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BUTTERFLY FAUNA (HESPEROIDEA & PAPILIONOIDEA) OF A RURAL PART OF ZAGREB CITY, CROATIA

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Entomologists have researched into the butterflies of Zagreb City with different levels of intensity since the beginning of the 20th century and recorded a great number of species. Many butterfly sites historically surveyed are now completely changed or have completely disappeared due to the expansion of the city and changes in habitat management. Our research was conducted between March 2009 and September 2010 in the Vugrovec area, located at the northeastern edge of the city. Vugrovec is still a rural area, but the city itself is fast approaching, and will probably be merged in the near future. So this area could be considered similar to the historically studied sites in the former rural areas nowadays urbanized. A total of 88 butterfly species were identified, which accounted for 45% of Croatian butterfly fauna. Ten recorded species are endangered and listed in the Red data list of Croatian Butterflies: *Lycaena dispar* (NT), *Glaucopsyche alexis* (NT), *Pseudophilotes vicrama* (NT), *Scolitantides orion* (NT), *Phengaris arion* (VU), *Papilio machaon* (NT), *Pieris brassicae* (DD), *Polyommatus thersites* (NT), *Apatura ilia* (NT), and *Heteropterus morpheus* (NT).

Key words: Lepidoptera, Vugrovec, diversity, threats

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Entomolozi su još od početka 20. stoljeća više ili manje sustavno istraživali faunu danjih leptira Zagreba i zabilježili velik broj vrsta. Nažalost, danas su mnoge lokacije na kojima su leptiri tada sakupljani, izmijenjene ili nestale zbog širenja grada te drugačijeg upravljanja gradskim parkovima i zelenim površinama. Između ožujka 2009. godine i rujna 2010. godine istraživani su danji leptiri na području Vugrovcu, na sjeveroistočnoj granici grada. Vugrovec je trenutačno ruralno područje, no vjerojatno će u bližoj budućnosti postati sastavni dio grada koji mu se ubrzano približava. S obzirom na to, faunu danjih leptira Vugrovcu možemo smatrati sličnom fauni povijesno istraživanih područja koja su danas urbanizirana i dio su grada Zagreba. Utvrđena je prisutnost 88 vrsta danjih leptira, odnosno 45% faune danjih leptira Hrvatske. Deset zabilježenih vrsta se smatra ugroženima te su navedene na Crvenom popisu danjih leptira Hrvatske: *Lycaena dispar* (NT), *Glaucopsyche alexis* (NT), *Pseudophilotes vicrama* (NT), *Scolitantides orion* (NT), *Phengaris arion* (VU), *Papilio machaon* (NT), *Pieris brassicae* (DD), *Polyommatus thersites* (NT), *Apatura ilia* (NT) i *Heteropterus morpheus* (NT).

Ključne riječi: Lepidoptera, Vugrovec, raznolikost, ugroženost

INTRODUCTION

Zagreb City is the capital and, with an area of 641 km², the largest city in Croatia. It is located in the northwestern part of the country, along the Sava River and on the sou-

thern slopes of Mt. Medvednica, at an elevation of approximately 122 m above sea level. The butterfly fauna of the Zagreb City area and its surroundings has been a subject of interest from the beginning of the 20th century on the part of a great number of researchers (e.g. ABAFY-AIGNER, 1910; GRUND, 1908; 1916, 1918; GUSSICH, 1917; KOČA, 1900, 1901; LORKOVIĆ, 1927, 1989, 1997, 2009; MLADINOV, 1973, 1975; VUKOTINOVIĆ, 1879; ŠTEINER, 1916, 1935). The researchers mostly collected butterflies in localities that were once natural habitats located at the city edge, but are nowadays semi-natural parks like Tuškanac, Cmrok and Maksimir, and also locations on the city edges, like Podsused and Rebro.

The most complete paper dealing with the butterflies of the area was written at the beginning of the 20th century, by one of the most reliable butterfly experts of that time, GRUND (1916), who recorded 117 butterfly species in the Zagreb City. According to the data from the previously mentioned studies, the number of butterflies recorded for Zagreb was over 120, which is an indication of a great diversity (e.g. the recorded number of species on the whole of Mt. Velebit is 137; MIHOVIĆ *et al.*, 2007). However, a few decades later MLADINOV (1973, 1975) published a list of the butterfly specimens in the collection of the Croatian Natural History Museum, from which it can be seen that all the species listed by the previously mentioned authors are not present in the Museum and thus their occurrence in Zagreb cannot be verified. It is also possible that not all the authors had their own entomological collections, or if they did, they were not preserved, or even included in the catalogs (MLADINOV, 1973, 1975).

The fauna of Zagreb has probably changed significantly during the last century, and the changes that occurred in the habitats across and around the city probably had a negative impact on the diversity of butterflies. Without systematic faunistic research and butterfly monitoring such changes in butterfly diversity and population trends cannot be observed. The only thing we can nowadays conclude from the museum specimens is that the species was present somewhere, but we do not know its number, or for how long it survived there. A reason for the changes lies in the urbanization of the city, which led to the disappearance of habitats, especially grasslands within the city limits. From the beginning of the 20th century until the beginning of World War II, the city limits spread towards the west, close to Podsused, towards the east to Dubrava, and to the south, with the river Sava being the city edge (TVRTKOVIĆ, 2010). The natural and semi-natural areas, such as present-day parks like Maksimir and Tuškanac were still kept in more or less natural states and were not threatened (TVRTKOVIĆ, 2010). After World War II, the city expanded, and its western side now included the areas of Podsused and the eastern side included Sesvete. On the north it expanded onto the foothills of Mt. Medvednica, and it spread to the area south of the Sava River (TVRTKOVIĆ, 2010). That was the period of the most intense changes in habitat management, especially of grasslands, which were left ungrazed. Many of such former natural and semi-natural habitats became urbanized, which led to their fragmentation. As the city expanded, previous city edges became urbanized, and many natural habitats, especially grasslands, were lost or greatly changed due to human impact. Once semi-natural parks on the border of the city (e.g. Cmrok, Tuškanac, Maksimir) became modern parks located inside the urban area, with regular monthly mowing. Those localities are nowadays, in the entomological sense, almost butterfly-free zones (KOREN, pers. obs.). Additionally, previous well-surveyed rural areas, like Podsused, are now incorporated in the city itself.

All in all, due to the changes in habitat management one could expect great changes also in butterfly diversity within the city limits. However, it very hard to prove without any recorded data for such changes for the areas that were surveyed in the, to see that

the fauna has changed, one can simply visit any of these sites and see the current situation. For example, places once good for butterflies, like Cmrok, are nowadays extremely unsuitable for them. So it is obvious that the localities in the urban city areas have significantly changed in a way that has had a negative impact on butterfly diversity. More interesting is the question of the butterfly diversity in the rural areas that are currently within the city limits.

The aim of this paper was to present the recent butterfly fauna of the Vugrovec valley, currently a rural area located about 12 kilometers north-east of the city. We hypothesized that the butterfly fauna of the Vugrovec area was similar to the historical fauna of the Podsused area, as well as of other rural areas around Zagreb.

MATERIALS AND METHODS

Study area

The Vugrovec area is characterized by a great diversity of natural habitats and land use. The research area is situated in a valley along the streams and on the slopes of small hills, with different habitats like wet and dry meadows, woodlands and arable land (fields, orchards, and vineyards) located around the Vugrovec village (Fig. 1). It is located only 4 kilometers to the east of Mt. Medvednica. Formerly it was a part of the Medvednica Nature Park, but in the year 2009, the area of the Medvednica Nature Park was reduced, and the Vugrovec area was excluded from it (Твртковић, 2010). This left the habitats in this very interesting area without any legal protection. However, two of the areas around the village (Vejalnica and Krč, Natura2000 code: HR2001298) were proposed for the Natura2000 network in 2013, so it is possible that at least a part of the area will again be legally protected.

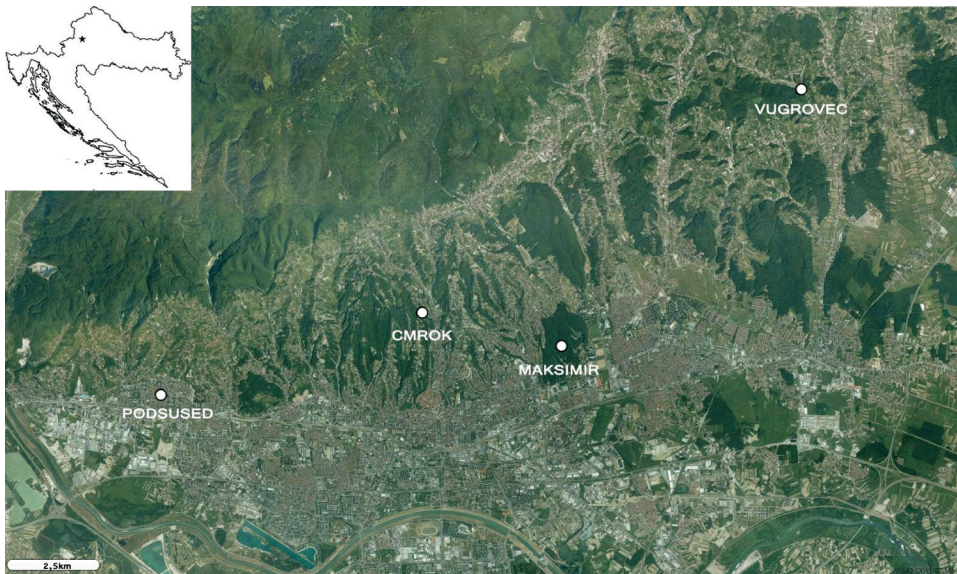


Fig. 1. The map of historically researched localities for butterflies in the Zagreb region and the area of the current survey.

The village itself is now still separated from the main city area, but urbanization is approaching fast and the merging of the village with the city is inevitable in the near future. This will certainly affect the flora and fauna of the area, therefore we consider this work an important document of butterfly diversity, which will be, at least partly, reduced with the continuous expansion of the city.

This research was conducted between March 2009 and September 2010 in the Vugrovec valley. We selected seven localities situated in the valley and on the slopes near the Vugrovec village. The coordinates of the central point of the locations and altitudes of each location are given in Tab. 1. Vegetation types were identified using the "Manual for terrestrial habitat classification according to the EU Habitats Directive" (TOPIĆ & VUKELIĆ, 2009) and the National Habitats Classification (TOPIĆ & VUKELIĆ, 2009; VUKELIĆ *et al.*, 2008) and the list of habitats in Zagreb area (TVRTKOVIĆ *et al.*, 2011).

Description of the selected localities:

(1) Meadows near the stream Vugrovec, downstream of the church in Vugrovec Donji.

The locality is characterized by vegetation consisting of *Bromo-Cynosuretum cristati* (NKS C 2.3.1.1), with small areas of reed (*Phragmites sp.*, NKS A.4.1) and a few willow trees (*Salix sp.*). On the right bank of the stream, hair grass (*Deschampsia caespitosa*) is very abundant, forming characteristic clumps on the meadow. The higher parts of the valley along the right bank of the stream are connected to the edge of the forest and abandoned meadows in which the dominant plant is the dropwort (*Filipendula vulgaris*). The western part of the locality is characterized by an oak and hornbeam forest (*Carpino betuli* – *Quercetum roboris*, NKS E.3.1.1).

(2) Meadows SE of Dološćak, N of Vugrovec Gornji, underneath the Bedenik hill.

The locality is characterized by a mosaic of rural areas under various crops, vineyards, plum and apple orchards, and abandoned dry grasslands. The forest marking the edge of the locality belongs to an oak and hornbeam forest type (*Erythronio* – *Carpinion*) (NKS E.3.1.5). A small intermittent stream is also present in this locality.

(3) Meadow between Dološćak, Žednjak and Bedenik, near the macadam road.

Moderately moist meadow of the *Arrhenatheretum elatioris* association (NKS C.5.1.1), rich with sainfoin (*Onobrychis viciaefolia*) and cow-wheat (*Melampyrum arvense*). No other plants typical for dry grasslands were found. The meadow is regularly mowed once a year.

(4) Southern slopes and the peak of Bedenik hill.

This locality is characterized by abandoned dry meadows on the steep southern slope of the hill. Meadows are not mowed and are in the initial stage of succession into a thicket with thermophilic shrubs. A rare orchid, *Ophrys apifera*, was observed on this site.

(5) Hiking path between the peaks Krč and Bedenik.

Woodlands on the locality belong to the typical Illyrian oak-hornbeam association (*Quercus petraea* and *Carpinus betulus*, NKS E.3.1.5), which is interspersed with the elements of thermophilic oak forests and mixed forests of *Q. petraea* and *Castanea sativa* (NKS E.3.2.1) on the northern slopes. Forest of common beech (*Fagus sylvatica*) is also present on the northern side of the hill.

(6) South slopes and the peak of the Krč hill.

A typical continental dry grassland (*Festuco-Brometalia*, NKS C.3), on a very shallow, marly, dry soil, rich with orchids like *Anacamptis pyramidalis* and *Gymnadenia conopsea*. The most common plants in these habitats are *Globularia sp.* and *Melampyrum barbatum*,

Tab. 1. Localities in the Vugrovec valley – numbers, altitudes and coordinates.

Locality number	Locality name	Locality height*	Locality coordinates**	
			N	E
1.	Meadows near the stream Vugrovec	155 m	45°52'26"	16°6'37"
2.	Meadows SE of Dološčak	244 m	45°53'46"	16°6'7"
3.	Meadow between Dološčak, Žednjak and Bedenik	329 m	45°53'56"	16°5'55"
4.	Southern slopes and the peak of Bedenik Hill	358 m	45°54'3"	16°5'23"
5.	Hiking path between the peaks Krč and Bedenik	360 m	45°54'6"	16°5'26"
6.	Southern slopes and the peak of Krč Hill	379 m	45°54'9"	16°5'2"
7.	Forest path on the hill between the Krč and Bedenik hills	315 m	45°54'3"	16°5'34"

*Mean height. **The coordinates of a locality represent the central point of the location

while *Onobrychis viciaefolia* is very rare. Because the meadows are not mowed, plants from thermophilic forest edges, such as *Geranium sanguineum* are present in great numbers. In some places with deeper soil, *Pteridium aquilinum* is also abundant.

(7) Forest path on the hill between the hills Krč and Bedenik.

The habitat is already in an advanced succession stage from dry grasslands on the acidic soil, with only a few places with characteristic dry grassland plants like *Himantoglossum adriaticum*. Juniper bushes (*Juniperus communis*) (NKS D.1) are very common, as well as other shrubs and trees of the pubescent oak (*Quercus pubescens*) forest (NKS E.3.4.7), like hornbeam (*Ostrya carpinifolia*), wild service tree (*Sorbus torminalis*), flowering ash (*Fraxinus ornus*) and others. *Pteridium aquilinum* is very dense on the ground.

Faunistic survey

A total of 25 field trips were conducted during the entire flight period of butterflies, between March and September, and at each visit all the sites were surveyed. Butterflies were caught with entomological nets and photographed. Only two specimens per species were collected for a butterfly collection of the region which could be used for further research. All the specimens are stored in the private butterfly collection of the first author (Koren, Pazin). The identification of species was done immediately in the field and most of the butterflies were released afterwards.

The collected butterflies were identified according to TOLMAN & LEWINGTON (2008). The butterfly nomenclature follows The European Red List of Butterflies (VAN SWAAY *et al.*, 2010). The position and coordinates (Tab. 1) of the researched localities were obtained using a Garmin eTrex Vista GPS device.

Notes were taken in the field to determine the abundance of species, according to the authors' best judgment. Abundant species, present with more than 15 specimens on at least 5 locations, were characterized as common (C). Less abundant species, present on all or a few locations, but with fewer than 15 observed specimens, were characterized as uncommon (U). Those species of which we found only two or three specimens on a

17.	<i>Pieris rapae</i> (Linnaeus, 1758)	•					•		U
18.	<i>Pieris napi</i> (Linnaeus, 1758)	•			•	•			U
19.	<i>Colias crocea</i> (Geoffroy, 1785)	•	•						R
20.	<i>Colias hyale</i> (Linnaeus, 1758)	•				•			R
21.	<i>Gonepteryx rhamni</i> (Linnaeus, 1758)				•	•			U
RIODINIDAE									
22.	<i>Hamearis lucina</i> (Linnaeus, 1758)	•	•				•		C
LYCAENIDAE									
23.	<i>Lycaena phlaeas</i> (Linnaeus, 1761)	•							R
24.	<i>Lycaena dispar</i> (Haworth, 1802)	•	•						U
25.	<i>Lycaena virgaureae</i> (Linnaeus, 1758)	•							R
26.	<i>Lycaena tityrus</i> (Poda, 1761)	•	•			•			U
27.	<i>Favonius quercus</i> (Linnaeus, 1758)							•	R
28.	<i>Callophrys rubi</i> (Linnaeus, 1758)				•	•		•	•
29.	<i>Satyrrium w-album</i> (Knoch, 1782)		•			•			R
30.	<i>Satyrrium spini</i> (Dennis & Schiffermüller, 1775)		•	•	•	•			C
31.	<i>Satyrrium acaciae</i> (Fabricius, 1787)					•		•	•
32.	<i>Cupido minimus</i> (Fuessly, 1775)		•			•	•	•	C
33.	<i>Cupido argiades</i> (Pallas, 1771)	•	•	•	•			•	C
34.	<i>Cupido decoloratus</i> (Staudinger, 1886)	•	•			•			•
35.	<i>Celastrina argiolus</i> (Linnaeus, 1758)	•	•	•	•	•	•	•	C
36.	<i>Pseudophilotes vicrama</i> (Moore, 1865)		•			•		•	U
37.	<i>Scolitantides orion</i> (Pallas, 1771)					•			R
38.	<i>Glaucopteryx alexis</i> (Poda, 1761)					•			R
39.	<i>Phengaris arion</i> (Linnaeus, 1758)		•						R
40.	<i>Plebejus argus</i> (Linnaeus, 1758)	•	•			•			C
41.	<i>Plebejus idas</i> (Linnaeus, 1761)		•					•	U
42.	<i>Plebejus argyrognomon</i> (Bergsträsser, 1779)	•			•	•	•		C
43.	<i>Aricia agestis</i> (Dennis & Schiffermüller, 1775)	•	•					•	U
44.	<i>Cyaniris semiargus</i> (Rottemburg, 1775)					•			R
45.	<i>Polyommatus amandus</i> (Schneider, 1792)		•						R
46.	<i>Polyommatus thersites</i> (Cantener, 1835)	•	•						U
47.	<i>Polyommatus icarus</i> (Rottemburg, 1775)	•	•			•			•
48.	<i>Polyommatus daphnis</i> (Dennis & S., 1775)	•	•	•	•			•	•
NYMPHALIDAE									
49.	<i>Argynnis paphia</i> (Linnaeus, 1758)	•	•						C
50.	<i>Argynnis pandora</i> (Dennis & Schiffermüller, 1775)				•				R
51.	<i>Argynnis adippe</i> (Dennis & Schiffermüller, 1775)				•	•		•	U
52.	<i>Brenthis ino</i> (Rottemburg, 1775)	•							R
53.	<i>Brenthis daphne</i> (Bergsträsser, 1780)	•	•				•		C

54.	<i>Brenthis hecate</i> (Dennis & Schiffermüller, 1775)	•		•	•				C
55.	<i>Issoria lathonia</i> (Linnaeus, 1758)	•							R
56.	<i>Boloria dia</i> (Linnaeus, 1767)	•	•	•	•	•	•	•	C
57.	<i>Vanessa atalanta</i> (Linnaeus, 1758)		•						R
58.	<i>Vanessa cardui</i> (Linnaeus, 1758)	•	•	•	•	•	•	•	C
59.	<i>Inachis io</i> (Linnaeus, 1758)	•	•	•	•	•			U
60.	<i>Polygonia c-album</i> (Linnaeus, 1758)		•	•	•				U
61.	<i>Araschnia levana</i> (Linnaeus, 1758)	•	•		•				U
62.	<i>Nymphalis antiopa</i> (Linnaeus, 1758)	•							R
63.	<i>Nymphalis polychloros</i> (Linnaeus, 1758)		•						R
64.	<i>Melitaea cinxia</i> (Linnaeus, 1758)		•		•	•			C
65.	<i>Melitaea phoebe</i> (Dennis & S., 1775)	•			•		•		C
66.	<i>Melitaea trivialis</i> (Dennis & Schiffermüller, 1775)	•							R
67.	<i>Melitaea didyma</i> (Esper, 1778)	•			•		•		U
68.	<i>Melitaea diamina</i> (Lang, 1789)	•							R
69.	<i>Melitaea athalia</i> (Rottemburg, 1775)	•	•		•		•	•	C
70.	<i>Melitaea britomartis</i> Assman, 1874	•							R
71.	<i>Melitaea ornata</i> Christoph, 1893	•							R
72.	<i>Limenitis camilla</i> (Linnaeus, 1764)					•		•	R
73.	<i>Limenitis reducta</i> Staudinger, 1901	•	•	•		•		•	C
74.	<i>Neptis sappho</i> (Pallas, 1771)	•		•	•	•		•	C
75.	<i>Apatura ilia</i> (Dennis & Schiffermüller, 1775)		•						R
76.	<i>Pararge aegeria</i> (Linnaeus, 1758)	•	•	•				•	C
77.	<i>Lasiommata megera</i> (Linnaeus, 1767)		•		•		•		U
78.	<i>Lasiommata maera</i> (Linnaeus, 1758)		•	•	•				U
79.	<i>Coenonympha arcania</i> (Linnaeus, 1761)	•		•	•		•	•	C
80.	<i>Coenonympha glycerion</i> (Borkhausen, 1788)	•							U
81.	<i>Coenonympha pamphilus</i> (Linnaeus, 1758)	•	•	•	•				C
82.	<i>Pyronia tithonus</i> (Linnaeus, 1767)		•			•	•		U
83.	<i>Aphantopus hyperantus</i> (Linnaeus, 1758)	•	•	•		•		•	C
84.	<i>Maniola jurtina</i> (Linnaeus, 1758)	•	•	•	•	•	•	•	C
85.	<i>Melanargia galathea</i> (Linnaeus, 1758)	•	•	•	•	•	•	•	C
86.	<i>Minois dryas</i> (Scopoli, 1763)	•	•	•	•		•	•	C
87.	<i>Hipparchia fagi</i> (Scopoli, 1763)		•		•	•	•	•	C
88.	<i>Brintesia circe</i> (Fabricius, 1775)	•			•	•	•	•	C
Total number of species per locality:		57	58	30	51	29	28	31	

*Presence of species in a locality is marked with •. Localities are: 1. Meadows near the stream Vugrovec, 2. Meadows SE of Dološćak, 3. Meadow between Dološćak, Žednjak and Bedenik, 4. Southern slopes and peak of the Bedenik hill, 5. Hiking path Krč – Bedenik, 6. Southern slopes and the peak of the Krč hill, 7. Forest path on the hill between the hills Krč and Bedenik.

**Commonness/rareness for each species was determined by the number of the observed specimens during the research period, regardless of the locality. C – common species; U – uncommon species, R – rare species.

stream Vugrovec. *Pyrgus armoricanus* (Oberthür, 1910) was recorded only in the village of Vugrovec, in a rural landscape and on agricultural land. The record of *M. trivialis*, a typical dry grassland species on a wet meadow, indicates the possibility that it came from some nearby location. The record of only one specimen of this species further strengthens this statement.

The comparison between historical records from Podsused, Cmrok and Maksimir with new records from Vugrovec using the Sørensen index (SÖRENSEN, 1948) showed that the most similar area to Vugrovec is Podsused, with 74% similarity, followed by Maksimir with 65% and Cmrok with 58%.

DISCUSSION

Out of 88 species recorded in Vugrovec, ten are listed in the Red Data List of Croatian Butterflies (ŠAŠIĆ *et al.*, 2013): *Lycæna dispar* (Haworth, 1802) (NT), *Glaucopsyche alexis* (Poda, 1761) (NT), *Pseudophilotes vicrama* (Moore, 1865) (NT), *Scolitantides orion* (Pallas, 1771) (NT), *Phengaris arion* (Linnaeus, 1758) (VU), *Papilio machaon* Linnaeus, 1758 (NT), *Pieris brassicae* (Linnaeus, 1758) (DD), *Polyommatus thersites* (Cantener, 1835) (NT), *Apatura ilia* (Denis & Schiffermüller, 1775) (NT), and *Heteropterus morpheus* (Pallas, 1771) (NT). Additionally, *L. dispar* is also listed in Annex II and Annex IV of the Habitats Directive (ANON., 1992) and in Appendix II of the Bern Convention (ANON., 1996). It was found in two localities with moist meadows and dense grassy vegetation close to the forest edge in moderate numbers. This type of habitat is becoming increasingly rare in Vugrovec due to the ongoing succession of old pastures toward bushy meadows and forests. Only the meadows near the Vugrovec stream maintain their semi-natural form, due to the regular annual mowing. *S. orion* and *G. alexis* were found only once during our surveys, both on the old pasture which has now being transformed into an orchard. This habitat is located between several houses in the village, and regular mowing of overgrown grass, along with a moderate amount of its larva host plant, *Sedum* sp. in the locality ensures its survival. *P. vicrama* prefers drier habitats and was found in three locations, most abundantly on the small hill called Bedenik. *P. arion* is considered a threatened species in Europe and is listed in Annex IV of the Habitats Directive (ANON., 1992) and in Appendix II of the Bern Convention (ANON., 1996). It was found only in one locality, on the meadows SE of Dološćak, in small numbers. Another faunistically interesting record is that of *H. morpheus*, which is listed as near-threatened (NT) in the Red Data List of Croatian Butterflies (ŠAŠIĆ *et al.*, 2013). Although the species is considered hygrophilous, it seems that it is not so specialized and can be considered moderately common in the Vugrovec area.

Some butterfly species in Vugrovec are connected to a specific habitat, for example, *L. dispar* and *B. ino* are present only in the first two locations on the meadows of the *Bromo-Cynosuretum cristati* (NKS C 2.3.1.1) association. The willows along the small stream in these two locations were also the only habitat for *A. ilia* in Vugrovec. Dry grassland-habitat specialists like *P. vicrama* and *Brenthis daphne* (Bergsträsser, 1780) were also present in the meadows south-east of Dološćak but had a much greater abundance on the dry slopes of the Krč hill. Strangely, *Carcharodus alceae* (Esper, 1780), *Polyommatus amandus* (Schneider, 1792) and *Nymphalis polychloros* (Linnaeus, 1758) were recorded only in cultivated meadows in the rural area of the village, which indicates that those regularly mowed, semi-natural habitats are also important for butterfly diversity.

Although some habitat types are becoming scarcer, mostly due to abandonment and overgrowing, there are still enough suitable habitats present to enable the survival of

most of the recorded species in Vugrovec. Unfortunately, even in this short two year period many changes were observed. Some new houses were built and a part of the forest was cleared to build new roads close to the village. The whole area is now much more urbanized, and further expansions of the village and the Zagreb city are expected. Also, it is only a matter of time when the moist meadows in the southern part of the village will be converted to arable land. With such a great species diversity Vugrovec and its surroundings should be considered as one of the last oases for some butterfly species in Zagreb, and therefore need to be preserved.

During this survey we recorded *B. ino* (KOREN & ZADRAVEC, 2010) in the Vugrovec, which is the first record of this species for the surroundings of Zagreb, another indication of the importance of this valley. One more interesting record in Vugrovec is that of *Melitaea ornata* Christoph, 1893 which is a newly recorded species for the fauna of Croatia (KOREN & ŠTIH, 2013).

With 74% similarity in the butterfly fauna, Podsused is the most similar to Vugrovec valley. The difference in 26% similarity can be explained in three ways. First, the data about the butterflies of Podsused were collected during a long period of time, almost a century, and in that time Podsused developed from the natural habitats on the city edge to into a part of the city itself, while Vugrovec was surveyed for only two years. The second reason may be in the general loss of biodiversity, which is obvious also in all of Croatia, for species such as *Colias myrmidone* (Esper, 1781) or *Nymphalis vaualbum* (Denis & Schiffermuller 1775), which disappeared from many sites where they were previously known (МИНОСИ *et al.*, 2012). Also, the differences between the habitats types and characteristics of Podsused and Vugrovec could have caused, or contributed to, the differences in butterfly fauna.

However, we did not record as many as the 43 species that were recorded by previous researchers in Zagreb. The lack of records for those species in Vugrovec could mean that they indeed have disappeared from the Zagreb City area, especially if we have in mind that the habitats in Vugrovec are much more preserved compared to all of the historical locations now within the city of Zagreb. However, Vugrovec cannot fully represent a surrogate area for the whole Zagreb City, especially due to the variability of habitats around the city, a number of which are not present in the Vugrovec area. So it is possible that some butterfly species recorded previously in Zagreb, and not currently in Vugrovec, could still be present somewhere in the Zagreb City area. The most probable location could be Mt. Medvednica, but even there succession is very noticeable and a lot of the former meadows are now overgrown with bushes or forests. However, without additional systematic surveys of the remains of the habitats in some of the historically researched sites, no decisive conclusions can be drawn.

CONCLUSIONS

Vugrovec, located at the outer border of Zagreb, represents a mixture of many different habitats, with a moderate anthropogenic impact, but still with enough conserved natural habitats to sustain a high butterfly diversity. In some ways it represents the former stage of other parts of the city (like Podsused, Maksimir, Cmrok) that were once systematically visited by entomologists. Some of the sites, like Maksimir and Cmrok, are nowadays city parks and almost completely changed due to the city's expansion and modern park management practices. With the recent knowledge about butterflies in the region, and with many protected and Natura 2000 species, as well as with the two Natura 2000 suggested areas, the Vugrovec valley might represent an ideal locality for future butterfly monitoring.

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SAŽETAK

Fauna danjih leptira (Hesperoidea & Papilionoidea) ruralnog dijela grada Zagreba, Hrvatska

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Istraživanje faune leptira Zagreba počelo je krajem 19. stoljeća te se intenzivno nastavilo sve do prve četvrtine 20. stoljeća (VUKOTINović, 1879; KOČA, 1900, 1901; GRUND, 1908, 1916; GUSSICH, 1917). Nakon toga perioda, može se reći da gotovo i nije bilo sustavnih istraživanja faune danjih leptira Zagreba, osim obrada postojećih zbirki (MLADINOV, 1973; 1975) i pojedinačnih priloga fauni leptira Zagreba (LORKOVIĆ, 1997). Ovim istraživanjem obuhvaćeno je sedam lokacija smještenih u bliskoj okolici sela Vugrovec koje se nalazi na vanjskom, sjevernom rubu područja grada Zagreba, ispod istočnih padina Medvednice. Faunističko istraživanje je trajalo od ožujka 2009. do rujna 2010. godine, prilikom čega je zabilježeno ukupno 88 vrsta, odnosno 45% faune danjih leptira Hrvatske. Deset vrsta leptira se smatra ugroženima te su navedene na Crvenom popisu danjih leptira Hrvatske (ŠAŠIĆ et al., 2013): *Lycaena dispar* (NT), *Glaucopsyche alexis* (NT), *Pseudophilotes vicrama* (NT), *Scolitantides orion* (NT), *Phengaris arion* (VU), *Papilio machaon* (NT), *Pieris brassicae* (DD), *Polyommatus thersites* (NT), *Apatura ilia* (NT) i *Heteropterus morpheus* (NT). Sa svojim raznolikim staništima Vugrovec je još uvijek ruralno područje koje spada u administrativno područje grada Zagreba i na taj način ga se može pojmiti kao svojevrsni surogat nekadašnjih takvih područja (poput Podsuseda) koja su danas skoro u potpunosti urbanizirana i čine sastavni dio grada Zagreba.