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NEW DATA ON DISTRIBUTION OF GENUS ZYGAENA FABRICIUS, 1775 IN BOSNIA AND HERZEGOVINA (LEPIDOPTERA: ZYGAENIDAE)

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ABSTRACT:
New data on distribution of genus Zygaena Fabricius, 1775 in Bosnia and Herzegovina (Lepidoptera: Zygaenidae)
We analysed the distribution of Zygaena Fabricius, 1775 moths on Čavljak and mountains: Bjelašnica, Igman and Trebević. Five different Zygaena species were found on investigated sites: Zygaenaviciae Denis & Schiffermuller, 1775, Z. filipendulae Linnaeus, 1758, Z. lonicerae Scheven, 1777, Z. purpuralis Brünnich, 1763 and Z. loti Denis & Schiffermüller, 1775. Simpson's diversity index was calculated based on the collected species and their population density by which we determined that Mtn.Igman was the locality with the highest species richness. Bray-Curtis cluster analysis was used to show that Mtn.Bjelašnica and Čavljak are the most similar localities in terms of the species that inhabit them.

KEY WORDS
Zygaena transalpina, Zigaena angelice, Distribution, Bosnia and Herzegovina.

1. Introduction

Genus *Zygaena* is in Bosnia and Herzegovina represented by 15 species. The list of therecorded species was based ona review of Rebel (1904) where 12 species weredescribed. The additional three species for Bosnia and Herzegovina were recorded by: Naumann et al. 1983; Nahirnić et al. 2015. The aim of this research is to evaluate the biodiversity and distribution of the genus *Zygaena* in the broader area of Sarajevo.

Finding biogeographic relicts *Zygaena angelicae* Ochsenheimer, 1808 and *Zygaena transalpine* Esper, 1780 and their hybrids would represent a significant contribution to the understanding of the biology of the mentioned species, as well as an analysis of richness of the sites that is based on the number of individuals and the number of species present. *Z. transalpina* complex is an interesting example of geographic variations, its three nominal taxa are involved in the occasional hybrid formation in the secondary contact zone.

Hybrids of the *Zygaena angelicae* and *Z. transalpina* species inhabit mountainous areas over 2000 meters above sea level. *Zygaena angelicae* inhabits areas of lower, while *Zygaena transalpina* inhabits areas of higher altitude (Efetov & Tarmann, 2016).

2. Material and methods

The material was collected on Mtn.Bjelašnica (1583 m), Mtn.Trebević (1627 m), Mtn.Igman (1250 m) and Čavljak (1359 m) (Figure 1.). The research period was based on the flight period of adults and the flowering period of foodplants in reference to (Naumann et al. 1999).

Field research consisted of collecting the target species using an entomological net. Afterwards they were transferred into a killing jar infused with chloroform.Specimen preparation was conducted using spreading boards, entomological needles and forceps while the preparation itself was done according to the description from (Schauff, 1986).

The identification was done using a key by (Naumann et al. 1999).Since individuals of certain species did not have a clear morphological difference that could be used for determination, further identification was based on analysis of the genital apparatus in reference to (Robinson 1976).The identification of morphological characteristics of the specimen (the appearance of the upper and lower surface of the wings) was done according to (Naumann et al. 1999), whilst the identification by the genital apparatus was done according to (Efetov, 2004).

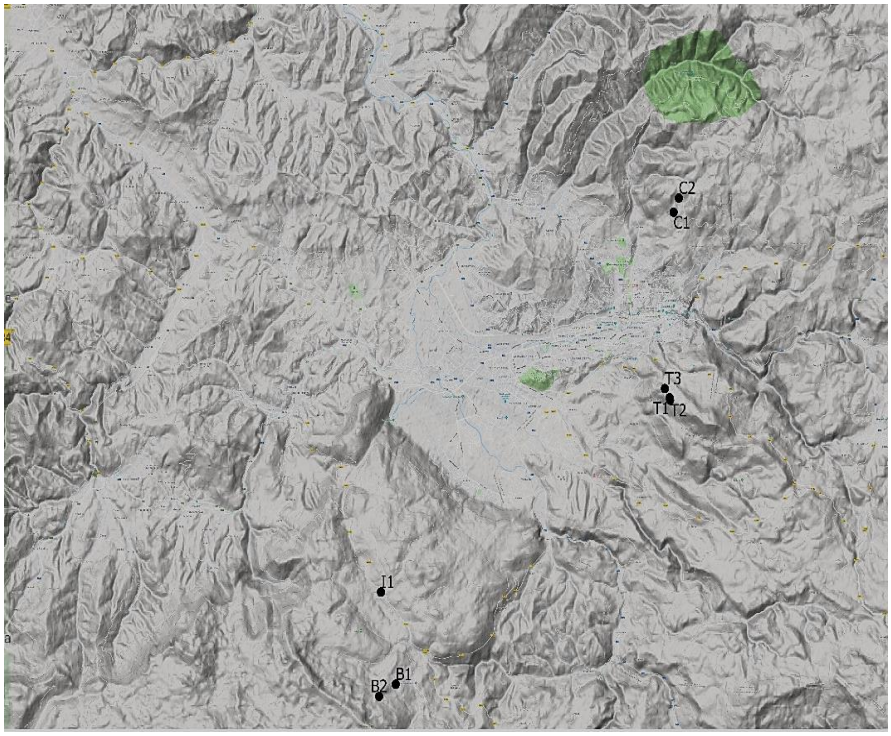


Figure 1: The distribution of investigated localities on mountains: I – Mt. Igman, B – Mt. Bjelašnica, T – Mt. Trebevic, C – Čavljak on Mt. Ozren.

Statistical data was processed using Past ver. 3.00 software with whichbiodiversity indices were calculated. Furthermore, the BioDiversity Pro software was used to analyse similarities between localities – Bray-Curtis cluster analysis.

3. Results and discussion

Five species i.e. 126 individuals were collected during fieldworkfrom the beginning of July to the middle of August. Species were collected on four localities, which were chosen based on the data from the entomological collection of the National Museum of Bosnia and Herzegovina, precisely the dates and locations of the target species. (Table 1.).

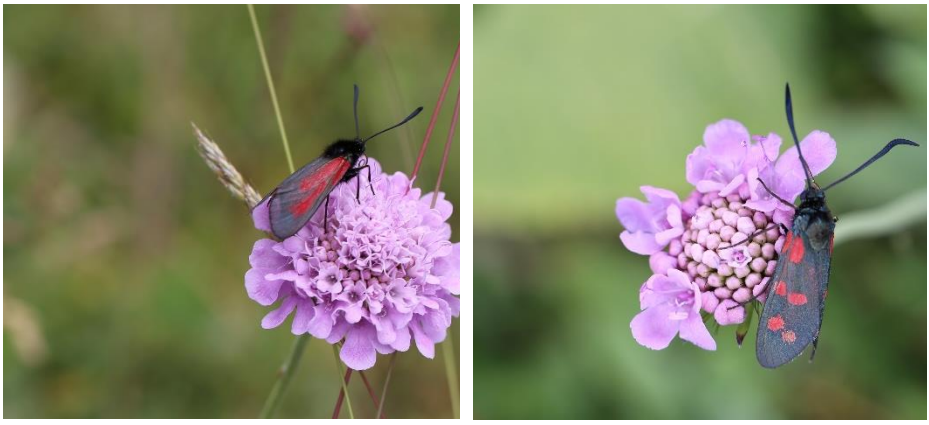
Table 1: Results of field research in 2017 with the distribution of individuals from the entomological collection.

Species	Number of individuals	Localities (sites)	Sample date
Zygaena purpuralis	9; 10*	Trebević	1.7.2017; 19.7.1970*
	10	Čavljak	2.7.2017; 2.7.1987*
	10; 1*	Igman	05.07.2017
	10	Bjelašnica	08.07.2017
Zygaena filipendulae	12	Bjelašnica	05.07.2017
	3	Čavljak	02.07.2017
	10		10.07.2017
	2	Igman	05.07.2017
	2*	Trebević*	10.07.1986.
Zygaena lonicerae	5; 2*	Trebević	01.07. 2017; 07.07.1977*
	2	Igman	05.07.2017
	14	Čavljak	10.07.2017
Zygaena loti	4; 3*	Igman	08.07.2017
	2*	Trebević*	27.07.1978
Zygaena viciae	18; 3*	Trebević	01.07.2017; 22.07.1984*
	7 2*	Igman	08.07.2017; 04.07.1979*
	3	Čavljak	10.07.2017
	7	Bjelašnica	05.07.2017
Zygaena angelicae*	6	Trebević	06.07.1989
	3		04.07.1986
Zygaena transalpina*	1	Vlašić	26.07.1978
Z. angelicae x Z. Transalpina*	2	Igman	21.07.1984
	2		29.07.1985

*data from the entomological collection of the National Museum of Bosnia and Herzegovina

Čavljak is the locality where the first find of *Zygaena* species was recorded as it was not pre-recorded in the entomological collection of the National Museum of Bosnia and Herzegovina. For the *Zygaenaviciae* species, the new recorded locality is Mtn.Bjelašnica. Adults of *Zygaenalonicerae* and *Zygaena. filipendulae* possess the same foodplant species (*Scabiosa* L., *Knautia* L., *Cirsium* Mill. and *Centaurea* L.) (Figs. 2-3.). However, by comparing the data of the field research carried out in 2017., it can be seen that *Zygaena filipendulae* was not recorded on Mtn.Trebević mountain meadow.

We can assume that one of the reasons for this, is that the larvae of this species feed off of plants from the genus *Lotus*L. (*Lotus corniculatus* L., *Lotus uliginosus* Cav.), and the larvae of the *Zygaenalonicerae* species feed from plants of genera: *Trifolium* L., *Lathyrus* L., *Onobrychis* Mill. and *Vicia* L. Plants from the genera which the adult forms feed from were observed during the field research at Mtn.Trebević This also applies to *Zygaenaviciae* and *Z. purpuralis* species, whose larvae feed on plants of the genera *Thymus* L., *Trifolium* and *Lathyrus.*



Figures 2-3: Zygaena purpuralis(left) and Zigaena filipendulae (right) on Scabiosa plant from Čavljakon Mt.Ozren.

Table 2: Biodiversity index values for collected species of the genus Zygena.

	Trebević	**Čavljak**	**Bjelašnica**	**Igman**
Taxa_S	3	4	3	5
Individuals	32	40	29	25
Dominance_DA	0,42	0,30	0,35	0,28 s
Simpson_1-D	0,58	0,70	0,65	0,72
Shannon_H	0,97	1,27	1,08	1,42
Evenness_e^H/S	0,88	0,89	0,98	0,83
Brillouin	0,86	1,14	0,95	1,19

Based on the Dominance analysis method (DA) (Table 2.) it can be concluded that Čavljak and Mtn.Igman are localities where all species are equally distributed while Mtn.Trebević is an example of a locality dominated by *Zygaenaviciae*(the value ranges from 0 to 1, where 0 represents an equal presence of species, and 1 dominance of one specific species in a community). By analysing Simpson's Diversity Index (1-D) on Mtn.Igman individuals are distributed in groups in approximately equal numbers compared to other sites. Based on this,Mtn.Igmanis the site with the highest biodiversity.

For the better understanding of the results an optimum number of clusters is displayed in the dendogram (Fig.1.). Clusters are ranked from one to three (which can be seen in the picture) ie, there is an increase of 7,21 in distance from the first to the second cluster between the sites, which corresponds to the similarities between Mtn.Trebević and Mtn.Igman, which is 63.16%. The distance increases from cluster two to cluster three by two, hence the similarity between Mtn.Igman and Mtn.Bjelašnica is 70,37%; Mtn.Bjelašnica and Mtn.Čavljak with the highest similarity of 72,47%.

Zygaena angelicae and *Zygaena transalpina* were chosen as particularly interesting for this research, since they are biogeographic relicts. Data on presence of these species were taken from the entomological collection of the National Museum of Bosnia and Herzegovina, and on this basis we received information that species were found on Mtn. Igman, Mtn. Vlašić and Mtn. Trebević in the month of July. Field research for adults was conducted from the beginning of June to the middle of August. However, these biogeographic relics as well as their hybrids were not observed at selected sites during field research in 2017. The absence of species can be caused by several factors, from unsteady weather conditions, insufficient data to the methodology of fieldwork itself.

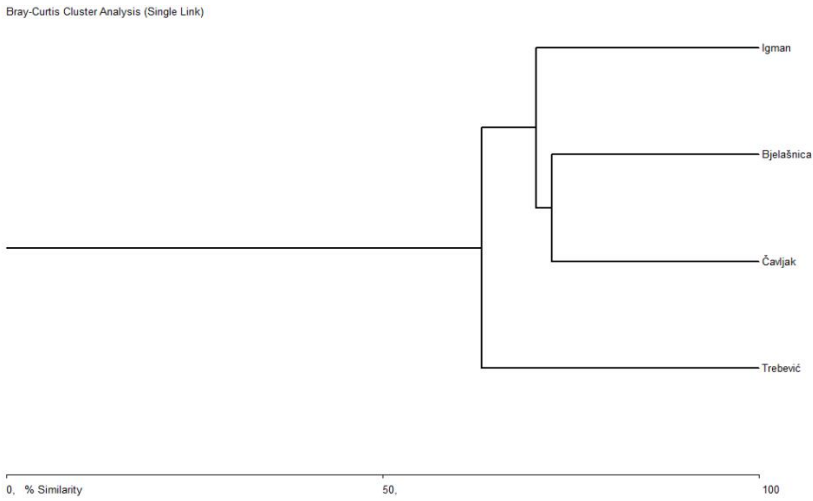


Figure 4: Dendogram: Bray-Curtis clusteranalysis.

Species that inhabit higher altitude habitats are sensitive to changes in the environment due to living mainly in small and isolated populations, within regions with limited climatic variations, as well as the increase in altitude resulting with reduced habitat conditions (Dieker, et al. 2011).Unstable weather during the summer season with a higher amount of rainfall can lead to either prolongation of the flight period or increase in larval mortality.

4. Conclusion

Of the 15 species from the genus *Zygena* described on the territory of Bosnia and Herzegovina, during field research five species were collected and identified. The aforementioned species are *Zygaena purpuralis, Zygaena lonicerae, Zygaena filipendulae, Zygaenaviciae, Zygaena loti,* while *Zygaena carniolica* Scopoli, 1763 and *Zygaenaephialtes* Linnaeus,

1767 were observed at selected sites but not sampled. During the fieldwork the biogeographic relics *Zygaena angelicae* and *Zygaena transalpina* were not sampled nor recorded. The statistical analysis has shown that Mtn.Igman is the site with the highest biodiversity of the target species.

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