

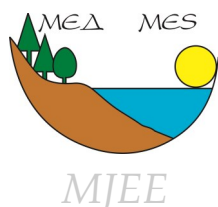
Contribution to the knowledge of the Lycaenidae fauna of central part of Kosovo

Прилог кон познавањето на фауната на Lycaenidae во централните делови на Косово

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Kosovo has a rich and diverse fauna of butterflies which, recently, is arising a huge interest of biodiversity researchers. In this paper, the results of the research of butterflies of the family Lycaenidae, conducted in the mountains of Ceri, Stermica and Kryeguri, in the central part of Kosovo, are presented. Butterflies were collected in the period May – September 2016 in 11 localities with diverse habitat types. In total 519 specimens that belong to thirty-one species of Lycaenidae have been recorded. The highest taxa richness, 28 species, was registered in the locality 2 (Shannon-Wiener diversity index $H' = 4.73$) whereas the poorest, with only 7 recorded species, was the locality 8 ($H' = 2.60$). Five out of 31 species occurred in all types of habitats in the study area, three species occurred only in one. The commonest and the most abundant species during the survey was *Glaucopsyche alexis* (Poda, 1761) that occurred in all 11 localities of the survey.

In regard to conservation status, all the recorded species are evaluated against the regional (European) IUCN categories in the European Red list of Butterflies. Out of them 29 are classified as Least Concerned (LC), one as Endangered (EN), and two as Near Threatened (NT).

Our results show that like all other butterflies, the diversity of Lycaenidae butterflies is influenced by diversity of habitats, climate, altitude, relief and other factors.

Key words: Lycaenidae, Kosovo, diversity, taxonomic richness, abundance

Богатата фауна на дневните пеперутки на Косово побудува голем интерес кај истражувачите на биолошката разновидност. Во овој труд ќе бидат прикажани резултатите од истражувањето на пеперутките од фамилијата Lycaenidae кои беа спроведени на планината Милановац (Цер, Стрмница и Заногина Краста) во централните делови на Косово. Пеперутките беа собирани во периодот мај-септември 2016 година на 11 локалитети во различни типови хабитати. Вкупно беа регистрирани 519 примероци од 31 вид од Lycaenidae. Најголем број видови (28) беше регистриран во локалитетот бр. 2 (Shannon-Wiener diversity index $H' = 4.73$), а најмал број видови (7) во локалитетот 8 ($H' = 2.60$). Пет видови беа утврдени во сите типови хабитати во истражуваното подрачје, а три видови се среќаваа само во еден локалитет. Најчест и најзастапен вид беше *Glaucopsyche alexis* (Poda, 1761) кој беше утврден во сите 11 локалитети.

Конзервациониот статус на видовите беше определен според Европската црвена листа на пеперутки на IUCN. Најголем дел (29 видови) беа класифицирани како *незасегнат* (LC), еден како *загрозен* (EN) и два како *близу загрозени* (NT).

Нашите резултати покажаа дека разновидноста на пеперутките од фамилијата Lycaenidae зависи од разновидноста на хабитатите, климата, надморската височина, релјефот и други фактори.

Клучни зборови: Lycaenidae, Косово, разновидност, видово разнообразие, абундантност.

Introduction

In Europe, there are 482 species of butterflies, divided into six families. Family Lycaenidae with 129 species, is the second largest, it includes the blues, the coppers and the hairstreaks, generally small brightly colored butterflies, sometimes with a metallic glow. (Van Swaay at al.2010).

The Balkan peninsula, due to its biogeography, climate and vegetation component is very rich in butterfly diversity, hosting numerous species of very restricted distribution. The highest number of species, 235 is recorded in

Greece (Pamperis, 2009). The evidence that Balkan Peninsula has a rich butterfly fauna is also supported by records and publication from neighboring countries with Kosovo. Based on existing data, in Macedonia 203 species of butterflies are recorded (Krpach & Mihailova, 1997; Micevski & Micevski, 2003; Verovnik at al.2010, Abdija, 2015). Regarding the Butterfly fauna in Albania, the recent studies have confirmed records of 200 species of butterflies (Misja, 2005; Verovnik and Popović, 2013; Micevski at al.2015, Šašić M. et al., 2015). According to existing data, the butterfly fauna in Serbia consists of 199 species, (Jakšić, Nahirnić and Petrović, 2013). Although in earlier survey the number of Lepidoptera species recorded in Montenegro was 160, (Sijarić, 1984) the recent data (Švara, Zakšek and Verovnik, 2015) show the record of 112 species for butterfly fauna of Montenegro.

Submitted: 25.11.2016

Accepted: 10.01.2017

The state of Kosovo covers an area of 10,887 square kilometers in the central part of Balkan Peninsula. Due to its geomorphology, climate and pedology, it represents a very rich area in terms of biodiversity and natural values. Despite the number of previous researches conducted in Kosovo, the inventory of butterfly fauna is not completed yet.

The first record of butterfly fauna from the territory of Kosovo was published by dr. H. Rebel (Rebel, 1913, 1917); Rebel and Zerny (1931) and Gradojević (1930-31). After these publications there was a long period without any butterfly research in this region. The new data on fauna of Lepidoptera for this territory were published by Djorović (1974, 1975, 1992) and Jakšić (1987, 1988, 1998, 1999, 2003, 2006 and 2007).

According to these sources, 147 butterfly species were reported from National Park Sharri (on both sides of the Kosovo-Macedonia border); 98 species in Mt. Pashtrik; 110 species from Regional Park Germia near Prishtina and 139 in Mt. Bjeshkët e Nemuna (Prokletije in Albanian Alps), which nowadays has a status of a National Park. (Jakšić, 1987; 1988, 1998, 1999; 2003, 2006 and 2007).

In recent years, no new research on fauna of butterflies were conducted nor published for Kosovo.

The main aim of our study was to expand the knowledge for butterfly fauna of Kosovo with new data from previously unexplored areas.

Material and Methods

Study area

The research was conducted once per week during the months May – September 2016 in 11 localities (Fig 2) in the mountains Ceri, Stermnica and Kryeguri, in the central part of Kosovo (Fig.1) that covers an area of about 7.9 km². These three mountains belong to the massif of Shkoza which divide the region of Llapusha from the Anadrini region. The terrain configuration is hilly mountainous with an altitude of 640 m up to 893 m asl. Mountain Gryeguri (893 m) lies in the north-west, and is characterized with karstic geological formations, whereas the mountain Ceri (810 m) has south-east position and is covered with high vegetation. In western direction of the village between these two massifs, lies a plateau 2-3 km², which creates a significant portion of agricultural land even though no irrigation. The north-eastern part represents the most important part, with few water sources, although poor in water (Samadraxha, 2009).



Figure 1. Position of Kosovo on the Balkan Peninsula and its regions

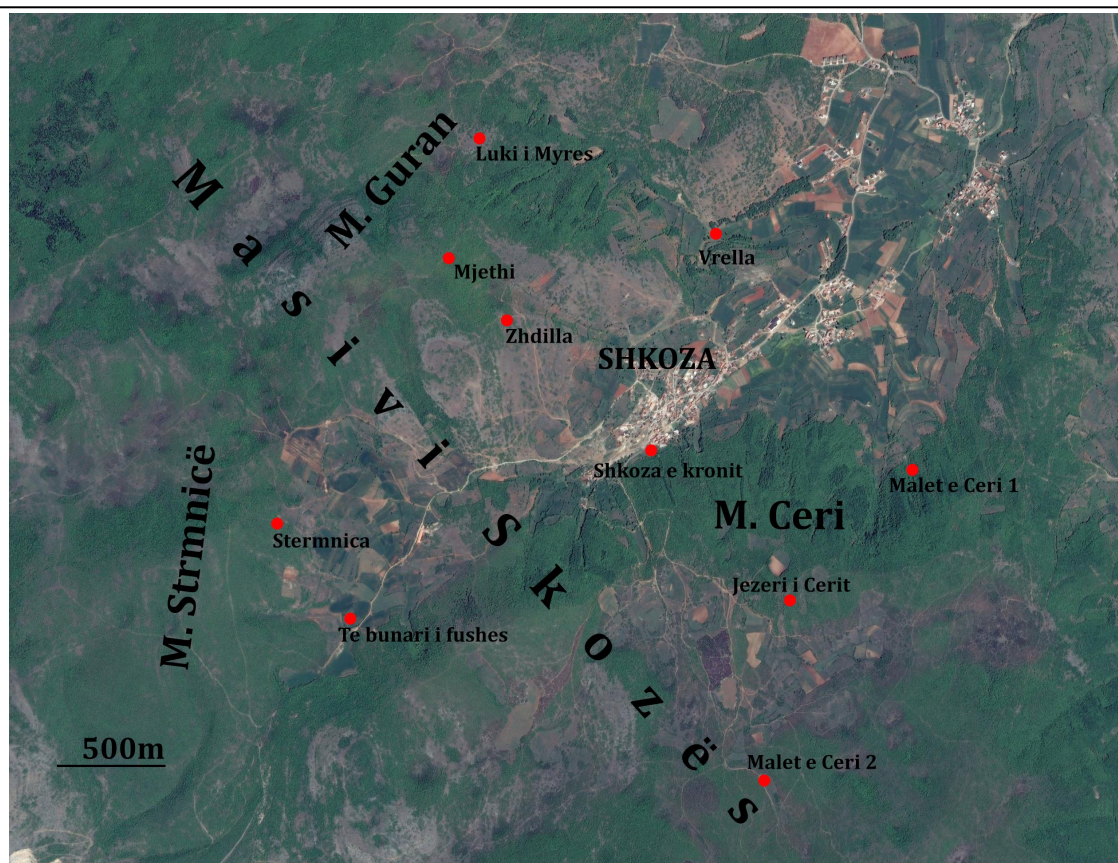


Figure 2. Map of study area, with survey localities

Table 1. The habitat types, coordinates of the surveyed localities and altitude

	Localities	N	E	Altitude
1.	Mjethi (Dry meadows with pastures)	42° 25'00. 40"	20 ° 42' 06.19"	712 m
2.	Te bunari i fushes (Agro ecosystems with water springs in the vicinity and animal stables)	42 ° 24'45. 57"	20 ° 41' 46.10"	706 m
3.	Stermnica (Woodland combined with grasslands with many pioneer species occurred after the fire in 2012)	42 ° 25'00. 20"	20 ° 41' 30. 95"	765 m
4.	Zhdilla (Dry meadows with mixed woodland)	42 ° 25'32. 44"	20 ° 42' 19.54"	753 m
5.	Arat në Rrafsh (Agroecosystems)	42 ° 25'19. 72"	20 ° 43' 21.71"	576 m
6.	Vrella (Agroecosystems with water springs in the vicinity)	42 ° 25'42. 87"	20 ° 42' 58.49"	574 m
7.	Malet e Cerit 1 (Woodland and woodland margins)	42 ° 43'39. 56"	20 ° 43' 39.56"	683 m
8.	Malet e Cerit 2 (Woodland with alpine meadows)	42 ° 24'20. 96"	20 ° 43' 10.22"	756 m
9.	Shkoza e kronit (Inside the settlements, near the area with wastes)	42 ° 25'10. 51"	20 ° 42' 45.32"	623 m
10.	Jezeri i Cerit (Woodland with dry rocky meadows)	42 ° 24'48. 37"	20 ° 43'15. 72"	751 m
11.	Luki i Myres (Woodland combined with mixed rocky meadows)	42 ° 25'56. 79"	20 ° 42'13. 56"	745 m

The climate of this region is continental, with some different elements of Mediterranean climate from the valley of the river White Drini. This climate is characterized by cold winters and long, hot and dry summers. The geology of Ceri, Stermnica and Kryeguri is composed of limestone rocks and serpentine, which makes this area very arid with poor water sources. In regard to pedology,

because of the limestone composition of the rocks, the soil composition is "tera rosa" (red- reddish earth) All these characteristics, geologic structure, altitude and weather conditions have influenced the diversity of flora and fauna. In terms of vegetation, in this region appears the plant association *Quercetum pubescentis - cerris* (Rexhepi, 1994) and is obvious the large presence of

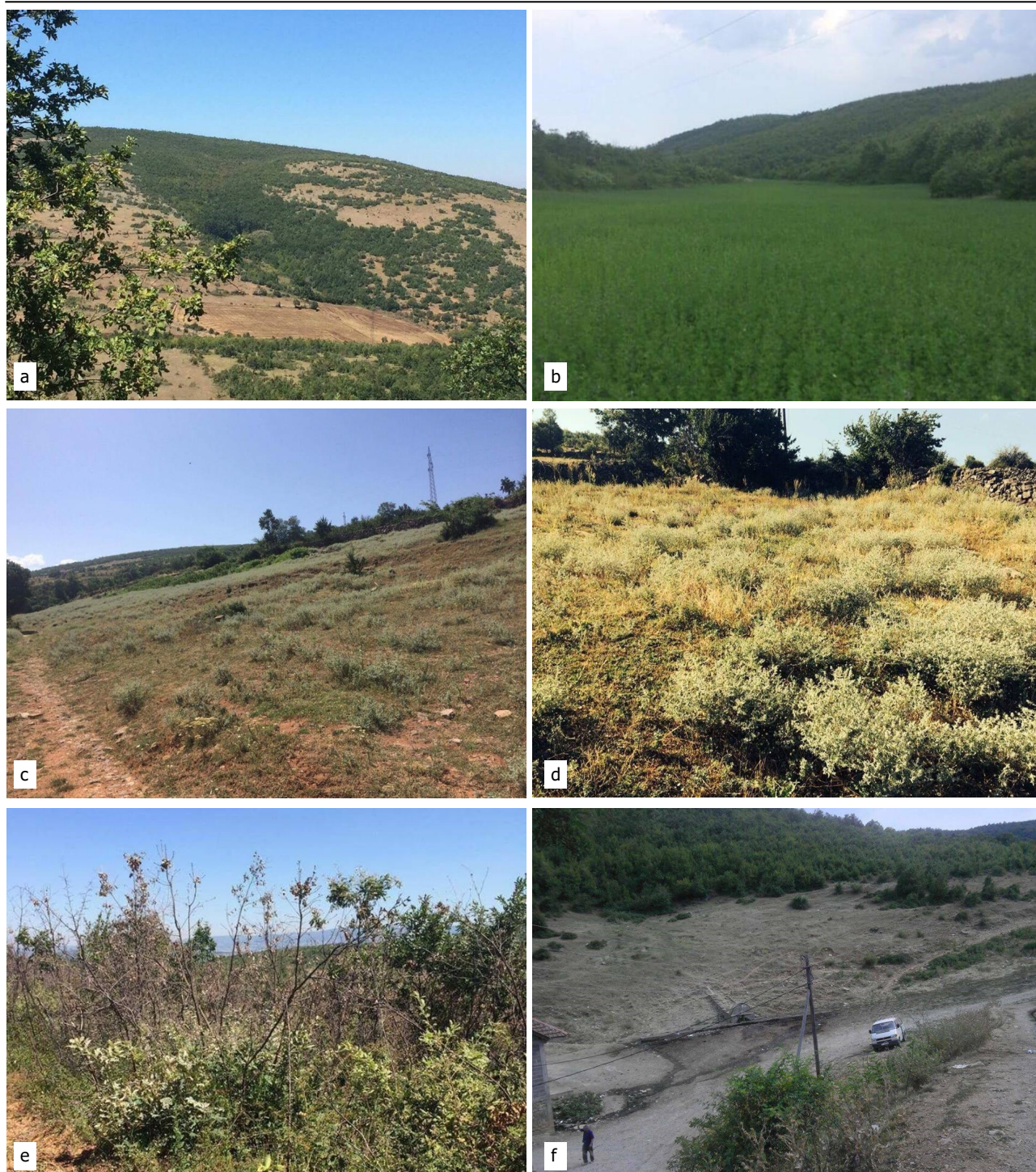


Figure 3. Pictures of some of the surveyed localities: a) Localities 1 and 2; b). Localities 3 and 4; c) & d): Localities 5 and 6; e). Localities 7 and 8; f). Localities 9 and 10 (Inside the settlements).

wood hornbeam *Carpinus betulus* (white hornbeam) and *Carpinus orinetalis* (black hornbeam).

Field study

Butterflies were collected once per week within two – three hours per site, using entomological net; they were observed, photographed and identified in the field, only a number of samples were preserved for further studies. The determination is performed in Zoology lab at the Department of Biology at the University of Prishtina "Hasan Prishtina". Identification is based according to Tolman and Lewington (1998). The nomenclature follows Van Swaay et al., 2010. In addition to these sources, the web-

site lepiforum (www.lepiforum.de, 2016) was consulted. The biogeographical categorization is accepted from Schaidler & Jakšić (1989).

Data analyses

Total species number, distribution of species per locality, diversity of species -Shannon-Wiener diversity index (H'), Simpson diversity index (D'), species richness estimator ($S_{Chao 1}$) (a species richness estimator estimate the total number of species present in a community and is based upon the number of rare species (singleton and doubleton) found in a sample (Chao, 1984) and similarity index (Jaccard's similarity index -Ja) were calculated us-

ing ComEcoPaC – Community Ecology Parameter Calculator, Version 1 (<http://prf.osu.cz/kbe/dokumenty/sw/ComEcoPaC/ComEcoPaC.xls>).

Results

A total of 31 species of Lycaenidae butterflies were recorded (Tab.2). The highest species richness was recorded in the locality 2 - Te bunari i fushes, where 28 out of 31 species occurred. The habitat type in this locality is mostly agricultural land with springs and animal stables. This locality has also the highest Shannon-Wiener diversity index ($H=4.72$) Locality 3- Stermnica, is specific in vegetation in comparison to others because of the many pioneer species that occurred after the fire in 2012. ($H=4.32$). A high diversity index was registered also in locality 1- Mjethi ($H=4.41$). The poorest in species richness is locality 8- Malet e Cerit, with only 7 species recorded, $H=2.59$.

The Simpson diversity index D was highest ($D=0.191$) in the locality 8 - Malet e Cerit. The variance of estimated richness $Var(S_{Chao1})$ was zero for the sampling locality 10- Jezeri i Cerit and the highest variance $Var(S_{Chao1})=6.25$ is registered in the sampling locality 2 - Te bunari i fushes, which is the richest in butterfly species.

Regarding the similarity in butterfly species composition between the sampling localities, the highest similarity ($Ja=88\%$) is registered between localities 1 - Mjethi and 2 - Te bunari i fushes. The most different in Lycaenidae species composition was the locality 8 - Malet e Cerit, which similarity index with all other localities is less than 35%.

As regarding the abundance, the most abundant species was *Callophrys rubi* (Linnaeus, 1758) with 51 specimens, recorded in all 11 localities of survey. The other species with occurrence in all localities are *Glaucopteryx alexis* (Poda, 1761), *Polyommatus bellargus* (Rottemburg, 1775), *Polyommatus coridon* (Poda, 1761) and *Polyommatus icarus* (Rottemburg, 1775). The species that were recorded in only one locality of the survey are *Phengaris arion* (Linnaeus, 1758) and *Thecla betulae* (Linnaeus, 1758).

In biogeographic aspect, the highest number of species are Circum-Palearctic-CP (29.03%), followed by West-Palearctic-WP (22.58 %) and Pontic-Mediterranean-PM (19.35%). Three species are Sibiric-SI (9.67%), two are Pontic-Caspic-Turkestanic Southsibiric - PCTSS (6.45%), two other Holarctic-HO (6.45%). The less distributed are North and Pontic-Mediterranean species - NPM and Oreal - Xeromontane-OXM with 3.22 % each.

Discussion

Butterflies due to their very specific food and habitat requirements are very sensitive to modifications of their environment. A number of species serve as an excellent indicator of ecosystems (Van Swaay et al, 2010).

The most species-rich biotopes in Europe are dry grasslands: dry calcareous grasslands and steppes support at least 274 butterfly species, alpine and subalpine grasslands 261, mesophilic grasslands 223 and dry siliceous grasslands 220 species (Van Swaay et al., 2006).

Lycaenidae alongside with Nymphalidae are the most distributed butterflies in grassland habitats. 31 butterfly species of Lycaenidae recorded in our survey consist about 24% of European Lycaenidae species (Van Swaay et al, 2010) and more than 50% of Lycaenidae recorded in neighboring countries with Kosovo.

According to existing data in Macedonia among 203 recorded species of butterflies, 55 are Lycaenidae (Krpach & Mihailova, 1997; Micevski & Micevski, 2003; Verovnik et al. 2010, Abdija, 2015). In Albania recent publications (Misja, 2005; Verovnik and Popović, 2013; Micevski et al. 2015) confirmed 51 species of Lycaenidae. The butterfly fauna in Serbia consists of 55 Lycaenidae species (Jakšić, Nahirnić and Petrović, 2013) and in Montenegro the recent data (Svara, Zakšek and Verovnik, 2015) show the record of 28 species of family Lycaenidae.

Comparing with existing data on butterfly fauna in Kosovo, the highest number of Lycaenidae butterflies was registered in National Park Sharri, 47 species (Jakšić,

1998), 25 species are common with our research. In national Park Bjeshket e Nemuna (earlier Prokletije) a total of 36 species of family Lycaenidae were recorded (Jakšić, 1997) and in Mt. Pashtrik (Jakšić, 2007) 32 species, 20 of which are common with our findings.

Among recorded species in our survey 7 species are grassland butterfly Indicator: *Lycaena phlaeas* and *Polyommatus icarus* are widespread grassland species. Five species that are categorized as grassland specialist are: *Polyommatus bellargus*, *Polyommatus semiargus*, *Cupido minimus*, *Phengaris arion* and *Polyommatus coridon*. *Polyommatus bellargus*, *P. coridon* and *P. icarus* were recorded in all types of habitat in 11 surveyed localities.

A special attention should be given to *Phengaris arion* that has the status of Endangered species (EN) in Europe (Van Swaay et al, 2010), and its habitat is protected under the Habitats Directive (92/43/EEC) Annexes II / IV and Bern Convention Annex II. The caterpillars of this species feed on foodplant *Thymus* spp. and *Origanum vulgare* but later development depends from the presence of Myrmica ants, especially species *Myrmica sabuleti* and *Myrmica scabrinodis* (Fiedler, 1991).



Figure 4. *Phengaris arion* (Linnaeus, 1758)
Large blue, female

Ph. arion is native in Balkan countries: Albania, Macedonia, Serbia, Montenegro, Greece, Bulgaria, etc. In our research, this species has been recorded only in locality 2 with one specimen, a fact that should be considered by local authorities but also researchers during butterfly collection for taking prevention measures that will avoid this species become extinct.

The main threat for butterfly species is habitat alteration and destruction including: changes in forestry practices in tropical and temperate regions, conversion of shrub lands to pasture and agricultural lands; wetland drainage; grassland management practices; the effects of grazing; expanding urban, industrial and recreational land use (Van Swaay et al, 2010).

Table 2. The list of Lycaenidae species in the surveyed area, Biogeographic group, number of species (S), number of individuals/abundance (N), Shannon-Wiener (H') and Simpson's (D') diversity index, species richness estimator (S_{Chao1}) and variance of estimated richness Var (S_{Chao1}) for each sampling locality

Species	Biog Gr.	Site 1	2	3	4	5	6	7	8	9	10	11
<i>Aricia agestis</i> (Denis & Schiffermüller, 1775)	WP	3	5	7			9	3			5	
<i>Callophrys rubi</i> (Linnaeus, 1758)	CP	5	6	4	7	2	7	3	2	5	6	4
<i>Celastrina argiolus</i> (Linnaeus, 1758)	HO	3	4	2						1		
<i>Cupido argiades</i> (Pallas, 1771)	HO	4	2	1		2						3
<i>Cupido decoloratus</i> (Staudinger, 1886)	PM		4		3		2			3		2
<i>Cupido minimus</i> (Fuessly, 1775)	CP	2	4	1	5	3	2	3				3
<i>Polyommatus semiargus</i> (Rottemburg, 1775)	CP	2	5	3						1	3	2
<i>Favonius quercus</i> (Linnaeus, 1758)	PM		3					2	5	4		3
<i>Glaucopsyche alexis</i> (Poda, 1761)	WP	5	7	2	3	6	1	4	2	3	3	5
<i>Lampides boeticus</i> (Linnaeus, 1767)	PM		5									
<i>Lycaena alciphron</i> (Rottemburg, 1775)	WP	1	3	1			1					
<i>Lycaena dispar</i> (Haworth, 1802)	SI	2	7	3	4	2	6	3				
<i>Lycaena phlaeas</i> (Linnaeus, 1761)	CP	1	4	2		3	2					
<i>Lycaena thersamon</i> (Esper, 1784)	WP	2	5	3		1	4					
<i>Lycaena tityrus</i> (Poda, 1761)	CP	2	6	1	3	2						
<i>Phengaris arion</i> (Linnaeus, 1758)	CP		1									
<i>Plebejus argus</i> (Linnaeus, 1758)	CP	1	4	2			3	2				2
<i>Plebejus argyrognomon</i> (Bergsträsser, 1779)	PCTSS	3	5			2		3	1			2
<i>Plebejus idas</i> (Linnaeus, 1761)	CP	1	3	2						1		
<i>Plebejus sephirus</i> (Frivaldzky, 1835)	PCTSS							2		3		
<i>Polyommatus admetus</i> (Esper, 1785)	WP	1	4	2	1	1				1		
<i>Polyommatus amandus</i> (Schneider, 1792)	SI			2			1	2		3	2	1
<i>Polyommatus bellargus</i> (Rottemburg, 1775)	WP	2	5	3	2	4	3	1	2	5	3	2
<i>Polyommatus dorylas</i> (Denis & Schiffermüller, 1775)	NPM	1	3	2		1						
<i>Polyommatus coridon</i> (Poda, 1761)	PM	2	6	3	4	3	2	3	1	4	2	4
<i>Polyommatus daphinus</i> (Denis & Schiffermüller, 1775)	PM	3		5	2		2	1			2	3
<i>Polyommatus eros</i> (Ochsenheimer, 1808)	OEX	3	4									
<i>Polyommatus icarus</i> (Rottemburg, 1775)	CP	4	6	2	4	3	1	3	2	4	3	5
<i>Polyommatus thersites</i> (Cantener, 1835)	WP	2	4	1			3					
<i>Satyrrium ilicis</i> (Esper, 1779)	PM	3	5	2	2							
<i>Thecla betulae</i> (Linnaeus, 1758)	SI		3									
<i>S-total number of species</i>		24	28	23	12	14	16	14	7	13	9	14
<i>N-total number of individuals/abundance</i>		58	123	56	40	35	49	35	15	38	29	41
<i>H-Shannon-Wiener diversity index</i>		4.41	4.72	4.32	3.43	3.62	3.65	3.72	2.59	3.50	3.06	3.69
<i>D-Simpson's diversity index</i>		0.05	0.09	0.05	0.10	0.09	0.09	0.07	0.19	0.09	0.12	0.08
<i>S_{Chao1}- species richness estimator</i>		26.2	2.85	24.2	12.1	14.9	17.6	14.5	7.5	NA	9	14.1
<i>Var (S_{Chao1})-variance of estimated richness</i>		6.25	1.75	2.65	0.28	2.14	4.67	1.06	1.06	NA	0	0.14

Table 3. Number of species in each biogeographic group of surveyed area Mountains Ceri, Kryeguri and Stermnica in Kosovo. After Schaider & Jakšić (1989)

Biogeographic group	Number of species	Percentage of species per biogeographic group
Circum-Palearctic (CP)	9	29.03%
West-Palearctic (WP)	7	22.58 %
Holarctic (HO)	2	6.45%
Pontic-Mediterranean (PM)	6	19.35
North and Pontic-Mediterranean (NPM)	1	3.22%
Sibirc (SI)	3	9.67%
Pontic- Caspic-Turkestanic Southsibirc (PCTSS)	2	6.45%
Oreal - Xeromontane (OXM)	1	3.22 %

Table 4. Similarity in butterfly species composition between sampling sites (Jaccard's index)

	Sam 2	Sam 3	Sam 4	Sam 5	Sam 6	Sam 7	Sam 8	Sam 9	Sam 10	Sam 11
Sam 1	0.79310	0.88	0.44	0.58333	0.53846	0.40740	0.24	0.32142	0.32	0.40740
Sam 2		0.7	0.37931	0.5	0.46666	0.35483	0.25	0.36666	0.2333	0.4
Sam 3			0.45833	0.54166	0.625	0.42307	0.2	0.38461	0.39130	0.42307
Sam 4				0.52941	0.47368	0.44444	0.35714	0.38888	0.4	0.44444
Sam 5					0.42857	0.4	0.4	0.28571	0.2778	0.4
Sam 6						0.57894	0.27777	0.31818	0.4705	0.5
Sam 7							0.5	0.42105	0.5333	0.64705
Sam 8								0.42857	0.4545	0.5
Sam 9									0.4666	0.5
Sam 10										0.5333

Among other species, worth mentioning as the species which habitat is threaten and it is listed on the Habitats Directive Annexes 2 and 4 and Bern Convention Annex 2 is *Lycaena dispar* (Haworth, 1802).

Drainage of wetlands is a serious threat for this species which host plants *Rumex hydrolapathum*, *R. crispus* and *R. aquaticus* depend on humidity (Tolman and Levington, 1998). Drainage of the fens in England last century was a prime cause of decline of *Lycaena dispar* (The IUCN Species Survival Commission).

Other Lycaenidae species recorded in our survey which habitat is protected under the Habitats Directive (92/43/EEC) are: *Cupido decoloratus* (Staudinger, 1886) *Polyommatus dorylas* (Denis & Schiffermuller, 1775) and *Polyommatus eros* (Ochsenheimer, 1808).

In biogeographic aspect the recorded species belong to 8 groups, most common species in our research are Circum-Palearctic species- 29.03%, followed by West-Palearctic-W P(22.58 %) and Pontic-Mediterranean-PM (19,35%). According to Varga (1977), Circum-Palearctic species are dominant in the European fauna.

Conclusions

Habitat type and its vegetation is one of the crucial determinants of butterfly fauna. This survey concluded this area has a rich diversity of butterflies of the Lycaeni-

dae family which requires more extensive researches in order to be fully recognized. The number of recorded species in our research present about 24% of the total number of Lycaenidae in Europe.

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