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Contribution to the knowledge of the butterfly fauna (Lepidoptera: Papilionoidea) of the north-eastern part of the Republic of Kosovo

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Abstract: Butterflies are highly sensitive to habitat and climate changes, and are recognized as important indicators of the state of the environment. Therefore their diversity needs to be studied on a regional scale in order to take actions for their protection by national and international legislation. Here, the results of a butterfly survey in the northeastern part of Kosovo are presented. A total of 93 species were recorded from 2014 to 2017 in six localities, including seven Hesperiidae, four Papilionidae, 15 Pieridae, 25 Lycenidae, 41 Nymphalidae and a single species of Riodinidae. Six of them are listed in the Red List of European Butterflies, all as Near Threatened: *Cupido decoloratus* (Staudinger, 1886), *Pseudophilotes vicrama* (Moore, 1865), *Hipparchia statilinus* (Hufnagel, 1766), Melitaea *aurelia* (Nickerl, 1850), Melitaea *diamina* (Lang, 1789) and *Parnassius mnemosyne* (Linnaeus, 1758). Five species are listed in the recently published Red book of the fauna of Kosovo: two species as Vulnerable (VU), *Lycaena dispar* (Haworth, 1802) and *Thecla betulae* (Linnaeus, 1758) and three as Near Threatened, *Cupido decoloratus* (Staudinger, 1886), *Papilio machaon* (Linnaeus, 1758) and *Zerynthia cerysi* (Godart, 1824). From a zoogeographical point of view, the reported species represent eight faunal elements: 51 Euro-Siberian (ES), 27 Euro-Oriental (EO), six Euro-Meridional (EM), five Holarctic (Hol), two Tropical (Tro), one Boreo-Montane (BM), one Cosmopolitan (Cos) and one Mediterranean (Med). We conclude that 93 species of butterfly fauna recorded in this survey represent a relatively high diversity, but further surveys need to be organized in order to gather more data.

Key words: survey, indicators, diversity, habitat, Red List

Introduction

There are 496 species of butterflies in Europe belonging to seven families: Hesperiidae, Lycaenidae, Nymphalidae, Hedylidae, Papilionidae, Pieridae and Riodinidae (Wiemers *et al.* 2018).

According to the Red List of European Butterflies (Van Swaay *et al.* 2010) about a third of European butterflies species experienced a decline in their populations over the last 10 years and 9% are threatened. The biggest threats for butterflies are considered to be the loss of suitable habitats as a result of the intensification of agricultural activities, deforestation, fires, climate change, construction of settlements in rural areas, and tourism.

The state of Kosovo covers an area of 10 887 km^2 in the central part of Balkan Peninsula. The country is surrounded by mountains, with the highest peak Gjeravica (2 656 m) in the Albanian Alps in the West; in the South, Sharri mountains separate Kosovo from North Macedonia (Humolli 2014); in the East, lower mountains Gollaku extend, whereas in the North and Northeast, Kopaonik mountains separate Kosovo from Serbia. Continental climate predominates, with hot

and dry summers and cold winters, with a Mediterranean influence from the Adriatic Sea along the border with Albania, the warmest area in the country, and Agean Sea in the South. Average annual temperature is 9.5°C (Pllana 2015).

There are two main protected areas in Kosovo: National Park Sharri and National Park Bjeshket e nemuna (both in the Albanian Alps).

In terms of vegetation, Kosovo is very diverse, with 139 plant associations, among which the dominant are: *Quercetum farnetto cerris scardicum, Quercetum montanum* and *Fagetum moseiacae montanum* (Rexhepi 1994).

The earliest researches on the butterfly fauna of Kosovo were organized by the Museum of Natural History in Vienna, and published by Rebel (1913, 1917) and Rebel & Zerny (1931). Other surveys in different parts of Kosovo were mainly carried out by Gradojević (1930/31) and Jakšić (1987, 1987, 1988, 1998, 1994/1998). Based on the analyses of the material collected systematically over 20 years (Jakšić and Zivic, 1994-98) the butterfly fauna of the present territory of the Republic of Kosovo is composed by 171 species of Papilionoidea and Hesperioidea.

Zhushi *et al.* (2016, 2017, 2018) continued contributing with data on butterfly diversity in Kosovo. However, a complete faunal check-list has not yet been published due to the lack of a systematic research in the entire territory of the country.

Previously, 147 species were reported from the National Park Sharri, on both sides of the Kosovo-Macedonia border (Jaksic, 1988), 83 species from the Regional Park Mirusha Waterfalls (Zhushi *et al.* 2018), 98 species from Mount Pashtrik (Jaksic 2007) and 139 from Mount Bjeshkët e Nemuna (Jakšić 2006), which nowadays has a National Park status, and 63 species (Lycaenidae and Nymphalidae) from the massif of Shkoza in central Kosovo (Zhushi *et al*. 2016, 2017)

The recently published Red Book of the Fauna of Kosovo includes 14 butterfly species listed in different categories (Ibrahimi *et al.* 2019). The aim of this study is to present the butterfly fauna of the northeastern part of Kosovo as a modest contribution to the general knowledge of the butterfly fauna of this country.

Material and methods

Butterflies were recorded by standard methods using an entomological net in a number of localities listed below (Table 1), differing in altitude above the sea level as well as in habitat types. Three out of six surveyed localities are located in the area of Kopaoniku mountains: Bollosicë, Marincë and Murgullë.

Most of the captured butterflies were released once identified in the field, except a certain number of individuals that were stored in the collection at the Department of Biology, Faculty of Natural Sciences at the University of Pristina. In a few cases male genitalia were examined using standard procedures, involving maceration in hot KOH, dissecting, cleaning and fixing in Canada balsam. Butterflies were mostly collected during dry and sunny days, from 10:00 to 16:00 p.m. Their identification is based on Tolman & Lewington (2008), whereas the nomenclature follows the updated checklist of European Butterflies (Wiemers *et al.* 2018). Zoogeographical classification of faunal elements is based on (Kudrna *et al.* 2019).

Study area

The field research was conducted in six localities in the northeastern part of the Republic of Kosovo, from April to September of 2014, and several times in 2015–2017. In order to include diverse habitats in our study, we decided to conduct our survey in areas situated at different altitudes above the sea level (890–1170 m, localities 1, 2, 3 and 4) as well as in lowland areas (500–600 m, localities 5 and 6). The surveyed area is situated in the northeastern part of Kosovo (Fig. 1), in the municipality of Podujevo. The landscape of this region is very diverse. In the western part

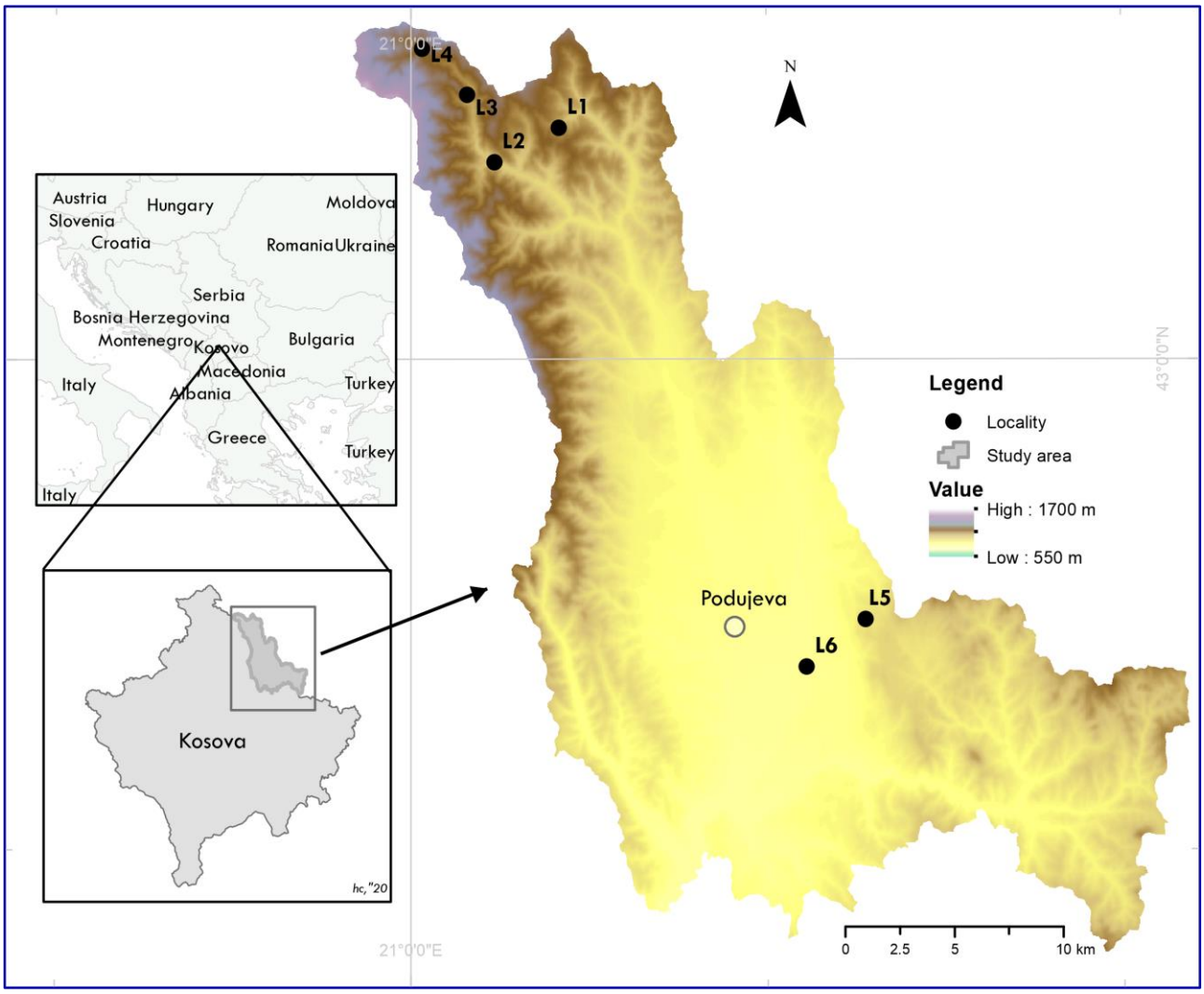

Fig. 1. The Map of surveyed area with localities.

border with Serbia, it reaches up to 1 770 m, while in the South, in the valley of the River Lab, it reaches about 550 m. The region is characterized by temperate continental climate but due to its geographical position and its landscape, it presents some specific characteristic features. This part of the study area is also rich in water resources. It is an agricultural province with plowing, livestock and to a lesser degree, forestry constitute its main economic activities. This area used to be identified as one of the largest areas of forests in Kosovo, which unfortunately, after 1999, became highly devastated. Its vegetation consists of the following plant associations: *Quercetum farnetto cerris scardicum*, *Fagetum moseiacae montanum, Abieti-Fagetum moseiacae, Erico-Pinetum nigrae, Polygalo-Pedicularietum heterodonate, Onobrychidi-Trifolium pannonici* and *Astragalo-Calamintheum hungaricum* (Rexhepi 1994).

Results

During this survey, a total of 2 600 butterfly individuals were recorded, belonging to 93 species, including seven Hesperiidae, four Papilionidae, 15 Pieridae, 25 Lycenidae, 41 Nymphalidae, and one Riodinidae (Table 2).

In terms of species richness, the recorded species represent 54.38% of the butterfly fauna of Kosovo (Zhushi *et al*. 2016, 2017, 2018, Jakšić & Živić 1994/1998).

The most species-rich locality is Recice with 68 recorded species, followed by Balloc and Sfeqel with 52 species each. In three other localities, Murgulle, Marince and Bollosice, situated in the Mount Kopaonik area a lower number of species was recorded. Among all

documented species, 27 were recorded in all localities, whereas 23 are recorded in only one out of six localities.

According to the Red Data List of European Butterflies among the 93 recorded species, six species belong to the near threatened (NT) category: *Cupido decolorata* (Staudinger, 1886), *Pseudophilotes vicrama* (Moore, 1865), *Hipparchia statilinus* (Hufnagel, 1766), *Melitaea aurelia* (Nickerl, 1850), *Melitaea diamina* (Lang, 1789) and *Parnassius mnemosyne* (Linnaeus, 1758).

The species *Colias crocea* (Geoffroy, 1785), was the most abundant species with the largest number of specimens in studied localities (59 specimens).

In zoogeographical terms, 49 species (53.1%) are Euro-Siberian (ES); 27 (28.12%) are Euro-Oriental (EO); 6 species (6.25%) are Euro-Meridional (EM); 5 species (5.2%) are Holarctic (Hol), 2 species (2.08%) are Tropical (Tro), and 1 are Boreo-Montane (BM), Cosmopolitan (Cos) and Mediterranean (Med) each (Tab. 2).

Discussion

Our study was the first survey of the faunal composition of butterflies in north-eastern Kosovo. Due to the fact that grassland was the most dominant habitat type in the surveyed area, the largest number of species are typical grassland species.

It should be noted that all seven Widespread grassland butterflies, indicator species for European grasslands (Van Swaay et al. 2005, 2008 were recorded in our survey: *Ochlodes sylvanus* (Esper, 1761), *Anthocharis cardamines* (Linnaeus, 1758), *Lycaena phlaeas* (Linnaeus, 1761), *Polyommatus icarus* (Rottemburg, 1775), *Lasiommata megera* (Linnaeus, 1767), *Coenonympha pamphilus* (Linnaeus, 1758) and *Maniola jurtina* (Linnaeus, 1758), as well as four out of ten specialist grassland species: *Erynnis tages* (Linnaeus, 1758), *Cupido minimus* (Fuessly, 1775), *Polyommatus bellargus* (Rottemburg, 1775) and *Polyommatus coridon* (Poda, 1761). The presence of the above grassland indicator species in the study area is a good opportunity to develop in the future butterfly monitoring schemes to record population dynamics trends.

Based on the recent report (Van Swaay *et al.* 2019), the index of grassland butterfly abundance has declined by 39% since 1990, indicating a dramatic loss of grassland biodiversity. The species trends in EU countries during the years 1990–2017 have shown a decline of six indicator species, a stable status of seven other species, while four species have increased as the result of the actions taken for prevention of loos of biodiversity and restoration measures.

Table1. Surveyed localities with geographic coordinates, altitudes and habitat type.

Locality	Altitude m asl	Latitude [N]	Longitude [E]	Habitat types
1. Reçicë	892	43°06'04"	21°05'51"	Wet grassland, stream bank, woodland margins
2. Murgullë	972–1 007	43°05'50"	21°02'15"	River bank, dry grassland on the right side of the river bridge, woodland margins
3. Marincë	982	43°06'99"	21°02'23"	Stream bank, deciduous woodland, wet grassland
4. Bollosicë	1176	43.06'71"	21.00'18"	Mountain grassland, stream bank, woodland margins
5. Balloc	600–700	42°53'41"	21°14'55"	Woodland, woodland margins, natural and cultivated grasslands, agriculture land and riverbank
6. Sveqël	580–600	42°53'52"	21°13'01"	Agriculture land, cultivated grassland with sparse shrubs and trees

Table 2. The list of butterfly species recorded in surveyed localities in the northeastern part of the Republic of Kosovo.

Species	Faunal Elements Kudrna *et al*. 2019)	IUCN Status	Reçicë	Murgull	Marincë	Bollosicë	Balloc	Sfeqël
Hesperiidae								
Erynnis tages (Linnaeus, 1758)	ES	LC	+	+	-	-	-	-
Hesperia comma (Linnaeus, 1758)	Hol	LC	+	-	-	-	-	-
Ochlodes sylvanus (Esper, 1761)	ES	LC	+	+	+	+	-	-
Pyrgus malvae (Linnaeus, 1758)	ES	LC	+	-	-	-	+	+
Pyrgus sidae (Esper, 1784)	EO	LC	+	-	-	-	+	+
Spialia orbifer (Hübner, 1823)	EO	LC	-	-	-	-	+	+
Thymelicus sylvestris (Poda, 1761)	EO	LC	+	-	-	-	-	-
Lycaenidae								
Aricia aegestis (Denis & Schiffermüller, 1775)	ES	LC	+	-	-	-	-	-
Callophrys rubi (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Celastrina argiolus (Linnaeus, 1758)	ES	LC	+	+	-	-	-	-
Cupido decoloratus (Staudinger, 1886)	EM	NT	-	+	-	-	-	-
Cupido minimus (Fuessly, 1775)	ES	LC	+	+	-	-	-	-
Cupido osiris (Meigen, 1828)	EO	LC	-	+	-	-	-	-
Glaucopsyche alexis (Poda, 1761)	ES	LC	+	-	+	-	-	-
Lampides boeticus (Linnaeus, 1767)	Tro	LC	+	-	-	-	-	-
Leptotes pirithous (Linnaeus, 1767)	Tro	LC	+	-	-	-	-	-
Lycaena alciphron (Rottemburg, 1775)	EO	LC	+	-	-	-	-	-
Lycaena dispar (Haworth, 1802)	ES	LC	+	+	+	+	+	+
Lycaena phlaeas (Linnaeus, 1761)	Hol	LC	+	-	-	-	+	+
Lycaena thersamon (Esper, 1784)	EO	LC	+	-	-	-	-	-
Lycaena tityrus (Poda, 1761)	ES	LC	+	-	-	-	+	+
Lycaena virgaureae (Linnaeus, 1758)	ES	LC	+	-	-	-	-	-
Plebejus argus (Linnaeus, 1758)	ES	LC	-	+	-	-	-	-
Plebejus argyrognomon (Bergsträsser, 1779)	ES	LC	-	+	-	-	-	-
Polyommatus bellargus (Rottemburg, 1775)	EO	LC	-	+	-	-	+	+
Polyommatus coridon (Poda, 1761)	EO	LC	-	+			+	+
Polyommatus daphnis (Denis & Schiffermüller, 1775)	EO	LC	-	+	-	-	-	-
Polyommatus icarus (Rottemburg, 1775)	ES	LC	+	+	+	+	+	+
Polyommatus thersites (Cantener, 1835)	ES	LC	-	+	-	-	-	-
Pseudophilotes vicrama (Moore, 1865)	EO	NT	-	+	-	-	-	-
Satyrium ilicis (Esper, 1779)	EO	LC	+	+	-	-	-	-
Thecla betulae (Linnaeus, 1758)	ES	LC	+	-	-	-	-	-
Nymphalidae								
Aglais io (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Aglais urticae (Linnaeus, 1758)	ES	LC	-	+	-	-	+	+
Apatura ilia (Denis & Schiffermüller, 1775)	ES	LC	+	-	-	-	-	-
Aphantopus hyperantus (Linnaeus, 1758)	ES	LC	+	+	-	-	-	-
Araschnia levana (Linnaeus, 1758)	ES	LC	+	-	-	-	-	-
Argynnis pandora (Denis & Schiffermüller, 1775)	ES	LC	+	-	-	-	-	-
Arethusana arethusa (Denis & Schiffermüller, 1775)	ES	LC	-	+	-	-	+	+
Argynnis adippe (Denis & Schiffermüller, 1775)	ES	LC	-	+	-	+	-	-
Speyeria (*Argynnis*) *aglaja* (Linnaeus, 1758)	ES	LC	+	-	+	-	-	-
Argynnis paphia (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Boloria euphrosyne (Linnaeus, 1758)	ES	LC	-	-	-	+	+	+
Brenthis daphne (Bergsträsser, 1780)	ES	LC	-	+	-	+	+	+
Brenthis hecate (Denis & Schiffermüller, 1775)	ES	LC	+	-	-	+	-	-
Brintesia circe (Fabricius, 1775)	EO	LC	+	+	-	-	+	+

Coenonympha arcania (Linnaeus, 1761)	EM	LC	+	-	-	-	-	-
Coenonympha leander (Esper, 1784)	EO	LC	-	-	-	-	+	+
Coenonympha pamphilus (Linnaeus, 1758)	EO	LC	+	+	+	+	+	+
Coenonympha rhodopensis (Esper, 1784)	Med	LC	-	-	-	-	+	+
Erebia medusa (Denis & Schiffermüller, 1775)	ES	LC	-	-	-	-	+	+
Hipparchia semele (Linnaeus, 1758)	EM	LC	+	-	-	-	-	-
Hipparchia statilinus (Hufnagel, 1766)	EM	NT	+	-	-	-	-	-
Issoria lathonia (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Kirinia roxelana (Cramer, 1777)	EO	LC	+	+	+	+	+	+
Lasiommata megera (Linnaeus, 1767)	EO	LC	+	+	+	+	+	+
Limenitis reducta (Staudinger, 1901)	EO	LC	+	-	-	-	+	+
Maniola jurtina (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Melanargia galathea (Linnaeus, 1758)	EO	LC	+	+	+	+	+	+
Melanargia larissa (Geyer, 1828)	EO	LC	+	+	+	+	+	+
Melitaea athalia (Rottemburg, 1775)	ES	LC	+	-	-	-	-	-
Melitaea aurelia (Nickerl, 1850)	ES	NT	-	+	+	+	-	-
Melitaea cinxia (Linnaeus, 1758)	ES	LC	-	-	+	+	+	+
Melitaea diamina (Lang, 1789)	ES	NT	-	-	-	-	+	+
Melitaea didyma (Esper, 1778)	ES	LC	+	+	+	+	+	+
Melitaea phoebe (Denis & Schiffermüller, 1775)	ES	LC	+	+	+	+	+	+
Minois dryas (Scopoli, 1763)	ES	LC	+	-	-	-	-	-
Nymphalis antiopa (Linnaeus, 1758)	Hol	LC	-	-	-	-	+	+
Pararge aegeria (Linnaeus, 1758)	EO	LC	+	-	-	-	+	+
Polygonia c-album (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Pyronia tithonus (Linnaeus, 1758)	EM	LC	+	-	-	-	+	+
Vanessa atalanta (Linnaeus, 1758)	Hol	LC	+	+	+	+	+	+
Vanessa cardui (Linnaeus, 1758)	Cos	LC	+	+	+	+	+	+
Papilionidae								
Iphiclides podalirius (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Papilio machon Linnaeus, 1758	ES	LC	-	-	-	-	+	+
Parnassius mnemosye (Linnaeus, 1758)	EO	NT	+	-	-	-	+	+
Zerynthia cerisy (Godart, 1824)	EO	LC	+	-	-	-	-	-
Pieridae								
Anthocharis cardamines (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Aporia crataegi (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Pieris ergane (Geyer, 1828)	EO	LC	+	-	-	-	-	-
Colias alfacariensis (Berger, 1948)	EO	LC	+	+	+	+	+	+
Colias crocea (Geoffroy, 1785)	ES	LC	+	+	+	+	+	+
Colias hyale (Linnaeus, 1758)	ES	LC	-	-	-	-	+	+
Gonepteryx rhamni (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Leptidea duponcheli (Staudinger, 1871)	EO	LC	+	-	+	-	-	-
Leptidea sinapis/juvernica (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Pieris balcana (Lorkovic, 1970)	ES	LC	-	+	-	-	-	-
Pieris brassicae (Linnaeus, 1758)	ES	LC	+	-	-	-	+	+
Pieris ergane (Geyer, 1828)	EO	LC	+	-	+	-	-	-
Pieris manni (Mayer, 1851)	EO	LC	+	+	+	+	+	+
Pieris napi (Linnaeus, 1758)	ES	LC	+	+	+	+	+	+
Pieris rapae (Linnaeus, 1758)	Hol	LC	+	+	+	+	+	+
Pontia edusa (Fabricius, 1777)	ES	LC	+	-	-	-	-	-
Riodinidae								
Hamearis lucina (Linnaeus, 1758)	EM	LC					+	
Number of species			**68**	**47**	**33**	**34**	**52**	**52**

In line with this, we should mention that the potential threats for grassland species in surveyed area are: mowing, which is done several times during the year, grazing, intensive agriculture, and changes in land use.

An interesting species reported during this study is *Parnassius mnemosyne* (Linnaeus, 1758), listed as a NT in Europe. It was found to be well represented species with numerous population in the study area, and was recorded in by other authors in Kosovo, in the National Park Malet e Sharrit (Šar Planina), National Park Bjeshket e nemuna (Prokletije) (Jakšić 2003, 2006), and in the Mirusha Waterfall Park (Zhushi-Etemi *et al*. 2018). During our survey it was recorded in three localities. Its populations are stable in Kosovo, therefore it is not considered a Near Threatened species in this country.

Lycaena dispar is a species listed on the Habitats Directive Annexes 2 and 4 and in the Bern Convention Annex 2. It was reported, although with low number of specimens, in all six surveyed localities, which indicates good habitat conditions for this species. However, the protection of its natural habitats and its management should be given more consideration in the future due to the exposition of this species to the threats from intensive agriculture, changes in water ecosystems, and abandoned grasslands.

Hipparchia statilinus is another species with NT status and listed in Annex 2 of Habitats Directive, reported during this survey. It was found only in the first locality, in woodland habitat. Similarly to grassland species, woodland species are also exposed to threats caused by changes in management practices. Intensive forestry for economic benefit has caused the abandonment of traditional practices, such as forest grazing and coppicing that benefited butterfly communities in the past (Slamova *et al*. 2013).

It is interesting to point out very limited records of *Pieris brassicae* (Linnaeus, 1758). Despite the fact that Sfeqel consists of large parts of cultivated areas potentially suitable for this species, only one specimen was recorded in July. A very fast decline of the populations of this species in Kosovo must increase the awareness of the need of urgent measures to be taken from the government to protect this species before it becomes extinct. This species was earlier recorded in most of the surveyed areas in Kosovo (Jakšić-Zivic 1998, Zhushi-Etemi *et al*. 2018).

Pseudophilotes vicrama is another interesting species reported here. Only a few records in Kosovo were known so far. We found a single individual in Murgulle in 2017, in a wet habitat near a river bank. In the neighboring countries surrounding Kosovo (North Macedonia: Verovnik *et al*. 2010, Albania: Cuvelie *et al*. 2018, Serbia: Popovic & Verovnik 2018), *P. vicrama* is a common and widespread species. The lack of historical records from Kosovo should be attributed to the lack of systematic butterfly surveys in most parts of the country.

The difference in the total number of butterflies as well as in the number of species between the localities can be related to intensity of survey but also to different geographic and climate conditions, as well as different level of anthropogenic disturbances in studied localities. The localities 1, 2, 3 and 4 are situated in sparsely populated areas, characterized by the heterogeneity of habitat types and less anthropogenic impact, whereas localities 5 and 6 are located in rural areas with intensive agricultural activities and severe anthropogenic impact, in line with many studies, including the one carried out in in central Spain (Gutiérrez *et al.* 2016), which demonstrate that urban areas and arable lands habitats are unfavorable to butterflies. The data provided by the Podujevo Municipal authorities showed that important logging of forests has been taking place in this region over the last seventeen years. As mentioned above, forestry activities are listed as one of the major threats for butterfly diversity in Europe, therefore it may have influenced butterfly diversity over the time.

Conclusion

This research is a valuable contribution to the knowledge of the butterfly fauna on a local and regional scale. Although the surveyed area is not large, the number of 93 recorded species shows a rich butterfly fauna. In terms of habitat dominance, the grassland habitats were the most dominant and richest in species diversity.

Nymphalidae dominate with 42 species (43.75%), whereas from a zoogeographical point of view this study revealed a strong dominance of Euro-Siberian elements, which made up 53.10% of all species.

Due to the lack of sampling for butterflies of this part of the country in the past, it is impossible to compare our results from a historical perspective. We consider that it should be recommended to the local and national authorities to control the grassland management as well as forestry activities/ logging in this area having in mind, among others, the protection of butterflies and their habitats.

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