UNIVERSITETI I PRISHTINËS
"HASAN PRISHTINA"
FAKULTETI I SHKENCAVE MATEMATIKE NATYRORE
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Ref. nr. 2970 Prishtinë, Dt: 23.06.2023

KËRKESË

PËR: Departamentin e Biologjisë
Këshillin e studimeve të Doktoratës
Këshillin e Fakultetit të Shekncave Matematike- Natyrore

LËNDA: Formimi i komisionit për vlerësimin e dorëshkrimit të temës së doktoraturës

Bazuar në Rregulloren Nr.1/96, për studime të doktoratës, kërkoj nga organet e lartëpërmendur të FSHMN-së të formojnë Komisionin për vlerësimin e dorëshkrimit të punimit të doktoratës me titull: **"BIODIVERSITETI I FLUTURAVE NË MALIN E KORITNIKUT NË REPUBLIKËN E KOSOVËS"**

Kërkesës i bashkangjes:

1. Publikimet shkencors
2. Dëshmit për pjesmarrje në konferenca shkencore
3. Kopjen e dorëshkrimit
4. Pëlqiminn e mentorit
5. F6

Kandidati: Pajtim Bytyçi

Nënshkrimi: Bytyçi

Data, Vendi: 23.06.2023

UNIVERSITETI I PRISHTINËS
FAKULTETI I SHKENCAVE MATEMATIKO-NATYRORE
DEPARTAMENTI I BILOGJISË

PAJTIM BYTYÇI

BIODIVERSITETI I FLUTURAVE NË MALIN E KORITNIKUT NË REPUBLIKËN E KOSOVËS

PUNIM I DOKTORATËS

Prishtinë, 2023

UNIVERSITY OF PRISHTINA
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
DEPARTMENT OF BIOLOGY

PAJTIM BYTYÇI

BIODIVERSITY OF BUTTERFLIES IN THE MOUNTAIN KORITNIK IN REPUBLIC OF KOSOVO

DOCTORAL THESIS

Pristina, 2023

UNIVERSITETI I PRISHTINËS
FAKULTETI I SHKENCAVE MATEMATIKO-NATYRORE
DEPARTAMENTI I BIOLOGJISË

PAJTIM BYTYÇI

BIODIVERSITETI I FLUTURAVE NË MALIN E KORITNIKUT NË REPUBLIKËN E KOSOVËS

PUNIMI I DOKTORATËS

Mentor: Prof. Dr. Sc. Ferdije Zhushi-Etemi

Prishtinë, 2023

Rezyme

Në këtë punim paraqiten të dhëna e para nga hulumtimi i parë sistematik, gjithëpërfshirës i fluturave (Lepidoptera) në Malin Koritnik, i cili është pjesë e Parkut kombëtar "Sharri". Hulumtimet e realizuara gjatë viteve 2019-2022 kanë përfshirë aspektin taksonomik, ekologjik dhe biogjeografik të fluturave. Mbledhja e fluturave të ditës (Papilionoidea) në 18 lokalitetet e caktuara është bërë me anë të rrjetës entomologjike, gjatë ditëve me diell, kryesisht nga ora 10 deri në ora 14 duke filluar nga muaji mars deri në fund të tetorit. Fluturat e natës (molat) u mblodhën gjatë viteve 2021 - 2022 duke filluar nga maji deri në fund të muajit tetor. Mostrat u mblodhën në 7 lokalitete me ndihmën e kurthave me dritë.

Gjatë përzgjedhjes së lokaliteteve të hulumtimit vëmendje iu kushtua llojeve të habitateve dhe lartësisë mbidetare të tyre, duke e pasur parasysh së lartësia është faktor i cili ndikon në zhvillimin dhe përhapjen e fluturave. Lokalitetet në të cilat janë mbledhur fluturat e ditës dhe të natës janë shtrirë në lartësi mbidetare prej 585 - 2197 m. Nga 8166 ekzemplarë të mbledhur të fluturave të ditës në 18 lokalitete janë konstatuar 131 lloje të cilat ju takojnë 50 gjinive dhe 6 familjeve. Nga ky numer, 55 lloje i takojnë familjes Nymphalidae, 40 Lycaenidae, 15 Pireidae, 15 Hesperidae, 5 Papilonidae dhe 1 familjes Rionidae.

Vlerat e indekseve të diversitetit të llogaritura për lokalitete dëshmuan për një diversitet të lartë të fluturave në lokalitete në lartësi mbidetare 800- 1245m, dhe një rënie të tij në lokalitetet mbi 1245 m. Analizat statistikore të rezultateve gjithashtu treguan se ekziston korelacion sinjifikant negativ në mes të numrit të llojeve të fluturave dhe abundancës së tyre me lartësinë mbidetare, kurse temperatura, si faktor mjedisor me rëndësi për përhapjen e fluturave kishte një korelacion pozitiv sinjifikant me diversitetin dhe abundancën e tyre. Nga grupi i Zyganideve, në hulumtimin tonë u konstatuan 11 lloje nga të cilat lloji *Jordanita notata* është lloj i ri për regjistër të Kosovës.

Gjatë këtij hulumtimi u regjitruan 224 lloje të fluturave të natës (molave) të cilët në aspektin taksonomik iu takojnë 14 familjeve. Familjes Sphingidae i takojnë 12 lloje, prej tyre 7 lloje të reja për regjistrin e Kosovës, Lasiocampidae përfaqësohet me 10 lloje, 2 prej të cilave janë lloje të reja për Kosovë, 9 lloje u regjistruan nga familja Notodontidae, prej tyre 4 lloje të reja. Familja Noctuidae ishte më e pasura, me 89 lloje, prej tyre 8 regjistrohen për herë të parë në Kosovë, familja Erebidae me 36 lloje, 11 nga të cilat të reja për Kosovë. Nga familja Geometridae u regjistruan 50

lloje, 3 lloje të reja për Kosovë, Hepialidae me 1 lloj, Drepanidae 6 lloje, prej tyre 3 te reja për Kosovë, Brahmaeidae me 1 lloj, familja Saturniidae me 4 lloje, Cossidae me 2 lloje, Crambidae me 2 lloje dhe familjet Limacodidae dhe Psychidae me nga 1 lloj.

Hulumtimi i parë sistematik i diversitetit të fluturave në malin Koritnik rezultoi me një listë prej 366 llojesh, prej tyre 38 lloje të molave janë lloje të reja për inventarin e llojeve të Kosovë. Konsiderojmë se kjo listë nuk është definitive por duhet të shërbejë si bazë e mirë për monitorimin e këtyre insekteve me qëllim të identifikimit të rreziqeve eventuale që qojnë në ndryshimin dhe shkatërrimin e habitateve të tyre, që rezulton të jetë shkaktar kryesor i rënies së biodiversitetit në nivel global.

Fjalë Kyçe: Fluturat, molat, habitat, diversitet, ruajtje, mal, faunë, invazive

Summary

This paper presents the data from the first systematic, comprehensive research of butterflies (Lepidoptera) in Mount Koritnik, which is part of the "Sharri" National Park.

The research carried out during the years 2019-2022 has included the taxonomic, ecological and biogeographic aspects of butterflies. The collection of diurnal butterflies (Papilionoidea) in the 18 designated localities was done with an entomological net, during sunny days, mainly from 10 a.m. to 2 p.m., starting from March to the end of October.

Moths were collected during 2021 – 2022, starting from May to the end of October. Samples were collected in 7 localities with the help of light traps.

During the selection of the research localities, attention was paid to the types of habitats and their altitude, since the altitude is a factor that affects the development and distribution of butterflies. The localities in which butterflies and moths were collected are located at altitudes of 585 - 2197 m above sea level.

From 8166 collected butterfly specimens in 18 localities, 131 species were found, belonging to 50 genera and 6 families. Of this number, 55 species belong to the Nymphalidae family, 40 to Lycaenidae, 15 to Pireidae, 15 to Hesperidae, 5 to Papilonidae and 1 to Rionidae family.

The values of diversity indices calculated for localities confirmed a high diversity of butterflies in localities at altitudes from 800-1245m, and a decline in localities above 1245m.

The statistical analysis of the results also showed that there is a significant negative correlation between the number of butterfly species and their abundance with altitude, while temperature, as an important environmental factor for the distribution of butterflies, had a significant positive correlation with their diversity and abundance.

From the Zyganidae group, 11 species were found in our research, among which *Jordanita notata* is a new species for the Kosovo register.

During this research in Mount Koritnik, 224 species of moths were registered, which taxonomically belong to 14 families. The Sphingidae family includes 12 species, of which 7 are new species for the Kosovo register, Lasiocampidae is represented with 10 species, 2 of which are new species for Kosovo, 9 species were recorded from the Notodontidae family, of which 4 new species. The Noctuidae family was the richest, with 89 species, of which 8 are recorded for

the first time in Kosovo, the Erebidae family is represented with 36 species, 11 are new records for the country, from the Geometridae family 50 species were recorded, 3 new species for Kosovo, Hepialidae with 1 species, Drepanidae 6 species, of which 3 are new, Brahmaeidae with 1 species, family Saturniidae with 4 species, Cossidae with 2 species, Crambidae with 2 species, Limacodidae with 1 species, and family Psychidae with 1 species.

The first systematic research of butterfly diversity in Mount Koritnik resulted in a list of 366 species, of which 38 species of moths are new species for the Kosovo species inventory.

We consider that this list is not a definitive one but should serve as a good basis for monitoring of these insects in order to identify the eventual threats that can cause changes and destruction of their habitats, which turns out to be the main cause of the biodiversity decline at the global level.

Key words: Butterfly, moths, habitat, diversity, conservation, mountain, fauna, invasive.

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Për: Këshillin për studime të Doktoratës në FSHMN

Këshillin Mësimor Shkencor të Fakultetit të Shkencave Matematike Natyrore

LËNDA:Pëlqimi i mentorit për dorëzimin e dorëshkrimit të temës së doktoratësme titull: "Biodiversiteti i Fluturave në Malin e Koritnikut në Republikën e Kosovës" të kandidatit Pajtim Bytyçi

Mendim:

Kandidati Dr. Sc. Pajtim Bytyçi ka përfunduar dorëshkrimin e temës së doktoratës me titull" Biodiversiteti i fluturave në malin e Koritnikut në Republikën e Kosovës" në të cilën ka paraqitur rezultatet e hulumtimit trevjeçar. Gjatë hulumtimit të tij kandidati ka hulumtuar fluturat e ditës (Papilionoidea) në aspektin taksonomik, ekologjik dhe biogjeografik, ne 18 lokalitete me habitate te ndryshme, që shtrihen në lartësi mbidetare prej 585 - 2197m. Në hulumtim janë përfshirë edhe fluturat Zygaenidae si dhe fluturat e natës, molat, të cilët janë mbledhur në 7 lokalitete me ndihmën e kurthave me dritë. Fluturat e ditës janë mbledhur me rrjetën entomologjike, gjatë kohës me diell, shumica e të cilave janë determinuar në terren.
Janë mbledhur gjithësej 8166 individë të fluturave të ditës të cilët në aspektin taksonomik iu takojne 131 llojeve, 50 gjinive dhe 6 familjeve.Familja më e pasur me lloje ishte Nymphalidae me 55 lloje, pastaj Lycaenidae me 40, Pireidae dhe Hesperidae me nga 15 lloje, Papilonidaeme 5 lloje dhe familja Rionidae me 1lloj.
Vlerat e indeksit të diversitetit kanë treguar vlerën më të lartë në S2 dhe S12, kurse vlerat më të ulëta në S17 dhe S18. Indeksat e Jaccardit dhe Sorensenit për llogaitjen e ngjashmërisë së lokaliteteve në përbërje llojore të fluturave tregojnë ngashmëri të lartë në mes të L17 dhe L18, kurse S8 kishte treguar ngjashmërinë më të vogël me të gjitha lokalitetet.Temperatura dhe lartësia mbidetare janë faktorë mjedisor që ndikojnë në përbërjen dhe përhapjen e fluturave.

Analizat statistikore të rezultateve gjithashtu treguan se ekziston korelacion sinjifikant negativ në mes të numrit të llojeve të fluturave dhe abundancës së tyre me lartësinë mbidetare, kurse temperatura, si faktor mjedisor me rëndësi për përhapjen e fluturave kishte një korelacion pozitiv sinjifikant me diversitetin dhe abundancën e tyre.
regjistër të Kosovës. Në këtë hulumtim janë regjistruar edhe 224 lloje të fluturave të natës (molave) të cilët në aspektin taksonomik iu takojnë 14 familjeve. 38 lloje të molave janë lloje të reja për inventarin e llojeve të Kosovë,që paraqesin një kontribut të rëndësishëm shkencor për njohjen e diversitetit të molave, pak të studiuar në vendin tonë.

Kandidati ka publikuar një pjesë të rezulateteve nga tema në tre artikuj shkencor në revista me recenzion ndërkombëtar, të indeksuara në SCOPUS dhe ka prezentuar rezultatet e tij në dy konferenca ndërkombëtare,

Artikujt shkencor të publikuar:

1. **Bytyçi, P.**, Zhushi-Etemi, F., Kabashi-Kastrati, E., Çadraku, H. (2023): Biodiversity of Butterflies (Lepidoptera: Papilionoidea) in Mountain Koritnik in the Republic of Kosovo. Journal of Insects Biodiversity and Systematics 09(4),623-642
2. **Bytyçi, P.**, Zhushi-Etemi, F., Kabashi-Kastrati, E., Çadraku, H., & Koren, T.(2023). Diversity of burnetmoths (Lepidoptera: Zygaenidae) on Mountain Koritnik, Kosovo. *Nat. Croat.*, Vol. 32, No. 1.,177-187
3. **Bytyçi,P.**, Zhushi-Etemi,F.,Kabashi-Kastrati,E.,Çadraku,H and Koren,T.(2023). The first record of Euphyia biangulata (Haëorth, 1809)(Lepidoptera: Geometridae) for Kosovo. *Ekologia Balkanica* Vol. 15, Issue 1 ,June 2023 pp. 184-18

Pjesëmarrja në Konferenca ndërkombëtare:

1. **Bytyçi, P.,** Zhushi Etemi,F., Kabashi-Kastrati, E., Koren, T.(2023). Composition of the geometrid moth fauna(Lepidoptera:Geometridae) in Koritnik Mountain in Kosovo. Fourt International Black Sea Modern Scientific Research Congress, June 6-7,2023, Rize,Turkiye
2. **Bytyçi,P.**,Zhushi Etemi,F., Kabashi-Kastrati, E., Koren, T. (2022). Fauna of the moth family Sphingidae(Insecta:Lepidoptera) in Koritniku Mountain in The Republic of Kosovo. 6-th Congressof Ecologists of North Macedonia, 15-18 October, Ohrid, North Macedonia

Prishtinë, 22.06.2023

Prof. Dr. Ferdije Zhushi Etemi

PARAQITJA E PUNIMIT TË DOKTORATËS [1]	
TË DHËNAT E PËRGJITHSHME	
Doktoranti:	Pajtim Bytyçi
Adresa:	Rr. Baresha nr 3, Shkozë, Malishevë
Tel./ fax:	+38344766442
E-mail:	pajtim.bytyqi@hotmail.com
Emërtimi i studimit:	Biologji e organizmave dhe ekologji
Udhëheqësi i studimit:	Prof. Dr. Ferdije Zhushi Etemi
TË DHËNAT PËR PUNIMIN E DOKTORATËS	
Titulli në gjuhën shqipe	"Biodiversiteti i Fluturave në Malin e Koritnikut në Republikën e Kosovës"
Titulli në gjuhën angleze	"Biodiversity of Butterflies in Mountain Koritnik in Republic of Kosovo"
Fusha e hulumtimit	

DEKLARATA E MENTORIT/BASHKËMENTORIT

1

Kandidati Dr. Sc. Pajtim Bytyqi ka përfunduar doreshkrimin e temës së doktoratës me titull" Biodiversiteti i fluturave në malin e Koritnikut në Republikën e Kosovës" në të cilën ka paraqitur rezultatet e hulumtimit trevjeçar. Gjatë hulumtimit të tij kandidati ka hulumtuar fluturat e ditës (Papilionoidea) në aspektin taksonomik, ekologjik dhe biogjeografik, ne 18 lokalitete me habitate te ndryshme, që shtrihen në lartësi mbidetare prej 585 - 2197m. Në hulumtim janë përfshirë edhe fluturat Zygaenidae si dhe fluturat e natës, molat, të cilët janë mbledhur në 7 lokalitete me ndihmën e kurthave me dritë. Fluturat e ditës janë mbledhur me rrjetën entomologjike, gjatë kohës me diell, shumica e të cilave janë determinuar në terren.
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[1] Lutei që ta plotësoni formularin dhe ta dërgoni të nënshkruar me postë elektronike.

Nga grupi i Zyganideve, në Koritnik janë regjistruar 11 lloje nga të cilat lloji *Jordanita notata* është lloj i ri për regjistër të Kosovës. Në këtë hulumtim janë regjistruar edhe 224 lloje të fluturave të natës (molave) të cilët në aspektin taksonomik iu takojnë 14 familjeve. 38 lloje të molave janë lloje të reja për inventarin e llojeve të Kosovë,që paraqesin një kontribut të rëndësishëm shkencor për njohjen e diversitetit të molave, pak të studiuar në vendin tonë.

Kandidati ka publikuar një pjesë të rezulateteve nga tema në tre artikuj shkencor në revista me recenzion ndërkombëtar dhe ka prezentuar rezultatet e tij në dy konferenca ndërkombëtare,

Artikujt shkencor të publikuar:

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Pjesëmarrja në Konferenca ndërkombëtare:

1. **Bytyçi, P.,** Zhushi Etemi,F., Kabashi-Kastrati, E., Koren, T.(2023). Composition of the geometrid moth fauna(Lepidoptera:Geometridae) in Koritnik Mountain in Kosovo. Fourt International Black Sea Modern Scientific Research Congress, June 6-7,2023, Rize,Turkiye
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Vendi, data dhe nënshkrimi

Në Prishtinë, 22.06.2023.

Nënshkrimi_____

Prof. Dr.Ferdije Zhushi Etemi

UNIVERSITETI I PRISHTINËS
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FSHMN Ref. nr. 2944 Prishtinë, Dt. 23-06-2023

DEKLARATË E STUDENTIT PËR PUNË ORIGJINALE

Me anë të kësaj deklarate, unë **PAJTIM BYTYÇI,** me Nr. të ID: **160240300001,** student i nivelit të Doktoratës në drejtimin: **Biologji e Organizmave dhe Ekologji,** Departamenti i Biologjisë në FSHMN – UP "Hasan Prishtina", me përgjegjësi, deklaroj se i gjithë dorëshkrimi i Disertacionit të cilin e kamë dorëzuar është punë e imja origjinale e bazuar në rezultatet e arritura nga puna kërkimore shkencore, ndërsa pjesë të caktuara të rezultateve apo shënimeve nga autorë të ndryshëm që janë përdorë si referenca për krahasim, janë cituar në bazë të standardeve për citime dhe referenca. Gjithashtu, ky punim nuk është prezantuar për vlerësim apo botuar më parë, pjesërisht apo në tërësi, pranë këtij apo ndonjë institucioni tjetër.

Më tej, deklaroj se:

a) punimi i paraqitur këtu është origjinal dhe është punuar në tërësi nga unë;
b) punimi nuk është marrë nga studentë të tjerë apo nga punime të tjera në Universitetin e Prishtinës "Hasan Prishtina" ose nga ndonjë universitet tjetër;
c) punimi nuk është kopje e ndonjë punimi të marrë në internet apo në bibliotekë;
d) punimi nuk përmban modifikim të dhënash, duke i paraqitur ato si kontribut origjinal;
e) punimi i respekton të gjitha kërkesat për të drejtat e autorit, duke i saktësuar dhe cituar të gjitha kontributet nga burime të tjera.

Ky punim i disertacionit mban titullin: **"BIODIVERSITETI I FLUTURAVE NË MALIN E KORITNIKUT NË REPUBLIKËN E KOSOVËS"** dhe vlen për plotësimin e pjesshëm të obligimeve për të fituar titullin: Doktor i shnkencave të Biologjisë.

Dëshmoj se jam vënë në dijeni që vërtetimi ndryshe i atyre që u thanë më sipër do të rezultojë me tërheqjen e titullit të fituar bazuar në këtë punim.

Prishtinë, më 23/06/2023

Kandidat:

Pajtim BYTYÇI

Pajtim Bytyçi

J. Insect Biodivers. Syst. 09 (4), 623–642

https://jibs.modares.ac.ir

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

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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.

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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

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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 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.

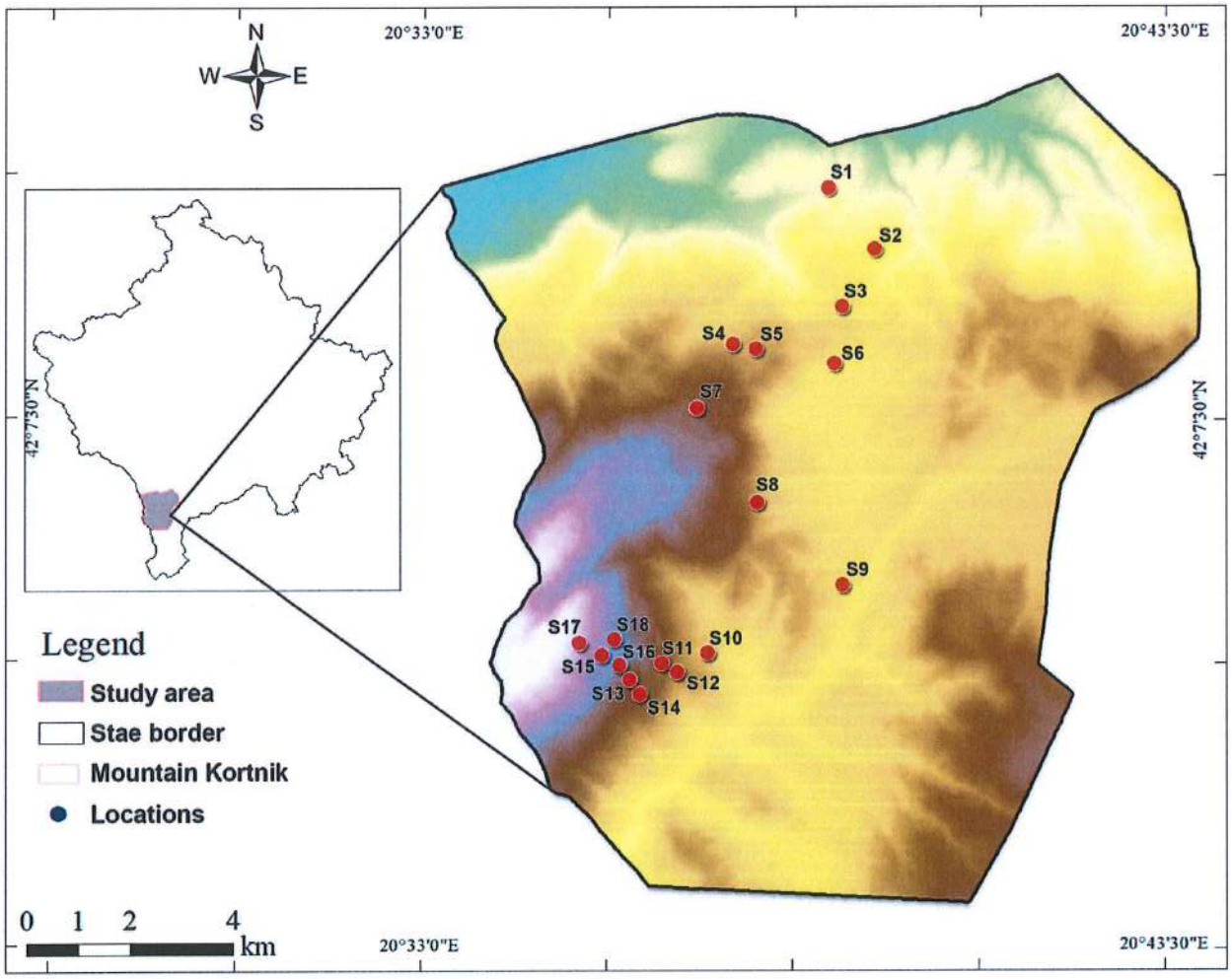

Figure 1. Map of Mt. Koritnik with the position of study localities.

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 agestis* (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.

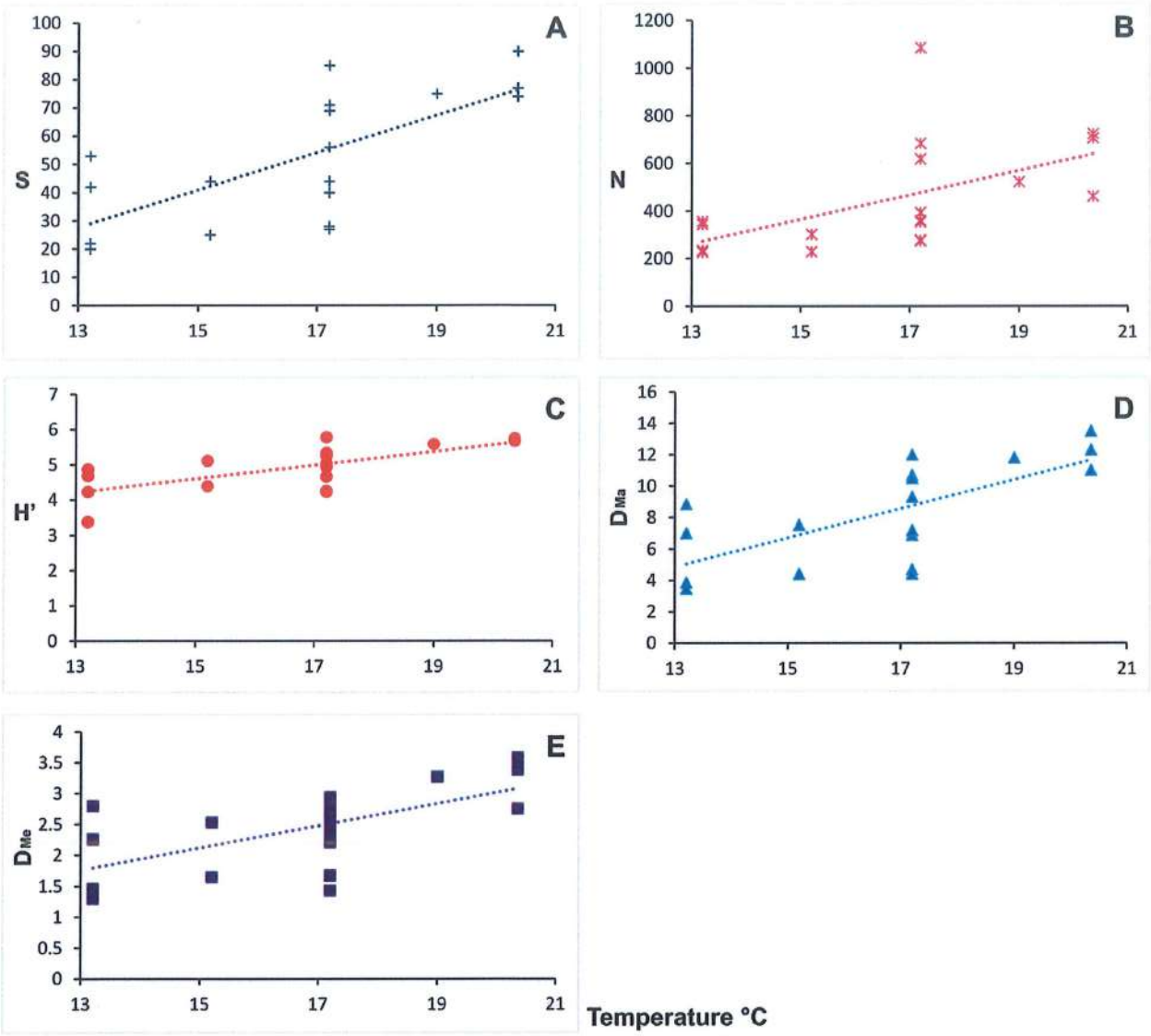

Figure 2. The relationship between temperature (T°C) with the diversity indices. **A.** Species richness – S; **B.** Abundance – N; **C.** Shannon Wiener - H'; **D.** Margalef – D_{Ma}; **E.** Menhinick's – D_{Me}.

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' 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).

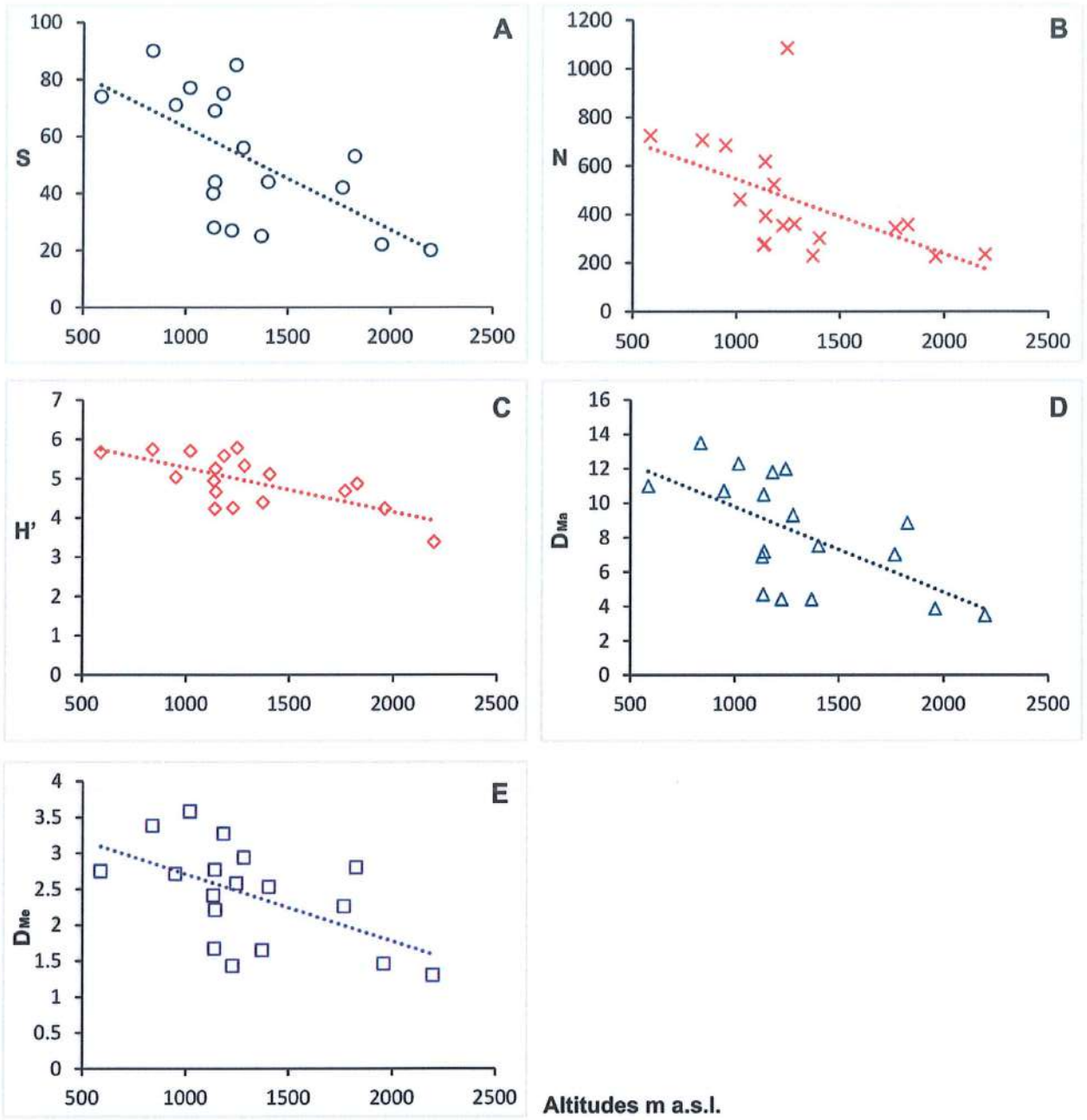

Figure 3. The relationship between altitude with the diversity indices. **A.** Species richness – S; **B.** Abundance – N; **C.** Shannon Wiener - H'; **D.** Margalef – D_{Ma}; **E.** Menhinick's – D_{Me}.

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 locality, 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–Eveness, 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.

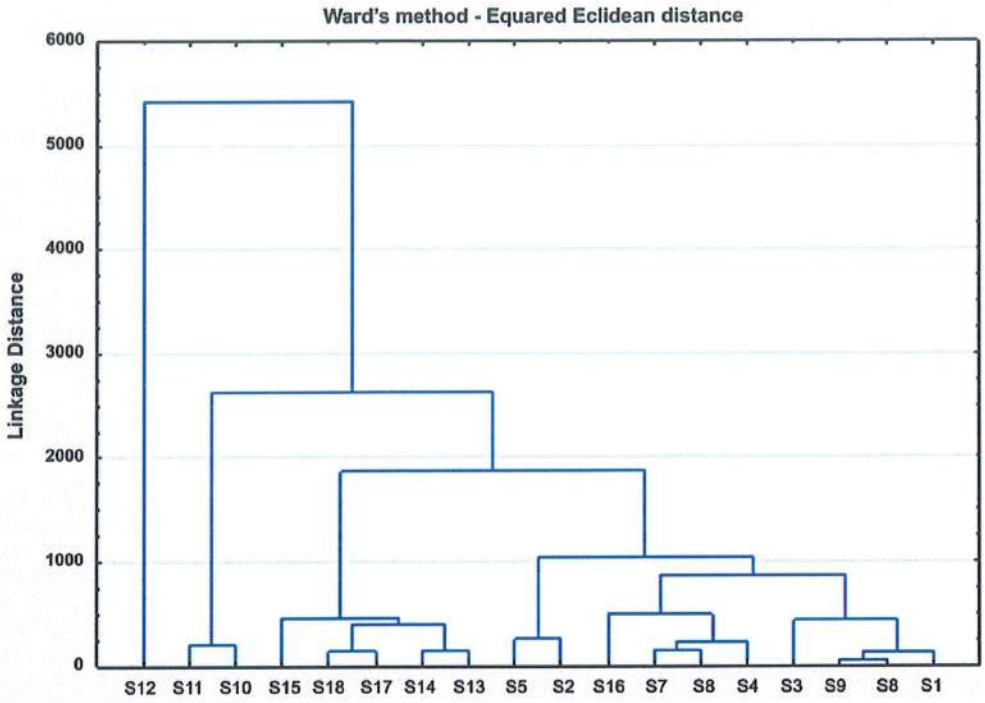

Figure 4. Dendrogram about butterfly similarity between habitats generated using statistica 12.

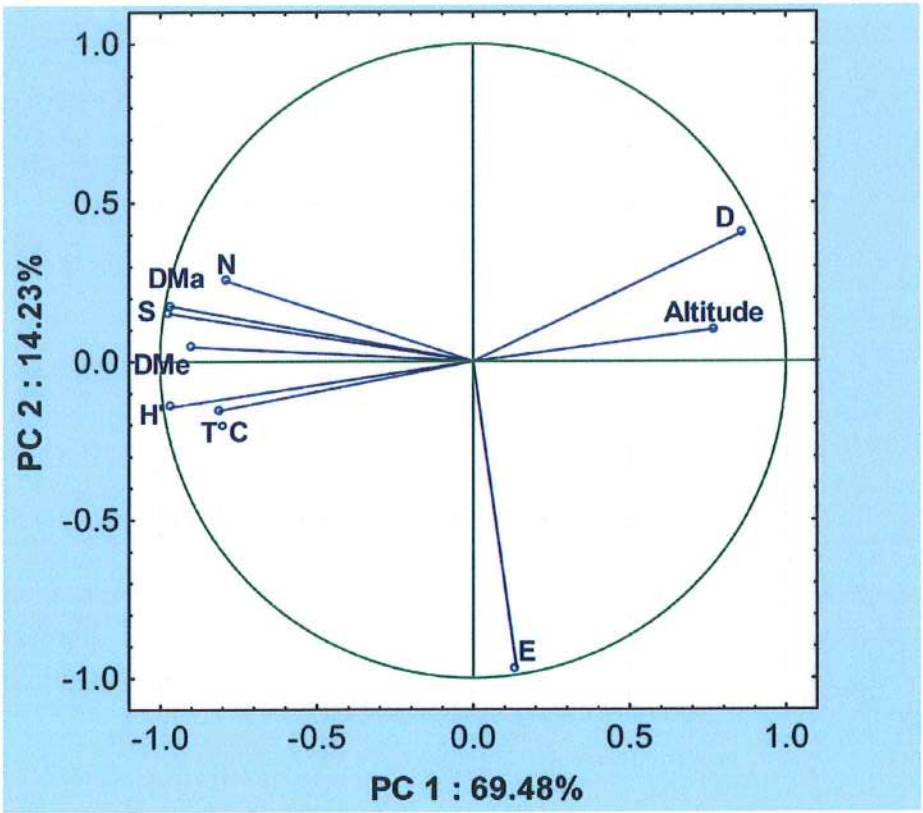

Figure 5. Principal component analysis (PCA) between diversity indices with temperature and altitude

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 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 neighboring 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 gradient 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 decrease as the altitudinal gradient increases (Mihoci et al., 2011). The results of diversity analysis according to the altitudineal 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 have 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 behavior 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, comparing 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 are no historical data on butterfly diversity from Mt. Koritnik prevents us from making comparison between the currents and past states of butterflies in the area. The 131 recorded butterfly species in Koritnik Mountain represents a 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 protection of biodiversity, including butterflies. However, despite the existing legislation, no programs for monitoring of 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 desingn 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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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

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چکیده: 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.

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

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DIVERSITY OF BURNET MOTHS (LEPIDOPTERA: ZYGAENIDAE) ON MOUNTAIN KORITNIK, KOSOVO

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Bytyçi, P., Zhushi-Etemi, F., Kabashi-Kastrati, S., Çadraku, H., & Koren, T.: Diversity of burnet moths (Lepidoptera: Zygaenidae) on Mountain Koritnik, Kosovo. Nat. Croat., Vol. 32, No. 1., 177-187, Zagreb, 2023.

The aim of this paper is to present the first data on the diversity of the moth family Zygaenidae, on Koritnik Mountain in Kosovo. Although this mountain is a biodiversity hotspot, no study of Zygaenidae has ever been conducted. During our survey in 2021 and 2022, in ten localities, 11 Zygaenid species were recorded. Among them *Jordanita notata* (Zeller, 1847) is reported for the first time for Kosovo.

Key words: burnet moths, forester moths, distribution, *Jordanita notata*

Bytyçi, P., Zhushi-Etemi, F., Kabashi-Kastrati, S., Çadraku, H., & Koren, T.: Raznolikost ivanjskih ptičica (Lepidoptera: Zygaenidae) planine Koritnik, Kosovo. Nat. Croat., Vol. 32, No. 1., 177-188, Zagreb, 2023.

Cilj ovog rada je prikazati prve podatke o raznolikosti porodice Zygaenidae planine Koritnik na Kosovu. Iako je ta planina središte biološke raznolikosti, ivanjske ptičice nikad nisu istraživane. Tijekom našeg istraživanja 2021. i 2022. na deset lokaliteta zabilježeno je 11 vrsta porodice Zygaenidae. Jedna od njih, *Jordanita notata* (Zeller, 1847), zabilježena je po prvi puta za Kosovo.

Ključne riječi: ivanjske ptičice, rasprostranjenost, *Jordanita notata*

INTRODUCTION

Representatives of the family Zygaenidae Latreille, 1809, are day-flying moths, which are known as burnets (subfamily Zygaeninae) and foresters (subfamily Procridinae). In most of the Balkan countries, the general distribution of the zygaenid moths is well studied: Albania (Nahirnić & Beshkov, 2018; Vrenozi et al., 2019; 2020), North Macedonia (Micevski *et al.*, 2018; Nahirnić & Beshkov, 2018; Nahirnić-Beshkova *et al.*, 2021); Montenegro (Jakšić et al., 2019; Jakšić & Nahirnić-Beshkova, 2020), Serbia (Jakšić, 2016), Croatia (Razov *et al.*, 2017; Koren, 2021). As for the Republic of Kosovo, the data are

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still incomplete and most records date from the beginning of the 20th century (Rebel, 1917; Rebel & Zerny, 1931); more recent data are very scarce (Jakšić, 1986; 2006).

Zygaenidae are excellent indicators of environmental changes (Nahirnić *et al.*, 2019) and show biological similarities with butterflies which are also good indicators of biodiversity in Europe (van Swaay *et al.*, 2013; Nahirnić *et al.*, 2019). Zygaenidae react very quickly to the presence of chemical substances (pesticides) and soon disappear from contaminated habitats (Tarmann, 2009: Nahirnić *et al.*, 2019). Accordingly, they can be used as a good model organism to establish a biodiversity baseline for an area that can be compared to future states.

The aim of this study is to present the first results on Zygeanidae studies on Mt Koritnik and to contribute to a better knowledge of moth diversity in Kosovo.

Mt Koritnik is located in the south of Republic of Kosovo and stretches along the state border with Albania. The highest part of the mountain, above 1470 m, with an area of 818 ha, is designated a strict nature protection area. The reserve is a high limestone mountain area, characterized by special geomorphological and biodiversity values. The special feature of this mountain is the presence of the largest area (nearly 2000 ha) of Heldreich's pine forest (*Pinus heldreichii*) in the Balkans.

MATERIAL AND METHODS

The material for this study was collected during June, July and August in 2021 and 2022, in different habitats on Mt Koritnik (Tab. 1). The collected and preserved specimens were identified at the National Museum of Natural History in Sophia in Bulgaria and at the Department of Biology of the Faculty of Natural Science, University of Prishtina.

For each specimen, the genitals were isolated by being boiled in 10% KOH solution, after which the excess organic material was removed and stored in genital micro vials that were pinned to the specimen they originated from. The identification of the specimens was based on Naumann *et al.* (1999).

Tab. 1. Studied localities, habitat types, geographic coordinates and altitudes.

Nr	Locality- EU NATURA 2000	Latitude	Longitude	Altitude (m a.s.l.)
S1	Zhur 1. Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)	N 42°10'05"	E 20°38'49"	585
S2	Zhur 2. Agriculturally improved, re-seeded and heavily fertilized grassland, in area of oak forest (*Quercus frainetto* woods)	N 42°09'24"	E 20°39'21"	835
S3	Brezne 1. Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)	N 42°08'08"	E 20°38'54"	949
S4	Brezne 2. *Quercus frainetto* woods	N 42°08'19"	E 20°37'41"	1167
S5	Brezne 3. Dry grasslands	N 42°07'41"	E 20°36'49"	1395
S6	Rapçe. Temperate thickets and scrub (*Juniperus communis* formations on heaths or calcareous grasslands)	N 42°4'46"	E 20°36'31"	1226
S7	*Fagus* woodland and Beech forests near the water springs	N 42°04'52"	E 20°36'20"	1245

Nr	Locality- EU NATURA 2000	Latitude	Longitude	Altitude (m a.s.l.)
S8	Subalpine Mediterranean Pinus woodland and High oro-Mediterranean pine forests)	N 42°5'8"	E 20°35'36"	1624
S9	Recently felled areas (*Epilobium angustifolium* (L.) Scop) & *Salix caprea* L.)	N 42°4'52"	E 20°35'24"	1720
S10	Recently felled areas (*Epilobium angustifolium* (L.) Scop) & *Salix caprea* L.)	N 42°4'55"	E 20°35'3"	1866

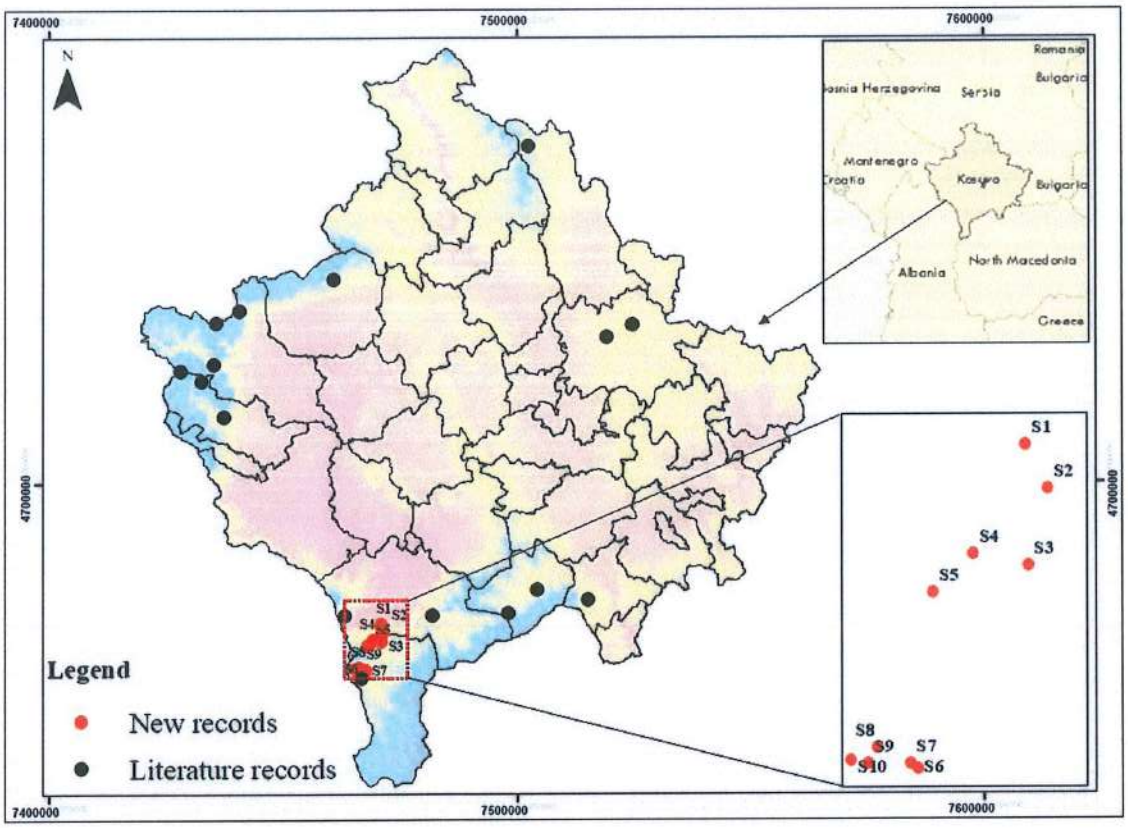

Fig. 1. Records of Zygaenidae in Kosovo from literature (black dots) and records from our study (red dots).

RESULTS

During our research 11 Zygaenidae species were recorded, among them five Procridinae and six Zygaeninae. Procridinae were represented by 2 species of the genus *Adscita* and three species of the genus *Jordanita*, whereas Zygaeninae were represented with 6 species of the genus *Zygaena*. For each species, the locality number and dates of observations are given.

The systematics of Zygaenidae in this publication follows the last revisions of the group (Efetov, 2001; Efetov *et al.*, 2022; Hofmann & Tremewan, 2017):

Subfamily Procridinae

Genus *Adscita* Retzius, 1783

Subgenus *Adscita* Retzius, 1783

Adscita (*Adscita*) *geryon* (Hübner, 1813)

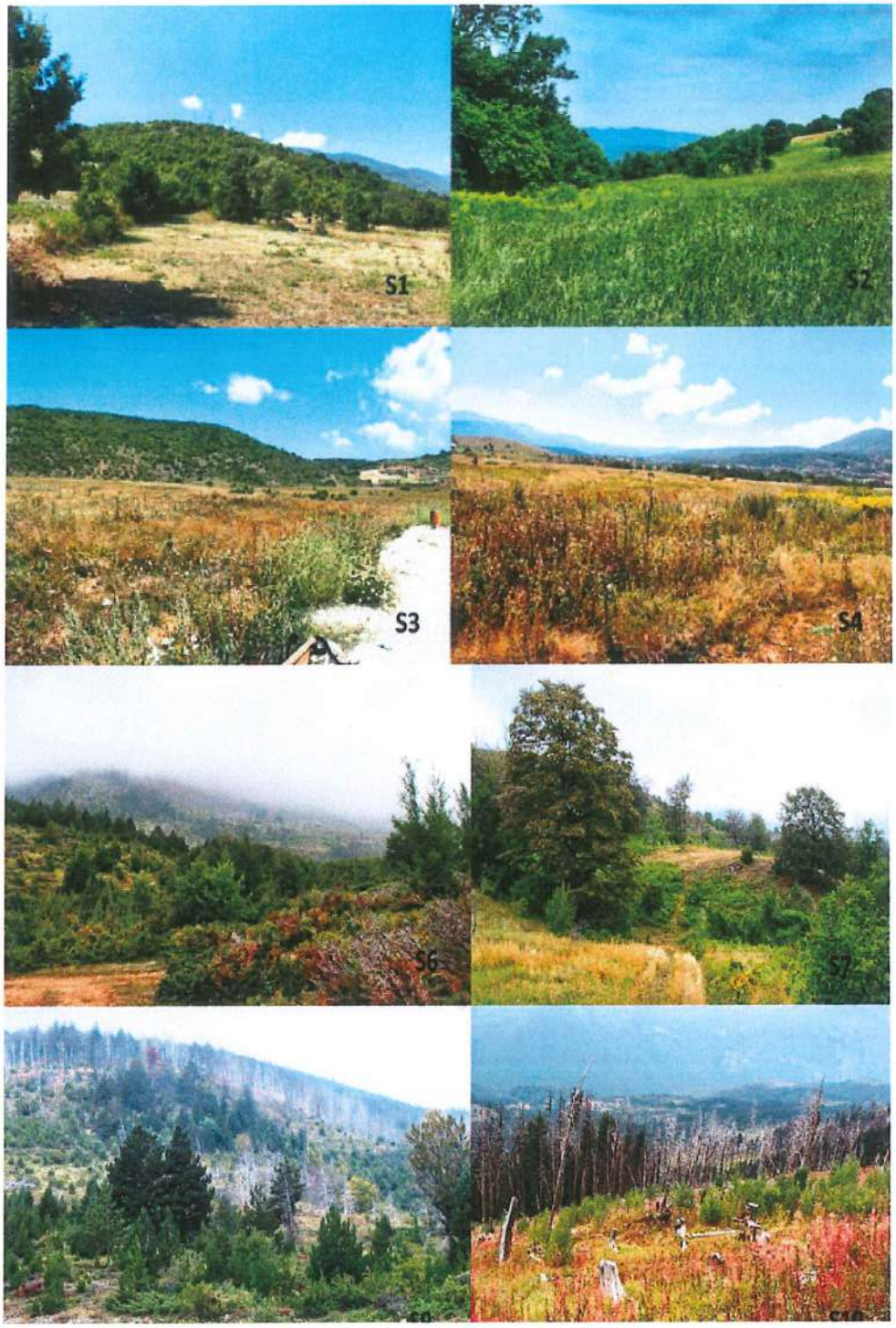

Fig. 2. Surveyed localities on Mt. Koritniku. S1) Zhur 1. Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia), 28.08.2022 (Photo by F. Millaku); S2) Zhur 2. Agriculturally improved, re-seeded and heavily fertilized grassland, in area of oak forest (*Quercus frainetto* woods, 28.06.2022 (Photo by F. Millaku); S3) Brezne 1. Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia), 30.06.2022 (Photo by F. Millaku); S4) Brezne 2. *Quercus frainetto* woods, 30.06.2022 (Photo by F. Millaku); S6) Rapçe, Temperate thickets and scrub (Juniperus communis formations on heaths or calcareous grasslands), 30.06.2022 (Photo by F. Millaku); S7) Fagus woodland and Beech forests near the water spring, 30.06.2022 (Photo by F. Millaku); S9) and S10) Recently felled areas (*Epilobium angustifolium* (L.) Scop) & *Salix caprea* L.), 30.06.2022 (Photo by F. Millaku).

Subgenus *Tarmannita* Efetov, 2000

Adscita (*Tarmannita*) *mannii* (Lederer, 1853)

Genus *Jordanita* Verity, 1946

Subgenus *Roccia* Alberti, 1954

Jordanita (*Roccia*) *budensis* (Speyer & Speyer, 1858)

Subgenus *Tremewania* Efetov & Tarmann, 1999

Jordanita (*Tremewania*) *notata* (Zeller, 1847)

Subgenus *Solaniterna* Efetov, 2004

Jordanita (*Solaniterna*) *subsolana* (Staudinger, 1862)

Subfamily Zygaeninae

Genus *Zygaena* Fabricius, 1775

Subgenus *Mesembrynus* Hübner, 1819

Zygaena (*Mesembrynus*) *purpuralis* (Brünnich, 1763)

Subgenus *Agrumenia* Hübner, 1819

Zygaena (*Agrumenia*) *carniolica* (Scopoli, 1763)

Zygaena (*Agrumenia*) *loti* ([Denis & Schiffermüller], 1775)

Subgenus *Zygaena* Fabricius, 1775

Zygaena (*Zygaena*) *ephialtes* (Linnaeus, 1767)

Zygaena (*Zygaena*) *filipendulae* (Linnaeus, 1758)

Zygaena (*Zygaena*) *lonicerae* (Scheven, 1777)

Procridinae

Adscita (*Adscita*) *geryon* (Hübner, 1813): locality S5 (14.vi.2021; 28.vii.2022), S6 (14. vi.2021), S7 (14.vi.2021), S8 (13.vi.2021), S9 (14.vi.2021), S10. (14.vi.2021; 28.vii.2022).

Adscita (*Tarmannita*) *mannii* (Lederer, 1853): locality S1 (10.vi.2021), SP2 (10.vi.2021), SP3 (10.vi.2021; 28. V.2021, 16.vi.2022), SP4 (10.vi.2021; 28.V.2021, 16.vi.2022), SP5 (28.V.2021; 16.vi.2022), SP6 (28.V.2021), SP7 (28.V.2021; 16.vi.2022), S9 (28.V.2021; 16. vi.2022).

Jordanita (*Roccia*) *budensis* (Speyer & Speyer, 1858) (Speyer & Speyer, 1858): locality S3 (22.v.2021), S4 (22.v.2021), S5 (22.v.2021), S6 (22.v.2021), S7 (22.v.2021; 17-30.vi.2022), S9 (30.vi.2022), S10 (22.v.2021; 17-30.vi.2022)

Jordanita (*Tremewania*) *notata* (Zeller, 1847): locality S6 (26.vii.2021; 28.vi.2022), S7 (26. vii.2021; 28.vi.2022), S10 (28.vi.2022).

Jordanita (*Solaniterna*) *subsolana* (Staudinger, 1862) (Staudinger, 1862): locality S2 (21. vi.2021), S3 (21.vi.2021), S4 (21.vi.2021; 24.vii.2021), S5 (21.vi.2021; 24.vii.2021), S6 (21. vi.2021), S7 (21.vi.2021; 24.vii.2021), S9 (24.vii.2021; 25.vii.2022).

Zygaeninae

Zygaena (*Mesembrynus*) *purpuralis* (Brünnich, 1763): locality S3 (11.vii.2021: 27. vii:2022), S4 (11.vii.2021: 27.vii:2022), S5 (11.vii.2021; 27.vii:2022), S6 (16.vii.2021; 29.vii:2022), S7 (11.vii.2021: 29.vii:2022), S10 (29.vii:2022).

Zygaena (*Agrumenia*) *carniolica* (Scopoli, 1763): locality S1 (11.vii.2021; 26-30.vi.2022), S2 (11.vii.2021; 26-30.vi.2022), S3 (11.vii.2021; 26-30.vi.2022), S4 (30.vi.2022), S5 (26-30. vi.2022), S6 (26-30.vi.2022), S7 (11.vii.2021; 26-30.vi.2022).

Zygaena (*Agrumenia*) *loti* ([Denis & Schiffermüller], 1775): S1 (11.vii.2021; 27.vi.2022), S3 (11.vii.2021; 27.vi.2022), S4 (11.vii.2021; 27.vi.2022), S5 (11.vii.2021; 27.vi.2022), S6 (11.vii.2021; 27.vi.2022), S7 (27.vi.2022), S10. (27.vi.2022).

Zygaena (*Zygaena*) *ephialtes* (Linnaeus, 1767): locality S2 (11.vii.2021; 27.vi.2022), S4 (11.vii.2021; 27.vi.2022), S5 (11.vii.2021; 27.vi.2022), S7 (11.vii.2021), S10 (27.vi.2022).

Zygaena (*Zygaena*) *filipendulae* (Linnaeus, 1758): locality S1 (26.vi.2022), S3 (26. vi.2022), S4 (26.vi.2022), S5 (11.vii.2021) S6 (11.vii.2021; 26.vi.2022), S7 (11.vii.2021: 26.vi.2022).

Zygaena (*Zygaena*) *lonicerae* (Scheven, 1777): locality S1 (13.vii.2021; 28-30.vi.22), S2 (13.vii.2021; 28-30.vi.22), S3 (13.vii.2021; 28-30.vi.22), S4 (13.vii.2021; 28-30.vi.22), S5 (13. vii.2021; 28-30.vi.22), S6 (13.vii.2021; 28-30.vi.22), S7 (13.vii.2021; 28-30.vi.22), S8 (13. vii.2021; 28-30.vi.22), S9 (13.vii.2021; 28-30.vi.22), S10 (13.vii.2021; 28-30.vi.22).

DISCUSSION

This work significantly contributes to knowledge of the Zygaenidae diversity of Mt Koritnik and represents the first recent study of this family in Kosovo. From the 11 recorded species, several of them can be considered rare or interesting records for Kosovo.

Adscita geryon (Hübner, 1813) is a species distributed from southern and central Europe, the Iberian Peninsula to southern Russia, Crimea and north-western Turkey and England (Naumann *et al.*, 1999). According to historical data, it was recorded on Mt Koritnik and Mt Pashtrik (Rebel & Zerny, 1931). The present record is the first in Kosovo in the last 90 years. It is also present in the other countries in the region: Albania (Rebel & Zerny, 1931), North Macedonia (Rebel & Zerny, 1931), Montenegro (Rebel & Zerny, 1931), Serbia (Nahirnić *et al.*, 2012) and Croatia (Šašić *et al.*, 2016; Koren, 2021).

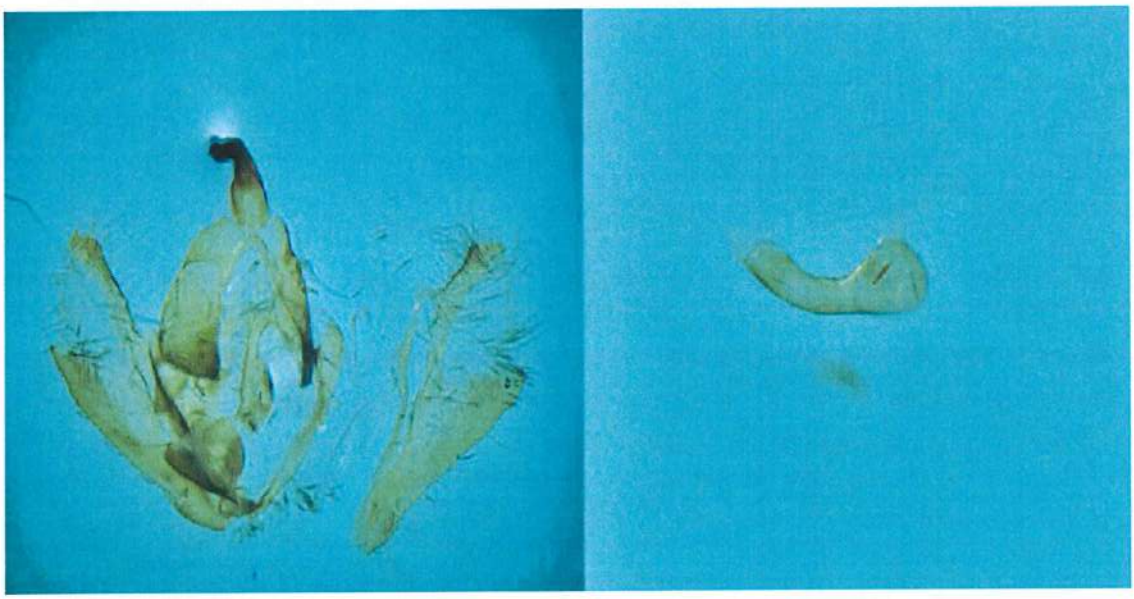

Fig. 3. Male genitalia of *Adscita geryon* recorded on Koritnik on 14.vi.2021, 28.vii.2022.

Adscita mannii (Lederer, 1853) is a species distributed from Spain, France across southern parts of central Europe, Italy, to the Balkans, Greece and Turkey (Naumann *et al.*, 1999). So far in Kosovo it was recorded in Pashtrik, Zhleb (Rebel & Zerny, 1931), and in Brezovicë in Sharr Mountain (Jakšić, 2006). It is a rather common species, present in all the surrounding countries: Albania (Rebel & Zerny, 1931), North Macedonia (Rebel & Zerny, 1931), Montenegro (Rebel & Zerny, 1931), Serbia (Nahirnić *et al.*, 2012), Croatia (Koren, 2021).

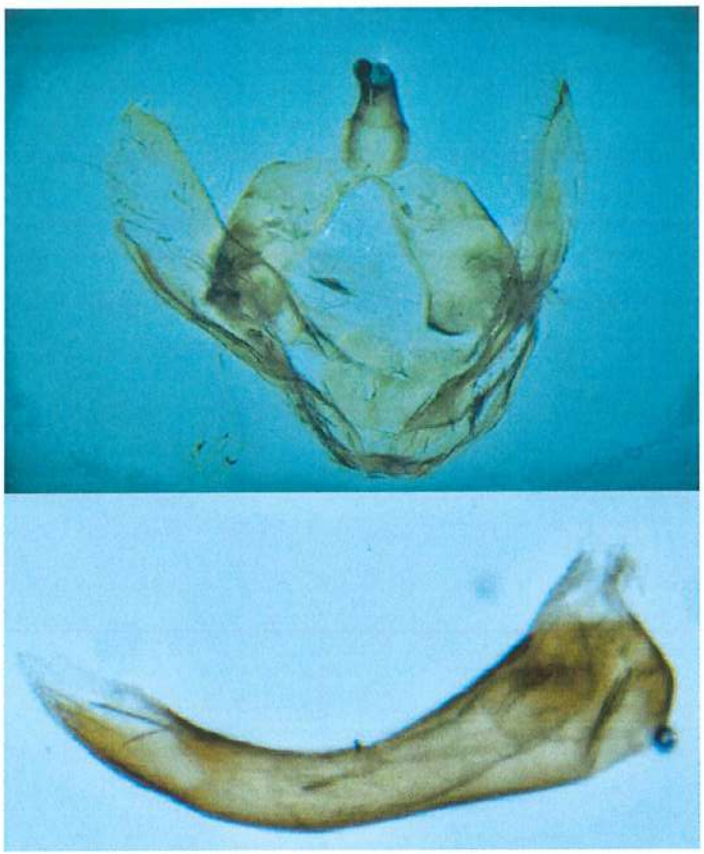

Fig. 4. Male genitalia of *Adscita mannii*, recorded on Koritnik on 10.vi.2021; 28.V.2021, 16.vi.2022

Jordanita budensis (Speyer & Speyer, 1858) has a very fragmented distribution, with isolated populations occurring in central Spain, southern France, Italy, Balkans, eastern Austria, Slovakia, Hungary, southern Russia, Caucasus, Transcaucasia and further East to eastern Asia (Amur, Mongolia) (Naumann *et al.*, 1999). This species was earlier recorded only at two localities in Kosovo, Mt Pashtrik (Rebel & Zerny, 1931), and in Sharri (Jakšić, 2006). It is considered a rare species. In the region it is present in North Macedonia (Rebel & Zerny, 1931), Bulgaria (Nahirnić *et al.*, 2021). The historical record from Croatia (Mladinov, 1958) has not been confirmed in recent studies (Koren, 2021).

Jordanita notata (Zeller, 1847) this species is distributed across western and central Europe, through the northern part of the Mediterranean region, up to Turkey and Transcaucasia (Naumann *et al.*, 1999). In the region it has somewhat limited distributions in Croatia (Koren, 2021), Montenegro (Jakšić & Nahirnić-Beshkova, 2020), Albania (Vrenozi *et al.*, 2020), and Serbia (Nahirnić *et al.*, 2012). This is the first record of

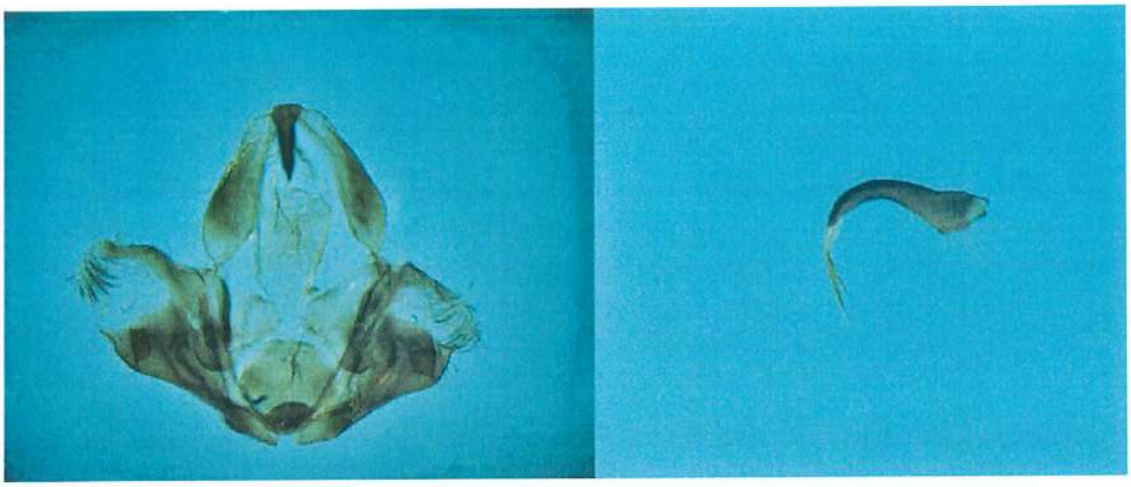

Fig. 5. Male genitalia of *Jordanita budensis* recorded on Koritnik on 22.v.2021; 17-30.vi.2022.

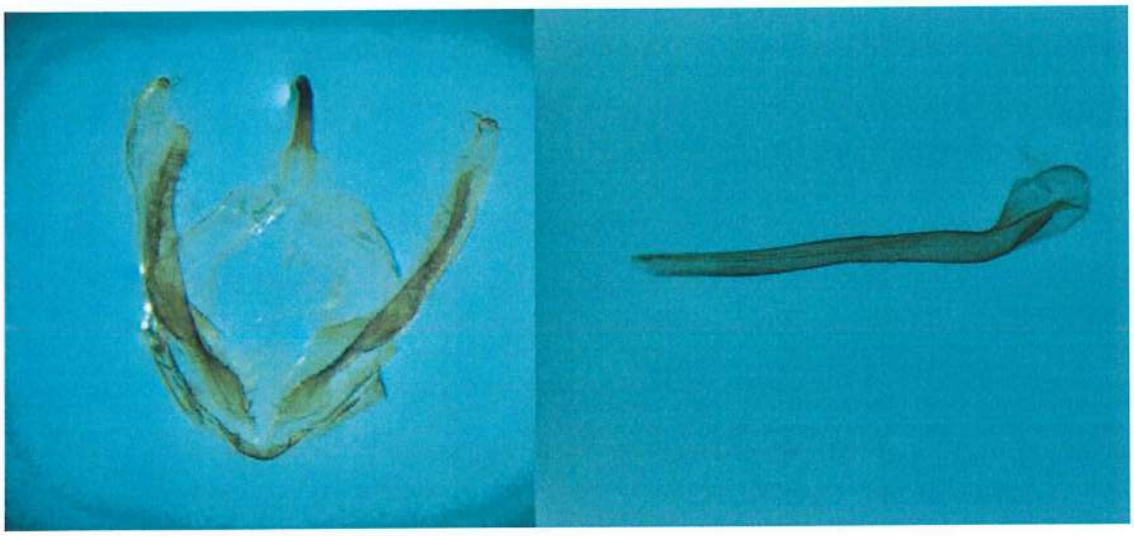

Fig. 6. Male genitalia of *Jordanita notata*, recorded on Koritnik on 26.vii.2021; 28.vi.2022.

Jordanita notata in Kosovo. It prefers semi-dry habitats and habitats with dry grass (Jakšić *et al.*, 2019) which are common in Kosovo, so further records are to be expected.

Jordanita subsolana (Staudinger, 1862), is distributed from southern Spain through the southern part of central Europe, Italy, the Balkan Peninsula and Greece to southern Russia and Ukraine, Turkey and Transcaucasia up to the Altai (Naumann *et al.*, 1999). Earlier this species was recorded at several localities in Kosovo: Mt Pashtrik (Rebel & Zerny, 1931), Rugova George, Milishevc, Bistricë e Deçanit, Prishtinë-Gërmi (Jakšić, 2006). In Kosovo this species inhabits grasslands and dry pastures, as recorded, as recorded in other research papers (Koren, 2021; Naumann *et al.*, 1999). This species is also distributed in the other countries in the region: Albania (Rebel & Zerny, 1931), North Macedonia (Rebel & Zerny, 1931), Serbia (Jakšić, 2003; 2006; Nahirnić *et al.*, 2012), Croatia (Šašić *et al.*, 2016; Koren, 2021).

Zygaena purpuralis (Brünnich, 1763) inhabits a wide range of habitats at an altitude up to 2000 m. It is distributed from the Pyrenees, the British Isles, through central and

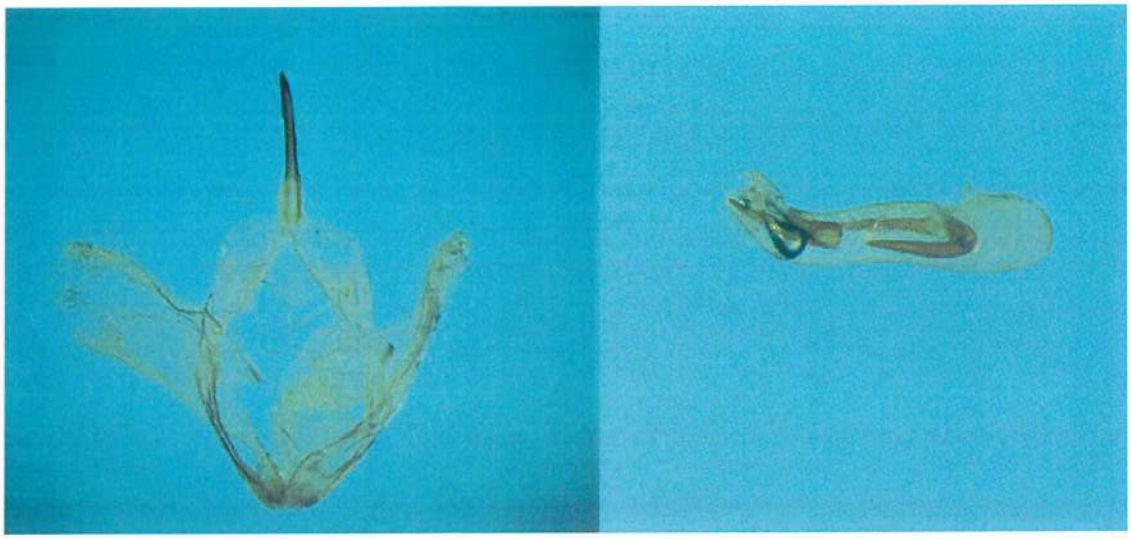

Fig. 7. Male genitalia of *Jordanita subsolana* recorded on Koritnik on 21.vi.2021; 24.vii.2021.

southern Europe to Asia Minor, the Caucasus and southern Russia (Naumann *et al.*, 1999). In Kosovo it was previously recorded in a few localities in Zhleb (Rebel & Zerny, 1931), while in the publications from Jakšić (Jakšić, 2006), it is stated that this species was recorded in Sharr and in Kopaonik.

This species is also distributed in other countries in the region: Albania (Rebel & Zerny, 1931; Vrenozi *et al.*, 2020), North Macedonia (Rebel & Zerny, 1931), Montenegro (Rebel & Zerny, 1931; Jakšić & Nahirnić, 2020), Serbia (Nahirnić *et al.*, 2012), Croatia (Šašić *et al.*, 2016), and Bulgaria (Nahirnić *et al.*, 2021).

Zygaena carniolica (Scopoli, 1763), is a common species in the Balkan Peninsula (Nahirnić *et al.*, 2012), and inhabits limestone habitats (Naumann *et al.*, 1999). It is distributed in Europe, in north, south and central Spain, in Asia Minor and in Transcaucasia (Naumann *et al.*, 1999). In Kosovo this species was previously registered on Pashtrik (Rebel & Zerny, 1931), as well as in Mokna, Rugova George, Gërmi, Brezovicë and in Bistrica e Prizrenit (Jakšić, 2006).

This species is also distributed in other countries in the region: Albania (1931), North Macedonia (Rebel & Zerny, 1931), Montenegro (Rebel & Zerny, 1931; Jakšić & Nahirnić, 2020), Serbia (Nahirnić *et al.*, 2012) and Croatia (Šašić *et al.*, 2016).

Zygaena loti (Denis & Schiffermüller, 1775) is a common species in the Balkan Peninsula (Nahirnić *et al.*, 2012). The distribution ranges from Spain in the Iberian Peninsula (locally and only in the north) across central and southern Europe to Siberia (Naumann *et al.*, 1999). In Kosovo this species is recorded on Pashtrik, Zhleb and Çakor (Rebel & Zerny, 1931) as well as in Rugova Gorge, on Milishevc, in Brezovicë and Gërmi (Jakšić, 2006). In the region it is known from Albania (Rebel & Zerny, 1931; Vrenozi *et al.*, 2020), North Macedonia (Rebel & Zerny, 1931), Montenegro (Jakšić & Nahirnić, 2022), Serbia (Nahirnić *et al.*, 2012), Croatia (Šašić *et al.*, 2016), Bulgaria (Nahirnić *et al.*, 2021).

Zygaena ephialtes (Linnaeus, 1767) is distributed from the western and northern Spain to central and southern Europe to the Urals and to Anatolia (Naumann *et al.*, 1999). According to the data from literature, this species is earlier recorded from Rugova

Gorge, Milishevc, Bistrica e Prizrenit Gorge, in several localities on Sharr Mountain as well as in Gërmi (Jakšić, 2006).

This species is also distributed in the other countries in the region: Albania (Rebel & Zerny, 1931), North Macedonia (Rebel & Zerny, 1931), Montenegro (Rebel & Zerny, 1931), Serbia (Nahirnić *et al.*, 2012), and Croatia (Šašić *et al.*, 2016).

Zygaena filipendulae is a common species throughout Europe, excluding the Atlantic coast of the Iberian Peninsula, northern Scandinavia and the Great Russian North (Naumann *et al.*, 1999). It is also present in Turkey, the Caucasus to Syria and Lebanon (Naumann *et al.*, 1999). This species is recorded for the first time in Kosovo from Pashtrik and Zhleb (Rebel & Zerny, 1931), whereas later on it was recorded by Jakšić (2006) in Bjeshket e Nemuna at the localities Milishevc and Rugova Gorge (Jakšić, 2006). This species is also distributed in the other countries in the region: Albania (Rebel & Zerny, 1931; Vrenozi *et al.*, 2020), North Macedonia (Rebel & Zerny, 1931), Montenegro (Rebel & Zerny, 1931), Serbia (Nahirnić *et al.*, 2012), Croatia (Šašić *et al.*, 2016), and Bulgaria (Nahirnić *et al.*, 2021).

Zygaena lonicerae (Scheven, 1777) is distributed across Ireland and Fennoscandia, to western China up to central and northern Spain through southern Europe to Turkey and the Caucasus (Naumann *et al.*, 1999). It is a common species that was earlier recorded at several localities in Kosovo; Vermosh Pejë (Rebel & Zerny, 1931), as well as Milishevc, Rugova Gorge, Zhleb, Prishtinë and on Mt Sharri (Jakšić, 2006). This species is also distributed in the other countries in the region: Montenegro (Jakšić & Nahirnić, 2020), Albania (Rebel & Zerny, 1931; Nahirnić & Beshkov, 2018), North Macedonia (Rebel & Zerny, 1931; Nahirnić & Beshkov, 2018), Serbia (Nahirnić *et al.*, 2012), Croatia (Mladinov, 1976; Šašić *et al.*, 2016).

In respect to the Zygaenidae diversity of Kosovo, 17 species were known prior to this survey (Rebel, 1917; Rebel & Zerny, 1931; Jakšić, 2006) and now, with the first record of *Jordanita notata*, the number has increased to 18. From those, eight species were not recorded during this survey: *Jordanita chloros* (Hübner, 1813), *J. globulariae* (Hübner, 1793), *Adscita albanica* (Naufock, 1926), *A. statices* (Linnaeus, 1758), *Zygaena transalpina* (Esper, 1780), *Z. osterodensis* (Reiss, 1921), and *Z. exulans* (Reiner & Hohenwarth, 1792). Some of them could also be expected on Mt. Koritnik with additional surveys in the parts of the mountain that were not included in this research.

If we compare the Zygaenidae diversity of Kosovo with that of other states in the region, 17 species are known in Albania and North Macedonia (Nahirnić & Beshkov, 2018), 23 in Serbia (Nahirnić *et al.*, 2012) and 24 in Croatia (Šašić *et al.*, 2016). Accordingly, we can expect the number of species in Kosovo to increase with additional surveys.

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SUMMARY

Diversity of burnet moths (Lepidoptera: Zygaenidae) on Mountain Koritnik, Kosovo

P. Bytyçi, F. Zhushi-Etemi, E. Kabashi-Kastrati, H. Çadraku & T. Koren

Representatives of the family Zygaenidae Latreille, 1809, are day-flying moths, which are known as burnets and foresters. The data for the diversity of this moth family for Republic of Kosovo are still scarce and incomplete. Most records of Zygaenidae in Kosovo date from the beginning of the 20th century (Rebel, 1917; Rebel & Zerny, 1931), whereas the latest data are these from Jakšić (1986; 2006).

In this paper we presented the first data on diversity of the moth family Zygaenidae in the Koritnik Mountain in Kosovo. The survey was conducted during the period June–August in 2021 and 2022, in ten localities. Moths were collected during the day, with entomological net. Collected and preserved specimens were identified at the National Museum of Natural History in Sophia in Bulgaria and at the Department of Biology at the Faculty of Natural Science, University of Prishtina. Identifications were based on Naumann *et al.* (1999).

During our research 11 Zygaenid species were recorded, among them five Procridinae and six Zygaeninae.

The Procridinae species: *Adscita geryon* (Hübner, 1813); *A. mannii* (Lederer, 1853); *Jordanita budensis* (Speyer & Speyer, 1858); *J. notata* (Zeller, 1847) – new record for Republic of Kosovo; *J. subsolana* (Staudinger, 1862).

Zygaeninae species: *Zygaena purpuralis* (Brünnich, 1763); *Z. carniolica* (Scopoli, 1763); *Z. loti* (Denis & Schiffermüller, 1775); *Z. ephialtes* (Linnaeus, 1767); *Z. filipendulae* (Linnaeus, 1758); and *Z. lonicerae* (Scheven, 1777).

Together with *Jordanita notata* (Zeller, 1847), the new species recorded in our research, and 17 species known prior to this survey (Rebel, 1917; Rebel & Zerny, 1931; Jakšić, 2006) the number of burnet moths in Kosovo came to 18. Seven species that were recorded earlier in other areas in Kosovo were missing in our survey. Some of them could also be expected in Mt. Koritnik with additional surveys in the parts of the mountain that were not included in this research.

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Short note

The first record of Euphyia biangulata (Haworth, 1809) (Lepidoptera: Geometridae) for Kosovo

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Abstract. In this article, we present a new record for moth fauna in Kosovo. The specimens of *Euphyia biangulata* (Haworth, 1809) (Lepidoptera, Geometridae) were collected at two localities on Mt. Koritnik. This newly recorded species increases the number of geometrid species recorded for Kosovo to 248.

Key words: distribution, new records, range, Balkan peninsula.

Euphyia biangulata (Haworth, 1809) is a medium-sized, easily recognizable geometrid species. The larvae mostly feed on the flowering plant species of the genus *Stellaria*, family Caryophyllaceae. Three species are known to be primary host plants: *Stellaria holostea* L., *Stellaria media*, and *Stellaria nemorum* (Hausmann & Viidalepp, 2012; Leraut, 2009).

Euphyia biangulata occurs in open woods such as oak and hornbeam forests, also in ash forests and coniferous forests.

The flight period time depends on altitude, usually in two generations from May to late August (Hausmann & Viidalepp, 2012). It is distributed across Europe, Anatolia, the Caucasus region, and also NE Turkey and Iran. It was reported from all countries in the Balkan Peninsula: Albania (Beshkov & Nahirnić, 2020), Serbia (Tomić et al., 2002; Dodok, 2006), North Macedonia (Huemer et al., 2011) Bulgaria (Nestorova, 1990; Zlatkov, 2007; Beshkov & Langourov, 2011), Greece (Gozmány, 2012), Bosnia and Herzegovina (Lelo, 2004), Romania (Rákosy et al., 2003), Croatia (Koren, 2018), and Slovenia (Hausmann & Viidalepp, 2012), except Kosovo.

Here we report the first observations of this species in Kosovo.

Moths were collected in the summer of 2021 and 2022, with 6W 12V Portable Heath Moth Traps, in the period from eight o'clock in the evening up to eight in the morning, when the traps were emptied.

During this investigation, *Euphyia biangulata* has been observed from two localities (Fig. 1) in Mountain Koritnik in Kosovo: 1) village Rapçë, in a stony slope with *Juniperus communis* and *Pinus heldreichii*, 42°04'49" N, 20°36'32" E, 1214 m a.s.l., on 08.VII.2021 (Fig. 2), and 2) near the village Brezne (Fig. 3), in a mountain steppe

with *Quercus, Carpinus*, and *Acer* trees (*Festuco-Brometalia* and *Quecus Frainetto* woods), 42°07'59" N, 20°38'07" E, 1064 m a.s.l., on 23.VII.2022.

The habitats are described according to EUNIS -European Nature Information System for habitat classification (Chytry et al., 2020).

In total, two individuals have been collected. The first individual was collected on 08.VII.2021 in the first locality, Rapçë (Fig. 4), whereas the second specimen was collected on 23.VII.2022 in the second locality, Brezne. In both localities the host plant *Stellaria holostea* was present.

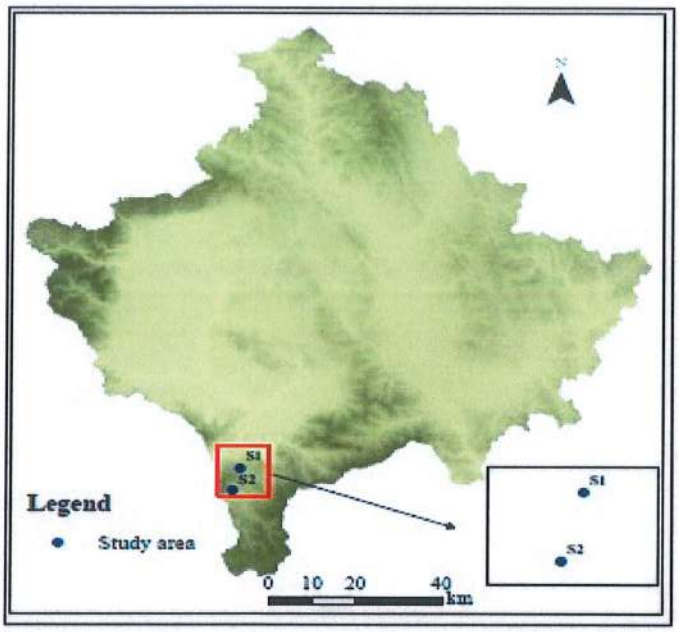

Fig. 1. The localities in Kosovo where *Euphyia biangulata* was observed.

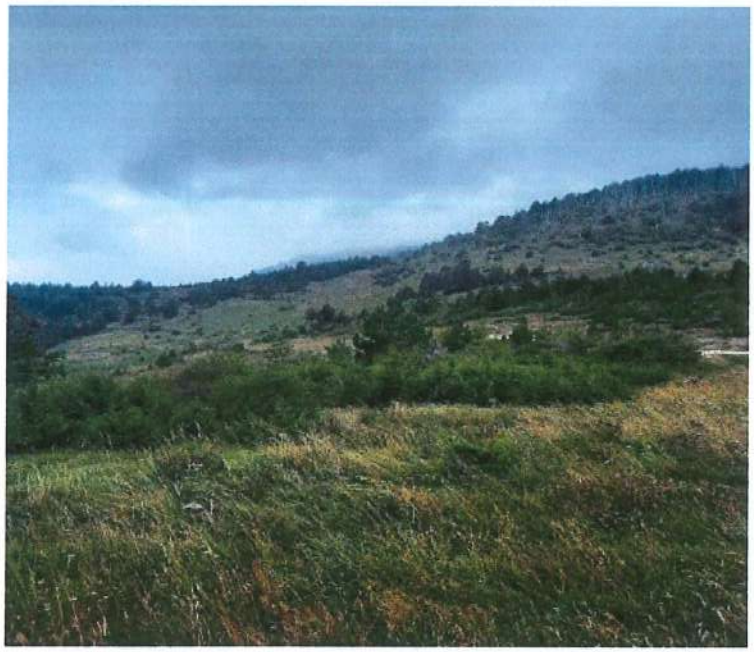

Fig. 2. Habitat of *Euphya biangulata* at the locality Rapçë (1214 m), photograph by PB, 08 July 2021.

Fig. 3. Habitat of *Euphya biangulata* at the locality Brezne (1064 m), photograph by PB, 23 July 2022.

Fig. 4. *Euphyia biangulata* (Haworth, 1809), collected by PB in Rapçë, 08 July 2021

The geometrid moths are the only lepidopteran family with a recent checklist for Kosovo considering all available literature as well as new records (Bytyçi et al., 2022). Accordingly, *E. biangulata* is added to the list of Geometridae of Kosovo, and with this species the number of geometrid species in the country is 248. Considering the size of Kosovo, the number of 248 geometrid species can be considered a high number, however comparing to the other Balkan countries, Serbia 390 species (Stojanovic, 2010), Croatia 440 (Mihoci 2008), Bulgaria 442, and the European part of Turkey 200 species (Okyar& Mironov, 2008), it can be expected the number of geometrid species in Kosovo to increase with further research.

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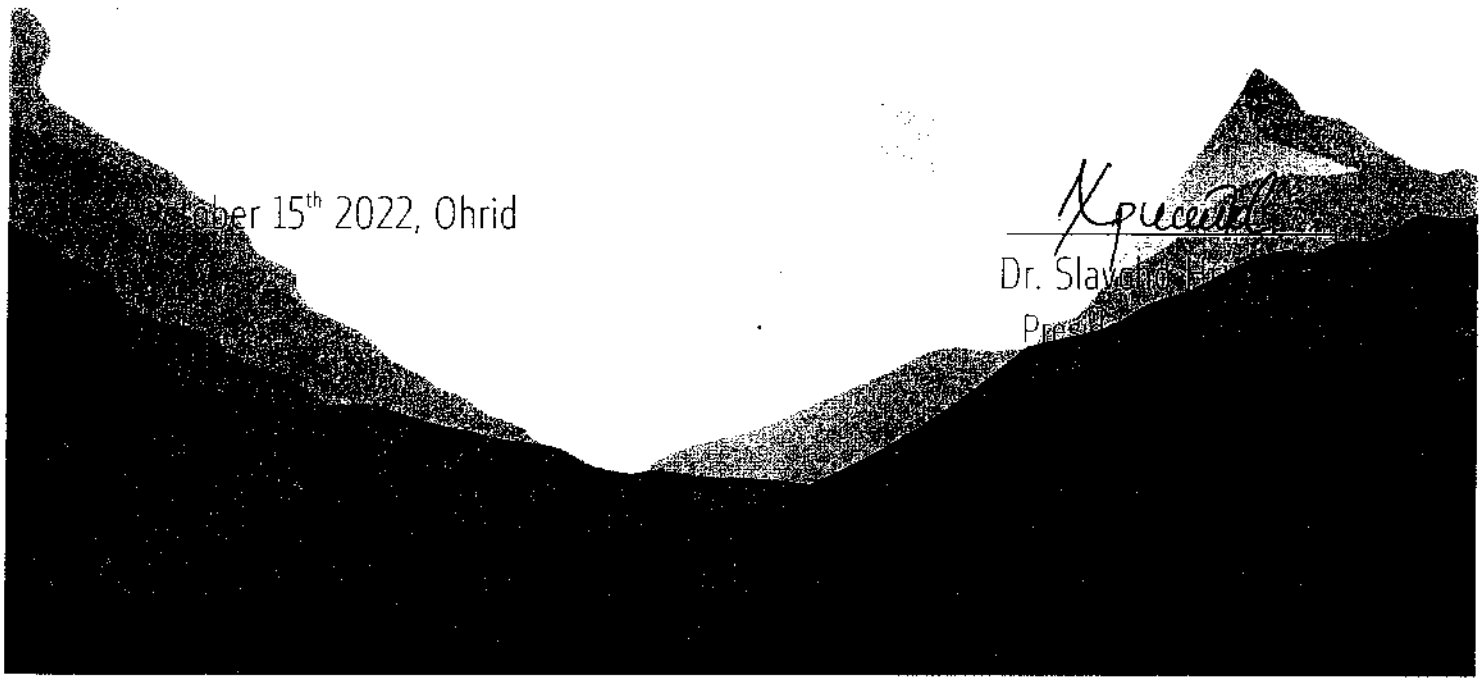

October 15th 2022, Ohrid

Dr. Slavčo
President