

Research Article / Artículo de Investigación

Bioecological aspects of *Cynea (Cynea) diluta* (Herrich-Schäffer, 1869) (Lepidoptera: Hesperiiidae: Hesperiiinae)

Aspectos bioecológicos de *Cynea (Cynea) diluta* (Herrich-Schäffer, 1869) (Lepidoptera: Hesperiiidae: Hesperiiinae)

Ayane Suênia-Bastos^{1*} , Suianne Cajé¹ , Jefferson Duarte-de-Mélo¹ , Iracilda Maria de Moura Lima² , Olaf Hermann Hendrik Mielke¹ 

¹Departamento de Zoologia, Universidade Federal do Paraná (UFPR), Curitiba, Paraná, Brazil. ²Instituto de Ciências Biológicas e da Saúde (ICBS), Universidade Federal de Alagoas (UFAL), Maceió, Alagoas, Brazil.

* sueniaayane@gmail.com

ZooBank: urn:lsid:zoobank.org:pub:90F44121-468E-4B97-BDBB-C4AEA1A92336
<https://doi.org/10.35249/rche.50.1.24.09>

Abstract. In Hesperiiidae (Lepidoptera), many species build shelters during their ontogeny which may serve as a scape strategy to reduce attacks from natural enemies and dislodgment from the host plant. This paper provides bioecological information regarding host plant, natural parasitism, and distribution of *Cynea (Cynea) diluta* (Herrich-Schäffer) (Hesperiidae: Hesperiiinae) collected near remnants of the Atlantic Forest “Centro de Endemismo Pernambuco” (CEPE), Northeast Region of Brazil. Larvae and pupae, the later showing signs of parasitism, were collected from a garden at the Universidade Federal de Alagoas, Maceió, State of Alagoas, Brazil. They were brought to the laboratory to record emergences and possible parasitoids. Data from distribution were obtained from labels of hesperiid deposited from the Coleção Entomológica Padre Jesus Santiago Moure, Curitiba, State of Paraná. The host plant was identified as *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberaceae). From the 13 larvae and two pupae collected in the environment, 20 specimens of *Brachymeria* sp. (Hymenoptera: Chalcididae) emerged from the pupae. This is the first report of parasitism on pupae of *Cynea (C.) diluta*.

Key words: Biological control; host plant; parasitoid; red ginger; tritrophic association.

Resumen. En Hesperiiidae (Lepidoptera), muchas especies construyen refugios durante su ontogenia que pueden servir como estrategia de escape para reducir los ataques de enemigos naturales y el desprendimiento de la planta huésped. Este artículo proporciona información bioecológica sobre la planta huésped, el parasitismo natural y la distribución de *Cynea (Cynea) diluta* (Herrich-Schäffer) (Hesperiidae: Hesperiiinae) recolectada cerca de remanentes del Bosque Atlántico “Centro de Endemismo Pernambuco” (CEPE), región noreste de Brasil. Las larvas y pupas; estas últimas mostrando signos de parasitismo se recolectaron de un jardín de la Universidad Federal de Alagoas, Maceió, Estado de Alagoas, Brasil. Estas fueron llevadas al laboratorio para registrar emergencias y posibles parasitoides. Los datos de distribución se obtuvieron de etiquetas de hespéridos depositados en la Coleção Entomológica Padre Jesus Santiago Moure, Curitiba, Estado de Paraná. La planta huésped fue identificada como *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberáceas). De las 13 larvas y dos pupas recolectadas en el ambiente, se identificaron 20 ejemplares de *Brachymeria* sp. (Hymenoptera: Chalcididae) que emergieron de las pupas. Este es el

Received 23 December 2023 / Accepted 23 February 2024 / Published online 31 March 2024

Responsible Editor: José Mondaca E.

primer registro de parasitismo en pupas de *Cynea (C.) diluta*.

Palabras clave: Asociación tritrófica; control biológico; jengibre rojo; parasitoide; planta huésped.

Introduction

Amongst the Lepidoptera most of the species are phytophagous (Triplehorn and Johnson 2015). During the larval stages, the immatures are susceptible to natural enemies either parasitoids, for instance, flies or wasps, or predators such as wasps and birds (Duarte *et al.* 2012). Most of the parasitoids are Hymenoptera and Diptera, whose larval stages requires a host (Matthews and Matthews 2010). In order to avoid natural enemies, several Lepidoptera use aposematic colour, camouflage, mimicry when adults (Duarte *et al.* 2012; Triplehorn and Johnson 2015), and shelters as well during the larval stage (Loeffler 1996; Greeney and Jones 2003).

Several species of Hesperidae are noticed by presenting the behavior of building shelters as juveniles (Greeney and Jones 2003; Greeney 2009), which changes according to the hesperiid genera or the host plant tissue (Lind *et al.* 2001; Greeney 2009). In general, shelters are useful to reduce predation and protect the larvae from dislodgments (Loeffler 1996). These shelters could also be beneficial to difficult or to avoid the attack of enemies as parasitoids. Given this scenario, this paper contributes to the bioecological knowledge of *Cynea (Cynea) diluta* (Herrich-Schäffer, 1869) (Hesperidae: Hesperinae) by reporting its immature stages, a Zingiberaceae as host plant, parasitoid wasp associated, and a *C. (C.) diluta* distribution map.

Material and Methods

Thirteen larvae of *Cynea (C.) diluta* were collected on October 2019 in an ornamental plant in the garden of the Instituto de Ciências Biológicas e da Saúde (ICBS) (9°33'28"S, 35°46'32"W) at the Universidade Federal de Alagoas (UFAL), Maceió, State of Alagoas, Brazil, where the annual temperature ranges approximately from 22 to 28 °C (Nascimento *et al.* 2018). Also, two pupae with signs of parasitism were collected on the same plant in September 2021, in the beginning of the dry season (Silva and Souza 2013).

These larvae were transported to the Laboratório de Bioecologia de Insetos (LABIN) and placed into "bernadete cage" (300 mL) (see Lima and Carvalho 2017) with paper towel covering its base and kept with the temperature ranging daily 24.5-26.2 °C and relative humidity from 55-72.2%. Daily, the cages were cleaned using alcohol (70%), papers towel were changed, and fresh leaves from the host plant were given to the immatures. The cephalic heads were stored into eppendorf tubes (0.5 mL). The pupae were placed into long tubes (capacity of 45 mL) to record parasitoid egressions.

After emergence, the adults were sacrificed by freezing, pinned, and accommodated on the Laboratório de Bioecologia de Insetos (LABIN-UFAL). Voucher specimens were deposited at the Coleção Entomológica Padre Jesus Santiago Moure, Departamento de Zoologia da Universidade Federal do Paraná (DZUP), Curitiba, State of Paraná, Brazil. The emerged parasitoids were kept in alcohol (70%). In order to confirm the host plant species, branches with inflorescence were led to MAC Herbarium of Instituto do Meio Ambiente de Alagoas (IMA-AL).

To create a distribution map, data of the labels of 52 hesperiid specimens deposited at DZUP as well as the data available in bibliography, were collected and inserted in the software QGIS, version 3.32.1. Information without city or locality was not used in the map. The data in the results are shown following: **Country:** Department/State/Province/Region (City or/and locality) (Source of information).

Results and Discussion

Cynea (C.) diluta (Fig. 1), a native species from the neotropics, was feeding on *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberaceae) (exsiccate MAC 65226) (Fig. 2A). From the thirteen larvae of many instars collected, there was the average of 13.84 days of pupa duration, and all emerged as adults. The immatures found on the leaves maintained a solitary behavior (Figs. 3A-C), and built shelters during the larval stage, which increases in size as they develop. The shelters were classified as proposed by Greeney (2009) as “no-cut shelter”, the most common shelter built by Pyrginae and Eudaminae larvae which consists by folding the leaf and attaching with silk (Figs. 2B-C).



Figure 1. *Cynea (Cynea) diluta* (Herrich-Schäffer, 1869). Scale bar: 1 cm. **A-B.** Male: dorsal and ventral view (DZ 59.896-DZUP). **C-D.** Female: dorsal and ventral view (DZ 59.897-DZUP). / **Figura 1.** *Cynea (Cynea) diluta* (Herrich-Schäffer, 1869). Escala: 1 cm. **A-B.** Macho: vista dorsal y ventral (DZ 59.896-DZUP). **C-D.** Hembra: vista dorsal y ventral (DZ 59.897-DZUP).



Figure 2. Host plant. **A.** Tussock of *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberaceae). **B-C.** Shelters built by the late instar larvae of *Cynea* (*Cynea*) *diluta* (Herrich-Schäffer, 1869). / **Figura 2.** Planta huésped. **A.** Mata de *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberaceae). **B-C.** Refugios construídos por las larvas de último estadio de *Cynea* (*Cynea*) *diluta* (Herrich-Schäffer, 1869).

The host plant *A. purpurata* (known as red ginger, ostrich plume, and pink cone ginger) is a shrub which presents bright red bracts and almost unnoticeable white flowers. This Malaysian species is widely cultivated in tropical and subtropical regions of the world as ornamental plant and cut flowers (Kobayashi *et al.* 2007; Teixeira and Loges 2008). The varieties of this species (white, pink, red inflorescences) are amongst the main items exported to the international tropical flower market by producers from Northeastern Region of Brazil (Teixeira and Loges 2008). Several insects of nine insect orders were reported interacting with *A. purpurata* in Alagoas performing at least five bioecological roles: herbivorous, predators, pollinators, parasitoids, or detritivores – Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mantodea, Neuroptera, Odonata and Orthoptera (Broglia-Micheletti *et al.* 2011).

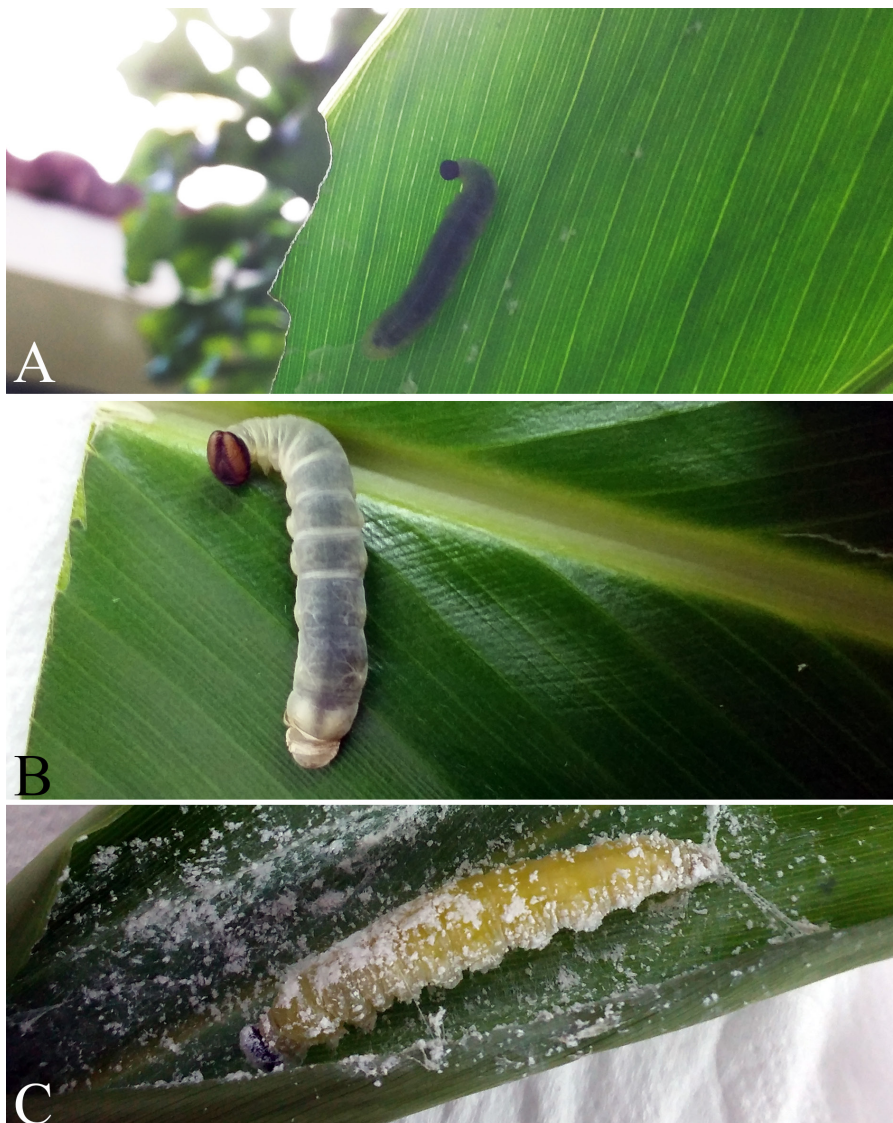


Figure 3. Immature stages of *Cynea (Cynea) diluta* (Herrich-Schäffer, 1869) on its host plant, *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberaceae). **A.** Earlier instar larva. **B.** Last instar larva. **C.** Prepupa.
 / **Figura 3.** Etapas inmaduras de *Cynea (Cynea) diluta* (Herrich-Schäffer, 1869) en su planta huésped, *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberaceae). **A.** Larva en estadios iniciales. **B.** Larva de último estadio. **C.** Prepupa.

Immatures of *Cynea (C.) diluta* feed on native Zingiberaceae plants from the neotropics such as *Renalmia alpinia* (Tottb.) Maas., *R. cernua* (Sw. ex Roem. & Schult.) J. F. Macbr., and *R. mexicana* Klotzsch ex Petersen (Cock 2006; Janzen and Hallwachs 2009); only *R. mexicana* does not occur in Brazil (André 2024). Exotic species from this family were also used by *C. (C.) diluta* immatures, such as *Hedychium coronarium* J. Koenig, and *H. gardnerianum* Sheppard ex Ker Gawl. (Janzen and Hallwachs 2009), both native from Asia (Rojas-Sandoval and Acevedo-Rodríguez; Pereira *et al.* 2021). This implies that Zingiberaceae may be specific host for immatures of *C. (C.) diluta*. Other species of *Cynea* had already been reported feeding on Arecaceae, Cannaceae, Heliconiaceae, Marantaceae, Zingiberaceae (Janzen and Hallwachs 2009), and Poaceae (Murillo-Hiller *et al.* 2019).



Figure 4. Parasitoidism by *Brachymeria* sp. (Hymenoptera: Chalcididae) on pupa of *Cynea* (*Cynea*) *diluta* inside *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberaceae) leaf shelter. **A.** Parasitized pupa with several holes laid after parasitoid egression. **B.** *Brachymeria* sp., body length ~4-5 mm. / **Figura 4.** Parasitoidismo por *Brachymeria* sp. (Hymenoptera: Chalcididae) sobre pupa de *Cynea* (*Cynea*) *diluta* dentro de *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberaceae) refugio de hojas. **A.** Pupa parasitada con varios agujeros creados después de la egresión del parasitoide. **B.** *Brachymeria* sp., longitud corporal ~4-5 mm.

The pupae collected with signs of parasitism were found inside *A. purpurata* leaf shelters built by last instar larvae. Different number of *Brachymeria* Westwood, 1829 (Hymenoptera: Chalcididae) emerged throughout holes (Figs. 4A-B) built in the integument from each pupa. In total, 16 specimens emerged from both pupae – 14 specimens from 11 holes, and six 68

specimens from five holes –, implying gregarious parasitoid behavior. Some adult wasps do not cut holes in the pupal integument but take advantage of the opening left by the first to leave the pupa, which explains the difference between the number of parasitoids and holes (Santos-Murgas *et al.* 2021).

Brachymeria species are widely distributed, and it is considered parasitoid from several Lepidoptera pupae, even though many species act as hyperparasitoid (Burks 1960). There are some records of *Brachymeria* spp. parasitising directly Lepidoptera pupae, such as Nymphalidae (Gil-Santana and Tavares 2005, 2006; Nardi *et al.* 2006; Tinôco *et al.* 2012; Santos-Murgas *et al.* 2019), Geometridae (Zache *et al.* 2012), Saturniidae (Ramírez *et al.* 2004), and Hesperidae around Indonesia, India, Panama, and North and South Regions of Brazil (Salgado-Neto *et al.* 2010; Erniwati and Ubaidillah 2011; Tinôco *et al.* 2012; Gupta and Kalesh 2012; Gupta *et al.* 2016; Santos-Murgas *et al.* 2021; James *et al.* 2022). The only information in respect of parasitism of *Cynea* is a report of the braconid *Alphomelon xestopyga* Deans, 2003 on larvae of *C. irma* (Janzen and Hallwachs 2009).

After examining the labels of specimens of *C. (C.) diluta* from the DZUP and bibliography, the species is recorded occurring during all months of the year in the neotropics biomes of Tropicals Rain, Dry and Atlantic Forests, Andes, and Savana, reaching heights until 1.074 meters. The records of the species are **Mexico:** Oaxaca (Luís-Martínez *et al.* 2016). **Honduras:** no locality (Evans 1955); Atlantida, and Yoro (Parque Nacional Pico Bonito) (Miller *et al.* 2012); Santa Bárbara, and Córtes (Emerald Valley Nature Reserve) (Gallardo 2022). **El Salvador:** no locality (Steinhauser 1975). **Nicaragua:** Región Autónoma de la Costa Caribe Sur (Bluefields) (Anderson 2007). **Costa Rica:** Guanacaste (Área de Conservación Guanacaste) (Janzen and Hallwachs 2009). **Panama:** no locality (Evans 1955); Panama (Madden Dam) (DZUP). **Trinidad and Tobago:** no locality (Evans 1955); Tunapuna Piarco (Curepe, Morne Bleu, El Tucuche) (Cock 2006); Mayaro Rio-Claro (Trinity Hills) (Cock 2006); Port of Spain (Cock 2006). **Venezuela:** no locality (Evans 1955); Maracay (Aragua) (DZUP); Trujillo (Valera) (Mabille 1891). **Guyana:** no locality (Godman 1901; Evans 1955); Potaro-Sinapure (Kaieteur National Park) (Shambu and Nankishore 2018); Berbice Oriental-Corentine (Parika) (Shambu and Nankishore 2018). **Surinam:** no locality (Plötz 1883; Evans 1955); Surinam (Paramaribo) (Möschler 1883). **Colombia:** no locality (Möschler 1878; Godman 1907; Evans 1955); Meta (Villavicencio) (DZUP). **Peru:** Madre de Dios (Reserva Tambopata) (DZUP); Loreto (Iquitos, and Pebas) (Evans 1955). **Bolivia:** no locality (Godman 1901); La Paz (Yungas) (Evans 1955). **Brazil:** Amazonas (Godman 1901); Amapá (Serra do Navio) (Mielke 1973); Pará - no locality (Evans 1955), (Oriximiná, and São Antônio de Tauá) (DZUP), (Belém: Utinga) (Mielke 1973); Roraima (Alto Alegre) (DZUP); Maranhão (Imperatriz) (DZUP); Pernambuco (Recife: Parque Estadual Dois Irmãos) (Melo *et al.* 2019), (Camaragibe) (DZUP), (Caruaru: Parque Ecológico João Vasconcelos Sobrinho) (Paluch *et al.* 2011); Alagoas (Maceió) (DZUP); Bahia (Rio Mucuri) (DZUP), (Itaparica) (Evans 1955); Distrito Federal (Brasília) (DZUP); Goiás (Goiânia) (DZUP), (Vianópolis) (DZUP); Minas Gerais (Corinto) (DZUP); São Paulo (Baixada Santista) (Francini *et al.* 2011); Espírito Santo (Linhares, and Conceição da Barra) (DZUP); Rio de Janeiro (Cachoeiras de Macacu) (DZUP), (Guapimirim) (Soares *et al.* 2011), (Itatiaia) (Zikán and Zikán 1968); Paraná (Foz do Iguaçu) (DZUP); Santa Catarina (Joaçaba) (DZUP). The points of occurrence are shown in Fig. 5.

This paper reports for the first time the natural parasitism from pupae of *C. (C.) diluta* by *Brachymeria* sp. (Hymenoptera: Chalcididae) near remnants of the Atlantic Forest “Centro de Endemismo Pernambuco” (CEPE) (see Brown 1977), State of Alagoas, Northeast Region, Brazil. Despite the immatures of *C. (C.) diluta*, as other hesperiid species, build shelters by using plant leaves, the specimens still are susceptible to parasitoids. Also, this paper contributes providing information regarding behavior and feeding that may be used to study evolutionary aspects in the future.

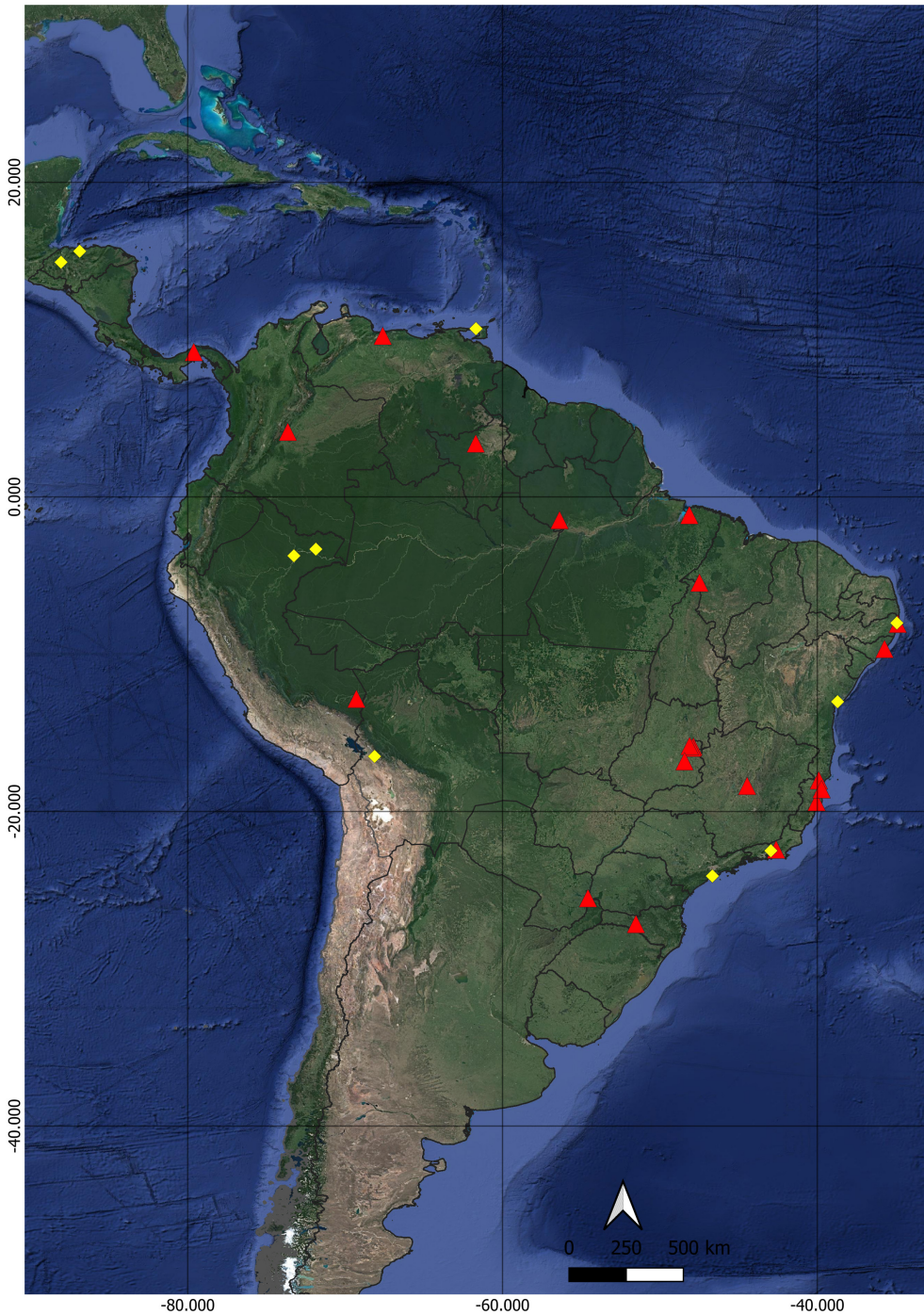


Figure 5. Geographic distribution of *Cynea* (*Cynea*) *diluta* (Herrich-Schäffer, 1869) (Hesperiidae: Hesperinae) in the Neotropical Region, from label data specimens deposited at Coleção Entomológica Padre Jesus Santiago Moure (DZUP) and from bibliography. Data from DZUP (triangles) and bibliography (diamonds). / **Figura 5.** Distribución geográfica de *Cynea* (*Cynea*) *diluta* (Herrich-Schäffer, 1869) (Hesperiidae: Hesperinae) en la Región Neotropical, a partir de datos de etiquetas de especímenes depositados en la Coleção Entomológica Padre Jesus Santiago Moure (DZUP) y de bibliografía. Datos de DZUP (triángulos) y bibliografía (diamantes).

Author Contributions

ASB: Specimens collection, laboratory observations, writing-original draft, reviewing, figures' edition. **SC:** Laboratory observations, writing, reviewing. **JDM:** Laboratory observations, writing, reviewing. **IMML:** Writing, reviewing. **OHHM:** Writing, reviewing.

Acknowledgements

Firstly, the authors thank to MAC Herbarium at the Instituto do Meio Ambiente de Alagoas (IMA-AL), especially to the Director Rosângela Pereira Lyra Lemos and Erlande Lins da Silva, for receiving, depositing, and identifying the ornamental plant species. Secondly, the first author thanks to Andrew Warren from the McGuire Center for Lepidoptera and Biodiversity of Florida Museum of Natural History, University of Florida, Gainesville, Florida, United States of America for all the attention and identification of hesperiid species around the year 2020 when she still was graduating at the university. Also, the authors thank to Mirna Martins Casagrande, the curator of Lepidoptera Collection at Coleção Entomológica Padre Jesus Santiago Moure in Departamento de Zoologia da Universidade Federal do Paraná (DZUP), Curitiba, Paraná, for contributing with data from this collection. We thank Editor-in-Chief, José Mondaca E., and the two reviewers for suggestions that improved the manuscript. The authors also thank to Universidade Federal de Alagoas (UFAL) for the opportunity of Institutional Scientific Initiation Program, Fundação de Amparo à Pesquisa do Estado de Alagoas (FAPEAL). Finally, the thanks go to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for the fellowship to the first author (88887.667353/2022-00) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the fellowships to the second (162126/2021-2), third (131206/2021-4) and fifth (304849/2019-7) authors.

Literature Cited

- Anderson, R.A. (2007)** A list of HesperIIDae collected in Nicaragua. *Bulletin of the Allyn Museum*, 146: 1-19.
- André, T. (2024)** Zingiberaceae. Flora e Funga do Brasil. Available at: <https://floradobrasil.jbrj.gov.br/> Accessed on: 14 February 2024.
- Broglia-Micheletti, S.M.F., Diniz, M.C.C., Silva-Dias, N., Araújo, A.M.N., Girón-Pérez, K. and Madalena, J.A.S. (2011)** Insetos associados a *Alpinia purpurata* (Vieill.) K. Schum. (Zingiberaceae) em Maceió y Rio Largo (AL), Brasil. *Revista Caatinga*, 24(1): 1-8.
- Brown, K.S. (1977)** Centros de evolução, refúgios quaternários e conservação de patrimônios genéticos na região neotropical: padrões de diferenciação em Ithomiinae (Lepidoptera: Nymphalidae). *Acta Amazonica*, 7(1): 75-137. <https://doi.org/10.1590/1809-43921977071075>
- Burks, B.D. (1960)** A revision of the genus *Brachymeria* Westwood in America North of Mexico (Hymenoptera: Chalcididae). *Transactions of the American Entomological Society*, 86(3): 225-273.
- Cock, M.J.W. (2006)** The Skipper butterflies (HesperIIDae) of Trinidad Part 14, HesperIIDae, Genera Group L. *Living World, Journal of the Trinidad and Tobago Field Naturalists' Club*, 8-26.
- Duarte, M., Marconato, G., Specht, A. and Casagrande, M.M. (2012)** *Lepidoptera*. In: Rafael, J.A., Melo, G.A.R., Carvalho, C.J.B., Casari, A.S. and Constantino, R. *Insetos do Brasil: Diversidade e Taxonomia*. Ribeirão Preto: Holos Editora, 1ª ed. Pp. 626-682.

- Erniwati, E. and Ubaidillah, R. (2011)** Hymenopteran parasitoids associated with the banana-skipper *Erionota thrax* L. (Insecta: Lepidoptera, Hesperidae) in Java, Indonesia. *Biodiversitas Journal of Biological Diversity*, 12(2): 76-85. <https://doi.org/10.13057/biodiv/d120204>
- Evans, W.H. (1955)** *A Catalogue of the American Hesperidae Indicating the Classification and Nomenclature Adopted in the British Museum (Natural History). Part IV. Hesperinae and Megathyminae*. British Museum, London, 499 pp.
- Francini, R.B., Duarte, M., Mielke, O.H.H., Caldas, A. and Freitas, A.V.L. (2011)** Butterflies (Lepidoptera, Papilionoidea and Hesperioidea) of the “Baixada Santista” region, coastal São Paulo, southeastern Brazil. *Revista Brasileira de Entomologia*, 55(1): 55-68. <https://doi.org/10.1590/S0085-56262011000100010>
- Gallardo, R.J. (2022)** Inventory of butterflies of Emerald Valley Nature Reserve, Honduras (Lepidoptera: Papilionoidea). *Tropical Lepidoptera Research*, 33(1): 1-22.
- Gil-Santana, H.R. and Tavares, M.T. (2005)** *Brachymeria pandora* (Crawford) (Hymenoptera: Chalcididae): a new parasitoid of *Historis odius* (Fabricius) (Lepidoptera: Nymphalidae). *Revista Brasileira de Entomologia*, 22(4): 1211-1212. <https://doi.org/10.1590/S0101-81752005000400060>
- Gil-Santana, H.R. and Tavares, M.T. (2006)** Chalcidoid parasitoids (Hymenoptera) of *Actinote paraphelus* Jordan, 1913 (Lepidoptera: Nymphalidae). *Biota Neotropica*, 6(1): N01006012006. <https://doi.org/10.1590/S1676-06032006000100016>
- Godman, F.D. (1901)** *Hesperidae*. In: Godman, F.D. and Salvin, O. (1879-1901). *Biologia Centrali-Americana, Insecta, Lepidoptera Rhopalocera* 2. Pp. 244-637, [pls.73-106].
- Godman, F.D. (1907)** Notes on the American species of Hesperidae described by Plötz. *The Annals and Magazine of Natural History; Zoology, Botany and Geology*, 20(115-120): 132-155.
- Greeney, H.F. (2009)** A revised classification scheme for larval hesperiid shelters, with comments on shelter diversity in Pyrginae. *Journal of the Research on the Lepidoptera*, 41: 53-59.
- Greeney, H.F. and Jones, M.T. (2003)** Shelter building in the Hesperidae: A classification scheme for larval shelters. *Journal of the Research on the Lepidoptera*, 37: 27-36.
- Gupta, A. and Kalesh S. (2012)** Reared parasitic wasps attacking hesperiids from Western Ghats (Kerala, India) with description of a new species of *Dolichogenidea* (Hymenoptera: Braconidae) as a larval parasitoid of *Thoressa evershedi* (Evans) (Lepidoptera: Hesperidae). *Zootaxa*, 3413: 29-43. <https://doi.org/10.11646/zootaxa.3413.1.3>
- Gupta, A., Saji, K. and Manoj, P. (2016)** Parasitoids of butterflies: reassignment of *Dolichogenidea hasorae* (Wilkinson, 1928) as a new combination along with new host-parasitoid linkages and notes on host specificity from Kerala, India. *Journal of Biological Control*, 30(2): 61-67. <https://doi.org/10.18641/jbc/30/2/79953>
- James, R.V., Binoy, C., Santhosh, S. and Nasser, M. (2022)** A peculiar case of parasitisation with two new species of wasps parasitizing the rice leaf-roller *Pelopidas mathias* (Fabricius, 1798) (Lepidoptera: Hesperidae) from southern India. *Systematic Parasitology*, 99: 715-726. <https://doi.org/10.1007/s11230-022-10061-5> (0123456789)
- Janzen, D.H. and Hallwachs, W. (2009)** Dynamic database for an inventory of the macrocaterpillar fauna, and its food plants and parasitoids, of Area de Conservación Guanacaste (ACG), northwestern Costa Rica (nn-SRNP-nnnnn voucher codes). Available in: <<http://janzen.sas.upenn.edu>>. Accessed on 13 February 2024.
- Kobayashi, K.D., Mcewen, J. and Kaufman, A.J. (2007)** Ornamental ginger, red and pink. Ornamentals and Flowers, OF-37, College of Tropical Agriculture and Human Resources, Honolulu: University of Hawaii. Pp. 1-8.
- Lima, I.M.M. and Carvalho, M.B. (2017)** Garrafas pet como alternativa para a confecção de recipientes para criação de insetos em laboratório. *Revista Ciência Agrícola*, 15(1): 79-86. <https://doi.org/10.28998/rca.v15i1.2300>

- Lind, E.M., Jones, M.T., Long J.D. and Weiss, M.R. (2001)** Ontogenetic changes in leaf shelter construction larvae of *Epargyreus clarus* (Hesperiidae), the silver-spotted skipper. *Journal of the Lepidopterists' Society*, 54(3): 77-82.
- Loeffler, C.C. (1996)** Catterpillar leaf folding as a defense against predation and dislodgment: staged encounters using *Dichomeris* (Gelechiidae) larvae on goldenrods. *Journal of the Lepidopterists' Society*, 50(3): 245-260.
- Luis-Martínez, A., Hernández-Mejía, B., Trujano-Ortega, M., Warren, A., Salinas-Gutiérrez, J., Ávalos-Hernández, O., Vargas-Fernández, I. and Llorente-Bousquets, J. (2016)** Avances faunísticos en los Papilionoidea (Lepidoptera) *sensu lato* de Oaxaca, México. *Southwestern Entomologist*, 41(1): 171-224.
- Mabille, M.P. (1891)** Description d'Hespérides nouvelles. *Annales de la Société Entomologique de Belgique*, 35: 60-68.
- Matthews, R.W. and Matthews, J.R. (2010)** *Insect behavior*. Dordrecht: Springer, 2^a ed. Pp. 148-152.
- Melo, D.H., Duarte, M., Mielke, O.H., Robbins, R.K. and Freitas, A.V. (2019)** Butterflies (Lepidoptera: Papilionoidea) of an urban park in northeastern Brazil. *Biota Neotropica*, 19(1): 1-10. <https://doi.org/10.1590/1676-0611-BN-2018-0614>
- Mielke, O.H.H. (1973)** Contribuição ao estudo faunístico dos Hesperíidae americanos. III Espécies coletadas em duas excursões ao Pará e Amapá, Brasil. *Acta Biológica Paranaense*, 2(1-4): 17-40.
- Miller, J.Y., Matthews, D.L., Warren, A.D., Solis, M., Harvey, D.J., Gentili-Poole, P., Lehmann, R., Emmerl, T.C. and Covell, C.V. (2012)** An annotated list of the Lepidoptera of Honduras. *Insecta Mundi*, 025: 1-72.
- Möschler, H.B. (1878)** Neue exotische Hesperidae. *Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien*, 28: 203-230.
- Möschler, H.B. (1883)** Beiträge zur Schmetterlings-Fauna von Surinam. V. *Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien*, 32: 303-362.
- Murillo-Hiller, L.R., Segura-Bermúdez, O.A., Barquero, J.D. and Bolños, F. (2019)** The skippers butterflies (Lepidoptera: Hesperíidae) of the Reserva Ecológica Leonelo Oviedo, San José, Costa Rica. *Revista de Biología Tropical*, 67(2): 228-248.
- Nardi, C., Guerra, T.M., Orth, A.I. and Tavares, M.T. (2006)** Himenópteros parasitoides associados a pupas de *Methona themisto* (Lepidoptera: Nymphalidae) em Florianópolis, Santa Catarina, Brasil. *Iheringia. Série Zoológica*, 96(3): 373-375. <https://doi.org/10.1590/S0073-47212006000300014>
- Nascimento, M.C., Lombardo, M.A., Júnior, S.A.M. and Andrade, E.L. (2018)** Análise da vulnerabilidade físico-ambiental causada pelas chuvas intensas na Região Metropolitana de Maceió. *Revista Caminhos da Geografia*, 19(67): 268-288. <https://doi.org/10.14393/Hygeia196718>
- Paluch, M., Mielke, O.H.H., Nobre, C.E.B., Casagrande, M.M., Melo, D.H.A. and Freitas, A.V.L. (2011)** Butterflies (Lepidoptera: Papilionoidea and Hesperioidea) of the Parque ecológico João Vasconcelos Sobrinho, Caruaru, Pernambuco, Brazil. *Biota Neotropica*, 11(4): 229-238.
- Pereira, M.J., Eleutério, T., Meirelles, M.G. and Vasconcelos, H.C. (2021)** *Hedychium gardnerianum* Sheph. ex Ker Gawl. from its discovery to its invasive status: a review. *Botanical Studies*, 62(1): 1-24.
- Plötz, C. (1883)** Die Hesperíinen-gattung *Hesperia* aut. und ihre arten. *Entomologische Zeitung*, 44: 26-64.
- QGIS Development Team (2023)** QGIS Geographic Information System. Open Source Geospatial Foundation Project. Available in: <http://qgis.osgeo.org> (Accessed 23 October 2023)

- Ramírez, R., Domínguez, O., Inciarte, E. and Burgos, M.E. (2004)** Himenópteros y dípteros parasíticos de *Automeris incarnata* Walker, 1865 (Lepidoptera: Saturniidae) defoliador del cultivo plátano (*Musa AAB*, sub-grupo plátano cv. Hárton) en la zona sur y este del lago de Maracaibo, Venezuela. *Revista de la Facultad de Agronomía de la Universidad del Zulia*, 1: 148-154.
- Rojas-Sandoval, J. and Acevedo-Rodríguez, P. (2013)** *Hedychium coronarium* (white butterfly ginger lily). Cabi Compendium, 26678. <https://doi.org/10.1079/cabicompendium.26678>
- Salgado-Neto, G., Di Mare, R.A. and Lopes-da-Silva, M. (2010)** Parasitismo de pupas de *Argon lota* Hewitson (Lepidoptera: Hesperidae) por *Brachymeria pandora* (Crawford) (Hymenoptera: Chalcididae) no Rio Grande do Sul. *Neotropical Entomology*, 39(2): 311-312. <https://doi.org/10.1590/S1519-566X2010000200027>
- Santos-Murgas, A., Cambra, R.A. and Abrego, J.C. (2019)** *Brachymeria annulata* y *Anastatus* sp. (Hymenoptera: Chalcidoidea) parasitoides respectivos de *Historus odius* (Lepidoptera: Nymphalidae) y *Liturgusa* sp. (Mantodea: Liturgusidae). *Tecnociencia*, 21(1): 57-64.
- Santos-Murgas, A., Gutiérrez-Lanzas, J.J. and Lanuza-Garay, A. (2021)** Registro de parasitismo de *Brachymeria annulata* (Hymenoptera: Chalcididae) en Panamá. Poyeana, *Revista Cubana de Zoología*, 512: 1-3.
- Shambu, H. and Nankishore, A. (2018)** Butterflies (Lepidoptera) of Guyana: A compilation of records. *Zootaxa*, 4371(1): 1-187. <https://doi.org/10.11646/zootaxa.4371.1.1>
- Silva, D.F. and Sousa, A.B. (2013)** Detecção de tendências climáticas no Estado de Alagoas. *Revista Brasileira de Geografia Física*, 6(3): 442-455.
- Soares, A., Bizarro, J.M., Bastos, C.B., Tangerini, N., Silva, N.A., da Silva, A.S. and Silva, G.B. (2011)** Preliminary analysis of the diurnal Lepidoptera fauna of the Três Picos State Park, Rio de Janeiro, Brazil, with a note on *Parides ascanius* (Cramer, 1775). *Tropical Lepidoptera Research*, 21(2): 66-79.
- Steinhauser, S.R. (1975)** An annotated list of the Hesperidae of El Salvador. *Bulletin of the Allyn Museum*, 29: 1-34.
- Teixeira, M.C.F. and Loges, V. (2008)** Alpinia-cultivo e comercialização. *Revista Brasileira de Horticultura Ornamental*, 14: 9-14.
- Tinôco, R.S., Ribeiro, R.C., Tavares, M.T., Vilela, E.F., Lemos, W.P. and Zanuncio, J.C. (2012)** *Brachymeria* spp. (Hymenoptera: Chalcididae) parasitizing pupae of Hesperidae and Nymphalidae (Lepidoptera) pests of oil palm in the Brazilian Amazonian Region. *Florida Entomologist*, 95(3): 788-789.
- Triplehorn, C.A. and Johnson, N.F. (2015)** *Lepidoptera*. In: Triplehorn, C.A. and Johnson, N.F. *Estudo dos insetos*. São Paulo: Cengage Learning, 2ª ed. Pp. 545-610.
- Zache, B., Zache, R.R.C., Tavares, M.T. and Wilcken, C.F. (2012)** *Brachymeria pandora* (Crawford) (Hymenoptera: Chalcididae) as a new parasitoid of *Thyrinteina leucocerae* (Rindge) (Lepidoptera: Geometridae) in Brazil. *Neotropical Entomology*, 41: 343-344. <https://doi.org/10.1007/s13744-012-0049-5>
- Zikán, J.F. and Zikán, W. (1968)** Inseto-fauna do Itatiaia e da Mantiqueira. III. Lepidoptera. *Pesquisa Agropecuária Brasileira*, 3: 45-109.