

# BUTTERFLY FAUNA (INSECTA, LEPIDOPTERA, PAPILIONOIDEA) OF NORTHERN MOSLAVINA (CROATIA)

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This research into the butterfly fauna of the northern parts of the Moslavina region (northern Moslavina) was conducted between July 2004 and September 2006 with the aim of providing the first information on the butterfly fauna for the area and contributing to the overall knowledge on butterfly species distribution in Croatia. The analysis of samples collected from 13 locations demonstrates the presence of 69 species, which corresponds to 35% of all species recorded in Croatia. Since the research area is subject to significant anthropogenic influence, this share can be considered as significant. Strictly protected species *Lycaena dispar* (Haworth, 1802), *Euphydryas aurinia* (Rottemburg, 1775) *Lopinga achine* (Scopoli, 1763), *Papilio machaon* (Linnaeus, 1758) and *Parnassius mnemosyne* (Linnaeus, 1758) were recorded during the research. Furthermore, the research provided the first data on butterfly fauna of the northern parts of the Moslavina region, and can serve as a basis for further research in the wider region.

**Keywords:** butterflies, Moslavina, conservation

**Fištrek, Ž.: Fauna danjih leptira (Insecta, Lepidoptera, Papilionoidea) sjeverne Moslavine. Nat. Croat., Vol. 27, No. 1, 97-109, 2018, Zagreb.**

Istraživanje faune danjih leptira sjevernih predjela Moslavine (sjeverna Moslavina) provedeno je u razdoblju od srpnja 2004. do rujna 2006. godine s ciljem prikupljanja prvih informacija o fauni leptira na navedenom području, te kako bi pridonijelo općem poznavanju rasprostranjenosti leptira u Hrvatskoj. Analiza uzoraka sakupljenih na 13 lokacija ukazuje na prisutnost 69 vrsta što čini 35 % od svih zabilježenih vrsta u Hrvatskoj. Budući da se radi o području koje je pod značajnim utjecajem ljudskih aktivnosti, ovaj udio može se smatrati značajnim. Ovim istraživanjem na navedenom području zabilježene su strogo zaštićene vrste *Lycaena dispar* (Haworth, 1802), *Euphydryas aurinia* (Rottemburg, 1775) *Lopinga achine* (Scopoli, 1763), *Papilio machaon* (Linnaeus, 1758) i *Parnassius mnemosyne* (Linnaeus, 1758). Nadalje, istraživanje pruža prve podatke o fauni leptira sjevernih predjela Moslavine, te može poslužiti kao podloga za daljnja istraživanja u široj regiji.

**Ključne riječi:** leptiri, Moslavina, zaštita

## INTRODUCTION

Butterflies are indicators of changes in the environment due to their specific life cycle and their dependency on larval food plant. Any increase or decrease in their numbers is often a sign of changes in their natural habitat and an indicator of ecological processes (OOSTERMEIJER & VAN SWAAY, 1998). Numerous human activities such as urbanization, intensive forestry, irrigation, intensive agricultural production with the intensive use of herbicides and pesticides, and abandonment of the traditional way of mowing, are some of the drivers of changes in the composition of butterfly fauna (VAN SWAAY *et al.*, 2010).

In Croatia, butterflies have been studied since the 19th century. Over the last two decades, a major number of articles have been published in which significant data were given regarding butterfly fauna in Croatia (MIHOČI *et al.*, 2007b; ŠAŠIĆ & MIHOČI, 2011; ŠAŠIĆ *et al.*, 2015; KOREN *et al.*, 2017), some very rare or new species for Croatian fauna were recorded (KUČINIĆ *et al.* 1999; MIHOČI *et al.*, 2005; MIHOČI & ŠAŠIĆ, 2005a; MIHOČI & ŠAŠIĆ, 2005b; PERKOVIĆ, 2006; MIHOČI *et al.*, 2007a; ŠAŠIĆ & MIHOČI, 2007; KOREN, 2010; MIHOČI & ŠAŠIĆ, 2009) or a contribution to knowledge about and distribution of a given species was provided (MIHOČI & ŠAŠIĆ, 2006; MIHOČI *et al.*, 2007c; TVRTKOVIĆ *et al.*, 2011; KUČINIĆ *et al.*, 2014). Nevertheless, the butterfly fauna of some parts of Croatia has remained unknown due to the lack of systematic research. The northern part of the Moslavina region (northern Moslavina) is one such area in which no research has been conducted. Moslavina is a micro-region situated in central Croatia (Fig. 1) within the territory of three counties. The northern part covers the area from the northern forested slopes of Moslavačka gora (489 m) up to the River Česma and its floodplains (ROGLIĆ, 2006). The average elevation of the whole area is between 120-150 meters above sea level. The Moslavina region is characterised by a continental climate and central European vegetation. Fertile soil and rich forest resources have influenced the development of the agriculture (mostly animal husbandry) and forestry sectors, resulting in a significant impact by human intervention into the environment and nature. The objective of this research was to record the butterfly species in semi-natural habitats of northern Moslavina, to create a baseline for further research in this area, and to contribute to knowledge on the distribution of butterfly fauna in Croatia, especially endangered and strictly protected species. In order to understand the potential for species distribution, the diversity of butterfly fauna identified by this research has been compared to available records on butterfly fauna of the other researched areas relatively close to the research area, more precisely the fauna of the surroundings of Karlovac (ŠPANIĆ, 2012) and the fauna of rural parts of Zagreb (KOREN *et al.*, 2013).

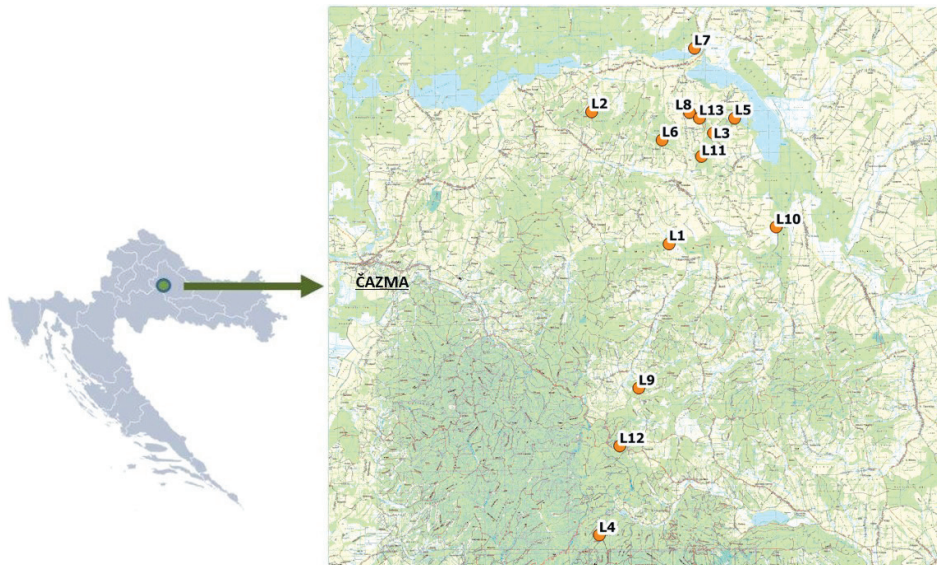


Fig. 1. Position of the research area in Croatia and exact locations of sampling within the northern Moslavina.

## MATERIAL AND METHODS

The butterflies were collected with an entomological net at 13 locations within the area of northern Moslavina (Fig. 1). The sampling was performed at least once a month from July 2004 to September 2006, during sunny days, between 10 am and 6 pm. Due to the size of the area and the distance between the locations, 2-4 days were needed to visit all the locations. Each location was visited at least 15 times.

When on the spot positive visual identification could be made, butterflies were captured, observed and released, in some cases photographed, while their presence at the location was marked in the research logbook. At the time protected species were not collected. The collected specimens are stored in the author's private butterfly collection.

The altitudes of all collecting sites are between 109 and 356 meters above the sea level (Tab. 1). The sampling locations were chosen based on habitat characteristics, with the aim of achieving greater habitat diversity. The coordinates of the locations, altitudes and types of the habitats are given in Tab. 1. The locations include open patches within dense forest (L12), orchards (L9) and open flooded meadows (L7, L5). All locations have in common significant exposure to anthropogenic influence evident in the presence of agricultural and forestry activities. Two locations (L4 & L12) are situated within the Moslavačka gora Regional Park while seven locations (L3, L5, L7, L8, L10, L11 & L13) are within the Natura 2000 site SRA HR1000009 Fishponds along the Česma River. However, the collection of specimens at these locations was conducted prior to the establishment of the Park in 2011 (Regulation on a proclamation of the Moslavačka gora Regional Park, OG 68/11) or the Natura 2000 area in 2013 (Regulation on Ecological Network, OG 124/13). Identification based on wing morphology was made according to TOLMAN & LEWINGTON (1997). Butterfly nomenclature and systematics follow ŠAŠIĆ & MIHOČI (2011). Specimens of *Leptidea* genus, the identification of which is not possible based on the morphology of the wings because of great similarities between species, are identified based on variations in the morphology of their genitalia, which are specific for each species. The analysis of the morphological characteristics of the genitalia was made according to LORKOVIĆ (1993), JAKŠIĆ (1998), LELO (2002) and LELO (2003).

Some species of Lycaenidae family were identified by comparison with the entomological collections of the Croatian Natural History Museum (CNHM) in Zagreb.

**Tab. 1.** List of locations with geographical coordinates (according to Google Earth), altitude and habitat type.

Loc. num.	Name	Coordinates	Av. altitude (m)	Habitat type
L1	Babinac	45°45'29"N, 16°48'27"E	130	Broadleaved deciduous woodland dominated by beech, oak and hornbeam. Smaller clearings dominated by shrubs.
L2	Blatnica	45°48'52.2"N, 16°45'27.2"E	119	Mesophilous cultivated meadow surrounded by broadleaved deciduous woodland.
L3	Bukvik	45°48'17"N, 16°50'3.2"E	140	Recently felled area in broadleaved deciduous woodland dominated by beech and oak. Poplar patches along the stream.

Tab. 1. Continued

Loc. num.	Name	Coordinates	Av. altitude (m)	Habitat type
L4	Garić	45°37'51.7"N, 16°45'41.8"E	356	Broadleaved deciduous woodland dominated by beech. Clearing dominated by shrubs and invasive vegetation.
L5	Kolarevo Selo	45°48'43.7"N, 16°50'48"E	115	Humid meadows with occasional willow and poplar trees and smaller shrubs. Reeds at the edges.
L6	Mali Bjelovar	45°48'4"N, 16°48'9.7"E	131	Riparian woodland dominated by oak, poplar and alder.
L7	Narta	45°50'28.7"N, 16°49'30.4"E	108	Humid meadows in succession due to cultivation abandonment. Individual willow, poplar, alnus trees and shrubs. Evidence of invasive vegetation.
L8	Perinac	45°49'1.9"N, 16°48'56"E	137	Mesophilous cultivated meadow surrounded by arable land.
L9	Samarica	45°41'50.5"N, 16°47'15.5"E	207	Fruit and nut tree orchard. Pasture with mixed broadleaved deciduous woodland at edges.
L10	Srijedska	45°45'47.6"N, 16°52'20.7"E	114	Humid grassland surrounded by riparian woodland and mosaic of cultivated areas.
L11	Sutanjska	45°47'36.2"N, 16°49'28.1"E	132	Humid grassland surrounded by broadleaved deciduous woodland dominated by oak, hornbeam, beech.
L12	Šimljanik	45°40'15.2"N, 16°46'1.2"E	239	Broad-leaved deciduous woodland dominated by beech.
L13	Škarcev Gaj	45°48'41.5"N, 16°49'34.8"E	145	Mesophilous cultivated meadow surrounded by arable land.

## RESULTS

When the collected samples had been examined, 69 species of butterflies belonging to five butterfly families were identified. The species identified are listed in Tab. 2 according to the systematics by ŠAŠIĆ & MIHOČI (2011). Next to the species name, the location and the date of collection or observation are given.

Tab. 2. List of recorded butterfly species in the study area, with location and date of collection or observation

Species	Location and date of finding
Fam. Papilionidae Latreille, 1802	
<i>Parnassius mnemosyne</i> (Linnaeus, 1758)	Kolarevo Selo, May 16 <sup>th</sup> , 2005; Mali Bjelovar, May 27 <sup>th</sup> , 2005; Narta, May 14 <sup>th</sup> , 2005; Srijedska, May 15 <sup>th</sup> , 2006
<i>Iphiclides podalirius</i> (Linnaeus, 1758)	Bukvik, August 1 <sup>st</sup> , 2005; Mali Bjelovar, August 19 <sup>th</sup> , 2005; Babinac, June 23 <sup>rd</sup> , 2006
<i>Papilio machaon</i> (Linnaeus, 1758)	Bukvik, August 1 <sup>st</sup> , 2005; Mali Bjelovar, June 21 <sup>st</sup> , 2005; Narta, August 18 <sup>th</sup> , 2005*; Sutanjska, August 26 <sup>th</sup> , 2005; Škarcev Gaj, August 1 <sup>st</sup> , 2005; Perinac, August 16 <sup>th</sup> , 2006; Srijedska, July 20 <sup>th</sup> , 2006
Fam. Hesperidae Latreille, 1809	
<i>Erynnis tages</i> (Linnaeus, 1758)	Bukvik, August 1 <sup>st</sup> , 2005; Sutanjska, August 2 <sup>nd</sup> , 2005; Samarica, July 20 <sup>th</sup> , 2006;
<i>Carcharodus alceae</i> (Esper, 1780)	Narta, August 18 <sup>th</sup> , 2005; Sutanjska, August 2 <sup>nd</sup> , 2005; Mali Bjelovar, July 24 <sup>th</sup> , 2006; Samarica, August 10 <sup>th</sup> , 2006

Tab. 2. Continued

Species	Location and date of finding
<i>Pyrgus malvae</i> (Linnaeus, 1758)	Perinac, August 9 <sup>th</sup> , 2004; June 12 <sup>th</sup> , 2005; Mali Bjelovar, April 30 <sup>th</sup> , 2005; May 27 <sup>th</sup> , 2005; Srijedska, June 20 <sup>th</sup> , 2005; Samarica, June 26 <sup>th</sup> , 2005; Sutanjska, April 29 <sup>th</sup> , 2005; Blatnica, July 19 <sup>th</sup> , 2006; Šimljanik July 20 <sup>th</sup> , 2006; Škarcev Gaj, August 16 <sup>th</sup> , 2006
<i>Heteropterus morpheus</i> (Pallas, 1771)	Samarica, August 10 <sup>th</sup> , 2006
<i>Thymelicus lineola</i> (Ochsenheimer, 1808)	Srijedska, June 27 <sup>th</sup> , 2005; Na rta, August 18 <sup>th</sup> , 2005; Mali Bjelovar, July 24 <sup>th</sup> , 2006
<i>Thymelicus sylvestris</i> (Poda, 1761)	Mali Bjelovar, August 1 <sup>st</sup> , 2005
<i>Ochlodes sylvanus</i> (Esper 1777)	Samarica, August 9 <sup>th</sup> , 2004; Bukvik, June 4 <sup>th</sup> , 2005; Kolarevo Selo, May 16 <sup>th</sup> , 2005; Mali Bjelovar, August 19 <sup>th</sup> , 2005*; Sutanjska, May 26 <sup>th</sup> , 2005; Šimljanik, August 14 <sup>th</sup> , 2006
Fam. Pieridae Swainson, 1820	
<i>Leptidea sinapis</i> (Linnaeus, 1758)	Sutanjska, August 17 <sup>th</sup> , 2004, m; Mali Bjelovar, May 27 <sup>th</sup> , 2005, f; Bukvik, May 16 <sup>th</sup> , 2006, f; Samarica, May 27 <sup>th</sup> , 2005, m; May 15 <sup>th</sup> , 2006, m; May 15 <sup>th</sup> , 2006, m; Narta, April 20 <sup>th</sup> , 2006, m; Srijedska, May 15 <sup>th</sup> , 2006, m; May 26 <sup>th</sup> , 2005, f; Šimljanik, June 26 <sup>th</sup> , 2005, f; Garić, July 20 <sup>th</sup> , 2006, f; Perinac, August 1 <sup>st</sup> , 2005, m (Expl: f- female, m- male)
<i>Leptidea juvernica</i> (Williams, 1946)	Sutanjska, August 17 <sup>th</sup> , 2004, m; Kolarevo Selo, June 4 <sup>th</sup> , 2005, m; Narta, June 27 <sup>th</sup> , 2005, f; Mali Bjelovar, May 16 <sup>th</sup> , 2006, m; Babinac, July 19 <sup>th</sup> , 2006 f; August 17 <sup>th</sup> , 2006, f; Blatnica, July 19 <sup>th</sup> , 2006, f; August 15 <sup>th</sup> , 2006, m; Šimljanik, July 20 <sup>th</sup> , 2006, f. (Expl: f- female, m- male)
<i>Anthocharis cardamines</i> (Linnaeus, 1758)	Bukvik, April 29 <sup>th</sup> , 2005; Kolarevo Selo, May 16 <sup>th</sup> , 2005; Mali Bjelovar, April 30 <sup>th</sup> , 2005; Narta, May 14 <sup>th</sup> , 2005; Srijedska, May 16 <sup>th</sup> , 2005; Sutanjska, April 29 <sup>th</sup> , 2005; Blatnica, April 17 <sup>th</sup> , 2006; Samarica, May 15 <sup>th</sup> , 2006;
<i>Pieris brassicae</i> (Linnaeus, 1758)	Perinac, August 1 <sup>st</sup> , 2004; Bukvik, June 4 <sup>th</sup> , 2005; Babinac, July 19 <sup>th</sup> , 2006; Blatnica, June 20 <sup>th</sup> , 2006; Sutanjska, August 16 <sup>th</sup> , 2006
<i>Pieris mannii</i> (Mayer, 1851)	Škarcev Gaj, August 2 <sup>nd</sup> , 2004; Blatnica, June 27 <sup>th</sup> , 2005
<i>Pieris rapae</i> (Linnaeus, 1758)	Samarica, August 9 <sup>th</sup> , 2004; Mali Bjelovar, August 16 <sup>th</sup> , 2004; Kolarevo Selo, June 4 <sup>th</sup> , 2005
<i>Pieris napi</i> (Linnaeus, 1758)	Perinac, August 1 <sup>st</sup> , 2004; Blatnica, August 19 <sup>th</sup> , 2005; Bukvik, August 1 <sup>st</sup> , 2005; Kolarevo Selo, June 4 <sup>th</sup> , 2005; Narta, June 27 <sup>th</sup> , 2005; Sutanjska, May 26 <sup>th</sup> , 2005; Babinac, August 17 <sup>th</sup> , 2006; Garić, June 23 <sup>rd</sup> , 2006; Mali Bjelovar, May 16 <sup>th</sup> , 2006; Samarica, August 20 <sup>th</sup> , 2006; Srijedska, August 17 <sup>th</sup> , 2006; Šimljanik, July 20 <sup>th</sup> , 2006; Škarcev Gaj, July 18 <sup>th</sup> , 2006.
<i>Colias crocea</i> (Geoffroy, 1785)	Perinac, August 1 <sup>st</sup> , 2004; Kolarevo Selo, July 9 <sup>th</sup> , 2005; Narta, August 18 <sup>th</sup> , 2005; Sutanjska, May 26 <sup>th</sup> , 2005; Samarica, July 20 <sup>th</sup> , 2006; Srijedska, July 20 <sup>th</sup> , 2006; Škarcev Gaj, July 18 <sup>th</sup> , 2006
<i>Colias hyale</i> (Linnaeus, 1758)	Perinac, August 1 <sup>st</sup> , 2004; Narta, June 27 <sup>th</sup> , 2005; Blatnica, July 19 <sup>th</sup> , 2006; Škarcev Gaj, August 16 <sup>th</sup> , 2006
<i>Gonepteryx rhamni</i> (Linnaeus, 1758)	Samarica, September 10 <sup>th</sup> , 2004; Bukvik, March 26 <sup>th</sup> , 2005; Blatnica, June 27 <sup>th</sup> , 2005; Mali Bjelovar, April 30 <sup>th</sup> , 2005; August 19 <sup>th</sup> , 2005; Srijedska, May 16 <sup>th</sup> , 2006; Sutanjska, May 26 <sup>th</sup> , 2005; Šimljanik, May 26 <sup>th</sup> , 2005; Babinac, August 17 <sup>th</sup> , 2006; Garić, April 15 <sup>th</sup> , 2006; Narta, June 19 <sup>th</sup> , 2006
Fam. Riodinidae Grote, 1895	
<i>Hamearis lucina</i> (Linnaeus, 1758)	Sutanjska, April 29 <sup>th</sup> , 2005; Samarica, May 15 <sup>th</sup> , 2006; July 20 <sup>th</sup> , 2006
Fam. Lycaenidae Leach, 1815	
<i>Lycaena phlaeas</i> (Linnaeus, 1761)	Samarica, May 7 <sup>th</sup> , 2005; Narta, July 18 <sup>th</sup> , 2005; Škarcev Gaj, September 15 <sup>th</sup> , 2005

Tab. 2. Continued

Species	Location and date of finding
<i>Lycaena dispar</i> (Haworth, 1802)	Perinac, August 1 <sup>st</sup> , 2004; Samarica, August 9 <sup>th</sup> , 2004; Sutanjska, August 17 <sup>th</sup> , 2004; Mali Bjelovar, August 19 <sup>th</sup> , 2005; Škarcev Gaj, August 1 <sup>st</sup> , 2005; Kolarevo Selo, June 19 <sup>th</sup> , 2006; Narta, August 21 <sup>st</sup> , 2006
<i>Lycaena tityrus</i> (Poda, 1761)	Samarica, May 7 <sup>th</sup> , 2005; June 26 <sup>th</sup> , 2005; Babinac, August 17 <sup>th</sup> , 2006; Mali Bjelovar, May 16 <sup>th</sup> , 2006
<i>Lycaena alciphron</i> (Rottemburg, 1775)	Mali Bjelovar, May 28 <sup>th</sup> , 2005; Samarica, May 15 <sup>th</sup> , 2006; August 1 <sup>st</sup> , 2005; Kolarevo Selo, May 16 <sup>th</sup> , 2006
<i>Lycaena hippothoe</i> (Linnaeus, 1761)	Perinac, August 1 <sup>st</sup> , 2004; Kolarevo Selo, June 4 <sup>th</sup> , 2005; Samarica, August 14 <sup>th</sup> , 2005; Narta, August 18 <sup>th</sup> , 2005
<i>Thecla betulae</i> (Linnaeus, 1758)	Samarica, August 14 <sup>th</sup> , 2006
<i>Callophrys rubi</i> (Linnaeus, 1758)	Samarica, May 7 <sup>th</sup> , 2005
<i>Satyrrium w-album</i> (Knoch, 1782)	Mali Bjelovar, July 24 <sup>th</sup> , 2006
<i>Satyrrium pruni</i> (Linnaeus, 1758)	Samarica, May 7 <sup>th</sup> , 2005
<i>Cupido argiades</i> (Pallas, 1771)	Narta, June 4 <sup>th</sup> , 2005; Mali Bjelovar, August 1 <sup>st</sup> , 2005; Perinac, August 1 <sup>st</sup> , 2005; Škarcev Gaj, August 2 <sup>nd</sup> , 2005; Samarica, August 14 <sup>th</sup> , 2005; Sutanjska, August 17 <sup>th</sup> , 2005; Srijedska, August 20 <sup>th</sup> , 2005; Garić, June 23 <sup>rd</sup> , 2006; Blatnica, July 19 <sup>th</sup> , 2006; Šimljanik, August 14 <sup>th</sup> , 2005; July 20 <sup>th</sup> , 2006; Babinac, July 19 <sup>th</sup> , 2006; Bukvik, August 16 <sup>th</sup> , 2006; Kolarevo Selo, July 19 <sup>th</sup> , 2006
<i>Cupido alcetas</i> (Hoffmannsegg, 1804)	Srijedska, May 15 <sup>th</sup> , 2006; Škarcev Gaj, August 16 <sup>th</sup> , 2006
<i>Celastrina argiolus</i> (Linnaeus, 1758)	Garić, August 11 <sup>th</sup> , 2005; Narta, June 27 <sup>th</sup> , 2005; Bukvik, August 1 <sup>st</sup> , 2005; Samarica, May 27 <sup>th</sup> , 2005; Šimljanik, August 25 <sup>th</sup> , 2005; Babinac, July 19 <sup>th</sup> , 2006; Mali Bjelovar, July 20 <sup>th</sup> , 2006; July 24 <sup>th</sup> , 2006; Srijedska, July 20 <sup>th</sup> , 2006; Sutanjska, June 4 <sup>th</sup> , 2006
<i>Polyommatus icarus</i> (Rottemburg, 1775)	Perinac, August 1 <sup>st</sup> , 2004, f,m; Samarica, August 9 <sup>th</sup> , 2004; Škarcev Gaj, August 2 <sup>nd</sup> , 2004; August 1 <sup>st</sup> , 2005; Babinac, May 14 <sup>th</sup> , 2005; Bukvik, July 9 <sup>th</sup> , 2005; Mali Bjelovar, August 1 <sup>st</sup> , 2005; Šimljanik, June 26 <sup>th</sup> , 2005; August 16 <sup>th</sup> , 2006; Blatnica, July 19 <sup>th</sup> , 2006; Garić, July 20 <sup>th</sup> , 2006; Narta, June 19 <sup>th</sup> , 2006; Kolarevo Selo, August 15 <sup>th</sup> , 2006; Srijedska, June 19 <sup>th</sup> , 2006; Sutanjska, August 16 <sup>th</sup> , 2006
Fam. Nymphalidae Rafinesque, 1815	
<i>Argynnis paphia</i> (Linnaeus, 1758)	Samarica, August 9 <sup>th</sup> , 2004; Sutanjska, August 17 <sup>th</sup> , 2004; Babinac, July 10 <sup>th</sup> , 2005; Blatnica, August 19 <sup>th</sup> , 2005; Bukvik, August 27 <sup>th</sup> , 2005 (f. valezina); Garić, August 14 <sup>th</sup> , 2005; Narta, June 27 <sup>th</sup> , 2005; August 18 <sup>th</sup> , 2005; August 25 <sup>th</sup> , 2005; Mali Bjelovar, August 1 <sup>st</sup> , 2005 <sup>*</sup> ; August 19 <sup>th</sup> , 2005; Srijedska, June 20 <sup>th</sup> , 2005; Šimljanik, August 20 <sup>th</sup> , 2006
<i>Argynnis adippe</i> (Denis and Schiffermuller, 1775)	Samarica, June 26 <sup>th</sup> , 2005., Mali Bjelovar, July 19 <sup>th</sup> , 2005; Blatnica, August 19 <sup>th</sup> , 2005
<i>Issoria lathonia</i> (Linnaeus, 1758)	Perinac, August 1 <sup>st</sup> , 2004; Narta, June 27 <sup>th</sup> , 2005; Srijedska, June 27 <sup>th</sup> , 2005; Blatnica, August 19 <sup>th</sup> , 2005
<i>Brenthis daphne</i> (Bergsträsser, 1780)	Bukvik, June 4 <sup>th</sup> , 2005; Mali Bjelovar, August 1 <sup>st</sup> , 2005; Narta, June 27 <sup>th</sup> , 2005; Samarica, August 10 <sup>th</sup> , 2005; Srijedska, June 27 <sup>th</sup> , 2005; Sutanjska, August 2 <sup>nd</sup> , 2005; Perinac, June 4 <sup>th</sup> , 2006; Babinac, June 23 <sup>rd</sup> , 2006; Garić, July 20 <sup>th</sup> , 2006; Šimljanik, June 23 <sup>rd</sup> , 2006
<i>Boloria euphrosyne</i> (Linnaeus, 1758)	Bukvik, July 9 <sup>th</sup> , 2006
<i>Boloria dia</i> (Linnaeus, 1767)	Samarica, May 7 <sup>th</sup> , 2005; June 26 <sup>th</sup> , 2005
<i>Vanessa atalanta</i> (Linnaeus, 1758)	Bukvik, October 3 <sup>rd</sup> , 2004; Kolarevo Selo, June 4 <sup>th</sup> , 2005; Mali Bjelovar, May 25 <sup>th</sup> , 2005; Narta, August 16 <sup>th</sup> , 2005; Perinac, June 25 <sup>th</sup> , 2005; Škarcev Gaj, August 1 <sup>st</sup> , 2005; Samarica, June 23 <sup>rd</sup> , 2006

Tab. 2. Continued

Species	Location and date of finding
<i>Vanessa cardui</i> (Linnaeus, 1758)	Škarcevi Gaj, August 2 <sup>nd</sup> , 2004; July 4 <sup>th</sup> , 2004; Perinac, June 25 <sup>th</sup> , 2005; Narta, July 19 <sup>th</sup> , 2006
<i>Aglais io</i> (Linnaeus, 1758)	Perinac, August 1 <sup>st</sup> , 2004; Sutanjska, August 17 <sup>th</sup> , 2004; Škarcevi Gaj, August 2 <sup>nd</sup> , 2004; Babinac, July 10 <sup>th</sup> , 2005; Bukvik, June 4 <sup>th</sup> , 2005; Blatnica, August 19 <sup>th</sup> , 2005; Garić, June 26 <sup>th</sup> , 2005; Kolarevo Selo, June 21 <sup>st</sup> , 2005; Mali Bjelovar, August 19 <sup>th</sup> , 2005; Samarica, August 19 <sup>th</sup> , 2005; Srijednska, August 20 <sup>th</sup> , 2005; Narta, July 19 <sup>th</sup> , 2006; Šimljanik, June 4 <sup>th</sup> , 2006
<i>Aglais urticae</i> (Linnaeus, 1758)	Škarcevi Gaj, March 20 <sup>th</sup> , 2005; Perinac, June 12 <sup>th</sup> , 2005; May 28 <sup>th</sup> , 2005
<i>Polygonia c-album</i> (Linnaeus, 1758)	Samarica, August 9 <sup>th</sup> , 2004; Perinac, August 9 <sup>th</sup> , 2004; Babinac, July 10 <sup>th</sup> , 2005; Blatnica, August 19 <sup>th</sup> , 2005; Bukvik, June 24 <sup>th</sup> , 2005; Garić, August 14 <sup>th</sup> , 2005; Mali Bjelovar, April 16 <sup>th</sup> , 2005; Narta, June 27 <sup>th</sup> , 2005; Sutanjska, May 26 <sup>th</sup> , 2005; Srijednska, August, 20 <sup>th</sup> , 2005; Šimljanik, June, 26 <sup>th</sup> , 2005 Garić, July 20 <sup>th</sup> , 2006;
<i>Araschnia levana</i> (Linnaeus, 1758)	Sutanjska, August 17 <sup>th</sup> , 2004; Bukvik, April 16 <sup>th</sup> , 2005; Kolarevo Selo, April 24 <sup>th</sup> , 2005; Mali Bjelovar, April 30 <sup>th</sup> , 2005*; Narta, April 17 <sup>th</sup> , 2005; Perinac, August 18 <sup>th</sup> , 2005; Samarica, May 7 <sup>th</sup> , 2005; 16 <sup>th</sup> , 2006; Srijednska, August 20 <sup>th</sup> , 2005; Babinac, May 15 <sup>th</sup> , 2005; Blatnica, August 16 <sup>th</sup> , 2006; Garić, July 19 <sup>th</sup> , 2006; Šimljanik, April 14 <sup>th</sup> , 2005; Škarcevi Gaj, July 18 <sup>th</sup> , 2006
<i>Nymphalis antiopa</i> (Linnaeus, 1758)	Blatnica, June 27 <sup>th</sup> , 2005; Bukvik, June 4 <sup>th</sup> , 2006; Samarica, May 27 <sup>th</sup> , 2006
<i>Nymphalis polychloros</i> (Linnaeus, 1758)	Bukvik, March 26 <sup>th</sup> , 2005; April 29 <sup>th</sup> , 2005; Sutanjska, April 14 <sup>th</sup> , 2006*; Mali Bjelovar, April 16 <sup>th</sup> , 2005; Samarica, May 15 <sup>th</sup> , 2006
<i>Euphadryas aurinia</i> (Rottemburg, 1775)	Srijednska, July 19 <sup>th</sup> , 2006
<i>Melitaea cinxia</i> (Linnaeus, 1758)	Samarica, May 7 <sup>th</sup> , 2005; Bukvik, June 4 <sup>th</sup> , 2005
<i>Melitaea phoebe</i> (Denis and Schiffermüller, 1775)	Perinac, August 1 <sup>st</sup> , 2004; Sutanjska, August 17 <sup>th</sup> , 2004; Bukvik, August 27 <sup>th</sup> , 2005
<i>Melitaea didyma</i> (Esper, 1775)	Sutanjska, May 26 <sup>th</sup> , 2005; Mali Bjelovar, July 1 <sup>st</sup> , 2005; August 19 <sup>th</sup> , 2005; Samarica, August 14 <sup>th</sup> , 2005
<i>Melitaea aurelia</i> (Nickerl, 1850)	Perinac, August 1 <sup>st</sup> , 2004; Mali Bjelovar, August 1 <sup>st</sup> , 2005; Samarica, June 23 <sup>rd</sup> , 2006; Šimljanik, July 20 <sup>th</sup> , 2006
<i>Melitaea athalia</i> (Rottemburg, 1775)	Sutanjska, August 17 <sup>th</sup> , 2004; Kolarevo Selo, June 4 <sup>th</sup> , 2005; Škarcevi Gaj, August 1 <sup>st</sup> , 2005; Bukvik, August 16 <sup>th</sup> , 2006
<i>Neptis sappho</i> (Pallas, 1771)	Perinac, August 1 <sup>st</sup> , 2004; Samarica, August 9 <sup>th</sup> , 2004; June 26 <sup>th</sup> , 2005; Sutanjska, August 17 <sup>th</sup> , 2004; April 29 <sup>th</sup> , 2005; Babinac, June 26 <sup>th</sup> , 2005; Blatnica, August 19 <sup>th</sup> , 2005; Bukvik, May 16 <sup>th</sup> , 2005; August 1 <sup>st</sup> , 2005; Garić, August 1 <sup>st</sup> , 2005; Mali Bjelovar, May 16 <sup>th</sup> , 2005; Kolarevo Selo, June 4 <sup>th</sup> , 2005; Srijednska, August 20 <sup>th</sup> , 2005; Šimljanik, August 14 <sup>th</sup> , 2005; Škarcevi Gaj, September 15 <sup>th</sup> , 2005; Narta, July 20 <sup>th</sup> , 2006
<i>Apatura ilia</i> (Denis and Schiffermüller, 1775)	Šimljanik, June 26 <sup>th</sup> , 2005; Blatnica, August 1 <sup>st</sup> , 2005; Mali Bjelovar, August 2 <sup>nd</sup> , 2005
<i>Apatura iris</i> (Linnaeus, 1758)	Šimljanik, June 26 <sup>th</sup> , 2005
<i>Pararge aegeria</i> (Linnaeus, 1758)	Samarica, June 26 <sup>th</sup> , 2005; Bukvik, August 18 <sup>th</sup> , 2005; Sutanjska, August 26 <sup>th</sup> , 2005; Šimljanik, July 20 <sup>th</sup> , 2006
<i>Lasiommata megera</i> (Linnaeus, 1758)	Perinac, September 12 <sup>th</sup> , 2004; Samarica, May 7 <sup>th</sup> , 2005; Bukvik, June 4 <sup>th</sup> , 2005; Mali Bjelovar, August 1 <sup>st</sup> , 2005
<i>Lasiommata maera</i> (Linnaeus, 1758)	Samarica, June 26 <sup>th</sup> , 2005; July 20 <sup>th</sup> , 2006; Sutanjska, August 26 <sup>th</sup> , 2005
<i>Lopinga achine</i> (Scopoli, 1763)	Bukvik, June 4 <sup>th</sup> , 2005; Mali Bjelovar, August 19 <sup>th</sup> , 2005; Samarica, May 27 <sup>th</sup> , 2006
<i>Coenonympha arcania</i> (Linnaeus, 1758)	Šimljanik, June 26 <sup>th</sup> , 2005

Tab. 2. Continued

Species	Location and date of finding
<i>Coenonympha glycerion</i> (Borkhausen, 1758)	Sutanjska, August 17 <sup>th</sup> , 2004; May 26 <sup>th</sup> , 2005; Perinac, June 25 <sup>th</sup> , 2005; Samarica, June 26 <sup>th</sup> , 2005; Srijedska, August 20 <sup>th</sup> , 2005; August 17 <sup>th</sup> , 2006; Šimljanik, August 14 <sup>th</sup> , 2006
<i>Coenonympha pamphilus</i> (Linnaeus, 1758)	Sutanjska, August 2 <sup>nd</sup> , 2004; Škarcevi Gaj, August 2 <sup>nd</sup> , 2004; Bukvik, August 27 <sup>th</sup> , 2005; Kolarevo Selo, August 25 <sup>th</sup> , 2005; Mali Bjelovar, August 19 <sup>th</sup> , 2005; Perinac, September 15 <sup>th</sup> , 2005; Samarica, May 7 <sup>th</sup> , 2005; Srijedska, August 20 <sup>th</sup> , 2005; Šimljanik, August 25 <sup>th</sup> , 2005; Babinac, June 23 <sup>rd</sup> , 2006; Blatnica, June 20 <sup>th</sup> , 2006; Kolarevo Selo, August 15 <sup>th</sup> , 2006
<i>Pyronia tithonus</i> (Linnaeus, 1758)	Samarica, August 9 <sup>th</sup> , 2004; Blatnica, August 19 <sup>th</sup> , 2005
<i>Aphantopus hyperantus</i> (Linnaeus 1758)	Srijedska, August 17 <sup>th</sup> , 2006
<i>Maniola jurtina</i> (Linnaeus, 1758)	Perinac, August 1 <sup>st</sup> , 2004; Babinac, August 1 <sup>st</sup> , 2005; Bukvik, August 1 <sup>st</sup> , 2005; Kolarevo Selo, June 4 <sup>th</sup> , 2005; Narta, June 27 <sup>th</sup> , 2005; Mali Bjelovar, August 1 <sup>st</sup> , 2005; Samarica, August 14 <sup>th</sup> , 2005; Srijedska, August 20 <sup>th</sup> , 2005; Sutanjska, August 26 <sup>th</sup> , 2005; Šimljanik, August 14 <sup>th</sup> , 2005; Blatnica, July 19 <sup>th</sup> , 2006; Garić, July 20 <sup>th</sup> , 2006; Mali Bjelovar, July 24 <sup>th</sup> , 2006; Škarcevi Gaj, June 4 <sup>th</sup> , 2006
<i>Erebia aethiops</i> (Esper, 1777)	Mali Bjelovar, August 1 <sup>st</sup> , 2005; Samarica, August 19 <sup>th</sup> , 2005; Garić, July 20 <sup>th</sup> , 2006
<i>Minois dryas</i> (Scopoli, 1763)	Samarica, August 9 <sup>th</sup> , 2004; Babinac, August 1 <sup>st</sup> , 2005; Blatnica, August 19 <sup>th</sup> , 2005; Mali Bjelovar, August 19 <sup>th</sup> , 2005; Narta, August 18 <sup>th</sup> , 2005; Perinac, May 25 <sup>th</sup> , 2005; Srijedska, August 20 <sup>th</sup> , 2005; Sutanjska, August 2 <sup>nd</sup> , 2005; Bukvik, July 9 <sup>th</sup> , 2006; Garić, July 20 <sup>th</sup> , 2006; Kolarevo Selo, July 19 <sup>th</sup> , 2006; Šimljanik, July 20 <sup>th</sup> , 2006; Škarcevi Gaj, July 18 <sup>th</sup> , 2006

The species that were present in high numbers and were found at all localities are: *Pieris napi* L., *Cupido argiades* Pall., *Polyommatus icarus* Rott., *Araschnia levana* L., *Aglais io* L., *Argynnis paphia* L., *Neptis sappho* Pall., *Coenonympha pamphilus* L., *Maniola jurtina* L., and *Minois dryas* L. Several species were found only at one of the locations. These are *Thecla betulae* L. (Samarica, August 14<sup>th</sup>, 2006), *Satyrium w-album* Knoch (Mali Bjelovar, July 24<sup>th</sup>, 2006), *Satyrium pruni* L. (Samarica, May 7<sup>th</sup>, 2005), *Callophrys rubi* L. (Samarica, May 7<sup>th</sup>, 2005), *Apatura iris* L. (Šimljanik, June 26<sup>th</sup>, 2005), *Boloria euphrosyne* L. (Bukvik, July 9<sup>th</sup>, 2006), *Boloria dia* L. (Samarica, May 7<sup>th</sup>, 2005, June 26<sup>th</sup>, 2005), *Euphydryas aurinia* Rott. (Srijedska, July 19<sup>th</sup>, 2006), *Aphantopus hyperantus* L. (Srijedska, August 17<sup>th</sup>, 2006), *Coenonympha arcania* L. (Šimljanik, May 26<sup>th</sup>, 2005), *Thymelicus sylvestris* Poda (Mali Bjelovar, August 1<sup>st</sup>, 2005), *Heteropterus morpheus* Pall. (Samarica, August 10<sup>th</sup>, 2006).

The location with the highest number of observed and reported species is L9 - Samarica (47 species), a combination of meadow and an orchard on the sunny slopes of Moslavačka gora which is occasionally grazed by sheep. In fact, locations on forest edges were in general characterised by the highest number of butterfly species. At the localities Samarica, Šimljana, Srijedska several species not found at any other locality were recorded.

The conservation and protection status of the species recorded in northern Moslavina was evaluated according to Red List of Butterflies of Croatia (Šašić *et al.*, 2015), and the Ordinance on the proclamation of protected and strictly protected wild taxa (OG 144/13). From 69 recorded species, 9 are listed in the Red List as nearly threatened (NT), while for two species there are insufficient data for estimation of risk of being endangered (DD). From the list, 5 species are recorded in the Ordinance (OG 144/13) and are strictly protected by the Act on Nature Protection (OG 80/13). The conservation actions for butterflies are given in Red Book of Butterflies of Croatia (Šašić *et al.*, 2015). The locations with the highest number



of endangered butterflies are L6, L8 and L9 (Tab. 3). The species *Lopinga achine* and *Euphydryas aurinia* were recorded only once.

The analysis of genitalia of cryptic *Leptidea* genus detected two distinct species, *Leptidea sinapis* and what was thought to be at the time *Leptidea reali*. However, the analysis of mitochondrial and nuclear DNA markers of *Leptidea* genus by DİNCA *et al.* (2011) revealed that *L. sinapis* – *L. reali*, previously understood to be a cryptic pair, are really part of a triplet of species that also includes *L. juvernica*. SHITINKOV *et al.* (2016) indicate that the *Leptidea* triplet is most likely represented in the Balkans only by *L. sinapis* and *L. juvernica*, while *L. reali* is confined to Iberia, southern France and Italy. Therefore, the specimens identified as *L. reali* in 2006, are after the revision indicated as *L. juvernica*.

**Tab. 3.** Protection status of endangered butterflies recorded in northern Moslavina

SPECIES	National category	Strictly protected (OG 73/16)	Locality
<i>Heteropterus morpheus</i> (Pallas, 1771)	NT	NO	L9
<i>Lycaena dispar</i> (Haworth, 1802)	NT	YES	L6,L8,L9,L11,L13
<i>Lycaena hippothoe</i> (Linnaeus, 1761)	NT	NO	L5,L7,L8,L9
<i>Apertura ilia</i> (Denis & Schiffermüller, 1775)	NT	NO	L12
<i>Apertura iris</i> (Linnaeus, 1758)	NT	NO	L12
<i>Euphydryas aurinia</i> (Rottemburg, 1775)	NT	YES	L10
<i>Lopinga achine</i> (Scopoli, 1763)	NT	YES	L3, L6, L9
<i>Melitaea aurelia</i> (Nickerl, 1850)	DD	NO	L6,L8,L9,L12
<i>Papilio machaon</i> (Linnaeus, 1758)	NT	YES	L7,L11
<i>Parnassius mnemosyne</i> (Linnaeus, 1758)	NT	YES	L5,L6,L10
<i>Pieris brassicae</i> (Linnaeus, 1758)	DD	NO	L1,L2,L3,L8,L11

DD (data deficient), NT (near threatened)

## DISCUSSION

Research into butterflies in the area of northern Moslavina recorded 69 species at 13 localities. This constitutes only 35% of species of overall butterfly fauna of Croatia, which amounts to 197 species in all (ŠAŠIĆ *et al.*, 2015). If this number is compared to a number of species found in geographically, climatically and ecologically similar areas, such as the rural parts of Zagreb (KOREN *et al.*, 2013), or the surroundings of Karlovac (ŠPANIĆ, 2012), it can be assumed that the fauna of northern Moslavina should comprise more species than were found in this research. From 88 species recorded for rural parts of Zagreb, 55 species were also found in northern Moslavina, while some species quite common in the surroundings of Zagreb (found at 4 or more locations) were not found in northern Moslavina. The later include *Cupido mimimus*, *Cupido decoloratus*, *Plebejus argyrognomon*, *Polyommatus daphnis* from the Lycaenidae family, and *Limentis reducta*, *Melanargia galathea*, *Hipparichia fagi*, and *Brintesia circe* from the Nymphalidae family. Of the 64 species recorded for the fauna of the surroundings of Karlovac, 53 are also found in northern Moslavina. Species found near Karlovac but not in northern Moslavina, include *Carterocephalus palaemon* from the Hesperidae family, *Satyrum spini*, *Satyrum ilicis*, *Plebeius argus*, *Plebeius idas* from the Lycaenidae family and *Brenthis ino*, *Boloria selene*, *Melitae diamina*, *Nepthis rivularis*, *Brintesia circe* and *Melanargia galathea*

from the Nymphalidae family. The species *Melanargia galathea* and *Brintesia circe* are common species in Karlovac and in the area of rural Zagreb recorded at almost all locations. *Carterocephalus palaemon* and *Satyrium spini* were recorded in the environs of both Karlovac and Zagreb, but not in northern Moslavina. The number of species from the Lycaenidae family recorded by this research is surprisingly low (13 sp.). Significantly, more species from the Lycaenidae family (18 sp.) were recorded for the surroundings of Zagreb. Even though these localities are relatively far from northern Moslavina, some common species with wide distributions over continental Croatia could reasonably also be expected in northern Moslavina.

The difference in altitude among the localities is minor and it is unlikely that altitude is one of the factors that defines distribution and structure of butterfly fauna in this area. The differences in composition of butterfly fauna between locations is probably the result of habitat diversity.

Among the collected specimens an intermediate form of the species the European Map Butterfly, *Araschnia levana* L. (Srijedska, August 20<sup>th</sup>, 2006) was recorded. This species exhibits a distinct seasonal polyphenism associated with non-overlapping generations that have different developmental pathways (MOREHOUSE *et al.* 2012). Intermediate forms, *Araschnia levana porima*, develop from the long-day larvae or young pupae but at lower temperatures (SAPHIRO, 1976). The different wing pattern formation in the spring- and summer-generation butterflies is proximately triggered by the timing of ecdysteroid release, which is under photoperiodic control and which is mediated by temperature in the pupal stage (FRIC *et al.*, 2004).

Agricultural intensification, abandonment of traditional agricultural practices, climate change (including droughts) and change of woodland management are recognised as major threats to butterflies in Europe (VAN SWAAY, 2010), and were recorded at some locations here as well. ŠAŠIĆ & МИНОЦИ (2011) indicate that some species have also suffered major losses in distribution in Croatia and large numbers of butterflies are threatened due to rapid changes in land use. They emphasise the need to identify sites important for such species, which then need to be protected for their survival to be ensured. Eleven recorded species are listed in the Red Book of Butterflies of Croatia. To protect those species, it is important to determine their range of distribution and develop measures of management for these threatened areas. Conservation measures depend on the particular species, but in general include extensive grazing, regular mowing of grasslands, maintenance of forest management etc.

While some localities are well maintained, some are facing changes in the form of either the abandonment of traditional agriculture activities or intensification of farming practice. A potential temporal comparison study of butterfly fauna between the 2006 and today could give us some answers as to how the fauna has changed with the change of habitats.

## CONCLUSIONS

The first survey of butterfly fauna in the north of Moslavina recorded 69 species of butterflies. This number can be considered as significant having in mind that the area of research is subject to significant anthropogenic impact, primarily through agriculture and forestry. Comparison with butterfly fauna of similar and relatively close areas in Croatia, indicates that probably more species should be expected, especially from the Lycaenidae family. To verify this possibility, further research at more localities is needed.

Eleven species recorded by this research, are listed in the Red Book of Butterflies of Croatia, from which five species are strictly statutorily protected. To strengthen the conservation of threatened species, further research on distribution and population trends is needed that could serve as a foundation for the development of plans, strategies and guidance for conservation.

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## SAŽETAK

**Fauna danjih leptira (Insecta, Lepidoptera, Papilionoidea)  
sjeverne Moslavine (Hrvatska)**

Ž. Fištrek

U Republici Hrvatskoj do sada je zabilježeno 197 vrsta danjih leptira (Šašić *et al.*, 2015). Terenskim istraživanjem u razdoblju od srpnja 2004. do rujna 2006. na području sjeverne Moslavine zabilježeno je 69 vrsta danjih leptira, odnosno 35 % ukupne faune danjih leptira Hrvatske. Terenska istraživanja na ovom području do sada nisu provedena tako da je ovo prvi cjeloviti popis faune danjih leptira ovog područja. Utvrđene su rijetke i ugrožene vrste koje se nalaze na crvenom popisu leptira Hrvatske: *Heteropterus morpheus* Pall., *Parnassius mnemosyne* L., *Apatura iris* L., *Apatura ilia* D&S., *Lycaena dispar* Haworth., *Lycaena hippothoe* L., *Euphydryas aurinia* Rott., *Lopinga achine* Scop., *Heteropterus morpheus* Pall., te *Mellicta aurelia* Nick. Zabilježena je i netipična forma ljetne generacije vrste *Araschnia levana* L.

Iz priloženih rezultata možemo reći da je fauna danjih leptira sjeverne Moslavine relativno bogata i raznolika vrstama. Međutim, posljednjih godina vidljiv je trend promjene poljoprivredne strukture što potencijalno može utjecati i na faunu leptira. Da bi se mogle poduzeti odgovarajuće mjere potrebno je prvo napraviti inventarizaciju i kartiranje rasprostranjenosti leptira jer se na temelju tih podataka može procijeniti stvarna ugroženost i utvrditi odgovarajuće mjere zaštite.

