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THE BUTTERFLY (LEPIDOPTERA: PAPILIONOIDEA) DIVERSITY OF THE BARAĆ CAVES SIGNIFICANT LANDSCAPE (KORDUN, CROATIA)

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Koller Šarić, K., Kranželić, D., Schmidt, B. & Koren, T.: The butterfly (Lepidoptera: Papilionoidea) diversity of the Barać Caves Significant Landscape (Kordun, Croatia). Nat. Croat., Vol. 31, No. 1, 43-62, Zagreb, 2022.

We studied the butterfly fauna of the protected area Barać Caves Significant Landscape, which is located in the southern part of the Kordun region. The surveys,carried out during 2020 and 2021, recorded a total of 79 butterfly species. The species recorded in the area outnumber those far recorded in northern Kordun (74) and Plitvice Lakes NP (71), but this is probably due to the lack of systematic surveys of those two areas. The comparison of habitat and biogeographical affiliation between these three areas revealed a similar number of species per habitat and affiliation type. During this survey, several interesting or rare species were recorded like *Lycaena hippothoe, L. dispar, Phengaris arion, Melitaea aurelia, M. britomartis, Euphydryas aurinia, Apatura ilia, A. iris,* and *Boloria selene* and their records are discussed. The results of the present study greatly contribute to the knowledge of the butterfly fauna of the Barać Caves Significant Landscape, and they can be used as a basis for the future conservation of butterfly species of the Kordun and Lika region.

Key words: distribution, biogeography, habitat affiliation, conservation, habitat management

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Istraživali smo faunu danjih leptira Značajnog krajobraza Baraćeve špilje smještenog u južnom dijelu Kordunske regije. Istraživanja su provedena tijekom 2020. i 2021. godine te je zabilježeno ukupno 79 vrsta leptira. Broj vrsta zabilježenih na ovom području veći je od dosada zabilježenih vrsta na sjevernom Kordunu (74) i NP Plitvička jezera (71), no vjerojatni razlog za to je nedostatak sustavnih istraživanja ta dva područja. Usporedba staništa i biogeografske pripadnosti ova tri područja pokazala je sličan broj vrsta po staništu i biogeografskoj pripadnosti. Tijekom ovog istraživanja zabilježeno je nekoliko zanimljivih ili rijetkih vrsta poput *Lycaena hippothoe, L. dispar, Phengaris arion, Melitaea aurelia, M. britomartis, Euphydryas aurinia, Apatura ilia, A. iris* i *Boloria selene* čiji su nalazi dodatno raspravljeni. Rezultati ovog istraživanja uvelike doprinose poznavanju faune leptira Značajnog krajobraza Baraćeve špilje, te se mogu koristiti kao temelj za buduće očuvanje vrsta leptira Korduna i Like.

Ključne riječi: rasprostranjenost, biogeografija, pripadnost staništu, očuvanje, održavanje staništa

INTRODUCTION

Insect biodiversity loss is a subject that has a long history of discussion and is currently attracting increased public attention (Hallmann *et al.*, 2017; Cardoso *et al.*, 2020; Jactel *et al.*, 2021; Warren *et al.*, 2021). One of the most charismatic insect groups, where biodi-

versity loss has been noted in Europe, is butterflies (van Swaay *et al.*, 2019; Warren *et al.*, 2021). Due to their characteristics and beauty, they form one of the few insect groups to the diversity and abundance of which more time is devoted than to other taxa, occupying a greater geographical area. Thus, butterflies make an adequate group on the basis of which to study long-term changes in nature that are backed by field data. Their changes reflect changes in other animal taxa, which makes them an adequate model for nature monitoring (Thomas, 2005; van Swaay *et al.*, 2019; Warren *et al.*, 2021). Over many years of research across Europe, a decline of grassland butterfly species of as much as 39% has been observed (van Swaay *et al.*, 2019). For some species the index is growing, for some it is stagnant, but in general, the average shows a decline in population trends (van Swaay *et al.*, 2019; Warren *et al.*, 2021). To tackle these problems protected areas have been established to prevent biodiversity loss and protect other agendas such as preservation of habitats, preservation of gene pool, natural disaster prevention, and so on (Mose & Weixlbaumer, 2007). Protected areas can thus help in the mitigation of biodiversity loss with adequate management and expansion in the most crucial areas where the most endangered species live (Le Saout *et al.*, 2013; Venter *et al.*, 2014). In Europe, the largest protected area system is the Natura 2000 network, which is one of the largest networks of conservation areas worldwide. The aim of such a network of areas and thus habitats is the long-term survival of threatened species and habitat types (Anonymous, 1992, 2010).

The Barać Caves Significant Landscape, situated in the mountainous part of Croatia near Plitvice Lakes Nature Park, were proclaimed a protected landscape due to their cave systems, diverse habitat, endemic biodiversity, and anthropological findings (Department of Environmental and Nature Protection of The Ministry of Economy and Sustainable Development, 2021). Apart from the cave systems, the area has a mosaic of habitats such as pastures, woodland, agricultural fields, and nearby villages. Even though most of these habitats are protected and government owned, some of the land is privately owned or are agricultural fields. To ensure the long-term survival of butterflies in the area, it is necessary to have an insight into their diversity and the status of their habitats.

The butterfly diversity of this significant landscape has never been assessed. The closest surveyed areas are northern Kordun and Plitvice Lakes NP. The list of the species for northern Kordun, mainly Karlovac and surroundings according to (Španić, 2009, 2012) includes 74 species and the list for Plitvice Lakes NP based on literature (Rebel 1895; Abafy-Aigner *et al.*, 1896; Koča, 1901; Seyer, 1938; Lipscomb, 1958; Moucha, 1966; Mladinov, 1973; Kučinić, 1999; Šašić, 2004; Lorković, 2009) contains 71 butterfly species.

Accordingly, the goals of our paper are: to study the butterfly diversity of the Barać Caves Significant Landscape, to categorize the habitats occupied by butterflies, and discuss the butterfly diversity with an emphasis on some rare and interesting species recorded during the survey. Additionally, the goal is to compare the butterfly diversity of the significant landscape with that of the nearby areas of north Kordun and Plitvice lakes NP. Finally, we wish to emphasise the importance of proper management of the area for biodiversity conservation, as well as provide guidance for the future habitat management in the area.

MATERIALS AND METHODS

Study area

The Barać Caves Significant Landscape is situated in central Croatia, in the Kordun region, in the southeastern part of the Una-Korana plateau, within the inner belt of the

Dinaric Karst (Bočić *et al.*, 2015). Lika region continues on from the Kordun region in the south and is bordered by prominent mountain ridges of Velebit, Kapela, and Plješevica and covers the territory from Donji Lapac in the north to Korenica in the south (Crkvenčić, 1976). Kordun stretches between Karlovac in the north, the Una River which represents the natural boundary between Croatia and Bosnia and Herzegovina in the east, and the Lika mountains in the south. The significant landscape is located in the southern part of Karlovac County, within the bounds of the municipality of Rakovica, 7 km northeast from the border of Plitvice Lakes National Park. It has a total area of 5.19 km^2 (Department of Environmental and Nature Protection of The Ministry of Economy and Sustainable Development, 2021). According to Köppen's classification, the area of the caves has a moderately warm humid climate with a warm summer (Cfb) (Šegota & Filipčić, 2003). As this area is rich in elements of cultural-historical, tourist-recreational, and aesthetic and speleological significance, in 2016 it was designated the Barać Caves Significant Landscape (Anonymous, 2016a).

This is an area of shallow karst with the elements of intermittent flows, sinkholes, sources, and caves (Bočić *et al.*, 2015; Czuppon *et al.*, 2018). Within the significant landscape, on the northern slopes of the hill Baraćeva brina the entrance to Barać caves is situated, and at the foot of the hill is the spring-cave Baraćevac. The water from the Baraćevac spring forms the Kršlja stream on the surface, which flows through the eastern part of the area. The Kršlja stream is important for the formation of wet grasslands which are nowadays rare in the area and are considered to be a critically endangered habitat that requires the implementation of conservation measures (Anonymous, 1992). Along the watercourses of the Kršlja stream, there are also floodplain forests of willows (*As. Salicetum cinereae* Zolyomi 1931) and poplars (genus *Populus*). Outside the floodplain, at lower and higher altitudes, the oak-hornbeam forest community, *Erythronio-Carpinion* (Horvat 1958) is present. The highest altitudes are occupied by mountain beech forests (*Fagus sylvatica* L.). At the very foot of the hill, where the cave entrance is located, a coniferous forest has been planted. Grasslands are dispersed through the whole area but are today mostly in different successional stages due to the decline of agriculture. On the west side of the area, above and on Baraćeva brina, mountain meadows in different successional stages are present. On the east side of the area, mesophilic meadows and moderately wet grasslands are dominant. The country road represents the southern and eastern boundary of the area along which there are several houses with small vegetable gardens and orchards.

METHODS

Field surveys of the butterfly fauna of the Barać Caves Significant Landscape were carried out over two years, from 2020 to 2021, from early May to the end of August. Earlier visits were not made due to the low temperatures and high precipitation in the springs of the two mentioned years. The study area was divided into six localities using satellite topography and habitat type, to optimize the fieldwork. The fieldwork was conducted on the following dates: 25-V-2020, 26-V-2020, 29-VI-2020, 27-VIII-2020, 28-VIII-2020, 11-V-2021, 16-V-2021, 9-VI-2021, 10-VI-2021, 17-VI-2021, and 23-VII-2021. All six localities were visited on each date. The list of localities sampled for butterflies contains the locality numbers and names, a short description of the habitat, altitude, and WGS84 coordinates (Tab. 1). All butterfly records were collected using the Biologer application (Popović *et al.*, 2020) and the data processing was performed in the Micro-

soft Excel program. The national threat categories were added according to the Croatian Red List of Butterflies (Šašić *et al.*, 2015) while strictly protected species are determined by the Ordinance on Strictly Protected Species (2016, *b*). European threat categories were added according to the European Red List of Butterflies (Swaay *et al.*, 2010).

Tab. 1. The list of researched localities in the Barać Caves Significant Landscape. Localities are arranged in geographical order from northwest towards southeast.

Locality No.	Locality name	Habitat description	WGS N	WGS E	Altitude (m a.s.l.)
1.	Vojvodić Valley	montane meadows and agricultural fields, footpath surrounded by bushy vegetation	44,98482	15,704626	365
2.	Ralići	oak-hornbeam forest community, montane beech forest and grasslands, the remains of old houses surrounded by bushy vegetation	44,980874	15,712093	352
3.	Kulunđije, north of the village	abandoned arable land surrounded by bushes, mesophilic meadows	44,977838	15,717457	327
4.	Barać caves with the surroundings	floodplain forests, wet grasslands and mesophilic meadows surrounded by stream with marsh willow thickets, reeds, rushes and sedges and bushy forest edge, neglected agricultural areas	44,984198	15,723084	296
5.	Nova Kršlja	Stream surrounded by wet grasslands, bushy vegetation, mountain grasslands at different stages of succession	44,992438	15,726098	294
6.	Mudrići, north of the village	mesophilic meadows and the remains of old houses	44,98998	15,731062	348

Butterflies were observed in flight or collected with handheld aerial sweep nets and released after identification. Butterfly species were identified directly in the field using standard field guides (Tolman & Lewington, 2008). Collection of the specimens was restricted to the genera *Leptidea*, *Melitaea*, *Lycaena,* and *Plebejus*, which cannot be identified correctly without genitalia examination, which was carried out according to Jakšić (1998). All scientific names follow (Wiemers *et al.*, 2018). Spatial analyses, data visualization, and survey maps were performed in ArcGIS 10.2.2. Desktop program.

For the Barać Caves Significant Landscape, the habitats occupied by butterflies have been categorized according to several authors (Beneš *et al.*, 2002; Macek *et al.*, 2015) and are grouped into four main types: mesophilic species (species of open non-forested habitat, especially meadows, species preferring transitory zones between meadow and forest habitats or in forest habitats), xerothermophilic species (species living in open steppe and xerophilous grasslands or meadows and bushy steppes), ubiquitous species (generalists able to live in all kinds of habitats, including ruderal sites, farmlands, and urban areas), and hydrophilic species (species living in open waterlogged meadows, or in waterlogged forests, especially in waterlogged spruces, willow-poplar meadows, alders, riparian shrubs). Some butterflies prefer a combination of habitat types, so additional six types are: mesophilic to xerothermophilic species, mesophilic to hydrophilic species, hydrophilic to xerothermophilic species, mesophilic to tryphophilic species (tryphophil-

ic species - species inhabiting peatlands of all types), tyrphophilic to hygrophilic species, ubiquitous to xerotermophilic species. The analysis of the biogeographical affiliation was conducted according to Kudrna (2015). Finally, the same categories for habitat affiliation of butterflies and biogeographical affiliation were assigned to butterfly species from Plitvice Lakes NP and north Kordun for the sake of a comparison of the species composition between these three areas.

RESULTS

During this study, a total of 79 butterfly species were observed across six localities of the Barać Caves Significant Landscape (Fig. 1; Tab. 2). The number of species ranged from seven to 68 per location. Most species were recorded in locality 4, with a total of 68 species. Three species were recorded at all six sites: *Plebejus argyrognomon* (Bergsträsser, 1779), *Melitaea athalia* (Rottemburg, 1775) and *Aporia crataegi* (Linnaeus, 1758). Additionally, 27 species were observed only at a single location (Tab. 2).

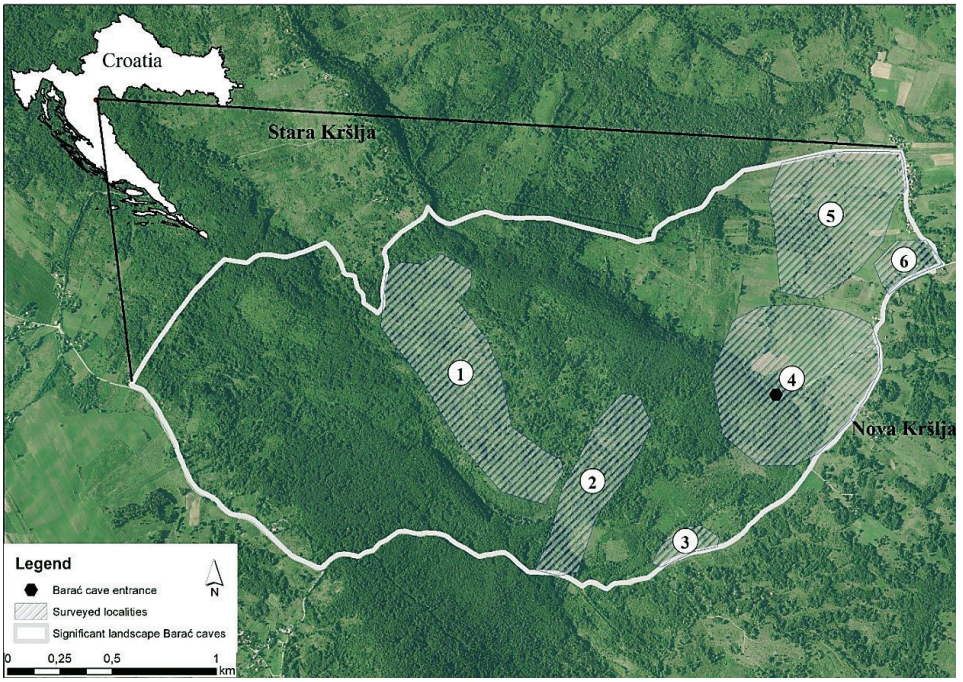

Fig. 1. Map of Barać Caves Significant Landscape with surveyed localities. Locality numbers correspond to those in the Tab.1.

We recorded 11 species that were previously recorded neither in Kordun nor in Plitvice Lakes NP: *Glaucopsyche alexis* (Poda, 1761), *Leptotes pirithous* (Linnaeus, 1767), *Lycaena hippothoe* (Linnaeus, 1761), *Plebejus argyrognomon*, *Polyommatus amandus* (Schneider, 1792), *Satyrium acaciae* (Fabricius, 1787), *Apatura iris* (Linnaeus, 1758), *Brenthis hecate* (Denis & Schiffermüller, 1775), *Erebia medusa* (Denis & Schiffermüller, 1775), *Melitaea britomartis* Assmann, 1847 and *Zerynthia polyxena* (Denis & Schiffermüller, 1775). In the

Tab. 2. List of species recorded in Barać Caves Significant Landscape during the studies carried out in 2020 and 2021 with locality number and their status in the Red list of Croatia and Europe (Šašić *et al.*, 2015). Locality numbers correspond to those in the Tab. 1 and Fig. 1. Red list categories: DD: Data Deficient, NT - Near Threatened, VU – Vulnerable, EN – Endangered. * Protected species according to Ordinance on Strictly Protected Species, 2016. The list is arranged taxonomically according to (Wiemers *et al.*, 2018).

List of species		Locality number	Red List Croatia	Red list Europe
Hesperiidae				
1.	*Heteropterus morpheus* (Pallas, 1771)	1, 4, 5	NT	
2.	*Ochlodes sylvanus* (Esper, 1777)	2, 4		
3.	*Thymelicus sylvestris* (Poda, 1761)	1, 2, 4, 5, 6		
4.	*Thymelicus lineola* (Ochsenheimer, 1808)	2, 4		
5.	*Erynnis tages* (Linnaeus, 1758)	2, 4, 5		
6.	*Pyrgus malvae* (Linnaeus, 1758)	1, 4, 5, 6		
Papilionidae				
7.	*Iphiclides podalirius* (Linnaeus, 1758)	1, 4, 5		
8.	*Papilio machaon* Linnaeus, 1758	4	NT	
9.	*Parnassius mnemosyne* (Linnaeus, 1758)	2, 4	NT	NT
10.	*Zerynthia polyxena* (Denis & Schiffermüller, 1775)	4	NT	LC
Pieridae				
11.	*Leptidea sinapis* (Linnaeus, 1758)	1, 2, 4, 5, 6		
12.	*Gonepteryx rhamni* (Linnaeus, 1758)	1, 2, 4, 5		
13.	*Colias cf. hyale* (Linnaeus, 1758)	4		
14.	*Colias crocea* (Geoffroy, 1785)	1, 4, 5		
15.	*Aporia crataegi* (Linnaeus, 1758)	1, 2, 3, 4, 5, 6		NT
16.	*Pieris brassicae* (Linnaeus, 1758)	4		
17.	*Pieris rapae* (Linnaeus, 1758)	1, 4, 5		
18.	*Pieris napi* (Linnaeus, 1758)	2, 4, 5		
19.	*Pieris balcana* Lorkovic, 1970	4		
Lycaenidae				
20.	*Lycaena alciphron* (Rottemburg, 1775)	4		
21.	*Lycaena dispar* (Haworth, 1802)	5	NT	
22.	*Lycaena hippothoe* (Linnaeus, 1761)	4, 5	NT	
23.	*Lycaena phlaeas* (Linnaeus, 1761)	4		
24.	*Lycaena virgaureae* (Linnaeus, 1758)	4		
25.	*Lycaena tityrus* (Poda, 1761)	4, 5, 6		
26.	*Callophrys rubi* (Linnaeus, 1758)	4		
27.	*Satyrium acaciae* (Fabricius, 1787)	4		
28.	*Leptotes pirithous* (Linnaeus, 1767)	4		
29.	*Celastrina argiolus* (Linnaeus, 1758)	2, 4		
30.	*Phengaris arion* (Linnaeus, 1758)	1, 2	VU	EN
31.	*Glaucopsyche alexis* (Poda, 1761)	4	NT	
32.	*Cupido argiades* (Pallas, 1771)	1, 4, 5		
33.	*Cupido minimus* (Fuessly, 1775)	1, 4		
34.	*Plebejus argus* (Linnaeus, 1758)	1, 3, 4, 5, 6		
35.	*Plebejus argyrognomon* (Bergsträsser, 1779)	1, 2, 3, 4, 5, 6		
36.	*Cyaniris semiargus* (Rottemburg, 1775)	2, 4, 5, 6		

Tab. 2. Continued

List of species		Locality number	Red List Croatia	Red list Europe
37.	*Aricia agestis* (Denis & Schiffermüller, 1775)	1, 2, 4, 6		
38.	*Lysandra bellargus* (Rottemburg, 1775)	1		
39.	*Polyommatus amandus* (Schneider, 1792)	1, 2, 4		
40.	*Polyommatus icarus* (Rottemburg, 1775)	1, 4, 5, 6		
Nymphalidae				
41.	*Neptis sappho* (Pallas, 1771)	1, 4		
42.	*Limenitis reducta* Staudinger, 1901	5		
43.	*Issoria lathonia* (Linnaeus, 1758)	5		
44.	*Brenthis hecate* (Denis & Schiffermüller, 1775)	2, 4, 5, 6		
45.	*Brenthis ino* (Rottemburg, 1775)	2, 4, 5		
46.	*Brenthis daphne* (Bergsträsser, 1779)	2, 4, 5, 6		
47.	*Argynnis paphia* (Linnaeus, 1758)	2, 4, 6		
48.	*Speyeria aglaja* (Linnaeus, 1758)	2		
49.	*Fabriciana adippe* (Denis & Schiffermüller, 1775)	2, 5		
50.	*Boloria selene* (Denis & Schiffermüller, 1775)	5		
51.	*Boloria euphrosyne* (Linnaeus, 1758)	4		
52.	*Boloria dia* (Linnaeus, 1767)	4, 5		
53.	*Apatura iris* (Linnaeus, 1758)	4	NT	
54.	*Apatura ilia* (Denis & Schiffermüller, 1775)	4, 5	NT	
55.	*Araschnia levana* (Linnaeus, 1758)	4, 5, 6		
56.	*Vanessa cardui* (Linnaeus, 1758)	4		
57.	*Vanessa atalanta* (Linnaeus, 1758)	1, 2, 4, 5		
58.	*Aglais io* (Linnaeus, 1758)	4		
59.	*Polygonia c-album* (Linnaeus, 1758)	2, 4, 5		
60.	*Nymphalis antiopa* (Linnaeus, 1758)	4		
61.	*Euphydryas aurinia* (Rottemburg, 1775)	5	NT	
62.	*Melitaea didyma* (Esper, 1778)	5		
63.	*Melitaea phoebe* (Denis & Schiffermüller, 1775)	4, 5		
64.	*Melitaea cinxia* (Linnaeus, 1758)	4, 5, 6		
65.	*Melitaea diamina* (Lang, 1789)	4, 5		
66.	*Melitaea britomartis* Assmann, 1847	2, 3, 4, 5, 6	DD	NT
67.	*Melitaea athalia* (Rottemburg, 1775)	1, 2, 3, 4, 5, 6		
68.	*Melitaea aurelia* Nickerl, 1850	2, 4, 5, 6	DD	NT
69.	*Coenonympha pamphilus* (Linnaeus, 1758)	1, 2, 3, 4, 5		
70.	*Coenonympha arcania* (Linnaeus, 1761)	1, 2, 4, 5, 6		
71.	*Pararge aegeria* (Linnaeus, 1758)	2, 4, 5		
72.	*Lasiommata megera* (Linnaeus, 1767)	4		
73.	*Melanargia galathea* (Linnaeus, 1758)	1, 2, 4, 5		
74.	*Minois dryas* (Scopoli, 1763)	1, 4, 5		
75.	*Brintesia circe* (Fabricius, 1775)	1, 4		
76.	*Aphantopus hyperantus* (Linnaeus, 1758)	2, 5		
77.	*Pyronia tithonus* (Linnaeus, 1767)	1, 2, 4, 5		
78.	*Maniola jurtina* (Linnaeus, 1758)	2, 3, 4, 5, 6		
79.	*Erebia medusa* (Denis & Schiffermüller, 1775)	4	NT	

previous surveys in the most northern part of the Kordun region, in the Karlovac surroundings, 10 additional species were found, which are not present in the surrounding Barać Caves and Plitvice Lakes NP (Appendix I). Also, 16 additional species were recorded only for Plitvice Lakes NP (Appendix I). Altogether, with our survey, the list of species for the Kordun region contains 89 butterfly species.

The habitat affiliation analysis showed that the majority of butterfly species found around Barać Caves belonged in four categories: mesophilic (25%), mesophilic to xerothermophilic (24%), xerothermophilic (16%), and ubiquitous (16%) (Tab. 3). The comparison of species habitat preferences in these three areas revealed a similar number of species per occupied habitat (Tab. 3). The majority of butterfly species within all three areas are mesophilic, mesophilic to xerothermophilic, xerothermophilic and ubiquitous, represented by 83% in the Barać Caves, 77% in north Kordun, and 84% in Plitvice Lakes NP (Tab. 3).

Tab. 3. A list of habitats occupied by butterflies modified according to Beneš et al. (2002). Numbers of species per occupied habitat with percentages are shown.

Habitat occupied by butterflies	Barać caves	Kordun	NP Plitvice lakes
mesophilic	20 (25%)	15 (23%)	15 (21%)
mesophilic/ xerothermophilic	19 (24%)	15 (23%)	14(20%)
xerothermophilic	13 (17%)	8 (12%)	18 (25%)
ubiquitous	13 (17%)	12 (19%)	13 (18%)
mesophilic/ hydrophilic	7 (9%)	6 (9%)	4 (6%)
hygrophilic/ xerothermophilic	3 (4%)	4 (6%)	3 (4%)
mesophilic/ tryphophilic	1 (1%)	1 (2%)	1 (1,5%)
tyrphophilic/ hygrophilic	1 (1%)	1 (2%)	1 (1,5%)
hygrophilic	1 (1%)	1 (2%)	1 (1,5%)
ubiquitous/ xerotermophilic	1(1%)	1 (2%)	1 (1,5%)

According to the biogeographical affiliation, most butterfly species of the significant landscape have Euro-Siberian (53) and Euro-Oriental affiliation (15). The comparison of biogeographical affiliations in the Barać Caves Significant Landscape, Plitvice Lakes NP, and north Kordun revealed a similar number of species per affiliation type (Appendix I). The most noticeable difference is in the smaller number of Euro-Siberian species in NP Plitvice Lakes and north Kordun (43 and 39) in comparison with the significant landscape (Appendix I).

Six species found in the Barać Caves Significant Landscape (7,6%) are strictly protected by law (Anonymous, 2016b): *Phengaris arion* (Linnaeus, 1758), *Lycaena dispar* (Haworth, 1802), *Euphydryas aurinia* (Rottemburg, 1775), *Papilio machaon* Linnaeus, 1758, *Parnassius mnemosyne* (Linnaeus, 1758), and *Zerynthia polyxena*. Altogether 14 species fall into one of the endangered categories of the Croatian Red List of Butterflies, which represents 18% of the species detected in the study area. One species is considered vulnerable (VU) (*P. arion*), 11 near threatened (NT) and two data deficient (DD) (Tab. 2). According to the European Red List, six species are considered threatened. *P. arion* is assessed as Endangered (EN), four species are assessed as Near threatened (NT): *M. britomartis, M. aurelia*, *P. mnemosyne,* and *Aporia crataegi*, while *Z. polyxena* is considered as of Least concern (LC).

DISCUSSION

Data about the butterfly diversity of some regions in Croatia, including Lika and Kordun are very limited. In the Lika region, Plitvice Lakes National Park can be regarded as the best-studied area, as many researchers have visited it across a wide time frame and a total of 71 species have been recorded so far (Rebel, 1895; Abafy-Aigner *et al.*, 1896; Kočа, 1901; Seyer, 1938; Lipscomb, 1958; Moucha, 1966; Mladinov, 1973; Kučinić, 1999; Šašić, 2004; Lorković, 2009; Appendix I). The Kordun region in general is less researched and most of the studies have been conducted around Karlovac which is at the northern border of the region, while the southern part has remained almost completely unexplored. Previous research counted 74 species for the Kordun region (Táborsky, 1910; Španić, 2012; Appendix I), while with our research the number of the species increased to 89.

If we compare the fauna of all three areas, Barać Caves with 79 recorded species have the greatest butterfly diversity (Appendix I). This is possibly connected with the great habitat heterogeneity which is extreme for such a small area (Fig. 2). This does not mean that also other areas of Lika and Kordun will not be similarly rich or even more diverse, but further surveys are needed to prove this.

Large areas around the Barać caves are forest habitats without passable paths in which a very small number of species have been recorded. Predominantly meadows and transitory zones between meadow and forest habitats with grasslands and bushy vegetation were researched, so the dominance of mesophilic and xerothermophilic species was recorded. These species prefer warm and dry slopes with southern exposures, sunny edges of deciduous forests (Kočíková & Čanády, 2015), which is the predominant type of habitat of the studied area. Besides, the high presence of ubiquitous, species able to live

Fig. 2. a-d) Habitats in the Barać Caves Significant Landscape. a) Mesophilic meadow, b) Moderately wet grasslands, c) Forest ride, d) Partially overgrown mesophilic meadow.

in all types of habitats may indicate that a high proportion of the recorded species can move from one habitat to another if the conditions are unfavourable (Kočíková & Čanády, 2015). The comparison of habitat affiliation of butterfly species in the three areas, Barać Caves, north Kordun and Plitvice Lakes NP, revealed similar compositions.

During this survey, several interesting or unexpected species were recorded and for each of them, detailed information on the occurrence and distribution in Croatia is provided.

Lycaena dispar

This easily distinguishable species is rather local in the mountainous areas of Kordun and Lika. Historical records from these parts are very limited (Lorković, 2009). In the Barać caves area, a rather numerous population was discovered, inhabiting the same habitats as *L. hippothoe*. The habitat of *L. dispar* needs regular management of low intensity. Wet grassland should be maintained by extensive mowing and grazing so the larval habitats and mating sites are preserved. Mowing should be carried out when the caterpillars are in hibernation, after mid-October (van Swaay, 2000). The mowing regime should include mowing only a part of the habitat each year in rotation so that at least some caterpillars survive (van Swaay, 2000). Sites with host plants (*Rumex* spp.) and sites with ruderal vegetation need to be preserved. The Wetland habitat of *L. dispar* must not be drained and the water level should be maintained (van Swaay *et al.*, 2012; Šašić Kljajo, 2014).

Lycaena hippothoe

In Croatia, this species is distributed in the northern part of Gorski Kotar across the continental parts of the country (Lorković & Mihljević, 1988). It is not rare but can be local and thus the conservation status in the country is near threatened (Šašić *et al.*, 2015). In the majority of the montane areas in Croatia, usually at elevations higher than 1000 m a.s.l. it is replaced by a very similar species, *Lycaena candens*. As stated by Lorković & Mihljević (1988), the easiest distinguishable character is the presence of two posterior processes on each side of the valva in *L. hippothoe* while in *L. candens* there is only one (Higgins, 1975; Jakšić, 1998). The most detailed distribution of these two species for the area of Croatia is given by Lorković & Mihljević (1988), while for *L. hippothoe* the map is presented in Šašić *et al.* (2015). Accordingly, in the area of the Barać Caves, *L. candens* was expected to occur, however, examination of the genital structures of collected specimens yielded only *L. hippothoe*. This record further expands the known range of *L. hippothoe* in Croatia to the lower Kordun region. Both sexes of the species were rather common and numerous in the wetland meadows of the Barać Caves area.

Phengaris arion

This is a rather localized but widely distributed species across the mountainous parts of Croatia (Lorković, 2009). It also inhabits the continental area of Croatia, where it is very local and always connected to thermophilous slopes with larval host plants (*Thymmus* sp., *Origanum* sp.). It is more widespread in the mountainous areas of Gorski Kotar, Velebit, and Plješevica Mountains (Mihoci *et al.*, 2007; Koren *et al.*, 2020). In the surveyed area, we recorded it in the northern dry grasslands, with several specimens observed. The habitat in the area seems to be suitable for this species but the lack

of mowing and grazing is also obvious. Only the central part of the path is regularly maintained while the lateral grassland patches seemingly remain unmaintained. Thus, to maintain the population of *P. arion* in the area, regular mowing should be incorporated into habitat management. Mowing should occur once per year or even once every two or three years a few weeks before or after the flight period (Johst *et al*., 2006). To control vegetation succession extensive grazing is also recommended. Some patches of scrub should be maintained to provide shelter and warmth but no more than 20% of cover in the breeding habitat. The excess area of scrub should be maintained by mowing in a yearly rotation (Anonymous, 2009; van Swaay *et al*., 2012).

Apatura iris and *A. ilia*

Both species are considered near threatened in Croatia (Šašić *et al*., 2015) and are mostly present in the northern part of the country while records from other parts are rather sparse. According to Šašić *et al*. (2015). *A. iris* is present only in the uppermost northern part of Gorski Kotar and Kordun, while it does not enter the southern parts of Kordun and Lika. However, the map is not that precise as the species has indeed historically as well as recently been recorded in Lika (Franić, 1910; Koren *et al*., 2020) and on Mt. Velebit (Mihoci *et al*., 2007). Our record from the Barać Caves area fills the gap between the known areas of distribution. In the area, the species is not common and only one individual was observed during this survey.

The second species, *A. ilia* is more common in Croatia and mostly inhabits river and stream banks or lakes and fishponds, around which its host plants grow (Tshikolovets, 2011). This species is also more common in northern Croatia, while records from southern Kordun and Lika areas are sparse, especially recent ones (Koren *et al*., 2020). Unlike the first species, *A. ilia* is very common in the area of Barać Caves with several specimens seen together around the forest edges.

Boloria selene

The record of *B. selene* in the Barać Caves area is rather surprising as no recent records exist from the region. The center of distribution of this species in Croatia is in the northern parts of the country, where it is present in humid grasslands mostly around streams and rivers, but even there they tend to be local (Koren *et al*., 2017). Only in some areas, like Turopolje and the Bednja river valley (Koren, pers. comm.) is the species more widespread. While historical records from the Lika region exist (Lorković, 2009), recent ones are limited to the areas of Lička Plješevica and even there it was recorded only from a single locality (Koren *et al*., 2020). In 2020 a single specimen was observed on wet meadows in the eastern part of a Significant landscape, but in 2021 a strong population was found in the area. While the species is not included in the Red Book of Butterflies of Croatia (Šašić *et al*., 2015), its scarcity and dependence on the endangered wetland habitats deserve a second assessment. Its habitat in the significant landscape is threatened as, at least in two-year period in which this study took place, no mowing or grazing was observed in the habitat. Succession is therefore very advanced and the small remaining grassland fragments are now slowly been overgrown by bushes of, for example, *Prunus* sp. and *Crataegus* spp. While such development benefits some species, for the survival of wetland specialists like *B. selene* habitat restoration is needed.

Euphydryas aurinia

This is a rather widespread species in Croatia (Lorković, 2009) the occurrence of which was expected in the Barać Caves Significant Landscape. However, it is a species of European importance being listed in Annexes II and IV of the Habitat directive (Anonymous, 1992), therefore special care should be given to the monitoring of the species and conservation of its habitats. The key for the management of habitats for *E. aurinia,* especially meadows, is an appropriate (light) grazing or mowing regime preventing succession (Schtickzelle *et al.*, 2005; Smee *et al.*, 2011). Grazing should be of low intensity so that vegetation height is not uniform and less than 5 cm tall. The aim is to have a vegetation height of 8 – 25 cm at the end of the growing season. The mowing regime should include mowing less than one third of the habitat each year in rotation and avoiding mowing the hibernation sites. On sites where the tradition of occasional burning exists, avoid burning more than a third of the habitat each year. Also, burning should be done at beginning of the year before larvae emerge from hibernation (van Swaay *et al.*, 2012).

Melitaea athalia, M. britomartis, and *M. aurelia*

The only reliable method for distinguishing these three species is the examination of their genitalia which show constant differences, especially in males (Higgins, 1975). The distribution of these three species in Croatia is still being investigated, and is rather problematic as most of the historical records are based only on the examination of the wing morphology, while only recently were specimens examined by the checking of their genital structures (Koren & Jugovic, 2012). As no previous studies have been conducted in the area of lower Kordun, it was not clear which of the three species from the complex are present in the area. Especially taking into consideration that the area is located very close to Bosnia and Herzegovina in which *M. britomartis* has only recently been recorded (Koren & Jugovic, 2012). We dissected about 20 male specimens from the study area and were able to confirm the presence of all three species. All three species occupy the same grassland habitats and can be considered common in the area. Accordingly, *M. britomartis* will likely be recorded in the bordering area of Bosnia and Herzegovina and lower Kordun.

Aside from the above-mentioned species, some other records can be regarded as interesting. In the area of Barać Caves, there are several species like *Araschnia levana*, *Apanthopus hyperanthus,* and *Neptis sappho*, which reach their south-western distribution limit in Croatia in the studied area. These species are widespread in northern Croatia (e.g. Lorković, 2009) but very local in central parts, including the southern Kordun area.

Conservation of the butterflies in the Barać Caves area

The most significant threats for butterflies in Europe are the intensification of farming in some parts, and the abandonment of grassland habitats in others (Bubová *et al.*, 2015; van Swaay *et al.*, 2019; Warren *et al.*, 2021). Thus, if biodiversity losses are recorded, habitats need to be managed in certain ways to reverse negative effects. This kind of landscape-scale conservation includes certain necessary elements such as the increase of the area of the breeding habitat, an increase of general habitat quality for all species, and an increase of the connectivity among sites to maximize the rate of colonization and gene flow (Ellis *et al.*, 2011; Warren *et al.*, 2021). For example, the

appropriate management of meadows is extensive grazing and rotational mowing, which compensate for the lack of traditional meadow use. Also, a mosaic design of low intensity management is recommended, in which different parts are managed at different times. Such management could also be applied to the Significant Landscape of the Barać Caves. Although the surveyed area hosts significant butterfly diversity, a high proportion of all types of grasslands and meadows is in the process of becoming overgrown, so the preservation of remaining habitats and the restoration of others are needed. The management of these habitats, which aims at maintaining low, early-successional vegetation through clearing trees and shrubs, is favorable for butterfly species (Berg *et al*., 2013). Currently, only a minor part of the studied area is managed properly by extensive mowing. Sheep grazing is present only in small parts of the area, and usually only in early spring. Most of the meadows and former agricultural fields are currently abandoned and not managed. One of the reasons for this was the ongoing depopulation of the area after the Homeland War in the 90s. Accordingly, the management of the Significant Landscape should take care that the owners still situated in the area are educated and encouraged to manage land appropriately (Warren *et al*., 2021).

Butterflies represent a good indicator group of species (Thomas, 2005; van Swaay *et al*., 2012, 2019), and their diversity could be used for biodiversity and habitat quality assessments of the area in the future. Additionally, it would be important to commence monitoring of butterflies listed in Annexes II and IV of the Habitats Directive.

In the terms of awareness-raising for the visitors of the significant landscape, the diversity of butterflies could be used to promote the area and make it more attractive for visitors. For example, through educational workshops or presentations, the public could be informed about the endangered, rare, or interesting butterfly species and their relation to correct grassland and forest edge management.

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SAŽETAK

Raznolikost leptira (Lepidoptera: Papilionoidea) "Značajnog krajobraza Baraćeve špilje" (Kordun, Hrvatska)

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Značajni krajobraz Baraćeve špilje smješten je na području Kordunske zavale. Iako je područje proglašeno Značajnim krajobrazom prvenstveno radi speleoloških objekata, nadzemna staništa predstavljaju vrijedan mozaik šumskih staništa te manjih površina suhih i vlažnih travnjaka. Istraživanja danjih leptira Korduna povijesno vrlo su oskudna te postoji svega nekoliko sporadičnih istraživanja pretežno sjevernog dijela, dok danji leptiri Značajnog krajobraza nikada nisu bili istraživani. Tijekom 2020. i 2021. godine provedeno je istraživanje danjih leptira Značajnog krajobraza Baraćeve špilje prilikom čega je zabilježeno 79 vrsta. Taj je broj veći od broja vrsta zabilježenih prethodnim istraživanjima na području sjevernog Korduna (74) i Nacionalnog parka Plitvička jezera (71). Većina zabilježenih vrsta na istraživanome području spada u mezofilne, mezofilne do kserotermofilne, kserotermofilne vrste te ubikviste. Što se tiče biogeografske pripadnosti, većina vrsta ima Euro-Sibirsku i Euro-Orijentalnu pripadnost. Najveća raznolikost leptira nalazi se na travnjacima te djelomično zaraslim travnjacima. To su ujedno i najugroženija staništa za opstanak leptira budući da su u većoj mjeri neodržavani i nalaze se u nekoj od faza sukcesije. Prilikom istraživanja zabilježeno je i nekoliko značajnih vrsta čiji nalazi dodatno proširuju njihovu poznatu rasprostranjenost u Hrvatskoj, poput vrsta *Lycaena hippothoe, Lycaena dispar, Boloria selene* i *Apatura iris*. Rezultati ovog istraživanja moći će se koristiti kao osnova za buduće očuvanje vrsta leptira, kako za ovo područje, tako i za područje cijeloga Korduna.

Appendix I. List of butterfly species recorded in the areas of Barać Caves Significant Landscape, Kordun and Plitvice Lakes NP with biogeographical and habitat affiliation type.

No.	Species	Barać caves	Kordun	NP Plitvice lakes	Biogeo. affiliation	Habirat type selected
Hesperiidae						
1.	*Carterocephalus palaemon* (Pallas, 1771)		+		HOL	mesophilic/ hydrophilic
2.	*Erynnis tages* (Linnaeus, 1758)	+	+		ES	mesophilic/ xerothermophilic
3.	*Heteropterus morpheus* (Pallas, 1771)	+	+		ES	mesophilic/ xerothermophilic
4.	*Ochlodes sylvanus* (Esper, 1777)	+	+	+	ES	ubiquitous
5.	*Pyrgus carthami* (Hübner, 1813)			+	EO	xerothermophilic
6.	*Pyrgus malvae* (Linnaeus, 1758)	+	+	+	ES	mesophilic/ xerothermophilic
7.	*Spialia orbifer* (Hübner, 1823)			+	EO	xerothermophilic
8.	*Spialia sertorius* (Hoffmannsegg, 1804)			+	EM	xerothermophilic
9.	*Thymelicus lineola* (Ochsenheimer, 1808)	+	+		HOL	mesophilic
10.	*Thymelicus sylvestris* (Poda, 1761)	+	+		EO	mesophilic
Lycaenidae						
11.	*Aricia agestis* (Denis & Schiffermüller, 1775)	+		+	ES	mesophilic/ xerothermophilic
12.	*Callophrys rubi* (Linnaeus, 1758)	+	+		ES	mesophilic
13.	*Celastrina argiolus* (Linnaeus, 1758)	+	+	+	ES	mesophilic
14.	*Cupido argiades* (Pallas, 1771)	+	+		HOL	hygrophilic/ xerothermophilic
15.	*Cupido minimus* (Fuessly, 1775)	+		+	EO	xerothermophilic
16.	*Cyaniris semiargus* (Rottemburg, 1775)	+		+	ES	mesophilic/ hydrophilic
17.	*Glaucopsyche alexis* (Poda, 1761)	+			ES	mesophilic/ xerothermophilic
18.	*Hamearis lucina* (Linnaeus, 1758)		+		EM	mesophilic
19.	*Leptotes pirithous* (Linnaeus, 1767)	+			TRO	xerothermophilic
20.	*Lycaena phlaeas* (Linnaeus, 1761)	+	+	+	HOL	ubiquitous
21.	*Lycaena alciphron* (Rottemburg, 1775)	+	+	+	EO	mesophilic/ hydrophilic
22.	*Lycaena dispar* (Haworth, 1802)	+	+		ES	mesophilic/ hydrophilic
23.	*Lycaena hippothoe* (Linnaeus, 1761)	+			ES	mesophilic/ hydrophilic
24.	*Lycaena tityrus* (Poda, 1761)	+	+		ES	mesophilic/ xerothermophilic

No.	Species	Barać caves	Kordun	NP Plitvice lakes	Biogeo. affiliation	Habirat type selected
25.	*Lycaena virgaureae* (Linnaeus, 1758)	+		+	ES	mesophilic
26.	*Lysandra bellargus* (Rottemburg, 1775)	+		+	EO	xerothermophilic
27.	*Lysandra coridon* (Poda, 1761)			+	EO	xerothermophilic
28.	*Phengaris alcon* (Denis & Schiffermüller, 1775)			+	ES	hygrophilic/ xerothermophilic
29.	*Phengaris arion* (Linnaeus, 1758)	+		+	ES	xerothermophilic
30.	*Plebejus argus* (Linnaeus, 1758)	+	+	+	ES	hygrophilic/ xerothermophilic
31.	*Plebejus argyrognomon* (Bergsträsser, 1779)	+			ES	mesophilic/ xerothermophilic
32.	*Plebeius idas* (Linnaeus, 1761)		+		HOL	xerothermophilic
33.	*Polyommatus amandus* (Schneider, 1792)	+			ES	mesophilic/ hydrophilic
34.	*Polyommatus icarus* (Rottemburg, 1775)	+	+	+	ES	ubiquitous
35.	*Satyrium acaciae* (Fabricius, 1787)	+			EO	xerothermophilic
36.	*Satyrium ilicis* (Esper, 1779)		+		EO	mesophilic/ xerothermophilic
37.	*Satyrium spini* (Denis & Schiffermüller, 1775)		+	+	EO	xerothermophilic
38.	*Scolitantides orion* (Pallas, 1771)			+	ES	xerothermophilic
39.	*Thecla betulae* (Linnaeus, 1758)		+	+	ES	mesophilic/ xerothermophilic
Nymphalidae						
40.	*Aglais io* (Linnaeus, 1758)	+	+	+	ES	ubiquitous
41.	*Aglais urticae* (Linnaeus, 1758)			+	ES	ubiquitous
42.	*Apatura ilia* (Denis & Schiffermüller, 1775)	+	+		ES	mesophilic
43.	*Apatura iris* (Linnaeus, 1758)	+			ES	mesophilic
44.	*Aphantopus hyperantus* (Linnaeus, 1758)	+	+		ES	mesophilic
45.	*Araschnia levana* (Linnaeus, 1758)	+	+		ES	mesophilic/ hydrophilic
46.	*Argynnis pandora* (Denis & Schiffermüller, 1775)			+	EO	xerothermophilic
47.	*Argynnis paphia* (Linnaeus, 1758)	+	+	+	ES	mesophilic
48.	*Boloria dia* (Linnaeus, 1767)	+	+	+	ES	mesophilic/ xerothermophilic
49.	*Boloria euphrosyne* (Linnaeus, 1758)	+		+	ES	mesophilic
50.	*Boloria selene* (Denis & Schiffermüller, 1775)	+	+	+	HOL	mesophilic/ tryphophilic
51.	*Brenthis daphne* (Bergsträsser, 1779)	+	+		ES	mesophilic/ xerothermophilic

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52.	*Brenthis hecate* (Denis & Schiffermüller, 1775)	+			ES	xerothermophilic
53.	*Brenthis ino* (Rottemburg, 1775)	+	+	+	ES	mesophilic/ hydrophilic
54.	*Brintesia circe* (Fabricius, 1775)	+	+	+	EO	xerothermophilic
55.	*Coenonympha arcania* (Linnaeus, 1761)	+	+	+	EM	mesophilic/ xerothermophilic
56.	*Coenonympha pamphilus* (Linnaeus, 1758)	+	+	+	EO	mesophilic/ xerothermophilic
57.	*Erebia aethiops* (Esper, 1777)			+	EO	mesophilic/ xerothermophilic
58.	*Erebia ligea* (Linnaeus, 1758)			+	ES	mesophilic
59.	*Erebia medusa* (Denis & Schiffermüller, 1775)	+			ES	mesophilic
60.	*Euphydryas aurinia* (Rottemburg, 1775)	+	+	+	ES	hygrophilic
61.	*Fabriciana adippe* (Denis & Schiffermüller, 1775)	+	+	+	ES	mesophilic
62.	*Fabriciana niobe* (Linnaeus, 1758)			+	ES	mesophilic
63.	*Hipparchia semele* (Linnaeus, 1758)			+	EM	xerothermophilic
64.	*Issoria lathonia* (Linnaeus, 1758)	+	+		ES	ubiquitous
65.	*Lasiommata maera* (Linnaeus, 1758)			+	ES	mesophilic/ xerothermophilic
66.	*Lasiommata megera* (Linnaeus, 1767)	+	+	+	EO	ubiquitous
67.	*Limenitis camilla* (Linnaeus, 1764)			+	ES	mesophilic
68.	*Limenitis reducta* Staudinger, 1901	+		+	EO	xerothermophilic
69.	*Maniola jurtina* (Linnaeus, 1758)	+	+	+	ES	ubiquitous
70.	*Melanargia galathea* (Linnaeus, 1758)	+	+	+	EO	mesophilic
71.	*Melitaea athalia* (Rottemburg, 1775)	+	+	+	ES	mesophilic
72.	*Melitaea aurelia* Nickerl, 1850	+		+	EO	mesophilic/ xerothermophilic
73.	*Melitaea britomartis* Assmann, 1847	+			ES	xerothermophilic
74.	*Melitaea cinxia* (Linnaeus, 1758)	+	+		ES	mesophilic/ xerothermophilic
75.	*Melitaea diamina* (Lang, 1789)	+	+	+	ES	tyrphophilic/ hygrophilic
76.	*Melitaea didyma* (Esper, 1778)	+	+	+	ES	xerothermophilic
77.	*Melitaea phoebe* (Denis & Schiffermüller, 1775)	+	+	+	ES	xerothermophilic
78.	*Minois dryas* (Scopoli, 1763)	+	+		ES	hygrophilic/ xerothermophilic
79.	*Neptis rivularis* (Scopoli, 1763)		+	+	ES	hygrophilic/ xerothermophilic

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80.	*Neptis sappho* (Pallas, 1771)	+	+		ES	mesophilic
81.	*Nymphalis antiopa* (Linnaeus, 1758)	+	+		HOL	mesophilic
82.	*Nymphalis polychloros* (Linnaeus, 1758)		+	+	EO	mesophilic/ xerothermophilic
83.	*Nymphalis vaualbum* (Denis & Schiffermüller, 1775)			+	ES	mesophilic
84.	*Pararge aegeria* (Linnaeus, 1758)	+	+	+	EO	mesophilic/ xerothermophilic
85.	*Polygonia c-album* (Linnaeus, 1758)	+	+	+	ES	mesophilic
86.	*Pyronia tithonus* (Linnaeus, 1767)	+	+		EM	mesophilic/ xerothermophilic
87.	*Speyeria aglaja* (Linnaeus, 1758)	+		+	ES	mesophilic/ xerothermophilic
88.	*Vanessa atalanta* (Linnaeus, 1758)	+	+	+	HOL	ubiquitous
89.	*Vanessa cardui* (Linnaeus, 1758)	+	+	+	COS	ubiquitous/ xerotermophilic
Papilionidae						
90.	*Iphiclides podalirius* (Linnaeus, 1758)	+	+		ES	xerothermophilic
91.	*Papilio machaon* Linnaeus, 1758	+	+	+	ES	ubiquitous
92.	*Parnassius apollo* (Linnaeus, 1758)			+	ES	xerothermophilic
93.	*Parnassius mnemosyne* (Linnaeus, 1758)	+		+	EO	mesophilic
94.	*Zerynthia polyxena* (Denis & Schiffermüller, 1775)	+			EO	mesophilic/ xerothermophilic
95.	*Anthocharis cardamines* (Linnaeus, 1758)		+	+	ES	mesophilic/ hydrophilic
96.	*Aporia crataegi* (Linnaeus, 1758)	+		+	ES	mesophilic/ xerothermophilic
97.	*Colias crocea* (Geoffroy, 1785)	+	+		EO	xerothermophilic
98.	*Colias cf. hyale* (Linnaeus, 1758)	+		+	ES	ubiquitous
99.	*Gonepteryx rhamni* (Linnaeus, 1758)	+	+	+	ES	mesophilic
100.	*Leptidea sinapis* (Linnaeus, 1758)	+	+	+	ES	mesophilic/ xerothermophilic
101.	*Pieris balcana* Lorkovic, 1970	+		+	ES	mesophilic
102.	*Pieris brassicae* (Linnaeus, 1758)	+	+	+	ES	ubiquitous
103.	*Pieris ergane* (Geyer, 1828)			+	EO	xerothermophilic
104.	*Pieris mannii* (Mayer, 1851)		+	+	EO	xerothermophilic
105.	*Pieris napi* (Linnaeus, 1758)	+	+	+	ES	ubiquitous
106.	*Pieris rapae* (Linnaeus, 1758)	+	+	+	HOL	ubiquitous