

CONTRIBUTION TO THE KNOWLEDGE OF BUTTERFLY FAUNA (LEPIDOPTERA: RHOPALOCERA) OF ZRMANJA RIVER REGION, CROATIA

Toni KOREN^{1,2}, Maja BJELIĆ², Emilija BOŽINOVSKA³, Ana ŠTIH² & Ivona BURIĆ²

¹ University of Primorska, Science and Research Center Koper, Institute for Biodiversity Studies, Si-6000 Koper, Slovenia (koren.toni1@gmail.com)

²Biology student association - BIUS, Marulicev trg 20, 10 000 Zagreb, Croatia

³Istrazivačko Drustvo na Studenti Biolozi - IDSB, Institute of Biology, Faculty of Natural Sciences and mathematics, Gazi Baba bb., 1000 Skopje, Republic of Macedonia

Abstract - A total of 104 butterfly species were recorded in the wider surroundings of the river Zrmanja in Croatia between April and September of 2010. The region is exceptionally rich as this number represents 55% of all species recorded in Croatia. Euro-Siberian and Mediterranean species are prevailing. The known area of occurrence has been expanded for some interesting species: *Hyponephele lupina* (Costa, 1836), *Lycaena thersamon* (Esper, 1784), *Polyommatus damon* (Esper, 1785), *Melitaea aurelia* Nickerl, 1850 and *Euchloe ausonia* (Hübner, 1804).

KEY WORDS: butterfly diversity, regional hot spot, Dalmatia, *Lycaena thersamon*

Izveček: PRISPEVEK K POZNAVANJU METULJEV (LEPIDOPTERA: RHOPALOCERA) OBMOČJA REKE ZRMANJE, HRVAŠKA

Na območju reke Zrmanje na Hrvaškem so bile med aprilom in septembrom 2010 zabeležene skupno 104 različne vrste metuljev, kar predstavlja 55% vseh zabeleženih vrst Hrvaške. Prevladujejo evrosibirske in sredozemske vrste. Za nekatere zanimive vrste se je povečalo znano območje razširjenosti: *Hyponephele lupina* (Costa, 1836), *Lycaena thersamon* (Esper, 1784), *Polyommatus damon* (Esper, 1785), *Melitaea aurelia* Nickerl, 1850 and *Euchloe ausonia* (Hübner, 1804).

KLJUČNE BESEDE: diverziteta metuljev, regionalna vroča točka, Dalmacija, *Lycaena thersamon*

Introduction

Zrmanja is a carstic river situated in the northern part of Dalmatia. It delimits the mountainous Lika region from the warmer Dalmatia, a typical Mediterranean region. The river is flowing from its source at Zrmanja Vrelo, just below the uplift Nad Vrelo which is a part of Mt. Poštak situated at the edges of southeastern Velebit, towards Novigrad Sea. Area of the river's source is a meeting point of three great mountains - Velebit, Lička Plješivica and Dinara. Zrmanja flows to the south from Zrmanja Vrelo towards Mokro polje. At its very beginning the river flows through narrow, elongated karstic field after which it enters the gorge (Pelivan 2003). First part of the river is around 20 kilometers long and its middle part has the appearance of a lowland river. At Mokro polje Zrmanja disappears underground for the following 20 kilometers. Just above the settlement of Kaštel Zegarski the river is fed with the water from two smaller springheads and from this location on it again starts to flow above the ground all the way to its mouth (Matoničkin & Pavletic 1961). Downstream of Kaštel Zegarski Zrmanja enters another gorge. It is a river with three tributaries - the main one is Krupa and the other, much smaller ones, are Krnjeza and Dobarnica. Krupa flows into Zrmanja just above waterfall of Veliki Buk. There are several smaller waterfalls and rapids between Veliki Buk and Jankovica Buk which is the last waterfall on the river. The third tributary, Dobarnica, flows into Zrmanja very close to Berbera Buk. This part of the river is dammed for the reversible hydro power plant. The biggest town situated on both sides of the river's shore is Obrovac. Downstreams of Obrovac Zrmanja enters a gorge for the last time. Sides of this section of the gorge are characterized by sparse vegetation (Pelivan 2003). Canyon type of the river bed occupies most of the river Zrmanja surface as well as the bed of her three tributaries - Krupa, Krnjeza and Dobarnica. Special ecological and climatic conditions that exist along the gorges are the main reason why many rare and endemic plant species are present in this region (Pelivan 2004). Zrmanja is navigable for smaller boats all the way to Jankovica Buk. Navigable section of the river is characterized by brackish water (Pelivan 2003). Due to its specific geographical position Zrmanja is considered as partly mountain and partially littoral river what is directly linked to the 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. There are some transitional areas where characteristics of both climates exist and interchange. Vegetation patterns follow the climatic conditions while in some locations the vegetation has been substantially modified by humans. This is why some areas lack natural forests which once used to exist along the river. Today they are replaced by maquis and garrigue, thickets and stone grasslands. Some parts of the rivers Zrmanja and Krupa have wetland vegetation. Geological structure of the surrounding mountains as well as that of the riverbed is made of carbonate rocks. Although carbonate rocks are

porous and are subject to abrasion, the riverbed itself in some areas has become non porous due to millions of years long accumulation of sediments (Pelivan 2004).

Such diversity of habitats along with the mixture of different climatic zones and different ecological elements along the river greatly contributes to the diversity of plants and animals around it. Unfortunately no historical data regarding the butterfly fauna in the surroundings of river Zrmanja exist. The nearest location around river Zrmanja where the butterflies were studied in detail is Knin which is less than 20 kilometers to the south-east. Hafner (1994) recorded 91 butterfly species in the surroundings of the town at the beginning of the 20th century. Due to its vicinity, these results can be used for the comparison with our researched areas.

The aim of this paper is to give the first systematic list of butterflies of this insufficiently surveyed part of Croatia.

Materials and methods

The research took place mainly around river Zrmanja, especially in the locations where the river is easily accessible and is not flowing through the inaccessible parts of the gorges. These locations are the source of Zrmanja, Kastel Žegarski and Obrovac. Two river's tributaries, Krupa and Dobranica, were also included in the research. Some other locations were surveyed only because the approach to Zrmanja in that part of its flow was not possible due to high cliffs (e.g. between Zrmanja Vrelo and Kastel Žegarski), or is unfortunately still under mines (locations around Zrmanja firth). The list of all locations that were under research, along with the coordinates, altitudes and UTM fields are shown in Tab. 1. Localities from the numbers 15 to 20 do not strictly belong to the Zrmanja region, but were included in this paper due to the insufficiently known fauna of the area.

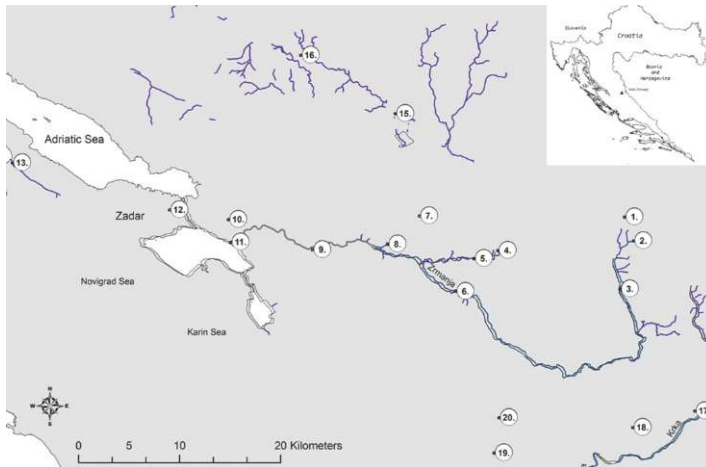


Fig. 1. Surveyed localities along river Zrmanja and in the surrounding area.

A total of five field trips amounting to 20 days of field work were done between April and September 2010. Butterfly species were identified in the field using Tolman & Lewington (2008) and immediately released. Only unknown or interesting specimens were sacrificed and later identified. All collected butterflies were mounted and stored in private collection (coll. Koren). Nomenclature follows the European Red List of Butterflies (Van Swaay *et al.* 2010). Biogeographical analysis is based on combining the data from Hruby (1964), Mihoci *et al.* (2007) and Tolman & Lewington (2008). Map of researched locations is given in Fig. 1.

Results

During the 2010 year season, 104 butterfly species were recorded on 20 localities around river Zrmanja and its close surrounding.

The systematic list of recorded species is given in Tab. 2. Zoogeographical analysis of found species is given in Tab. 3. As the localities differ in the habitat types, and were visited irregularly, a brief description is needed.

1. Pond beneath Postak mountain - grassland covered with scarce bushes and dry walls, used for pastures. Field trips: 01.05., 01.07. and 11.08.2010.
2. Zrmanja Vrelo - wet meadows (cut once a year) interchanging with deciduous woods. Field trips: 01.05., 04.05., 02.07., 11.08. and 10.09.2010.
3. Zrmanja village - similar as Zrmanja Vrelo, covered with wet meadows and, only sporadically, agriculture fields. Field trips: 04.05., 02.07., 11.08. and 10.09.2010.
4. Krupa spring - karstic spring, in surroundings are karstic pastures with scarce vegetations. Field trips: 02.05., 03.07. and 11.08.2011.
5. Manastir Krupa - moist meadows are the typical habitat around Manastir Krupa. The meadow grass is cut regularly. Field trips: 02.05., 03.07., 11.08. and 10.09.2010.
6. Kaštel Zegarski - characterized by agriculture fields and only few spots are wet meadows surrounded by deciduous woods. Field trips: 30.04., 04.07., 10.08. and 11.08.2010.
7. Golubici village, road to Jabukovac - rocky pastures with scarce vegetation, and few single bushes and trees. Field trips: 30.04.2010.
8. Dobarnica, river, meadows near the river - the river valley is characterized by fragmented mosaic of wet meadows, bushy shores of the river, as well as karstic habitats near the road. Field trips: 03.05. 04.07. and 11.08.2010.
9. Obrovac - dry meadows near the river Zrmanja covered with low grassy vegetation. Field trips: 03.05. 04.07. and 11.08.2010.
10. Jasenice - karstic pastures and dry grasslands. Field trip: 04.07.2010.
11. Zrmanja firth - rocky sea shore, covered with bushes and scarce grasses. Field trip: 04.07.2010.
12. Karinsko Zdrilo, village Perice - karstic pastures and dry grasslands. Field trip: 11.08.2010.

13. Ljubacki Zaljev, close to river Jaruga - karstic pastures, dry meadows and *Pinus* forests. Field trip: 05.05.2010.
14. Rtina, towards Ljubacki zaljev - karstic pastures. Field trip: 05.05.2011.
15. Ricica, river - moist grasslands, with some rocky karstic habitats. Field trip: 05.05.2010.
16. Sveti Rok - moist meadows, high grass mowed probably irregularly. Field trip: 01.07.2010.
17. Očestovo, near the water tower - dry, karstic habitats with scarce vegetation. Field trips: 02.07., 04.07. and 11.08.2010.
18. Mokro Polje - a mosaic of moist and dry grasslands, with some rocky pastures. Field trips: 01.05. and 11.08.2010.
19. Kistanje village, dump yard near the road - dry grassland, highly anthropogenic habitat with large litter. Field trip: 02.07.2010.
20. Ervenik, pond near the macadam road - dry bushy habitat, with a small amount of open meadows around the ponds. Field trip: 03.07.2010.

Discussion

The recorded number of 104 butterfly species represents 55% of butterfly fauna of Croatia, which counts 194 species. The only place in Croatia with greater number of species recorded is Mt. Velebit, where 137 species were recorded (Mihoci *et al.* 2007), however, this mountain system is more than 5 times larger than the surveyed area. In the nearby city of Knin 91 butterfly species were recorded (Hafner 1994), but the area is few times smaller than the Zrmanja region. Both Knin and Zrmanja show the fauna richness and importance of this part of Croatia for butterfly conservation. As one would expect, Zrmanja and Knin share most species, but 13 species recorded in Knin were not found during our survey: *Pyrgus carthami* (Hübner, 1813), *Pyrgus serratulae* (Rambur, 1839), *Gegenes nostradamus* (Fabricius, 1793), *Gonepteryx cleopatra* (Linnaeus, 1767), *Favonius quercus* (Linnaeus, 1758), *Lampides boeticus* (Linnaeus, 1767), *Leptopes pirithous* (Linnaeus, 1767), *Cupido osiris* (Meigen, 1829), *Phengaris arion* (Linnaeus, 1758), *Aglais urticae* (Linnaeus, 1758), *Neptis rivularis* (Scopoli, 1763), *Aphantopus hyperantus* (Linnaeus, 1758) and *Melanargia larissa* (Geyer, 1828). Additional research in the future could reveal the presence of some of these species at some locations around Zrmanja.

The largest number, a total of 86 species, were recorded at Zrmanja Vrelo. One of the few possible explanations for this is the interchange of two different geographical and climatic areas (Lika and Dalmatia) resulting in greater species richness. Zrmanja Vrelo is also a place where none or very little human impact was observed. The abundance of clean water throughout the year enables vegetation to develop richly. In almost all other surrounding localities grassland vegetation starts to dry out at the beginning of summer and thus leads to decrease in butterfly species richness.

The "Provisional Distribution Maps of the Butterflies of Yugoslavia" (Jaksić 1988) represents the largest repository of the butterfly data in the area of former

Yugoslavia (including Croatia) until 1988. Even in this publication, most UTM fields covering the area of river Zrmanja and nearby locations are almost completely empty indicating lack of surveys in this region.

For the UTM fields covering surveyed area around river Zrmanja 6 records exist (Jaksic 1988): *Spialia orbifer* (Hubner, 1823) (WJ59), *Pieris ergane* (Geyer, 1828) (WJ59), *Colias croceus* (Fourcroy, 1785) (WJ59), *Pseudophilotes vicrama* (Moore, 1865) (WJ59), *Vanessa atalanta* (Linnaeus, 1758) (WJ59) and *Hipparchia statilinus* (Hufnagel, 1766) (WJ79), but these could not be traced down to exact localities. Single species records for butterflies around Zrmanja are present in two published papers. *Hipparchia syriaca* (Staudinger, 1871) was found around village Golubici (Lorkovic 1976) while *Proterebia afra* (Fabricius, 1787) was recorded in Kistanje, Zrmanja village and Vrelo Zrmanje (Mihoci & Sasic 2007). During this survey we have confirmed the presence of all above mentioned species.

Several of the observed species are either rare or reach their edge of the distribution in Zrmanja River region, at least in comparison with maps in Jaksic (1988). Some of them require further clarification:

Euchloe ausonia (Hübner, 1804) - The findings of *E. ausonia* at Zrmanja Vrelo, Kaštel Zegarski and Manastir Krupa expand its distribution on the mainland of Croatia further to the north-east. The most northern record of this species in Croatia is for the island Pag (Zakšek 2005).

Lycaena thersamon (Esper, 1784) - Two observations of this species at Zrmanja Vrelo and Manastir Krupa are only the third time that this species was found in coastal part of Croatia (Mann 1869, Wermers 1982). This species is probably more widespread in Croatia than it was previously believed.

Satyrrium w-album (Knoch, 1782) - The records from Zrmanja are the first for Dalmatia, and the most southern observation in Croatia. The species is however present on nearby Velebit Mts. (Mihoci et al. 2007)

Cupido argiades (Pallas, 1771) - This very common butterfly species was surprisingly never recorded in Dalmatia. Until now, the southernmost records for this species in Croatia originate from Istria, Gorski Kotar (Jakšić 1988) and islands Cres and Lošinj (Writhrington & Verovnik 2008). The finding of *C. argiades* at Zrmanja Vrelo greatly expands its known area of distribution to the south east.

Polyommatus damon (Esper, 1785) - Only two records for this rare species in Croatia exist. Mann (1869) recorded it in Dalmatia, but without any precise location. Until now the only known population was recorded in Gornja Korita (Mihoci et al. 2006). The record from Zrmanja Vrelo is the most northern record in Croatia.

Brenthis daphne (Bergstrasser, 1780) - Surprisingly, *B. daphne* was never recorded in Dalmatia, but the species is known from nearby Velebit Mts. (Mihoci et al. 2007). This species is probably more widespread in the hinterland of Dalmatia than it was previously believed.

Melitaea aurelia Nickerl, 1850 - According to Jaksić (1988) this species is not present in southern regions of Croatia. The record from Mt. Velebit (Mihoci et al. 2007) expanded its known range of occurrence, and the record from the Zrmanja Vrelo further contributes to its known range of occurrence in Croatia. Because this species is not easily recognizable and can often be confused with a more common species, *Melitaea athalia* (Rottemburg, 1775) a strong possibility exist that it is present in many more areas of Croatia than it was previously expected.

Hyponephele lupina (Costa, 1836) - As is the case with the previous species, *H. lupina* can also easily be confused with two superficially similar and more common species, *Hyponephele lycaon* (Rottemburg 1775) and *Maniola jurtina* (Linnaeus, 1758). Only several records for this species exist in Croatia, and the records from Zrmanja region fills existing gap between northern and southern records of this species in Croatia (Jaksić 1988).

Across the surveyed area 19 protected species were recorded. The list of protected species, their status in the Red list of Croatia (Sasić & Kucinić 2004) and Europe (Van Swaay *et al.* 2010) as well as their presence in the Habitat Directive Annexes and the Bern Convention Annexes is given in Tab. 4. Many rare species were recorded during this research, including the first finding of *Polyommatus ripartii* Freyer, 1830 in Croatia (Koren 2010) and the second record of *Polyommatus damon* (Esper, 1785). This only implies great importance of the Zrmanja region for the butterfly diversity. Due to the rich butterfly diversity it would be of great importance to preserve the Zrmanja region from further degradation and conserve it in its natural form.

We would like to encourage other butterfly enthusiasts to conduct and publish papers about butterfly fauna of other unexplored localities in Croatia, so a more complete picture about the distribution, diversity and status of butterflies inhabiting Croatia could be obtained in the future.

Acknowledgments

This research in May and September was organized by Biology student organization - BIUS in association with DZZP - Croatian Society for Nature Conservation, while the third part, in August, was organized by group of individuals in order to make a more complete picture of butterfly fauna. We would like to thank both organization committees for giving us the opportunity to start and finish this research and to all members of both organizations for their help and support during field work.

Table 1. List of surveyed locations along the river Zrmanja and its surroundings.

Locality name	X	Y	Altitude	UTM
1. Pond beneath Poštak mountain	44°12'17" N	16°04'51" E	320	WJ89
2. Zrmanja Vrelo	44°12'14" N	16°04'29" E	348	WJ89
3. Zrmanja village	44°11'39" N	16°03'59" E	294	WJ89
4. Krupa spring	44°11'51" N	15°54'34" E	158	WJ79
5. Manastir Krupa	44°11'21" N	15°53'13" E	103	WJ79
6. Kaštel Žegarski	44°09'19" N	15°51'30" E	56	WJ69
7. Golubici village, road to Jabukovac	44°12'00" N	15°49'00" E	363	WJ69
8. Dobarnica, river, meadows near the river	44°11'41" N	15°51'14" E	68	WJ69
9. Obrovac	44°12'04" N	15°40'57" E	7	WJ59
10. Jasenice	44°13'42" N	15°34'39" E	124	WJ49
11. Zrmanja firth	44°12'10" N	15°35'21" E	27	WJ49
12. Karinsko Ždrilo, village Perice	44°07'13" N	15°37'43" E	9	WJ49
13. Ljubački Zaljev, close to river Jaruga	44°15'50" N	15°17'57" E	2	WK20
14. Rtina, towards Ljubački zaljev	44°17'37" N	15°18'18" E	38	WK10
15. Ričica, river	44°20'06" N	15°44'36" E	4	WK60
16. Sveti Rok	44°18'26" N	15°40'40" E	585	WK51
17. Ocestovo, near the water tower	44°03'32" N	16°07'31" E	323	WJ97
18. Mokro Polje	44°04'22" N	16°02'29" E	194	WJ87
19. Kistanje village, dump yard near the road	43°58'49" N	15°57'40" E	242	WJ77
20. Ervenik, pond near the macadam road	44°06'31" N	15°56'30" E	126	WJ77

Table 2. The distribution of the recorded butterfly species in the river Zrmanja region. The numbering of the localities follows the list of localities given in the results section.

Species	Locality number																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
HESPERIIDAE																				
1. <i>Erynnis tages</i> (Linnaeus, 1758)	•		•		•	•			•			•		•				•		•
2. <i>Carcharodus alceae</i> (Esper, 1780)			•	•	•				•											
3. <i>Carcharodus lavatherae</i> (Esper, 1783)																				
4. <i>Carcharodus floccifera</i> (Zeller, 1847)				•					•											
5. <i>Spialia orbifer</i> (Hübner, 1823)																				
6. <i>Pyrgus armoricanus</i> (Oberthür, 1910)				•			•													
7. <i>Pyrgus malvae</i> (Linnaeus, 1758)				•				•			•				•					
8. <i>Thymelicus lineola</i> (Ochsenheimer, 1808)	•																		•	
9. <i>Thymelicus sylvestris</i> (Poda, 1761)																				•
10. <i>Thymelicus acteon</i> (Rottemburg, 1775)																				•
11. <i>Hesperia comma</i> (Linnaeus, 1758)				•																
12. <i>Ochlodes sylvanus</i> (Esper 1777)																			•	
12. <i>Ochlodes sylvanus</i> (Esper 1777)																				•
PAPILIONIDAE																				
13. <i>Zerynthia polyxena</i> (Denis & Schiff., 1775)				•		•	•	•												
14. <i>Parnassius mnemosyne</i> (Linnaeus, 1758)																				
15. <i>Iphiclides podalirius</i> (Linnaeus, 1758)																			•	•
16. <i>Papilio machaon</i> (Linnaeus, 1758)													•		•					
PIERIDAE																				
17. <i>Leptidea sinapis</i> (Linnaeus, 1758)	•		•					•	•			•				•				•
18. <i>Anthocharis cardamines</i> (Linnaeus, 1758)	•		•		•			•	•											
19. <i>Euchloe ausonia</i> (Hübner, 1804)																				
20. <i>Aporia crataegi</i> (Linnaeus, 1758)				•																•
21. <i>Pieris brassicae</i> (Linnaeus, 1758)										•										
22. <i>Pieris manii</i> (Mayer, 1851)				•						•										
23. <i>Pieris rapae</i> (Linnaeus, 1758)										•				•	•	•		•	•	•
24. <i>Pieris ergane</i> (Geyer, 1828)	•			•								•						•		•
25. <i>Pieris napi</i> (Linnaeus, 1758)				•		•		•												
26. <i>Pontia edusa</i> (Fabricius, 1777)										•		•								•
27. <i>Colias crocea</i> (Geoffroy, 1785)				•	•					•	•	•						•	•	•
28. <i>Colias hyale</i> (Linnaeus, 1758)										•										
29. <i>Colias alfacariensis</i> (Ribbe, 1905)							•								•				•	•
30. <i>Gonepteryx rhamni</i> (Linnaeus, 1758)	•																			
RIODINIDAE																				
31. <i>Hamearis lucina</i> (Linnaeus, 1758)																				
LYCAENIDAE																				
32. <i>Lycena phlaeas</i> (Linnaeus, 1761)			•		•	•														•
33. <i>Lycena thersamon</i> (Esper, 1784)				•		•														
34. <i>Callophrys rubi</i> (Linnaeus, 1758)				•																
35. <i>Satyrrium w-album</i> (Knoch, 1782)				•	•															
36. <i>Satyrrium spini</i> (Denis & Schiffemüller, 1775)					•															•
37. <i>Satyrrium ilicis</i> (Esper, 1779)	•	•										•								•
38. <i>Satyrrium acaciae</i> (Fabricius, 1787)	•	•																		•
39. <i>Tarucus balkanicus</i> (Freyer, 1844)													•							
40. <i>Cupido minimus</i> (Fuessly, 1775)				•	•															

Species	Locality number*																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
41. <i>Cupido argiades</i> (Pallas, 1771)																				
42. <i>Celastrina argiolus</i> (Linnaeus, 1758)			•							•									•	•
43. <i>Pseudophilotes vicrama</i> (Moore, 1865)																				
44. <i>Scolitantides orion</i> (Pallas, 1771)						•	•													
45. <i>Glaucopsyche alexis</i> (Poda, 1761)			•		•	•						•								
46. <i>Iolana iolas</i> (Ochsenheimer, 1816)			•																	
47. <i>Plebejus argus</i> (Linnaeus, 1758)	•		•			•									•	•				
48. <i>Aricia agestis</i> (Denis & Schiff., 1775)																				
49. <i>Cyaniris semiargus</i> (Rottemburg, 1775)																			•	
50. <i>Polyommatus escheri</i> (Hübner, 1823)			•																	
51. <i>Polyommatus dorylas</i> (Denis & Schiff., 1775)			•																	
52. <i>Polyommatus amandus</i> (Schneider, 1792)	•																			
53. <i>Polyommatus thersites</i> (Cantener, 1835)							•											•		
54. <i>Polyommatus icarus</i> (Rottemburg, 1775)																				•
55. <i>Polyommatus daphnis</i> (Denis & Schiff., 1775)																				
56. <i>Polyommatus bellargus</i> (Rottemburg, 1775)			•			•														
57. <i>Polyommatus coridon</i> (Poda, 1761)																				
58. <i>Polyommatus admetus</i> (Esper, 1783)			•															•		•
59. <i>Polyommatus ripartii</i> (Freyer 1830)																				
60. <i>Polyommatus damon</i> (Denis & Schiff., 1775)			•																	
NYPHALIDAE																				
61. <i>Libythea celtis</i> (Laicharting, 1782)	•		•			•														
62. <i>Argynnis paphia</i> (Linnaeus, 1758)			•						•											
63. <i>Argynnis pandora</i> (Denis & Schiff., 1775)						•		•												•
64. <i>Argynnis adippe</i> (Denis & Schiff., 1775)																				•
65. <i>Argynnis niobe</i> (Linnaeus, 1758)									•											
66. <i>Issoria lathonia</i> (Denis & Schiff., 1775)																				
67. <i>Brenthis daphne</i> (Bergstrasser, 1780)			•													•				
68. <i>Brenthis hecate</i> (Denis & Schiff., 1775)															•	•				
69. <i>Boloria dia</i> (Linnaeus, 1767)																				
70. <i>Vanessa atalanta</i> (Linnaeus, 1758)							•				•							•	•	•
71. <i>Vanessa cardui</i> (Linnaeus, 1758)			•	•	•	•	•		•		•							•	•	
72. <i>Aglais io</i> (Linnaeus, 1758)					•	•														•
73. <i>Polygonia c-album</i> (Linnaeus, 1758)			•		•	•														
74. <i>Polygonia egea</i> (Cramer, 1775)									•	•	•	•								
75. <i>Nymphalis antiopa</i> (Linnaeus, 1758)					•															
76. <i>Nymphalis polychloros</i> (Linnaeus, 1758)																				
77. <i>Euphydryas aurinia</i> (Rottemburg, 1775)								•												
78. <i>Melitaea cinxia</i> (Linnaeus, 1758)			•																	
79. <i>Melitaea phoebe</i> (Denis & S., 1775)																				
80. <i>Melitaea trivia</i> (Denis & Schiff., 1775)																		•		
81. <i>Melitaea didyma</i> (Esper, 1778)	•		•		•					•							•	•		
82. <i>Melitaea diamina</i> (Lang, 1789)																				
83. <i>Melitaea athalia</i> (Rottemburg, 1775)	•		•		•										•	•				
84. <i>Melitaea aurelia</i> Nickerl 1850			•																	
85. <i>Limenitis reducta</i> Staudinger, 1901			•																	
86. <i>Pararge aegeria</i> (Linnaeus, 1758)						•	•													
87. <i>Lasiommata megera</i> (Linnaeus, 1767)																			•	
88. <i>Lasiommata maera</i> (Linnaeus, 1758)						•														
89. <i>Coenonympha arcania</i> (Linnaeus, 1761)	•																			

Species	Locality number*																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
90. <i>Coenonympha glycerion</i> (Borkhausen, 1788)	•																			
91. <i>Coenonympha pamphilus</i> (Linnaeus, 1758)	•			•	•			•				•		•	•	•	•			•
92. <i>Pyronia tithonus</i> (Linnaeus, 1767)																				
93. <i>Maniola jurtina</i> (Linnaeus, 1758)															•	•	•			
94. <i>Hyponphele lupina</i> (Costa, 1836)								•				•								•
95. <i>Proterebia afra</i> (Fabricius, 1787)																			•	
96. <i>Erebia medusa</i> (Denis & Schiff., 1775)																				
97. <i>Melanargia galathea</i> (Linnaeus, 1758)	•														•	•	•			
98. <i>Hipparchia fagi</i> (Scopoli, 1763)				•	•			•				•						•		
99. <i>Hipparchia syriaca</i> (Staudinger, 1871)					•															
100. <i>Hipparchia semele</i> (Linnaeus, 1758)												•						•		•
101. <i>Hipparchia statilinus</i> (Hufnagel, 1766)				•							•	•								
102. <i>Arethusana arethusana</i> (Denis & Schiff., 1775)	•			•														•		
103. <i>Brintesia circe</i> (Fabricius, 1775)					•			•			•	•						•		•
104. <i>Chazara briseis</i> (Linnaeus, 1764)	•			•						•	•							•		
Number of species per locality:	24	86	50	20	32	48	11	25	14	12	14	9	6	7	10	18	21	5	30	10

Table 3. Biogeographical features of butterflies found in the researched areas.

Biogeographical features	Number of species	Proportion (%)
Euro- Siberian	54	51,43%
Mediterranean	22	20,95%
Oriental	19	18,10%
Holarctic	3	2,86%
European	3	2,86%
Tropic	1	0,95%
Cosmopolit	1	0,95%
Alpine	1	0,95%
Atlantic	1	0,95%

Table 4. Endangered butterfly species recorded in the Zrmanja river area.

Species list	Red list status*		Habitats Directive Annexes ³	Bern Convention Annexes ⁴
	Europe ¹	Croatia ²		
<i>Carcharodus lavatherae</i> (Esper, 1783)	NT			
<i>Carcharodus floccifera</i> (Zeller, 1847)	NT			
<i>Thymelicus acteon</i> (Rottemburg, 1775)	NT	DD		
<i>Zerynthia polyxena</i> (Denis & Schiffermüller, 1775)		NT	IV	II
<i>Parnassius mnemosyne</i> (Linnaeus, 1758)	NT	NT	IV	II
<i>Lycaena thersamon</i> (Esper, 1784)		DD		
<i>Pseudophilotes vicrama</i> (Moore, 1865)	NT	DD		
<i>Scolitantides orion</i> (Pallas, 1771)	LC	NT		
<i>Glaucopteryx alexis</i> (Poda, 1761)		NT		
<i>Iolana iolas</i> (Ochsenheimer, 1816)	NT			
<i>Polyommatus dorylas</i> (Denis & Schiffermüller, 1775)	NT			
<i>Polyommatus damon</i> (Esper, 1785)	NT			
<i>Euphydryas aurinia</i> (Rottemburg, 1775)		DD	II	II
<i>Melitaea aurelia</i> Nickerl, 1850	NT	DD		
<i>Protorebia afra</i> (Fabricius, 1787)		DD		
<i>Erebia medusa</i> (Denis & Schiffermüller, 1775)		DD		
<i>Hypparchia fagi</i> (Scopoli, 1763)	NT			
<i>Hypparchia statilinus</i> (Hufnagel, 1766)	NT			
<i>Chazara briseis</i> (Linnaeus, 1764)	NT			

^xvan Swaay *et al.* (2010), ²Sasic & Kucinic (2004), ³Anon. (1992), ⁴Anon. (1996)

*NT-Near threatened, LC-Least concern, DD-Data deficient

References

- Anonymus**, 1992: Habitat Directive Annexes II and IV. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and wild fauna and flora. Annex I-VI. Council of the European Communities.
- Anonymus**, 1996: Convention on the conservation of European wildlife and natural habitats (Bern/Berne, 19.IX.1979) European Treaty Series/104. (+Appendices I-IV). Council of the European Communities 2-25.
- Hafner, I.**, 1994: Verzeichnis der bei Knin gesammelten Schmetterlinge (Lepidoptera). *Natura Croatica*, 3 (2): 119-184.
- Hruby, K.**, 1964: Prodromus Lepidopter Slovenska. Vydavatelstvo Slovenskej akademievied, Bratislava, pp. 962.
- Jakšić, P.**, 1988: Privremene karte rasprostranjenosti dnevnih leptira Jugoslavije. Jugoslavensko entomološko društvo. Posebna izdanja 1, Zagreb, 214 pp.
- Koren, T.**, 2010: First finding of Ripart's Anomalous Blue *Polyommatus* (*Agrodiaetus*) *ripartii* (Freyer, 1830) (Lepidoptera, Lycaenidae) in Croatia. *Natura Croatica*, 19(2): 463-467.
- Lorković, Z.**, 1976: Taxonomische, ökologische und chorologische Beziehungen zwischen *Hipparchia fagi* Scop., *H. syriaca* Stgr. und *H. alcyone* D.& S. (Lepidopt. Satyridae). *Acta entomologica Jugoslavica*, 12 (1-2): 11-33.
- Lorković, Z.**, 2009: The Rhopalocera Fauna of Croatia with Special Respect to the Fauna of Plitvice Lakes. *Entomologia Croatica*, 13: 15-78.
- Mann, J.**, 1869: Lepidopteren gesammelt während dreier reisen nach Dalmatien in den Jahren 1850, 1862 und 1868. Verhandlungen zoologisch-botanischen Gesellschaft in Wien, 19: 371-388.
- Matonickin, I., Pavletić, Z.**, 1961: Taložni fenomeni u Zrmanji s biološkog stanovišta. *Geografski glasnik*, 23: 103 - 114.
- Mihoci, I., Sašić, M.**, 2007: New distribution data on the endemic butterfly *Proterebia afra dalmata* (Godart, [1824]) (Nymphalidae, Satyrinae) in Croatia. *Natura Croatica*, 16 (3): 205-210.
- Mihoci, I., Vajdić, M., Šašić, M.**, 2006: The status of the Damon Blue *Polyommatus* (*Agrodiaetus*) *damon* (Denis and Schiffermuller, 1775) (Papilionoidea: Lycaenidae, Polyommataini) in the Croatian butterfly fauna. *Natura Croatica*, 15 (1-2), 15-25.
- Mihoci, I., Sašić, M., Vuković, M.**, 2007: Contribution to the butterfly fauna (Hesperioidea & Papilionoidea) of the Velebit Mountain, Croatia. *Natura Croatica*, 16 (1): 29-62.
- Pelivan, A.**, 2003: Vodič kroz prirodne ljepote u Hrvatskoj, 2. Preuredeno i prošireno izdanje, Donja Lomnica, pp. 260 - 262.
- Pelivan, A.**, 2004: Zrmanja, Krka, Cetina i njihovi pritoci, Donja Lomnica, pp. 14 - 34.
- Sašić, M. & Kucinić, M.**, 2004: Danji leptiri. In: Marković, D. (ur.) Crveni popis ugroženih biljaka i životinja Hrvatske. Državni zavod za zaštitu prirode, Zagreb, 71-74.

- Tolman, T., Lewington, R.,** 2008: Butterflies of Britain & Europe. Harper Collins Publishers, London, 384 pp.
- Van Swaay, C., Cuttelod, A., Collins, S., Maes, D., Lopez Munguira, M., Sašić, M., Settele, J., Verovnik, R., Verstrael, T., Warren, M., Wiemers, M. & Wynhof, I.,** 2010: European Red List of Butterflies, Luxembourg: Publications Office of the European Union.
- Wermers, M.,** 1982: Tagfalterbeobachtungen in Dalmatien/Jugoslawien. *Atalanta*, 13(3): 217-224.
- Withrington, D. K. J., Verovnik, E.,** 2008: Butterflies (Rhopalocera) of the Croatian islands. *Entomologist's Gazette*, 59: 3-25.
- Zakšek, V.,** 2005: On the presence of *Proterebia afra* (Lepidoptera: Nymphalidae: Satyrinae) on the island of Pag, Croatia. *Phegea*, 33 (3): 118-120.

Received / Prejeto: 17. 3. 2011