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# The lepidopterofauna and its representativeness in Bahia: What do the computerized data tell us?

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## ABSTRACT

Lepidoptera represents one of the richest insect orders, with about 160,000 species described. Brazil is home to approximately half of the order's neotropical richness, with about 57% of the known species, and the state of Bahia is an important center of lepidopteran endemism. Scientific collections summarize important information about species and incorporated into computerized databases, can provide more efficient access to taxonomy, systematics, and biodiversity data. Thus, the present work analyzed the scientific production of Lepidoptera inventories bibliometrically and inventoried the richness of Lepidoptera recorded for Bahia, based on information available in online collections and records of specific literature. The survey of the species was compiled from the records of valid names in the speciesLink database and survey work carried out in Bahia. The names of the taxa included in the analyses were reviewed for taxonomic status, and for taxonomic and systematic treatment the specialized literature was used. In total, n = 891 species and 12 families were recorded, from 52 municipalities in the state, with emphasis on Nymphalidae and Hesperiidae, which concentrated 68% of the total. Most of these records were largely associated with the Atlantic Forest (with 85% of the taxa), compared to areas of *Caatinga* and *Cerrado*. The inventories were increasing, revealing a richness of the lepidopterofauna of Bahia. Although much effort has been made in the area, computerized entomological data from Brazilian collections are still incipient, evidencing the need for the development of effective infrastructures for the cataloguing of Brazilian biodiversity.

## RESUMO

Lepidoptera representa uma das ordens de insetos com maior riqueza, com cerca de 160.000 espécies descritas. O Brasil abriga aproximadamente metade da riqueza neotropical da ordem, com cerca de 57% das espécies conhecidas, sendo o Estado da Bahia um importante centro de endemismo de lepidópteros. As coleções científicas sumarizam informações importantes sobre as espécies e, incorporadas a bancos de dados informatizados, podem fornecer um acesso mais eficiente sobre dados de taxonomia, sistemática e biodiversidade. Assim, o presente trabalho analisou bibliométricamente a produção científica de inventários de Lepidoptera e inventariou a riqueza de Lepidoptera registrada para a Bahia, a partir das informações disponíveis em coleções on-line e registros da literatura específica. O levantamento das espécies foi compilado a partir dos registros de nomes válidos no banco de dados do *species*Link e trabalhos de levantamentos realizados na Bahia. Os nomes dos táxons incluídos nas análises foram revisados quanto ao status taxonômico, e para o tratamento taxonômico e sistemático foi utilizado a literatura especializada. No total, foram registradas n = 891 espécies e 12 famílias, oriundos de 52 municípios do estado, com destaque para Nymphalidae e Hesperiidae, que concentraram 68% do total. Majoritariamente estes registros foram amplamente associados à Mata Atlântica (com 85% dos táxons), em comparação com áreas de Caatinga e Cerrado. Os inventários foram crescentes, revelando uma riqueza da lepidopterofauna da Bahia. Embora muito esforços tenham sido realizados na área, os dados entomológicos informatizados das coleções brasileiras ainda são incipientes, evidenciando a necessidade da elaboração de infraestruturas eficazes para a catalogação da biodiversidade brasileira.

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## Introduction

The Lepidoptera Order, which encompasses butterflies and moths, comprises approximately 160,000 described species, distributed in a wide variety of habitats and regions (Teston *et al.*, 2006; Duarte *et al.*, 2012). This order constitutes one of the main biological radiations in the Insecta class. In the Neotropical region, specifically, there are about 46,313 species of lepidoptera cataloged (Heppner, 1991; Aguiar *et al.*, 2009). Brazil, due to its immense diversity of insects, is home to approximately half of the Neotropical richness, corresponding to about 57% of the known species (Aguiar *et al.*, 2009; Rocha & Boeger, 2009; Duarte *et al.*, 2012), distributed in the six national biomes.

Lepidoptera species perform crucial functions in terrestrial ecosystems, participating in various ecological interactions. These interactions include the pollination of flowers by nectarivorous species and the control of plant populations through herbivorous habit (Freitas & Marini-Filho, 2011). In addition, lepidoptera can be considered indicators of the degree of environmental preservation (Duarte *et al.*, 2012), playing a key role in assessing the conservation status of the environment because they are sensitive to environmental changes and many species have specific habitat requirements. Therefore, the presence or absence of certain butterfly species can serve as indicators of habitat quality and overall ecosystem health. For this reason, these animals also stand out as valuable models for studies related to conservation biology, ecology, and evolution (Soga *et al.*, 2015).

Conducting faunal inventories provides information about the diversity of butterfly species in a given area. This is essential to understand local biodiversity and monitor changes over time (e.g., habitat loss, climate change, and anthropogenic action), in addition to making it possible to better understand the biogeography, taxonomy, and systematics of species (Favretto *et al.*, 2013). These surveys contribute to the dissemination and sharing of biodiversity data, and are considered the basis for the elaboration of conservation plans and environmental assessment methods (Mielk *et al.*, 2008). In this scenario, Brazil's responsibility increases in proportion to its biodiversity, one of the largest in the world, including two biodiversity hotspots: the Atlantic Forest and the Cerrado (Myers *et al.*, 2000). Because without this information about biodiversity, wrong decisions can be made regarding the conservation of species and their environments (Favretto *et al.*, 2013).

The insertion of specimens in scientific biological collections is a permanent means of knowledge about biodiversity under ex situ conditions (Marinoni & Peixoto, 2010). This information incorporated into computerized databases can provide more efficient access to data from systematics, taxonomy and molecular studies (Brandão *et al.*, 2000; Marinoni & Peixoto, 2010). Despite hosting about 20% of global biodiversity, Brazil holds only 1% of the world's scientific biological physical collection (Canhos *et al.*, 2015). For megadiverse countries like Brazil, actions to mitigate the global biodiversity crisis include free and open access to

research data in usable formats is crucial for the knowledge of its biological components (Peixoto *et al.*, 2006; Canhos *et al.*, 2015).

Broad access to a standardized and well-structured database is essential to identify the scientific gaps that still exist on biodiversity (Ministério do Meio Ambiente, 2017). The scarcity of data on the number, distribution, and status of species hinders and influences key biodiversity metrics; the proposition of conservation plans (Pimm *et al.*, 2014); the establishment of areas with little known biota; priority areas for research and conservation of little-studied taxonomic groups, with direct and indirect applicability of biological diversity (Ribeiro *et al.*, 2020). In this field, taxonomists are a key player in the conservation of biodiversity, as they help to map which areas concentrate the largest number of species, which are fundamental for the conservation of different evolutionary lineages. It is noteworthy that the current numerical deficit in the training of these professionals has a direct impact on the cataloguing of the diversity of taxa.

The State of Bahia stands out as an important center of lepidopteran endemism (Silva & Casteleti, 2003), and despite the publication of several lists of species in recent years, there is still much to be discovered (Kerpel *et al.*, 2014). The data currently available in the specific literature can be considered insufficient and show gaps that limit knowledge, discussions and the development of conservation plans for the group in question. In this context, this work aimed to: (1) carry out a bibliometric analysis of the scientific production of lepidopteran inventories in Bahia, highlighting the participation of the main researchers in this production; and (2) to make a survey of the Lepidoptera fauna inventoried for the State of Bahia, using data from online collections and records of specific literature, with the main goal of identifying the gaps in the digital data for each biome of the State of Bahia. Given that the Atlantic Forest biome is home to approximately two-thirds of the butterfly species recorded in Brazil, our hypothesis is that the Bahian Atlantic Forest concentrates the largest number of records and collections compared to the other non-forest biomes in the state (*Cerrado* and *Caatinga*).

## Material and methods

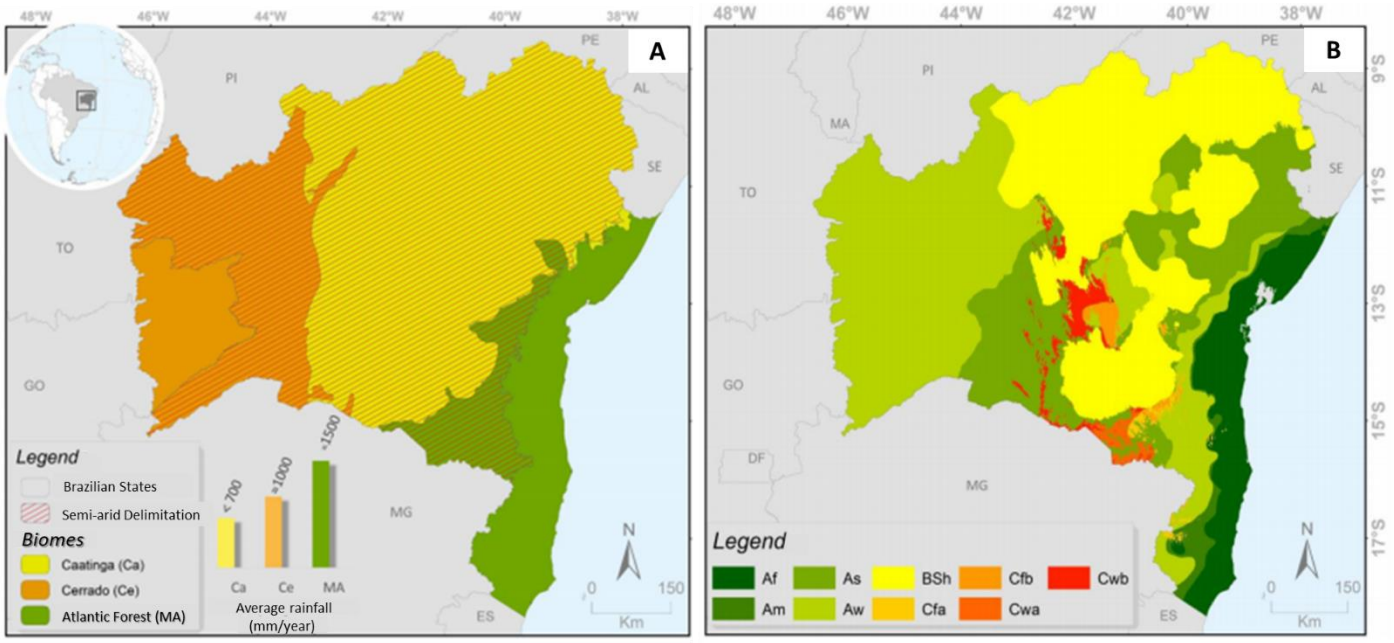
### Field of Study

The study area comprised the State of Bahia, located between the coordinates 08°29'14" and 18°24'34" S and 37°18'11" and 46°59'58" W, with a total area of 564,760.427 km², representing the largest territorial extension in the Northeast region of Brazil (about 37.7%) (IBGE, 2021a). Bahia is home to a vast environmental potential, characterized by the *Caatinga*, *Cerrado* and Atlantic Forest biomes, which cover 54%, 27% and 19% of the entire state extension, respectively (Leal *et al.*, 2003; IBGE, 2021b) (Figure 1A). Bahia is known for its great diversity of climatic typologies, encompassing nine of the twelve national climatic types, according to the Köppen classification (Alvares *et al.*, 2013). It has a rainfall variability

ranging from 300 to 2,000 mm per year (Kousky, 1979) and average annual temperatures in the range of 18 ºC to 36 ºC (Alvares *et al.*, 2013) (Figure 1B). Most of the state's territory is located in regions with a semi-arid climate, covering an area of 388,274 km², equivalent to 68% of the total extension of Bahia (Dourado *et al.*, 2013; Dourado, 2017).

**Figure 1.**

*Vegetation and climatic representativeness in the State of Bahia, Northeast Brazil.* ***A.*** *Biomes and average annual rainfall.* ***B.*** *Climates according to the Köppen classification (1936): Af = humid tropical; Am = tropical with rainy and dry seasons; As = tropical with dry season; Aw = tropical with dry season in winter; Bsh = semi-arid; Cfa = humid oceanic subtropical with hot summer and no dry season; Cfb = humid oceanic subtropical with temperate summer and no dry season; Cwa = humid subtropical with dry winter and hot summer; Cwb = humid subtropical with dry winter and temperate summer.*




*Source: Adapted from Dutra (2019), based on Alvares et al. (2013).*

## Inclusion of lepidopterofauna data

The survey of lepidopteran species occurring in the state of Bahia was compiled from records with specific determination, obtained from three main sources: 1) available on the speciesLink network data platform (2020) (http://splink.cria.org.br); 2) records sent by e-mail to the curators of non-computerized collections available on the speciesLink network; and, 3) publications of surveys carried out in Bahia on the Google Scholar platforms using the terms “Lepidoptera” and “Bahia” until the period of December 2020. From the inclusion of the articles in the analyses, the strategy of seeking new references from the bibliographic references cited in the articles included in our analyses was used.

The data considered included records from eight collections: Entomological Collection of the Oswaldo Cruz Institute (*Coleção Entomológica do Instituto Oswaldo Cruz* - CEIOC); Museum of Science and Technology of the Pontifical Catholic University (*Museu de Ciências e*

*Tecnologia da Pontifícia Universidade Católica* - MCT-PUCRS); Museum of Comparative Zoology (*Museu de Zoologia Comparada* - MCZ); Museum of Natural History of Bahia (*Museu de História Natural da Bahia* - MHNBA); Natural History Museum of Paris (*Muséum National d'Histoire Naturelle de Paris* - MNHN); Museum of Zoology of the State University of Feira de Santana (*Museu de Zoologia de Feira de Santana* - MZFS); Natural History Museum London (*Museu de História Natural de Londres* - NHMUK); Federal University of Espírito Santo (*Universidade Federal do Espírito Santo* - UFES-ENTOMOLOGY); National Museum of Natural History (*Museu Nacional de História Natural* - USNM); Yale Peabody Museum of Natural History (*Museu Peabody de História Natural* - YPM) and Museum of Zoology of the State University of Campinas (*Museu de Zoologia da Universidade Estadual de Campinas* - ZUEC).

For specific literature, a total of 16 publications were considered: Vasconcelos *et al.* (2009), Zacca (2009), Zacca *et al.* (2011), Oliveira (2012), Silva (2012), Zacca and Bravo (2012), Kerpel *et al.* (2014), Lima and Zacca (2014), Neves and Paluch (2016), Paluch *et al.* (2016), Santos *et al.* (2018), Vila-Verde and Paluch (2019), Vila-Verde *et al.* (2020), Vila-Verde and Paluch (2020), Dantas *et al.* (2021) and Ramos *et al.* (2021). For the taxonomic and systematic treatment, the specific literature was used: Lamas (2004), Martin *et al.* (2011), Camargo *et al.* (2018) and Martin (2019). All taxon names were reviewed for taxonomic status according to GBIF.

**Bibliometric analysis**

The bibliometric analysis of the scientific production exclusively considered the 16 publications listed in the section, Inclusion of lepidopterofauna data, covering the period from 2009 to 2021. The evaluation of the number of publications per author and the analysis of the collaboration network between the authors were carried out using the R software version 4.1.2 (R Core Team, 2021) and the 'iGraph' package (Csardi & Nepusz, 2006). After viewing these preliminary results, the analysis was refined and presented clearly in Microsoft PowerPoint, ensuring that the results did not overlap.

## Results and discussion

**Lepidoptera in Bahian biomes**

In the State of Bahia, 891 species of lepidoptera were listed, considering the digitized data and the specific literature (Table 1, taxa and associated reference available in Supplementary Material 1). These species belong to 382 genera and 12 families (Figure 2). Of the records, about 20% (n = 179 species) were obtained from the digitized databases, while 80% (n = 712 species) came from specialized literature.

***Table 1.***

*Lepidoptera taxa considering digitized data and specific literature till 2021.*

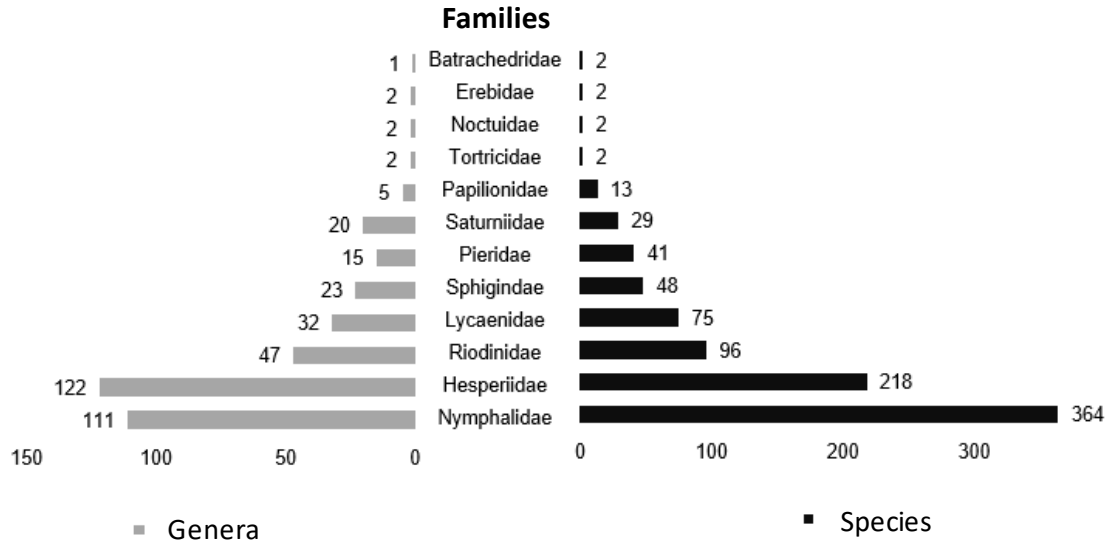
| n | Family | n species | % (of total) |
|---|---|---|---|
| 1 | Batrachedridae | 1 | 0.11% |
| 2 | Erebidae | 2 | 0.22% |
| 3 | Hesperiidae | 218 | 24.41% |
| 4 | Lycenidae | 75 | 8.40% |
| 5 | Noctuidae | 2 | 0.22% |
| 6 | Nymphalidae | 365 | 40.87% |
| 7 | Papilionidae | 13 | 1.46% |
| 8 | Pieridae | 42 | 4.70% |
| 9 | Riodinidae | 96 | 10.75% |
| 10 | Saturniidae | 29 | 3.25% |
| 11 | Sphingidae | 48 | 5.38% |
| 12 | Tortricidae | 02 | 0.22% |

*Source: The authors (2024).*

Of these species, 91% (n = 807 species) are butterflies, while moths accounted for 9% (n = 84 species). This discrepancy reflects the amount of study conducted on each of these groups in the order Lepidoptera, with butterflies being much more studied and known than moths. The limited knowledge about moths beyond their original description (Schmidt *et al.*, 2012) is attributed, in part, to their generally brown and dark colorations, as well as their crepuscular or nocturnal habits, which make their visibility and study more challenging, especially in the area of taxonomy (Iserhard *et al.,* 2017).

**Figure 2.**

*Number of genera (in gray) and species (in black) recorded in the scientific collections digitized until 2021 and in the field surveys carried out in Bahia.*




*Source: The authors (2024).*

A total of 85 species were found exclusively in the digitized collections, with no records in previously published works. Therefore, it is possible that these records have not yet been scientifically reported at the national level or have not been verified according to the search criteria used. Among these 85 species, six of them have been described in recent decades. Among the species most frequently mentioned in the literature, the following stand out: *Eueides isabella dianasa* (Hübner, [1806]), *Heliconius erato phyllis* (Fabricius, 1775), *Heliconius ethilla narcaea* (Godart, 1819), *Heraclides thoas brasiliensis* (Rothschild & Jordan, 1906), *Hermeuptychia hermes* (Fabricius, 1775) and *Siproeta stelenes meridionalis* (Fruhstorfer, 1909), cited in nine to eleven studies (Table S1). The species with the highest number of records in the digitized collections was *Hamadryas feronia* (Linnaeus, 1758).

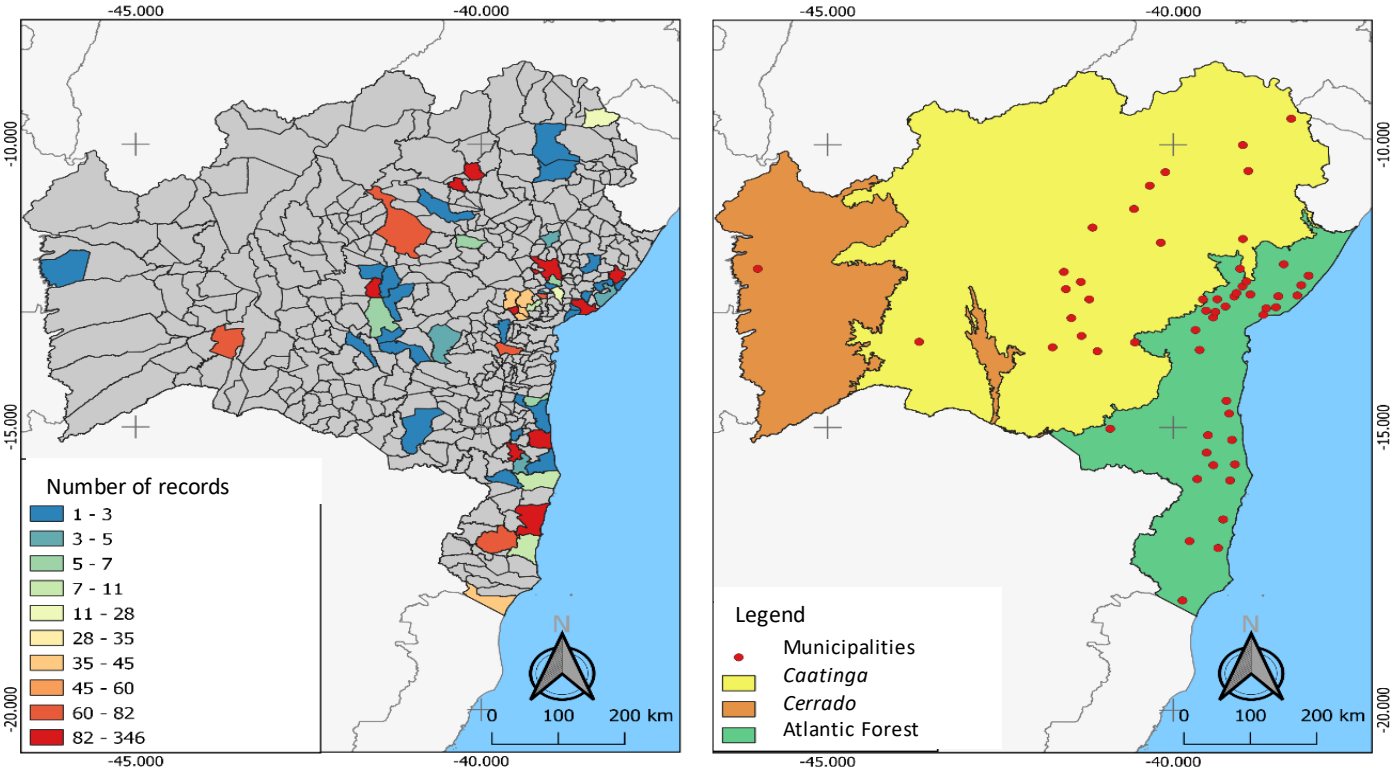
Nymphalidae (with 364 species) and Hesperiidae (with 218 species) were the families with the largest number of species recorded in the digitized collections and cited in the literature, representing approximately 68% of the total species listed in this study (Table S1). These two families were also the most representative in terms of species richness among diurnal lepidoptera, according to Brown and Freitas (1999) and Boggs *et al.* (2003).

As for moths, the Esfingidae family concentrated the largest number of records (with 48 species), being one of the most studied families due to its economic importance in agriculture, acting as pollinators and herbivores (Martins & Johnson, 2007; Johnson *et al.*, 2017). However, despite its representativeness, Bahia still lacks comprehensive inventories for the group, especially when compared to other states in the Northeast, where 97 species of moths have already been cataloged. In the State of Bahia, collections were carried out more sparsely, especially in the *Cerrado* region (Haxaire & Mielke, 2013; Camargo *et al.*, 2018; Vila-Verde & Paluch, 2019).

The computerized records of lepidopteran patients considered in this study come from 52 municipalities in Bahia (listed in Supplementary Material 1). Of these, Serra da Jiboia (with 188 species), a forest area surrounded by *Caatinga*, covering five municipalities (Castro Alves, Elísio Medrado, Santa Teresinha, São Miguel das Matas and Varzedo), together with Itanagra (with 281 species) and Porto Seguro (with 346 species), concentrated the largest number of records (Figure 3). The municipalities of Feira de Santana, Vitória da Conquista, Maracás and São Gonçalo dos Campos were considered ecotone areas between the Atlantic Forest and the Caatinga, representing about 14% of the records.

**Figure 3.**

*Distribution of Lepidoptera records in the municipalities (left) and biomes (right) of the state of Bahia, based on information from digitized scientific collections and field surveys carried out until 2021.*




*Source: The authors (2024).*

Although the Atlantic Forest in Bahia is the least representative biome in the state (19%) (Leal *et al.*, 2003; IBGE, 2021a), these areas are close to the main Lepidoptera research centers in Bahia and, therefore, probably influenced the abundance of species records and inventories (Machado *et al.*, 2008; Freitas & Marini-Filho, 2011; Iserhard *et al.*, 2017). Five inventories included this forest biome: Vasconcelos *et al.* (2009), Zacca *et al.* (2011), Neves and Paluch (2016), Paluch *et al.* (2016) and Vasconcelos *et al.* (2019), and most of the collections were concentrated in the Atlantic Forest region of Southern Bahia, which has the best conservation indices for the biome. However, a large part of this micro-region still lacks more inventories (Santos *et al.*, 2008; Vila-Verde *et al.*, 2020). In addition, the entire Atlantic Forest region along the northern coast of Bahia, towards Sergipe, remains unexplored.

The richness of species listed for the Atlantic Forest is much higher compared to the other biomes, concentrating about two-thirds of the butterfly species recorded in Brazil. Although the data from this study only include information from digitized collections and available literature, they represent about 6% of the Lepidoptera species listed for Brazil

(Casagrande & Duarte, 2021). Although Bahia contains three of the six national biomes, as expected, more than half of the records (85%) were reported for the Atlantic Forest, an ecological hotspot that is home to about two-thirds of the butterfly species recorded in Brazil (Iserhard *et al.*, 2017). Therefore, considering the limitations of the breadth of the data presented in this study, the values found for Bahia are significant, representing approximately 20% of the Lepidoptera biodiversity of the Atlantic Forest in national terms.

Regarding dry biomes, approximately 41% of the records were found in the *Caatinga*, which is the most representative biome in the state, covering about ⅔ of its total area. Although there have been significant efforts to understand butterflies in the semi-arid region in recent decades, such as the studies by Zacca and Bravo (2012), Kerpel *et al.* (2014) and Lima and Zacca (2014), most of these studies have been limited to preliminary lists of species (Kerpel *et al.*, 2014). The *Cerrado*, the second largest Brazilian biome, occupying almost a quarter of the national territory (IBGE, 2021a), is considered a biodiversity hotspot (Myers *et al.*, 2000; Klink & Machado, 2005), with high richness of lepidoptera (Camargo, 1997), however, only two species have been recorded in this biome. We believe that the occurrence of only two species for the *Cerrado* is very unlikely, but this reflects, in part, an insufficient sampling effort in most of the biome at the national level, with the exception of the Federal District (Diniz *et al.*, 2010), where more comprehensive studies have been carried out. Overall, it is evident that knowledge about the lepidopterofauna of non-forest biomes is still scarce and insufficient, and more in-depth studies are needed in these regions. This is a critical aspect, especially considering that more than half of these two non-forest biomes have already been lost (Machado *et al.*, 2004; Souza *et al.*, 2015) due to habitat loss and degradation (Garda, 1996; Klink & Machado, 2005).

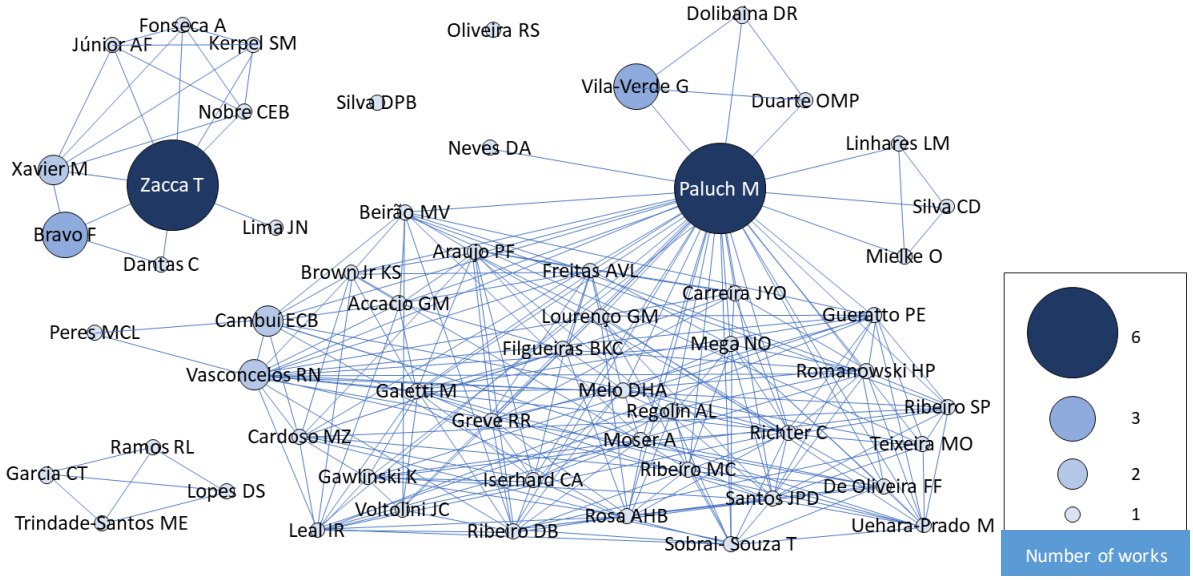
**Bibliometric analysis**

In Figure 4, the co-authorship analysis, considering the number of papers per author, was used to generate the knowledge domain maps of the main research groups, resulting in three connection networks that highlighted the significant contribution of the main authors. Each node represents one author, and the sizes indicate the number of articles published. The links connecting the nodes represent cooperative relationships between two authors.

The researchers Paluch M. and Zacca T. were considered central in their respective co-authorship networks, formed by research and inventories of the lepidopterofauna in Bahia, presenting the largest nodes in the co-authorship clusters, each with six papers. These researchers played a key role, leading the authors' collaboration network and contributing significantly to the deepening of knowledge about lepidopterauna in the region (Figure 4).

**Figure 4.**

*Network map that illustrates the collaborations between authors related to works published between 2009 and 2021 that address the survey of Lepidoptera species in the State of Bahia, Northeast Brazil. Each node represents an author and the lines connect the authors of the same document to each other or share the authorship of a publication. The size of each node depicts the number of citations from each author.*




*Source: The authors (2024).*

Paluch M. stood out as the author with the largest number of collaborations and connections, totaling 40, being the main link in Lepidoptera's studies. It is noteworthy that, between these two authors, the network led by Zacca T., although smaller in number of authors and connections, concentrated most of the surveys unrelated to forest environments in Bahia, places with the greatest deficit of knowledge. The third collaboration network is the smallest, formed by four members (Garcia C. T., Lopes D. S., Ramos R. L. and Trindade-Santos M. E.), with similar node sizes, that is, there is no central researcher.

It is important to highlight that, despite the limited number of documents considered in this study (n = 16), the interaction between the researchers involved is remarkable, reflecting the cooperation in the development of research. Other authors, such as Bravo F. and Vila-Verde G., contributed three papers each, while Xavier M. was involved in two projects (Table S1). The other authors contributed with a single work. In addition, the analysis of the clusters in the collaboration network between authors revealed well-established networks, with only two authors who did not establish collaborations.

Due to the need for human and logistical resources to be used to study taxonomic inventories, it is common for researchers to establish different networks. In this sense, creating

and analyzing the co-authorship networks of productive authors provides important information about researchers and their contributions to the field of taxonomy and systematics, reinforcing the advantages for individual researchers to seek opportunities for cooperation.

**Challenges to the computerization and sharing of biological data in Brazil**

Despite the representativeness of the digitization of biodiversity data in Brazil, the lack of computerization and sharing of these data from Brazilian collections, together with the deficit of sampling effort in isolated areas and non-forest environments, contributes substantially to the undersampling of data. The scarcity of research is also hampered by the lack of taxonomists, as well as by the lack of training of human resources in this field, affecting the characterization, description, and identification of new species. All these factors make it difficult to create lists of species that correspond to the actual species richness (or closer to reality), not only for Lepidoptera, but also for other taxa. The digitization of scientific collections is crucial not only to ensure open and free access to data, but also to expand knowledge about the country's biological diversity, through inventories and related research.

The Brazilian biodiversity goals for 2020 were assumed in the Aichi Treaty, in Japan, in 2010. This agreement provided for the complete compilation of existing records of fauna, flora and microbiota and their availability in permanent and freely accessible databases (Evangelista, 2015). Although there are management initiatives and broad access to data on Brazilian biodiversity (e.g. Brazilian Biodiversity Information System - SiBBr, available at: https://www.sibbr.gov.br/), much data is still scattered in several institutions and stored in non-standardized structures and in independent information systems, making it difficult to have broad access and use of data from the collections (Silva *et al.*, 2015).

In addition to the difficulties related to obtaining specific calls for proposals and funding from research funding agencies, in order to fill gaps in basic science knowledge (e.g., collection, identification, and systematics), works such as this case study, which focuses on a taxonomic group in a heterogeneous and megadiverse Brazilian state in terms of biodiversity, play a key role. They provide essential subsidies for the formulation of proposals that demonstrate the real diversity of taxonomic groups. The information generated and evaluated in these studies can be used as essential tools in the definition of research priorities and in the effective allocation of human and financial resources, and are almost always limited.

When considering the broad and unrestricted computerization of zoological data, especially those related to invertebrates, we are faced with the need for an extensive network of functional databases that integrate biological information, something that is still a gap. This integration requires collaboration between the institutions that maintain collections and researchers and taxonomists, both national and foreign. We can take as a beautiful example the successful case of the Moure Bee Catalog (http://moure.cria.org.br), which contributed

significantly to increasing public and open access to scientific information on the taxonomy and geographic distribution of bees native to Brazil and later extended to species in the Neotropical region (Almeida *et al.*, 2020).

Recently, the Moure Bee Catalog, together with other systems, including the Biodiversity Heritage Library (BHL), Bioline International, Fototeca Cristiano Menezes, speciesLink network, the bibliography system of IBICT (Brazilian Institute of Information in Science and Technology), oasisbr (Brazilian Portal of Publications and Scientific Data in Open Access), and other specialized information sources, has considerably updated and expanded the knowledge of bees in the Region Neotropical, becoming the Neotropical Bee Scientific Information System (http://abelha.cria.org.br). On this platform, to consult and start navigation, just type the scientific name or the common name of the bee. As the name is typed, the main information about the chosen species and the results of the searches in the different sources are displayed.

Almeida *et al.* (2020) emphasized the importance of updating e-data for bees, as it represents an essential step to support the decision-making of environmental agencies, the definition of public policies for the conservation of native bees, and scientific development in the field of taxonomy. Open data sharing not only increases recognition of the value of biological collections, but also contributes to information-dependent science and policymaking on the distribution of bee species. Therefore, the sharing of information is vital for the training of human resources and the development of true collaborative networks. Research networks with other equally diverse groups of insects (such as lepidoptera, diptera, coleoptera, ants, among others) can learn from the collaborative initiatives of bees and advance in the cataloguing of our national biodiversity. After all, it is only possible to preserve what we know.

## Final Considerations

Our results highlight that, despite technological advances, the computerization of entomological data from Brazilian collections is still at an early stage, especially when we consider the vast biological diversity of the country and, specifically, of the order Lepidoptera, which was the focus of the present study. The list of species resulting from our analyses highlights the urgent need to develop effective projects and infrastructures for the cataloguing and digitization of Brazilian biodiversity. It is important to highlight that, although this survey has logistical limitations in the use of data, the number of species compiled in this study can serve as a valuable indicator of the remarkable richness of the state's biodiversity, especially in the areas of the Atlantic Forest, which is the best studied biome. At the same time, this list highlights the gap in knowledge about the *Caatinga* and *Cerrado* areas in Bahia. On the other hand, it also underlines the importance of carrying out more comprehensive studies in the poorly inventoried areas of Bahia, which can further increase knowledge about the group's

species richness. In addition, it highlights the crucial role of leading researchers working in this region.

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