897/jhr.71.32375

**Brullé, M.A. (1846)** Tome Quatrième. Des Hyménoptères. Les Ichneumonides. *In:* Lepeletier de Saint Fargeau, A. (Ed.), *Histoire Naturelles des Insectes*. Imprimerie et Fonderie de Fain, Paris, pp. 56-324.

**Burla, J.P., Castiglioni, E., Návia, D. & Aldabe, J. (2019)** First record of *Palpita persimilis* (Lepidoptera, Crambidae) and *Oxycenus maxwelli* (Acari, Eriophyidae) in south-eastern Uruguay. *Agrociencia Uruguay*, *23*(2): 1-7. https://doi.org/10.31285/AGRO.23.91

**Camargo, A.J.A., Oliveira, C.M., Frizzas, M.R., Sonoda, K.C. & Corrêa, D. (2015)** *Coleções entomológicas:* legislação brasileira, coleta, curadoria e taxonomias para as principais ordens. Embrapa Cerrados-Livro científico (ALICE).

**Cameron, P. (1911)** On the Hymenoptera of the Georgetown Museum, British Guiana. *Timehri: The Journal of the Royal Agricultural and Commercial Society of British Guiana*, *1*: 154-186.

**Castiglioni, E., Perini, C.R., Chiaravalle, W., Arnemann J.A., Ugalde, G. & Guedes, J.V.C. (2016)** Primer registro de ocurrencia de *Helicoverpa armigera* (Hübner, 1808) (Lepidoptera: Noctuidae) en soja, en Uruguay. *Agrociencia Uruguay*, *20*(1): 31-35.

**Castiglioni, E., Perioto, N.W., Lara, R.I. R., Burla, J. P., Arbulo, N. & Aldabe, J. (2017)** Análisis de esfuerzo de muestreo de himenópteros parasitoides em três ambientes del este uruguayo. *INNOTEC, Revista del Laboratorio Tecnológico del Uruguay*, *13*: 98-105. https://doi.org/10.26461/13.10

**Dixon, A.F.G. (2003)** Climate change and phenological asynchrony. *Ecological Entomology*, *28*: 380-381.

**Fernandes, D.R.R., Querino, R.B. & Hamada, N. (2018**) Order Hymenoptera, pp 339–347. *In*: JH Thorp & DC Rogers (Eds.). Thorp and Covich's freshwater invertebrates. Academic Press, Cambridge.

**Fernandes, D.R.R., Alves F.P., Shimbori, E.M., Lara, R.I.R., Silva Junior, J.C. & Perioto, N.W. (2017)** New distribution records of Sclerogibbidae (Hymenoptera: Chrysidoidea) in Brazil. *EntomoBrasilis*, *10*: 33-36. https://doi.org/10.12741/ebrasilis.v10i1.658

**Fernandes, D.R.R., Pádua, D.G., Lara, R.I.R., Perioto, N.W., Burla, J.P. & Castiglioni, E. (2019)** Subfamily composition of Ichneumonidae (Hymenoptera: Ichneumonoidea) from Eastern Uruguay. *Entomological Communications*, *1*: 2675-1305. https://doi.org/10.37486/2675-1305.ec01016

**Fox, L.R., Letourneau, D.K., Eisenbach, J. & Van Nouhuys, S. (1990)** Parasitism rates and sex ratios of a parasitoid wasp: effects of herbivore and plant quality. *Oecologia*, *83*(3): 414-419.

**Freire, G., Nascimento, A.R., Malinov, I.K. & Diniz, I.R. (2014)** Temporal occurrence of two *Morpho* butterflies (Lepidoptera: Nymphalidae): influence of weather and food resources. *Environmental Entomology*, *43*(2): 274-282. https://doi.org/10.1603/EN12352

**Háva, J. (2011)** A new *Trogoderma* species from Uruguay (Coleoptera: Dermestidae: Megatominae). *Studies and Reports-Taxonomical Series*, *7*(1/2): 117-120.

**Klopfstein, S., Santos, B.F., Shaw, M.R., Alvarado, M., Bennett, A.M.R., Dal Pos, D., Giannotta, M., Herrera-Florez, A.F., Karlsson, D., Khalaim, A.I., Lima, A.R., Mikó, I., Sääksjärvi, I.E., Shimizu, S., Spasojevic, T., van Noort, S., Vilhelmsen, L. & Broad, G.R. (2019)** Darwin wasps: a new name heralds renewed efforts to unravel the evolutionary history of Ichneumonidae. *Entomological Communications*, *1*: ec01006. https://doi.org/10.37486/2675-1305.ec01006

**Krieger, R. (1903)** Zur Synonymik der Ichneumoniden (Hym.). *Zeitschrift für Systematische Hymenopterologie und Dipterologie*, *4*: 290-294.

**Lara, R.I.R. & Perioto, N.W. (2014)** Seasonality of *Pelecinus polyturator* (Drury) (Hymenoptera, Pelecinidae) in the Atlantic Rainforest of São Paulo State, Brazil. *Revista Brasileira de Entomologia*, *58*: 63-65. https://doi.org/10.1590/S0085-56262014000100010

**Lucena, D.A.A., Santos Neto, P.E., Zanella, F.C.V., Alves, F.P., Trindade, O.S.N. & Silva Junior, J.C. (2012)** Chrysididae diversity (Hymenoptera) in caatinga vegetation in Jequié, Bahia state, Northeastern Brazil. *Magistra*, *24*: 215-220.

**Martínez, G. & Bianchi, M. (2010)** Primer registro para Uruguay de la chinche del eucalipto, *Thaumastocoris peregrinus* Carpintero y Dellappé, 2006 (Heteroptera: Thaumastocoridae). *Agrociencia Uruguay*, *14*(1): 15-18.

**Miguel, L., Lorier, E. & Zerbino, S. (2014)** Caracterización y descripción de los estadios ninfales de *Borellia bruneri* (Rhen, 1906) (Orthoptera: Gomphocerinae). *Agrociencia Uruguay*, *18*(2): 72-81.

**Onody, H.C., Perioto, N.W., Lara R.I.R., Fernandes, D.R.R., Nascimento, A.R. & Penteado-Dias, A.M. (2021)** Preferência de habitat e fenologia de *Nonnus niger* (Brullé, 1846) (Hymenoptera, Ichneumonidae) em diferentes fitofisionomias em uma reserva de cerrado no brasil. *In:* Iwata, B.F., Rocha, I.L. (eds.). *Cerrado: Capital Natural e Serviços Ambientais*, Paco Editorial.

**Pádua, D.G., Fernandes, D.R.R. & Sääksjärvi, I.E. (2020)** *Pimpla* Fabricius, 1804 (Ichneumonidae, Pimplinae) from Uruguay: a replacement name, new records, and an identification key to the species. *ZooKeys, 1007*: 23-47. https://doi.org/10.3897/zookeys.1007.56328

**Perioto, N.W., Lara, R.I.R., Fernandes, D.R.R., De Bortoli, C.P., Salas, C., Crosariol Netto, J., Perez, L.A., Trevisan, M., Kubota, M.M., Pereira, N.A., Gil, O.J.A., Santos, R.F., Jorge, S.J. & Laurentis, V.L. (2016)** *Monomachus* (Hymenoptera, Monomachidae) from Atlantic rainforests in São Paulo State, Brazil. *Revista Colombiana de Entomología, 42*: 171-175. https://doi.org/10.25100/socolen.v42i2.6688

**R Development Core Team (2021)** *R: A language and environment for statistical computing*. Vienna, R Foundation for Statistical Computing. Available from: http://www.R:project.org/

**Ruppert, E.E., Fox, R.S. & Barnes, R.D. (2005)** Zoologia dos invertebrados: uma abordagem funcional-evolutiva. *In*: *Zoologia dos invertebrados: uma abordagem funcional-evolutiva* p. 1045-1045.

**Shaw, M.R. (2006)** Habitat considerations for parasitic wasps (Hymenoptera). *Journal of Insect Conservation, 10*: 117-127. https://doi.org/10.1007/s10841-006-6288-1

**Shimizu, S. & Alvarado, M. (2020)** A new genus and two new species of the subfamily Nesomesochorinae Ashmead (Insecta: Hymenoptera: Ichneumonidae). *Neotropical Entomology, 49*(5): 704-712. https://doi.org/10.1007/s13744-020-00778-7

**Shorthouse, D.P. (2010)** SimpleMappr, an online tool to produce publication-quality point maps (www.simplemappr.net). Accessed January 2022.

**Sutcliffe, O.L., Thomas, C.D. & Moss, D. (1996)** Spatial synchrony and asynchrony in butterfly population dynamics. *Journal of Animal Ecology, 65*: 85-95.

**Townes, H.K. (1970)** The genera of Ichneumonidae, part 3. *Memoirs of the American Entomological Institute, 13*: 1-307.

**Townes, H. & Townes, M. (1966)** A catalogue and reclassification of the Neotropic Ichneumonidae. *Memoirs of the American Entomological Institute, 8*: 1-367.

**Trillo, M.C., Agudelo, A.A., Guerrero, J.C., Miguel, L. & Lorier, E. (2021)** Mantodea (Insecta) of Uruguay: diversity and distribution. *Zootaxa, 4963*(3): 423-456. https://doi.org/10.11646/zootaxa.4963.3.3

**Vasconcellos, A., Andreazze, R., Almeida, A.M., Araujo, H.F.P., Oliveira, E.S. & Oliveira, U. (2010)** Seasonality of insects in the semi – arid Caatinga of northeastern Brazil. *Revista Brasileira de Entomologia, 54*(3): 47-147. https://doi.org/10.1590/S0085-56262010000300019

**Versuti, D.R., Paz, C.C.P., Lara, R.I.R., Fernandes, D.R.R. & Perioto, N.W. (2014)** Comparative abundance and diversity of Dryininae (Hymenoptera, Dryinidae) in three savannah phytophysiognomies in southeastern Brazil, under three sampling methods. *Revista Brasileira de Entomologia, 58*: 273-279. https://doi.org/10.1590/S0085-56262014000300008

**Wahl, D.B. & Bennett, A.M. (2020)** First record of Nesomesochorinae (Hymenoptera: Ichneumonidae) from America north of Mexico with descriptions of two new species of *Nonnus* Cresson. *Zootaxa, 4779*(1): 38-50. https://doi.org/10.11646/zootaxa.4779.1.2

**Wallner, W.E. (1987)** Factors affecting insect population dynamics: differences between outbreak and non-outbreak species. *Annual Review of Entomology, 32*: 317-340.

**Wolda, H. (1988)** Insect seasonality: why? *Annual Review of Ecology and Systematics, 19*(1): 1-18.

**Yu, D.S., van Achterberg, C. & Horstmann, K. (2016)** *World Ichneumonoidea 2015*. Ottawa, Taxapad. Database on flash-drive. Accessed January 2022.

**Zolessi, L.C.D., Abenante, Y.P.D. & Philippi, M.E (1989)** *Catálogo sistemático de las especies de Formicidae de Uruguay (Hymenoptera: Formicidae)*, pp. 40. Montevideo: ORCYT Unesco.