

Original scientific article  
Received: 2011-08-28

UDK 595.76:591.9(497.5)

## ADDITIONS TO THE FAUNAL LIST OF SCARABAEOID BEETLES (INSECTA, SCARABAEOIDEA) OF THE RIVER ZRMANJA AND ITS SURROUNDINGS, CROATIA

*Toni KOREN*

University of Primorska, Science and Research Centre of Koper, Institute for Biodiversity Studies, SI-6000 Koper, Garibaldijeva 1, Slovenia

E-mail: koren.toni1@gmail.com

*Ivana ROJKO & Boris LAUŠ*

Biology Students Association - BIUS, HR-10000 Zagreb, Marulićev trg 20, Croatia

### ABSTRACT

*The aim of this study is to contribute to the knowledge of scarabaeoid beetle (Insecta, Scarabaeoidea) fauna of the river Zrmanja and its surroundings, Croatia. Beetles were sampled using standard beetle collecting methods, including hand collecting, pitfall traps and light traps throughout the season 2010. During that time, 52 scarabaeoid species were recorded, 37 of which are new for the area. The presence of several species was recorded for the first time either in Lika or Dalmatia. A rare cetoniid beetle, *Osmoderma barnabita* Motschulsky, 1845, was for the first time recorded for the area.*

**Key words:** Zrmanja, Coleoptera, Scarabaeoidea, biodiversity, *Osmoderma barnabita*

## CONTRIBUTO ALLA FAUNA DI COLEOTTERI SCARABAEOIDEI (INSECTA, SCARABAEOIDEA) DEL FIUME ZRMANJA E LOCALITÀ CIRCOSTANTI, CROAZIA

### SINTESI

*Lo scopo di questo studio è stato quello di contribuire alla conoscenza dei coleotteri scarabaeoidei (Insecta, Scarabaeoidea) del fiume Zrmanja e delle località circostanti, in Croazia. Gli esemplari sono stati catturati utilizzando metodi standard per la raccolta di coleotteri, compresi la raccolta a mano, le trappole trabocchetto e le trappole luminose. L'indagine è durata da maggio a ottobre del 2010. In tale periodo, 52 specie di scarabaeoidei sono state registrate, di cui 37 sono ritrovamenti nuovi per l'area. La presenza di numerose specie è stata registrata per la prima volta nella Lika e in Dalmazia. Pure la presenza di un raro coleottero cetonide, *Osmoderma barnabita* Motschulsky, 1845, è stata confermata per la prima volta nell'area.*

**Parole chiave:** Zrmanja, Coleotteri, Scarabaeoidea, diversità, *Osmoderma barnabita*

## INTRODUCTION

The knowledge about the scarabaeoids (Scarabaeoidea) in Croatia was mainly collected by Novak (1952) and Mikšić (1950, 1953, 1954, 1956, 1970). Mikšić (1958, 1962, 1965) also created some of the best determination keys for the members of this superfamily, written in Serbo-Croatian language. Unfortunately, after Mikšić hardly any papers regarding scarabaeoid beetle fauna in Croatia were published. Only a few papers dealing with one or a few species exist (Britvec, 2008; Ražov *et al.*, 2009; Harvey & Gange, 2011). So we can conclude that the knowledge about scarabaeoid beetles of Croatia remained almost the same as it was 40 years ago.

The river Zrmanja is an ecologically interesting area between two large Croatian regions, the Mediterranean Dalmatia and the mountainous Lika. This area can be very interesting to entomologists, especially because it is one of the rare locations in Croatia where traditional grazing of pastures is still fairly common, with a large number of cattle present. This is probably so due to the still visible impact of the last war, which left many villages and small towns almost completely empty, disabling the development of industry in that area. Local people thus survive by tending large amounts of cattle.

The only data about scarabaeoids of the river Zrmanja has so far been given by Novak (1952) who recorded 27 species in locations around the river Zrmanja.

The aim of this study is to report on recent data about the fauna of scarabaeoid beetles found around the river Zrmanja and its surroundings and the comparison with limited historical data, and to give some new distributional notes. The conservation status of several species is also discussed.

## MATERIAL AND METHODS

## Study area

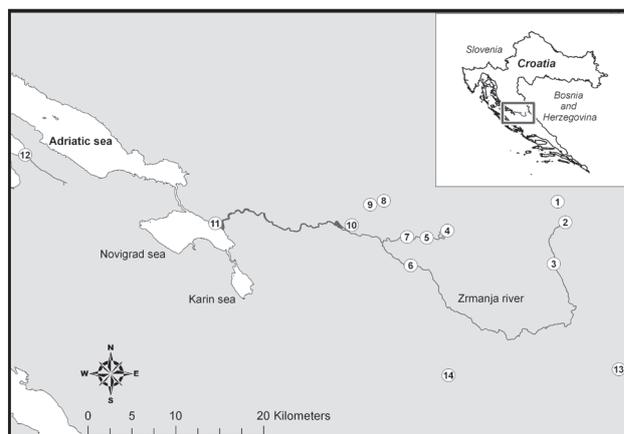
Zrmanja is a 69 km long karstic river situated on the boundary between Lika and Dalmatia (Fig. 1). The river flows from the spring at Zrmanja Vrelo, just underneath Mt. Poštak, towards the Novigrad Sea. The area of the river spring is a meeting point of mountains Velebit, Lička Plješivica and Dinara. The river Zrmanja has a southern flow from Zrmanja Vrelo all the way to Mokro polje, where the river flows across a narrow, elongated field after which it enters the canyon area (Pelivan, 2004). At Mokro polje, Zrmanja transforms into an underground river and disappears for the following 20 km. Just above Kaštel Žegarski, the river is fed with water from two smaller springheads and from this location onwards, it again flows above the ground all the way to its mouth (Matoničkin & Pavletić, 1964). Downstream of Kaštel Žegarski, the river enters another part of the canyon. Zrmanja has three tributaries, Krupa, Krnjeza and Dobranica. After Obrovac, the biggest town situated on the

banks of the river, Zrmanja enters the canyon for the last time.

Due to its specific geographical position, the river Zrmanja is considered as partly mountain, partly lowland and partly littoral river, which directly determines climatic conditions that exist along its course. From the source to the river's mouth, continental climate is gradually being influenced by the Mediterranean conditions which are characteristic for the lower parts of the river. The main annual temperature varies from 9°C (Gračac) to 14°C (Zrmanja spring). Mean annual precipitation varies between 1100 and 2100 mm/m<sup>2</sup> with an average of 1600 mm/m<sup>2</sup> (Bonacci, 1999). Vegetation patterns follow the climatic conditions while in some locations the vegetation has been substantially modified by humans, mainly referring to pastures and arable fields. This is why some areas lack natural forests which used to grow along the river. Today they are replaced by maquis and garrigue, thickets and stone grasslands. Some parts of the rivers Zrmanja and Krupa have typical wetland vegetation (Pelivan, 2004).

The main vegetation types around the river Zrmanja are mixed coastal thermophilous forests and scrubs of *Quercus pubescens* and mixed forests and scrubs of *Q. pubescens* and *Carpinus orientalis*. The main tree species in the area are *Q. pubescens*, *Quercus cerris*, *Acer monspessulanum*, *C. orientalis*, while the bushes consist mainly of *Fraxinus ornus*, *Juniperus oxycedrus*, *Coronilla emeroides*, with the evergreen elements of *Asparagus acutifolius*, *Ruscus aculeatus* and *Smilax aspera*.

In the Zrmanja area, the most common grasslands are dry and rocky pastures, created by the degradation of former oak forests and deciduous forests of hornbeam and oak, and maintained primarily by grazing. On many locations around the river Zrmanja (e.g., Vrelo Zrmanje, Kaštel Žegarski, Manastir Krupa) traditional, extensive livestock (mostly cows, sheep and goats) grazing still exists.



**Fig. 1: Location of the river Zrmanja and research localities.**

**Sl. 1: Lokacija reke Zrmanje in raziskanih lokalitet.**

### Methods

This survey started in May and lasted until October 2010, with five 20-day-long field trips. The survey was done unsystematically, during several visits in the spring and summer during one season. We mostly targeted dung species, and flower visiting scarabaeoid species, but other groups were collected as well, mainly on locations surrounding the river Zrmanja. The list of surveyed locations is given in Table 1, and shown on Figure 1.

Scarab beetles were collected using standard beetle collecting methods including manual collecting, pitfall traps and light traps (Vrezec *et al.*, 2005; Vrezec & Kapla, 2007). Members of the Cetoniidae family were mostly collected manually from flowers and trees, while other beetles were mostly picked from the ground. To collect Geotrupidae and Scarabaeidae, cow, sheep and goat dung was examined. To attract crepuscular beetles, such as some members of Scarabidae and Trogidae, a pyramid-light trap was used. In Kaštel Žegarski, ten 0.5 l plastic pitfall traps were placed, distanced 10 meters one from another. A modified standard mix for attracting beetles was used (Sorka & Finch, 2007), containing beer, vinegar, ethanol and water. For the trees dwelling species, tree trunks and tree hollows were searched (Vrezec & Kapla, 2007). All collected beetles were conserved in 70% ethanol, prepared using entomological equipment and placed into a private beetle collection (coll. T. Koren).

Due to the lack of newly published determination keys dealing with the area of Croatia, we used standard determination keys (Mikšić, 1958, 1962, 1965) to identify beetles, along with the comparison with the beetle collections of the Croatian Museum of Natural History (CHNM). To make later comparisons with this paper easier, we used the taxonomy that corresponds to the web portal Fauna Europaea (Alonso-Zarazaga & Miguel, 2011), with the exception of newly published data regarding *Osmoderma* sp. complex (Audisio *et al.*, 2009). The data analysis was conducted using historical records from the area (Novak, 1952).

### RESULTS

During one year survey around the river Zrmanja, a total of 52 scarabaeoid species belonging to 9 families were recorded (Tab. 2). The largest number of species belonged to the Scarabaeidae family (23), followed by Cetoniidae (11), Aphodiidae (4), Geotrupidae (4), Dynastidae (4), Melolonthidae (2), Lucanidae (2), Rutelidae (1) and Trogidae (1). The greatest number of species was recorded in Kaštel Žegarski (33), the Zrmanja spring (11) and Ljubački Zaljev (11).

*Cetonia aurata* (Linnaeus, 1761) was the only species recorded in all localities, *Oxythyrea funesta* (Poda, 1761) was recorded in 10 localities, *Tropinota hirta* (Poda, 1761) and *Jekelius brullei* (Jekel, 1866) in 7, while all other species were recorded in fewer localities, with more than 44% of species in only one locality.

**Tab. 1: Surveyed locations along the river Zrmanja and its near surroundings (S Croatia).**

**Tab. 1: Seznam raziskanih lokacij ob reki Zrmanji in okolici (J Hrvatska).**

	Locality name	X	Y	Altitude	UTM
1	Pond beneath Poštak mountain	5585544	4898461	320	WJ89
2	Zrmanja spring	5586431	4896100	348	WJ89
3	Zrmanja village	5585099	4891335	294	WJ89
4	Krupa spring	5573001	4895146	158	WJ79
5	Manastir Krupa	5570651	4894343	103	WJ79
6	Kaštel Zegarski, meadows near the village	5568827	4891149	56	WJ69
7	Krnjeza	5568404	4894417	62	WJ69
8	Golubići village, road to Jabukovac	5565225	4898572	363	WJ69
9	Berberi, Berberov buk waterfall	5564213	4898122	73	WJ69
10	Dobarnica, river, meadows near the river	5562104	4895769	68	WJ69
11	Zrmanja firth	5546564	4895976	27	WJ49
12	Ljubački Zaljev, close to river Jaruga	5524936	4903822	2	WK20
13	Očestovo, near the water tower	5592506	4879261	323	WJ97
14	Ervenik, pond near the macadam road	5573120	4878589	126	WJ77

Tab. 2: Recorded Scarabaeoidea species for the river Zrmanja and its near surroundings. \* - Newly recorded species for the area (locality names are given in Table 1).

Tab. 2: Seznam vrst družine Scarabaeoidea, najdenih ob reki Zrmanji in okolici. \* - novo zabeležene vrste za območje (imena lokalitet so podana v Tabeli 1).

	Species name and author	Locality													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
<b>Aphodiidae</b>															
1.	<i>Colobopterus erraticus</i> (Linnaeus, 1758)*		•				•			•					
2.	<i>Coleobothrus luridus</i> (Wollaston, 1860)*						•						•		
3.	<i>Eudolus quadriguttatus</i> (Herbst, 1783)				•										
4.	<i>Nialus varians</i> (Duftschmid, 1805)*									•			•		
<b>Scarabeidae</b>															
5.	<i>Scarabaeus typhon</i> (Fischer, 1824)						•		•						
6.	<i>Scarabaeus variolosus</i> Fabricius, 1787				•	•	•			•					
7.	<i>Gymnopleurus mopsus</i> (Pallas, 1781)*						•								
8.	<i>Gymnopleurus geoffroyi</i> (Fuessly, 1775)*								•						
9.	<i>Sisyphus schaefferi</i> (Linnaeus, 1758)								•						
10.	<i>Copris hispanus</i> (Linnaeus, 1764)*						•	•		•			•		
11.	<i>Copris lunaris</i> (Linnaeus, 1758)*						•			•					
12.	<i>Bubas bison</i> (Linnaeus, 1767)*						•		•	•					
13.	<i>Euoniticellus fulvus</i> (Goeze, 1777)						•								
14.	<i>Caccobius schreberi</i> (Linnaeus, 1758)						•								
15.	<i>Euonthophagus amyntas</i> (Olivier, 1789)								•						
16.	<i>Onthophagus taurus</i> (Schreber, 1959)						•			•					
17.	<i>Onthophagus illyricus</i> (Scopoli, 1763)*						•	•		•					
18.	<i>Onthophagus ovatus</i> (Linnaeus, 1767)*						•								
19.	<i>Onthophagus grossepunctatus</i> (Reitter, 1905)*						•								
20.	<i>Onthophagus ruficapillus</i> (Brullé, 1832)*						•								
21.	<i>Onthophagus furcatus</i> (Fabricius, 1781)						•								
22.	<i>Onthophagus opacicollis</i> (Reitter, 1893)*						•								
23.	<i>Onthophagus coenobita</i> (Herbst, 1783)*													•	
24.	<i>Onthophagus lemur</i> (Fabricius, 1781)						•	•	•						
25.	<i>Onthophagus vacca</i> (Linnaeus, 1767)						•	•		•					
26.	<i>Onthophagus nuchicornis</i> (Linnaeus, 1758)*						•								
27.	<i>Onthophagus lucidus</i> (Sturm, 1800)*														
<b>Geotrupidae</b>															
28.	<i>Geotrupes mutator</i> (Marsham, 1802)*		•				•								
29.	<i>Anoplotrupes stercorosus</i> (Scriba, 1791)*			•											
30.	<i>Trypocopris vernalis</i> (Linnaeus, 1758)*								•						
31.	<i>Jekelius brullei</i> (Jekel, 1866)		•	•	•	•	•	•	•				•		
<b>Melolonthidae</b>															
32.	<i>Melolontha melolontha</i> (Linnaeus, 1758)*		•				•								
33.	<i>Haplidia transversa</i> (Fabricius, 1801)*											•	•		
<b>Rutelidae</b>															
34.	<i>Anisoplia agricola</i> (Poda, 1761)	•	•												
<b>Dynastidae</b>															
35.	<i>Pentodon idiota</i> (Herbst, 1789)*												•		
36.	<i>Pentodon bidens</i> (Villers, 1789)*			•			•	•	•				•		•
37.	<i>Phyllognathus excavatus</i> (Forster, 1771)*		•				•								
38.	<i>Oryctes nasicornis</i> (Linnaeus, 1758)		•										•		
<b>Cetoniidae</b>															
39.	<i>Valgus hemipterus</i> (Linnaeus, 1758)		•	•	•		•								

40.	<i>Osmoderma barnabita</i> Motschulsky, 1845 *		•															
41.	<i>Trichius fasciatus</i> (Linnaeus, 1758)*									•								
42.	<i>Trichius sexualis</i> (Bedel, 1906)*								•									
43.	<i>Tropinota squalida</i> (Scopoli, 1783)*		•															
44.	<i>Tropinota hirta</i> (Poda, 1761)*	•	•			•	•						•	•	•			
45.	<i>Oxythyrea funesta</i> (Pod, 1761)*	•	•	•	•		•			•	•	•	•	•	•			
46.	<i>Cetonia aurata</i> (Linnaeus, 1761)*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
47.	<i>Protaetia aeruginosa</i> (Linnaeus, 1767)*						•											
48.	<i>Protaetia cuprea</i> (Fabricius, 1775)*																	•
49.	<i>Protaetia angustata</i> (Germar, 1817)*						•											
	<b>Lucanidae</b>																	
50.	<i>Dorcus parallelipedus</i> (Linnaeus, 1758)*		•	•	•	•	•											
51.	<i>Lucanus cervus</i> (Linnaeus, 1758)*		•	•						•								
	<b>Trogidae</b>																	
52.	<i>Trox hispidus</i> Pontoppidan, 1763*	•				•	•											
	<b>No. species</b>	5	15	8	8	6	33	7	11	10	3	3	11	4	5			

## DISCUSSION

For the area around the river Zrmanja, Novak (1952) mentions 27 species of scarabaeoid beetles, mostly belonging to the Scarabaeidae and Aphodiidae families. During this survey, we recorded a total of 52 scarabaeoid beetles species, 37 of which are new for this area (Tab. 2). The largest amount of species that Novak (1952) recorded belonged to the Aphodiidae family (13), while we recorded only 4 species from this family. However, we did not confirm the presence of 12 previously recorded species: *Acanthobodilus immundus* (Creutzer, 1799), *Amidorus cribrarius* (Brulle, 1832), *Agrilinus constans* (Duftschmid, 1805), *Bodilus ictericus* (Laicharting, 1781) (= *Aphodius nitidulus* Fabricius, 1792), *Esymus merdarius* (Fabricius, 1775), *Euorodalus coenosus* (Panzer, 1798), *Labarrus lividus* (Olivier, 1789), *Melinopterus consputus* (Creutzer, 1799), *Melinopterus prodromus* (Brahm, 1790), *Nimbus obliterated* (Panzer, 1823), *Pleurophorus caesus* (Creutzer, 1796) and *Sigorus porcus* (Fabricius, 1792). In addition to this, from the Scarabaeidae family we did not record *Onthophagus fracticornis* (Preyssler, 1790), which was previously recorded by Novak (1952). All other recorded scarabaeoid species were confirmed during this survey. Our data increase the number of scarabaeoid beetles known from the area of the river Zrmanja to 68 species, which is still moderately low in comparison to some better researched areas, for example in Slovenia (Brelj *et al.*, 2010).

For some species, their known range of occurrence in Croatia has been expanded. According to Mikšić (1965), *Onthophagus nuchicornis* (Linnaeus, 1758) was recorded at Kaštel Žegarski, and this is the first record in the Mediterranean part of Croatia. The same applies for *Melolontha melolontha* (Linnaeus, 1758), recorded in a few locations around the river Zrmanja and *Trichius fasciatus* (Linné, 1758), recorded on the shores of the river Dobranica.

We recorded all species from the Dynastidae family previously mentioned by Mikšić (1965) for the territory of Croatia, including the interesting finding of *Phyllo-gnathus excavatus* (Forster, 1771). This Mediterranean species was previously recorded in southern Istria, Kvarner and Dalmatia (Mikšić, 1965). During this survey, it was recorded at the Zrmanja spring, and it represents the first record for Lika.

Faunistically the most important species is *Osmoderma barnabita* Motschulsky, 1845. Recently, it has been proven to be a separate species, genetically different from *Osmoderma eremita* (Scopoli, 1763) (Audisio *et al.*, 2009), and it is treated here as such. *O. eremita* complex (including *O. barnabita*) is listed as Near Threatened in the IUCN (2011), and also in the Habitat Directive Annexes II and IV (European Commission, 1992). *O. barnabita* has a broad range in Europe, but it is rare, due to the fact that each hollow tree sustains a local population with limited connections to the populations in the surrounding trees, resulting in the metapopulation structure of the population (Ranius & Hedin, 2001). In Croatia, only 31 records between 1892 and 2000 exist (Ranius *et al.*, 2005). This species was found on a willow tree close to the Zrmanja spring. It was collected on July 11<sup>th</sup> at dusk, which is unusual for this predominantly daytime active species.

On the nearby willow trees, a large number of tree hollows were seen and investigated, but no further *O. barnabita* were recorded. This finding, along with our observations of a large number of tree hollows, suggests that the area around the Zrmanja spring is still a good habitat for this endangered species.

Another recorded species with a special conservation status is *Lucanus cervus* (Linnaeus, 1758). In many countries, where it is present, it has an endangered or protected status and has been included in Annex II of the EC Habitats Directive, together with the status of near threatened in 2010 across Europe according to the International Union for Conservation of Nature (IUCN,

2011). As it seems, this species is expanding its areal in Europe, with the exception of Slovakia and Croatia (Harvey & Gange, 2011). Its distribution in Croatia is poorly known in comparison with the nearby Slovenia (Breljih *et al.*, 2010), but still much better in comparison with Bosnia and Herzegovina or Serbia (Harvey & Gange, 2011). In the Zrmanja area, it was recorded on three locations, and was common on each of them.

As previously stated, no scarabaeoid beetles surveys were carried out for some time, which makes it difficult to compare our data with any other area in Croatia. But even for itself, the number of 52 recorded species represents more than 25% scarabaeoid fauna of Croatia (Mikšić, 1958, 1962, 1965). As this survey was done sporadically, no significant comparisons between different locations on the river Zrmanja can be done. On two areas we recorded the largest number of scarabaeoid beetles: the Zrmanja spring (15) and Kaštel Žegarski (33). This can probably be assigned to the high number

of present cattle, as well as fairly natural habitats with many different habitats.

Conservation status of most scarabaeoid species in Croatia is unknown. This can be assigned to the lack of continuous research on beetles in Croatia, as well as to no comprehensive papers dealing with this group published in almost 40 years. Scarabaeoid beetle communities, especially dung beetles are very fragile because they are influenced by complex biotic and abiotic interactions between many environmental factors such as resource availability, vegetation structure, the use of pesticides (Hutton & Giller, 2003), elevation, exposure (Jay-Robert *et al.*, 2008) and herbivorous animal presence and diversity (Carpaneto *et al.*, 2005) and as such are in need of conservation concern. This is the reason why more systematic, as well as unsystematic, surveys of different parts of Croatia are needed, to evaluate the conservation status of scarabaeoid species and to determine eventual conservation strategies for the future.

## DODATKI K SEZNAMU FAVNE PLOJKAŠEV (INSECTA, SCARABAEOIDEA) REKE ZRMANJE IN OKOLIŠKIH KRAJEV, HRVAŠKA

Toni KOREN

Univerza na Primorskem, Znanstveno-raziskovalno središče, Inštitut za biodiverzitetne študije, SI-6000 Koper, Garibaldijeva 1  
E-mail: koren.toni1@gmail.com

Ivana ROJKO &amp; Boris LAUŠ

Biology Students Association - BIUS, HR-10000 Zagreb, Marulićev trg 20, Hrvaška

## POVZETEK

*Cilj te raziskave je bil doprinos k popisu favne scarabeoidnih hroščev (plojkaši ali pahljačniki) (Insecta, Scarabaeoidea) iz okolice reke Zrmanje na Hrvaškem. Hrošči so bili vzorčeni z uporabo standardnih metod za lov hroščev, in sicer z ročnim zbiranjem, uporabo pasti in svetlobnih vab v sezoni 2010. Potrjena je bila prisotnost 52 vrst, od katerih je bilo kar 37 vrst prvič zabeleženih na raziskovanem območju. Nekateri teh vrst so prvič opažene tudi na območju Dalmacije in Like, na tem območju pa je bil prvič najden tudi redek puščavnik (Osmoderma barnabita Motschulsky, 1845).*

**Ključne besede:** Zrmanja, Coleoptera, Scarabaeoidea, biodiverzitetna, *Osmoderma barnabita*

## REFERENCES

- Alonso-Zarazaga, M. A. (2011):** Coleoptera, Scarabaeoidea. Fauna Europaea version 2.4. www.faunaeur.org (Accessed 15.8.2011)
- Audisio, P., H. Brustel, G. M. Carpaneto, G. Coletti, E. Mancini, M. Trizzino, G. Antonini & A. De Biase (2009):** Data on molecular taxonomy and genetic diversification of the European Hermit beetles, a species complex of endangered insects (Coleoptera: Scarabaeidae, Cetoniinae, *Osmoderma*). J. Zool. Syst. Evol. Res., 47(1), 88-95.
- Bonacci, O. (1999):** Water circulation in karst and determination of catchment areas: example of the River Zrmanja. Hydrol. Sci., 44(3), 373-386.
- Brelj, S., A. Kajzer & A. Pirnat (2010):** Gradivo za favno hroščev (Coleoptera) Slovenije = Material for the Beetle Fauna (Coleoptera) of Slovenia. 4. prispevek/4<sup>th</sup> contribution: Polyphaga: Scarabaeoidea (=Lamellicornia). Scopolia, 70, 1-386.
- Britvec, B. (2008):** *Scarabaeus sacer* L., 1758 (Scarabaeidae, Col.) from deity to realty. Entomol. Croat., 12(1), 83-102.
- Carpaneto, G. M., A. Mazziotta & E. Piattella (2005):** Changes in food resources and conservation of scarab beetles: from sheep to dog dung in a green urban area of Rome (Coleoptera, Scarabaeoidea). Biol. Conserv., 123, 547-556.
- European Commission (1992):** Council Directive 92/43/EEC of 21 May 1992 on the Conservation of natural habitats and of wild fauna and flora (OJ L206, 22.7.1992, p. 7), last amended 23.09.2003 (L236, pp. 33), Strasbourg.
- Harvey, D. J. & A. C. Gange (2011):** The stag beetle: a collaborative conservation study across Europe. Insect Conserv. Diversity, 4, 23-38.
- Hutton, S. A. & P. S. Giller (2003):** The effects of the intensification of agriculture on northern temperate dung beetle communities. J. Appl. Ecol., 40, 994-1007.
- IUCN (2011): Red List of Threatened Species. www.iucnredlist.org (Accessed: 21.12.2011)
- Jay-Robert, P., J. P. Lumaret & J. D. Lebreton (2008):** Spatial and temporal variation of mountain dung beetle assemblages and their relationships with environmental factors (Aphodiinae: Geotrupinae: Scarabaeinae). Ann. Entomol. Soc. Am., 101, 58-69.
- Matoničkin, I. & Z. Pavletić (1964):** Faktori razvoja biocenoza u slatkovodnom dijelu rijeke Zrmanje i njena pritoka Kupe. Krš Jugoslavije, 4, 47-63.
- Mikšić, R. (1950):** Beitrag zur Kenntnis der Scarabaeiden der Herzegovina. Godišnjak Biološkog instituta u Sarajevu, Sarajevo, 3, 219-224.
- Mikšić, R. (1953):** Fauna insectorum Balcanica - Scarabaeidae. Narodna štamparija Sarajevo, pp. 49-281.
- Mikšić, R. (1954):** Beitrag zur varietät der *Cetonia aurata* L. in Jugoslavien. Glasnik Prirodnačkog muzeja srpske zemlje, 457-485, b5-6.
- Mikšić, R. (1956):** Zweiter Nachtrag zur Fauna Insectorum Balcanica - Scarabaeidae. Acta Musei Macedonici scientiarum naturalium, IV, 7-9, (38-40), 97-130.
- Mikšić, R. (1958):** Scarabaeidae Jugoslawien. Naučno društvo Bosne i Hercegovine – Djela, 6(2), 150 p.
- Mikšić, R. (1962):** Scarabaeidae Jugoslawien II. Srpska akademija nauka i umetnosti, Odeljenje prirodno-matematičkih nauka, Beograd, posebna izdanja, 28, 199 p.

**Mikšić, R. (1965):** Scarabaeidae of Yugoslavia III. Naučno društvo Bosne i Hercegovine – Djela, 25(6), 210-215.

**Mikšić, R. (1970):** Katalog der Lamellicornia Jugoslaviens. Institut za šumarstvo, Sarajevo, posebno izdanje, 57 p.

**Novak, P. (1952):** Kornjaši Jadranskog primorja (Coleoptera). JAZU, Zagreb, 521 p.

**Pelivan, A. (2004):** Zrmanja, Krka, Cetina i njihovi pritoci. Ekološki glasnik, Donja Lomnica, 239 p.

**Ranius, T. & J. Hedín, 2001.** The dispersal rate of a beetle, *Osmoderma eremita*, living in tree hollows. *Oecologia*, 126, 363–370.

**Ranius, T., L. O. Aguado, K. Antonsson, P. Audisio, A. Ballerio, G. M. Carpaneto, K. Chobot, B. Gjurašin, O. Hanssen, H. Huijbregts, F. Lakatos, O. Martin, Z. Neculiseanu, N. B. Nikitsky, W. Paill, A. Pirnat, V. Rizun, A. Ruicănescu, J. Stegner, I. Süda, P. Szwalko, V. Tamutis, D. Telnov, V. Tsinkevich, V. Versteirt, V. Vignon, M. Vögeli & P. Zach (2005):** *Osmoderma eremita* (Coleoptera, Scarabaeidae, Cetoniinae) in Europe. *Anim. Biodiversity Conserv.*, 28(1), 1-44.

**Ražov, J., B. Barić & M. Dutto (2009):** Fauna of the cetoniid beetles (Coleoptera, Cetonidae) and their damages on peach fruits in orchards of northern Dalmatia. *Entomol. Croat.*, 13(2), 7-20.

**Sroka, K. & O.-D. Finch (2006):** Ground beetle diversity in ancient woodland remnants in north-western Germany (Coleoptera, Carabidae). *J. Insect Conserv.*, 4, 335-350.

**Vrezec, A. & A. Kapla (2007):** Kvantitativno vzorčenje hroščev (Coleoptera) v Sloveniji: referenčna študija. *Acta Entomol. Slov.*, 15(2), 131-160.

**Vrezec, A., A. Kapla, A. Pirnat & Š. Ambrožič (2005):** Primerjava številčnosti govnačev (Coleoptera: Scarabaeoidea: Geotrupidae) v Sloveniji: uporaba popisne metode za hrošče z zemeljskimi pastmi na širšem območju. *Acta Entomol. Slov.*, 13(2), 145-164.