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Lepidopteran Biodiversity in Madagascar's Eastern Forests: Assessing Species Distribution Across Protected and Anthropized Landscapes

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Academic Editors: Shao-Ji Hu and Luc Legal

Received: 21 December 2024
Revised: 18 January 2025
Accepted: 21 January 2025
Published: 28 January 2025

Citation: Hannoteau, R.; Ravalison, F.A.T.; Randrianarivelo, B.F.; Ravelomanana, A.; Trolin, N.; Caparros Megido, R.; Segers, A.; Francis, F.; Noël, G. Lepidopteran Biodiversity in Madagascar's Eastern Forests: Assessing Species Distribution Across Protected and Anthropized Landscapes. *Diversity* **2025**, *17*, 95. https://doi.org/10.3390/d17020095

Abstract: Madagascar, renowned for its unique biodiversity, faces significant environmental threats. Despite their vital ecosystem services, invertebrates, such as Lepidoptera, remain understudied, especially within the Malagasy Island. Indeed, butterflies and moths often serve as biodiversity indicators. This study investigates lepidopteran community structure across different habitat types: protected areas and anthropized areas, represented by forest edges and agroforestry through four expeditions to Madagascar's moist eastern forests. Both sampling methods were employed including butterfly nets and fermented fruit-baited traps. While nets accounted for 90% of captures, highlighting operator bias, bait traps captured unique species, emphasizing the complementarity of these methods. With over 891 captured specimens, 418 macrolepidopterans were identified at the species level for a total of 50 species. Protected forests hosted 80% of endemic Lepidoptera reliant on specialized ecological niches, while anthropized zones were dominated by common generalist species which are resilient to habitat changes. While the species richness and composition of sampled microlepidoptera are similar, habitat fragmentation created diverse environmental conditions, hosting specific populations. Conservation challenges persist, particularly for endemic species vulnerable to poaching. It is crucial to continue sampling Madagascar's lepidofauna, as this offers considerable potential for the sustainable maintenance of ecosystems and the long-term preservation of biodiversity of the Malagasy Island.

Keywords: african entomofauna; agroforestry; community analysis; endemism; lepidoptera

1. Introduction

Madagascar is recognized as a biodiversity hotspot with exceptional species endemism due to its long geological isolation [1,2]. Covering over 587,000 square kilometers, the island harbors various ecosystems, ranging from humid tropical forests in the East, to dry deciduous forests and thorny bushland in the West and South [3,4]. These ecosystems host many endemic species, particularly within the order Lepidoptera [5].

The importance of Malagasy's butterfly and moth diversity is underscored by their role in maintaining the ecological balance [6]. The most recent estimate of Malagasy-described butterfly species was around 340 [7]. However, limited information regarding their biology is available due to a lack of specialists. Indeed, more studies are required for understanding Malagasy macrolepidoptera diversity, as this taxonomic group not only contributes to the pollination of plants but also serves as a food source for other animals [8]. Their sensitivity to habitat changes makes them ideal subjects for studies aiming to understand the impact of human activities on the environment [9–11]. While butterflies and moths are often seen as an aesthetic representation of nature, their presence and diversity can provide critical insights into ecosystem health and the effects of anthropogenic disturbances [12,13].

Despite its rich natural heritage, Madagascar faces severe environmental threats, including deforestation, habitat fragmentation, and land-use changes driven by agricultural expansion [14–16]. These pressures are particularly evident in Madagascar's eastern rainforests, which have experienced a significant decline in forest cover over the past few decades [17,18]. The fragmentation of forested areas is altering the habitat of many lepidopteran species, which potentially affect their population dynamics and distribution patterns [9,10].

Furthermore, the world trade of macrolepidoptera poses an additional and significant threat, with an underestimated market value of USD$100 million annually [19,20]. This trade is fueled by collectors and the high demand for rare species, often sold at elevated prices due to their conservation status [21]. Butterflies and moths designated as "threatened" or "endangered" by the IUCN are primarily targeted [22], and this demand exacerbates the pressure on their populations. Among the Malagasy species affected by illegal trade are: *Charaxes* spp., *Chrysiridia* spp., *Hypolimnas* spp. and *Argema* spp. (Andrianjaka Ravelomanana, personal communication). These species have become increasingly difficult to observe in their natural habitats, making them rare in the wild [23]. The primary cause of this rarity is the ongoing destruction of their natural habitats. Additionally, the lack of specialists and limited interest in these taxa have resulted in a scarcity of published data. However, common species, such as pioneer taxa like *Papilio* sp. or *Heteropsis* sp., have been relatively well studied and are often used for ecological monitoring [24]. The number of species considered at risk may increase as studies reflect more accurately on the current state of habitat fragmentation and its impact on biodiversity [20,25].

This study aims to assess macrolepidoptera diversity in Madagascar across protected areas and anthropized landscapes, including forest edges and agroforestry zones. Previous research has demonstrated that lepidopteran communities are susceptible to the structure of their habitats [10,26]. In protected areas, lepidopteran assemblages are often dominated by endemic species adapted to specialized ecological niches, whereas anthropized zones tend to support more generalist and resilient species capable of thriving in disturbed environments [5,27]. Fragmented landscapes may even provide new niches for certain species, allowing some butterflies or moths to exploit different ecological conditions created by human activities [28]. To better understand these dynamics, we conducted a series of field sampling in Madagascar's eastern forests (Figure 1). The sampling of lepidopteran community was performed in a gradient of anthropized ecosystems, ranging from untouched forests to areas heavily influenced by human activity [29–31]. In addition to documenting species richness, we analyzed the frequency of endemic versus non-endemic species across different landscape types. Previous studies have shown that protected forests tend to harbor more endemic species. In contrast, disturbed habitats, such as agroforestry areas, are more likely inhabited by widespread, generalist species [5,10,25]. By comparing these findings across the landscape modalities, we aim to quantify the impact of land-use changes on macrolepidoptera biodiversity [32,33].

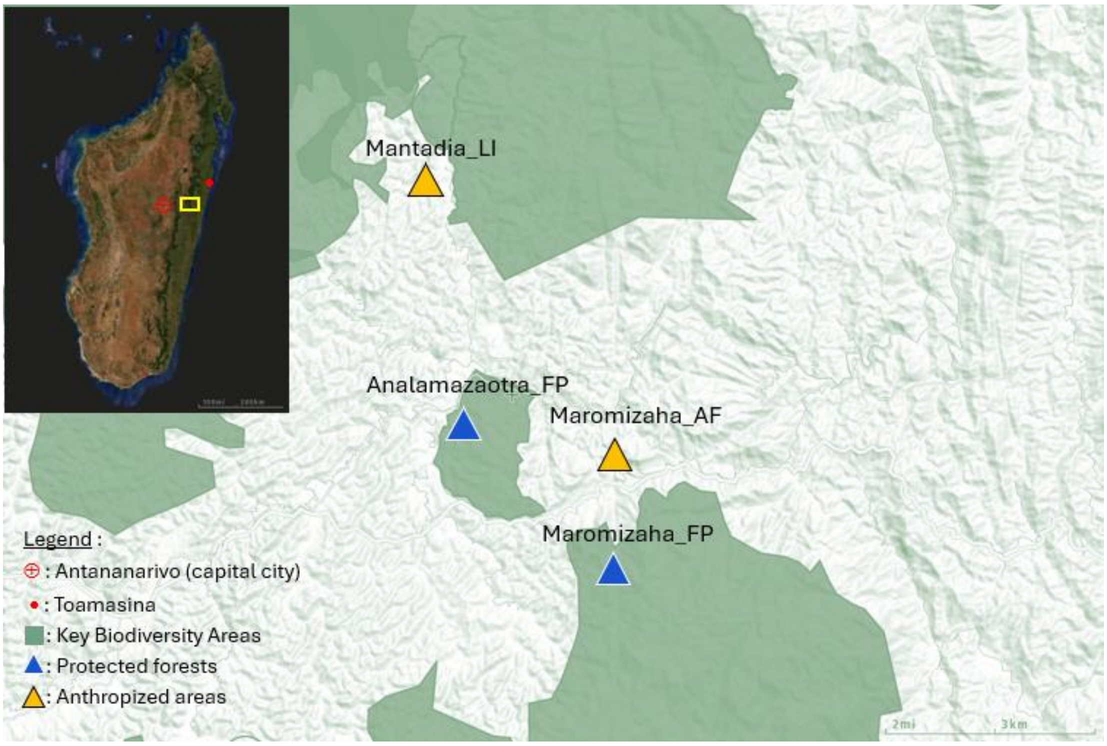

Figure 1. Malagasy island (in upper left part), the yellow rectangle shows the study area. Position of the four sampling sites on Google Earth, 2024. Mantadia_LI and Maromizaha_AF were regrouped as anthropized sites while Analamazaotra_FP and Maromizaha_FP were regrouped as protected forest sites.

2. Materials and Methods

2.1. Study Area

The Andasibe region, located 150 km from the capital Antananarivo and 200 km from Toamasina, is part of the Alaotra-Mangoro region in the Toamasina province (Figure 1). It comprises fragments of mid-altitude, dense, humid evergreen forests (800 to 1200 m) [18] and is renowned for its high biodiversity and endemic species [28]. Established in 1989, Mantadia National Park spans 15,480 ha, with 80% of primary forests. The forest edge of Mantadia, influenced by agricultural expansion, was classified as an anthropized site in this study, i.e., Mantadia_LI (Figure 1). The adjacent Special Reserve of Analamazaotra (Analamazaotra_FP; Figure 1), covering 810 ha, is a protected forest site. The Maromizaha Reserve, managed by the Group for Study and Research on Primates of Madagascar, encompasses 1880 ha and includes a protected forest area and an agroforestry zone. Sampling was conducted in both zones, with the agroforestry zone categorized as an anthropized site (Maromizaha_AF; Figure 1) and the protected forest as a protected forest site (Maromizaha_FP; Figure 1), enabling comparison of lepidopteran distribution between anthropized and protected areas.

2.2. Sampling Design

Sampling took place over three days at each site, in March and April 2024: from 6th to 9th March for Maromizaha_AF, from 11st to 14th March for Analamazaotra_FP, from 18th to 21st April for Mantadia_LI, and from 22nd April to 25th April for Maromizaha_FP. A triangular sampling framework was designed to sample lepidopteran communities in the field in each of the four sampling sites according to the land conditions (Figure 2; Figure A1). Each vertex of the triangle corresponds to a sampling unit (SU) with a radius of 30 m called “SUA”, “SUB”, and “SUC” (Figure 2). The three sample units were selected based on the characteristics of the sites and localities known by local forest agents. Each zone reflected distinct features (Figure A1): Maromizaha_AF included an orchard, forest edge, and bamboo nursery; Analamazaotra_FP covered a lake border, dense forests, and a near fish farm; Mantadia_LI is located along the road near the protected park boundary; and Maromizaha_FP corresponded to campsites established within the forest. All micro-habitat specificities were not considered, and the triangular sampling framework is treated as homogeneous. According to Freitas and colleagues (2021) [12], a minimum distance of 100 m is maintained between each sampling unit to ensure the independence of the sampling zones (Figure 2). Butterfly netting is conducted within the bounds of this triangular configuration (Figure 2). In addition, each sampling zone is equipped with five fruit-baited traps, strategically placed approximately 25 m from the unit’s center (Figure 2).

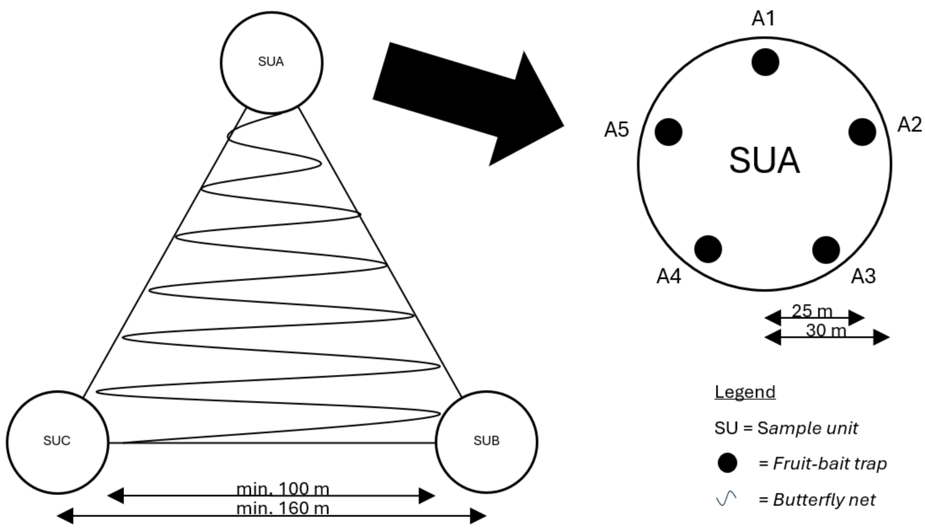

Figure 2. Scheme of the triangular sampling framework including three sampling units (SU) with 30 m radius: “SUA”, “SUB” and “SUC”. Each SU contains five fruit-baited traps from A1 to A5 at 25 m from the SU center. The butterfly netting was performed inside the designed triangular sampling framework.

2.2.1. Fruit-Baited Traps

Fifteen traps were constructed based on the Van Someren-Rydon model as described by Devries and colleagues (2016) [29]. Each trap consists of a cylindrical netting structure, 80 cm high and 30 cm in diameter, with an inverted funnel opening of 25 cm at the bottom to allow large butterflies or moths to enter. A plastic plate (40 cm in diameter) is suspended 5 cm below the trap to facilitate lepidopteran landing. A container with fermented bait, consisting of two bananas mixed with beer and left to ferment for 48 h, was secured inside each trap. Traps were lifted to a minimum height of 3 m to capture both canopy and understory species and were checked twice daily, in the morning and afternoon (Figure 3A–C).

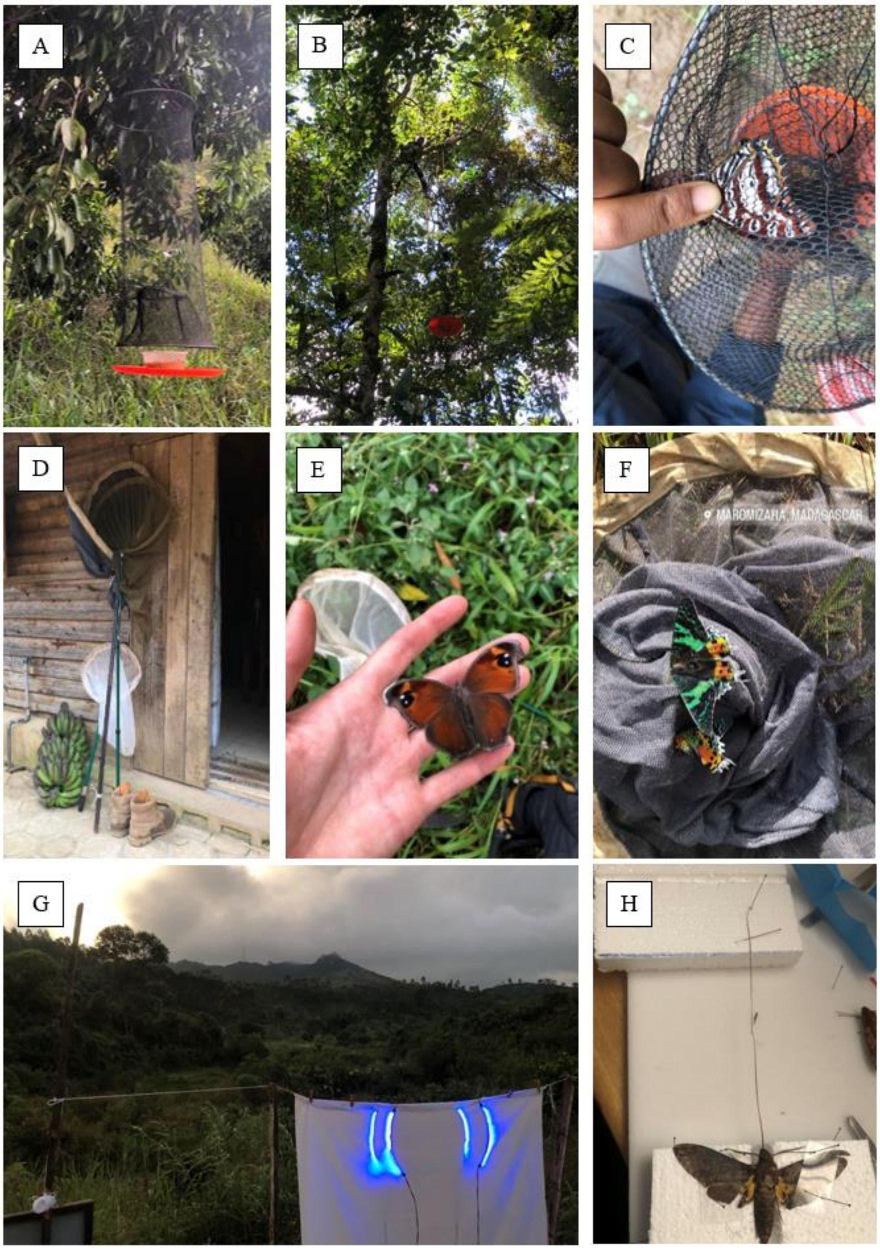

Figure 3. (**A**) Fruit-baited trap based on the Van Someren-Rydon model described by Devries et al. [29]. (**B**) Trap placed at canopy height > 3 m. (**C**) *Charaxes andranadorus* Mabille, 1884 caught in a fruit-baited trap. (**D**) Butterfly nets at the refuge. (**E**) *Melanitis leda* Linnaeus, 1758 captured with a net. (**F**) Two *Chrysiridia rhipheus* Drury, 1773 captured with a net. (**G**) The light sheet was placed in the Maromizaha agroforestry area (Maromizaha_AF). (**H**) *Coelonia solani* Boisduval, 1833 captured with the light sheet set-up.

2.2.2. Butterfly Netting

Standardized net captures were conducted every morning and afternoon under ideal conditions (no rain and low wind) by walking a fixed path for three hours at a constant pace, capturing butterflies within a $5 \times 5 \times 5$ m^3 area (Figure 3D–F).

2.2.3. Light Sheet

Targeting silk-producing moths and Sphingidae, an adapted UV-light trap device from Segers (2018) [34] consisting of a 2 m^2 white sheet and is suspended with four UV LED lights (395–405 nm) powered by 12 V batteries (Figure 3G,H). The light trap was set from 6 to 9 PM each sampling day, with moths recorded every half hour.

2.3. Specimen Preparation and Identification

Each specimen was killed using ethyl acetate ($C_4H_8O_2$) with cotton after collection netting on the field. The captured specimens were then preserved in paper envelopes for butterfly and stored in an airtight box with silica gel to prevent tropical mold before laboratory insect preparation. After the collection sampling, specimens were rehydrated for 24 h in an airtight box, over water vapour and denatured ethanol (EtOH at 90°) to prevent mold. Lepidoptera specimens were pinned and vouchered in collection boxes at the entomology collection of the University of Antananarivo and Zà Bibikely Insectarium in Madagascar.

Firstly, pinned specimens were morphologically identified using the species description of Collins and Congdon (2017) [35]. Then, a taxonomic revision was conducted using the illustrated key of Beccaloni and colleagues (2024) [36]. Despite their significance and richness for studies on adaptability and endemism, the Hesperiidae and Lycaenidae families were not further identified to the species levels given the lack of our taxonomic expertise, no precise identification keys or reference collection. Therefore, they were excluded of the dataset. Endemism and habitat guild of our identified lepidopteran species were determined using Lees & Minet (2003) [25]:

- Forest species: Species depending on the woodlands (all-natural types, primary or slightly degraded), secondary formations, and forest edges (including Savona, tavy, and other types of cleared forests, typically for hillside rice).
- Generalist species: Species found in all the above habitats, marshes, grasslands, anthropogenic zones (villages, roadsides), rocky areas (rocky outcrops, ridges with rupicolous vegetation), farmlands, and beaches.

According to Mendenhall et al., (2016), we used 50% threshold to determine the species dependence for a habitat type [37].

2.4. Statistical Community Analysis

Analyses were conducted in RStudio with R version 4.4.0 [38]. The following statistical analysis focused exclusively on lepidopteran identified to the most specific taxonomic rank, at the species level. Community structure was assessed at three levels: (i) regional capture (γ-diversity); (ii) community diversity according to the different landscape (α-diversity); and (iii) the dissimilarity of the community composition (β-diversity) [39].

Community analysis quantified species richness and diversity metrics. Metrics included species abundance, richness, and non-parametric Chao's bias-corrected index (i.e., Chao1). Chao's bias-corrected [40] was estimated using "estimateR" function in the vegan package [41] to predict the "true" number of species in a community based on our community matrix. The structure of the same sampled communities was evaluated by considering the abundance of individuals and a sequence of Hill numbers [42] to compare alpha diversity estimations according to our habitat type using iNEXT R package [43]. Studies proposed a unified framework regarding Hill numbers extended from works based on rarefaction and extrapolation (R/E) sampling curve for species richness and sample completeness [44]. Each Hill number corresponds to a diversity order q, which defines species diversity measures as a particular feature: observed species richness (q = 0), the exponential of the Shannon entropy (q = 1) and the inverse Simpson concentration index (q = 2) [44]. R/E curves were built specifying 100 bootstrap replications on individual-based abundance data of our lepidopteran datasets.

In our β analysis, the permutational analysis of variance (PERMANOVA) test assesses whether lepidopteran communities from habitat type and sampling method are (dis-) similar. To display of the lepidopteran community composition, Bray-Curtis dissimilarity matrix was computed and Principal Coordinates Analysis (PCoA) was used to visualize habitat type proximity in terms of species assemblages [41].

To determine if the proportion of the different species traits varied according to the habitat type, a G-test of independence for the contingency table was performed using the RVAideMemoire package in R (Herve 2020) [45].

3. Results

3.1. Butterfly Fauna of the Region

The sampling using baited traps and butterfly nets captured 891 specimens. This included 53 taxonomic units: fifty identified to the species level (418 specimens; Table A1), one morpho-species (Tribe *Satyrini*) and two family-level groups (Hesperiidae and Lycaenidae; Figure 4). The specimens identified at the species level mostly belonged to the families Nymphalidae (57.1%), Pieridae (23%), and Papilionidae (8%). The most abundant genera are *Eurema* (Pieridae), *Acraea* (Nymphalidae), and *Papilio* (Papilionidae). Some moths (Sphingidae, Uraniidae, and Erebidae) with diurnal or potentially cathemeral behavior were also recorded.

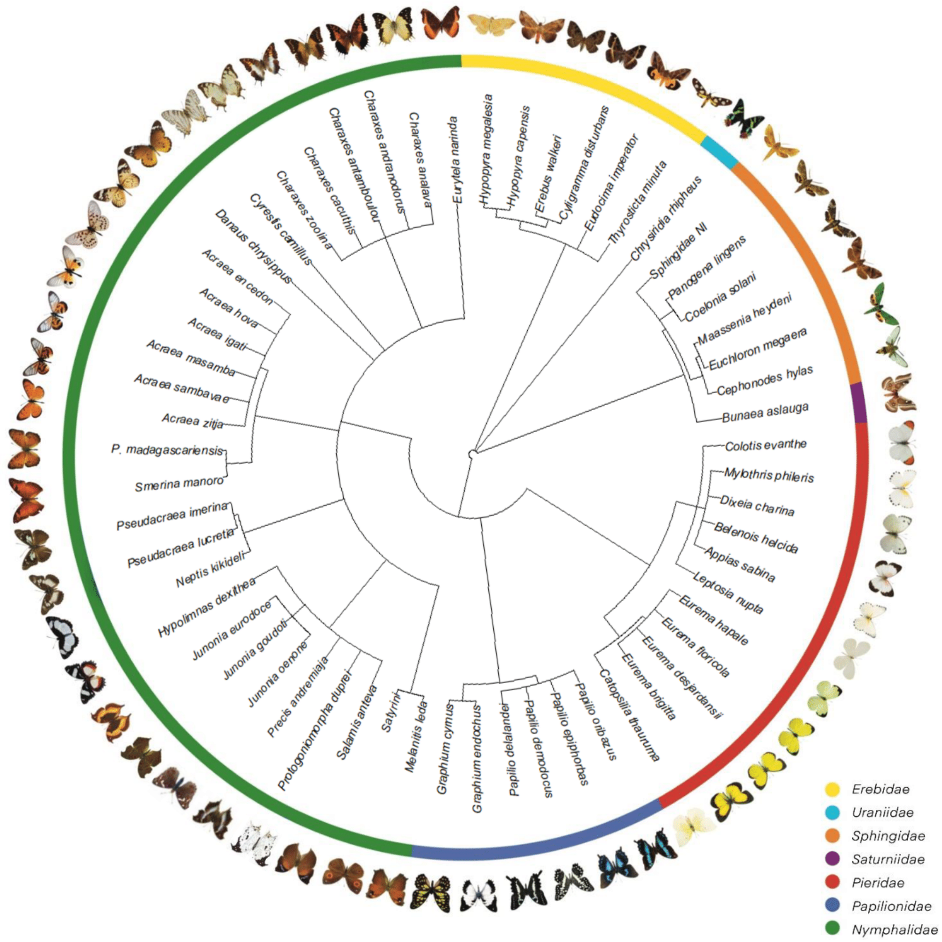

Figure 4. The evolutionary wheel of Lepidoptera collection (including identified species, the *Satyrini* morpho-species). The graphical representation is not to morphological scale. The classification ranges from the order level to the most minor identified taxa (species, tribe, or family). Families are

represented by the colors in the legend (right). The taxonomic tree was generated using the "taxtotree" function from comecol R package [46] and illustrated with the Procreate graphic application (Savage Interactive Pty Ltd., Hobart, Australia). Illustration sources are available in Appendix A.

More species were exclusively found in protected areas (Figure 5): twenty-four species, compared to sixteen in anthropized zones. Of the 50 species captured, 37 were exclusively caught with the butterfly net, eight with the fruit-baited trap, and five were found using both methods. The fruit-baited traps captured Nymphalidae from the genera *Charaxes* (five species, 20 individuals), *Eurytela* (one species, one individual), *Melanitis* (one species, four individuals), *Neptis* (one species, two individuals), and *Pseudacraea* (two species, four individuals). A Pieridae from the genus *Dixeia* and two species of Erebidae (from the genera *Erebus* and *Hypopyra*) were also trapped. *Charaxes antamboulou* Lucas, 1872, *Melanitis leda* Linnaeus, 1758, *Pseudacraea imerina* (Hewitson, 1865), *Pseudacraea lucretia* (Cramer, 1775) (Nymphalidae), and *Dixeia charina* (Boisduval, 1836) (Pieridae) were captured using both the butterfly net and fruit-baited traps.

The light sheet method captured Erebidae, specifically two species and six specimens from the genus *Hypopyra*, which were also caught with the baited trap. Four species totaled eight specimens for Sphingidae, while Saturniidae included one species and one specimen, *Bunaea aslauga* Kirby, 1877. However, due to unforeseen disturbances, the community analysis did not include specimens captured using the light sheet method.

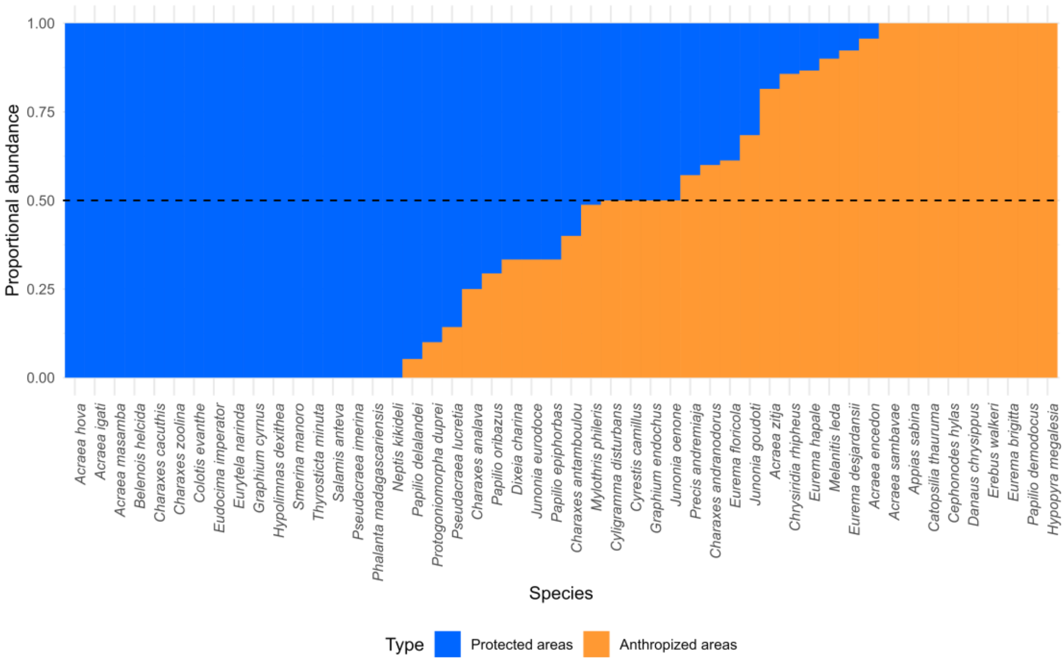

Figure 5. Butterfly and moth distribution given the proportional abundance per habitat type: protected areas (blue) and anthropized areas (orange).

3.2. Community Structure Analysis

There was greater abundance in anthropized areas but more observed species in protected areas (Table 1). The predicted species richness was quite similar with a higher number of species in anthropized areas (Table 1). Protected areas had higher Hill-Shannon and Hill-Simpson index than anthropized areas (Figure 6). Lepidopteran community composition did not differ according to the habitat type (df = 1; F-stat = 1.07; p-value = 0.38; Figure 7) but was mainly driven by the trapping method (df = 1; F-stat = 3.42; p-value < 0.01). Endemism (df = 1; G-test stat = 67.84; p-value < 0.01) and landscape distribution rates (df

= 1; G-test stat = 58.08; *p*-value < 0.01) significantly differed between the habitat types (Figure 8).

Table 1. Observed abundance, observed specific richness, and Chao1's estimator (±SE) across land types.

By Land Type and Site	Abundance	Species Richness	Chao1
Protected areas	165	41	44.92 ± 3.37
Analamazaotra_FP	107	33	42.10 ± 6.48
Maromizaha_FP	58	22	33.25 ± 9.53
Anthropized areas	253	33	46.00 ± 9.63
Mantadia_LI	182	20	22.50 ± 3.15
Maromizaha_AF	71	24	33.17 ± 7.37
Total	418	50	55.06 ± 4.13

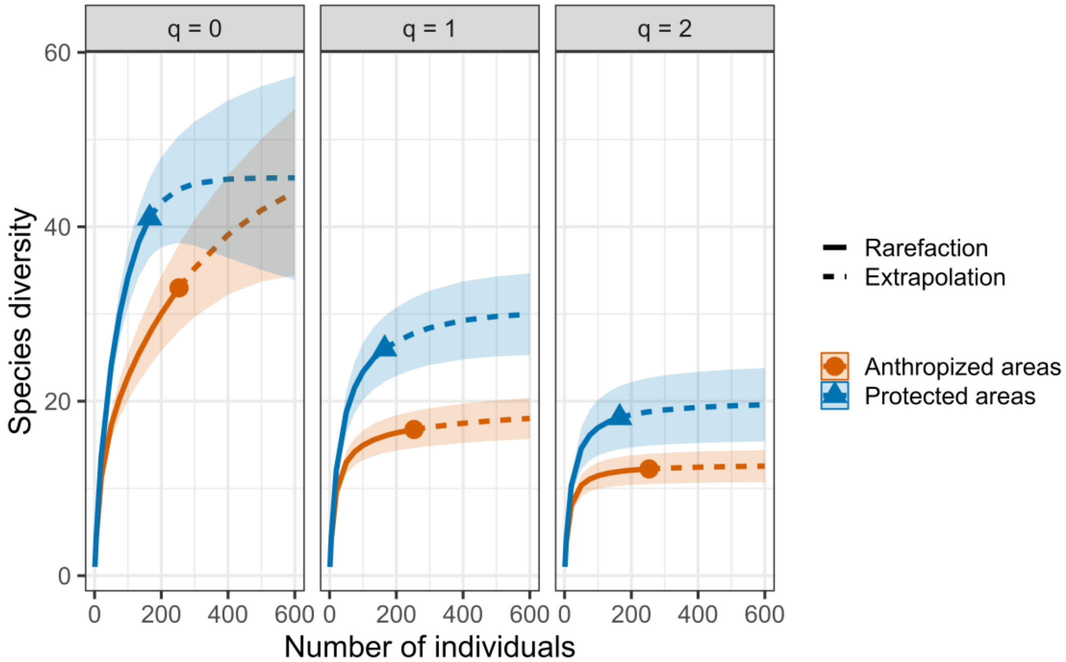

Figure 6. Comparison between lepidopteran α communities based on abundance data with sample-size-based rarefaction (solid curves) and extrapolation (dashed curves) across the habitat type: Anthropized areas (orange) and protected areas (blue). Each grid panel shows a different Hill's number: observed richness (q = 0), the exponential of the Shannon entropy (q = 1) and the inverse Simpson concentration index (q = 2). The 95% confidence intervals (colored-shaded regions) were obtained by a bootstrap method based on 100 replications.

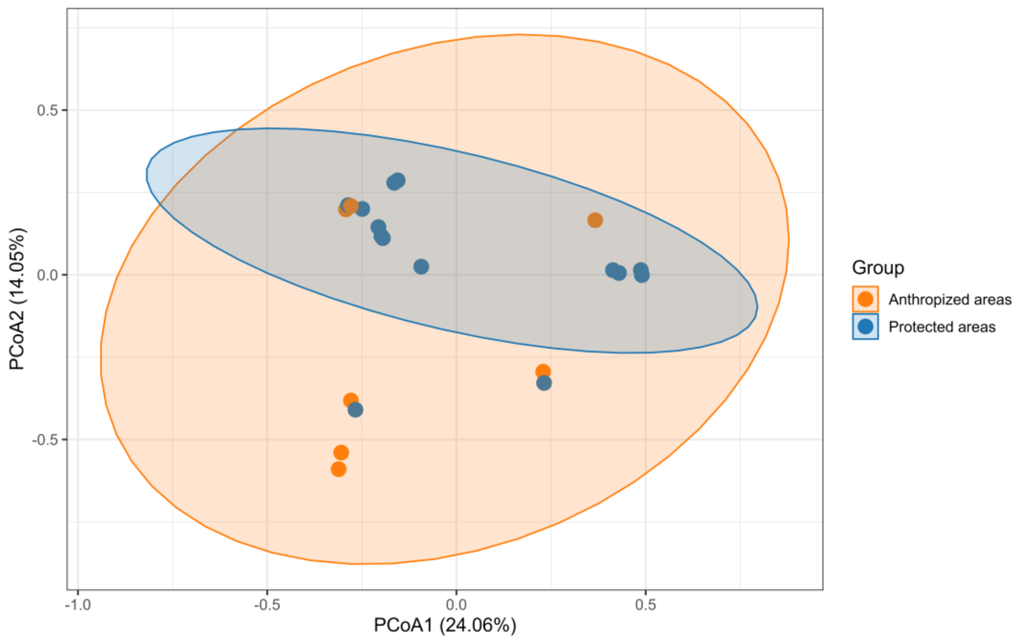

Figure 7. Principal Coordinate Analysis (PCoA) showing lepidopteran community composition across anthropized areas (orange dots) and protected areas (blue dots). The ellipses are built with 95% confidence.

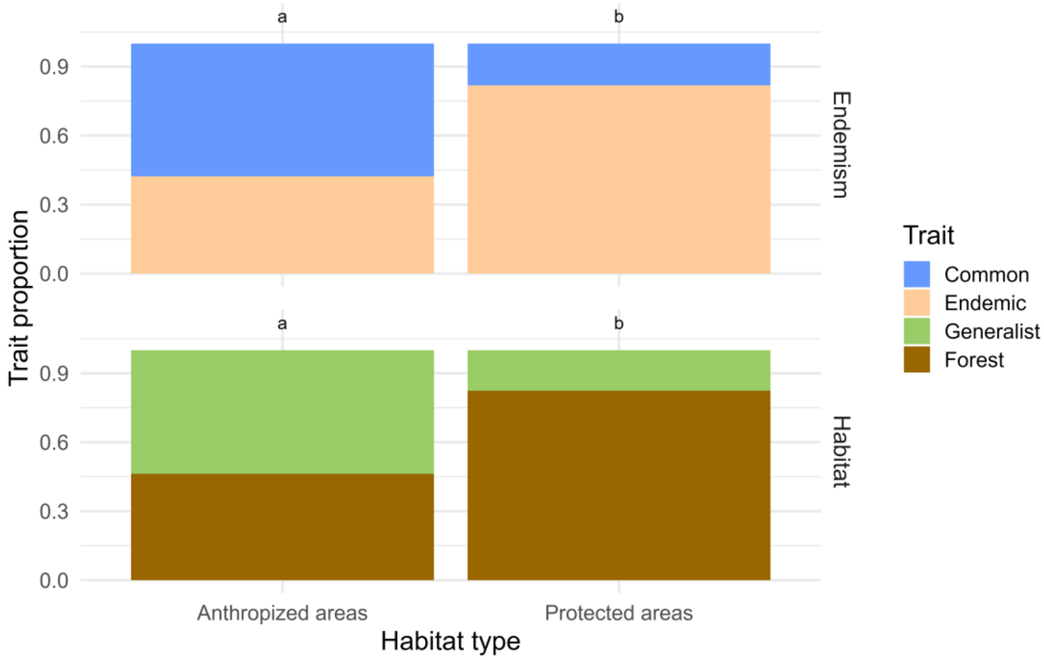

Figure 8. Life trait distribution of macrolepidoptera per habitat type. The life traits are proportionally displayed in function of the endemism (upper part) and habitat (lower part). Letters indicate significant differences ($p < 0.05$) according to the G-test performance of species traits distribution according to the habitat type.

4. Discussion

This study examined lepidopteran communities in four sites in the moist forest of eastern Madagascar that were exposed to different landscape disturbances. As limited reference inventory was available for the surrounding sites [24], this study marked a strong starting point to represent macrolepidoptera biodiversity in this region during the last decade. A single expedition to each destination was feasible within the framework of the experiment similar to other studies on macrolepidoptera in Madagascar which encounter the same difficulties of access to the sampling sites [5,47].

Capture with a light sheet allowed for observation of some remarkable species that differed from the anticipated families. Sampling using two trapping methods—butterfly nets and fruit-baited traps—captured 891 lepidopteran specimens, 418 of which were identified to the most precise taxonomic level, representing 50 species. Despite the trends observed in the description of the captures, we observed a homogeneity of the lepidopteran community structure characterized by similar lepidopteran richness and community composition between both habitat types. However, observation of the butterflies and moths in their habitat and their distinct correlation with their life history (endemism and distribution) allows us to formulate some hypotheses about their resilience to environmental change.

Forest lepidopterans are more abundant in protected areas, with an interesting specific composition. They specialize in the narrow ecological niches of old-growth forests, strongly dependent on specific host plants [5,26]. Larger forest cover and a denser canopy favor the presence of endemic plants and trees [26]. The correlation between endemism and distribution aligns with the literature, which states that 90% of endemic species are forest-dependent [2]. The sensitivity of endemic species to disturbance is explained by their geographically restricted ranges and greater specialization than Malagasy common species [27]. Within the protected areas, butterflies and moths were mainly found where the canopy was open. This is particularly the case at Analamazaotra, on the edge of the lake and along the fish farm; and in the protected forest of Maromizaha, where the sampling areas correspond to the three camps (Figure A1). No macrolepidopterans were observed in the closed canopy forest probably too specific the vertical stratification of insects [48]. This observation is confirmed by Rajaonarimalala et al., (2024) [49] which stipulates that the leaf area index (m^2 leaf area/m^2 soil) correlates with high species richness.

Macrolepidoptera has specific needs and use gaps and closed canopies for different activities. The light in the gaps provides the right conditions for collecting nectar and sunbathing (thermoregulation) [31]. Butterflies were also abundantly observed along roadsides and on building sites, particularly at Camp 1 in Maromizaha (Figure A1). Indeed, butterflies supplement their diet with water rich in mineral salts, increasing egg production and sometimes offspring survival. Some species also show interspecific attraction [50]. Also, the abundance of captured specimens is greater in anthropized areas. In nectar-poor habitats such as Mantadia, butterflies fly erratically for extended periods [30], making them more difficult to capture. In the Maromizaha agroforestry, butterflies were most abundant in the orchard, around the fruit trees and near the nursery, where there are endemic shrubs.

Agroforestry provides a variety of microhabitats that support a wide diversity of butterflies and moths [5] while also offering promising opportunities for ecosystem restoration, particularly in degraded lands with reduced biodiversity and ecosystem services [33]. Mixed agroforestry systems, often based on crops such as cloves, vanilla, coffee or cocoa, combined with fruit trees, show great potential for restoring biodiversity to degraded and fallow land [51]. Across the sites, nectarivorous butterflies were very frequently found near natural flowering, including small cleared plots and roadsides, notably colonized by Fabaceae. These included *Crotalaria* sp. and *Desmodium uncimatum*, a neotropical plant introduced for fodder and now invasive. *Lantana camara* was probably the most frequently flowering plant. Its attraction to butterflies was remarkable. It is one of the 100 worst invasive species according to the IUCN. Although invasive plants are not immediately harmful to butterflies, they could become so in the long term depending on the ecological context of the interaction [52].

5. Conclusions

The results of this research will contribute to ongoing efforts to protect Madagascar's unique lepidopteran fauna and promote sustainable land-use practices that reconcile biodiversity conservation with human development [32]. This study also highlights the need for continuous monitoring of diverse lepidopteran communities in Madagascar, especially given the increasing pressures from climate change and deforestation. Understanding the distribution patterns of macrolepidoptera across protected and anthropized landscapes will be essential for developing effective conservation strategies and ensuring the long-term survival of these valuable species [5,25].

Author Contributions: Conceptualization, R.H., A.R., F.F., and G.N.; methodology, R.H., A.S., A.R., F.F., and G.N.; software, R.H. and G.N.; validation, R.H.; formal analysis, R.H. and G.N.; investigation, R.H., F.A.T.R., B.F.R., A.R., and N.T.; resources, A.R. and F.F.; data curation, R.H. and G.N.; writing—original draft preparation, R.H. and G.N.; writing—review and editing, F.A.T.R., B.F.R., A.R., N.T., R.C.M., A.S., and F.F.; visualization R.H. and G.N.; supervision, A.R., F.F., and G.N.; project administration, A.R. and F.F.; funding acquisition, A.R. and F.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by ARES Belgium (Académie de Recherche et d'Enseignement supérieur—Coopération au Développement) under a project entitled "Développement d'un Insectarium Zà bibikely à Madagascar».

Data Availability Statement: All data generated during this study are included in the published article.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Illustration sources of Figure 5.

26 Precis Illustrations Image: PICRYL—Public Domain Media Search Engine Public Domain Search}. (s.d.). Accessed on 16th August 2024 https://renopenrose.getarchive.net/amp/topics/precis+illustrations .

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Appendix B

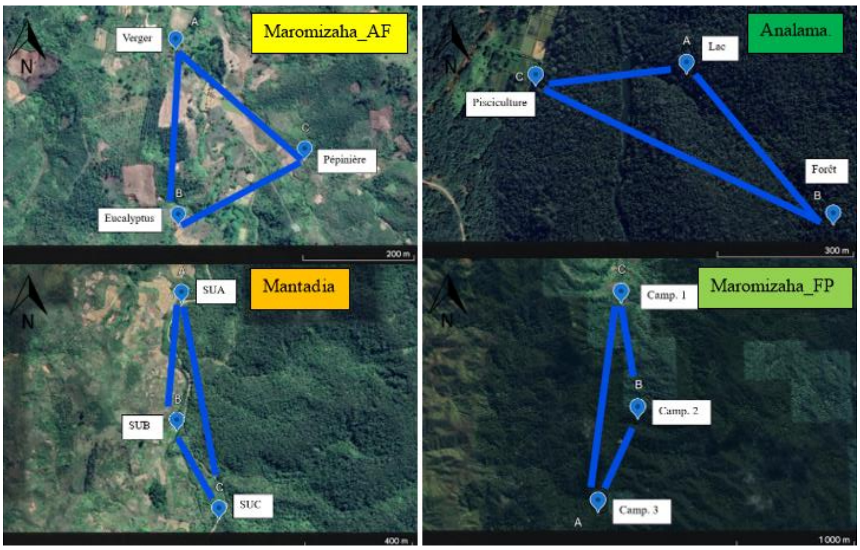

Figure A1. Representation of the triangular sampling framework at the four sampling sites.

Table A1. Identified butterfly and moth dataset. The symbol "(*)" corresponds to endemic species. Bold values correspond to some subtotals per family and habitat type or sampling site.

	Protected Areas		Sub-Total	Antrhopozed Areas		Sub-Total	Total
Butterfly Species Per Family	**Analamazaotra_FP**	**Maromizaha_FP**		**Mantadia_LI**	**Maromizaha_AF**		
Erebidae	**4**	**1**	**5**		**4**	**4**	**9**
Cyligramma	**2**		**2**		**2**	**2**	**4**
Cyligramma disturbans (*) (Walker, 1858)	2		2		2	2	4
Erebus					**1**	**1**	**1**
Erebus walkeri Butler, 1875					1	1	1
Eudocima		**1**	**1**				**1**
Eudocima imperator (Boisduval, 1833)		1	1				1
Hypopyra					**1**	**1**	**1**
Hypopyra megalesia (*) Mabille, 1879					1	1	1
Thyrosticta	**2**		**2**				**2**
Thyrosticta minuta (*) Boisduval, 1833	2		2				2
Nymphalidae	**43**	**40**	**83**	**96**	**24**	**120**	**203**
Acraea	**12**	**11**	**23**	**59**	**9**	**68**	**91**
Acraea encedon Linnaeus, 1758	1	1	2	37	7	44	46
Acraea hova (*) Boisduval, 1833		3	3				3
Acraea igati Boisduval, 1833		3	3				3
Acraea masamba (*) Ward, 1872	9	1	10				10
Acraea sambavae (*) Ward, 1873				2		2	2
Acraea zitja (*) Boisduval, 1833	2	3	5	20	2	22	27
Charaxes	**2**	**14**	**16**	**8**	**2**	**10**	**26**
Charaxes analava (*) Ward, 1872		3	3	1		1	4
Charaxes andranodorus (*) Mabille, 1884		2	2	3		3	5
Charaxes antamboulou (*) Lucas, 1872	1	8	9	4	2	6	15
Charaxes cacuthis (*) Hewitson, 1863		1	1				1
Charaxes zoolina (*) Lucas, 1872	1		1				1
Cyrestis	**1**		**1**		**1**	**1**	**2**
Cyrestis camillus (*) Fabricius, 1781	1		1		1	1	2
Danaus				**2**		**2**	**2**
Danaus chrysippus (Linnaeus, 1758)				2		2	2
Eurytela	**1**		**1**				**1**
Eurytela narinda (*) Ward, 1872	1		1				1
Hypolimnas	**1**	**1**	**2**				**2**
Hypolimnas dexithea (*) Hewitson, 1863	1	1	2				2
Junonia	**7**	**2**	**9**	**7**	**8**	**15**	**24**
Junonia eurodoce (*) (Westwood, 1850)	1	1	2		1	1	3
Junonia goudoti (Boisduval, 1833)	5	1	6	7	6	13	19
Junonia oenone (Linnaeus, 1764)	1		1		1	1	2
Melanitis	**1**	**1**	**2**	**16**	**2**	**18**	**20**
Melanitis leda Linnaeus, 1758	1	1	2	16	2	18	20
Neptis	**2**		**2**				**2**
Neptis kikideli (*) Boisduval, 1833	2		2				2
Phalanta		**2**	**2**				**2**
Phalanta madagascariensis (*) (Mabille, 1887)		2	2				2
Precis	**2**	**1**	**3**	**3**	**1**	**4**	**7**
Precis andremiaja (*) Boisduval, 1833	2	1	3	3	1	4	7
Pseudacraea	**6**	**3**	**9**	**1**		**1**	**10**
Pseudacraea imerina (*) Westwood, 1850	3		3				3
Pseudacraea lucretia (*) Cramer, 1779	3	3	6	1		1	7
Protogoniomorpha	**5**	**4**	**9**	**1**			**10**
Protogoniomorpha duprei (*) (Vinson, 1863)	5	4	9		1	1	10
Salamis	**1**		**1**				**1**
Salamis anteva (*) Ward, 1870	1		1				1
Smerina	**2**	**1**	**3**				**3**
Smerina manoro (*) (Ward, 1870)	2	1	3				3
Papilionidae	**24**	**9**	**33**	**2**	**16**	**18**	**51**
Graphium	**2**		**2**	**1**		**1**	**3**
Graphium cyrnus (*) (Boisduval, 1836)	1		1				1
Graphium endochus (*) (Boisduval, 1836)	1		1	1		1	2

Papilio	**22**	**9**	**31**	**1**	**16**	**17**	**48**
Papilio delalandei (*) Godart, 1824	17		17	1	1	2	19
Papilio demodocus Esper, 1798					9	9	9
Papilio epiphorbas (*) Boisduval, 1833	2		2		1	1	3
Papilio oribazus (*) Boisduval, 1836	3	9	12		5	5	17
Pieridae	**35**	**8**	**43**	**84**	**20**	**104**	**147**
Appias				**2**		**2**	**2**
Appias sabina (*) (C. & R. Felder, 1865)				2		2	2
Belenois	**3**		**3**				**3**
Belenois helcida (*) (Boisduval, 1833)	3		3				3
Catopsilia					**1**	**1**	**1**
Catopsilia thauruma (Reakirt, 1866)					1	1	1
Colotis	**1**		**1**				**1**
Colotis evanthe (Boisduval, 1836)	1		1				1
Dixeia	**2**		**2**	**1**		**1**	**3**
Dixeia charina (*) (Boisduval, 1836)	2		2	1		1	3
Eurema	**14**	**2**	**16**	**63**	**17**	**80**	**96**
Eurema brigitta (Stoll, 1780)				19	5	24	24
Eurema desjardansii (*) (Boisduval, 1833)	2		2	17	7	24	26
Eurema floricola (Boisduval, 1833)	12		12	19		19	31
Eurema hapale (Mabille, 1882)		2	2	8	5	13	15
Mylothris	**15**	**6**	**21**	**18**	**2**	**20**	**41**
Mylothris phileris (*) (Boisduval, 1833)	15	6	21	18	2	20	41
Sphingidae					**1**	**1**	**1**
Cephonodes					**1**	**1**	**1**
Cephonodes hylas Linnaeus, 1771					1	1	1
Uraniidae	**1**		**1**		**6**	**6**	**7**
Chrysiridia	**1**		**1**		**6**	**6**	**7**
Chrysiridia rhipheus (*) Drury, 1773	1		1		6	6	7
Total	**107**	**58**	**165**	**182**	**71**	**253**	**418**

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