



SHILAP Revista de lepidopterología

ISSN: 0300-5267

ISSN: 2340-4078

avives@orange.es

Sociedad Hispano-Luso-Americana de Lepidopterología
España

Vieira, L. R.; Henriques, N. R.; de Souza, M. M.
Communities of Lepidoptera along an elevational gradient
in the Brazilian Atlantic Forest (Lepidoptera: Papilionoidea)
SHILAP Revista de lepidopterología, vol. 50, núm. 197, 2022, Enero-Marzo, pp. 175-189
Sociedad Hispano-Luso-Americana de Lepidopterología
Madrid, España

Disponible en: <https://www.redalyc.org/articulo.oa?id=45570566027>

- Cómo citar el artículo
- Número completo
- Más información del artículo
- Página de la revista en redalyc.org

redalyc.org

Sistema de Información Científica Redalyc

Red de Revistas Científicas de América Latina y el Caribe, España y Portugal
Proyecto académico sin fines de lucro, desarrollado bajo la iniciativa de acceso
abierto

Communities of Lepidoptera along an elevational gradient in the Brazilian Atlantic Forest (Lepidoptera: Papilionoidea)

L. R. Vieira, N. R. Henriques & M. M. de Souza

Abstract

The diversity and composition of Lepidoptera communities vary along an elevational gradient, with richness and abundance generally decreasing as elevation increases. In Brazil, however, there is a lack of data on the topic and many elevation zones remain unexplored. This study aimed to examine the effect of elevation variation on the richness, frequency, abundance, and composition of Lepidoptera in an Atlantic Forest region in southern Minas Gerais State, Brazil, and we also present the first species list of Lepidoptera of the Fernão Dias Environmental Protection Area. The study was conducted between October 2019 and March 2020, and sampling was performed with the same sampling effort at three elevation levels by active (nets) and passive (bait trap) methods. A total of 622 Lepidoptera individuals, belonging to 154 species, were sampled. The family Nymphalidae exhibited the highest richness and abundance. The highest elevation zone showed the greatest number of exclusive species. Richness and abundance were highest at middle elevation, but differences between elevation zones were not statistically significant. Richness estimators indicated a mean sampling efficiency of 64.97%. In contrast to the expected pattern, species richness was highest in middle and high elevation zones, which might reflect the greater degree of conservation of these areas. The findings reported here contribute to a better understanding of the diversity of Lepidoptera in higher elevation zones of Atlantic Forest regions in Brazil.

KEY WORDS: Lepidoptera, Papilionoidea, altitude, insect conservation, inventory, biodiversity, species richness, Brazil.

Comunidades de Lepidoptera a lo largo de un gradiente de elevación en el bosque atlántico brasileño (Lepidoptera: Papilionoidea)

Resumen

La diversidad y composición de las comunidades de Lepidoptera varían a lo largo de un gradiente de elevación y, la riqueza y abundancia, generalmente disminuyen a medida que aumenta la elevación. En Brasil, sin embargo, hay una falta de datos sobre el tema y muchas zonas de elevación permanecen sin explorar. Este estudio tuvo como objetivo examinar el efecto de la variación de elevación sobre la riqueza, frecuencia, abundancia y composición de los Lepidoptera en una región del bosque atlántico en el sur del Estado de Minas Gerais, Brasil, y también presentamos la primera lista de especies de Lepidoptera de Fernão Dias Ambiental Área de Protección. El estudio se realizó entre octubre de 2019 y marzo de 2020 y el muestreo se realizó con el mismo esfuerzo de muestreo en tres niveles de elevación por métodos activos (redes) y pasivos (trampa de cebo). Se muestrearon un total de 622 individuos de Lepidoptera, pertenecientes a 154 especies. La familia Nymphalidae exhibió la mayor riqueza y abundancia. La zona de mayor elevación mostró el mayor número de especies exclusivas. La riqueza y abundancia fueron más altas en la elevación media, pero las diferencias entre las zonas de elevación no fueron estadísticamente significativas. Los estimadores de riqueza indicaron una eficiencia muestral media del 64,97%. En contraste con el patrón esperado, la riqueza de especies fue mayor en las zonas de elevación media y alta, lo que podría reflejar el mayor grado de conservación de estas áreas. Los hallazgos indicados aquí, contribuyen a una

mejor comprensión de la diversidad de Lepidoptera en zonas de mayor elevación de las regiones del Mata Atlántica en Brasil.

PALABRAS CLAVE: Lepidoptera, Papilionoidea, altitud, conservación de insectos, inventario, biodiversidad, riqueza de especies, Brasil.

Introduction

Butterflies, together with moths, belong to the order Lepidoptera and are represented in Brazil by about 3,487 described species (CASAGRANDE & DUARTE, 2021), currently grouped into seven families (Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae, Riodinidae, and Hedyliidae) (MITTER *et al.*, 2017). These insects are considered excellent biological indicators because they have short life cycle, show high sensitivity to environmental changes, are easy to sample at all times of the year, and are well known taxonomically (BROWN, 1991; FREITAS *et al.*, 2006; BOGIANI *et al.*, 2012). Lepidoptera are also important pollinators, sometimes more efficient than bees in high-altitude environments (GIULIETTI *et al.*, 1987; MOTA *et al.*, 2016; PIRES *et al.*, 2020), being used as flag species for biodiversity conservation (HENRIQUES *et al.*, 2019).

The composition, diversity, and distribution of Lepidoptera communities vary along environmental gradients and are influenced by several environmental factors, including elevation (LIEN & YUAN, 2003; FREITAS *et al.*, 2007; FERNANDES *et al.*, 2016). An increase in elevation influences abiotic conditions such as temperature, humidity, atmospheric pressure, solar radiation, wind speed and direction, among others, affecting the development, feeding, and general behaviour of insects (HODKINSON, 2005). The most commonly observed pattern for insect communities is a reduction in richness and abundance at higher elevations, with greater diversity in low or mid zones (FERNANDES *et al.*, 2016; PIRES *et al.*, 2020), and such trend also applies to Lepidoptera. Studies carried out in different environments demonstrated that low elevations host a greater diversity of Lepidoptera, with more uniform species distribution (SPARROW *et al.*, 1994; ISMAIL *et al.*, 2018). Other investigations found greater diversity in mid-elevation zones, where temperature and rainfall levels were within the optimal range for butterfly survival (STEFANESCU *et al.*, 2004; ILLÁN *et al.*, 2010; ABRAHAMCZYK *et al.*, 2011).

Previous studies evaluated the composition and diversity of Lepidoptera along elevational gradients in Brazil (CARNEIRO *et al.*, 2014; FERNANDES *et al.*, 2016; PEREIRA *et al.*, 2017; HENRIQUES *et al.*, 2019; BEIRÃO *et al.*, 2020; PIRES *et al.*, 2020). However, data related to the influence of elevation on Lepidoptera communities in Brazil are still scarce and many elevation zones remain to be studied (HENRIQUES *et al.*, 2019), especially considering its large territorial extension. From this perspective, this study aimed to examine the effects of elevation variation on the richness, frequency, abundance, and composition of a butterfly community in an Atlantic Forest region in southern Minas Gerais State, Brazil. It was hypothesized that species richness and abundance are lower at higher elevations, with richness decreasing as elevation increases or diversity peaking at mid-elevation, following the commonly observed pattern of species distribution for Lepidoptera and other terrestrial insects (FERNANDES *et al.*, 2016; PIRES *et al.*, 2020). This study also includes the first species list of Lepidoptera of the Fernão Dias Environmental Protection Area, Minas Gerais State, Brazil.

Material and methods

STUDY AREA

This study was conducted in the Fernão Dias Environmental Protection Area, located in the municipality of Gonçalves (22°30'13"S 45°31'24"W, Fig. 1), southmost part of Minas Gerais State, Mantiqueira Mountain region, Brazil. The area is covered by semideciduous and mixed seasonal forest formations, typical phytophysionomies of the Atlantic Forest domain (OLIVEIRA FILHO, 2006). The

climate is temperate rainy (Köppen classification: Cwb), the average annual rainfall is approximately 1500 mm, the average temperature is 14-19 °C, and elevations range from 880 to 1670 m (MELO & SALINO, 2007).

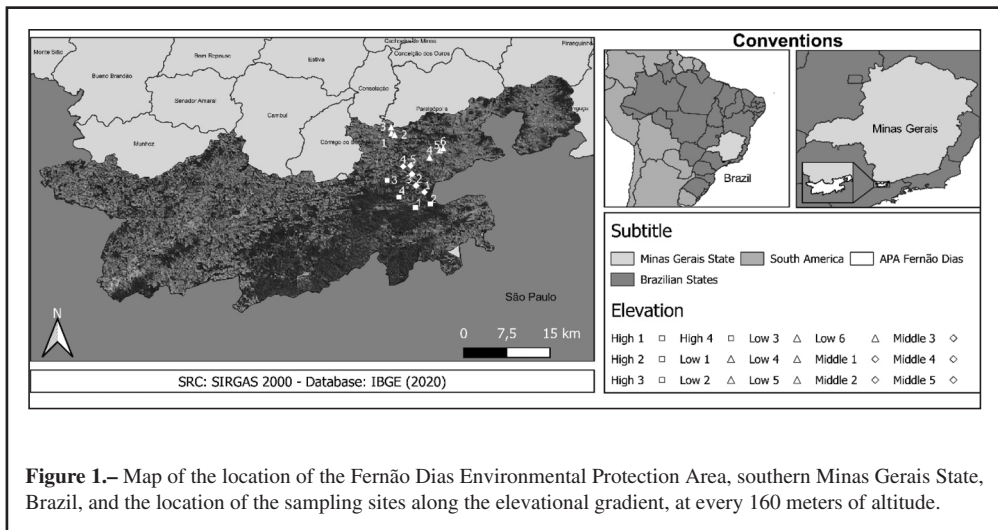


Figure 1.– Map of the location of the Fernão Dias Environmental Protection Area, southern Minas Gerais State, Brazil, and the location of the sampling sites along the elevational gradient, at every 160 meters of altitude.

DATA SAMPLING

Sampling was carried out in the rainy season during four campaigns (October and December 2019 and January and March 2020) of four consecutive days each at 160 m elevation increments in three (low, middle, and high) elevation zones ranging from 880 to 1670 m above sea level. Elevation zones were associated with different plant covers and degrees of conservation, which were assessed by field observation (for example, presence of Bromeliaceae and pasture). Characterization was also performed on the basis of information provided by the municipality of Gonçalves (presence of hiking trails, waterfalls, and tourist accommodation) (Table I). Google Earth satellite images were used to determine the degree of habitat fragmentation.

Table I.– Ecological, social, and economic characteristics of the three elevational zones in the Fernão Dias Environmental Protection Area, southern Minas Gerais State, Brazil.

Variable	Low elevation	Middle elevation	High elevation
Elevation	880 to 1090 m	1250 to 1410 m	1570 to 1670 m
Phytophysionomy	Semideciduous forest	Mixed and semideciduous forest	Mixed forest
Fragmentation	More fragmented	Moderately fragmented	Less fragmented
Regeneration stage	Early and intermediate	Intermediate	Advanced
Canopy formation	Rare	Less frequent	More frequent
Pasture areas	Many	Few	Few
<i>Eucalyptus</i> cultivation	Present	Present	Present
Ecotourism	Low	High	High
Riparian zone width	<5 m	5–10 m	>10 m
Residential areas	Many	Many	Few

Sampling was performed by passive and active methods. Passive sampling consisted of the use of three van Someren-Rydon traps baited with banana and sugarcane broth fermented for 48 h per

elevation zone (UEHARA-PRADO *et al.*, 2009). Nine baited traps were kept in the field for 4 consecutive days (96 h) during each campaign, totaling 1,632 h of trap sampling. Active sampling was performed for 17 days by using entomological nets during the same period of the day, between 8:00 and 16:00 h (8 h/day), with sampling times distributed equally between elevation zones, totaling 136 net-hours and a sampling effort of 1,738 h.

All sampled individuals were sacrificed in the field and stored in entomological envelopes labeled with locality, date, collector's name, type of collection, and elevation zone. Subsequently, samples were sent to the Laboratory of Butterfly Ecology and Systematics of the University of Campinas (LABBOR/UNICAMP) for identification. One part of the material was deposited in the collection of butterflies and moths of the Museum of Zoology of the University of Campinas (ZUEC-LEP, UNICAMP) and the other in the collection of the Laboratory of Zoology of the Federal Institute of Education, Sciences, and Technology of Southern Minas Gerais (IFSULDEMINAS), Inconfidentes campus, Brazil.

DATA ANALYSIS

The frequency distribution of butterfly species was assessed by classifying rare species as singletons (only one individual recorded in one sample), doubletons (two individuals recorded), unique (species recorded in only one sample), and duplicates (species recorded in two samples). Differences in richness and abundance between elevation zones were tested by generalized linear models, using richness and abundance as response variables and elevation as an explanatory variable. The diversity of each zone was measured by Shannon's diversity (H'), Pielou's evenness (J , calculated from H'), and Simpson's dominance (D) indices. Sampling efficiency and the total number of butterfly species in the experimental area were estimated from the mean values of Jackknife 1, Jackknife 2, and Chao 2 estimators, with 1000 randomizations. Analyses were performed using PAST software version 3.24 (HAMMER *et al.*, 2001) and R software (R Development Core Team, 2017).

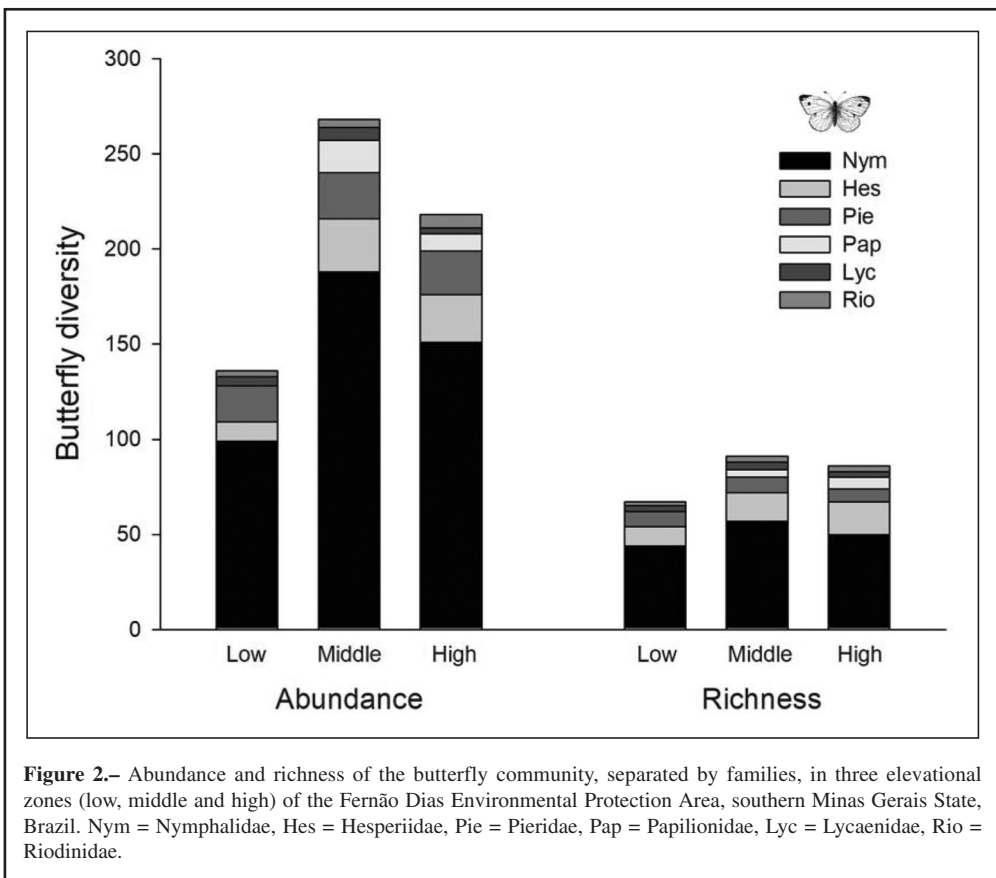
Results

In this study, we recorded 622 butterfly individuals, distributed in 154 species belonging to 6 families (Table II). Nymphalidae was the family with the highest species richness (89 species, 57.79% of the species sampled, Fig. 2), followed by Hesperidae (31 species, 20.13%), Pieridae (15 species, 9.74%), Papilionidae (7 species, 4.55%), and Lycaenidae and Riodinidae (6 species each, 3.9% each). Nymphalidae was also the most abundant family, accounting for well over half of the collected individuals ($n = 438$, 70.42%, Fig. 2), followed by Pieridae ($n = 66$, 10.61%), Hesperidae ($n = 63$, 10.13%), Papilionidae ($n = 26$, 4.18%), Lycaenidae ($n = 15$, 2.41%), and Riodinidae ($n = 14$, 2.25%). Of the 89 butterfly species belonging to the family Nymphalidae, 14 (15.7%) were sampled exclusively by using attractive traps.

The most abundant species were *Hermeuptychia* sp. (Nymphalidae: Satyrinae, $n = 54$), *Forsterinaria necys* (Godart, [1824]) (Nymphalidae: Satyrinae, $n = 30$), *Tegosa* sp. (Nymphalidae: Nymphalinae, $n = 20$), *Mechanitis lysimnia* (Fabricius, 1793) (Nymphalidae: Danaeinae, $n = 19$), and *Anartia amathea roeselia* (Eschscholtz, 1821) (Nymphalidae: Nymphalinae, $n = 17$), which together accounted for 22.5% of the sampled Lepidoptera. *M. lysimnia* (Fabricius, 1793) was the most frequent species, collected on 11 of the 17 days of sampling. A total of 20 species were found in all elevation zones (13.64% of the sampled community). Furthermore, 60 species were represented by only one individual (singletons) and 28 species by two individuals (doubletons), indicating that more than half of the recorded species (57.14%) can be classified as rare, 70 as unique (captured once), and 28 as duplicates (captured twice).

In comparing elevation zones (Fig. 2), it was found that the middle elevation had the highest richness ($n = 91$, 59%), abundance ($n = 268$, 48%), and diversity ($H' = 4.084$), whereas the high elevation zone showed the highest number of exclusive species ($n = 37$, 24%); however, differences

between elevation zones were not significant for richness ($P = 0.46$, $R^2 = 0.56$) or abundance ($P = 0.58$, $R^2 = 0.38$). All zones exhibited higher evenness than dominance, with the low elevation having the highest evenness ($J = 0.9462$) and the high elevation having the highest dominance ($D = 0.03409$) (Table II). Middle and high elevations had the greatest number of species in common ($n = 25$, 16%), whereas low and high elevations exhibited a lower number of common species ($n = 4$, 3%) (Fig. 3). Moreover, 16 species from the low elevation zone, 18 from the middle elevation zone, and 26 from the high elevation zone were singletons.



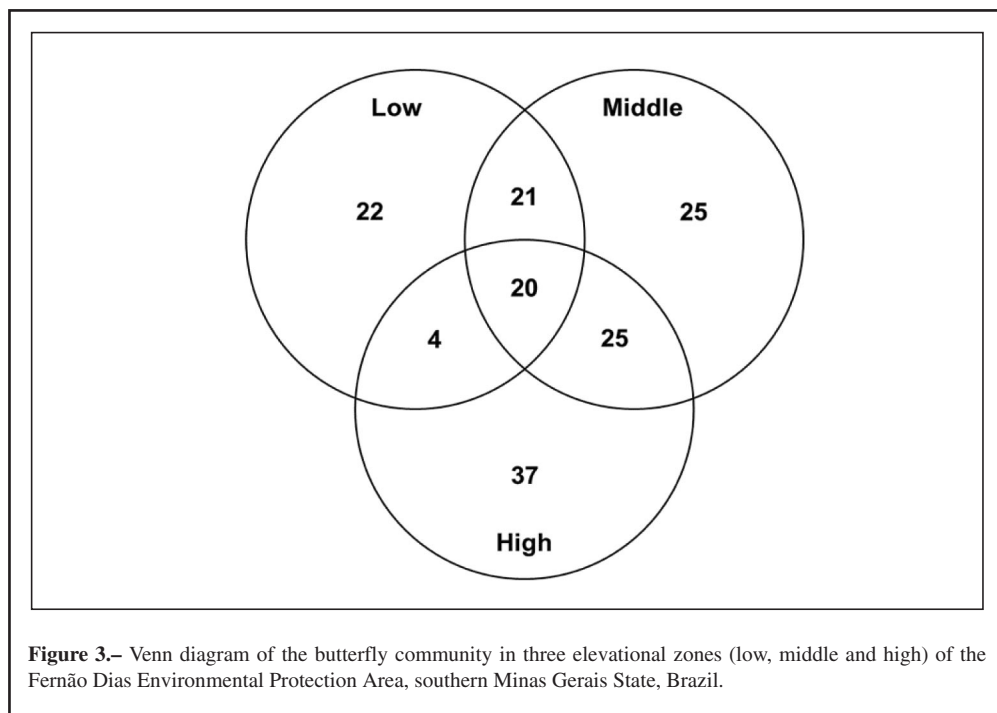
Richness estimators indicated that 237 species of Lepidoptera could be found in this mountainous region (83 more than were sampled), corresponding to a sampling efficiency of 64.97%. Analysis by elevation zone revealed that low, middle, and high elevations had 111, 143, and 163 butterfly species, respectively, and sampling efficiencies of 60.97, 63.36, and 52.76%, respectively (Table II).

Discussion

The richness of butterfly species in the Atlantic Forest region of the Fernão Dias Environmental Protection Area was higher than that observed in some studies (RITTER *et al.*, 2011; BORDIN *et al.*, 2019; BERTINOTI *et al.*, 2020; SILVA *et al.*, 2020) and lower than that reported in others (BONFANTTI *et al.*, 2011; BELLAVER *et al.*, 2012; VIEIRA *et al.*, 2020). Nevertheless, results

were within the expected range for forest regions in Brazil, given the differences in the size of experimental sites, sampling methods and efforts between studies. It is expected that the species accumulation curve will not reach the asymptote in studies with insects, even when small areas are sampled, because this group is extremely diverse (BEUTEL *et al.*, 2017). The Jackknife 1 richness estimator showed that the sample included 70.03% of the butterfly species occurring in the Environmental Protection Area; this result is in line with previous studies assessing forest regions, which found sampling efficiencies greater than 60% by using the same estimator as that used here (BORDIN *et al.*, 2019; MELO *et al.*, 2019; GUERATTO *et al.*, 2020; BERTINOTI *et al.*, 2020; VIEIRA *et al.*, 2020; ARAÚJO *et al.*, 2021).

Nymphalidae was the richest and most abundant family (see Fig. 2), as also observed in previous surveys carried out in southern Minas Gerais (ANDRADE & TEIXEIRA, 2017; OLIVEIRA *et al.*, 2018; VIEIRA *et al.*, 2020), followed by Hesperidae. Nymphalidae are found in almost all ecosystems (DEVRIES, 1987), have several food niches (BROWN JUNIOR *et al.*, 1999), and can be efficiently captured by baited traps (FREITAS *et al.*, 2003; UEHARA-PRADO *et al.*, 2007; VIEIRA *et al.*, 2020), which may explain its numerous captures. In addition to Nymphalidae, it was expected that a large number of Hesperidae individuals would be sampled, as these families have some of the highest species' richness in Brazil (BONFANTTI *et al.*, 2009).



F. necys (Godart, [1824]), *M. lysimnia* (Fabricius, 1793), and *A. amathea roeselia* (Eschscholtz, 1821), belonging to the family Nymphalidae, were the most abundant species in the Environmental Protection Area. These Lepidoptera are predominantly found in secondary forests, disturbed habitats, and anthropic environments (DEVRIES, 1987; BROWN, 1992), suggesting that the study area has been negatively affected by human action and is undergoing a process of regeneration. According to BROWN (1992), *F. necys* (Godart, [1824]) inhabits forests at elevations above 900 m and its larvae are associated with grasses, which are common in the study area. *A. amathea roeselia* (Eschscholtz, 1821)

shows a preference for humid environments, such as bogs and river banks. The three butterfly species are common in *Eucalyptus* and *Pinus* forests (BROWN, 1992), trees found at the sampling sites, which may be related to the abundance of these Lepidoptera. *M. lysimnia* (Fabricius, 1793) is found at different elevations, most commonly in the forest canopy (BROWN, 1992). In the current study, the species was sampled along the entire elevational gradient, exhibiting greater abundance at low and middle elevations.

Contrary to our expectation, the low elevation zone had a lower number of butterfly species and individuals than the other elevation zones, although differences in richness or abundance were not significant. Several studies found a decrease in richness with increasing elevation or a peak in diversity at mid-elevations (CARNEIRO *et al.*, 2014; FERNANDES *et al.*, 2016; PIRES *et al.*, 2020 and references therein), but there are also some studies that found greater diversity in high elevation zones (SHRESTHA *et al.*, 2020). In the current study, forests in middle and high elevation zones were more continuous, less fragmented, and at more advanced stages of regeneration than forest fragments occurring at low elevation (Table I), having greater availability of resources, which probably exerts a strong influence on the foraging and nesting activity of the butterfly community and may explain the observed patterns of species diversity.

The high elevation zone had a greater number of singletons and unique species than the other elevations, suggesting that the composition of the butterfly community is different at the mountain top, more represented by unique species than by common ones. These results may be related to differences in conservation level, given that high elevation zones are less influenced by anthropogenic activities such as pasturing and cropping (see Table I).

Elevation alone has no significant effect on insect populations; therefore, other biotic and abiotic factors should be considered when trying to understand the occurrence of species along an elevational gradient (SABU *et al.*, 2008; FERNANDES *et al.*, 2016). Several environmental conditions, such as temperature, wind speed, atmospheric pressure, and vegetation cover, exert a great influence on the distribution of insect communities in mountainous environments (HODKINSON, 2005; FERNANDES *et al.*, 2016). The richness of butterfly communities is strongly influenced by the diversity of host plants, and weather conditions and elevation may act as secondary factors in defining community structure (PIRES *et al.*, 2020). Thus, it is believed that the vegetation cover of middle and high elevation zones provided more favorable conditions for the growth and survival of these Lepidoptera.

Minas Gerais State has a large territory covered by three different biomes: Caatinga, Cerrado, and Atlantic Forest (DRUMONND *et al.*, 2005). Few butterfly inventories have been undertaken in the state, despite its great biodiversity and numerous Conservation Units. Some studies focused on Cerrado regions (SILVA *et al.* 2007; PASETO *et al.*, 2014; LUCENA *et al.*, 2018; HENRIQUES *et al.*, 2019), others on areas of transition from Caatinga to different phytophysionomies (GOZZI, 2012; NERY *et al.*, 2014; BEIRÃO *et al.*, 2017), and some on the Atlantic Forest (ANDRADE & TEIXEIRA, 2017; OLIVEIRA *et al.*, 2018; VIEIRA *et al.*, 2020). This study contributed to reducing the knowledge gap regarding butterfly diversity along elevational gradients in protected forest areas in Brazil, acting as a basis for the development of conservation strategies for butterfly communities in the Fernão Dias Environmental Protection Area.

Acknowledgements

We would like to thank Municipal Secretary of Tourism Rafaela Rosa from the Gonçalves City Hall (Minas Gerais State, Brazil); Isabel Lira from the Municipal Council of Tourism (COMTUR); Councilor Leandro Piola; the inns Bicho do Mato, Espaço Kalevala, Vida Verde, and Fazenda das Rosas; and the tour operators Tribo da Montanha, Gonçalves Radical, and Conexão Gonçalves. We are indebted to Padaria São Francisco, Editora Kalapalo, Imobiliária Campesino, Floresta Barnabé, and all residents of Gonçalves who contributed to the research, either directly or indirectly. We also extend our gratitude to Augusto Henrique Batista Rosa, Dr. André V. L. Freitas, Gustavo M. Acaccio, Diego R.

Dolibaina, and Tiago Barbosa for help with species identification; to all members of the Laboratory of Zoology of the Federal Institute of Southern Minas Gerais, Inconfidentes campus, for assistance with field work; to the Federal Institute of Southern Minas Gerais, Inconfidentes campus, for logistic support; to Dr. Mateus Clemente for assistance with statistical analysis; and to SISBIO (#71076-1) and IEF (#079/2019) for sampling licenses.

BIBLIOGRAPHY

- ABRAHAMCZYK, S., KLUGE, J., GARECA, Y., REICHLER, S. & KESSLER, M., 2011.– The influence of climatic seasonality on the diversity of different tropical pollinator groups.– *Plos One*, **6**(11): e27115. <https://doi.org/10.1371/journal.pone.0027115>.
- ANDRADE, D. & TEIXEIRA, I., 2017.– Diversidade de Lepidoptera em um fragmento florestal em Muzambinho, Minas Gerais.– *Ciência Florestal*, **27**(4): 1229-1241.
- ARAUJO, P. F., FREITAS, A. V. L., GONCALVES, G. A. D. S. & RIBEIRO, D. B., 2021.– Vertical stratification on a small scale: the distribution of fruit-feeding butterflies in a semi-deciduous Atlantic forest in Brazil.– *Studies on Neotropical Fauna and Environment*, **56**(1): 10-39.
- BEIRÃO, M. V., NEVES, F. S., PENZ, C. M., DEVRIES, P. J. & FERNANDES, G. W., 2017.– High butterfly beta diversity between Brazilian cerrado and cerrado-caatinga transition zones.– *Journal of Insect Conservation*, **21**(5): 849-860.
- BEIRÃO, M. V., NEVES, F. S. & FERNANDES, G. W., 2020.– Climate and plant structure determine the spatiotemporal butterfly distribution on a tropical mountain.– *Biotropica*, **53**(1): 191-200.
- BELLAVER, J., ISERHARD, C. A., SANTOS, J. P. D., SILVA, A. K., TORRES, M., SIEWERT, R. R., MOSER, A. & ROMANOWSKI, H. P., 2012.– Borboletas (Lepidoptera: Papilionoidea e Hesperioidea) de Matas Paludosas e Matas de Restinga da Planície Costeira da região Sul do Brasil.– *Biota Neotropica*, **12**(4): 181-190.
- BERTINOTI, G. K., DE SOUZA, A. S. B., DALO, L., DE ALMEIDA, M. & DE SOUZA, M. M., 2020.– Butterflies richness (Lepidoptera, Papilionoidea) from Ilha Grande National Park, Paraná, Brazil.– *Journal of Entomology and Zoology Studies*, **8**(5): 835-840.
- BEUTEL, R. G., YAVORSKAYA, M. I., MASHIMO, Y., FUKUI, M. & MEUSEMANN, K., 2017.– The phylogeny of Hexapoda (Arthropoda) and the evolution of megadiversity.– *Proceeding of the Arthropodan Embryological Society of Japan*, **51**: 1-15.
- BOGIANI, P. A., ARANDA, R. & MACHADO, C. O. F., 2012.– Riqueza de borboletas (Lepidoptera) em um fragmento urbano de Cerrado em Mato Grosso do Sul, Brasil.– *EntomoBrasilis*, **5**(2): 93-98.
- BONFANTTI, D., DI MARE, R. A. & GIOVENARDI, R., 2009.– Butterflies (Lepidoptera: Papilionoidea and Hesperioidea) from two forest fragments in northern Rio Grande do Sul, Brazil.– *CheckList*, **5**(4): 819-829.
- BONFANTTI, D., LEITE, L. A. R., CARLOS, M. M., CASAGRANDE, M. M., MIELKE, É. C. & MIELKE, O. H. H., 2011.– Riqueza de borboletas em dois parques urbanos de Curitiba, Paraná, Brasil.– *Biota Neotropica*, **11**(2): 247-253.
- BORDIN, S. M. S., MONTEIRO, M., FERREIRA, V. W., LUTINSKI, J. A. & RODRIGUES, E. N. L., 2019.– Frugivorous butterflies from the Atlantic Forest in Southern Brazil (Lepidoptera: Nymphalidae).– *Biota Neotropica*, **19**(4): e20180722. <http://dx.doi.org/10.1590/1676-0611-BN-2018-0722>.
- BROWN JR, K. S., 1991.– Conservation of Neotropical environments: insects as indicators.– In N. M. COLLINS & J. A. THOMAS (Eds.). *The conservation of insects and their habitats*: 349-404. Royal Entomological Society Symposium XV Academic Press, London.
- BROWN JUNIOR, K. S., 1992.– Borboletas da Serra do Japi: diversidade, habitats, recursos alimentares e variação temporal.– In L. P. C. MORELLATO. *História Natural da Serra do Japi: ecologia e preservação de uma área florestal do Sudeste do Brasil*: 142-186. UNICAMP, Campinas.
- BROWN JUNIOR, K. S. & FREITAS, A. V. L., 1999.– Lepidoptera.– In L. SIMONE, D. ISMAEL, W. VALENTI, T. MATSUMURA-TUNDISI & O. ROCHA. *Biodiversidade do Estado de São Paulo: síntese do conhecimento ao final do século XX*: 225-243.
- CARNEIRO, E., MIELKE, O. H. H., CASAGRANDE, M. M. & FIEDLER, K., 2014.– Skipper richness (Hesperiidae) along elevational gradients in Brazilian Atlantic Forest.– *Neotropical Entomology*, **43**(1): 27-38.

- CASAGRANDE, M. M. & DUARTE, M., 2021.– Lepidoptera.– *In Catálogo Taxonômico da Fauna do Brasil*. PNUD. Available from <http://fauna.jbrj.gov.br/fauna/faunadobrasil/84> (accessed in May 22, 2021).
- DEVRIES, P. J., 1987.– *The butterflies of Costa Rica and their natural history. Papilionidae, Pieridae and Nymphalidae*: 456 pp. Princeton University, New Jersey.
- DRUMMOND, G. M., MARTINS, C. S., MACHADO, A. B. M., SEBAIO, F. A. & ANTONINI, Y., 2005.– *Biodiversidade em Minas Gerais: um atlas para sua conservação*: 222 pp. Fundação Biodiversitas, Belo Horizonte.
- FERNANDES, G. W., ALMEIDA, H. A., NUNES, C. A., XAVIER, J. H. A., COBB, N. S., CARNEIRO, M. A., CORNELISSEN, T., NEVES, F. S., RIBEIRO, S. P., NUNES, Y. R. F., PIRES, A. C. V. & BEIRÃO, A., 2016.– Cerrado to rupestrian grasslands: patterns of species distribution and the forces shaping them along an altitudinal gradient.– *In G. FERNANDES (eds). Ecology and conservation of mountaintop grasslands in Brazil*: 345-377. Springer, Cham.
- FREITAS, A. V. L., FRANCINI, R. B. & BROWN JR, K. S., 2003.– Insetos como indicadores ambientais.– *In L. CULLEN JUNIOR, R. RUDRAN & C. VALLADARES-PÁDUA. Métodos de estudo em Biologia da Conservação e Manejo da Vida Silvestre*: 125-151. UFPR, Curitiba.
- FREITAS, A. V. L., LEAL, I. R., UEHARA-PRADO, M. & IANNUZZI, L., 2006.– Insetos como indicadores de conservação da paisagem.– *In C. F. D. ROCHA, H. G. BERGALLO, M. VAN SLUYS & M. A. S. ALVES. Biologia da Conservação*: 201-225, UERJ, Rio de Janeiro.
- FREITAS, S., FLINTE, V. & MACEDO, M. V., 2007.– Distribuição altitudinal e temporal de sete espécies de *Plagiometrona* (Coleoptera: Chrysomelidae: Cassidinae) no Parque Nacional Serra dos Órgãos, RJ.– *Anais do VIII Congresso de Ecologia do Brasil, 23 a 28 de Setembro de 2007, Caxambu - MG*: 1-2.
- GIULIETTI, A. M., MENEZES, N. L., PIRANI, J. R., MEGURO, M. & WANDERLEY, M. G. L., 1987.– Flora da Serra do Cipó, Minas Gerais: caracterização e lista das espécies.– *Boletim de Botânica da Universidade de São Paulo*, **9**: 1-151.
- GOZZI, M. R., BEIRÃO, M. V., MEDEIROS, L. R., NEVES, F. S. & FAGUNDES, M., 2012.– Borboletas frugívoras em uma região de transição entre cerrado sensu stricto e caatinga no norte de Minas Gerais, Brasil.– *MG Biota*, **4**: 25-37.
- GUERATTO, P. E., CARREIRA, J. Y., SANTOS, J. P., TACIOLI, A. & FREITAS, A. V., 2020.– Effects of forest trails on the community structure of tropical butterflies.– *Journal of Insect Conservation*, **24**(2): 309-319.
- HAMMER, Ø., HARPER, D. A. T. & RYAN, P. D., 2001.– PAST: Paleontological statistics software package for education and data analysis.– *Palaeontologia Electronica*, **4**(1): 9 pp.
- HENRIQUES, N. R., BEIRÃO, M. V., BRASIL, E. & CORNELISSEN, T., 2019.– Butterflies (Lepidoptera: Papilionoidea) from the campos rupestres of Serra de São José, Minas Gerais, Brazil.– *Biota Neotropica*, **19**(3): e20180655. <https://doi.org/10.1590/1676-0611-BN-2018-0655>.
- HODKINSON, I. D., 2005.– Terrestrial insects along elevation gradients: species and community responses to altitude.– *Biological reviews*, **80**(3): 489-513.
- ILLÁN, J. G., GUTIERREZ, D. & WILSON, R. J., 2010.– Fine-scale determinants of butterfly species richness and composition in a mountain region.– *Journal of biogeography*, **37**(9): 1706-1720.
- ISMAIL, N., MOHAMED, M., KHIM, P. C. & TOKIMAN, L., 2018.– Spatial distribution of butterfly (Lepidoptera: Papilionoidea) along altitudinal gradients at Gunung Ledang National Park, Johor, Malaysia.– *AIP Conference Proceedings*, **2002**(1): 020047. <https://doi.org/10.1063/1.5050143>.
- LIEN, V. V. & YUAN, D., 2003.– The differences of butterfly (Lepidoptera, Papilionoidea) communities in habitats with various degrees of disturbance and altitudes in tropical forests of Vietnam.– *Biodiversity and Conservation*, **12**(6): 1099-1111.
- LUCENA, V. P., SILVA, M. H., AQUINO, J. D., SOUSA, M. C., SILVA, W. J., SILVA, F. B. & MORAIS, C. R., 2018.– Levantamento de espécies de borboletas frugívoras em áreas de cerrado e mata ciliar, pertencentes ao distrito de Monte Carmelo, MG, Brasil.– *Revista GeTeC*, **7**(18): 26-42.
- MELO, D. H. A., FILGUEIRAS, B. K. C., ISERHARD, C. A., IANNUZZI, L., FREITAS, A. V. L. & LEAL, I. R., 2019.– Effect of habitat loss and fragmentation on fruit-feeding butterflies in the Brazilian Atlantic Forest.– *Canadian Journal of Zoology*, **97**(7): 588-596.
- MELO, L. C. & SALINO, A., 2007.– Pteridófitas em fragmentos florestais da APA Fernão Dias, Minas Gerais, Brasil.– *Rodriguésia*, **58**(1): 207-220.

- MITTER, C., DAVIS, D. R. & CUMMINGS, M. P., 2017.– Phylogeny and evolution of Lepidoptera.– *Annual Review of Entomology*, **62**: 265-283.
- MOTA, N. M., REZENDE, V. L., MOTA, G. S., FERNANDES, G. W. & NUNES, Y. R. F., 2016.– Forces driving the regeneration component of a rupestrian grassland complex along an altitudinal gradient.– *Brazilian Journal of Botany*, **39**(3): 845-860.
- NERY, I., CARVALHO, N. & PAPROCKI, H., 2014.– Checklist of butterflies (Insecta: Lepidoptera) from Serra do Intendente State Park-Minas Gerais, Brazil.– *Biodiversity data journal*, **2**: e3999. <https://doi.org/10.3897/BDJ>.
- OLIVEIRA FILHO, A. T., 2006.– Definição e delimitação de domínios e subdomínios das paisagens naturais do estado de Minas Gerais.– In J. R. SCOLFORO & L. M. T. CARVALHO. *Mapeamento e Inventário de Flora e dos Reflorestamentos de Minas Gerais*: 21-35. UFLA, Lavras.
- OLIVEIRA, L. A., MILANI, L. R. & SOUZA M. M., 2018.– Riqueza de borboletas (Lepidoptera) no Parque Estadual da Serra do Papagaio, sul de Minas Gerais, Brasil.– *MG Biota*, **11**(3): 5-21.
- PASETO, M. L., FÁRIA, L. S., MENDES, J. & LINHARES, A. X., 2014.– Diveristy and Faunistic Composition of Butterflies and New Records from Cerrado Biome, Minas Gerais State, Brazil.– *Trends in Entomology*, **10**: 21-28.
- PEREIRA, G. C. N., COELHO, M. S., BEIRÃO, M. V., BRAGA, R. F. & FERNANDES, G. W., 2017.– Diversity of fruit-feeding butterflies in a mountaintop archipelago of rainforest.– *PLOS ONE*, **12**(6): e0180007. <https://doi.org/10.1371/journal.pone.0180007>.
- PIRES, A. C. V., BARBOSA, M., BEIROZ, W., BEIRÃO, M. V., MARINI-FILHO, O. J., DUARTE, M., MIELKE, O. H. H., LADEIRA, F. A., NUNES, Y. R. F., NEGREIROS, D. & FERNANDES, G. W., 2020.– Altitudinal variation in butterfly community associated with climate and vegetation.– *Anais da Academia Brasileira de Ciências*, **92**(suppl. 2): <https://doi.org/10.1590/0001-3765202020190058>.
- RITTER, C. D., LEMES, R., MORAIS, A. B. B. & DAMBROS, C. S., 2011.– Butterflies (Lepidoptera: Hesperioidea and Papilionoidea) from Mixed Ombrophilous Forest fragments, Rio Grande do Sul, Brazil.– *Biota Neotropica*, **11**(1): 361-368.
- SABU, T. K., VINEESH, P. J. & VINOD, K. V., 2008.– Diversity of forest litter-inhabiting ants along elevations in the Wayanad region of the Western Ghats.– *Journal of Insect Science*, **8**(1): 69.
- SHRESTHA, B. R., TIMSINA, B., MÜNZBERGOVÁ, Z., DOSTÁLEK, T., GAUDEL, P., BASNET, T. B. & ROKAYA, M. B., 2020.– Butterfly-plant interactions and body size patterns along an elevational gradient in the Manang region of central Nepal.– *Journal of Mountain Science*, **17**: 1115-1127.
- SILVA, A. R., LANDA, G. G. & VITALINO, R. F., 2007.– Borboletas (Lepidoptera) de um fragmento de mata urbano em Minas Gerais, Brasil.– *Lundiana: International Journal of Biodiversity*, **8**(2): 137-142.
- SILVA, V. D., BEIRÃO, M. V. & CARDOSO, D. C., 2020.– Thermal Tolerance of Fruit-Feeding Butterflies (Lepidoptera: Nymphalidae) in Contrasting Mountaintop Environments.– *Insects*, **11**(5): 278.
- SPARROW, H. R., SISK, T. D., EHRLICH, P. R. & MURPHY, D. D., 1994.– Techniques and guidelines for monitoring neotropical butterflies.– *Conservation Biology*, **8**(3): 800-809.
- STEFANESCU, C., HERRANDO, S. & PÁRAMO, F., 2004.– Butterfly species richness in the north-west Mediterranean Basin: the role of natural and human-induced factors.– *Journal of biogeography*, **31**(6): 905-915.
- UEHARA-PRADO, M., BROWN JUNIOR, K. S. & FREITAS, A. V. L., 2007.– Species richness, composition and abundance of fruit-feeding butterflies in the Brazilian Atlantic Forest: comparison between a fragmented and a continuous landscape.– *Global Ecology and Biogeography*, **16**(1): 43-54.
- UEHARA-PRADO, M., FERNANDES, J. O., BELLO, A. M., MACHADO, G., SANTOS, A. J., VAZDE-MELLO, F. Z. & FREITAS, A. V. L., 2009.– Selecting terrestrial arthropods as indicators of small-scale disturbance: A first approach in the Brazilian Atlantic Forest.– *Biological Conservation*, **142**(6): 1220-1228.
- VIEIRA, L. R., SILVA, L. D., OLIVEIRA, L. A., ROSA, A. H. B. & SOUZA, M. M., 2020.– Borboletas (Lepidoptera, Papilionoidea) em floresta estacional semidecidual do sul do estado de Minas Gerais, Brasil.– *Nature and Conservation*, **13**(2): 14-25.

L. R. V.

Instituto Federal de Educação, Ciências e Tecnologia do Sul de Minas Gerais (IFSULDEMINAS)
Inconfidentes, MG
BRASIL / BRAZIL

E-mail: lucas.ramos@alunos.ifsuldeminas.edu.br
<https://orcid.org/0000-0001-6251-2114>

*N. R. H.

Universidade Federal de Minas Gerais (UFMG)

Instituto de Ciências Biológicas (ICB)

Departamento de Genética, Ecologia e Evolução (GEE)

Programa de Pós-Graduação em Ecologia, Conservação e Manejo da Vida Silvestre (ECMVS)

Belo Horizonte, MG

BRASIL / BRAZIL

E-mail: h.nathaliaribeiro@gmail.com

<http://orcid.org/0000-0002-3858-8423>

M. M. S.

Instituto Federal de Educação, Ciência e Tecnologia do Sul de Minas (IFSULDEMINAS)

Inconfidentes, MG

BRASIL / BRAZIL

E-mail: marcos.souza@ifsuldeminas.edu.br

<http://orcid.org/0000-0003-0415-1714>

* Autor para la correspondencia / *Corresponding author*

(Recibido para publicación / *Received for publication* 4-VII-2021)

(Revisado y aceptado / *Revised and accepted* 20-VIII-2021)

(Publicado / *Published* 30-III-2022)

Table II.– List of butterfly species from the elevational gradient of the Fernão Dias Environmental Protection Area, southern Minas Gerais State, Brazil, and ecological indices.

FAMILY/Subfamily (number of species)	Species	Low elevation	Middle elevation	High elevation
HESPERIIDAE (31)	Hesperiidae sp. 1	0	0	1
	Hesperiidae sp. 2	0	0	1
	Hesperiidae sp. 3	0	1	0
	Hesperiidae sp. 4	0	0	1
	Hesperiidae sp. 5	0	0	1
HESPERIINAE (5)	<i>Anthoptus epictetus</i> (Fabricius, 1793)	0	3	1
	<i>Polites vibex catilina</i> (Plötz, 1886)	0	2	0
	<i>Vettius diversa lyrcea</i> (Plötz, 1882)	0	1	1
	<i>Vehilius clavicula</i> (Plötz, 1884)	1	0	0
	<i>Vettius ploetzii</i> (Capronnier, 1874)	0	0	1
PYRGINAE (20)	<i>Autochton integrifascia</i> (Mabille, 1891)	0	1	0
	<i>Autochton zarex</i> (Hübner, 1818)	1	1	1
	<i>Celaenorrhinus eligius punctiger</i> (Burmeister, 1878)	0	1	0
	<i>Chioides catillus</i> (Cramer, 1779)	0	1	0
	<i>Diaeus lacaeana</i> (Hewitson, 1869)	0	0	1
	<i>Heliopetes omrina</i> (A. Butler, 1870)	1	2	0
	<i>Nisoniades bipuncta</i> (Schaus, 1902)	0	1	0
	<i>Nisoniades macarius</i> (Herrich-Schäffer, 1870)	1	0	0
	<i>Noctuana diurna</i> (A. Butler, 1870)	0	0	1
	<i>Phocides pialia maximus</i> (Mabille, 1888)	0	0	5
	<i>Polythrix octomaculata</i> (Sepp, [1844])	1	0	0
	<i>Pyrgus orcus</i> (Stoll, 1780)	1	5	3
	<i>Pythonides lancea</i> (Hewitson, 1868)	0	1	1
	<i>Staphylus ascalon</i> (Staudinger, 1876)	1	0	0
	<i>Staphylus</i> cf. <i>coecatus</i>	0	0	2
	<i>Theagenes dichrous</i> (Mabille, 1878)	0	0	1
	<i>Urbanus dorantes</i> (Stoll, 1790)	1	1	0
	<i>Urbanus simplicius</i> (Stoll, 1790)	1	1	0
	<i>Urbanus teleus</i> (Hübner, 1821)	0	6	2
	<i>Xenophanes tryxus</i> (Stoll, 1780)	1	0	0
PYRRHOPYGINAE (1)				
	<i>Mimoniades versicolor</i> (Latreille, [1824])	0	0	1
LYCAENIDAE (6)				
POLYOMMATINAE (1)				
	<i>Elkalyce cogina</i> (Schaus, 1902)	1	4	1
THECLINAE (5)				
	<i>Arawacus meliboeus</i> (Fabricius, 1793)	3	1	1
	<i>Atlides cosa</i> (Hewitson, 1867)	0	0	1
	<i>Contrafacia imma</i> (Prittwitz, 1865)	0	1	0
	<i>Strymon astiocha</i> (Prittwitz, 1865)	1	0	0
	<i>Strymon rana</i> (Schaus, 1902)	0	1	0
NYMPHALIDAE (89)				
BIBLIDINAE (7)				
	<i>Diaethria candrena</i> (Godart, [1824])	2	0	1
	<i>Diaethria eluina</i> (Hewitson, [1855])	0	0	2
	<i>Ectima thecla</i> (Fabricius, 1796)	2	0	0
	<i>Epiphile oreia</i> (Hübner, [1823])	0	0	2

CHARAXINAE (8)	<i>Eunica margarita</i> (Godart, [1824])	2	0	0
	<i>Hamadryas epinome</i> (C. Felder & R. Felder, 1867)	3	1	0
	<i>Hamadryas fornax</i> (Hübner, [1823])	0	0	1
	<i>Archaeoprepona chalciope</i> (Hübner, [1823])	0	3	8
	<i>Archaeoprepona demopoon antimache</i> (Hübner, [1819])	1	0	0
	<i>Fountainea ryphea phidile</i> (Geyer, 1837)	2	1	1
	<i>Hypna clytemnestra huebneri</i> A. Butler, 1866	1	0	0
	<i>Memphis acidalia victoria</i> (H. Druce, 1877)	0	1	0
	<i>Memphis appias</i> (Hübner, [1825])	1	2	1
	<i>Memphis otrere</i> (Hübner, [1825])	0	0	7
CYRESTINAE (1)	<i>Zaretis strigosus</i> (Gmelin, [1790])	0	2	0
DANAINAE (19)	<i>Marpesia chiron marius</i> (Cramer, 1779)	1	0	0
	<i>Aeria olena olena</i> Weymer, 1875	2	0	0
	<i>Danaus erippus</i> (Cramer, 1775)	1	1	1
	<i>Danaus gilippus</i> (Cramer, 1775)	1	1	0
	<i>Dircenna dero</i> (Hübner, [1823])	2	1	0
	<i>Episcada stripis</i> Haensch, 1909	0	0	1
	<i>Epityches eupompe</i> (Geyer, 1832)	2	2	4
	<i>Hypothyris euclea laphria</i> (E. Doubleday, 1847)	1	0	0
	<i>Hypothyris ninonia daeta</i> (Boisduval, 1836)	6	5	0
	<i>Ithomia agnosia zikani</i> d'Almeida, 1940	2	0	0
	<i>Ithomia drymo</i> Hübner, 1816	7	0	1
	<i>Lycorea halia discreta</i> Haensch, 1909	1	0	0
	<i>Lycorea ilione</i> (Cramer, 1775)	0	1	0
	<i>Mechanitis lysimnia</i> (Fabricius, 1793)	7	9	3
	<i>Mechanitis polymnia casabranca</i> Haensch, 1905	3	0	1
	<i>Methona themisto</i> (Hübner, 1818)	0	0	2
	<i>Placidina euryanassa</i> (C. Felder & R. Felder, 1860)	2	2	0
	<i>Pseudoscada acilla quadrifasciata</i> Talbot, 1928	2	1	0
	<i>Pseudoscada erruca</i> (Hewitson, 1855)	0	2	3
	<i>Pteronymia carlia</i> Schaus, 1902	1	0	1
HELICONIINAE (14)	<i>Actinote canutia</i> (Hopffer, 1874)	0	2	0
	<i>Actinote carycina</i> Jordan, 1913	0	2	5
	<i>Actinote conspicua</i> Jordan, 1913	0	0	1
	<i>Actinote genitrix</i> d'Almeida, 1922	0	0	1
	<i>Actinote pellenea</i> Hübner, [1821]	1	2	3
	<i>Actinote pyrrha</i> (Fabricius, 1775)	2	3	1
	<i>Actinote</i> sp.	3	4	7
	<i>Agraulis vanillae maculosa</i> (Stichel, [1908])	1	1	0
	<i>Dryadula phaetusa</i> (Linnaeus, 1758)	2	0	0
	<i>Dryas iulia alcionea</i> (Cramer, 1779)	1	0	0
	<i>Eueides aliphera</i> (Godart, 1819)	0	1	0
	<i>Heliconius besckei</i> (Ménétriés, 1857)	0	4	1
	<i>Heliconius erato phyllis</i> (Fabricius, 1775)	2	6	1
	<i>Heliconius ethilla narcaea</i> (Godart, 1819)	0	2	3
LIMENITIDINAE (2)	<i>Adelpha serpa</i> (Boisduval, 1836)	0	0	1
	<i>Adelpha syma</i> (Godart, [1824])	0	6	4
NYMPHALINAE (12)	<i>Anartia amathea roeselia</i> (Eschscholtz, 1821)	5	12	0

SATYRINAE (26)	<i>Anartia jatrophae</i> (Linnaeus, 1763)	3	1	0
	<i>Eresia lansdorfi</i> (Godart, 1819)	0	1	0
	<i>Hypanartia bella</i> (Fabricius, 1793)	1	1	0
	<i>Hypanartia lethe</i> (Fabricius, 1793)	0	1	0
	<i>Junonia</i> sp.	0	4	0
	<i>Ortilia sejona</i> (Schaus, 1902)	0	1	0
	<i>Ortilia velica</i> (Hewitson, 1864)	0	1	0
	<i>Smyrna blomfieldia</i> (Fabricius, 1781)	1	2	0
	<i>Tegosa</i> sp.	1	12	7
	<i>Telenassa teletusa</i> (Godart, [1824])	0	2	1
	<i>Vanessa braziliensis</i> (Moore, 1883)	0	5	0
	<i>Blepolenis batea</i> (Hübner, [1821])	0	1	1
	<i>Caligo arisbe fulgens</i> Rothschild, 1916	0	0	2
	<i>Carminda griseldis</i> (Weymer, 1911)	0	1	0
	<i>Cissia eous</i> (A. Butler, 1867)	4	2	0
	<i>Cissia phronius</i> (Godart, [1824])	3	2	1
	<i>Eryphanis reevesii</i> (E. Doubleday, [1849])	0	0	2
	<i>Eteona tisiphone</i> (Boisduval, 1836)	0	4	2
	<i>Forsterinaria necys</i> (Godart, [1824])	1	10	19
	<i>Forsterinaria pronophila</i> (A. Butler, 1867)	0	0	4
	<i>Forsterinaria quantius</i> (Godart, [1824])	0	2	1
	<i>Godartiana muscosa</i> (A. Butler, 1870)	0	0	1
	<i>Hermeuptychia atalanta</i> (A. Butler, 1867)	0	2	5
	<i>Hermeuptychia fallax marinha</i> Anken, 1994	0	1	0
	<i>Hermeuptychia gisella</i> (Hayward, 1957)	0	0	1
	<i>Hermeuptychia</i> sp.	5	25	24
	<i>Moneuptychia castrensis</i> (Schaus, 1902)	1	1	0
	<i>Moneuptychia</i> cf. <i>viviana</i> (Romieux, 1927)	0	0	1
	<i>Moneuptychia soter</i> (A. Butler, 1877)	0	7	1
	<i>Moneuptychia vitellina</i> Freitas & Barbosa, 2015	0	0	1
	<i>Morpho helenor achillides</i> C. Felder & R. Felder, 1867	5	2	0
	<i>Morpho portis kaysi</i> Le Moul't & Réal, 1962	0	1	1
	<i>Opoptera syme</i> (Hübner, [1821])	0	0	1
	<i>Pseudodebis ypthima</i> (Hübner, [1821])	0	2	2
	<i>Taydebis peculiaris</i> (A. Butler, 1874)	1	10	1
	<i>Taygetis laches</i> (Fabricius, 1793)	0	1	0
	<i>Ypthimoides ochracea</i> (A. Butler, 1867)	1	3	4
PAPILIONIDAE (7)				
PAPILIONINAE (7)				
PIERIDAE (15)	<i>Eurytides bellerophon</i> (Dalman, 1823)	0	2	3
	<i>Eurytides dolicaon deicoon</i> (C. Felder & R. Felder, 1864)	0	0	1
	<i>Heraclides hectorides</i> (Esper, 1794)	0	0	2
	<i>Mimoides lysithous</i> (Hübner, [1821])	0	3	1
	<i>Parides bunichus</i> (Hübner, [1821])	0	7	0
	<i>Parides proneus</i> (Hübner, [1831])	0	5	1
	<i>Pterourus cleotas</i> (G. Gray, 1832)	0	0	1
	<i>Colias lesbia mineira</i> J. Zikán, 1940	0	0	12
	<i>Eurema agave pallida</i> (Chavannes, 1850)	4	2	0
COLIADINAE (8)	<i>Eurema albula sinoe</i> (Godart, 1819)	5	4	1
	<i>Eurema deva</i> (E. Doubleday, 1847)	3	1	0
	<i>Eurema elathea flavescens</i> (Chavannes, 1850)	3	2	0
	<i>Phoebis sennae marcellina</i> (Cramer, 1777)	1	0	0

DISMORPHINAE (2)	<i>Pyrisitia leuce</i> (Boisduval, 1836)	1	0	0
	<i>Pyrisitia nise tenella</i> (Boisduval, 1836)	1	0	0
PIERINAE (5)	<i>Dismorphia thermesia</i> (Godart, 1819)	0	1	4
	<i>Enantia lina psamathe</i> (Fabricius, 1793)	1	1	0
	<i>Catasticta bithys</i> (Hübner, [1831])	0	0	1
	<i>Leptophobia aripa balidia</i> (Boisduval, 1836)	0	8	0
	<i>Pereute antodyca</i> (Boisduval, 1836)	0	0	1
RIODINIDAE (6)	<i>Pereute swainsoni</i> (G. Gray, 1832)	0	0	1
	<i>Theochila maenacte itatiayae</i> (Foetterle, 1902)	0	5	3
RIODININAE (6)	<i>Charis cadytis</i> Hewitson, 1866	0	2	3
	<i>Emesis ocypore zelotes</i> Hewitson, 1872	0	1	3
	<i>Eurybia pergaea</i> (Geyer, 1832)	0	0	1
	<i>Panara soana bacana</i> Callaghan, 1997	1	0	0
	<i>Stichelia bocchoris</i> (Hewitson, 1876)	0	1	0
	<i>Synargis paulistina</i> (Stichel, 1910)	2	0	0
ECOLOGICAL INDICES				
	Richness	67	91	86
	Abundance	136	268	218
	Exclusive species	22	25	37
	Dominance (D)	0.02325	0.02592	0.03409
	Shannon's diversity (H')	3.978	4.084	3.94
	Pielou's evenness (J)	0.9462	0.9053	0.8845
	Jackknife 1	102,667	135,571	138
	Jackknife 2	123,879	158,516	174,132
	Chao 2	108,059	134,643	175,375