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Biodiversity of butterflies (Lepidoptera, Papilionoidea) in Mountain Koritnik in the Republic of Kosovo

Pajtim Bytyçi

Department of Biology, Faculty of Mathematics and Natural Sciences, University of Prishtina, Prishtina 10000, Kosovo.

✉ *pajtim.bytyqi@hotmail.com* *https://orcid.org/0000-0002-1521-3370*

Ferdije Zhushi-Etemi

Department of Biology, Faculty of Mathematics and Natural Sciences, University of Prishtina, Prishtina 10000, Kosovo.

✉ *ferdije.zhushi@uni-pr.edu* *https://orcid.org/0000-0002-1627-2479*

Edona Kabashi-Kastrati

Department of Biology, Faculty of Mathematics and Natural Sciences, University of Prishtina, Prishtina 10000, Kosovo.

✉ *edonak88@gmail.com* *https://orcid.org/0000-0001-5582-9471*

Hazir Çadraku

2UBT - Higher Education Institution, Kalabria, street Rexhep Krasniqi Nr. 56, Prishtina 10000, Kosovo.

✉ *hazir.cadraku@ubt-uni.net* *https://orcid.org/0000-0002-6406-4666*

ABSTRACT. The following paper outlines a study conducted on the abundance, distribution, and diversity of butterflies in Mt. Koritnik. located in the Republic of Kosovo, during 2019–2022. This research resulted in a total of 8166 recorded specimens, which belonged to 6 butterfly families, 50 genera and 131 species. The richest family in terms of abundance was Nymphalidae with 4611 specimens (56.47%), followed by Lycaenidae 1924 specimens (23.56%), Pieridae 856 (10.48%), 561 Hesperiidae (6.87%), Papilionidae 179 specimens (2.19%) and Riodinidae with 24 specimens (0.29%). In terms of species richness, Nymphalidae were the richest with 55 species, Lycaenidae 40, followed by 15 Pieridae, 15 Hesperiidae, 5 Papilionidae and 1 Roidinidae. Among 131 registered species, 11 have Near Threatened status in Europe. Our results indicated that species richness and abundance of butterflies were significantly negatively correlated with altitude (p<0.01), whereas they showed a strong positive correlation (p<0.01) with the temperature. The highest abundance and number of species were presented in the lower altitudinal range and the numbers decreased with altitude increasing. Activities such as intensive agriculture, grazing, fires and illegal timber cutting, which were observed during our survey, may be the main threats for butterflies in Mt. Koritnik in the future, therefore, we suggest the data from this research serve as a basic information for authorities to monitor future changes in butterfly diversity.

Key words: Abundance, altitude, environment, distribution, temperature, richness

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INTRODUCTION

Butterflies are among the biggest and most studied insect group. The global butterfly fauna is estimated to be composed of 18,732 described species (Nieukerken et al., 2011), out of which 10,891 species are distributed in Europe. The updated species list of European butterflies includes 496 species (Wiemers et al., 2018), according to a recent publication, the superfamily Papilionoidea in Europe is represented

Corresponding author: Zhushi-Etemi, F., ✉ *ferdije.zhushi@uni-pr.edu*

with 552 species (Landry, 2023). Butterflies are regarded as significant climate and habitat bioindicators (Pe'er & Settele, 2008; Comay et al., 2021). Since they may be easily tracked, caught, tagged, and identified in the wild, butterflies are great for studies of populations and ecosystems (Nowicki et al., 2008; Ren et al., 2022). Due to their sensitivity to environmental changes, butterflies have emerged as the primary indicator for monitoring and evaluating environmental changes in their habitats in the face of escalating global change and habitat destruction (Ren et al., 2022). As a result of their functions as pollinators and as links in the food chain, their conservation is crucial to maintaining the productivity of natural and agricultural landscapes (Tzortzakak et al., 2019; Zhang et al., 2021; Xie et al., 2021). The data on entomofauna decline worldwide (Sánchez-Bayo et al., 2019), as well as data on butterfly decline in Europe (Warren et al., 2021), have increased the intensity of the research on the main drivers of this decline and also on possible solutions for taking measures on butterfly protection and conservation. The main causes of butterfly decline are habitat loss and change, intensive agriculture, land use and pollution, urbanization, pathogens, invasive species and climate changes (Warren et al., 2021). Since their response to environmental deterioration or disturbances is amplified and quick, butterflies are sensitive indicators of future changes in vertebrates and plants (Thomas et al., 2005).

The Republic of Kosovo is a country in Southeast Europe located in the center of Balkan peninsula, which is one of the biodiversity hotspots in Europe (Griffiths et al., 2004), rich in diversity of butterflies and moths (Varga, 2014). The butterflies of Kosovo have been studied for a long time, with the first records from the area having been published in the early part of the 20th century (Rebel, 1913; Rebel & Zerny, 1931). A number of recent studies (Zhushi-Etemi et al., 2016, 2017a, 2017b, 2018, 2020; Koren et al., 2021; Kabashi-Kastrati et al., 2022; Bytyçi et al., 2021) along with the research from the previous decades (Jakšić, 1987, 1998a, 1998b; Jakšić & Živić, 1998) have significantly increased the knowledge of Kosovo's Lepidoptera diversity, which now numbers at 174 species. Nevertheless, in contrast to other places in the region, research on the butterfly diversity in Kosovo is still inadequate as there are still unexplored regions in Kosovo where surveys could uncover new species records. Expanding knowledge on butterfly diversity and their distribution in Mt. Koritnik, which is considered one of the less studied areas in the country, was one of the main goals of our survey. Mt. Koritnik is located in the south of Republic of Kosovo and stretches along the state border with Albania. The mountain is surrounded by branches of Drini i Bardhë (white Drini) river. In Albania it belongs to the Korab-Koritnik Nature Park, whereas in Kosovo it is part of Sharri National Park (Ahmetaj & Lenjani, 1989). The vegetation in the area is mainly represented by oak, beech and pine (Rexhepi, 1994). Many studies have shown that climate change and habitat loss and destruction are the main drivers of biodiversity decrease (Warren et al., 2021; Cerrato et al., 2019). Mountain massifs are not an exception in this regard, since they are already facing the impact of these changes not only in temperature variation but also in biodiversity shifting upwards, toward higher altitudinal gradients (Pauli et al., 2012; Scridel et al., 2018). Kosovo’s part of Koritnik Mountain was never studied earlier in terms of butterfly diversity, therefore the aim of our work was to explore it in this aspect.

Considering that studies on butterfly diversity can provide important information for implementing effective conservation measures for species and their habitat, our objectives in this study were: 1) to determine how the species richness, abundance and distribution change along the altitudinal gradient in Kosovo’s site of Mt. Koritnik , 2) to find out how the altitudinal gradient and temperature impacts the species distribution, and 3) to identify which are the main threats for butterflies in this area.

MATERIAL AND METHODS

Study area. Our survey was carried out in Mt. Koritnik in Republic of Kosovo, during the years 2019, partially in 2020, 2021 and 2022. Mt. Koritnik is a coniferous forest-covered limestone mountain situated between the cities of Kuks and Prizren in northeastern Albania and southwest Kosovo. On the border in Kukës, Koritnik riches the maximum altitude of 2396 m. In the northeast it ends in the Prizren basin, while in the southwest the mouth of the river Luma separates it from Mt. Gjallica.

Koritnik has an extended northeast-southwest shape of 15 km. In its peak, there are two glacial cirques (of Bele and Prace). Its climate is continental with Mediterranean impact coming from the Adriatic see in Albania, characterized with hot summers and cold winters. The Palaearctic temperate broadleaf and mixed forests biome's Balkan mixed forests terrestrial ecoregion includes Mt. Koritnik. An area of 818 ha with *Pinus heldreichii* pine in Koritnik is declared as a Strict nature reserves area, named "Pisha e madhe" as part of Koxha Ballkan massif in Sharri National Park. It is the largest area of pine forests in the Balkans (Ahmetaj & Lenjani, 1989). During the survey, butterflies were recorded in 18 sites in natural or semi-natural habitats (Fig. 1, Table 1). The sites were selected to represent different habitat types at different altitudes, the lowest being at 585 m and the highest at 2197 m. Altitude and coordinates for each sampling site were determined through the use of the Global Positioning System (GPS) and using Google Earth Map. Fieldwork was carried out regularly once per month from March to late October each year, except in the first part of 2020, due to the Covid-19 pandemic lock-down. In the field, butterflies were collected with butterfly nets during the sunny days, from 10 am to 2 pm. Most of the recorded specimens were identified in the field and released, but few from each species are preserved for the collection. Specimens that couldn't be identified in the field were placed in transparent envelopes and were identified later in the laboratory using books by Tolman and Lewington (2008) and Tshikolovets (2011). The mean temperature values per month for Prizren and Dragash municipalities, where the study area lies, were obtained from the Hidrometeorological Institute of Kosovo.

Table 1. Sampling sites with their geographic coordinates and altitudes. The habitat types are determined according to European Nature Information System (EUNIS).

Locality	EUNIS Habitat Code and Names	Latitude	Longitude	Altitude (m a.s.l.)
S1	E1.2 Perennial calcareous grassland and basic steppes	N 42°10'05"	E 20°38'49"	585
S2	E2 Mesic grasslands	N 42°09'24"	E 20°39'29"	835
S3	G1.7 Thermophilous deciduous woodland	N 42°08'46"	E 20°38'59"	955
S4	E1. Dry grasslands	N 42°08'22"	E 20°37'21"	1018
S5	G1.7 Thermophilous deciduous woodland	N 42°08'19"	E 20°37'41"	1281
S6	E1.2 Perennial calcareous grassland and basic steppes	N 42° 08'08"	E 20°38'54"	949
S7	3. E1 Dry grasslands	N 42°07'41"	E 20°36'49"	1140
S8	1.3 Arable land with unmixed crops grown by low-intensity agricultural methods	N 42°06'41"	E 20°37'45"	1138
S9	E2.1 Permanent mesotrophic pastures and aftermath-grazed meadows	N 42°05'45"	E 20°39'01"	1133
S10	7 Thermophilous deciduous woodland	N 42°05'01"	E 20°36'58"	1142
S11	F3.1 Temperate thickets and scrub	N 42°4'46"	E 20°36'31"	1226
S12	G1.6 Beech woodland	N 42°04'52"	E 20°36'20"	1245
S13	G3.6 Subalpine mediterranean Pinus	N 42°04'37"	E 20°36'06"	1371
S14	E2.3 Mountain hay meadows	N 42°04'32"	E 20°35'57"	1403
S15	G3.6 Subalpine mediterranean Pinus	N 42°05'08"	E 20°35'35"	1766
S16	G3.6 Subalpine mediterranean Pinus	N 42°04'58"	E 20°35'23"	1825
S17	G5.8 Recently felled areas	N 42°05'05"	E 20°35'04"	1959
S18	E4.4 Calcareous alpine and subalpine grassland	N 42°05'04"	E 20°35'40"	2197

Statistical analysis. We conducted statistical analyses to examine the relationship between altitude and species richness in butterflies. Principal component analysis (PCA) was carried out using Statistica 12 program for Windows based on the Pearson correlation matrix, while other plots were generated using Microsoft Excel 2016. We employed a regression-based test to test the change of species richness with altitude and calculated the alpha diversity of butterfly populations using the Shannon-Wiener diversity index (H) and the Simpson diversity index (D) (Jørgensen & Costanza, 2016). The biogeographical categorization of the butterflies followed the method described in Kudrna et al. (2011). Other diversity indices used include the Mergalef Species richness index (Jørgensen et al., 2016; Margalef, 1958), Menhinick's diversity index (Menhinick, 1964), Jaccard's (Vorontsov et al., 2013; Gupta & Sardana, 2015), Sorensen (Rempala & Seweryn, 2013) and the S_{Chao1-} (Chao1) species richness index (Chao, 1984). To investigate the similarity of butterfly communities across diverse habitats, we employed the Jacard and Sørensen similarity indices. These indices were calculated using Excel, and dissimilarity values (1-Sørensen index) were utilized for cluster analysis. The clustering of each community was presented as dendrograms, which were constructed hierarchically in Statistica *ver. 12*. Ludwig and Reynolds (1988) and Krebs (1999) have previously discussed the use of cluster analysis for this purpose.

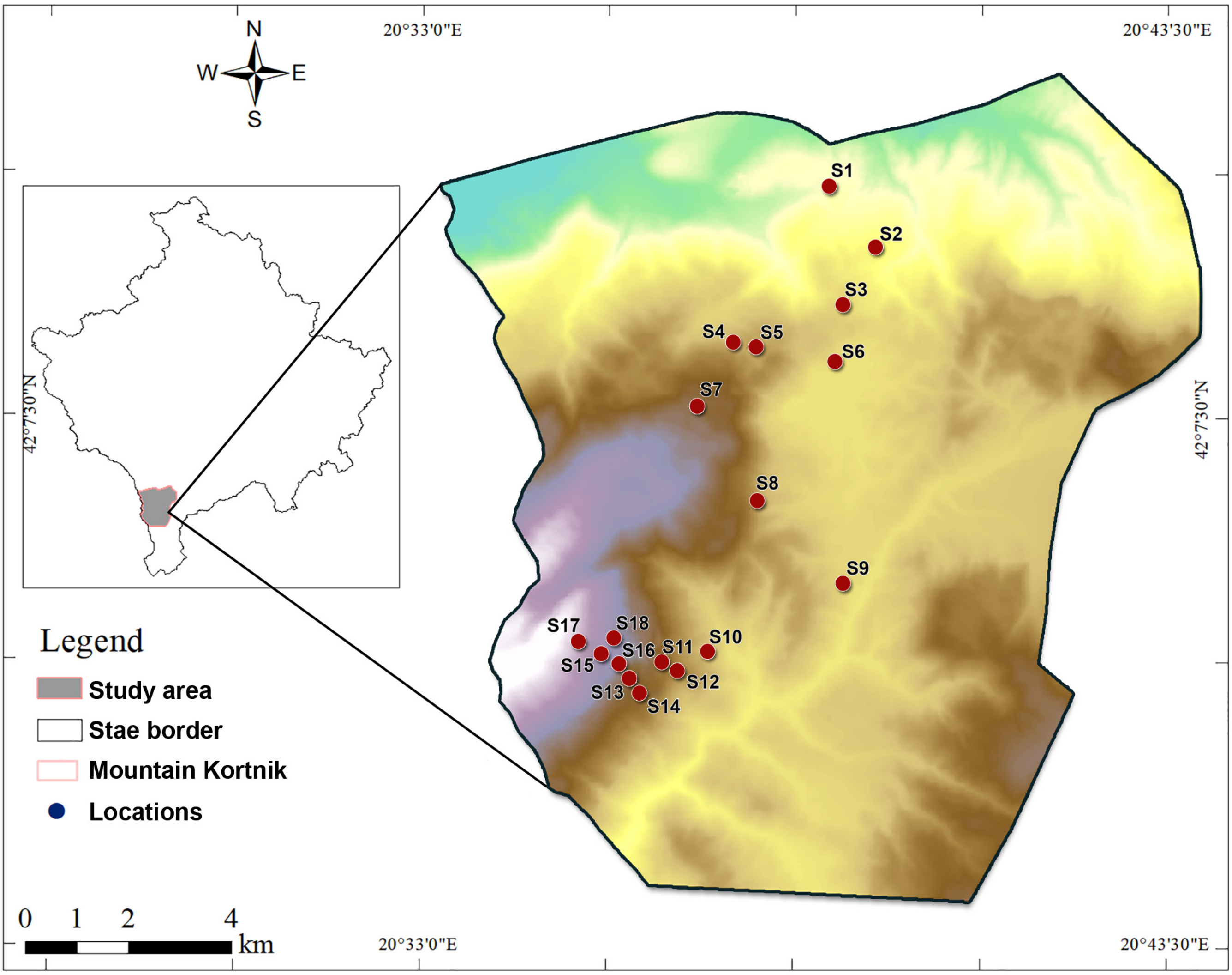

Figure 1. Map of Mt. Koritnik with the position of study localities.

RESULTS

During this research conducted from 2019–2022 in 18 localities in Kosovo's part of Mt. Koritnik in the border with Albania, a total of 8166 butterfly specimens were collected. As shown in Table 2, the observed specimens belong to 131 species, among them 55 Nymphalidae, 40 Lycaenidae, 15 Pieridae, 15 Hesperidae, 5 Papilonidae and 1 Rionidae. The results indicate that in terms of zoogeography, 69 of the 131 (52.6%) identified butterfly species are part of the Euro-Siberian faunal elements. A total of 36 species (27.4%) are classified as Euro-Oriental (EO), while 8 species (6.1%) fall under the Holarctic (Hol) category. The Euro-Meridional (EM) category includes 7 species (5.3%). The remaining categories have smaller representation, with 4 species (3.05%) classified as Montane (Mon), 3 species (3.29%) as Mediterranean (Med), 2 species (1.5%) as Tropical (Tro), 1 species (0.76%) as Cosmopolitan (Cos), and 1 species (0.76%) as Boreo-Montane (BM). In terms of species number and abundance, the richest were localities S2 (90 species) and S12 (85 species) (Table 3). The species richness and abundance changed with altitude, achieving the maximum values from 835-1245 m and showing declining trend towards higher altitude, above 1245 m. At the two locations with the highest altitudes, 1959 m and 2197 m, the least number of species are recorded. Species that had higher frequencies in the studied area included *Arethusana arethusa* (Denis & Schiffermüller, 1775), *Maniola jurtina* (Linnaeus, 1758), *Coenonympha pamphilus* (Linnaeus, 1758), *Melanargia galathea* (Linnaeus, 1758), *Boloria dia* (Linnaeus, 1767), *Erebia ligea* (Linnaeus, 1758), *Issoria lathonia* (Linnaeus, 1758), *Lasiommata maera* (Linnaeus, 1758), *Plebejus argus* (Linnaeus, 1758), *Aricia aegestis* (Denis & Schiffermüller, 1775), *Cupido minimus* (Fuessly, 1775), *Glaucopsyche alexis* (Poda, 1761), *Polyommatus amandus* (Schneider, 1792), *Polyommatus daphnis* (Denis & Schiffermüller, 1775), and *Aporia crataegi* (Linnaeus, 1758). In contrast, *Nymphalis antiopa* (Linnaeus, 1758), *Minois dryas* (Scopoli, 1763), Kirinia roxelana (Cramer, 1777), *Apatura ilia* (Denis & Schiffermüller, 1775), *Hipparchia syriaca* (Staudinger,1871), *Zerynthia cerisy* (Godart, 1824), *Parnassius mnemosye* (Linnaeus, 1758), *Aglais urticae* (Linnaeus, 1758), *Hipparchia statilinus* (Hufnagel, 1766), Araschnia levana ((Linnaeus, 1758), *Polommatus dorylas* (Denis & Schiffermüller, 1775), *Scolitantides orion* (Pallas, 1771), *Cupido alcetas* (Hoffmannsegg, 1804), *Polommatus eros* (Ochsenheimer, 1808), *Pyrgus serratulae* (Rambur, 1839) were species with low abundance as well as with low distribution, registered only in one or maximum in two localities during all the period of the survey.

Our results also show significant correlation between altitude and butterfly community parameters (number of individuals, species, Shannon Wiener, Margalef and Menhinick's diversity indices (Fig. 2). Altitude showed a negative correlation with the abundance ($R^2=0.29$, $p<0.05$), number of species ($R^2=0.39$, $p<0.01$), Shannon-Wiener diversity index ($R^2=0.47$, $p<0.01$), Margalef index ($R^2=0.38$, $p<0.01$), and Menhinick index ($R^2=0.49$, $p<0.05$). The values of Shannon-Wiener diversity index were high at almost all habitats up to 1500 m altitude. At sites above this altitude the diversity index showed a slight decrease. In our study, we found a positive correlation between temperature and the abundance of butterflies (Fig. 3), as well as the number of species, Shannon-Wiener diversity index, Margalef index, and Menhinick index ($R2=0.29$, $p<0.05$ for abundance; $R^2=0.48$, $p<0.01$ for number of species; $R^2=0.50$, $p<0.01$ for Shannon-Wiener diversity index; $R^2=0.47$, $p<0.01$ for Margalef index; $R^2=0.39$, $p<0.01$ for Menhinick index).

Locality S12, which had the highest species diversity ($H=5.78$) is a locality with mix habitat types and also with presence of water resources, which are important parameters for species distribution. We also observed that in localities with high plant diversity, the number of butterfly species was higher. Localities S13, S14, S15, S16, S17 and S18 were in a mountainous area where a decade ago was subject to a massive forest fire, the consequences of which can be seen by low species abundance as well as low values of the biodiversity index. This is also reflected in Simpson's diversity index, where the lowest value 0.023, meaning the highest diversity, is registered in S12, whereas the highest value, indicating the low diversity, was in S18 ($D=0.089$). The Menhinick Index and Margalef's Richness Index values also demonstrated the study area's high level of species diversity. The richest were the habitats in S2, S3 and S12, while localities S17 and S18 had the lowest index values.

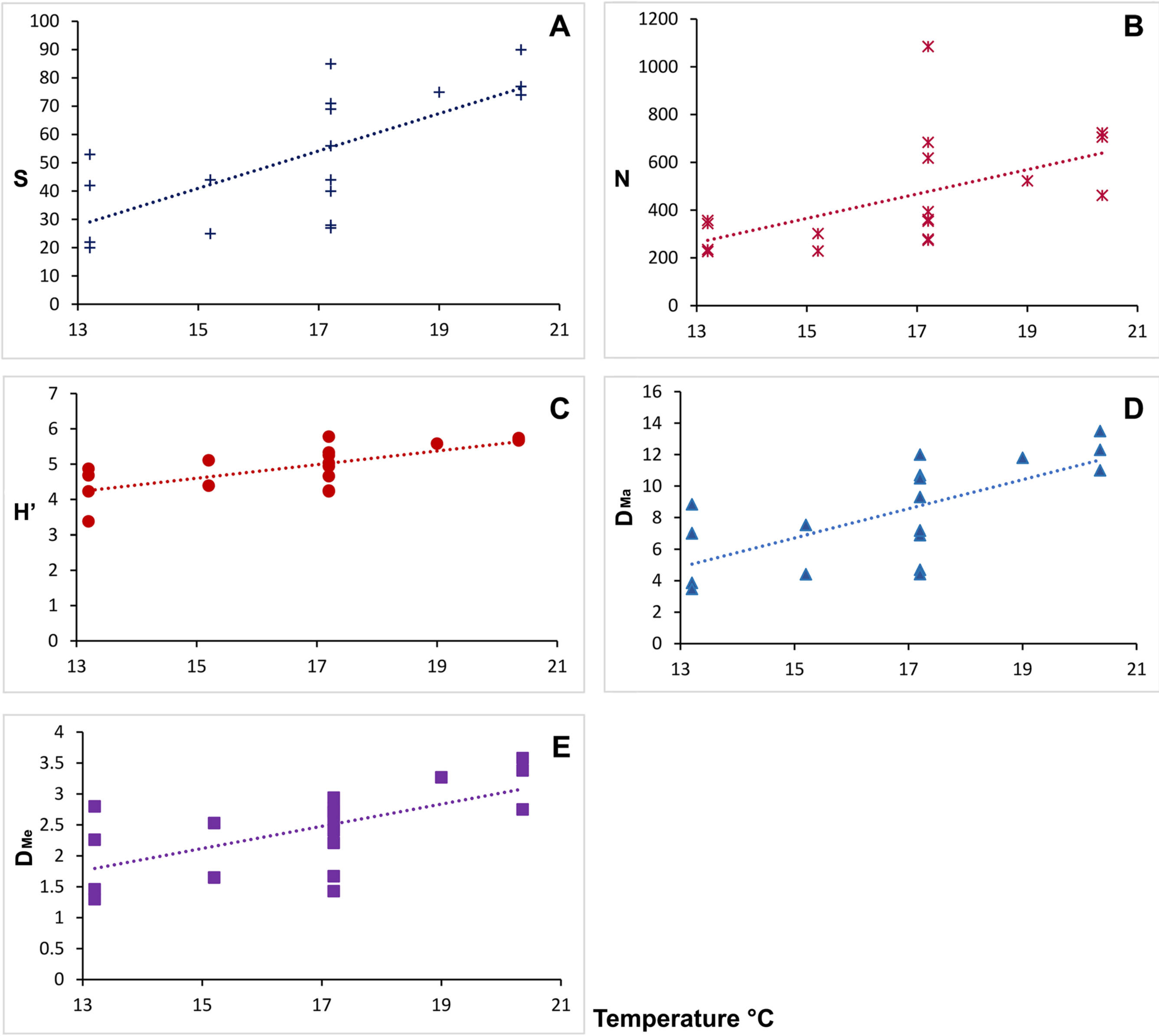

Figure 2. The relationship between temperature (T°C) with the diversity indices. **A.** Species richness – S; **B.** Abundance – N; **C.** Shannon Wiener - H'; **D.** Margalef – D_{Ma}; **E.** Menhinick's – D_{Me}.

Chao 1 richness estimators indicated that in most of the surveyed sites, the number of observed species is 100% of the estimated. The only exceptions are the two richest sites, S2 and S12, where the number of observed species are respectively 78.94% and 83.66 % of the estimated species numbers. As for the similarity in butterfly species composition between the surveyed localities, the highest score of Jaccard's index, 0.90 was shown between localities 17 and 18 (Fig. 2, Appendix 1). These two localities are at highest altitude and share almost identical habitats and similar environmental parameters. The communities at the highest altitudes were undoubtedly the most distinct, but those in the middle altitudes also tended to create a special group of localities with high species diversity. Our results show that the highest values of this index are seen among localities that are closer to each other and have similar habitats, while the least similarity with other localities is represented by the community of locality S8. These similarities are also obtained through Sorensen's index, where the highest value of the index 0.95 is shown between localities S17 and S18 (Appendix 2).

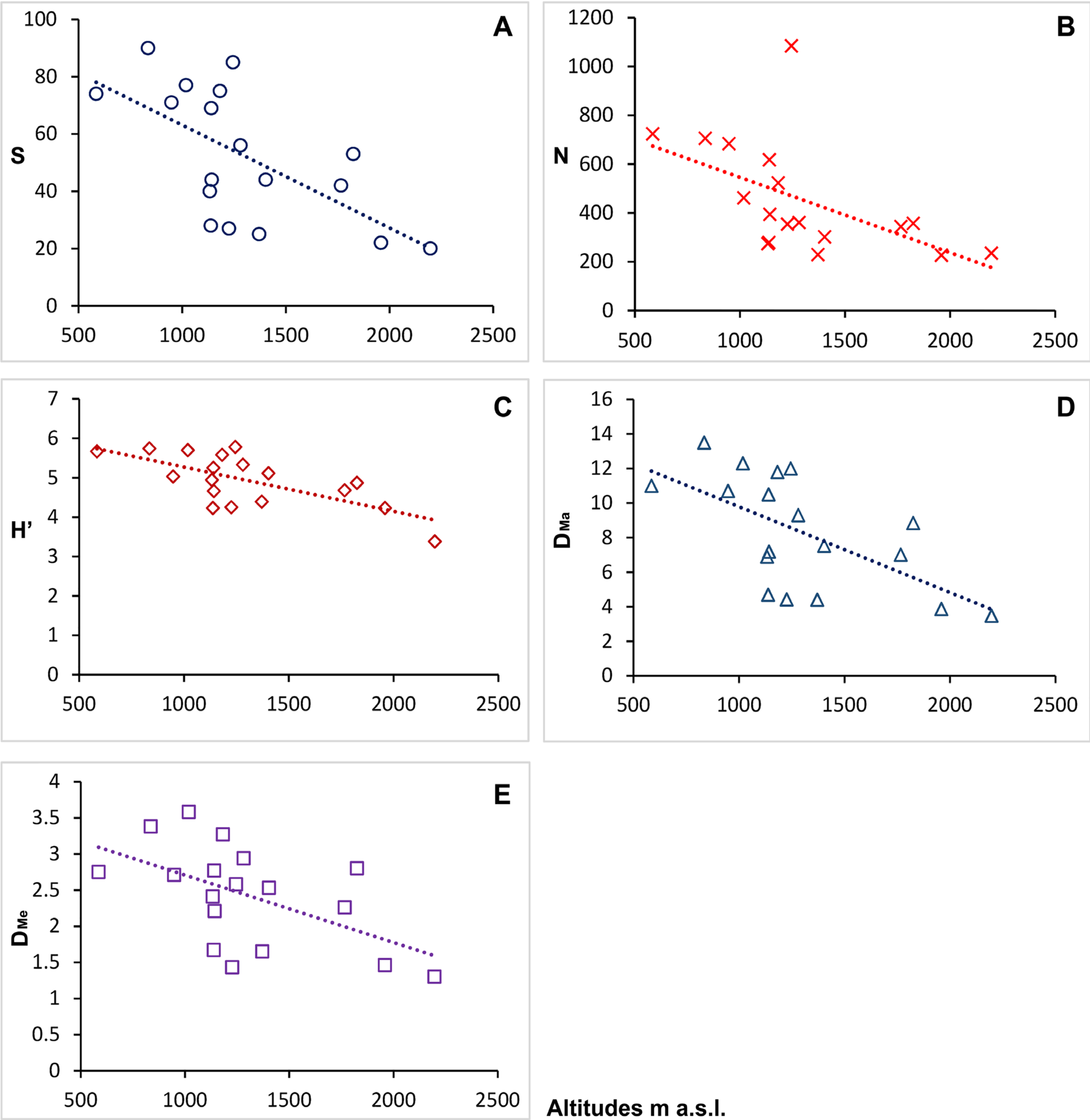

Figure 3. The relationship between altitude with the diversity indices. **A.** Species richness – S; **B.** Abundance – N; **C.** Shannon Wiener - H'; **D.** Margalef – D_{Ma}; **E.** Menhinick's – D_{Me}.

The cluster analysis (Fig. 4) determined six distinct groups based on the species composition observed in each site. The first group includes locality S12, which has the highest butterfly abundance and reflects the diversity of present habitats in these localities; the second group includes localities S11 and S10, which are close to each other and have similar habitats; the third group includes localities S15, S18, S17, S14 and S13 which are the localities with the highest altitude above sea level, where S14 and S13 are localities dominated by *Pinus heldreichii* forests, while localities 15, 16, S17 and 18 are high altitude habitats with low plant species diversity, mostly with pioneer plants as a result of recent forest fires.

Table 2. The list of butterfly species recorded in Mt. Koritnik in 2019–2022.

Families	Red list Europe	Red list Kosovo	Faunal elements	Occurence (Localities on Fig. 1)
Hesperiidae				
Carcharodus alceae (Esper, 1780)	LC	-	MED	1,2,6,7
Carcharodus floccifera (Zeller, 1847)	NT	VU	EO	1,2,4,6,7,9,10
Carterocephalus palaemon (Pallas, 1771)	LC	VU	ES	6
Erynnis tages (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11, 12,16,17,18
Hesperia comma (Linnaeus, 1758)	LC	LC	Hol	1,2,3,4,5,6,7,9,10,11,12
Ochlodes sylvanus (Esper, 1761)	LC	LC	ES	1,2,3,4,6,15,16
Pyrgus andromedae (Wallengren, 1853)	LC	-	BM	2,3,7,12
Pyrgus armoricanus (Oberthur, 1910)	LC	LC	EO	1,3,12
Pyrgus malvae (Linnaeus, 1758)	LC	-	ES	1,2,3,5,6,7,8,9,10,11,12, 13,14,15,16
Pyrgus serratulae (Rambur, 1839)	LC	-	ES	12
Pyrgus sidae (Esper, 1784)	LC	VU	EO	1,2,3,4,6,12
Spialia orbifer (Hübner, 1823)	LC	LC	EO	1,2,4,6,7,12
Thymelicus acteon (Rottemburg, 1775)	NT	NT	EO	2,3,4,5,10
Thymelicus lineola (Ochsenheimer, 1808)	LC	-	Hol	1,2,12
Thymelicus sylvestris (Poda, 1761)	LC	-	EO	1,2,4,5,6,7,9,12,15,16
Lycaenidae				
Aricia agestis (Denis & Schiffermüller, 1775)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18
Aricia anteros (Freyer, 1838)	LC	-	Mon	1,2,3,4,5,6,10,12
Aricia eumedon (Esper, 1838)	LC	-	ES	1,2,6,12
Callophrys rubi (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,7,8,9,10,11,12,13,14,15
Celastrina argiolus (Linnaeus, 1758)	LC	-	ES	1,2,6,12,16
Cupido alcetas (Hoffmannsegg, 1804)	LC	-	ES	2,12
Cupido argiades (Pallas, 1771)	LC	-	Hol	2,12
Cupido decolorata (Staudinger, 1886)	NT	NT	EM	12,15
Cupido minimus (Fuessly, 1775)	LC	-	ES	1,2,3,4,5,6,7,12,16
Cupido osiris (Meigen, 1828)	LC	-	EO	1,3,3,4,12
Cyaniris semiargus (Rottemburg, 1775)	LC	-	ES	2,5,6,7,10,12,15,16
Glaucopsyche alexis (Poda, 1761)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18
Lampides boeticus (Linnaeus, 1767)	LC	-	Tro	3,4
Leptotes pirithous (Linnaeus, 1767)	LC	-	Tro	3,4,12
Lycaena alciphron (Rottemburg, 1775)	LC	-	EO	2,6,9
Lycaena candens (Herrich-Schäffer, 1844)	LC	-	Mon	1,12,13,14,15,16
Lycaena dispar (Haworth, 1802)	LC	VU	ES	2,9,12
Lycaena phlaeas (Linnaeus, 1761)	LC	-	Hol	2,9,12
Lycaena thersamon (Esper, 1784)	LC	-	EO	12
Lycaena tityrus (Poda, 1761)	LC	-	ES	2,6,7,9,12
Lycaena virgaureae (Linnaeus, 1758)	LC	-	ES	2,3,4,5,6,7,8,9,10,11,12
Phengaris alcon (Denis & Schiffermüller, 1775)	LC	VU	ES	6,7,12,15,16
Plebejus argus (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18
Plebejus argyrognomon (Bergsträsser, 1779)	LC	-	ES	1,2,4,5,6,7,12
Plebejus idas (Linnaeus, 1761)	LC	-	Hol	1,2,4,5,6,7,10
Plebejus sephirus (Frivaldszky, 1835)	LC	-	Med	1,4,5,6,12,15
Polyommatus amandus (Schneider, 1792)	LC	-	ES	1,2,4,5,6,7,10,12,15,16
Polyommatus bellargus (Rottemburg, 1775)	LC	-	EO	3,4,5,7,12,16
Polyommatus coridon (Poda, 1761)	LC	-	EO	2,3,4,5,7,10,12
Polyommatus daphnis (Denis & Schiffermüller, 1775)	LC	-	EO	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18
Polyommatus dorylas (Denis & Schiffermüller, 1775)	NT	-	EO	2,12
Polyommatus eros (Ochsenheimer, 1808)	NT	-	ES	7,12
Polyommatus icarus (Rottemburg, 1775)	LC	-	ES	1,2,3,4,5,6,7,10,12,14,16
Polyommatus thersites (Cantener, 1835)	LC	-	ES	1,2,7,10
Pseudophilotes vicrama (Moore, 1865)	NT	-	EO	7,12,13,14,15,16
Satyrium acaciae (Fabricius, 1787)	LC	-	EO	3,6,7
Satyrium ilicis (Esper, 1779)	LC	-	EO	1,2,3,4,10,12
Satyrium spini (Denis & Schiffermüller, 1775)	LC	-	EO	1,2,3,4,7
Scolitantides orion (Pallas, 1771)	LC	-	ES	1,2
Thecla betulae (Linnaeus, 1758)	LC	-	ES	3,4

Families	Red list Europe	Red list Kosovo	Faunal elements	Occurence (Localities on Fig. 1)
Nymphalidae				
Aglais io (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16
Aglais urticae (Linnaeus, 1758)	LC	-	ES	4
Apatura ilia (Denis & Schiffermüller, 1775)	LC	-	ES	3
Aphantopus hyperantus (Linnaeus, 1758)	LC	-	ES	3,4,5,6,7,10,12,15
Araschnia levana (Linnaeus, 1758)	LC	-	ES	8
Arethusana arethusa (Denis & Schiffermüller, 1775)	LC	-	EO	1,2,3,4,5,6,7,12
Argynnis adippe (Denis & Schiffermüller, 1775)	LC	-	ES	1,2,3,4,5,6,7,9,12,14,15,16
Argynnis aglaja (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,12,14,15,16
Argynnis niobe (Linnaeus, 1758)	LC	-	ES	2,3,4,5,7,12,14,16
Argynnis Pandora (Denis & Schiffermüller, 1775)	LC	-	ES	2,3,4,5,7,12
Argynnis paphia (Linnaeus, 1758)	LC	-	ES	1,2,3,4,7,12,14,16
Boloria dia (Linnaeus, 1767)	LC	-	ES	1,2,3,5,6,7,8,12,14,15,16
Boloria euphrosyne (Linnaeus, 1758)	LC	-	ES	1,2,6,7,12,16
Brenthis daphne (Bergsträsser, 1780)	LC	-	ES	1,3,12
Brenthis hecate (Denis & Schiffermüller, 1775)	LC	-	ES	6,7
Brintesia circe (Fabricius, 1775)	LC	-	EO	1,2,4,6,7,12
Chazara briseis (Linnaeus, 1764)	NT	NT	ES	1,2,6
Coenonympha arcania (Linnaeus, 1761)	LC	-	EM	1,2,3,4,7,14,15,16
Coenonympha leander (Esper, 1784)	LC	-	EO	5,12,14,16,17,18
Coenonympha pamphilus (Linnaeus, 1758)	LC	-	EO	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,18
Coenonympha rhodopensis (Esper, 1784)	LC	-	Med	5,16,17,18
Erebia ligea (Linnaeus, 1758)	LC	-	ES	5,15,16,17,18
Erebia medusa (Denis & Schiffermüller, 1775)	LC	-	ES	5,6,11,12,16,17,18
Erebia oeme (Hübner, 1804)	LC	-	Mon	6,12,15,16,17,18
Erebia ottomana (Herrich-Schäffer, 1847)	LC	-	Mon	16,17,18
Euphydryas aurinia (Rottemburg, 1775)	LC	EN	ES	6,7,12
Hipparchia fagi (Scopoli, 1763)	NT	NT	EM	3,4,2
Hipparchia semele (Linnaeus, 1758)	LC	-	EM	3,4
Hipparchia statilinus (Hufnagel, 1766)	NT	NT	EM	3
Hipparchia syriaca (Staudinger, 1871)	LC	-	EO	3
Hyponephele lupines (Costa, 1836)	LC	-	ES	6,10
Issoria lathonia (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16,18
Kirinia roxelana (Cramer, 1777)	LC	-	EO	3
Lasiommata maera (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16
Lasiommata megera (Linnaeus, 1767)	LC	-	EO	1,3,4,5,7,8,9,10,11,12,13,14,15,16,17,18
Lasiommata petropolitana (Linnaeus, 1767)	LC	-	ES	3,4,5,15,16,17
Limenitis reducta (Staudinger, 1901)	LC	-	EO	1,2,3,4,6
Maniola jurtina (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16,17
Melanargia galathea (Linnaeus, 1758)	LC	-	EO	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16
Melanargia larissa (Geyer, 1828)	LC	-	EO	1,2,3,7,12
Melitaea athalia (Rottemburg, 1775)	LC	-	ES	1,3,3,4,5,6,7,10,12
Melitaea aurelia (Nickerl, 1850)	NT	DD	ES	3,4,5,6,10,16
Melitaea cinxia (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,8,12,14
Melitaea diamina (Lang, 1789)	LC	-	ES	12
Melitaea didyma (Esper, 1778)	LC	-	ES	1,2,4,6,7,9,12,14,16
Melitaea phoebe (Denis & Schiffermüller, 1775)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16
Melitaea trivia (Denis & Schiffermüller, 1775)	LC	-	EO	1,2,3,4,5,6,12,16
Minois dryas (Scopoli, 1763)	LC	-	ES	2
Neptis sappho (Pallas, 1771)	LC	-	ES	1,2
Nymphalis antiopa (Linnaeus, 1758)	LC	VU	Hol	16
Pararge aegeria (Linnaeus, 1758)	LC	-	EO	3,14,15
Polygonia c-album (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12, 3,14,15,16,17,18
Pyronia tithonus (Linnaeus, 1758)	LC	-	EM	3,4
Vanessa atalanta (Linnaeus, 1758)	LC	-	Hol	1,2,3,4,5,6,7,8,9,10,11,12, 3,14,15,16,17,18
Vanessa cardui (Linnaeus, 1758)	LC	-	Cos	1,2,3,4,5,6,7,8,9,10,11,12, 3,14,15,16,17,18

Families	Red list Europe	Red list Kosovo	Faunal elements	Occurence (Localities on Fig. 1)
Papilionidae				
Iphiclides podalirius (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16
Papilio machon (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15
Parnassius mnemosyne (Linnaeus, 1758)	NT	-	EO	2,12
Zerynthia cerisy (Godart, 1824)	NT	NT	EO	1
Zerynthia polyxena (Denis & Schiffermüller, 1775)	LC	EN	EO	1,8
Pireidae				
Anthocharis cardamines (Linnaeus, 1758)	LC	-	ES	
Aporia crataegi (Linnaeus, 1758)	LC	-	ES	1,2,3,4,6,7,10,12
Colias alfacariensis (Berger, 1948)	LC	-	EO	1,2,3,4,7,9,10,12,14
Colias crocea (Geoffroy, 1785)	LC	-	ES	1,2,3,4,5,6,7,9,10,11,12, 13,14,15,16,17,18
Colias hyale (Linnaeus, 1758)	LC	-	ES	1,3,4,7,10
Gonepteryx rhamni (Linnaeus, 1758)	LC	-	ES	1,2,3,4,5,6,7,8,9,10,11,12,
Leptidea duponcheli (Staudinger, 1871)	LC	-	EO	1,2,3,4,5,6,7,9,14
Leptidea sinapis/juvernica (Linnaeus, 1758)	LC	-	ES	1,2,3,6,7,8,9,12,16
Pieris balcana (Lorkovic, 1970)	LC	-	ES	1,2,3,4,5,6,7,9,14
Pieris brassicae (Linnaeus, 1758)	LC	-	ES	1,2,6,9,16
Pieris ergane (Geyer, 1828)	LC	-	EO	3,4,6,10,14
Pieris manni (Mayer, 1851)	LC	-	EO	1,2,3,9
Pieris napi (Linnaeus, 1758)	LC	-	ES	1,2,3,4,7,9,14,16
Pieris rape (Linnaeus, 1758)	LC	-	Hol	1,2,3,4,6,7,9,12,14
Pontia edusa (Fabricius, 1777)	LC	-	ES	1,2,7,10
Riodinidae				
Hamearis lucina (Linnaeus, 1758)	LC	-	EM	12,14,15

Abbreviations: BM: Boreo-Montane; **DD**: Data Deficient; **EM**: Euro-Meridional; **EO**: Euro-Oriental; **ES:** Euro-Siberian; **Hol**: Holarctic; **LC**: Least concern; **Med**: Mediterranean; **Mon:** Montane; **NT:** Near Threatened; **Tro:** Tropical; **VU:** Vulnerable; **Cos:** (Cosmopolitan).

Table 3. Values for the diversity indices. S-Number of species, N-Abudance, H'-Shannon-Wiener diversity Index, E–Evenness, D–Simpson's Index, D_{Ma}–Margalef index, D_{Me}–Menhinick Index, Species richness estimator (chao1) per each of the surveyed localities in Koritnik Mt.

Indices	Localities																	
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
S	74	90	77	75	56	71	69	28	40	44	27	85	25	44	42	53	22	20
N	724	706	462	523	361	684	618	279	274	394	354	1085	229	302	344	357	227	235
H'	5.67	5.74	5.70	5.58	5.33	5.03	5.25	4.23	4.94	4.66	4.25	5.78	4.39	5.11	4.68	4.87	4.23	3.38
E	0.91	0.88	0.90	0.89	0.91	0.81	0.86	0.88	0.92	0.85	0.89	0.90	0.94	0.93	0.86	0.85	0.94	0.88
D	0.03	0.03	0.03	0.03	0.03	0.06	0.04	0.08	0.04	0.06	0.07	0.02	0.05	0.04	0.05	0.06	0.06	0.09
D_{Ma}	11.0	13.5	12.3	11.8	9.3	10.7	10.5	4.7	6.9	7.19	4.42	12.0	4.41	7.53	7.01	8.84	3.87	3.48
D_{Me}	2.75	3.38	3.58	3.27	2.94	2.71	2.77	1.67	2.41	2.21	1.43	2.58	1.65	2.53	2.26	2.80	1.46	1.30
S_{Chao1}	74.0	114.0	77.6	75.5	56.6	76.5	71.4	28	40	52.1	27	101.6	NA	44	48.4	59.0	NA	20

The fourth group includes localities S5 and S2, which are dominated by deciduous forests and dry natural meadows. The fifth group includes localities S16, S7, S6 and S4 are localities with semi-natural meadows in the vicinity of the first mountainous area, and the sixth group includes localities S3, S9, S8 and S1, dominated by semi-natural meadows located in the vicinity of residential areas where human-induced pressures such as agricultural activities, cattle grazing, and mowing could threaten butterfly species. PCA analysis (Fig. 5) shows a highly significant (p<0.01) general association between altitude and D-Simpson's Index in one site, and of temperature with species number, abundance and diversity indices in another site, indicating that if more individuals are encountered during sampling, there are more chances to add new species and hence improve species richness.

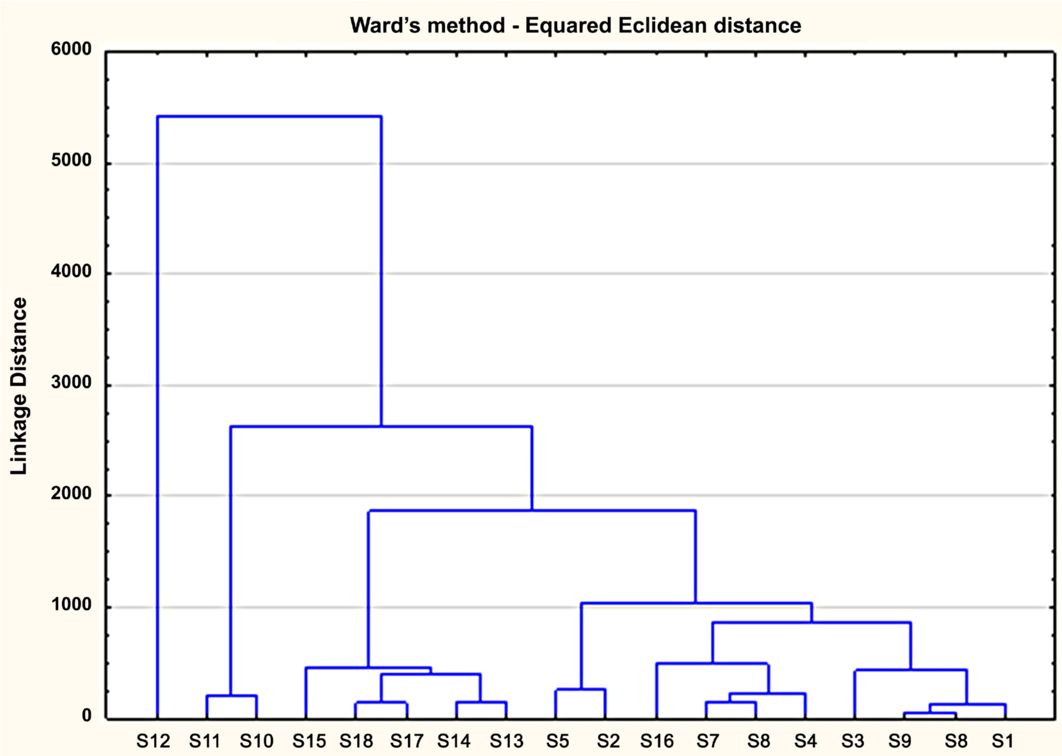

Figure 4. Dendrogram about butterfly similarity between habitats generated using statistica 12.

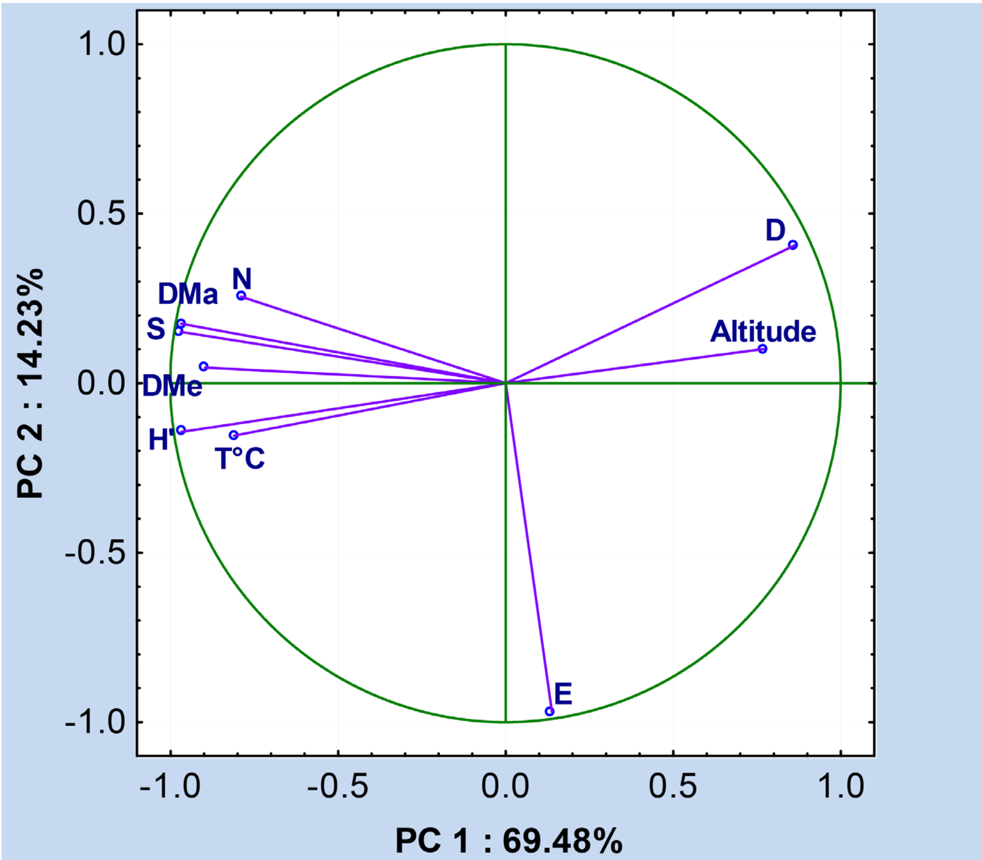

Figure 5. Principal component analysis (PCA) between diversity indices with temperature and altitude

DISCUSSION

Comprehensive studies on the biodiversity of butterflies in Kosovo are lacking, therefore, the final number of species in the country is yet to be determined. Previous studies have reported 174 butterfly species in Kosovo. Our first objective was to determine the species richness and abundance of butterfly in Kosovo's site of Mt. Koritnik. The findings from the first systematic survey of Mt. Koritnik in the Republic of Kosovo demonstrate a rich butterfly fauna, with 131 species recorded, accounting for 75.28% of the total number of species in Kosovo. This number of 131 recorded species makes up 75.2% of 174 species recorded so far in Kosovo (Rebel, 1913; Rebel & Zerny 1931; Jakšić & Živić, 1998; Zhushi-Etemi et al., 2016, 2017a, 2017b; Koren et al., 2021; Kabashi-Kastrati et al., 2022). According to Ibrahimi et al. (2019), two of these species are classified as endangered (EN) (*Zerynthia polyxena* and *Euphydryas aurinia*), six are vulnerable (VU) (*Carcharodus floccifera*, *Carterocephalus palaemon*, *Pyrgus sidae*, *Lycaena dispar*, *Phengaris alcon*, and *Nymphalis antiopa*), and six species are near threatened (NT) (*Thymelicus acteon*, *Cupido decolorata*, *Brintesia circe*, *Hipparchia fagi*, *Hipparchia statilinus*, and *Zerynthia cerisy*). At the European level, 11 species observed in the survey are near threatened, while the others are of least concern (van Swaay et al., 2010). The species *Hesperia comma*, *Lycaena dispar*, *Euphydryas aurinia*, and *Parnassius mnemosyne* have been included in both Annex II and IV of the Habitats directive (EU Habitat's Directive, 1992). Moreover, the Annex II of the Bern Convention (Conseil de l'Europe, 1979) also lists the species *Euphydryas aurinia*, *Apatura ilia*, *Parnassius mnemosyne*, *Lycaena dispar*, and *Zerynthia polyxena*. This number is comparable to other surveyed mountain massifs in the country, such as Sharri massif with 169 species, or Bjeshket e Numuna (Albanian Alps) with 139 species. However, this number is low in comparison with species number recorded in other mountain massifs in countries neighboring Kosovo, e.g. 168 species in Mt. Galičica in North Macedonia (Krpač et al., 2011; Popović et al., 2021), and 167 species in Stara Planina in Serbia (Popović et al., 2013; Langourov, 2019). Considering 496 butterfly species recorded in Europe (Wiemers et al., 2018), the 131 species recorded in our survey represent 26.14% of European butterfly fauna. Additional species are expected to be found in Kosovo due to their presence in neighbouring countries adjacent to the border. Butterfly distribution and diversity are influenced by several factors, such as habitat composition, vegetation, temperature, and altitude. These factors have been reported in various studies by other researchers (Meléndez-Jaramillo et al., 2021; Dar et al., 2022; Franzen et al., 2022). Vegetation is another important component that greatly influences butterfly composition (Luis-Martinez et al., 2000). Our study demonstrates that localities with rich floral diversity and medium altitudinal gradients have the highest diversity of butterflies. Our findings show that the distance between habitats, similar composition and structure of the vegetation, and other environmental parameters are substantially correlated with the similarity of the butterfly community between habitats. The Shannon diversity index values typically range from 1.5 to 3.5, seldom going higher than 4 in extremely diverse populations (Margalef, 1972). This shows that our study area in fact, has a very high diversity of butterflies. Similarly, high values have also been recorded by previous studies (Ren et al., 2022).

A frequent factor associated with changes in species richness and abundance is altitude (Meléndez-Jaramillo et al., 2019; Janzen, 1973). Numerous studies have shown the close relationship between altitude and diversity or distribution of butterflies (Muñoz & Amarillo-Suárez, 2010; Meléndez-Jaramillo et al., 2019). While most indices show a strong negative correlation (p <0.01) between altitude and species numbers and their abundance, Simpson's Index shows a positive correlation (p<0.05) (Fig. 5). In general, the number of specimens and species decreases as the altitudinal gradient increases (Mihoci et al., 2011). The results of diversity analysis according to the altitudinal changes were consistent with findings from other studies (Meléndez-Jaramillo et al., 2019; Habel et al., 2019; Topp et al., 2019; Popović et al., 2021; Kaltsas et al., 2018). Several studies have indicated that altitude is a crucial factor that affects climate patterns and the variation in plant species, which in turn have a significant influence on the distribution of butterfly species (Eyre et al., 2005). Studies on butterflies have also demonstrated how altitude affects their phenology in mountainous regions, showing that the timing of the flight period was later for assemblages at high altitudes than at low altitudes (Arce & Gutiérrez, 2011).

Many studies have shown that climate changes and habitat loss and destructions are the main drivers of biodiversity decrease (Cerrato et al., 2019; Warren, 2021). Mountain massifs are not an exception in this aspect since they are already facing the impact of these changes not only in temperature variation but also in biodiversity shifting upwards toward higher altitudinal gradients (Pauli et al., 2012; Scridel et al., 2018). Temperature is a factor that affects the distribution, activity, growth and reproduction of butterflies (Koneri et al., 2019). The correlation results show that temperature as an environmental factor has strong positive correlations (p<0.01) with the species abundance, species number, Shannon Wiener, Margalef and Menhinick's diversity indices, while Simpson's Index shows a strong negative correlation. Our results correspond with Munyuli (2013), suggesting that temperature has a strong positive correlation with the abundance of species. Temperature variation has both a negative and a positive impact on the abundance of the population (Colom et al., 2021). The influence of temperature on butterflies has been documented by numerous studies in different parts of the world (Na et al., 2021; Koneri et al., 2019; Aguirre-Gutiérrez et al., 2017). Our findings are consistent with these studies and indicate that as altitude increases and temperature decreases, both species richness and abundance decline. Due to their sensitivity to temperature, butterflies are impacted by climate change in many different ways (Na et al., 2021). Temperature is an important factor that influences the biological processes and survival, reproduction, and behaviour of butterflies, as noted by various researchers (Clarke, 2017; Franzén et al., 2022). The ability of the butterflies to survive and reproduce depends heavily on temperature changes; therefore, any deviation from the optimal temperature has a significant inhibitory effect (Dar et al., 2022). A research study conducted in the United States on lycaenid butterflies found that the start of their flight period advances by an average of two days for every degree Fahrenheit increase in temperature (Polgar et al., 2013). The authors argue that this response of butterfly species to temperature is similar to that of plant flowering and bee flight seasons.

Many insect species have perished as a result of human-induced alterations, but extinctions are best documented only in the most thoroughly studied taxa, such as Lepidoptera, highlighting their importance as indicator species for determining the severity of the current biodiversity crisis (Gupta et al., 2019). Although research at the European level has shown that grassland butterflies have decreased by 39% since 1990 (van Swaay et al., 2010; Warren et al., 2021), Lepidoptera (butterflies and moths) are declining in abundance globally, according to research conducted on a global scale (35% over 40 years) (Dirzo et al., 2014). Regarding the significant species for conservation, it should be noted that out of the 131 species recorded in our survey, 18 are included in the Red Book of Kosovo's Fauna (Ibrahimi et al., 2019). Among them, there are *Parnassius mnemosye*, *Euphydryas aurinia*, and *Zerynthia polyxena*, which are also listed in Annex II of the Bern Convention. As in other European countries, biodiversity has been degraded in Kosovo, primarily by anthropogenic activities. Even though Mt. Koritnik lies within the of the mountain massif Sharrit protected area, parts of it has been subject to forest fires. In line with this, we consider that the low number of *Erebia* species in our survey (n=4), which are typically forest species, compared to 12 species of *Erebia* recorded in Mt. Pashtrik (Jakšić & Živić, 1998), the closest aerial location to Koritnik, may be due to the disappearance of larval foodplants as a result of fires, habitat degradation and the succession where new pioneer plants have appeared. The fact that there is no historical data on butterfly diversity from Mt. Koritnik prevents us from making a comparison between the current and past states of butterflies in the area. The 131 recorded butterfly species in Koritnik Mountain represent the rich fauna of this area. However, this number should not be considered as final, considering that species of genus *Erebia* are only sporadically present due to the consequences of the forest fire some years ago.

One of our objectives in this paper was to find out how the altitudinal gradient and temperature impacts the species distribution. Our findings show that the environmental factor with the greatest influence on butterfly diversity, abundance, and dispersion is altitude. The lowest altitude zone has the most species, and as altitude increases, the number of species decreases. Moreover, temperature has a significant impact on the diversity of organisms. Contrary to altitude, temperature is shown to have a positive correlation with abundance, species number and diversity. However, poor butterfly diversity in low altitude and human-populated areas is primarily due to anthropogenic activities including intense agriculture, cattle grazing, and habitat changes. The biggest risks to the butterfly diversity in Mt. Koritnik are fires, intensive agriculture, lack of mowing in grasslands, and illegal timber cutting. Although the biodiversity protection measures in the country are far from the desired ones, it should be stated that in recent years protection of biodiversity in Kosovo has been given more attention compared to previous decades. The basis for such activities is the legislation set out by the Law NO. 03/L-025 on Environmental Protection, Law NO.03/L–233 of Nature Protection, and bylaws Administrative Instruction MEE - No. 12 /2020 For Proclamation of wild species protection. Also, thanks to the initiative by the Ministry of Environment and Spatial planning, in 2019 the Red book of the fauna of Kosovo was published. Since 2016, the area of Mt. Koritnik, based on decision no. 14/74 by the government of the Republic of Kosovo, has been placed under strict protection as a strict zone of endemic and relict forest of *Pinus heldrechii* and herbaceous vegetation rich in rare endemic and relict plants. All these legal actions are a good basis for the protection of biodiversity, including butterflies. However, despite the existing legislation, no programs for monitoring butterflies or other animal and plant species are organized or required in Mt. Koritnik or other protected areas by the competent authorities. Regular monitoring of the butterfly diversity would be necessary in order to identify the potential threats for species and take conservation measures in time.

AUTHOR'S CONTRIBUTION

The authors confirm their contribution in the paper as follows: P. Bytyçi and F. Zhushi-Etemi: Fieldwork, sampling of specimens, identification of specimens, writing, and reviewing.E. Kabashi-Kastrati: Fieldwork and literature review. H. Çadraku: Map design and Field work. The authors read and approved the final version of the manuscript.

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AVAILABILITY OF DATA AND MATERIAL

The specimens listed in this study are deposited at the Department of Biology, Faculty of Mathematics and Natural Sciences, University of Prishtina,and available upon request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this paper.

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REFERENCES

Aguirre-Gutiérrez, J., WallisDeVries, M.F., Marshall, L., van't Zelfde, M., Villalobos-Arámbula, A.R., Boekelo, B. & Biesmeijer, J.C. (2017) Butterflies show different functional and species diversity in relationship to vegetation structure and land use. *Global Ecology and Biogeography*, 26 (10), 1126–1137. https://doi.org/10.1111/geb.12622

Ahmetaj, I. & Lenjani, V. (1989) Veçoritë Morfohidrografike të Koritnikut verior, dhe gropes së Llapushës, me Veshtrim të Veqantë, Hidrografis Kastrike të tyre. *Kërkime Gjeografike, Prishtinë*, 10 (1), 29–36.

Bytyçi, P., Zhushi-Etemi, F., Çadraku, H., Kabashi-Kastrati, E., Muja-Bajraktari, N. & Fetoshi, O. (2021) Diversity of Hesperiidae, Pieridae and Papilionidae Butterflies (Lepidoptera, Papilionoidea) in the mountain massif Shkoza in Kosovo. *Entomologist's Gazette*, 72 (2), 131–136. https://doi.org/10.31184/G00138894.722.1790

Cerrato, C., Rocchia, E., Brunetti, M., Bionda, R., Bassano, B., Provenzale, A. & Viterbi, R. (2019) Butterfly distribution along altitudinal gradients: temporal changes over a short time period. *Nature Conservation*, 34 (34), 91–118. https://doi.org/10.3897/natureconservation.34.30728

Chao, A. (1984) Nonparametric estimation of the number of classes in a population. *Scandinavian Journal of statistics*, 34 (1), 265–270.

Clarke, A. (2017) Principles of thermal ecology: Temperature, energy and life. Oxford University Press, Oxford, 464 p. https://doi.org/10.1093/oso/9780199551668.001.0001

Colom, P., Traveset, A., Carreras, D. & Stefanescu, C. (2021) Spatio-temporal responses of butterflies to global warming on a Mediterranean island over two decades. *Ecological Entomology*, 46 (2), 262–272. https://doi.org/10.1111/een.12958

Comay, O., Ben Yehuda, O., Schwartz-Tzachor, R., Benyamini, D., Pe'er, I., Ktalav, I. & Pe'er, G. (2021) Environmental controls on butterfly occurrence and species richness in Israel: The importance of temperature over rainfall. *Ecology and Evolution,* 11 (17), 12035–12050. https://doi.org/10.1002/ece3.7969

Conseil de l'Europe (1979) *Convention relative à la conservation de la vie sauvage et du milieu naturel de l'Europe*. Berne, 19.ix.1979. Série des traités européens No. 104. Strasbourg, France. 12 p.

EU Habitat's Directive (1992) *Council directive 92/43/EEC of 21 may 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora. European Commission*: Brussels, Belgium, Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043 [Accessed April 18, 2023]

Dar, A.A., Jamal, K., Shah, M.S., Ali, M., Sayed, S., Gaber, A. & Salah, M. (2022) Species richness, abundance, distributional pattern and trait composition of butterfly assemblage change along an altitudinal gradient in the Gulmarg region of Jammu & Kashmir, India. *Saudi Journal of Biological Sciences*, 29 (4), 2262–2269. https://doi.org/10.1016/j.sjbs.2021.11.066

Arce, J.I. & Gutierrez, D. (2011) Altitudinal trends in the phenology of butterflies in a mountainous area in central Spain. *European Journal of Entomology*, 108 (4), 651. https://doi.org/10.14411/eje.2011.083

Dirzo, R., Young, H.S., Galetti, M., Ceballos, G., Isaac, N.J. & Collen, B. (2014) Defaunation in the Anthropocene. *Science*, 345 (6195), 401–406. https://doi.org/10.1126/science.1251817

Eyre, M.D., Foster, G.N. & Luff, M.L. (2005) Exploring the relationship between land cover and the distribution of water beetle species (Coleoptera) at the regional scale. *Hydrobiologia*, 533, 87–98. https://doi.org/10.1007/s10750-004-2397-6

Franzén, M., Francioli, Y., Askling, J., Kindvall, O., Johansson, V. & Forsman, A. (2022) Yearly weather variation and surface temperature drives the spatiotemporal dynamics of a threatened butterfly and its host plant. *Frontiers in Ecology and Evolution*, 10, 917991. https://doi.org/10.3389/fevo.2022.917991

Griffiths, H.I., Kryštufek, B. & Reed, J.M. (eds) (2004) *Balkan Biodiversity: Pattern and process in the European hotspot*. Springer, Netherlands. 368 p.

Gupta, A.K. & Sardana, N. (2015) Significance of clustering coefficient over jaccard index. *Eighth International Conference on Contemporary Computing* (IC3). 20–22 August, 2015. Noida, India, pp. 463–466. (IEEE 2015) https://doi.org/10.1109/IC3.2015.7346726

Gupta, H., Tiwari, C. & Diwakar, S. (2019) Butterfly diversity and effect of temperature and humidity gradients on butterfly assemblages in a sub-tropical urban landscape. *Tropical Ecology*, 60, 150–158. https://doi.org/10.1007/s42965-019-00019-y

Habel, J.C., Trusch, R., Schmitt, T., Ochse, M. & Ulrich, W. (2019) Long-term large-scale decline in relative abundances of butterfly and burnet moth species across south-western Germany. *Scientific Reports*, 9 (1), 1–9. https://doi.org/10.1038/s41598-019-51424-1

Ibrahimi, H., Gashi, A., Rexhepaj, D., Zhushi Etemi, F., Grapci Kotori, L., Fehér, Z., Bino, T., Šerić Jelaska, L., Mesaroš, G. & Théou, P. (2019) *Red book of fauna of the Republic of Kosovo*. Ministry of Environment and Spatial Planning. Kosovo Institute for Nature Protection, Prishtina. 210 p.

Jakšić, P. (1987) Specifični elementi faune Lepidoptera nekih kosovskih klisura. *Priroda Kosova, Priština*, 6 (1), 93–107.

Jakšić, P. (1998a) [The butterflies of Šar-planina Mt. (Lepidoptera: Hesperioidea & Papilionoidea)]. *Zaštita Prirode* (Beograd), 50, 229–252.

Jakšić, P. (1998b) Distribution of butterfly communities (Lepidoptera: Hesperioidea and Papilionoidea) in plant communities over the Jažinačko jezero lake region on Šar-planina Mt. *Natural Sciences*, 2, 71–75.

Jakšić, P. & Živić, N. (1998) The butterflies of the Kosovo and Metohija in south Serbia (Lepidoptera: Hesperioidea and Papilionoidea). *Glasnik Prirodnjačkog Muzeja u Beogradu*, 49–50, 201– 218.

Janzen, D.H. (1973) Sweep samples of tropical foliage insects: effects of seasons, vegetation types, elevation, time of day, and insularity. *Ecology*, 54 (3), 687–708. https://doi.org/10.2307/1935359

Jørgensen, S., Xu, L. & Costanza, R. (eds) (2016) *Handbook of Ecological Indicators for Assessment of Ecosystem Health*. CRC press, Boca Raton. 498 p. https://doi.org/10.1201/EBK1439809365

Kabashi-Kastrati, E., Zhushi-Etemi, F., Çadraku, H. & Bytyçi, P. (2022) First record of *Heteropterus morpheus* (Pallas, 1771)(Lepidoptera: Hesperiidae) from the Republic of Kosovo. *Ecologia Balkanica*, 14 (1), 149–153.

Kaltsas, D., Dede, K., Giannaka, J., Nasopoulou, T., Kechagioglou, S., Grigoriadou, E. & Avtzis, D.N. (2018) Taxonomic and functional diversity of butterflies along an altitudinal gradient in two NATURA 2000 sites in Greece. *Insect Conservation and Diversity*, 11 (5), 464–478. https://doi.org/10.1111/icad.12292

Koneri, R., Nangoy, M.J. & Siahaan, P. (2019) The abundance and diversity of butterflies (Lepidoptera: Rhopalocera) in Talaud Islands, North Sulawesi, Indonesia. *Biodiversitas Journal of Biological Diversity*, 20 (11), 3275–3283. https://doi.org/10.13057/biodiv/d201121

Koren, T., Kulijer, D., Vukotić, K. & Zhushi-Etemi, F. (2021) Contribution to the knowledge of the butterfly diversity (Lepidoptera: Papilionoidea) of Kosovo. *Entomologist's Gazette*, 72 (2), 119–129. https://doi.org/10.31184/G00138894.722.1789

Krebs, C.J. (1999) *Ecological Methodology*. 2nd edition. Addison-Welsey Educational Publishers, Menlo Park, CA, USA. 620 p.

Krpač, V., Darcemont, C., Krpač, M. & Lemonnier-Darcemont, M. (2011) Fauna of butterflies (Papilionoidea) in the National Park Galičica, Republic of Macedonia. *Nota Lepidopterologica*, 34 (1), 49–78.

Kudrna, O., Harpke, A., Lux, K., Pennerstorfer, J., Schweiger, O., Settele, J. & Wiemers, M. (2011) *Distribution Atlas of Butterflies in Europe*. Gesellschaft für Schmetterlingsschutz, Halle. 576 p.

Landry, B., Karsholt, O., Zahiri, R. & Rajaei, H. (2023) How many Lepidoptera species are waiting to be discovered in Iran? An estimation of the total lepidopteran fauna. *Integrative Systematics: Stuttgart Contributions to Natural History*, 6 (supple 1), 83–90. https://doi.org/10.18476/2023.997558.5

Langourov, M. (2019) New data on the butterflies of Western Stara Planina Mts (Bulgaria & Serbia) (Lepidoptera, Papilionoidea). *Ecologica Montenegrina*, 20, 119–162.

Ludwig, J.A. & Reynolds, J.F. (1988) *Statistical Ecology: A Primer in Methods and Computing*. Vol. 1. John Wiley & Sons, New York. 358 p.

Luis-Martinez, A., Llorente, J.B., Vargas, I.F., Gutiérrez, AL. (2000) Síntesis preliminar del conocimiento de los Papilionoidea (Lepidoptera: Insecta) de México. *Monografías Tercer Milenio*, 1, 275–285.

Margalef, R. (1958) Information theory in ecology. *General Systems*, 3 (1), 36–71.

Margalef, R. (1972) Homage to Evelyn Hutchinson, or why there is an upper limit to diversity. *Connecticut Academy of Arts and Sciences*, 44, 211–235. https://doi.org/10.3897/zookeys.1037.66001

Meléndez-Jaramillo, E., Cantú-Ayala, C., Sánchez-Reyes, U.J., Sandoval-Becerra, F.M. & Herrera-Fernández, B. (2019) Altitudinal and seasonal distribution of butterflies (Lepidoptera, Papilionoidea) in cerro bufa el diente, Tamaulipas, Mexico. *ZooKeys*, 900, 31–68. https://doi.org/10.3897/zookeys900.36978

Meléndez-Jaramillo, E., Cantú-Ayala, C.M., Treviño-Garza, E.J., Sánchez-Reyes, U.J. & Herrera-Fernández, B. (2021) Composition and diversity of butterflies (Lepidoptera, Papilionoidea) along an atmospheric pollution gradient in the Monterrey Metropolitan area, Mexico. *ZooKeys*, 1037, 73–103.

Menhinick, E.F. (1964) A comparison of some species-individuals diversity indices applied to samples of field insects. *Ecology*, 45, 859–861. https://doi.org/10.2307/1934933

Mihoci, I., Hršak, V., Kučlinić, M., Stanković, V.M., Delić, A. & Tvrtković, N. (2019) Butterfly diversity and biogeography on the Croatian karst mountain Biokovo: Vertical distribution and preference for altitude and aspect?. *European Journal of Entomology*, 108 (4), 623–633. https://doi.org/10.14411/eje.2011.081

Muñoz, A. & Amarillo-Suárez, Á. (2010) Variación altitudinal en diversidad de Arctiidae y Saturniidae (Lepidoptera) en un bosque de niebla Colombiano. *Revista Colombiana de Entomología*, 36 (2), 292–299. https://doi.org/10.25100/socolen.v36i2.9161

Munyuli, M.T. (2013) Drivers of species richness and abundance of butterflies in coffee–banana agroforests in Uganda. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 9 (4), 298–310. https://doi.org/10.1080/21513732.2012.709539

Na, S., Lee, E., Kim, H., Choi, S. & Yi, H. (2021) The relationship of mean temperature and 9 collected butterfly species' wingspan as the response of global warming. *Journal of Ecology and Environment*, 45, 1–8. https://doi.org/10.1186/s41610-021-00193-y

Nieukerken, V., Kaila, L., Kitching, I.J., Kristensen, N.P., Lees, D.C., Minet, J., Mitter, C., Mutanen, M., Regier, J.C., Simonsen, T.J. et al. (2011) Order Lepidoptera Linnaeus, 1758. In: Zhang, Z.-Q. (ed) Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. *Zootaxa*, 3148 (1), 99–103. https://doi.org/10.11646/zootaxa.3148.1.14

Nowicki, P., Settele, J., Henry, P. Y. & Woyciechowski, M. (2008) Butterfly monitoring methods: the ideal and the real world. *Israel Journal of Ecology & Evolution*, 54 (1), 69–88. https://doi.org/10.1560/IJEE.54.1.69

Pauli, H., Gottfried, M., Dullinger, S., Abdaladze, O., Akhalkatsi, M., Alonso, J.L.B., Coldea, G., Dick, J., Erschbamer, B., Calzado, RF. et al. (2012) Recent Plant Diversity Changes on Europe's Mountain Summits. *Science*, 336, 353–355. https://doi.org/10.1126/science.1219033

Pe'er, G. & Settele, J. (2008) Butterflies in and for conservation: Trends and prospects. *Israel Journal of Ecology & Evolution*, 54 (10), 7–17. https://doi.org/10.1560/IJEE.54.1.7

Polgar, C.A., Primack, R.B., Williams, E.H., Stichter, S. & Hitchcock, C. (2013) Climate effects on the flight period of Lycaenid butterflies in Massachusetts. *Biological Conservation,* 160, 25–31. https://doi.org/10.1016/j.biocon.2012.12.024

Popović, M., Đurić, M., Franeta, F. & Verovnik, R. (2013) On the extremely rich butterfly fauna (Lepidoptera: Rhopalocera) of the south-eastern foothills of Stara Planina Mts in Serbia. *Phegea*, 41, 74–81.

Popović, M., Micevski, B. & Verovnik, R. (2021) Effects of elevation gradient and aspect on butterfly diversity on Galičica Mountain in the Republic of Macedonia (south–eastern Europe). *Animal Biodiversity and Conservation*, 44 (1), 67–78. https://doi.org/10.32800/abc.2021.44.0067

Rebel, H. (1913) Studien über die Lepidopterenfauna der Balkanländer, Teil III. Sammelergebnisse aus Montenegro, Albanien, Mazedonien und Thrazien. Annalen des K.K. *Naturhistorischen Hofmuseums*, 27, 281–334.

Rebel, H. & Zerny, H. (1931) Die Lepidopterenfauna Albaniens. *Denkschriften der Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse,* 103, 37–161.

Rempala, G.A. & Seweryn, M. (2013) Methods for diversity and overlap analysis in T-cell receptor populations. *Journal of Mathematical Biology*, 67 (6–7), 1339–1368. https://doi.org/10.1007/s00285-012-0589-7

Ren, J., Li, S., He, M. & Zhang, Y. (2022) Butterfly community diversity in the Qinling mountains. *Diversity*, 14 (1), 27. https://doi.org/10.3390/d14010027

Rexhepi, F. (1994) *The Vegetation of Kosova. Monography*, University Prishtina. 10–120 [in Albanian]

Sánchez-Bayo, F. & Wyckhuys, K.A. (2019) Worldwide decline of the entomofauna: A review of its drivers. *Biological Conservation*, 232, 8–27. https://doi.org/10.1016/j.biocon.2019.01.020

Scridel, D., Brambilla, M., Martin, K., Lehikoinen, A., Iemma, A., Matteo, A. & Chamberlain, D. (2018) A review and meta-analysis of the effects of climate change on Holarctic mountain and upland bird populations. *Ibis*, 160 (3), 489–515. https://doi.org/10.1111/ibi.12585

Thomas, J.A., Clarke, R.T., Randle, Z., Simcox, D.J., Schönrogge, K., Elmes, G.W. & Settele, J. (2005) Maculinea and myrmecophiles as sensitive indicators of grassland butterflies (umbrella species), ants (keystone species) and other invertebrates. In Settele, J.; Kühn, E.; Thomas, J. (eds) *Studies on the Ecology and Conservation of Butterflies in Europe. Vol. 2. Species Ecology Along a European Gradient: Maculinea Butterflies as a Model.* Hauptlesesaal, Leipzig, pp: 28–31.

Tolman, T. & Lewington, R. (2008) *Collins Butterfly Guide. The most complete guide to the butterflies of Britain and Europe*. Harper Collins, London. 384 p.

Topp, E.N. & Loos, J. (2019) Local and landscape level variables influence butterfly diversity in critically endangered South African renosterveld. *Journal of Insect Conservation*, 23, 225–237. https://doi.org/10.1007/s10841-018-0104-6

Tshikolovets, V.V. (2011) *Butterflies of Europe and the Mediterranean Area.* Tshikolovets Publications, Pardubice. 544 p.

Tzortzakaki, O., Kati, V., Panitsa, M., Tzanatos, E. & Giokas, S. (2019) Butterfly diversity along the urbanization gradient in a densely-built Mediterranean city: Land cover is more decisive than resources in structuring communities. *Landscape and Urban Planning*, 183, 79–87. https://doi.org/10.1016/j.landurbplan.2018.11.007

van Swaay, C., Cuttelod, A., Collins, S., Maes, D., López Munguira, M., Šašić, M., Settele, J., Verovnik, R., Verstrael, T., Warren, M., Wiemers, M. & Wynhoff, I. (2010) *European Red List of Butterfies*. Publications Office of the European Communities, Luxembourg. 100 p.

Varga, Z. (2014) Biogeography of the high mountain Lepidoptera in the Balkan Peninsula. *Ecologica Montenegrina*, 1 (3), 140–168. https://doi.org/10.37828/em.2014.1.21

Vorontsov, I.E., Kulakovskiy, I.V. & Makeev, V.J. (2013) Jaccard index-based similarity measure to compare transcription factor binding site models. *Algorithms for Molecular Biology*, 8 (1), 1–11. https://doi.org/10.1186/1748-7188-8-23

Warren, M.S., Maes, D., van Swaay, C.A., Goffart, P., van Dyck, H., Bourn, N.A. & Ellis, S. (2021) The decline of butterflies in Europe: Problems, significance, and possible solutions. *Proceedings of the National Academy of Sciences*, 118 (2), e2002551117. https://doi.org/10.1073/pnas.200255111

Wiemers, M., Balletto, E., Dincă, V., Fric, Z.F., Lamas, G., Lukhtanov, V. & Verovnik, R. (2018) An updated checklist of the European butterflies (Lepidoptera, Papilionoidea). *ZooKeys*, 811, 9–45. https://doi.org/10.3897/zookeys.811.28712

Xie, Z., Wang, Y., Cao, J., Wang, J. & An, J. (2021) Ecological resilience of pollination in the face of pollinator decline: Content, mechanism and perspective. *Biodiversity Science*, 29 (7), 980–994. https://doi.org/10.17520/biods.2020470

Zhang, Z., Cui, X., Zhou, J., Huang, C., Deng, J., Tang, X. & Luo, S. (2021) Pollination of the orchid Habenaria rhodocheila by the swallowtail butterfly Papilio helenus in subtropical evergreen broad-leaved forests in Southern China. *Flora*, 274, 151736. https://doi.org/10.1016/j.flora.2020.151736

Zhushi-Etemi, F., Bytyçi, P., Ismaili, M., Visoka, V. & Musliu, M. (2016) Contribution to the knowledge of the Lycaenidae fauna of central part of Kosovo. *Macedonian Journal of Ecology and Environment*, 18 (2), 29–36. https://doi.org/10.59194/MJEE16182029ze

Zhushi-Etemi, F., Bytyci, P.S., Ismail, M.A. & Musliu, M.Q. (2017a) Contribution to the knowledge of Nymphalidae fauna (Lepidoptera: Rhopalocera) in Kosovo. *Trakia Journal of Sciences*, 2, 101–105. https://doi.org/10.15547/tjs.2017.02.001

Zhushi-Etemi, F., Bytyqi, P. & Visoka, V. (2017b) New records of *Araschnia levana* (Linneaus, 1758)(Lepidoptera: Nymphalidae) in Kosovo. *Journal of International Environmental Application and Science*, 12 (1), 5–8.

Zhushi-Etemi, F., Bytyqi, P., Musliu, M. & Ceka, R. (2018) Distribution of butterfly species (Lepidoptera: Papilionoidea) in the protected area "Mirusha waterfalls" in Kosovo. *Natura Croatica: Periodicum Musei Historiae Naturalis Croatici*, 27 (2), 305–314. https://doi.org/10.20302/NC.2018.27.19

Zhushi-Etemi, F., Visoka, V., Çadraku, H. & Bytyçi, P. (2020) Contribution to the knowledge of the butterfly fauna (Lepidoptera: Papilionoidea) of the north-eastern part of the Republic of Kosovo. *Polish Journal of Entomology*, 89 (4), 181–189. https://doi.org/10.5604/01.3001.0014.4590

Appendix 1. Similarity in butterfly species composition between sampling sites (Jaccard's index)

Ja	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
S1	0.7263	0.5100	0.5851	0.4444	0.6111	0.5889	0.3247	0.4250	0.4048	0.3117	0.5000	0.2857	0.4217	0.3488	0.4111	0.1707	0.1605
S2	-	0.5321	0.5714	0.4600	0.5784	0.5900	0.2688	0.4286	0.3814	0.2717	0.6355	0.2500	0.3958	0.3069	0.3884	0.1429	0.1340
S3	-	-	0.7273	0.5287	0.4369	0.5368	0.3291	0.3765	0.4578	0.3165	0.4727	0.2750	0.4578	0.3371	0.3830	0.1928	0.1687
S4	-	-	-	0.5976	0.5208	0.5824	0.2875	0.3855	0.5063	0.3077	0.5094	0.2658	0.4337	0.3448	0.3913	0.1975	0.1728
S5	-	-	-	-	0.5301	0.5432	0.4237	0.4118	0.5385	0.4561	0.5000	0.3729	0.4706	0.4848	0.5352	0.3448	0.3103
S6	-	-	-	-		0.5909	0.3200	0.4231	0.4375	0.3425	0.5294	0.2800	0.3690	0.3951	0.4588	0.2078	0.1974
S7	-	-	-	-	-	-	0.3472	0.4730	0.4868	0.3521	0.5876	0.3239	0.4675	0.4051	0.4699	0.1974	0.1867
S8	-	-	-	-	-	-	-	0.5111	0.4694	0.7188	0.2989	0.6563	0.4694	0.4583	0.3729	0.3889	0.3714
S9	-	-	-	-	-	-	-	-	0.4483	0.5581	0.3587	0.4773	0.5000	0.3898	0.3881	0.2917	0.2766
S10	-	-	-	-	-	-	-	-	-	0.5435	0.3723	0.4681	0.3968	0.4098	0.3472	0.2941	0.2800
S11	-	-	-	-	-	-	-	-	-	-	0.3023	0.7931	0.4792	0.5000	0.3793	0.4848	0.4688
S12	-	-	-	-	-	-	-	-	-	-	-	0.2791	0.3871	0.3956	0.4526	0.2022	0.1932
S13	-	-	-	-	-	-	-	-	-	-	-	-	0.5682	0.5952	0.3929	0.4242	0.4063
S14	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5636	0.4923	0.2941	0.2800
S15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5574	0.3617	0.3191
S16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4151	0.3774
S17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9091

Appendix 2. Sorensen similarity index in Koritnik Mountain.

So	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
S1	0.8410	0.6755	0.7383	0.6154	0.7586	0.7413	0.4902	0.5965	0.5763	0.4752	0.6667	0.4444	0.5932	0.5172	0.5827	0.2917	0.2766
S2	-	0.6946	0.7273	0.6301	0.7329	0.7421	0.4237	0.6000	0.5522	0.4274	0.7771	0.4000	0.5672	0.4697	0.5594	0.2500	0.2364
S3	-	-	0.8421	0.6917	0.6081	0.6986	0.4952	0.5470	0.6281	0.4808	0.6420	0.4314	0.6281	0.5042	0.5538	0.3232	0.2887
S4	-	-	-	0.7481	0.6849	0.7361	0.4466	0.5565	0.6723	0.4706	0.6750	0.4200	0.6050	0.5128	0.5625	0.3299	0.2947
S5	-	-	-	-	0.6929	0.7040	0.5952	0.5833	0.7000	0.6265	0.6667	0.5432	0.6400	0.6531	0.6972	0.5128	0.4737
S6	-	-	-	-	-	0.7429	0.4848	0.5946	0.6087	0.5102	0.6923	0.4375	0.5391	0.5664	0.6290	0.3441	0.3297
S7	-	-	-	-	-	-	0.5155	0.6422	0.6549	0.5208	0.7403	0.4894	0.6372	0.5766	0.6393	0.3297	0.3146
S8	-	-	-	-	-	-	-	0.6765	0.6389	0.8364	0.4602	0.7925	0.6389	0.6286	0.5432	0.5600	0.5417
S9	-	-	-	-	-	-	-	-	0.6190	0.7164	0.5280	0.6462	0.6667	0.5610	0.5591	0.4516	0.4333
S10	-	-	-	-	-	-	-	-	-	0.7042	0.5426	0.6377	0.5682	0.5814	0.5155	0.4545	0.4375
S11	-	-	-	-	-	-	-	-	-	-	0.4643	0.8846	0.6479	0.6667	0.5500	0.6531	0.6383
S12	-	-	-	-	-	-	-	-	-	-	-	0.4364	0.5581	0.5669	0.6232	0.3364	0.3238
S13	-	-	-	-	-	-	-	-	-	-	-	-	0.7246	0.7463	0.5641	0.5957	0.5778
S14	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7209	0.6598	0.4545	0.4375
S15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7158	0.5313	0.4839
S16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5867	0.5479
S17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9524

تنوع زیستی روزپرک‌ها (Lepidoptera, Papilionoidea) در کوهستان کوریتنیک، جمهوری کوزوو

پایتیم بیتیچی[1]، فردیجه ژوشی-اِتمی[1،*]، ادونا کاباشی-کاستراتی[1] و حاضر چادراکو[2]

۱ گروه زیست شناسی، دانشکده ریاضیات و علوم طبیعی، دانشگاه پریشتینا، کوزوو.
۲ مرکز آموزش عالی کالابریا، پریشتینا، کوزو.

* پست الکترونیک نویسنده مسئول مکـاتبه: *ferdije.zhushi@uni-pr.edu*

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چکیـــده: این مقاله، به مطالعه شاخص‌های فراوانی، توزیع و تنوع زیستی پروانه‌ها در کوه کوریتنیک در جمهوری کوزوو طی سال‌های ۲۰۱۹ تا ۲۰۲۲ می‌پردازد. طی این تحقیق در مجموعه ۸۱۶۶ نمونه پروانه متعلق به ۶ خانواده، ۵۰ جنس و ۱۳۱ گونه ثبت شد. فراوان ترین خانواده به لحاظ فراوانی، Nymphalidae با ۴۶۱۱ نمونه (۵۶.۴۷٪) بود و پس از آن خانواده Lycaenidae با ۱۹۲۴ نمونه (۲۳.۵۶٪)، Pieridae با ۸۵۶ نمونه (۱۰.۴۸٪)، Hesperiidae با ۵۶۱ نمونه (۶.۸۷٪)، Papilionidae با ۱۷۹ نمونه (۲.۱۹٪) و Riodinidae با ۲۴ نمونه (۰.۲۹%) قرار گرفتند. به لحاظ غنای گونه‌ای، خانواده Nymphalidae با ۵۵ گونه، Lycaenidae با ۴۰ گونه و Pieridae با ۱۵ گونه غنی‌ترین خانواده‌ها بودند. از بین ۱۳۱ گونه ثبت شده، ۱۱ گونه در اروپا در وضعیت نزدیک به تهدید قرار دارند. نتایج ما نشان داد که شاخص‌های غنای گونه‌ای و فراوانی به طور معنادار ($p<0.01$) با ارتفاع از سطح دریا منفی همبستگی داشت، در حالی که با دما همبستگی مثبت قوی نشان دادند ($p<0.01$). بیشترین فراوانی و تعداد گونه‌ها در محدوده ارتفاعات پایین‌تر بود و این تعداد با افزایش ارتفاع کاهش یافت. فعالیت‌هایی مانند کشاورزی شدید، چرای دام، آتش سوزی و قطع غیرقانونی درختان که در طول بررسی ما مشاهده شد، ممکن است از اصلی‌ترین تهدیدات پروانه ها در کوه کوریتنیک در آینده باشد. بنابراین، پیشنهاد می‌کنیم که یافته‌های این تحقیق به عنوان اطلاعات پایه و در راستای نظارت بر تغییرات آینده در تنوع پروانه ها توسط مقامات اجرای استفاده شود.

واژگـان کلیدی: فراوانی، ارتفاع، محیط زیست، انتشار، درجه حرارت، غنای گونه‌ای