

THE DIVERSITY OF THE FAMILY CETONIIDAE (COLEOPTERA: SCARABAEOIDEA) OF MOUNTAIN OZREN (BOSNIA AND HERZEGOVINA)

MIRZETA KAŠIĆ-LELO*, SUVAD LELO and ADI VESNIĆ

Faculty of Natural Sciences and Mathematics, Biology Department
Zmaja od Bosne 33 71000 Sarajevo, Bosnia and Herzegovina
* E-mail: mirzeta_kasic@hotmail.com

Abstract

From April to September of 2008 and 2009 samples of family Cetoniidae Leach, 1815 were collected on the vertical profile of the southern slopes of Mount Ozren near Sarajevo. Research was conducted at six selected localities: Orlovac, Nahorevo, Čavljak, Skakvac, Bukovik and Crepoljsko. After 41 field investigations, 594 individuals were collected and determined as representatives of seven species. Collected data were processed with statistical software Biodiversity Pro and with options Diversity/Compare diversities: Alpha index; Berger-Parker index; Simpsons index; Margaleff index; Mackintosh index; Bray-Curtis Cluster Analysis: Single Link.

By comparison of data it was concluded that Skakvac represents the typical locality for southern slopes of Mount Ozren. The species *Oxythyrea funesta* (Poda, 1761) is the most numerous faunistic element that was found.

KEY WORDS: Cetoniidae, fauna, biodiversity, Ozren, Sarajevo, Bosnia and Herzegovina

Introduction

After World War II the most important data on *flower chafer* Cetoniidae Leach, 1815 of Bosnia and Herzegovina were given by Rene MIKŠIĆ who investigated the area of Bosnia and Herzegovina, the entire Balkan Peninsula and most of the Palaearctic (MIKŠIĆ, 1950, 1953, 1956, 1958, 1962, 1965, 1970, 1976, 1977, 1980, 1982, 1987, e.g.). What little research done on this group after the war events in Bosnia and Herzegovina from 1992-1995 was undertaken mostly by authors of this paper (LELO, 2000, 2003; LELO & KAŠIĆ-LELO, 2006a, 2006b, 2007; LELO & ŠKRIJELJ, 2001; KAŠIĆ-LELO, 2005, 2011; KAŠIĆ-LELO & LELO, 2005, 2006, 2007, 2009a, 2009b; KAŠIĆ-LELO *et al.*, 2006), but it has been so little that it can be said that no

ecological research on the family of flower chafer in Bosnia and Herzegovina (LELO & KAŠIĆ-LELO, 2010; KAŠIĆ-LELO, 2011). has been conducted with contemporary views on biodiversity

Material and Methods

The research into family Cetoniidae was conducted from April to September 2008 and 2009 at six localities of Mountain Ozren (Orlovac, Nahorevo, Skakavac, Čavljak, Bukovik and Crepoljsko) on the southern slopes of Mountain Ozren near Sarajevo (Figs. 1-2; Tab. I). Ozren Mountain is determined by the following coordinates: 43° and 44° of north latitude and 18° and 19° of eastern longitude. The mountain covers an area of about 280 km² (REDŽIĆ, 1991; KAŠIĆ-LELO, 2011).



Figure 1. Display of position of Mount Ozren and studied area on the blank map of Bosnia and Herzegovina (created by: S. Đug based on GIS software),

During 41 field studies (17 in 2008 and 24 in 2009), 49 samples were collected.

During the field studies 594 individuals were collected by standard method.

In the laboratory the material was prepared by putting each insect on an entomological pin, properly labelling it and leaving it to dry for 14 days. After this period the insects were stored in entomological boxes. All materials are stored in the private Zoological collection "Lelo" in Sarajevo.

Identification of species was done through numerous morphological and anatomical character analyses according to the key of BARAUD (2001). Statistical analysis of the data was performed with the softwares "Past" and „BioDiversity Pro“.

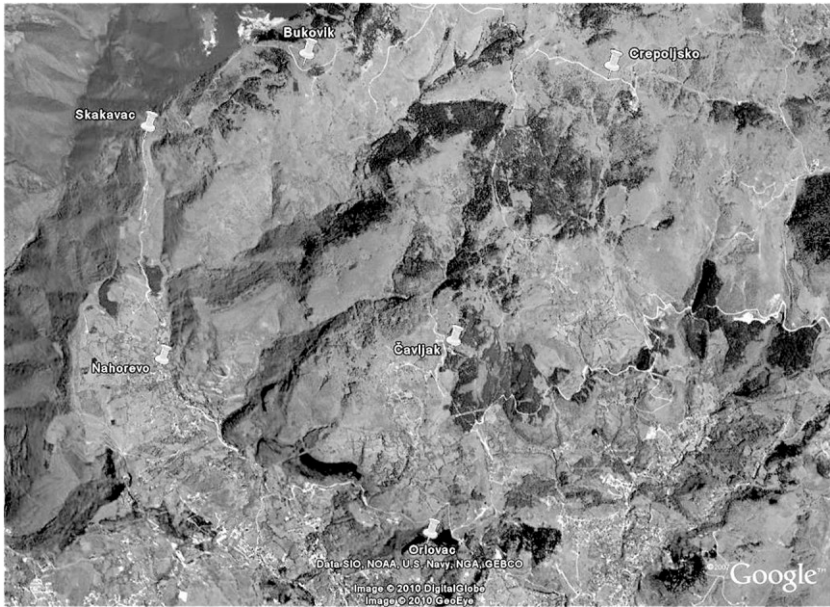


Figure 2. Display of studied localities position on Mount Ozren near Sarajevo (based on Google Earth software).

Table I. Review of studied localities on Mount Ozren near Sarajevo.

Toponym (and pointers) of locality	Geographical latitude and longitude	Altitude of pointers (m)
Orlovac	43°53' 09,68" N 18°25'53,33" E	869
Nahorevo	43°54' 53,46" N 18°24'32,50" E	781
Skakavac	43°56' 07,98" N 18°25'28,90" E	1.113
Čavljak	43°54' 06,65" N 18°26'49,64" E	1.202
Crepoljsko	43°55' 02,86" N 18°29'01,32" E	1.411
Bukovik	43°55' 57,95" N 18°26'55,75" E	1.492

Results and Discussion

During the research on Cetoniidae of Mount Ozren (Central Bosnia and Herzegovina) a total of seven species was collected (Tab. II).

The measurement is performed by counting the individuals of distinctive species within ecosystems and it is in direct correlation with the sample size. According to the primary pattern, the Alpha biodiversity index is highest at the Skakavac locality and smallest on Crepoljsko locality (Tab. III; Fig. 3).

Table II. Review of numbers of collected male and female flower chafer specimens at localities on Mt. Ozren (Central Bosnia and Herzegovina) in 2008 and 2009.

Species	Year	Locality / number of collected males and females											
		Orlovac		Nahorevo		Skakavac		Čavljak		Crepoljsko		Bukovik	
		♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
<i>Valgus hemipterus</i> (Linnaeus, 1758)	2008	-	-	-	-	-	-	-	-	-	-	-	-
	2009	11	2	-	-	-	-	-	-	-	-	-	-
<i>Gnorimus nobilis</i> (Linnaeus, 1758)	2008	-	-	-	-	-	-	-	-	-	-	-	-
	2009	-	-	-	1	-	-	-	-	-	-	1	-
<i>Trichius fasciatus</i> (Linnaeus, 1758)	2008	-	-	-	-	-	-	-	-	-	-	-	-
	2009	1	-	-	-	1	-	-	-	-	-	-	-
<i>Trichius sexualis</i> Bedel, 1906	2008	7	2	-	-	-	-	-	-	-	-	-	-
	2009	6	1	-	-	-	-	-	-	-	-	-	-
<i>Cetonia aurata</i> (Linnaeus, 1761)	2008	2	3	-	-	-	-	19	16	-	-	1	-
	2009	8	14	2	-	2	-	15	14	-	-	1	2
<i>Tropinota hirta</i> (Poda, 1761)	2008	-	-	-	-	-	-	-	-	-	-	-	-
	2009	-	-	4	-	-	-	-	-	-	-	-	-
<i>Oxythyrea funesta</i> (Poda, 1761)	2008	4	1	3	10	-	-	65	47	-	-	-	-
	2009	119	56	68	45	2	2	7	2	7	3	10	7
Sum by years	2008	13	6	3	10	-	-	84	63	-	-	1	0
	2009	19	13	74	46	5	2	22	16	7	3	12	9
	Total	145	73	77	56	5	2	106	79	7	3	13	9
Total	2008	218	120	7	38	10	21	158	79	77	56	5	2
	2009	237	133	7	185	10	22	218	120	7	38	10	21

By comparison with the Berger-Parker Dominance measure of numerical importance of the most abundant species ($d = N_{\max}/N$), it was shown that the species *Oxythyrea funesta* (Poda, 1761) is an important (in statistics mean by this model) faunistic element at the localities of Crepoljsko and Nahorevo. However, estimation of these (statistically by the model used) values ($1/d$) more clearly reflects the real situation between populations of Cetoniidae species at the observed localities on Mount Ozren (Tab. IV; Fig. 4). Crepoljsko locality, where only 10 individuals of *Oxythyrea funesta* (Poda, 1761) were collected, remains the locality with the lowest value of Berger-Parker Dominance (while in the basic pattern it had the greatest value). Skakavac locality as indicated above now has the highest value of Berger-Parker Dominance,

followed by Čavljak, Orlovac, Bukovik and Nahorevo. From this we clearly see that the statistical value for the most abundant species *Oxythyrea funesta* (Poda, 1761) is very high for the researched localities on Mount Ozren near Sarajevo, either because it is the only species (Crepoljsko: 100%) or because it is the most abundant species of every observed locality (Nahorevo: 94.74% - Skakavac: 57.14%).

Table III. Primary pattern biodiversity Alpha index at investigated localities.

Index	Orlovac	Nahorevo	Skakavac	Cavljak	Crepoljsko	Bukovik
Alpha	0.897	0.778	1.988	0.314	0.277	0.939

Table IV. Berger-Parker index comparison between the investigated sites.

Index	Orlovac	Nahorevo	Skakavac	Cavljak	Crepoljsko	Bukovik
Berger-Parker Dominance (d)	0.759	0.947	0.571	0.654	1.000	0.773
Berger-Parker Dominance (1/d)	1.317	1.056	1.750	1.529	1.000	1.294
Berger-Parker Dominance (d%)	75.949	94.737	57.143	65.405	100.000	77.273

As expected since the patterns are similar, an identical fluctuation was found after Simpson's index comparison (Tab. V; Fig. 5).

After comparison with Margeleff's index the Skakavac locality was again recognized as a typical locality in terms of Cetoniidae diversity on Mount Ozren (Central Bosnia and Herzegovina) (Tab. VI, Fig. 6).

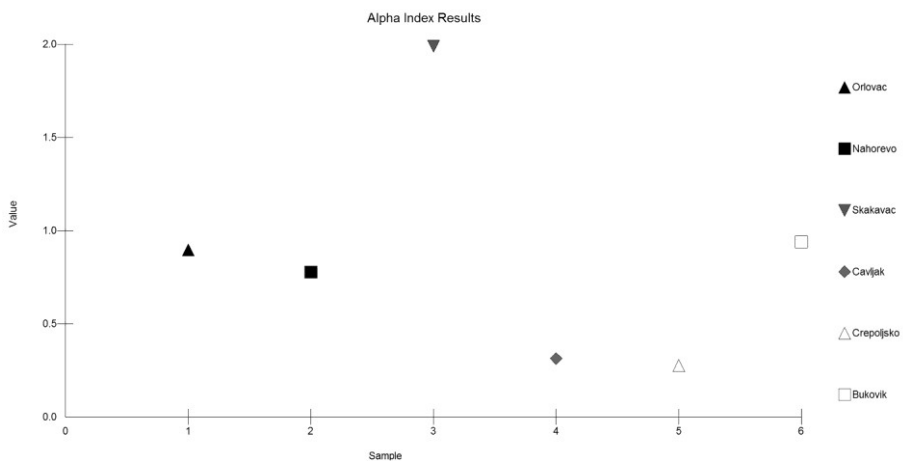


Figure 3. Alpha index values at investigated localities.

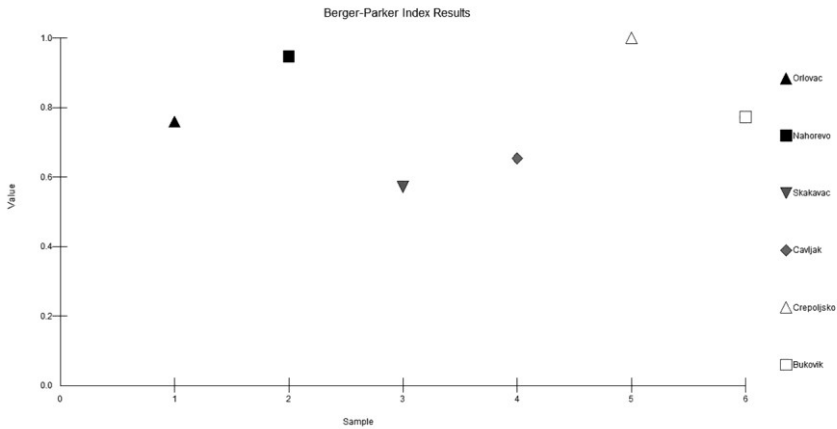


Figure 4. Berger-Parker index values at investigated localities.

The identical fluctuation was found after Simpson's index comparison (Tab. V; Fig. 5), what was expectable since the patterns are similar.

Table V. Simpson's index comparison between the investigated sites

Index	Orlovac	Nahorevo	Skakavac	Cavljak	Crepoljsko	Bukovik
Simpsons Diversity (D)	0.596	0.898	0.333	0.545	1.000	0.615
Simpsons Diversity (1/D)	1.679	1.114	3.000	1.835	1.000	1.627

Table VI. Margeleff's index comparison between the investigated sites

Index	Orlovac	Nahorevo	Skakavac	Cavljak	Crepoljsko	Bukovik
Margaleff M Base 10,	2.527	2.825	7.100	2.646	6.000	4.470

The comparison by Mackintosh's index also reflects a trend similar to the previous ones. The comparison indicates that the Bukovik and Crepoljsko sites are foremost in terms of diversity, but after estimation the Skakavac site becomes the most prominent locality, e.g., the typical locality regarding the diversity of Cetoniidae on Mount Ozren (Central Bosnia and Herzegovina) (Fig. 7; Tab. VII).

Table VII. Mackintosh's index comparison between the investigated sites.

Index	Orlovac	Nahorevo	Skakavac	Cavljak	Crepoljsko	Bukovik
Mackintosh Distance (U)	0.773	1.223	1.387	1.572	1.863	2.026
Mackintosh Diversity (D)	1.066	1.085	1.289	1.070	1.190	1.154

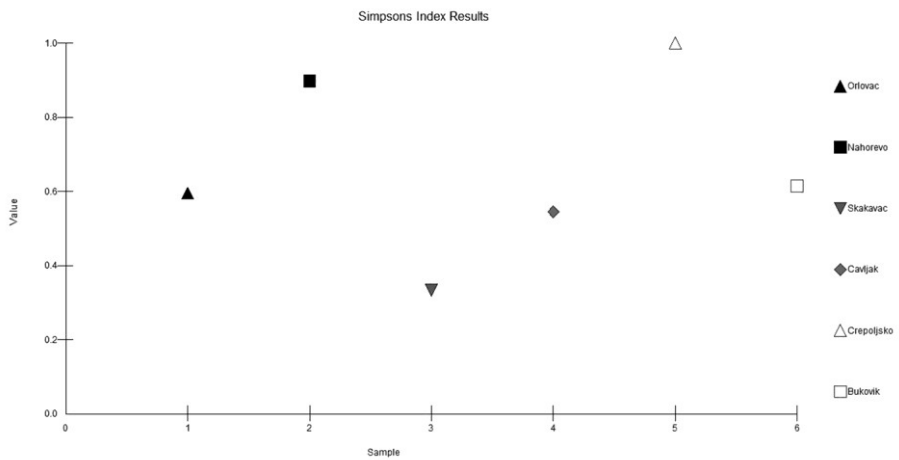


Figure 5. Simpson's index values at investigated localities.

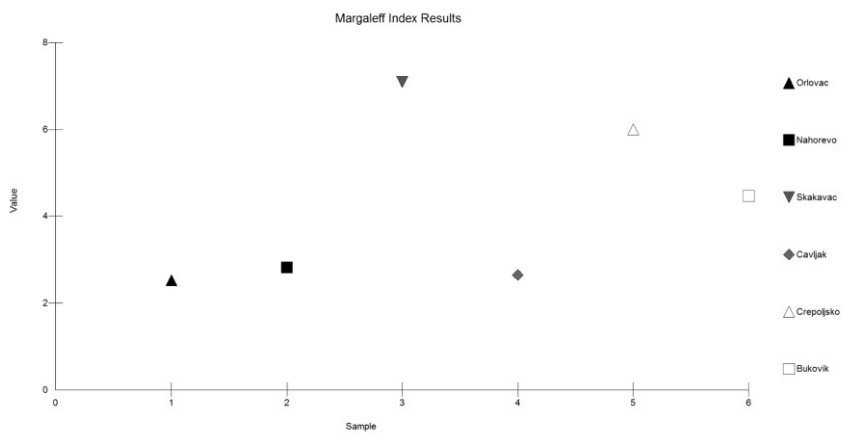


Figure 6. Margaleff's index values at investigated localities.

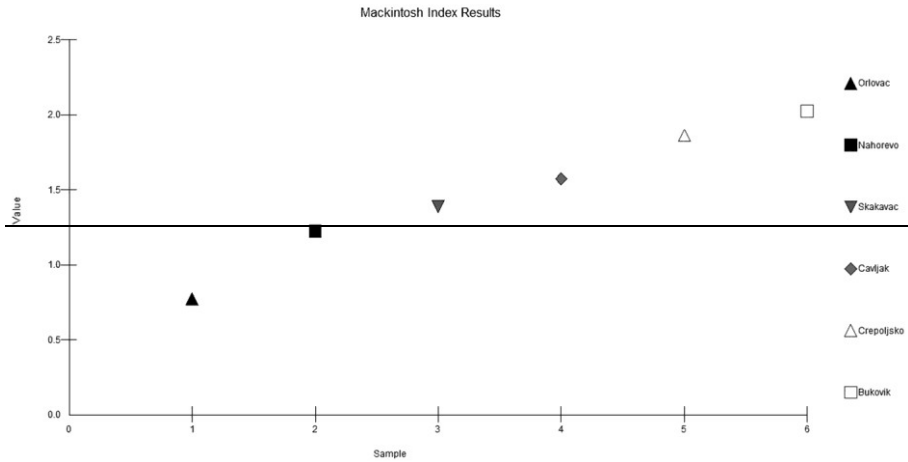


Figure 7. Mackintosh's index values at investigated localities.

We particularly emphasize that Margaleff's index and Mackintosh's index are patterns not often used in comparing the values of samples with a small number of species and samples under ten thousand individuals: we used them in this analysis as support of previous patterns (Alpha index of biodiversity and Simpson's diversity index). Nevertheless, results of these patterns used in analysis clearly demonstrate that the Skakavac locality has the highest values regarding the ratio number of species/number of collected individuals. It means that this locality is typical for fauna of flower chafer on Mount Ozren near Sarajevo.

By comparing general data on the number of species and recorded individuals, similarity between the following localities can be noticed: (1) Orlovac, Crepoljsko and Bukovik and (2) Nahorevo, Čavljak and Orlovac. The most similar localities in the first group are Crepoljsko and Bukovik, and in the second group, Nahorevo and Čavljak. We can conclude that the similarity of general ecological conditions of these localities reflects their statistical similarity as well (Figs. 8 and 9).

On the other hand, comparison of data according to Bray-Curtis Cluster Analysis (Bray-Curtis Cluster Analysis: Single Link using software Biodiversity Pro) on a number of species and recorded individuals per localities also shows a division into two groups: (1) Bukovik, Crepoljsko and Skakavac (with a small number of found species and individuals: Bukovik – two species with 22 individuals; Crepoljsko – 1 species with 10 individuals; Skakavac – three species with 7 individuals) and (2) Čavljak, Nahorevo and Orlovac (with a significantly larger number of found species and individuals: Čavljak – two species with 185 individuals; Nahorevo – four species with 133 individuals; Orlovac – five species with 237 individuals).

Therefore, the Bray-Curtis cluster analysis shows a very strong resemblance between localities where equal value of biodiversity of species of the observed group was found.

It is necessary to point out that because this study represents the first analysis on family Cetoniidae in Bosnia and Herzegovina this discussion is difficult to develop adequately. In a faunistic sense, Ozren Mountain was investigated as part of other research on coleoptera ecology at Sarajevo. So there is data about 13 of 17 species known in Bosnia and Herzegovina (MIKŠIĆ, 1962; LELO & KAŠIĆ-LELO, 2010; KAŠIĆ-LELO, 2011).

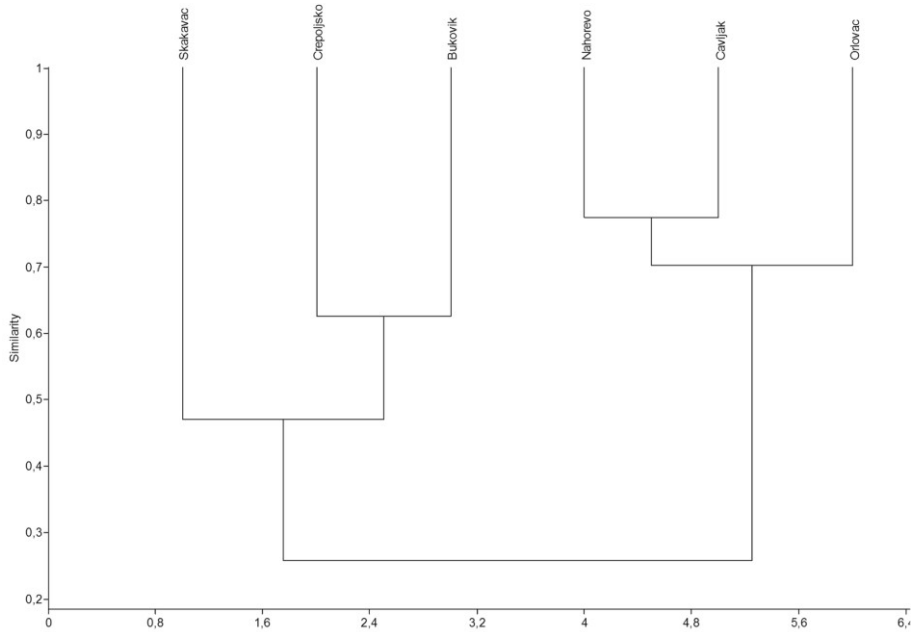


Figure 8. Review of similarity between investigated localities using the software Past.

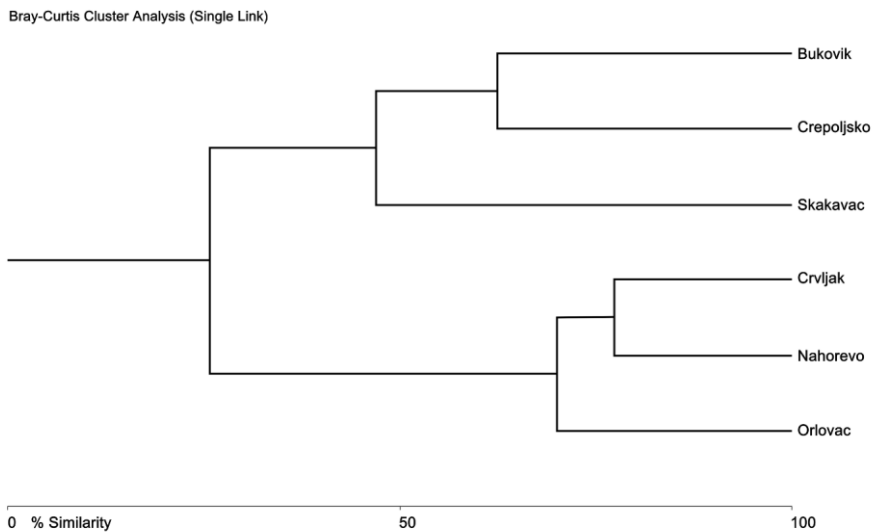


Figure 9. Review of similarity between investigated localities Bray Curtis Cluster Analysis: Single Link (software: BioDiversity Pro).

Our studies have clearly shown that the observed family members prefer lower, sunny habitats with southern exposure as evidenced by the largest number of individuals collected at the site Orlovac. Statistically, the established cetonian species number in Skakavac represents it as a typical locality while lower species number at higher positioned sites (Bukovik-Crepoljsko-Skakavac) indicates the adaptive zone modification of the taxon Cetoniidae.

Finally, it should be noted that the original software, which cannot be changed, presented certain obstacles for this paper, and that there is no option to enter certain letters (č, ć, š, ž, đ) into the data.

Conclusion

During 2008 and 2009 a total of 594 individuals of Cetoniidae were collected at six sites on the southern slopes of Mount Ozren (near Sarajevo). This research confirmed the presence of seven species of the family Cetoniidae for Mount Ozren. Analysis of literature data revealed that of the possible 17 species of family Cetoniidae found in Bosnia in Herzegovina, 13 existed in the wider area of the city of Sarajevo.

According to analysis of the researched localities using a primary index of diversity (Alpha index), the primary pattern of diversity index is highest at the Skakavac site, while it is lowest at the Crepoljsko site.

The comparison with the Berger-Parker Dominance model, the measure of numerical importance of the most abundant species ($d = N_{\max}/N$), shows that the species *Oxythyrea funesta* is a very important faunistic element at the Crepoljsko and Nahorevo sites.

Estimation of these (statistical) values ($1/d$) shows that the locality at Crepoljsko has the lowest value (and by the basic pattern it had the highest value), and the locality at Skakavac (after estimation) has the highest value, followed by the localities at Čavljak, Orlovac, Bukovik and Nahorevo.

It was observed that the statistical importance of the most abundant species *Oxythyrea funesta* is very high for researched localities on Mount Ozren either because it was the only species at the sites (Crepoljsko: 100%) or because it was the most abundant species there (Skakavac: 57.14% - Nahorevo: 94.74%). The identical fluctuations were found after the comparison with Simpson's index as well. After the comparison with Margaleff's index the Skakavac locality was recognized as a typical locality in terms of the diversity of flower chafers on Mount Ozren (Central Bosnia and Herzegovina). The comparison with Mackintosh's index reflects a trend similar to the previous ones. Statistical distance itself indicates that the Bukovik and Crepoljsko localities are the most prominent regarding the cetoniid diversity, but after estimation the most prominent locality is Skakavac, as a typical locality regarding the diversity of flower chafers on Mount Ozren (Central Bosnia and Herzegovina).

The results of all patterns used in this analysis clearly show that the locality at Skakavac, according to the ratio number of species/number of collected individuals, has the highest values and is a typical locality for fauna of *flower chafer* on Mount Ozren.

By comparing the similarity between the general data on the number of species and represented individuals, similarity between the following localities was found: (1) Orlovac, Crepoljsko and Bukovik and (2) Nahorevo, Čavljak and Orlovac. As the most similar localities in the first group are Crepoljsko and Bukovik, and in the

second group are Nahorevo and Čavljak, we can conclude that the similarity of general ecological conditions of these localities reflects their statistical similarity.

Comparison of obtained data on the number of species and represented individuals per localities using Bray-Curtis Cluster Analysis (Bray-Curtis Cluster Analysis: Single Link using the software Biodiversity Pro) also shows a distribution in two groups: (1) Bukovik, Crepoljsko and Skakavac (with a small number of found species and individuals: Bukovik – two species with 22 individuals; Crepoljsko – 1 species with 10 individuals; Skakavac – 3 species with 7 individuals) and (2) Čavljak, Nahorevo and Orlovac (with the significantly larger number of found species and individuals: Čavljak – 2 species with 185 individuals; Nahorevo – 4 species with 133 individuals; Orlovac – 5 species with 237 individuals). The Bray-Curtis Cluster Analysis shows a very clear resemblance between localities where equal value in the biodiversity of species in an observed group was found.

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ДИВЕРЗИТЕТ ПОРОДИЦЕ CETONIIDAE LEACH, 1815 (COLEOPTERA: SCARABAEOIDEA) НА ПЛАНИНИ ОЗРЕН (БОСНА И ХЕРЦЕГОВИНА)

МИРЗЕТА КАШИЋ-ЛЕЛО, СУВАД ЛЕЛО и АДИ ВЕСНИЋ

Извод

Током еколошких истраживања фамилије Cetoniidae Leach, 1815 на вертикалном профилу јужних падина планине Озрен код Сарајева у периоду април – септембар 2008. и 2009. године, са шест локалитета (Орловац, Нахорево, Чављак, Скакавац, Буковик и Црепољско), кроз 41 теренски излазак, сакупљене су 594 индивидуе које су детерминисане као представници седам врста (од 13 до сада познатих на датом подручју).

Добијени подаци су поређени статистичким софтвером PAST и то опцијама: Diversity/Compare diversities, Alpha index; Berger-Parker index; Simpsons index; Margaleff index; Mackintosh index; Bray-Curtis Cluster Analysis: Single Link softvera PAST. Резултати кориштених образаца показују да је локалитет Скакавац према односу број врста/број сакупљених индивидуа; са највисочијим вредностима, тј. да је типични локалитет за посматрану скупину, док локалитети Црепољско и Орловац представљају екстреме (највише разликују од локалитета Скакавац).

Уочено је да је статистичка важност најбројније врсте, *Oxythirea funesta* (Poda, 1761), за истраживане локалитете на планини Озрен код Сарајева врло висока јер је она или једина врста (Црепољско: 100,00%) или најбројнија врста сваког од посматраних локалитета (Нахорево: 94,74% – Скакавац: 57,14%). Компарирајући сличност између општих података о броју врста и заступљених индивидуа утврђена је сличност између локалитета: (1) Орловац, Црепољско и Буковик и (2) Нахорево, Чављак и Орловац. Како су најсличнији Црепољско и Буковик прве скупине, односно Нахорево и Чављак друге, онда можемо закључити да сличност општих еколошких услова на овим локалитетима одражава и њихову међусобну статистичку сличност.

Сматрамо да је објективно сагледавати височије позициониране локалитете (Буковик – Црепољско – Скакавац) као измењене адаптивне зоне такса фамилије Cetoniidae које се приближавају песимуму еколошких спектра из чега произилази смањење броја врста и броја индивидуа од подножја планине ка њеним врховима.

Важно је напоменути да представници посматране скупине избегавају северне падине, на којима су врло ретко налажене у прелиминарним истраживањима, те нису обухваћена у наставку рада.