J. Entomol. Res. Soc., 23(1): 27-40, 2021 *Research Article*
Doi: 10.51963/jers.v23i1.1955 *Online ISSN:2651-3579*

First Insights into the Springtime Butterfly (Rhopalocera) Fauna of Podgorica (Montenegro, Balkan Peninsula)

Sylwia Katarzyna PIETRZAK

Department of Invertebrate Zoology and Hydrobiology,
University of Łódź, Banacha 12/16, 90-237 Łódź, POLAND
e-mail: sylwia.pietrzak@edu.uni.lodz.pl
ORCID ID: 0000-0003-2648-6486

ABSTRACT

The work shows the results of research on butterfly species richness, which took place in Podgorica (Montenegro) between April and June of 2017. The material was gathered on 14 sites located within the city borders. Observations confirmed the presence of 48 species of butterflies representing 5 families: Hesperidae (5 species), Papilionidae (3 species), Pieridae (9 species), Lycaenidae (13 species) and Nymphalidae (18 species). The most common species were I*philcides podalirius*, *Papilio machaon*, *Colias croceus*, *Coenonympha pamphilus*, *Polyommatus icarus* and *Aricia agestis*. Results are discussed on a background of two species lists from other urban areas of Balkan Penisula (Zagreb and Patras) as well as a diversity of the butterfly fauna of Montenegro. It is the first analysis of the butterfly fauna of Podgorica city.

Key words: Lepidoptera, urban fauna, urban entomology, species richness, butterfly survey.

Pietrzak, S.K. (2021). First insights into the springtime butterfly (Rhopalocera) fauna of Podgorica (Montenegro, Balkan Peninsula). *Journal of the Entomological Research Society*, 23(1), 27-40.

INTRODUCTION

Urbanisation is amongst the most important reasons of biodiversity loss. Constant expansion of urban infrastructure onto natural ecosystems makes it one of the key problems of today's environmental protection (McKinney, 2002; McKinney, 2006; Clark, Reed, & Chew, 2007). Impermeable urban spaces reduce the amount of water reaching the soil, affecting the composition and distribution of plant communities. Local fauna is dependent on a mosaic fragmented landscapes created by small patches of vegetation and spaces covered with buildings, streets and pavements (McKinney, 2002; Alberti, 2005). Cities host a very specific set of species. Plant and animal communities are often simplified and dominated by synanthropic organisms, show lower diversity than natural areas and also are vulnerable to disturbances or influence of invasive species (Rebele, 1994; Alberti, 2005). Urban fauna is also characterized by high similarity, even between very distant cities (McKinney, 2006). Therefore, comprehensive biodiversity inventories are an indispensable element of current studies. Recognition of faunal communities might be a good base for further ecological studies as well as research focused on long term changes in species composition and distribution patterns (Pollard, 1977; Blair, 1999; McKinney 2007, Rochat, Manel, Deschamps-Cottin, Widmer & Joost, 2017; Lang, Dixon, Klaver,Thompson & Widrlechner, 2019; Aguilera, Ekroos, Persson, Petersson & Öckinger, 2019).

Butterflies are considered good indicators of changes associated with urbanization gradients and are frequently studied in cities all over the world (Blair & Launer, 1997; Thomas, 2005; Bergerot, Fontaine, Julliard, & Baguette, 2011; Konvicka & Kadlec, 2011; Dallimer et al, 2012; Koren, Zadravec, Ńtih, & Hlavati, 2013; Matsumoto, 2015; Ramírez-Restrepo & Macgregor-Fors, 2017; Rochat et al, 2017; Sobczyk, Pabis, Wieczorek, & Salamacha, 2017; Luppi, Dondina, Orioli, & Bani, 2018; Lang et al, 2019; Tzortzakaki, Kati, Panitsa, Tzanatos, & Giokas, 2019). At the same time our current knowledge on the butterfly fauna of larger cities on the Balkan Peninsula is poor. This area is situated in the Mediterranean sea basin - one of the 25 global biodiversity hotspots (Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000). Moreover the Balkan is an area with the highest level of endemism in Europe (Krystufek & Reed, 2004), what makes it more than appropriate to observe human influence on biodiversity.

The urbanisation level of Monetenegro is above 60%, which means that more than half of population lives in the cities. Podgorica is inhabited by about 30% of citizens of Montenegro and is the largest city in this country. The latest checklist of Montenegrian butterflies comprises 192 species (Franeta, 2018). Butterflies of Montenegro have mostly been investigated in larger natural ecosystems or protected areas like the Durmitor National Park, while the rest of the country is still poorly described in terms of butterfly diversity (Nicholl, 1899; Nicholl, 1902; Gibbs, 1913; Rebel, 1913; Sijarić 1984; Sijarić, Lorković, Carnelutti, & Jakšić, 1984; Koçak, 1989; Jakšić & Ristić, 1999; Radović et al, 2008; Švara, Zakńek, & Verovnik, 2015; Sobczyk & Gligorović, 2016). None of the studies was focused strictly on the urban areas (Franeta, 2018), although the region neighbouring to Podgorica was recently studied by Švara et al (2015) as well as Sobczyk & Gligorović (2016).

The aim of this study was to analyse the species richness of butterflies in Podgorica. It is the first study of the butterfly fauna of this city.

MATERIAL AND METHODS

Study area

Podgorica is the capital of Montenegro and is situated on the Zeta river plateau and surrounded by Kučke and Piperske mountain chains (Stešević, Caković, & Jovanović, 2014). The city consists of three basic districts: Novi Grad, Nova Varos, and Stara Varos, which are naturally separated by two rivers - Morača and Ribicnia (Stešević et al, 2014; Vujadinović, 2016). Podgorica is a developing city, where plenty of green space can be found, especially in the newest district Novi Grad, where green belts are distributed along most of the streets (Vujadinović, 2016). It is also worth to point out a special value of migration corridors for fauna along river banks as well as the presence of interesting xerothermic sites located on hills like Gorica or Malo Brdo. Podgorica is not a metropolitan type of city, thus it is difficult to draw strict borders delimiting urbanization zones. The most densely inhabited space can be found in the Stara Varos and the adjacent part of Nova Varos, while the rest of the residental areas are characterised by more dispersed buildings. The area surrounding the residential areas is used for industry and agriculture.

Data were collected on 14 sites (Fig. 1). Sites were chosen to represent different types of habitats. Investigated areas can be described as a mosaic of ruderal vegetation, parks, forests, meadows, hills, bushes, wastelands, crop fields and pastures. Specific characteristics of each site are given in Table 1.

Field studies

Data about the butterfly fauna of Podgorica were collected between April 15th and 30th of June 2017. Sites 1 - 8 were investigated 8 to 12 times during the whole observation period. The Mareza (site 9) was visited five times and sites 10-14 were visited only once (Table 1). Observations were qualitative and were carried out between 9 am - 6 pm under appropriate weather conditions: no rain, no strong wind, preferable sunny or mostly sunny days (Van Swaay, Brereton, Kirkland, & Warren, 2012). Time spent on particular site depended on its size. Four size classes were distinguished: small (up to 2 ha), medium (2-6 ha) and large (above 10 ha) sites. Butterflies were identified alive and photographed either, in natural conditions or after capture with an entomological net.

Data analysis

Analysis of ecological attributes of all recorded species was done based on the literature data (Sielezniev & Dziekańska, 2010; Tolman & Lewington, 1997) according to the method proposed by Shreeve, Dennis, Roy, & Moss (2001). Bray-Curtis similarity index was used to analyse ecological similarity of species.

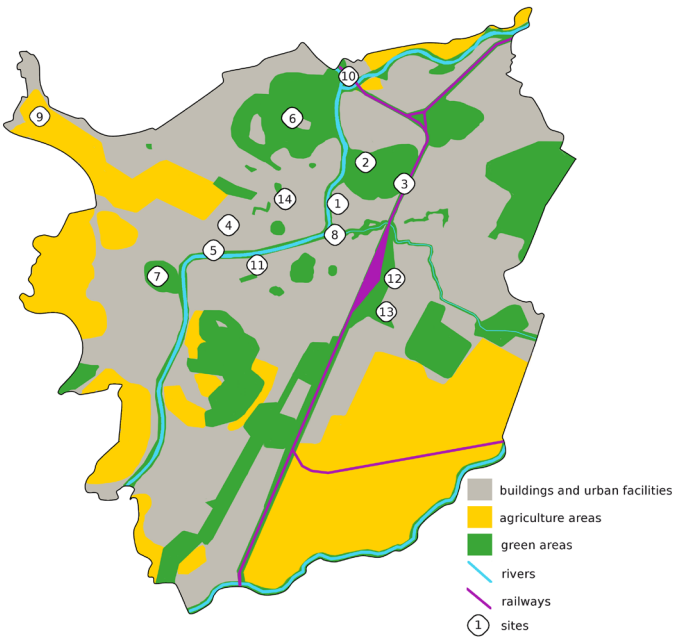

Fig. 1. Map of Podgorica with sites distribution on simplified image of landscape usage according to Stešević et al (2014).

Table 1. Location and description of observation sites.

No.	Observation site	Co-ordinates	Approximate site area [ha]	Size class	Number of visits	Habitat types
1	Milenium Bridge	42.446228, 19.260141	1,9	Small	10	Ruderal, Wasteland, Bushes
2	Park Šuma Gorica N-W	42.450784, 19.264975	3,9	Medium	11	Park, Meadow, Forest, Hill, Bushes
3	Park Šuma Gorica S-E	42.447554, 19.278419	4,5	Medium	9	Meadow, Hill, Bushes
4	Wasteland next to University of Montenegro	42.441740, 19.239559	3,0	Medium	12	Ruderal, Wasteland, Bushes
5	Wasteland next to Delta city mall	42.434825, 19.236777	0,5	Small	8	Wasteland, Meadow, Bushes
6	Malo Brdo	42.457750, 19.252788	8,7	Large	10	Hill, Meadow, Bushes, Pasture
7	Gorica Hill	42.428867, 19.221493	6,6	Large	9	Hill, Meadow, Bushes, Pasture
8	Old Bridge on Ribicnia River	42.439336, 19.258913	0,8	small	10	Ruderal, Park
9	Mareza	42.460069, 19.189503	39,2	Vast	6	Meadow, Pasture, Bushes, Agricultural landscape
10	Zeta and Moraca connection point	42.466689, 19.264685	4,9	Medium	2	Meadow, Bushes
11	Park Šuma Ljubović	42.431158, 19.254193	3,6	Medium	1	Park, Hill, Forest
12	Wasteland next to railway station	42.432230, 19.271820	11,2	Vast	1	Ruderal, Wasteland, Meadow
13	Stari Aeodrom district next to Tuški put	42.423857, 19.269952	2,5	Medium	1	Wasteland, Forest
14	Momišići	42.447793, 19.255759	3,1	Medium	1	Hill, Ruderal

The matrix for similarity comparison consisted of the following attributes: wing span (small: up to 3 cm; medium: 3 - 4 cm; big: above 4 cm), host plants used by caterpillars (polyphagous, oligophagous, monophagous), type of host plant used by caterpillars (grasses, herbs, shrubs, trees), dispersal potential (good disperser, poor disperser), myrmecophily (myrmecophilous, non myrmecophilous), habitat preference (rocky, ruderal, dry, humid, open, forest), overwintering stadium (egg, caterpillar, pupa, imago). Hierarchical agglomerative clustering and group average grouping method was used (Shreeve et al, 2001; Clarke, Gorley, Somerfield, & Warwick, 2014).

The analysis was performed in Primer 5.0 (Clarke et al., 2014).

RESULTS

Altogether 48 species of butterflies were observed from five different families: Nymphalidae (18 species), Lycaenidae (13 species), Pieridae (9 species), Hesperiidae (5 species), Papilionidae (3 species) (Table 2). The most common species were: *Iphilcides podalirius*, *Papilio machaon*, *Colias croceus*, *Coenonympha pamphilus*, *Polyommatus icarus* and *Aricia agestis*. They were recorded on all or almost all sites.

Seven species (*Zerynthia polyxena*, *Cupido decolorata*, *Lysandra bellargus*, *Plebejus argus*, *Cyaniris semiargus*, *Hipparchia volgensis* and *Euphydryas aurinia*) were found on only one of the investigated sites.

The highest total number of species was found on hill Malo Brdo (30 species), and the lowest number of species was recorded next to the Old Bridge on Ribicnia River (14 species). On average 7 species were observed during a single visit, the lowest number being 4 species per visit (Old Bridge on Ribicnia River, Wasteland next to Delta city mall) and the highest 10 species per visit (Malo Brdo, Mareza). Distribution of each species is given in Table 2.

All butterflies found in Podgorica have been assigned to Least Concern (LC) category on the Red List of Mediterranean Butterfly Species (Numa et al, 2016).

The Bray-Curtis similarity analysis distinguished five ecological groups of species (Fig. 2). For 1 - 4 groups, the similarity is 50% or higher and for group 5 is 38%. Group 1 includes mostly migratory (good dispersers) oligophagus species feeding on grasses. Group 2 consists of mostly large body size butterflies feeding on herbs or grasses. Group 3 is mainly comprised of small myrmecophilous species. Butterfly species in group 4 have an average body size, feed on herbs and prefer dry and open habitats. Group 5 consists of polyphagous species which are good dispersers. The full ecological characteristics of particular clusters are described in Table 3.

DISCUSSION

This study was a first attempt to describe the butterfly fauna of Podgorica by using monitoring scheme. The butterfly fauna of Podgorica is rich in species. Despite the relatively short study period (from April to the end of June) about 25 % of all Montenegrian butterflies were found in the city (Franeta, 2018). Some of the species

like *Celastrina argiolus* and *Antocharis cardamines* might not have been recorded only due to their early spring activity. Two species of *Hipparchia* were observed, but only one (*Hipparchia fagi*) was captured. The other species was only observed from a distance because of its flickering flight. It has been assumed to be *Hipparchia volgensis* because its sister species *Hipparchia semele* has not been recorded in Montenegro (Franeta, 2018). Previous studies have not provided records from urban parts of Podgorica, but do give information from the river valleys not far away from the city (Švara et al, 2015; Sobczyk & Gligorović, 2016). Švara et al. (2015) studied tree sites located in the river valley of Cijevna within 8 - 16 km distance to of the city center, from where 36 species of butterflies were recorded (Table 4). Twenty one of those species were found also in presented study (Table 4). Sobczyk & Gligorović (2016) also studied areas located in close proximity to Podgorica. Two sites from their study were situated very close to the sites presented in this study. Cypress forest site was set about 5 km from a centre of Nova Varos next to sites 12 and site 13. For Cypress forest site Sobczyk & Gligorović (2016) have noted 4 species: *Aricia agestis*, *Polyommatus icarus*, *Coenonympha pamphilus* and *Vanessa cardui*, while during presented observations on sites 12 and 13 - seven species were recorded (Table 2).

Table 2. List of species with occurence on investigated sites.

Family	No.	Species	Present on sites:
Hesperiidae	1	*Carcharodus alceae* (Esper, [1780])	1, 4, 6
	2	*Ochlodes sylvanus* (Esper, 1777)	3, 6
	3	*Spialia orbifer* (Hübner, [1823])	4, 5, 7
	4	*Thymelicus acteon* (Rottemburg, 1775)	3, 6, 7
	5	*Thymelicus silvestris* (Poda, 1761)	2, 6, 7
Papilionidae	6	*Iphilcides podalirius* (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 7, 8, 9
	7	*Papilio machaon* Linnaeus, 1758	1, 2, 3, 4, 5, 6, 7, (8), 9, 11, 14
	8	*Zerynthia polyxena* ([Denis & Schiffermüller], 1775)	9
Pieridae	9	*Colias croceus* (Fourcroy, 1785)	1, 2, 3, 4, 5, 6, 7, (8), 9, 10
	10	*Euchloe ausonia* (Hübner, [1804])	1, 2, 3, 4, 6, 7, 10, 12
	11	*Gonopteryx rhamni* (Linnaeus, 1758)	3, 6, 9
	12	*Leptidea sp.*	3, 5, 6, 9
	13	*Pieris brassicae* (Linnaeus, 1758)	6, 7, 8
	14	*Pieris ergane* (Geyer, [1828])	2, 3, 6, 7
	15	*Pieris napi* (Linnaeus, 1758)	1, 8, 9
	16	*Pieris rapae* (Linnaeus, 1758)	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14
	17	*Pontia edusa* (Fabricius, 1777)	3, 4
Lycaenidae	18	*Aricia agestis* ([Denis & Schiffermüller], 1775)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14
	19	*Celastrina argiolus* (Linnaeus, 1758)	3, 7
	20	*Cupido argiades* (Pallas, 1771)	1, 2, 5, 9
	21	*Cupido decolorata* (Staudinger, 1886)	1
	22	*Glaucopsyche alexis* (Poda, 1761)	1, 2, 3, 4, 5, 9, 10, 11, 12, 13
	23	*Lycaena phlaeas* (Linnaeus, 1761)	1, 2, 3, (8)
	24	*Lysandra bellargus* (Rottemburg, 1775)	2
	25	*Plebejus argus* (Linnaeus, 1758)	9
	26	*Polyommatus icarus* (Rottemburg, 1775)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14
	27	*Cyaniris semiargus* (Rottemburg, 1775)	5
	28	*Polyommatus thersites* (Cantener, 1835)	2, 6, 9
	29	*Pseudophilotes vicrama* (Moore, 1865)	2, 3, 6, 13
	30	*Satyrium spini* ([Denis & Schiffermüller], 1775)	3, 5, 6, 7

Family	No.	Species	Present on sites:
Nymphalidae	31	*Coenonympha pamphilus* (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13
	32	*Euphydryas aurinia* (Rottemburg, 1775)	3
	33	*Hipparchia fagi* (Scopoli, 1763)	2, 3
	34	*Hipparchia volgensis* (Mazochin-Porshnjakov, 1952)	6
	35	*Aglais io* (Linnaeus, 1758)	2, 9
	36	*Issoria lathonia* (Linnaeus, 1758)	2, 4, 6
	37	*Lasiommata maera* (Linnaeus, 1758)	1, 2, 6, 7, 8
	38	*Lasiommata megera* (Linnaeus, 1767)	1, 2, 3, 6, 7
	39	*Limenitis reducta* Staudinger, 1901	3, 6, 14
	40	*Libythea celtis* (Laicharting, 1782)	8, 9
	41	*Maniola jurtina* (Linnaeus, 1758)	1, 2, 3, 5, 6, 7, 9
	42	*Melanargia larissa* (Geyer, 1828)	2, 3, 6, 7
	43	*Melithaea didyma* (Esper, 1778)	1, 3, 4, 5, 6, 7, 9
	44	*Melithaea phoebe* ([Denis & Schiffermüller], 1775)	2, 3, 4, 6, 7, 9
	45	*Pararge aegeria* (Linnaeus, 1758)	1, 8, 14
	46	*Polygonia egea* (Cramer, 1775)	1, 6
	47	*Vanessa atalanta* (Linnaeus, 1758)	2, 6, (8)
	48	*Vanessa cardui* (Linnaeus, 1758)	2, 3, 4, 6, 7

Table 3. Species composition and characteristic features of particulary ecological groups obtained with Bray-Curtis similarity analysis.

<table>
<tr><th>No. of similarity group</th><th>Species composition</th><th colspan="2">Characteristic features for group</th></tr>
<tr><td>1</td><td>Colias croceus
Lasiommata megera
Thymelicus acteon
Maniola jurtina
Vanessa atalanta
Polygonia egea
Hipparchia volgensis
Melanargia larissa
Iphilcides podalirius
Papilio machaon</td><td colspan="2">Mostly large body size, Herbal or grass host plant for caterpillar</td></tr>
<tr><td>2</td><td>Cupido decolorata
Cupido argiades
Polyommatus icarus
Pseudophilotes vicrama
Lysandra bellargus
Polyommates thersites
Coenonympha pamphilus
Carcharodus alaceae
Lycaena phlaeas
Cyaniris semiargus Glaucopsyche alexis
Spialia orbifer</td><td colspan="2">Small body size,
Myrmecophilus (in case of Lycenidae)
Poor dispersers
Dry, open and rocky habitats
Overwintering as caterpillars</td></tr>
<tr><td>3</td><td>Leptidea sp.
Pieris ergane
Euchloe ausonia
Pontia edusa
Pieris napi
Pieris rapae
Melithaea phoebe
Euphydryas aurinia
Melithaea didyma
Aricia agestis
Issoria lathonia</td><td colspan="2">Average body size
Herbal host plant for caterpillar
Dry, open and ruderal habitats</td></tr>
<tr><td rowspan="2">4</td><td>Ochlodes sylvanus
Thymelicus silvestris
Hipparchia fagi
Lasiommata maera</td><td rowspan="2">Oligophagus, mostly good dispersers,
grass host plant for caterpillar,
overwintering as caterpillars</td><td>Open habitats</td></tr>
<tr><td>Limenitis reducta
Pararge aegeria</td><td>Moist habitat</td></tr>
<tr><td rowspan="2">5</td><td>Plebejus argus
Celastrina argiolus
Satyrium spini</td><td rowspan="2">Good dispersers
Polyphagus caterpillar
Open and woody habitats</td><td>Small, myrmecophilus</td></tr>
<tr><td>Zerynthia polyxena
Gonopteryx rhamni
Pieris brassicae
Aglais io
Vanessa cardui</td><td>Large</td></tr>
</table>

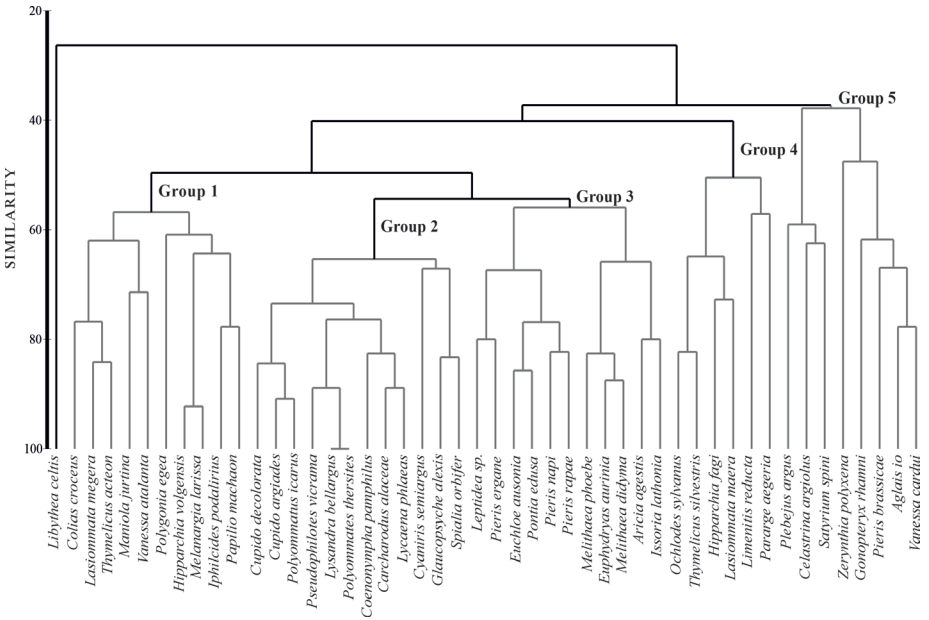

Fig. 2 Dendrogram

The site Mareza was established by Sobczyk & Glogorovic (2016) in 6 km distance from Novi Grad and can be described as contiguous (and possibly overlapping at some point) to site 9 of the present study (Mareza). Sobczyk & Gligorović (2016) listed 10 species on this site and only *Nymphalis polychloros* was not recorded in Podgorica during present observations. Complete list of species from Zeta-Skadar Plain provided by Sobczyk & Gligorović (2016) consists of 76 species and almost half of them (37 species) was confirmed in Podgorica urban area (Table 4). A comparison of the species composition between Podgorica and areas located outside the city (Švara et al, 2015; Sobczyk & Gligorović, 2016) demonstrate that those areas can be treated as a potential species pools for urban populations.

There is a lack of studies of the butterfly fauna from other cities located on the Balkan Peninsula. Koren et al (2013) studied the butterfly fauna of a small village located in the vicinity of Zagreb. Zagreb is situated on higher altitude (122 m a.s.l) than Podgorica (44 m a.s.l.) and despite covering only a half of area of Podgorica, it has four times more inhabitants. Studies lasted two full seasons, which resulted in a list of 88 species (Koren et al, 2013) including 37 species that were recorded also in Podgorica (Table 5). *Glaucopsyche alexis* was described as rare in Vugrovec, but in Podgorica, according to the definition given by Koren et al (2013) this species would be treated as uncommon - it is present on a few sites, but there were no more than 15 specimens observed. *Pseudophilotes vicrama* was given the status uncommon in Vugrovec and such a status could be also applied to this species in Podgorica. In 2019 a study of butterfly fauna of Patras (coastal Greece) was also carried out (Tzortzakaki et al, 2019). Patras is located in about 500 km distance from Podgorica.

The list of species observed in this city gives a good reference for comparison with the butterfly fauna of Podgorica, especially since both studies were carried out at a similar time of the year, from April to June (2015 - Patras, 2017 - Podgorica). Forty one species of butterflies were noted in Patras (Tzortzakaki et al, 2019), including 29 species common for both cities (Table 5). A comparison of the butterfly fauna of Zagreb, Patras and Podgorica demonstrates that there is a group of species that are most probably typical for various urban areas on the Balkan Peninsula. For these three particular urban areas, there were 25 common species (Table 5). Most of them are ubquitous and/or large size species with high dispersal potential.

An analysis using Bray-Curtis similarity indices showed that most of the species living in Podgorica prefer dry and open types of habitats (meadows and low shrubs). Their caterpillars were mostly oligophagous, i.e feeding on host plants from mainly one plant family and the species were very common in urbanised areas (Table 3). Many butterfly species were related to Fabaceae - plants that are common in the whole Podgorica (Stešević et al, 2014), about 30% of species which caterpillars feeding on herbs prefer this plant family and, additionaly Fabaceae melliferous flowers are also interesting for a lot of imagines of other species. Other habitat features that can also be assumed to be attractive elements of an investigated landscape and which were included in the analyses are: exposed rocky fields, woodland and ruderal areas. Sites characterised by the highest number of species, like Malo Brdo (30 species), Gorica (22 species), and two sites in Park Suma Gorica (NW part - 26 species, SE part - 28 species) fit mentioned patterns by combining almost all preferable habitat types. Additionally, all of the mentioned sites were located on hills, which could be an extra factor for a constant presence of species with hilltopping behaviour like Papilionidae (Pe'er, Saltz, Thulke, & Motro, 2004). Interestingly, a relatively high number of species (20 species) was recorded in the Milenium Bridge site, close to the city center. The high number of species here might be associated to a green corridor alongside the Morača river.

Some hints about distribution patterns of species group distinguished by Bray-Curtis analysis might only be indicated in case of group 1 and group 2 (Table 3). Group 1 is represented mostly by species appearing respectively on sites 6, 7, 2, 3 - already mentioned as hills with the highest number of species listed (Table 3, Fig. 1). Species from Group 2 are mostly found on sites 1, 2 and 5 (Table 3, Fig. 1), what can be associated with the available host plants along with the host ants and open space of the sites. Species composition of the other three groups includes butterflies that do not show a preference to particular sites.

Table 4. Comparison of species list from this study and from Zeta-Skadar Plain (Sobczyk & Gligorović, 2016) and from nearby sites in Cijevna valley (Švara et al. 2015). Species common to diiferent sites are underlined. Species recorded only during present study are marked in bold.

Family	Present Podgorica study	Zeta-Skadar Plain (Sobczyk & Gligorović, 2016)	Sites in Cijevna valley in close proximity to Podgorica (Švara et al. 2015)
Hesperiidae	*Carcharodus alceae* (Esper, [1780]) ***Ochlodes sylvanus* (Esper, 1777)** *Spialia orbifer* (Hübner, [1823]) *Thymelicus acteon* (Rottemburg, 1775) ***Thymelicus silvestris* (Poda, 1761)**	*Carcharodus alceae* (Esp er, 1780) *Erynnis tages* (Linnaeus , 1758) *Gegenes pumilio* (Hoffmannsegg, 1804) *Pyrgus serratule* (Rambur, 1839) *Pyrgus sidae* (Esp er, 1784) *Spialia orbifer* (Hübner, 1823)	*Erynnis tages* (Linnaeus, 1758) *Spialia orbifer* (Hubner, 1823) *Thymelicus acteon* (Rottemburg, 1775)
Papilionidae	*Iphilcides podalirius* (Linnaeus, 1758) *Papilio machaon* Linnaeus, 1758 *Zerynthia polyxena* ([Denis & Schiffermüller], 1775)	*Iphiclides podalirius* (Linnaeus , 1758) *Papilio machaon* Linnaeus , 1758 *Zerynthia polyxena* (Denis & Schiffermüller, 1775)	*Iphiclides podalirius* (Linnaeus, 1758) *Papillio machaon* Linnaeus, 1758 *Zerynthia polyxena* (Dennis & Schiffermuller, 1775)
Pieridae	*Colias crocea* (Fourcroy, 1785) *Euchloe ausonia* (Hübner, [1804]) *Gonopteryx rhamni* (Linnaeus, 1758) *Leptidea sp.* *Pieris brassicae* (Linnaeus, 1758) *Pieris ergane* (Geyer, [1828]) *Pieris napi* (Linnaeus, 1758) *Pieris rapae* (Linnaeus, 1758) ***Pontia edusa* (Fabricius, 1777)**	*Anthocharis cardamines* (Linnaeus , 1758) *Aporia crataegi* (Linnaeus , 1758) *Colias crocea* (Fourcroy, 1785) *Colias erate* (Esp er, 1805) *Euchloe ausonia* (Hübner, 1804) *Gonepteryx farinosa* (Zeller, 1847) *Gonepteryx rhamni* (Linnaeus , 1758) *Leptidea duponcheli* (Staudinger, 1871) *Leptidea sinapis* (Linnaeus , 1758) *Pieris brassicae* (Linnaeus , 1758) *Pieris mannii* (Mayer, 1851) *Pieris napi* (Linnaeus , 1758) *Pieris rapae* (Linnaeus , 1758) *Pontia chloridice* (Hübner, 1813)	*Antocharis cardamines* (Linnaeus, 1758) *Colias crocea* (Geoffroy, 1785) *Gonepteryx rhamni* (Linnaeus, 1758) *Pieris ergane* (Geyer, 1828) *Pieris mannii* (Mayer, 1851) *Leptidaea sinapis/juvernica*
Lycenidae	*Aricia agestis* ([Denis & Schiffermüller], 1775) *Celastrina argiolus* (Linnaeus, 1758) *Cupido argiades* (Pallas, 1771) ***Cupido decolorata* (Staudinger, 1886)** ***Cyaniris semiargus* (Rottemburg, 1775)** *Glaucopsyche alexis* (Poda, 1761)	*Aricia agestis* (Denis & Schiffermüller, 1775) *Callophrys rubi* (Linnaeus , 1758) *Celastrina argiolus* (Linnaeus , 1758) *Cupido argiades* (Pall as, 1771) *Glaucopsyche alexis* (Poda, 1775) *Iolana iolas* (Ochsenheimer, 1816) *Lycaena dispar* (Haworth, 1802) *Lycaena ottomanus* (Linnaeus , 1758) *Lycaena phlaeas* (Linnaeus , 1761) *Phengaris arion* (Linnaeus , 1758) *Plebejus argus* (Linnaeus , 1758) *Plebejus argyrognomon* (Bergsträss er, 1779) *Plebejus idas* (Linnaeus , 1761)	*Aricia agestis* (Dennis & Schiffermuller, 1775) *Callophrys rubi* (Linnaeus, 1758) *Cupido minimus* (Fuessly, 1775) *Glaucopsyche alexis* (Poda, 1761) *Iolana iolas* (Ochsenheimer, 1816) *Lycaena ottomana* (Lefebvre, 1830)

Table 4. Continued.

Family	Present Podgorica study	Zeta-Skadar Plain (Sobczyk & Gligorović, 2016)	Sites in Cijevna valley in close proximity to Podgorica (Švara et al. 2015)
Lycenidae	*Lycaena phlaeas* (Linnaeus, 1761) ***Lysandra bellargus* (Rottemburg, 1775)** *Plebejus argus* (Linnaeus, 1758) *Polyommatus icarus* (Rottemburg, 1775) *Polyommatus thersites* (Cantener, 1835) *Pseudophilotes vicrama* (Moore, 1865) *Satyrium spini* ([Denis & Schiffermüller], 1775)	*Polyommatus amandus* (Schneider, 1792) *Polyommatus coridon* (Poda, 1761) *Polyommatus escheri* (Hübner, 1823) *Polyommatus icarus* (Rottemburg, 1775) *Polyommatus thersites* (Cantener, 1835) *Pseudophilotes vicrama* (Moore, 1865) *Satyrium acaciae* (Fabricius , 1787) *Satyrium ilicis* (Esp er, 1779) *Satyrium pruni* (Linnaeus , 1758) *Satyrium spini* (Denis & Schiffermüller, 1775) *Scolitantides orion* (Pall as ,1771) *Tarucus balkanicus* (Freyer, 1844)	*Lycaena phleas* (Linnaeus, 1761) *Polyommatus icarus* (Rottemburg, 1775) *Scolitantides orion* (Pallas, 1771) *Tarucus balkanicus* (Freyer, 1844)
Nymphalidae	*Aglais io* (Linnaeus, 1758) *Coenonympha pamphilus* (Linnaeus, 1758) *Euphydryas aurinia* (Rottemburg, 1775) *Hipparchia fagi* (Scopoli, 1763) ***Hipparchia volgensis* (Mazochin-Porshnjakov, 1952)** *Issoria lathonia* (Linnaeus, 1758) ***Lasiommata maera* (Linnaeus, 1758)** *Lasiommata megera* (Linnaeus, 1767) *Libythea celtis* (Laicharting, 1782) *Limenitis reducta* Staudinger, 1901 *Maniola jurtina* (Linnaeus, 1758) *Melanargia larissa* (Geyer, 1828) *Melithaea didyma* (Esper, 1778) *Melithaea phoebe* ([Denis & Schiffermüller], 1775) *Pararge aegeria* (Linnaeus, 1758) *Polygonia egea* (Cramer, 1775) *Vanessa atalanta* (Linnaeus, 1758) *Vanessa cardui* (Linnaeus, 1758)	*Aglais io* (Linnaeus ,1758) *Aglais urticae* (Linnaeus , 1758) Argynnis adippe (Denis & Schiffermüller, 1775) Argynnis paphia (Linnaeus , 1758) *Brenthis hecate* (Denis & Schiffermüller, 1775) *Brintesia circe* (Fabricius , 1775) *Coenonympha pamphilus* (Linnaeus , 1758) *Erebia ligea* (Linnaeus , 1758) *Euphydryas aurinia* (Rottembu rg, 1775) *Euphydryas maturna* (Linnaeus , 1758) *Hipparchia fagi* (Scopoli, 1763) *Issoria lathonia* (Linnaeus , 1758) *Lasiommata megera* (Linnaeus , 1764) *Limenitis reducta* (Staudinger, 1901) *Maniola jurtina* (Linnaeus , 1758) *Melanargia galathea* (Linnaeus , 1758) *Melitaea cinxia* (Linnaeus , 1758) *Melitaea didyma* (Esp er, 1779) *Melitaea phoebe* (Denis & Schiffermüller, 1775) *Melitaea trivia* (Denis & Schiffermüller, 1775) *Nymphalis antiopa* (Linnaeus , 1758) *Nymphalis polychloros* (Linnaeus , 1758) *Pararge aegeria* (Linnaeus , 1758) *Polygonia c-album* (Linnaeus , 1758) *Polygonia egea* (Cramer, 1775) *Vanessa atalanta* (Linnaeus , 1758) *Vanessa cardui* (Linnaeus , 1758) *Libythea celtis* (Laicharting, 1782)	*Argynnis niobe* (Linnaeus, 1758) *Argynnis paphia* (Linnaeus, 1758) *Brintesia circe* (Fabricius, 1775) *Coenonympha arcania* (Linnaeus, 1761) *Coenonympha pamphilus* (Linnaeus, 1758) *Euphydryas aurinia* (Rottemburg, 1775) *Hypparchia syriaca* (Staudinger, 1871) *Issoria lathonia* (Linnaeus, 1758) *Lasiommata megera* (Linnaeus, 1767) *Libythea celtis* (Laicharting, 1782) *Limenitis reducta* (Staudinger, 1901) *Melanargia larissa* (Geyer, 1828) *Melitaea didyma* (Esper, 1778) *Nymphalis antiopa* (Linnaeus, 1758) *Satyrus ferula* (Fabricius, 1793) *Vanessa atalanta* (Linnaeus, 1758)

Table 5. Comparison of species lists from Podgorica and other cities on the Balkan Peninsula.

Common species for Podgorica, Zagreb and Patras (Koren et al., 2013; Tzortzakaki et al., 2019)	Common species just for Podgorica and Zagreb (Koren et al., 2013)	Common species just for Podgorica and Patras (Tzortzakaki et al., 2019)
Aricia agestis *Carcharodus alaceae* *Celastrina argiolus* *Coenonympha pamphilus* *Colias crocea* *Glaucopsyche alexis* *Gonopteryx rhamni* *Iphilcides podalirius* *Lasiommata megera* *Leptidea sp.* *Limenitis reducta* *Lycaena phlaeas* *Maniola jurtina* *Melithaea didyma* *Ochlodes sylvanus* *Papilio machaon* *Pararge aegeria* *Pieris brassicae* *Pieris rapae* *Polyommatus icarus* *Polyommatus thersites* *Pseudophilotes vicrama* *Thymelicus silvestris* *Vanessa atalanta* *Vanessa cardui*	*Cupido argiades* *Cupido decoloratus* *Cyaniris semiargus* *Glaucopsyche alexis* *Hipparchia fagi* *Aglais io* *Issoria lathonia* *Lasiommata maera* *Melitaea phoebe* *Pieris napi* *Plebejus argus*	*Euchloe ausonia* *Pontia edusa* *Thymelicus acteon* *Zerynthia polyxena*

CONCLUSIONS

Podgorica is very interesting for butterfly monitoring by being a developing city that does not yet have a metropolitan character, and where landscape planning could benefit from information obtained from an indicator group like butterflies. The list of 48 recorded species of butterflies is a preliminary list as observations were only carried out in the spring.

For a better understanding of the urban butterfly fauna additional observations from a wider range of sites and over a wider time span is needed. Additional sites might include areas like urban lawns, smaller parks and some ruderal sites. Species distribution results obtained in the present study demonstrate the importance of hills and ruderal sites, especially those connected to Morača river valley. Those facts should be taken into consideration for example during further urbanisation planning of Malo Brdo or Gorica as well as for developing business centres in Novi Grad.

ACKNOWLEDGEMENT

The author would like to thank for research opportunity in Montenegro given by Central European Exchange Program for University Studies (CEEPUS) and University of Montenegro hospitality.

REFERENCES

Alberti, M. (2005). The effects of urban patterns on ecosystem function. *International Regional Science Review*, 28 (2), 168-192.

Aguilera, G., Ekroos, J., Persson, A.S., Petersson, L.B., & Öckinger, E. (2019). Intensive management reduces butterfly diversity over time in urban green spaces. *Urban Ecosystems,* 22, 335-344.

Bergerot, B., Fontaine, B., Julliard, R., & Baguette, M. (2011). Landscape variables impact the structure and composition of butterfly assemblages along an urbanization gradient. *Landscape Ecology,* 26, 83-94.

Blair, R.B. & Launer, A. E. (1997). Butterfly diversity and human land use: Species assemblages along an urban grandient. *Biological Conservation,* 80 (1), 113-125.

Blair, R.B. (1999). Birds and butterflies along an urban gradient: surrogate taxa for assessing biodiversity?. *Ecological Applications,* 9, 164-170.

Clark, P.J., Reed, J.M., & Chew, F.S. (2007). Effects of urbanization on butterfly species richness, guild structure, and rarity. *Urban Ecosystems,* 10, 321-337.

Clarke, K., Gorley, R.N., Somerfield, P., & Warwick, R. (2014). *Change in Marine Communities: An Approach to Statistical Analysis*. Plymouth: Primer-E Ltd.

Dallimer, M., Rouquette, J.R., Skinner, A.M.J., Armsworth, P.R., Maltby, L.M., Warren, P.H., & Gaston, K.J. (2012). Contrasting patterns in species richness of birds, butterflies and plants along riparian corridors in an urban landscape. *Diversity and Distributions,* 18, 742-753.

Franeta, F. (2018). Checklist of the butterflies (Lepidoptera: Papilionoidea) of Montenegro. *Zootaxa*, 4392 (1): 128-148.

Gibbs, A.E. (1913). Butterfly-hunting in the Balkans. *Entomologist*, 46, 104-108, 122-130, 154-158.

Jakšić, P. & Ristić, G. (1999). New and rare species of lepidoptera in Yugoslavia. *Acta Entomologica Serbica*, 4 (1/2), 63-74.

Koçak, A.Ö. (1989). On the butterflies of Yugoslavia (Lepidoptera). *Centre for Entomological Studies, Priamus,* 5 (1/2), 3-22.

Konvicka, M. & Kadlec, T. (2011). How to increase the value of urban areas for butterfly conservation? A lesson from Prague nature reserves and parks. *European Journal of Entomology*, 108, 219-229.

Koren, T., Zadravec, M., Ńtih, A., & Hlavati, D. (2013). Butterfly fauna (Hesperoidea&Papilionoidea) of a rural part of Zagreb city, Croatia. *Natura Croatica*, 22, 253-264.

Krystufek, B. & Reed, J. (2004). Pattern and process in Balkan biodiversity - An Overview. In: Griffiths H.I., Kryńtufek B., & Reed J.M. (Eds.). *Balkan biodiversity*. Dordrecht: Springer, pp. 1-8.

Lang, B.J., Dixon, P.M., Klaver, R.W.,Thompson, J.R., & Widrlechner, M.P. 2019. Characterizing urban butterfly populations: the case for purposive point-count surveys. *Urban Ecosystems*, 22, 1083-1096.

Luppi, M., Dondina, O., Orioli, V. & Bani, L. (2018). Local and landscape drivers of butterfly richness and abundance in a human-dominated area. *Agriculture Ecosystems & Environment,* 254, 138-148.

Matsumoto, K. (2015). Habitat specificity of butterflies along urban environmental gradients in Tama City, Tokyo. *Entomological Science*, 18, 509-518.

McKinney, M. L. (2002). Urbanization, Biodiversity and Conservation. *BioScience*, 52 (10), 883-890.

McKinney, M. L. (2006). Urbanization as a major cause of biotic homogenization. *Biological Conservation*, 127, 247 -260.

McKinney, M. L. (2007). Effects of urbanization on species richness: A review of plants and animals. *Urban Ecosystems*, 11, 161-176.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspot for conservation priorities. *Nature*, 403, 853-858.

Nicholl M. de la B. (1899). Butterfly hunting in Dalmatia, Montenegro, Bosnia and Herzegovina. *Entomologists Record*, 11, 1-8.

Nicholl M. de la B. (1902). The Lepidoptera of Bosnia and Montenegro. *Entomologists Record*, 14, 141-146.

Numa, C., van Swaay, C., Wynhoff, I., Wiemers, M., Barrios, V., Allen, D., Sayer, C., Munguira, M.L., Balletto, E., Benyamini, D., Beshkov, S., Bonelli, S., Caruana, R., Dapporto, L., Franeta, F., Garcia-Pereira, P., Karaçetin, E., Katbeh-Bader, A., Maes, D., Micevski, N., Miller, R., Monteiro, E., Moulai, R., Nieto, A., Pamperis, L., Pe'er, G., Power, A., Ńańic, M., Thompson, K., Tzirkalli, E., Verovnik, R., Warren, M., & Welch, H. (2016). *The status and distribution of Mediterranean butterflies.* Solprint S. L, Malaga, Spain.

Pe'er, G., Saltz, D., Thulke, H., & Motro, U. (2004). Response to topography in a hilltopping butterfly and implications for modelling nonrandom dispersal. *Animal Behaviour*, 68, 825-839.

Pollard, E. (1977). A method for assessing change in abundance of butterflies. *Biological Conservation* 12: 115-134.

Radović, I., Radović, D., Jakšić, P., Džukić, G., Stevanović, V., Bulić, Z., & Bušković, V. (2008). Skadar Lake region and target species» species of European conservation concern. *Natura Montenegrina*, 7 (2), 31-44.

Ramírez-Restrepo, L. & MacGregor-Fors, I. (2017). Butterflies in the city: a review of urban diurnal Lepidoptera. *Urban Ecosystems*, 20, 171-182.

Rebel, H. (1913). Studien über die Lepidopterenfauna der Balkänlander. III Teil. Sammelergebenisse aus Montenegro, Albanien, Mazedonien und Thrazien. *Annalen des naturhistorischen Museums in Wien*, 27, 281-334.

Rebele, F. (1994). Urban Ecology and Special Features of Urban Ecosystems. *Global Ecology and Biogeography Letters*, 4, 173-187.

Rochat, E., Manel, S., Deschamps-Cottin, M., Widmer, I., & Joost, S. (2017). Persistence of butterfly populations in fragmented habitats along urban density gradients: motility helps. *Heredity*, 119, 328-338.

Shreeve, T.G., Dennis, R.L.H, Roy, D.B., & Moss, D. (2001). An ecological classification of British butterflies: Ecological attributes and biotope occupancy. *Journal of Insect Conservation*, 5, 145-161.

Sijarić, R. (1984). Istraženost Rhopalocera (Lepidoptera) u Crnoj Gori (Rhopalocera research in Montenegro). *Glasnik Odeljenja Prirodnih Nauka*, 4, 163-175. (in Serbian)

Sijarić, R., Lorković, Z., Carnelutti, J., & Jakšić, P. (1984). Rhopalocera (Insecta, Lepidoptera). In: Nonveiller, G. (Ed.): *The fauna of Durmitor, Part 1*. Titograd: The Montenegrin Academy of Sciences and Arts, Special Editions 18, Section of Natural Sciences, 11, 95-184.

Sielezniew, M. & Dziekańska, I. (2010). *Motyle dzienne* (*Butterflies*). Warszawa: Multico. (in Polish)

Sobczyk, R. & Gligorović, B. (2016). Diversity of Butterflies in the Zeta-Skadar Plain, Montenegro. *Acta Zoologica Bulgarica*, 68 (2), 183-190.

Sobczyk, R., Pabis, K., Wieczorek, G., & Salamacha, A. (2017). Distribution and diversity of butterflies (Lepidoptera, Rhopalocera) in the urbanization zones of the Central European city (Lodz, Poland). *North-Western Journal of Zoology*, 13, 337-340.

Stešević, D., Caković, D., & Jovanović, S. (2014). The Urban Flora Of Podgorica (Montenegro, SE Europe): Annotated Checklist, Distribution Atlas, Habitats And Life-Forms, Taxonomic, Phytogeographical And Ecological Analysis. *Ecologica Montenegrina*, Supplementum 1, 171.

Švara, V., Zakńek, B., & Verovnik, R. (2015). Contribution to the knowledge of the butterfly fauna of Montenegro (Lepidoptera:Rhopalocera). *Acta entomologica slovenica*, 23, 37-48.

Thomas, J. A. (2005). Monitoring change in the abundance and distribution of insects using butterflies and other indicator groups. *Philosophical Transactions of the Royal Society B*, 360, 339-357.

Tolman, T. & Lewington, R. (1997). *Colins Field Guide Butterflies of Britain and Europe*. London: HarperCollinsPublishers Ltd.

Tzortzakaki, O., Kati, V., Panitsa, M., Tzanatos, E., & Giokas, S. (2019). Butterfly diversity along the urbanization gradient in a densely-built Mediterranean city: Land cover is more decisive than resources in structuring communities. *Landscape and Urban Planning*, 183, 79-87.

Van Swaay, C.A.M., Brereton, T., Kirkland, P., & Warren, M.S. (2012). *Manual for Butterfly monitoring. report VS2012.010*, De Vlinderstichting/Dutch Butterfly Conservation, Butterfly Conservation UK & Butterfly Conservation Europe, Wageningen.

Vujadinović, M. (2016). The importance of application of urban ecology principles to urban regeneration of public open spaces - parks of Novi Grad in Podgorica. *Agriculture & Forestry*, 62, 359-371.

Received: September 30, 2020 *Accepted: March 11 2021*