

## The Diurnal Lepidoptera Fauna in Buila-Vânturarița National Park: One-Season Survey

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**Summary:** Diurnal Lepidoptera, mostly Papilionoidea, is a well-studied group of organisms, and its faunas are usually relatively well-documented all over Europe. However, the Romanian Lepidoptera fauna still lacks species lists from various regions, including National or Natural Parks. Buila-Vânturarița National Park is one of the protected areas that previously benefited from the implementation of several EC-funded projects that produced a management plan in 2005 in preparation for legislative changes with Romania's accession to the EU. However, the Lepidoptera species mentioned in this older management plan are just some of the few of the EC-Habitats Directive species, and there are still insufficient information about their distribution and conservation status. There are no checklists for the Lepidoptera from the Buila-Vânturarița National Park ever published. In this study, diurnal Lepidoptera from open or semi-open habitats were inventoried in the Buila-Vânturarița National Park. A method for efficiently sampling habitats is presented and analysed. The results produced a list of 64 diurnal Lepidoptera, representing approximately 80% of the species that should be found in the National Park Buila-Vânturarița. Additionally, three Natura 2000 species were found, not previously mentioned in the Management Plan.

**Key words:** Sampling design, suitable habitat, species list, Papilionoidea, Buila-Vânturarița, Romania.

### Introduction

Diurnal Lepidoptera, primarily butterflies, are a well-studied group of organisms, and their distribution and diversity are usually relatively well-documented all over Europe. However, the Romanian Lepidoptera fauna still lacks species lists from various regions, including, in some cases, species lists of protected areas like National or Natural Parks. Wildlife sampling efforts and documentation undertaken after Romania's EU accession in 2008 were primarily oriented toward finding and mapping species found on the Annexes of the Council's Habitats Directive. This led to the establishment of the Natura 2000 network in Romania. It was an important step for Romania in inventorying species and habitats, but it was often done hastily by recording only more charismatic or large species and ignoring some invertebrates. In the Buila-Vânturarița National Park (BVNP), wildlife inventorying efforts intensified before the elaboration of the Management Plan issued in 2005 (ROMANIAN GOVERNMENT, 2005). Since then, the species lists have not been officially updated so that they can benefit from conservation measures. In 2023, another project to produce a new version of the Management Plan started. As part of this project, the Natura 2000 species mentioned previously were to be inventoried and mapped, and new species were to be added to the list. This study results from the inventorying effort for diurnal Lepidoptera in BVNP. It analyses a method

proposed to efficiently sample habitats suitable for butterflies and offers an updated list of species.

### Materials and methods

#### 1. Sampling

The diurnal Lepidoptera fauna of the Buila-Vânturarița National Park (BVNP) was assessed in the 2023 season in eight open, semi-open habitat types suitable for butterflies and verges of forested habitats. First, we established a grid of squares of one km each that we superimposed over the BVNP map (Fig. 1). Subsequently, we used a habitat map obtained from contract no. 462/14.03.2011 implemented under the Operational Program Large Infrastructure for Environment to identify suitable open or semi-open habitat types. The habitat types correspond to the classification established by the EUNIS habitat classification (<https://eunis.eea.europa.eu/>) and are used in the EU Habitats Directive (THE COUNCIL OF THE EUROPEAN COMMUNITIES, 1992). By means of Google Earth Pro (GOOGLE, 2024), we explored the presence and position of suitable habitats in each square. In total, the area of the BVNP was included in 67 1-km squares. Of these, only 31 squares contained open or semi-open habitat types suited for butterflies, namely 6170 Alpine and subalpine calcareous grasslands, 6430 Hydrophilous tall herb fringe communities of plains and the montane to alpine levels, 6520 Mountain hay meadows, 8210 Calcareous

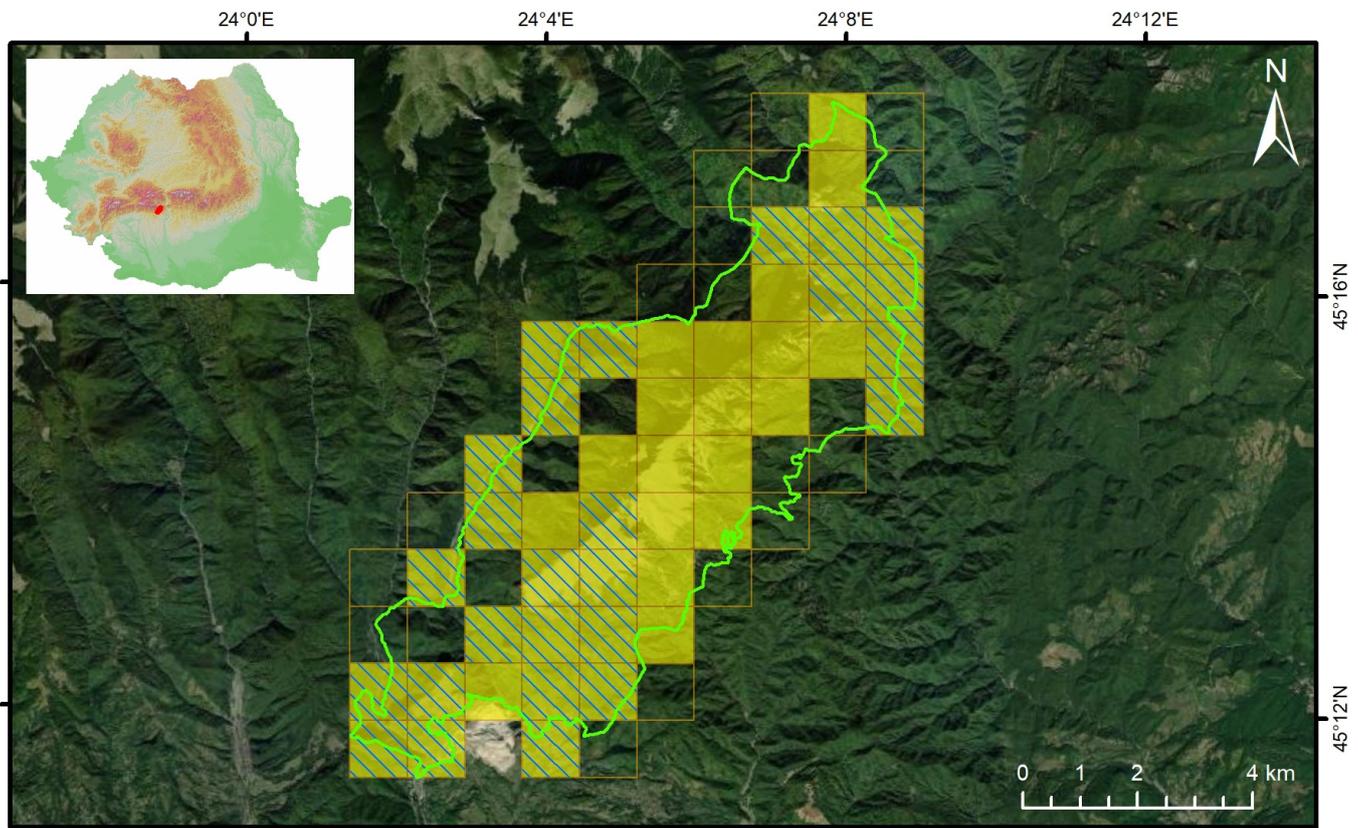


Fig. 1. Map of Buila-Vânturarița National Park (green outline) and the superimposed grid of squares of 1 km<sup>2</sup> (orange outline), the squares that include suitable habitats for butterflies (yellow filled squares), and visited squares (oblique blue lines) in the 2023 season. Aerial image source: ESRI, Maxar, Earthstar Geographics, and the GIS User Community

rocky slopes with chasmophytic vegetation, 6230 Species-rich *Nardus* grassland, on siliceous substrates in mountain areas. Additionally, Dacian Beech forests (Symphyto-Fagion, code 91V0), Luzulo-Fagetum beech forests (code 9110), Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea, code 9410) and Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, *Alnion incanae*, *Salicion albae*, code 91E0) were investigated along roads where small clearings allowed for forest-edge grassland patches.

Of the 67 squares, 26 were visited (Fig. 1), depending on the weather conditions and accessibility, mainly those where roads were present. Several identified suitable squares were inaccessible, on steep slopes, or surrounded by densely forested areas.

From May to August, all suitable habitat types were visited at least once in the 2023 season. Eight linear transects of each 200 m length were established, defined as T1+T2, T3, T4, T5, T6, T10, T11, T12. Three (T1+T2, T4, T6) were visited five times and three (T3, T5, T10) four times during the 2023 flight season. The six fixed transects were chosen in such a manner to maximise the number of suitable habitat types visited. The other two transects and additional observations in open or forest-edge habitats along roads were visited once and several times in transit, respectively. Habitats included in transects are summarised in Table 1. Butterflies (Papilionoidea) and day-flying moths

(Zygaenidae, Erebidae, Geometridae, Noctuidae, Sphingidae) were recorded between 10.00 and 17.00 h, under good weather conditions (sunny weather, temperature  $\geq 18$  °C and wind speed  $\leq 18$  km/h [Beaufort scale 3]). Identifications followed RÁKOSY (2013). An IUCN and national conservation status and European Directive protection status were associated with each species according to RÁKOSY *et al.* (2021) and the European Council Directive 92/43/EEC (THE COUNCIL OF THE EUROPEAN COMMUNITIES, 1992).

## 2. Data analyses

Species richness and abundance were computed for each transect. Because sampling effort varied throughout the season, rarefaction curves were plotted for each transect to estimate the quality of the sampling effort and the species richness. Individual rarefaction was performed in RStudio 2024.04.1+748 „Chocolate Cosmos” Release (RSTUDIO, 2024) with the package iNEXT. We computed the average percentage of observed versus extrapolated species richness based on the rarefaction data.

## Results

### 1. Lepidoptera diversity

We recorded 901 individuals belonging to 64 species on all transects and habitat types visited. Of these species, 54 are butterflies (Papilionoidea), and 11 belong to Erebidae, Geometridae, Sphingidae,

Table 1. Habitat types included in the eight sampled transects.

Habitat types	Transects
6170 Alpine and subalpine calcareous grasslands	T5, T11
6430 Hydrophilous tall herb fringe communities of plains and the montane to alpine levels	T1+T2
6520 Mountain hay meadows	T3
8210 Calcareous rocky slopes with chasmophytic vegetation	T11
6230 Species-rich <i>Nardus</i> grassland on siliceous substrates in mountain areas	T4, T6
91V0 Dacian Beech forests	T1+T2, T10, T12
9110 Luzulo-Fagetum beech forests	T12
91E0 Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i>	T10, T12
9410 Acidophilous <i>Picea</i> forests of the montane to alpine levels	T1+T2

Zygaenidae, and Noctuidae (Table 2). Almost all species found belonged to the Least Concern (LC) IUCN-category (RÁKOSY ET AL. 2021). Exceptions were *Pieris brassicae*, *Maculinea (Phengaris) arion*, *Argynnis niobe*, *Aglais urticae*, and *Limenitis camilla*, which have an NT or LC/NT status due to the unequal distribution of their populations over all regions of Romania. Three of the species found are listed in Annexes II and IV of the European Council Habitats Directive (THE COUNCIL OF THE EUROPEAN COMMUNITIES, 1992): *Euplagia quadripunctaria* (Annex II), *Parnassius mnemosyne* and *Maculinea (Phengaris) arion* (Annex IV).

The individual rarefaction results for each transect showed that transects T3 and T10 approached most

the asymptote with the highest species richness (Fig. 2). The rarefaction curve for T6 also indicates a good sampling, however, with a slightly lower species richness than T3 and T10. Transects with the highest species richness and estimated species richness (T3: observed richness = 32, extrapolated richness = 37.8; T10: observed richness = 25, extrapolated richness = 28, T6: observed richness = 21, extrapolated richness = 23) include open habitats of the types „6520 Mountain hay meadows”, „6230 Species-rich *Nardus* grassland, on siliceous substrates in mountain areas” and edges of „91V0 Dacian Beech forests” and „91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*”. Overall, observed richness represented an average of 80% of the extrapolated values.

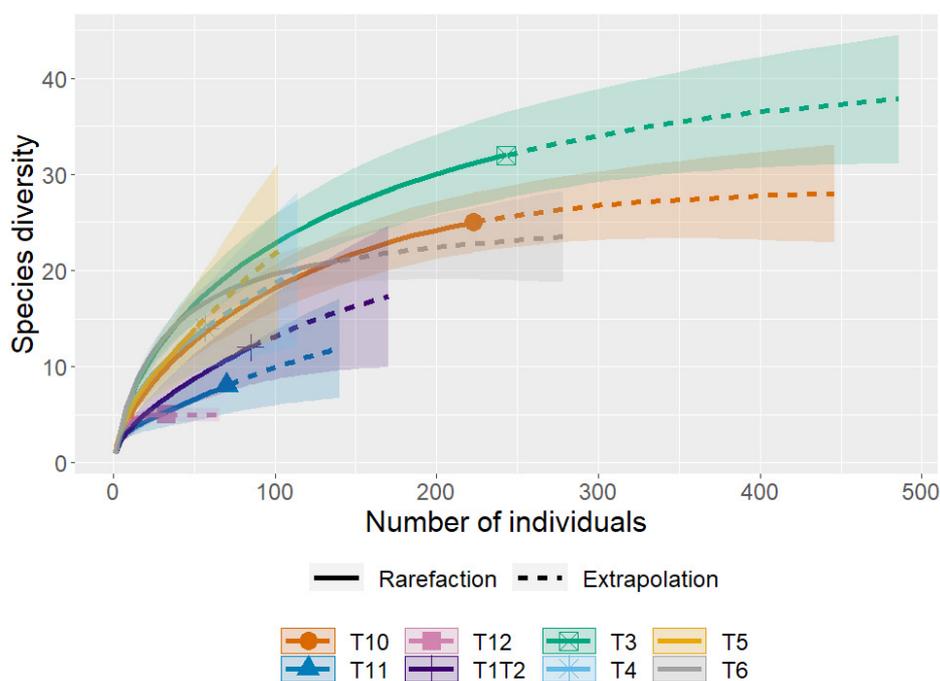


Fig. 2. Individual rarefaction curves showing species richness (uninterrupted lines) and extrapolated species richness (dotted line) computed for the eight established transects.

Table 2. Species of Lepidoptera found in the 2023 sampling season in Buila Vânturarița National Park according to habitat types, in eight sampled transects.

Family	Species	6170 Alpine and subalpine calcareous grasslands	6430 Hydrophilous tall herb fringe communities of plains and the montane to alpine levels	6520 Mountain hay meadows	8210 Calcareous rocky slopes with chasmophytic vegetation	6230 Species-rich Nardus grassland, on siliceous substrates in mountain areas	91V0 Dacian Beech forests	9110 Luzulo-Fagetum beech forests	91E0 Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i>	9410 Acidophilous <i>Picea</i> forests of the montane to alpine levels	Red List status in Romania	Protection status
Hesperiidae	<i>Erynis tages</i>			x			x		x		LC	
	<i>Pyrgus malvae</i>	x		x		x					LC	
	<i>Thymelicus sylvestris</i>										LC	
	<i>Ochlodes sylvanus</i>			x							LC	
	<i>Hesperia comma</i>			x		x			x		LC	
Papilionidae	<i>Parnassius mnemosyne</i>	x				x	x				LC	Annex IV of EHD
	<i>Iphiclides podalirius</i>			x							LC	
	<i>Papilio machaon</i>			x							LC	
Pieridae	<i>Leptidea sinapis</i>		x	x					x		LC	
	<i>Anthocaris cardamines</i>		x			x	x			x	LC	
	<i>Pieris brassicae</i>			x		x			x		LC/NT	
	<i>Pieris rapae</i>		x	x		x	x	x	x	x	LC	
	<i>Pieris napi</i>		x								LC	
	<i>Pontia edusa</i>	x			x	x					LC	
	<i>Colias hyale/alfacariensis</i>			x							LC	
	<i>Colias croceus</i>	x		x							LC	
Lycaenidae	<i>Lycaena alciphron</i>			x							LC	
	<i>Maculinea arion</i>			x							NT	Annex IV of EHD
	<i>Aricia agestis</i>	x		x			x		x		LC	
	<i>Polyommatus icarus</i>	x		x		x	x		x		LC	
Nymphalidae	<i>Argynnis aglaja</i>	x				x					LC	
	<i>Argynnis niobe</i>					x					LC/NT	
	<i>Argynnis paphia</i>						x	x	x		LC	
	<i>Issoria lathonia</i>	x		x		x					LC	
	<i>Brenthis daphne</i>						x		x		LC	
	<i>Boloria euphrosyne</i>					x					LC	
	<i>Boloria dia</i>			x		x					LC	
	<i>Vanessa atalanta</i>	x		x	x	x	x		x		LC	
	<i>Vanessa cardui</i>		x			x	x		x		LC	
	<i>Inachis io</i>	x	x			x	x		x		LC	
	<i>Aglais urticae</i>		x			x	x			x	LC/NT	
	<i>Polygonia c-album</i>	x	x		x	x	x	x	x	x	LC	
	<i>Araschnia levana</i>							x	x		LC	
<i>Apatura iris</i>		x					x		x	LC		

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	<i>Limenitis camilla</i>						x	x			LC/NT	
	<i>Neptis rivularis</i>						x		x		LC	
	<i>Melitaea dydima</i>						x		x		LC	
	<i>Melitaea trivia</i>			x							LC	
	<i>Melitaea athalia</i>			x							LC	
	<i>Melitaea aurelia</i>			x							LC	
	<i>Melitaea phoebe</i>			x							LC	
	<i>Pararge aegeria</i>						x			x	LC	
	<i>Coenonympha glycerion</i>			x		x	x		x		LC	
	<i>Coenonympha pamphilus</i>			x		x					LC	
	<i>Aphantopus hyperanthus</i>			x		x	x		x		LC	
	<i>Maniola jurtina</i>	x		x		x	x		x		LC	
	<i>Erebia ligea</i>			x		x	x	x	x		LC	
	<i>Erebia aethiops</i>	x				x	x	x	x	x	LC	
	<i>Erebia medusa</i>	x			x	x					LC	
	<i>Melanargia galathea</i>			x			x		x		LC	
	<i>Minois dryas</i>			x			x		x		LC	
	<i>Hipparchia fagi</i>						x	x			LC	
	<i>Brintesia circe</i>						x	x			LC	
Erebidae	<i>Callimorpha dominula</i>	x									LC/NT	
	<i>Euplagia quadripunctaria</i>	x					x	x			LC	Annex II of EHD
	<i>Amata phegea</i>						x		x		LC	
	<i>Diacrisia sannio</i>			x							LC	
Noctuidae	<i>Autographa gamma</i>	x	x	x		x	x		x	x	LC	
	<i>Heliothis peltigera</i>			x							LC	
Geometridae	<i>Siona lineata</i>	x			x	x	x		x		LC	
	<i>Ematurga atomaria</i>						x		x		LC	
	<i>Pseudopanthera macularia</i>		x	x			x		x	x	LC	
Sphingidae	<i>Macroglossum stellatarum</i>	x					x	x		x	LC	
Zygaenidae	<i>Zygaena sp</i>			x							-	

## Discussion

### 1. Lepidoptera diversity and sampling efficiency

This study intends to create an updated inventory of the Lepidoptera species from BVNP.

So far, there is no single inventory to include diurnal Lepidoptera species from this protected area. Previous publications have partly documented the presence of some Lepidoptera species in Vâlcea County, however, not specifically in the confines of this National Park (e.g. STĂNOIU ET AL. 1978, CHIMIȘLIU, 2011; TÖRÖK ET AL., 2022). Additionally, the Standard Form of the Natura 2000 site (THE ROMANIAN MINISTRY OF ENVIRONMENT, WATERS, AND FORESTS, 2007) does not include protected Lepidoptera species, and the management plan published in 2005 mentions only the presence of two Lepidoptera species: *Everes alcetas alcetas* and *Leptidea morsei major* (ROMANIAN GOVERNMENT, 2005). These species were not found during the sampling season 2023 presented in this study. However, three other protected Lepidoptera species listed in Annexes II and IV of the European Council Habitats Directive (THE COUNCIL OF THE EUROPEAN COMMUNITIES, 1992) were found: *Euplagia quadripunctaria* (Annex II), *Parnassius mnemosyne* and *Maculinea (Phengaris) arion* (Annex IV). As a result of this inventory, these species will be included in the future management plan of the BVNP and the corresponding Natura 2000 site.

This study's approach intended to sample mostly open or semi-open habitats preferred by day-flying Lepidoptera species. By dividing the area of the National Park into 1 km squares, superimposing them on the habitat map, selecting the squares with the largest area of open and semi-open habitats, and sampling transects in the selected squares, 65 species were identified. The rarefaction method indicated that only three of the eight transects reflect a relatively complete seasonal sampling. This is due to the variable sampling effort throughout the season. Some transects were walked only once in the season, whereas others were walked four or five times. The top three transects with the best data quality were located in open habitats and forested habitat verges, indicating the high value of forest edge habitat for Lepidoptera. Other studies also found that forest edges are rich in butterflies (VAN HALDER ET AL., 2011). As BVNP is mainly covered in various forest habitats, inventorying diurnal Lepidoptera is most efficient when forest edge habitats are considered. The observed species richness averaged 80% of the extrapolated richness. This indicates that another 20% of day-flying Lepidoptera are probably not included in this species list. The habitats with the lowest percentage (60%-70%) of observed/extrapolated richness are 6430 Hydrophilous tall herb fringe communities of plains and the montane to alpine levels, 6170 Alpine and subalpine calcareous grasslands, 6230 Species-rich *Nardus* grassland on siliceous substrates in mountain

areas, present in transects T1+T2, T4, T5, and T11. This means that future investigations should focus more on these habitats to complete the species list in the National Park.

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