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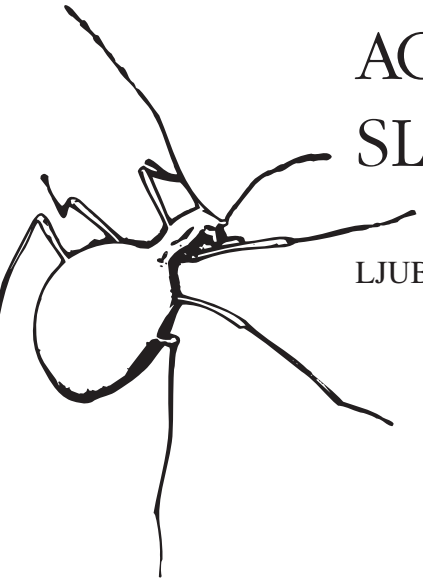

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Favnistični zapiski / Faunistical notes

ACTA ENTOMOLOGICA SLOVENICA
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THE DIVERSITY OF POLLINATORS ON GREEN ROOFS

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Abstract – The aim of this research was to survey green roofs for pollinator abundance and diversity. The research was conducted in 2019 on green roofs in Ljubljana and Škofja Loka (Slovenia). During the whole flowering season, we counted the number of honeybees, bumblebees, other wild bees, hoverflies, and butterflies. Results showed that various pollinators forage on blooming green roofs. The structure of flowering plants and pollinator communities also changed greatly during the season. During June and July, wild bees dominated, while in August and September, honeybees had the highest numbers. The results show that green roofs are important not only for domesticated honeybee or beekeeping, but also for biodiversity conservation. Based on the results, we also suggest improvements to make these roofs an even better food source for pollinators.

KEY WORDS: green roofs, green infrastructure, pollinators, honeybee, wild bees, bumblebees, hoverflies, urban ecology, biodiversity

Izvleček – PESTROST OPRAŠEVALCEV NA ZELENIH STREHAH

Cilj raziskave je bilo ugotoviti številčnost in pestrost opraševalcev na zelenih strehah. Raziskava je potekala leta 2019 na strehah v Ljubljani in Škofji Loki. V času cvetenja smo spremljali število medonosnih čebel, čmrljev, drugih divjih čebel, muh trepetavk in metuljev. Rezultati so pokazali, da se na strehah hranijo različni opraševalci. Cvetenje streh in združbe opraševalcev se preko sezone tudi precej spreminjajo. Junija in julija so prevladovale divje čebele, avgusta in septembra pa medonosna čebela. Rezultati kažejo, da zelene strehe niso pomembe samo za medonosno čebelo in čebelarstvo, ampak tudi za varovanje biodiverzitete. Na podlagi rezultatov predlagamo tudi izboljšave, da bi bile strehe za opraševalce še boljši vir hrane.

KLJUČNE BESEDE: zelene strehe, zelena infrastruktura, opraševalci, medonosna čebela, divje čebele, čmrlji, muhe trepetavke, urbana ekologija, biodiverziteta

Introduction

Pollinators provide one of the key ecosystem services – pollination, important for biodiversity and agriculture. Among insects, the main pollinators are bees, flies, butterflies, moths, wasps, beetles and thrips (Potts et al. 2016). The net worth of insect pollination is estimated to be around 10% of the total worth of agricultural production. This adds up to around €153 billion globally (Gallai et al. 2009), and up to €22 billion in Europe every year (Potts et al. 2015).

In recent decades, the populations and diversity of pollinators has declined rapidly (Potts et al. 2010, Hallmann et al. 2017, Wagner 2020). For instance, 9.2% of bees in Europe are threatened with extinction. However, for 56.7% of bees, there is not enough scientific information to evaluate their risk of extinction (Nieto et al., 2014). The main drivers for this decline are changes in land use, pesticide use, disease, and climate change. One of the biggest threats to pollinators is lack of food due to intensive farming, urbanisation, and climate change (Nieto et al., 2014, Gogala, 2014, Bevk et al. 2016). Increasing development of urban environments also puts pressure on green spaces, having a potential negative impact on biodiversity and ecosystem services (Braaker et. al 2017).

This problem can be partially alleviated by green infrastructure such as green roofs. A variety of native bee species can use green roofs as foraging and/or nesting sites (Colla et al., 2009; Ksiazek et al., 2012; Maclvor et al., 2015). Although pollinators are present on green roofs in lower abundances and species richness than in natural habitats and ground-level sites, roofs are potentially valuable sites for pollinator conservation in urban areas, particularly if planted with a diverse range of native plants (Tonietto et al., 2011; Braaker et. al 2017). Subsequently, the integration of green roofs in cities has great potential to enable higher connectivity among green spaces (Braaker et. al 2014). Green roofs become even more important under changing temperature conditions, as they can mitigate the negative effects of increasing temperatures on wild bees (Papanikolaou et al., 2017).

The aim of this research was to survey Urbanscape green roofs for pollinator abundance and diversity, and to determine their potential as food resource for pollinators in urban areas.

Methods

Investigation of pollinator foraging activity was conducted in 2019 on two Urbanscape green roofs. The first roof (700 m^2) was in Ljubljana, near the city centre on residential building Y (7th floor). There were three apiaries present within a radius of 500m, and another three within 1000m. The second roof (100 m^2) was in Škofja Loka, on the edge of the industrial zone on Knauf Insulation Experience Center (3rd floor). There was one apiary within a radius of 500m, and another five within 1000m.

We counted the number of honeybees, bumblebees, other wild bees, hoverflies and butterflies. Pollinator activity was monitored during the whole flowering season (June – September), three to five-times a month on each location, solely in sunny

Figure 1: Green roof in Ljubljana.

weather when pollinators are most active. Firstly, we looked at which plants were blooming and estimated the percentage of flowering roof area. We then defined five sampling sites. One sampling site represented one square meter of flowering plants. Pollinator activity was monitored on sampling sites for two hours between 8 a.m. and 11 a.m. Twenty monitoring counts on each sampling site were carried out per day (totalling 100 across the five sampling sites). After the last count was carried out, up

Figure 2: Green roof in Škofja Loka.

to three specimens that could not be determined in the field were caught with nets. Effort was made to catch samples of morphologically different specimens. These were prepared for later idenfication, to determine the species. In total in whole season, we caught 19 bees and one hoverfly in Ljubljana and 12 bees and three hoverflies in Škofja Loka.

Based on the obtained data, we calculated the structure of pollinator communities, density of pollinators and the dynamic of flowering on the roof across the season (composition of flower communities).

Results

In Ljubljana, the flowering period (established when at least part of the plants on the roof started to come into bloom, until the end of the blooming period) lasted from the middle of June to the end of September. During this period, 14 observation days were conducted and 869 pollinators were counted altogether. The most abundant pollinator observed was the honeybee (463, Figure 3), followed by "other wild bees", i.e. wild bees other than bumblebees (392). There were also some hoverflies recorded (6), butterflies (4) and bumblebees (4). In total, seven species of wild bees and one species of hoverfly were found (Table 1).

In Škofja Loka, the flowering period lasted only from the middle of June to the beginning of July. Therefore, only three observation days were conducted altogether, and 403 pollinators were counted. The most numerous pollinators by far were "other wild bees" (377). There were also some honeybees (19), hoverflies (6), one butterfly

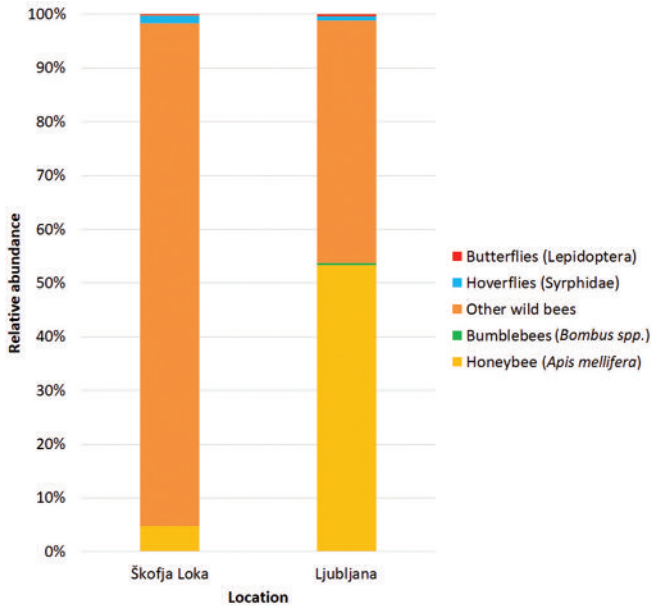

Figure 3: The structure of pollinator communities recorded on each green roof.

recorded, and no bumblebees. Together, five species of wild bee (Table 1) and three species of hoverfly were found. Two species of bee were found across both green roofs in Škofja Loka and Ljubljana

Table 1: List of bee and hoverfly species found on each green roof.

Ljubljana	**Škofja Loka**
Bees	
Andrena subopaca	*Andrena subopaca*
Lasioglossum politum	*Lasioglossum politum*
Hylaeus punctatus	*Lasioglossum laticeps*
Megachile willughbiella	*Lasioglossum lineare*
Megachile pilidens	*Lasioglossum malachurum*
Anthidium oblongatum	
Bombus terrestris/lucorum	
Hoverflies	
Eristalis tenax	*Helophilus trivittatus*
	Sphaerophoria sp.
	Eupeodes corollae

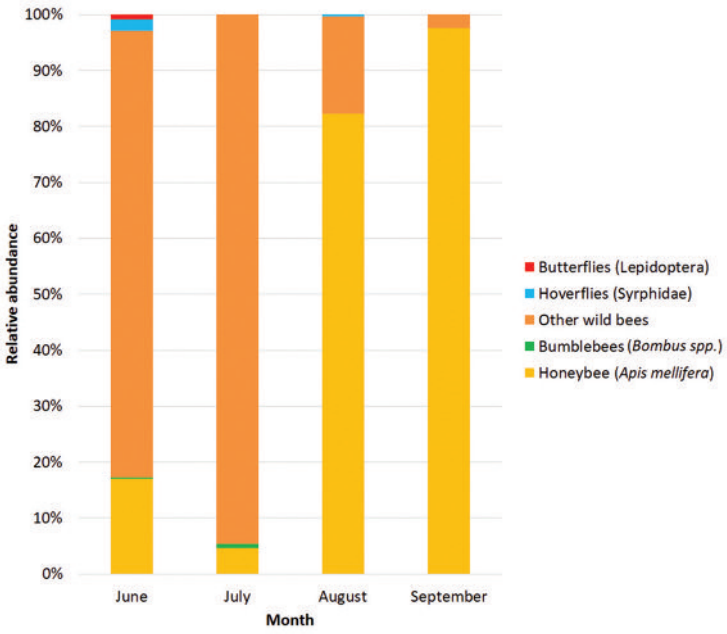

Figure 4: The structure of pollinator communities recorded by month (both locations together).

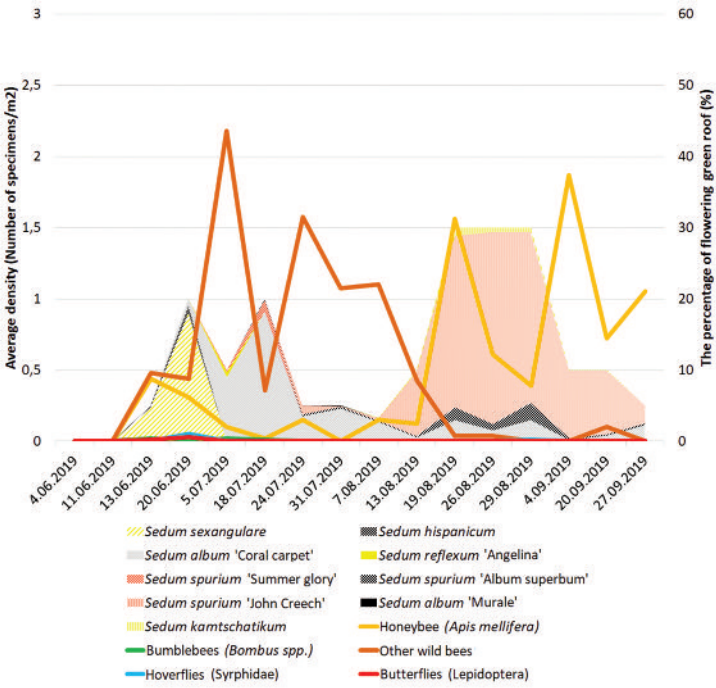

Figure 5: Pollinator density and flowering of the green roof in Ljubljana. The percentage of flowering green roof is presented on the secondary y-axis. The colour of the flowers is in line with the colour of the graphs (yellow, red, and white). Lines represent average density of pollinators (primary y-axis).

The structure of the pollinator communities changed greatly during the season. Wild bees dominated in June and July, while in August and September, honeybees dominated (Figure 4). Accordingly, the density of honeybees increased, and the density of wild bees decreased during the season. The average density in Ljubljana was 1,02 pollinators per square meter of flowering plants and 1,34 in Škofja Loka. The density of solitary bees was highest in June and July, in contrast to honeybees that had the highest density in August and September (Figure 5 and 6).

The flowering of *Sedum* spp. was very dynamic. In Ljubljana – where flowering lasted three and a half months, there were three peaks of blooming: in the middle of June (20% of roof), middle of July (20% of roof) and in the second half of August (30%, Figure 5). On the contrary, in Škofja Loka the flowering period lasted only one month, with peak of blooming (20%) at the end of June (Figure 6).

There were also differences in the species composition of flowering plants. We found nine different *Sedum* species on roofs. In Ljubljana (Figure 5), *Sedum sexangulare* (yellow) dominated in the beginning, then *Sedum album* 'Coral carpet' (white), followed by *Sedum spurium* 'John Creech' (red). In Škofja Loka (Figure 6), two

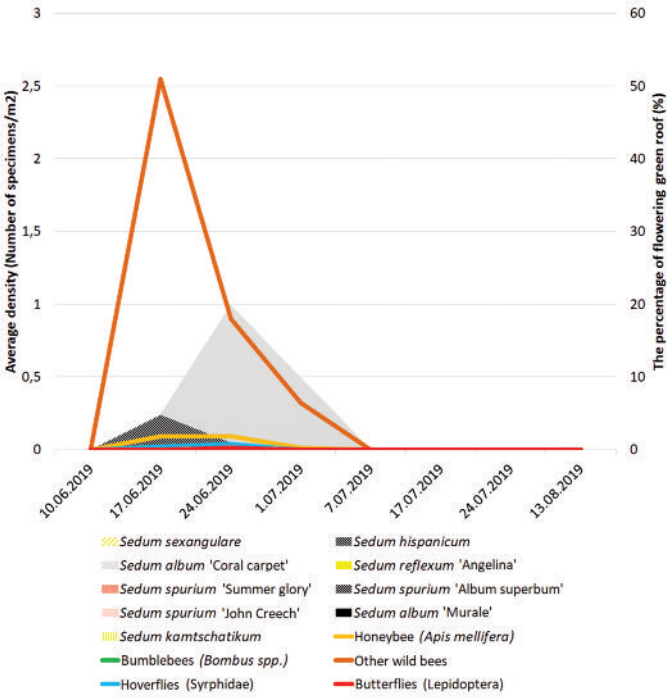

Figure 6: Pollinator density and flowering of the green roof in Škofja Loka.

species of white-flowered *Sedum* dominated (*Sedum album* 'Coral carpet' and *Sedum hispanicum*).

Discussion

Results show that green roofs can provide additional or alternative food sources for pollinators during the blooming period. Considering the lack of food being one of the main causes for pollinator decline, flowering green roofs can contribute to solving this problem.

Contrary to our expectations, with Slovenia having one of the highest densities of honeybee colonies in the European Union (Chausat et al. 2013), wild pollinators were more numerous than honeybees. This shows that green roofs are important not only for domesticated honeybees or beekeeping, but also in the aspect of biodiversity conservation.

Among wild pollinators, solitary bees were by far the most numerous. Their densities were surprisingly high. Hoverflies, butterflies, and bumblebees were rare. According to lepidopterists (Barbara Zakšek, pers. comm.), the low diversity of butterflies were expected, however, we expected much more bumblebees. The low number of bumblebees can at least partly be explained by smaller populations of bumblebees being present in 2019, due to a very rainy spring. As a result of the small number of

bees sampled (31) as well as hoverflies (4), species diversity is probably underestimated.

The structure of flowering plants and pollinator communities changed greatly during the season. In June and July, wild bees dominated, while in August and September honeybees had the highest numbers. A decrease in the number of solitary bees later in the season was expected, as most of these species are active in spring and early summer. As most Slovenian beekeepers have stationary apiaries, changes in the number of honeybees are probably not a consequence of moving bee colonies. The increase in the number of honeybees in late summer are more likely to be a consequence of decreases in nectar and pollen sources at this time of year. In June, honeybees probably prefer to forage on lime (*Tilia* spp.) and chestnut (*Castanea sativa*) trees and turn to alternative sources on green roofs when these are no longer in bloom. However, to obtain better understanding, longer research on more locations is needed.

According to our results, green roofs can play an important role in developing more pollinator and biodiversity friendly cities in general. Of course, biodiversity on rooftops cannot be compared to biodiversity of flowering meadows, but green roofs are one of the solutions for biodiversity and more environmentally friendly urbanization.

Based on the results, we suggest some improvements to make roofs an even better food source for pollinators. We recommend planting a selection of plants that provide good sources of nectar and/or pollen, and a combination of plants that provide food during the whole summer. We also recommend using a higher diversity of plants and the use of native plants.

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Thanks to Mojca Pibernik for help in field work, Blaž Koderman and dr. Andrej Gogala for determination of bees, dr. Maarten de Groot for determination of hoverflies and Emily Quinn for the improvement of the language. Thanks also to anonymous reviewer for all constructive comments and suggestions. The research was funded by Knauf Insulation d.o.o and Slovenian Research Agency (research core funding No. P1-0255).

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DNEVNA KOLIČINA NABRANE HRANE V POSAMEZNI DRUŽINI ŠTIRIH VRST ČMRLJEV

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Izvleček – Čmrlji se hranijo z medičino in cvetnim prahom. Nepoužito, podnevi nabrano hrano hranijo v satnih lončkih za kasnejše potrebe. V članku je obravnavana in merjena dnevna količina tako shranjene hrane. Ugotovitve temeljijo na izračunani razliki med težo čmrljega gnezda v panju zvečer in zjutraj. V eksperimentu, ki je potekal spomladi in poleti leta 2020, so bile v ta namen uporabljene 4 čmrlje družine, po ena iz vrst *B. hypnorum, B. jonellus, B. humilis* in *B. pascuorum.*

KLJUČNE BESEDE: čmrlji, čmrlja hrana, donos hrane, dnevni donos hrane, vrste čmrljev, razvojne stopnje gnezda, povezanost med donosom, temperaturo in vlago zraka.

Abstract – DAILY YIELD OF FORAGING FOOD IN EACH OF FOUR NESTS OF THE FOUR BUMBLEBEE SPECIES

Bumblebees food depends on pollen and nectar provided by flowers. They store the daily yielded food in nectar pots or in specially constructed cells for later use. In the paper the maximum daily yield of the foraging and not consumed food is discussed and computed. The findings are based upon the computed difference between the weights of nest placed into wooden box, measured in the evening and morning hours, respectively. The experiment took place in spring and summer periods in the year 2020. Four bumblebee nests of four bumblebee species were used for the purpose, that is *B. hypnorum, B. jonellus, B. humilis and B. pascuorum.*

KEY WORDS: bumblebees, bumblebee forage, yielded food, daily yielded food, bumblebee species, nest development stages, link-up between the yielded food, air temperature and its humidity.

Uvod

V članku so opisane in analizirane meritve dnevnih donosov na paši nabranih medičine in cvetnega prahu delavk iz obravnavanih čmrljih družin vrst *B. hypnorum, B. jonellus, B. humilis* ter *B. pascuorum* (Grad et al., 2016; 2010). Namen prispevka je ugotoviti največji donos. Donosi so pogojeni z danostmi okolja, lokacije gnezda, vremenom in številom delavk v družini.

Tuji raziskovalci čmrljev so problem mase nabrane medičine in cvetnega prahu, pri tem pridobljenih in porabljenih kalorij zaradi opravljenega dela pri letanju na pašo ter vpliv raznih okoliščin na to, že raziskovali na določenih vrstah čmrljev, vendar, po našem vedenju, ne na zgoraj omenjenih vrstah. Na primer, podrobno in z opravljenimi meritvami sta dogajanje raziskovala D. Goulson (Goulson, 2003; 2010) ter B. Heinrich (Heinrich, 2004), posplošeno, brez podanih meritev, pa je problem opisan v delih Hintermeier, 1997, Kearns in Thomson, 2001 in Prys-Jones in Corbet, 1987.

Pristop k raziskovanju teže nabrane medičine in cvetnega prahu

Za kakršno koli bolj natančno in verodostojno ugotavljanje nabrane hrane so potrebne meritve. V tem primeru so bile opravljene spomladi in poleti leta 2020. V ta namen so bili uporabljeni tehtnica »Beurer KS 36 precision scale«, Beurer GmbH, 89077 Ulm, Nemčija; ter vlagomer, barometer in termometer firme Fischer. Meritve so bile opravljene na čmrljih, ki so bili naseljeni v panjih čmrljaka prof. dr. Janeza Grada v vasi Petelinje, 1262 Dol - Ljubljana, Slovenija, v času od 4. 5. do 15. 6. pri čmrljih *B. jonellus* in *B. hypnorum* ter v času od 1. 6. do 20. 7. pri čmrljih *B. humilis* in *B. pascuorum*. Za začetek merjenja je bil izbran datum, ko je na pašo že izletavalo večje število delavk in so postale količine nabrane hrane merljive, merjenje pa se je končalo, ko se je število delavk v gnezdu toliko zmanjšalo, da je postajala količina nabrane hrane zanemarljivo majhna.

Vzporedno s temi meritvami so bile opravljene še jutranje in večerne meritve teže enakih praznih panjev, ki so bili postavljeni poleg panjev s čmrlji. Le-te so pokazale spreminjanje teže samega panja (z gnezdilnim materialom, brez satja in čmrljev), ki je bila pogojena z vremenskimi danostmi tekom dneva. To spreminjanje je bilo potrebno upoštevati pri izračunavanju razlike med večerno maso in jutranjo maso nabrane in použite količine hrane. Spreminjanje mase nabranega medu zaradi spreminjanja vremenskih pogojev v analizi niso zajete, kar opravičujemo s tem, da čmrlji vzdržujejo v gnezdu skoraj konstantno temperaturo, ne glede na zunanje vremenske razmere, izjema so seveda ekstremi.

Izhodiščne danosti

Vselitve matic v panje in začetki izletavanja prvih delavk ter pozneje prvih mladih matic so potekali v naslednjem zaporedju: *B. jonellus* matica 14. 3., prva delavka 4. 4. in prva mlada matica 3. 5., *B. hypnorum* 18. 3., 6. 4., in 26. 5., *B. humilis* 7. 4., 1.

5. in 20. 6., ter *B. pascuorum* 9. 4., 3. 5. in 29. 6.. Družine, v istem zaporedju, pa so umrle 22. 6., 3. 8., 11. 9. oziroma 11. 10.. Za prvi dve vrsti čmrljev je bilo značilno, da sta se matici vrnili s prezimovališča že marca, njuni družini pa imeli hiter razvoj, ki se je končal še pred koncem pomladi. Preostali matici sta se vselili aprila, njuni družini pa sta imeli počasnejši in časovno daljši razvoj družine, tja do sredine poletja.

Kot je bilo omenjeno že zgoraj, zavisi količina nabrane hrane od več faktorjev. Vas Petelinje leži v osrednji Sloveniji, na vzhodnem robu Ljubljanske kotline, na nadmorski višini okrog 250 m s predalpskim podnebjem, ki pogojuje vrsto rastlinstva. V našem primeru je bila pogojena tudi z značilnostmi bližnje okolice mesta gnezda, kot so vrtovi stanovanjskih hiš, prisojna stran gozda in travniki, ki jih kmetje intenzivno kosijo do 4 ali celo 5–krat v obdobju od začetka maja do sredine oktobra. Za razvoj obravnavanih vrst čmrljev sta bili pomembni predvsem prvi košnji v maju in juniju oziroma juliju. Vse to je poleg vremena in števila delavk vplivalo na uspeh pri paši.

Meritve, izračuni in rezultati meritev

Opravljene so bile naslednje dnevne meritve in izračuni:

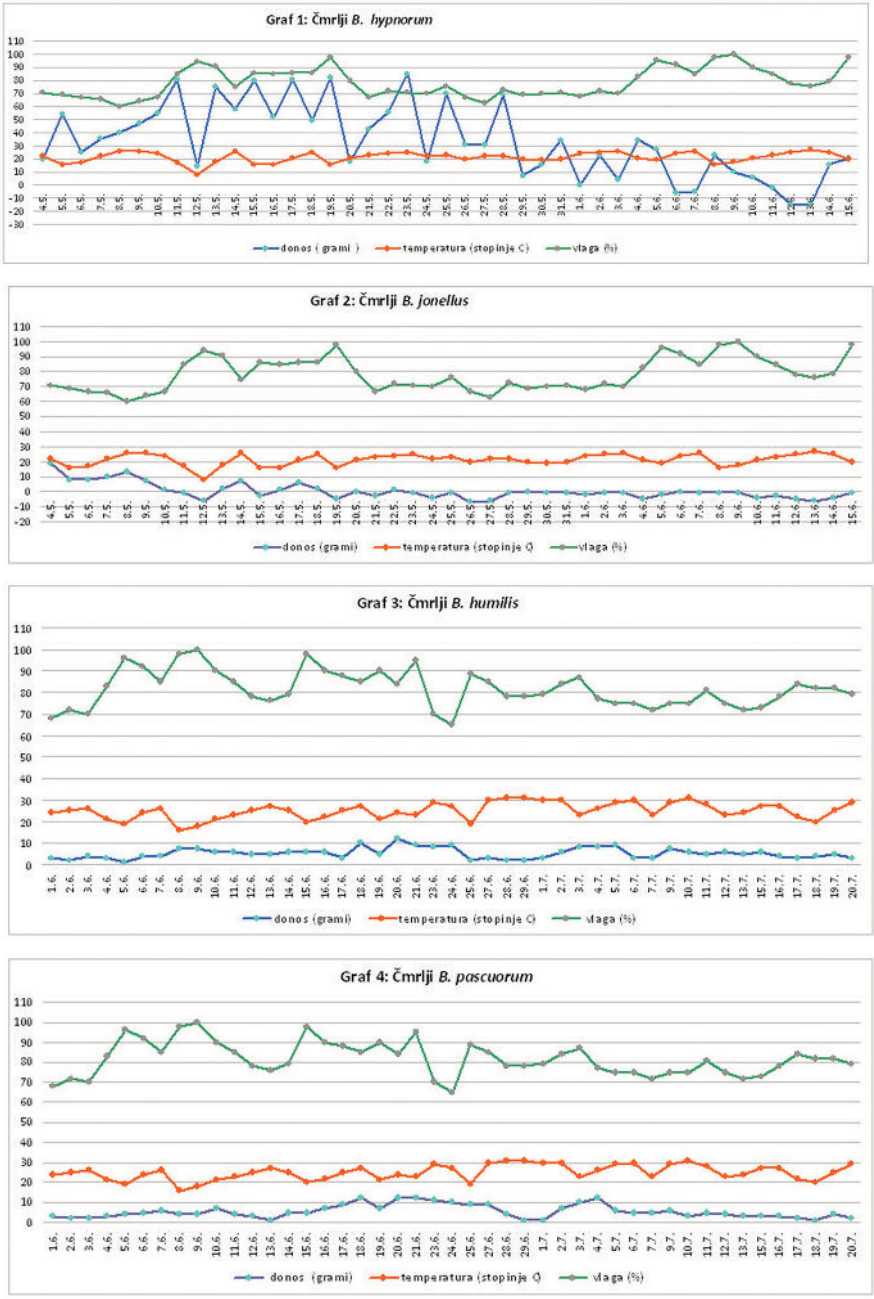
Meritve teže družine v panju: zjutraj, ko so bile še vse delavke v panju in zvečer, ko so se že vse delavke vrnile s paše, ter izračun razlike med njima.

Meritve jutranje in večerne teže praznega panja z vnešenim gnezditvenim materialom, vendar brez satja in čmrljev. Te meritve so bile potrebne, ker se je teža samega panja, brez čmrljev, zaradi vremenskega vpliva na panj v teku dneva spreminjala. Tako nastalo razliko teže je bilo potrebno upoštevati pri izračunu količine čez dan nabrane in ne konzumirane hrane.

Zaradi njihovega možnega vpliva na količino dnevno nabrane hrane so bili 3-krat dnevno (zjutraj, popoldne in zvečer) izmerjeni tudi vremenski parametri: vlaga ozračja, zračni pritisk in najvišja dnevna temperatura. Zabeleženi pa so bili še nekateri drugi vremenski parametri, kot na primer dež, veter in oblačnost.

Pri čmrljih vrst *B. jonellus* in *B. hypnorum* so bile meritve teže opravljene 43-krat, zjutraj in zvečer, v dnevih od 4. 5. do 15. 6. vključno. Podobne meritve pri čmrljih *B. humilis* in *B. pascuorum* pa so bile opravljene 45-krat, v dnevih 1. 6. do 20. 7.; izjemoma meritev ni bilo v 5 vmesnih dnevih, kar je razvidno iz *Tabele 2*. Jutranje meritve so bile opravljene preden so bili panji odmašeni (ponoči so bili zaradi nevarnosti vdora voščene vešče zamašeni) v času med 4.30 in 5.30 uro pri *B. hypnorum* in med 6.00 in 7.30 uro pri ostalih vrstah čmrljev. Večerne meritve so bile opravljene, ko so se s paše vrnile vse delavke, pri *B. hypnorum* v času med 20.45 in 21.45 uro, pri ostalih vrstah pa v času med 20.30 in 21.30 uro.

Numerični rezultati meritev mase so prikazani v Tabelah 1-2 v stolpcu **donos**. Negativna vrednost spremenljivke **donos** pomeni, da so čmrlji ta dan več hrane použili kot pa nabrali. V prikazih so podane vrednosti vremenskih parametrov, ki so bile izmerjene v zgodnjem popoldnevu, okrog 14. ure. Grafična predstavitev numeričnih rezultatov pa je prikazana v Grafih 1-2 za Tabelo 1, oziroma v Grafih 3-4 za Ta-



Grafi 1 – 4: Grafi prikazujejo povezanost dnevnih **donosov** hrane (grami) z najvišjo **temperaturo** zraka, v tabelah je to postavka **m-t** (stopinje C) in zračno **vlago** (%) za štiri vrste opazovanih čmrljev.

belo 2. V Tabelah 3-6, v katerih so prikazane samo največje vrednosti **donosa**, pa so podane izmerjene jutranje, popoldanske in večerne vrednosti vremenskih parametrov, kar omogoča še natančnejši vpogled na stanje vremena na dan meritev.

Analiza rezultatov merjenja

V letu 2020 opravljena raziskava dnevne količine nabranih in tudi použitih medičine in cvetnega prahu čmrljih družin *B. hypnorum*, *B. jonellus, B. humilis* in *B. pascuorum* je bil naš drugi tovrstni poizkus. Prvi poizkus je bil opravljen na čmrljih *B. hortorum* leta 2019, ko je bila dne 22. 5. izmerjena največja količina nabrane in ne použite hrane 22 gramov. Čmrlje gnezdo je bilo v lesenem panju, katerega teža pa se je pod vplivom vremena spreminjala. Pri izračunavanju razlike med večerno in jutranjo težo čmrlje družine, in s tem izračunavanju količine dnevno nabrane in použite hrane, je bila upoštevana tudi razlika med večerno in jutranjo težo z gnezdilnim materialom napolnjenega panja brez satja in čmrljev. Spoznane ugotovitve bodo koristile za odstranitev možnih odklonov od eksaktnih izračunov v nadaljnjih raziskavah z namestitvijo čmrljega gnezda v prostoru, kjer vreme ne bo vplivalo na težo uporabljenih materialov za namestitev gnezda, ali pa z uporabo na vreme neobčutljivih materialov.

Čmrlji B. hypnorum in B. jonellus

Čmrlje *B. hypnorum* in *B. jonellus* lahko prištevamo med spomladanske vrste, saj sta se njihovi matici vrnili s prezimovališča že marca, razvojno obdobje pa končalo v prvi polovici junija. Zanje so bile zato pomembne vremenske danosti v tem obdobju leta. V splošnem velja, seveda so možne tudi izjeme, da so jutra hladna, lahko tudi zelo hladna, dnevne temperature pa ne zelo visoke. V obdobju merjenja donosov med 4. 5. in 15. 6. so bile jutranje temperature med 3 in 16 stopinjami C, najvišje dnevne temperature med 16 in 26 stopinjami C, večeri pa razmeroma topli, med 13,7 in 23 stopinjami C, izjemoma je bilo 12. maja samo 8 stopinj C; značilni so bili tudi pogosti severni in zahodni vetrovi. Vse to je vplivalo na medenje rastlin in na količino dnevno nabrane hrane. Pri tem moramo seveda upoštevati tudi število delavk v gnezdu, ki je največje v času pojava prvih mladih matic, pri *B. jonellus* je bilo to 3. 5., največji donos pa 4. 5. in pri *B. hypnorum* 26. 5., z največjim donosom 23. 5.. Izmerjene vrednosti omenjenih spremenljivk pri najvišjih donosih hrane so podane v Tabelah 3-4. V Tabeli 1 in njej pripadajočih Grafih 1-2, v katerih je zajeto celotno opazovano obdobje od 4. 5. do 15. 6., pa so izpuščene, sicer izmerjene in shranjene jutranje in večerne vrednosti teh spremenljivk (temperatura ter vlaga ozračja in zračni tlak).

Čmrlji B. humilis in B. pascuorum

Podobna analiza velja tudi za vrsti *B. humilis* in *B. pascuorum*, vendar z upoštevanjem časovnega zamika dogajanja, od aprila do julija. Rezultati meritev so podani v Tabeli 2 in njej pripadajočih Grafih 3-4, ter Tabelah 5-6. Tudi v teh dveh primerih je

razvidna soodvisnost med največjim donosom in največjim številom delavk v gnezdu v času pojavljanja prvih mladih matic: pri *B. humilis* je bilo to 20. 6., ko je bila opažena prva mlada matica in je bil hkrati dosežen največji donos, pri *B. pascuorum* pa je bil največji donos v dneh 18. 6., 20. 6. in 21.6., prva mlada matica pa je bila opažena 29. 6.

Zaključek

Čmrlje družine so enoletne, kar pogojuje število delavk v posameznem gnezdu in namen nabiranja in hranjenja hrane. Število delavk se med vrstami čmrljev lahko zelo razlikuje, v splošnem jih je v ugodnih razmerah nekaj deset do nekaj sto (Grad et al., 2010; Hagen, 1994). Čmrlji, v nasprotju z medonosnimi čebelami, ne shranjujejo nabrane medičine za zimo, ki je družina ne preživi, temveč porabijo nabrano hrano za sprotne potrebe oziroma za preživetje v obdobju svojega obstoja. Zaradi majhnega števila delavk se masa dnevno nabrane hrane meri v gramih (g). V našem primeru obravnave zgoraj omenjenih vrst čmrljev so največje vrednosti med dnevno nabrano in použito hrano znašale **19 g pri *B. jonellus***, **85 g pri *B. hypnorum***, **12 g pri *B. humilis*** in **12 g pri *B. pascuorum***. Pri raziskavi čmrljev ***B. hortorum*** v letu 2019 je bil največji izmerjeni donos **22 g**. Močno izstopajo čmrlji *B. hypnorum*. Iz opazovanj (Grad, 2013) je razvidno, da se ta vrsta odlikuje po številčnosti delavk v posameznem gnezdu in dnevnem letanju na pašo od ranega jutra do poznega večera, v dežju in hladnem vremenu. Tudi po velikosti delavk ne spadajo med manjše vrste.

Iz zapisanega sledi, da so čmrlji, glede na naravne zakonitosti njihovega življenja, samozadostni nabiralci hrane – medičine in cvetnega prahu, s tem pa tudi nepogrešljivi opraševalci rastlin.

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Tabela 1: Dnevni donosi čmrljev *B. hypnorum* in *B. jonellus*, 4. 5. 2020 – 15. 6. 2020

	B. hypnorum			*B. jonellus*			vremenske razmere			
dat.	**tv-tj-po**	**tv-tj-pr**	**donos**	**tv-tj-po**	**tv-tj-pr**	**donos**	**m-t**	**vlaga**	**pritisk**	**vreme**
4.5.	22	2	**20**	14	-5	**19**	22	71	1017	jasno, pretežno sončno, jasno
5.5.	57	3	**54**	11	3	**8**	16	69	1014	plitka oblač., oblačno, občasen dež
6.5.	28	3	**25**	6	-2	**8**	17	67	1018	po dežju, SV, pretežno oblačno, sončno
7.5.	26	-10	**36**	8	-2	**10**	22	66	1018	jasno z meglico nas reko Savo, sončno
8.5.	30	-10	**40**	9	-4	**13**	26	60	1017	jasno - koprene, sončno, močan JZ, sončno
9.5.	42	-5	**47**	5	-2	**7**	26	64	1012	delno oblačno, sončno, močan JZ, sončno
10.5.	51	-4	**55**	-1	-2	**1**	24	67	1012	plitka oblač., delno oblačno, močan JZ, sonč.
11.5.	88	7	**81**	2	3	**-1**	17	85	1007	oblačno, občasen dež, pretež. oblač., moč. JZ
12.5.	14	0	**14**	-4	2	**-6**	8	94	1017	oblač. po dežju, občas. dež, močan SV, oblač.
13.5.	75	0	**75**	4	2	**2**	18	91	1013	deževno, delno do pretež. oblač., plitka oblač.
14.5.	46	-12	**58**	5	-2	**7**	26	75	1009	jasno, del. oblač., močan JZ, oblač., močan SV
15.5.	87	7	**80**	-2	1	**-3**	16	86	1012	dež(tudi močan) ves dan, dopol. in zvečer SV
16.5.	49	-3	**52**	2	1	**1**	16	85	1023	nizka oblač. po dežju, oblač.-svetleje, rahel SV
17.5.	72	-9	**81**	6	0	**6**	21	86	1020	dež, pretež. oblač., SV, oblačno, rahel SV
18.5.	41	-8	**49**	1	-1	**2**	25	86	1021	megla, delno oblačno, JZ, delno oblačno
19.5.	83	1	**82**	-2	3	**-5**	16	98	1019	megleno, po dežju, oblačno, dež, SV, deževno
20.5.	7	-11	**18**	-2	-2	**0**	21	80	1015	oblačno po dežju, pretež. oblač., zelo moč. SV
21.5.	31	-12	**43**	-6	-3	**-3**	23	67	1018	jasno, močan SV, pretež.-delno sončno, SV
22.5.	47	-9	**56**	-1	-2	**1**	24	72	1022	koprene, svetla oblač., rahel Z, kopr.-sončno
23.5.	82	-3	**85**	-2	-1	**-1**	25	71	1020	rahel dež, koprene, močan Z, delno oblačno
24.5.	5	-13	**18**	-7	-3	-4	22	70	1026	po obilnem dežju, delno oblač., sunki Z, sonč.
25.5.	63	-7	**70**	-1	0	-1	23	76	1023	delno oblačno, rahel Z, pretežno oblačno, SV
26.5.	23	-8	**31**	-9	-2	**-7**	20	67	1027	po dežju, rahel SV, toča, SV, pretež. jasno, SV
27.5.	21	-10	**31**	-4	-2	**-6**	22	63	1027	jasno, pretežno sončno, Z, sončno
28.5.	64	-5	**69**	-1	0	**-1**	22	73	1023	sončno, svetla oblač., ploha, močan hladen S
29.5.	-3	-10	**7**	-2	-2	**0**	20	69	1021	megla, delno sončno, S, pretežno oblačno, S
30.5.	11	-5	**16**	-2	-1	**-1**	19	70	1018	pretrgana oblač., oblačno, S, oblačno, rahel S
31.5.	26	-8	**34**	-2	-1	**-1**	20	71	1015	sončno in mrzlo, prosojna oblač., Z, pričel dež
1.6.	-16	-14	**-2**	-5	-3	**-2**	24	68	1016	pretež. oblačno, del. sončno, SV, pretež. sonč.
2.6.	15	-8	**23**	-2	-1	**-1**	25	72	1013	delno sončno, toplo, delno oblačno, kratek dež
3.6.	-6	-10	**4**	-3	-2	**-1**	26	70	1005	delno oblačno, toplo, močan Z, sončno s kopr.
4.6.	34	0	**34**	-4	1	**-5**	21	83	1003	po dežju, oblačno, silovit JZ, oblačno, zmeren Z
5.6.	33	6	**27**	0	2	**-2**	19	96	1002	po dežju, močan dež, občasno dež
6.6.	-9	-6	**-3**	0	0	**0**	24	92	1008	megla, delno sončno – močna ploha, jasno
7.6.	-10	-5	**-5**	-2	-1	**-1**	26	85	1006	megla, delno oblačno, toplo, ploha
8.6.	24	1	**23**	-1	0	**-1**	16	98	1009	dež davi, dopoldne dež, dež, SV
9.6.	11	1	**10**	-1	0	**-1**	18	100	1009	dež, dopoldanski dež, delno sončno
10.6.	0	-6	**6**	-4	0	**-4**	21	90	1008	delno oblačno, dopoldne ploha, oblačno
11.6.	-15	-13	**-2**	**-5**	-2	**-3**	23	85	1009	megla, hladno, pretež. sončno, delno oblač.
12.6.	-28	-13	**-15**	-10	-5	**-5**	25	78	1009	sončno, močan Z
13.6.	-29	-15	**-14**	-10	-4	**-6**	27	76	1009	sončno, močan Z
14.6.	8	-8	**16**	-6	-2	**-4**	25	79	1008	delno sončno, močan Z, nevihta v okolici
15.6.	27	6	**21**	1	2	**-1**	20	98	1011	dež, občasno dež, oblačno

Opombe: Prva mlada matica je izletela (opažena): pri *B. hypnorum* 25. 5. in pri *B. jonellus* 3. 5.
Družini sta umrli: *B. hypnorum* dne 3. 8., *B.jonellus* dne 22. 6.

Legenda: **tv-tj-po** = **(večerna teža(tv) - jutranja teža(tj))** polnega panja(po), v gramih;
tv-tj-pr = **(večerna teža(tv) - jutranja teža(tj))** praznega panja(pr), v gramih;
donos = **(tv-tj-po – tv-tj-pr)** … razlika v masi(grami) med nabrano in použito hrano;
m-t … maksimalna dnevna temperatura, v stopinjah C;
vlaga … popoldanska vlaga, v procentih;
pritisk … popoldanski zračni pritisk, v milibarih;
Z, JZ, S, SV … vetrovi: zahodnik, jugozahodnik, sever, severovzhodnik

Tabela 2: Dnevni donosi čmrljev *B. humilis* in *B. pascuorum*, 1. 6. 2020 – 20. 7. 2020

	B. humilis			*B. pascuorum*			vremenske razmere			
dat.	**tv-tj-po**	**tv-tj-pr**	**donos**	**tv-tj-po**	**tv-tj-pr**	**donos**	**m-t**	**vlaga**	**pritisk**	**vreme**
1.6.	1	-2	**3**	3	0	**3**	24	68	1016	delno sončno, SV, pretežno sončno
2.6.	2	0	**2**	2	0	**2**	25	72	1013	delno oblačno, toplo, popoldne kratek dež
3.6.	3	-1	**4**	1	-1	**2**	26	70	1005	delno oblačno, zelo toplo, močan Z
4.6.	3	0	**3**	3	0	**3**	21	83	1003	po dežju, pretrgana oblač., moč. JZ, oblačno
5.6.	2	1	**1**	5	1	4	19	96	1002	po dežju, močan dež, občasno dež
6.6.	5	1	**4**	6	1	**5**	24	92	1008	megla, delno sončno – močna ploha, jasno
7.6.	4	0	**4**	5	-1	**6**	26	85	1006	megla, delno oblačno, ploha
8.6.	7	0	**7**	5	1	**4**	16	98	1009	dež davi, dopoldne dež, dež, SV
9.6.	7	0	**7**	5	1	**4**	18	100	1009	dež, dopoldanski dež, delno sončno
10.6.	6	0	**6**	7	0	**7**	21	90	1008	delno oblačno, dopoldne ploha, oblačno
11.6.	6	0	**6**	4	0	**4**	23	85	1009	megla, hladno, pretež. sončno, delno oblač.
12.6.	5	0	**5**	1	-2	**3**	25	78	1009	sončno, močan Z
13.6.	4	-1	**5**	0	-1	**1**	27	76	1009	sončno, močan Z
14.6.	6	0	**6**	5	0	**5**	25	79	1008	delno sončno, močan Z, nevihta v okolici
15.6.	8	2	**6**	6	1	**5**	20	98	1011	dež, občasno dež, oblačno
16.6.	6	0	**6**	7	0	**7**	22	90	1011	megleno, pretežno oblačno, rahel SV
17.6.	3	0	**3**	9	0	**9**	25	88	1008	delno oblačno, Z, pretežno sončno
18.6.	7	-3	**10**	8	-4	**12**	27	85	1010	sončno, močan JZ
19.6.	5	0	**5**	7	0	**7**	21	90	1011	pretežno sončno, ploha, delno oblačno
20.6.	11	-1	**12**	10	-2	**12**	24	84	1014	dež, prosojna oblačnost, pretežno oblačno
21.6.	10	1	**9**	12	0	**12**	23	95	1013	po dežju, prosojna oblačnost, rahel dež
22.6.	-	-	-	-	-	-	-	-	-	-
23.6.	6	-2	**8**	8	-3	**11**	29	70	1014	sončno, rahel do opazen SV
24.6.	8	-1	**9**	8	-2	**10**	27	65	1018	sončno, SV, oblačno in rahel SV
25.6.	4	2	**2**	11	2	**9**	19	89	1020	po dežju, oblačno, večkrat dež
26.6.	-	-	-	-	-	-	-	-	-	-
27.6.	2	-1	**3**	6	-3	**9**	30	85	1014	sončno, močan JZ, sončno, rahel JZ
28.6.	1	-1	**2**	2	-2	**4**	31	78	1012	sončno, kopasti oblaki, rahel JZ, jasno
29.6.	1	-1	**2**	0	-1	**1**	31	78	1008	sončno, delno oblačno, močan JZ, naliv, SV
30.6.	-	-	-	-	-	-	-	-	-	-
1.7.	2	-1	**3**	-1	-2	**1**	30	79	1009	megla, delno sončno, pretežno oblačno
2.7.	6	0	**6**	5	-2	**7**	30	84	1010	delno oblačno, dež, Z, pretežno oblačno
3.7.	9	1	**8**	11	1	**10**	23	87	1015	dež, dež in oblačno, koprenasti oblaki
4.7.	6	-2	**8**	8	-4	**12**	26	77	1016	megla, delno oblačno, SV, sončno, rahel SV
5.7.	8	-1	**9**	4	-2	**6**	29	75	1015	sončno, rahel SV, sončno, rahel Z, sončno
6.7.	2	-1	**3**	3	-2	**5**	30	75	1008	sončno, vroče, SV, delno oblačno, rahel SV
7.7.	2	-1	**3**	3	-2	**5**	23	72	1016	dež, pretežno oblačno, SV, jasno, rahel SV
8.7.	-	-	-	-	-	-	-	-	-	-
9.7.	7	0	**7**	4	-2	**6**	29	75	1016	jasno in hladno, sončno, zmeren SV, jasno
10.7.	5	-1	**6**	2	-1	**3**	31	75	1012	jasno, kopren. oblaki, sončno, pret. Jasno
11.7.	4	-1	**5**	4	-1	**5**	28	81	1013	jasno, oblačno, rahel SV, neurje, ohladitev
12.7.	4	-2	**6**	0	-4	**4**	23	75	1022	megla, rahel S, delno sončno, močan S, jasno
13.7.	3	-2	**5**	0	-3	**3**	24	72	1019	jasno, hladno, pret. sončno, močan S, jasno
14.7.	-	-	-	-	-	-	-	-	-	-
15.7.	5	-1	**6**	1	-2	**3**	27	73	1011	jasno, hladno, pret. sončno, toplo, ploha
16.7.	4	0	**4**	2	-1	**3**	27	78	1012	pret. oblačno, precej oblačno, nevihta
17.7.	3	0	**3**	1	-1	**2**	22	84	1014	po dežju, pret. oblačno, SV, dež, oblačno, SV

18.7.	4	0	**4**	0	-1	**1**	20	82	1014	del. oblač., rahel SV, nekaj dežja, SV, oblač.
19.7.	4	-1	**5**	2	-2	**4**	25	82	1013	meglen pokrov, rahel SV, del. sončno, jasno
20.7.	2	-1	**3**	0	-2	**2**	29	79	1014	sončno, sončno, rahel JZ, jasno

Opombe: Prva mlada matica je izletela (opažena): pri *B. humilis* 20. 6. in pri *B. pascuorum* 29. 6.;
Družini sta umrli: *B. humilis* dne 11. 9., *B. pascuorum* dne 11. 10.;

Legenda: tv-tj-po … večerna teža(tv) - jutranja teža(tj) polnega panja(po), v gramih;
tv-tj-pr … večerna teža(tv) - jutranja teža(tj) praznega panja(pr), v gramih;
donos = (tv-tj-po – tv-tj-pr) … razlika v masi(grami) med nabrano in použito hrano;
m-t … maksimalna dnevna temperatura, v stopinjah C;
vlaga … popoldanska vlaga, v procentih;
pritisk … popoldanski zračni pritisk, v milibarih;
Z, JZ, S, SV … vetrovi: zahodnik, jugozahodnik, sever, severovzhodnik

Tabela 3: Največji donosi *B. hypnorum* - 3 meritve dnevno, 4. 5. 2020 – 15. 6. 2020

dat.	donos	tj	vj	pj	tp	vp	pp	tv	vv	pv	vreme
11.5.	**81**	13	79	1009	17	85	1007	16	83	1005	oblačno, občasen dež, pretež. oblač., močan JZ
13.5.	**75**	8	95	1016	18	91	1013	17	95	1009	deževno, delno do pretež. oblačno, plitka oblač.
15.5.	**80**	11	85	1011	16	86	1012	14	91	1013	dež(tudi močan) ves dan, dopoldne in zvečer SV
17.5.	**81**	11	96	1018	21	86	1020	18	90	1019	dež, pretež. oblač., SV, oblačno, rahel SV
19.5.	**82**	13	96	1019	16	98	1019	15	99	1017	megleno, po dežju, oblačno, dež, SV, deževno
23.5.	**85**	14	88	1024	25	71	1020	21	80	1018	rahel dež, koprene, močan Z, delno oblačno
25.5.	**70**	9	86	1028	23	76	1023	17	77	1022	delno oblačno, rahel Z, pretežno oblačno, SV
28.5.	**69**	8	83	1027	22	73	1023	14	85	1022	sončno, svetla oblač., ploha, močan hladen S

Opombe: Matica se je naselila 18. 3.
Prva delavka je izletela 6. 4.
Prva mlada matica je izletela 26. 5.
Družina je umrla dne 3. 8.

Legenda: (glej Tabelo 5)
Z, JZ, S, SV … vetrovi: zahodnik, jugozahodnik, sever, severovzhodnik

Tabela 4: Največji donosi *B. jonellus* – 3 meritve dnevno, 4. 5. 2020 – 15. 6. 2020

dat.	donos	tj	vj	pj	tp	vp	pp	tv	vv	pv	vreme
4.5.	**19**	5	56	1018	22	71	1017	17	69	1015	jasno, pretežno sončno, jasno
5.5.	**8**	7	69	1015	16	69	1014	14	69	1013	plitka oblač., oblačno, občasen dež
6.5.	**8**	8	69	1017	17	67	1018	14	70	1017	po dežju, SV, pretežno oblačno, sončno
7.5.	**10**	3	86	1021	22	66	1018	17	70	1019	jasno z meglico nas reko Savo, sončno
8.5.	**13**	7	85	1021	26	60	1017	19	62	1016	jasno - koprene, sončno, močan JZ, sončno
9.5.	**7**	9	75	1016	26	64	1012	20	66	1012	delno oblačno, sončno, močan JZ, sončno
14.5.	**7**	12	94	1008	26	75	1009	18	80	1008	jasno, del. oblač., močan JZ, oblač., močan SV
17.5.	**6**	11	96	1018	21	86	1020	18	90	1019	dež, pretež. oblač., SV, oblačno, rahel SV
18.5.	**2**	11	99	1023	25	86	1021	20	80	1019	megla, delno oblačno, JZ, delno oblačno

Opombe: Matica se je naselila 14. 3.
Prva delavka je izletela 4. 4.
Prva mlada matica je izletela 3. 5.
Družina je umrla dne 22. 6.

Legenda: (glej Tabelo 5)
JZ, SV … vetrovi: jugozahodnik, severovzhodnik

Tabela 5: Največji donosi *B. humilis* – 3 meritve vremena dnevno, 1. 6. – 20. 7. 2020

dat.	donos	tj	vj	pj	tp	vp	pp	tv	vv	pv	vreme
18.6.	**10**	14	96	1010	27	85	1010	22	79	1010	sončno, močan JZ
20.6	**12**	15	100	1015	24	84	1014	21	88	1013	dež, prosojna oblačnost, pretežno oblačno
21.6.	**9**	11	100	1012	23	95	1013	18	97	1014	po dežju, prosojna oblačnost, rahel dež
23.6.	**8**	14	89	1019	29	70	1014	24	69	1017	sončno, rahel do opazen SV
24.6.	**9**	15	84	1021	27	65	1018	21	72	1019	sončno, SV, oblačno in rahel SV
3.7.	**8**	18	87	1011	23	87	1015	20	87	1014	dež, dež in oblačno, SV, sončno, reahel SV
4.7.	**8**	15	87	1019	26	77	1016	21	80	1016	megla, delno oblačno, SV, sončno, rahel SV
5.7.	**9**	14	87	1018	29	75	1015	23	82	1013	sončno, rahel SV, sončno, rahel Z, sončno

Opombe: Matica se je naselila 7. 4.
Prva delavka je izletela 1. 5.
Prva mlada matica je izletela 20. 6.
Družina je umrla 11. 9.

Legenda: **donos** … razlika v masi(grami) med dnevno nabrano in použito hrano;
tj, tp, tv … temperatura (v stopinjah C): jutranja(tj), popoldanska(tp), večerna(tv);
vj, vp, vz … vlaga zraka (v procentih): jutranja(vj), popoldanska(vp), večerna(vv);
pj, pp, pv … zračni pritisk (v milibarih): jutranji(pj),popoldanski(pp), večerni(pv);
Z, JZ, SV … vetrovi: zahodnik, jugozahodnik, severovzhodnik.

Tabela 6: Največji donosi *B. pascuorum* – 3 meritve dnevno, 1. 6. 2020 – 20. 7. 2020

dat.	donos	tj	vj	pj	tp	vp	pp	tv	vv	pv	vreme
17.6.	**9**	16	99	1010	25	88	1008	21	88	1008	delno oblačno, Z, pretežno sončno
18.6.	**12**	14	96	1010	27	85	1010	22	79	1010	sončno, močan JZ
20.6.	**12**	15	100	1015	24	84	1014	21	88	1013	dež, prosojna oblačnost, pretežno oblačno
21.6.	**12**	11	100	1012	23	95	1013	18	97	1014	po dežju, prosojna oblačnost, rahel dež
23.6.	**11**	14	89	1019	29	70	1014	24	69	1017	sončno, nekaj oblačnosti, opazen SV, jasno
24.6.	**10**	15	84	1021	27	65	1018	21	72	1019	sončno, SV, oblačno in rahel SV
25.6.	**9**	16	87	1020	19	89	1020	16	95	1019	po dežju, oblačno, večkrat dež
27.6.	**9**	16	96	1016	30	85	1014	24	80	1013	sončno, močan JZ, sončno, rahel JZ
3.7.	**10**	18	87	1011	23	87	1015	20	87	1014	dež, dež in oblačno, koprenasti oblaki
4.7.	**12**	15	87	1019	26	77	1016	21	80	1016	megla, delno oblačno, SV, sončno, rahel SV

Opombe: Matica se je naselila 9. 4.
Prva delavka je izletela 3. 5.
Prva mlada matica je izletela 29. 6.
Družina je umrla dne 11. 10.

Legenda: (glej Tabelo 5)
Z, JZ, SV … vetrovi: zahodnik, jugozahodnik, severovzhodnik

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LACEWINGS (INSECTA: NEUROPTERIDA) IN THE ŠTEFAN MICHIELI'S ENTOMOLOGICAL COLLECTION

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Abstract – Štefan Michieli (1933-1968), Slovenian entomologist and physiologist, best known for the study of butterflies and moths (Lepidoptera) in Slovenia and the Balkan countries, was an outstanding lepidopterist. Slovenian Entomological Society is bearing his name. In addition to the Lepidoptera, he also collected small insect orders – Embioptera, Mecoptera and neuropterid orders. In nineties of the 20th century, Academician Professor Matija Gogala transferred the Michieli's collection of the Neuropterida to the author of this paper. It is believed that the inspected small neuropterid collection is only a part of formerly larger one, which had been partially destroyed or specimens lost. The remaining collection was restored and specimens identified to species level where possible. The restored collection contains one alderfly (Megaloptera) species, two snakefly (Raphidioptera) species, and 44 lacewing (Neuroptera) species. Collected specimens originate from Slovenia, Croatia and Montenegro. The total species number collected in Slovenia is surprisingly high and represents approx. 37% of the number of the Neuropterida species known nowadays in Slovenia. Štefan Michieli identified 76 individuals and his determinations were mostly made correctly.

KEY WORDS: history of entomology, Neuroptera, Megaloptera, Raphidioptera, Slovenia

Izvleček – MREŽEKRILCI (INSECTA: NEUROPTERIDA) V ENTOMOLOŠKI ZBIRKI ŠTEFANA MICHIELIJA

Štefana Michielija (1933-1968), slovenskega entomologa in fiziologa, ki ga najbolje poznamo po raziskavah metuljev (Lepidoptera) Slovenije in Balkana, imamo za iz-

jemnega lepidopterologa. Slovensko entomološko društvo nosi v nazivu njegovo ime. Poleg metuljev je zbiral tudi predstavnike manjših redov žuželk – nogoprelcev (Embioptera), kljunavcev (Mecoptera) in mrežekrilcev. V devetdesetih letih 20. stoletja je akademik prof. Matija Gogala prenesel Michielijevo zbirko mrežekrilcev avtorju tega prispevka. Prav gotovo je sedanja zbirka le del nekoč večje zbirke, ki je bila deloma uničena ali so bili primerki izgubljeni. Preostanek zbirke smo restavrirali in osebke določili do vrst, kjer je bilo mogoče. Restavrirana zbirka mrežekrilcev vključuje eno vrsto velekrilcev (Megaloptera), dve vrsti kamelovratnic (Raphidioptera) in 44 vrst pravih mrežekrilcev (Neuroptera). Osebki izvirajo iz Slovenije, Hrvaške in Črne gore. 42 vrst mrežekrilcev v širšem smislu (Neuropterida) je iz Slovenije, kar je presenetljivo veliko, saj predstavljajo pribl. 37% vrst vseh, ki jih danes poznamo iz Slovenije. Štefan Michieli je določil 76 osebkov in njegove determinacije so v veliki večini pravilne.

KLJUČNE BESEDE: zgodovina entomologije, mrežekrilci, blatnice, kamelovratnice, Slovenija

Introduction

Neuropterological investigations in Slovenia have a rich tradition. The oldest documented record of any lacewing in the country dates back to the year 1685 when Janez Vajkard Valvasor (1641-1693) prepared an unpublished collection of aquarelles

Fig. 1. Štefan Michieli (1933-1968).

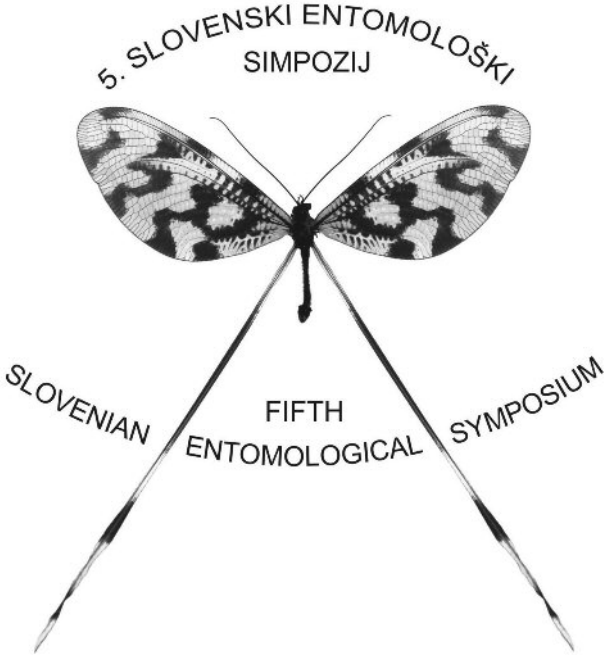

Fig. 2. Logo of the 5th Slovenian Entomological Symposium (5SES) with International Attendance. The Symposium was dedicated to Profs. M. Gogala and Š. Michieli. The logo contained a figure of the spoonwing species *Nemoptera sinuata*.

of Slovenian plants and animals, among them also an excellent illustration of one lacewing species (Valvasor 1685; Wraber at al. 1990). Research of the neuropterology in Slovenia started in 1763 with the Scopoli's famous *Entomologia carniolica* containing a description of three new neuropteran species (Scopoli 1763).

In 20th century, in the period after the WWII, a new era of the study of Slovenian insects begun. In 1952, the Slovenian Entomological Society was founded and an outstanding zoologist Štefan Michieli (1933-1968) (Fig. 1) promoted progress in entomology as a mentor of young students and a brilliant researcher. Professor Michieli who was well known as a lepidopterologist was also a founder of Animal Physiology at the University of Ljubljana (Gogala 2018). His lepidopterological collection is now deposited in the Natural History Museum of Slovenia in Ljubljana. His focus in the field of entomology was – besides butterflies and moths – small insect orders, such as Embioptera, Mecoptera and neuropterid orders (Raphidioptera, Megaloptera, Neuroptera). While Michieli studied biology of two western Balkan embiopteran species thoroughly (Michieli 1956, 1958; Michieli & Bole 1956; Bole 1978), unfortunately, he did not publish any paper on faunistics of Neuropterida in Slovenia. First comprehensive lists of Neuropterida and Mecoptera in Slovenia were published only three decades later, in 1984 and 1988 (Devetak 1984, 1988).

During his lepidopterological field trips in the Balkan countries, Michieli collected Neuroptera occasionally. Well known is his interest for spoonwings (Nemopteridae) and after his death, the distribution of a species *Nemoptera sinuata* Olivier, 1811 (Fig. 2) in North Macedonia also based on his collection was presented by Popov (1970).

Štefan Michieli collected lacewings and identified most of the specimens. After his premature death, nobody took care of his lacewing collection and a part of it was crumbling. In nineties of the 20th century, Academician Professor Matija Gogala left the Michieli's collection of the Neuropterida to the author of this paper. Now, this collection is deposited in the Entomological Collections of the Natural History Museum of Slovenia in Ljubljana. In the present paper, a revision of Michieli's collection and a list of species with localities are provided.

Material and methods

Insects were originally preserved in glass vials, filled with 70% ethanol. Later, the medium evaporated and some of the specimens were more or less damaged or even destroyed by pests (Fig. 3 A, B). After restoration, dried specimens are preserved in original glass vials (Fig. 3 C, D). Specimens were identified to species level where possible. For identification we used Aspöck et al. (1980). Reliable identification of *Wesmaelius*-females was only possible by means of examination of their genitalia. Genital preparations were made by clearing the apex of the ab-

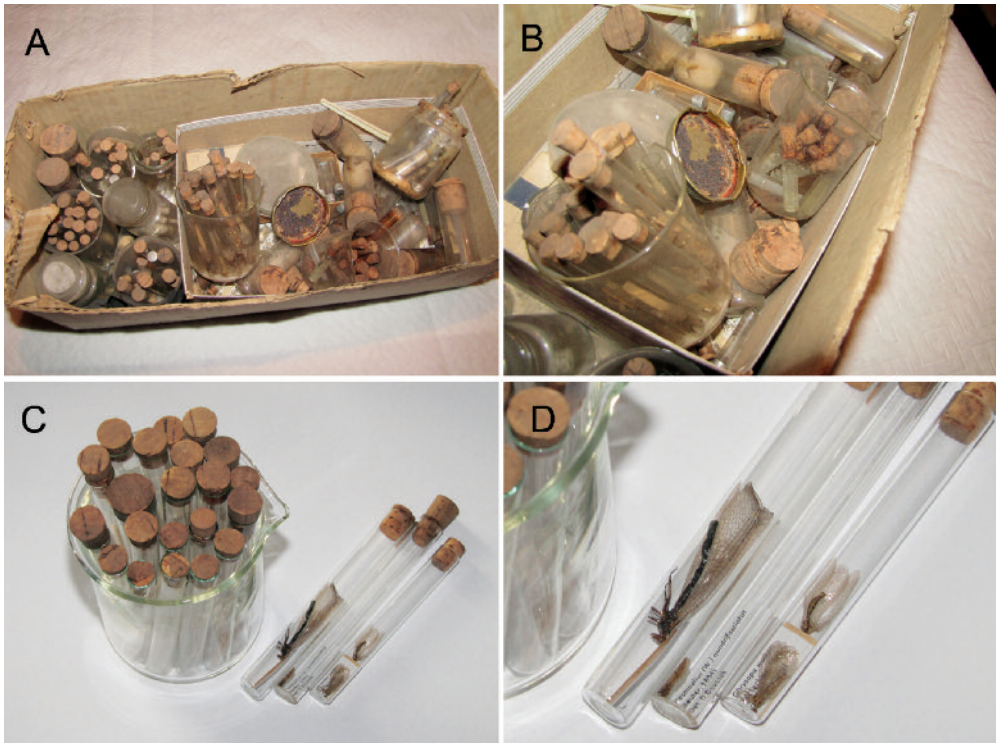

Fig. 3. A part of the Michieli's neuropterid collection before (A, B) and after (C, D) the reconstruction.

domen in saturated KOH solution. Nomenclature has been used in accordance with Oswald (2017).

Results and discussion

We believe that the investigated small collection is only a part of formerly larger one, which had been partially destroyed or specimens lost. The collection after restoration (Fig. 3) contains 184 specimens belonging to 47 neuropterid species – one alderfly (Megaloptera) species, two snakefly (Raphidioptera) species, and 44 lacewing (Neuroptera) species (Table 1). Collected specimens originate from Slovenia, Croatia and Montenegro. The total species number is surprisingly high. Forty-two neuropterid species originating from Slovenia represents 37% of the Slovenian fauna (Devetak 2018). Štefan Michieli identified 76 individuals and most of his determinations were made correctly. Collected lacewings are common species, wide spread in Slovenia (Devetak 2018). In the period after WWII, in Michieli's times, any similar collection of the neuropterid orders did not exist in Slovenia.

Neuropterids were, besides other taxa, also a subject for the study of visual properties of insect eyes. Professor Michieli and his colleague professor Matija Gogala studied the structure and function of owlfly compound eyes in a context of UV-vision (Gogala and Michieli 1965). Later, after Michieli's death, the research initiated by the both scientists lead to the discovery and isolation of the first known UV-photopigment in invertebrates (Gogala et al. 1970; Hamdorf et al. 1971).

Štefan Michieli died very young, in the age of 35. He was the first Slovenian entomologist studying Neuropterida in the country. If he had lived longer, he would have a greater impact on the world neuropterology.

Acknowledgement

I am very grateful to Academician Professor Matija Gogala who transmitted the Michieli's collection of the Neuropterida to me.

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Table 1: A list of species of the Neuropterida in the Michieli's collection. Legend: Carn – J. Carnelutti leg.; Mich – Š. Michieli leg.

Current valid name	Collecting place, date	Original label (identification); remarks	Number of individuals	Identification: corr-correct; incorr-incorrect
R A P H I D I O P T E R A				
RAPHIDIIDAE				
Dichrostigma flavipes (Stein, 1863)	Nanos 4.-6. VII. 1959	-	1 female	-
Venustoraphidia nigricollis (Albarda, 1891)	Ljubljana 10.V.1959	Raph.	1 ind	-
M E G A L O P T E R A				
SIALIDAE				
Sialis sp.	Posavje	Sialis flavilatera /no abdomen/	1 ind	-
Sialis sp.	Slovenija, Ljubljana	Sialis fuliginosa - unidentified	2 ind	-
N E U R O P T E R A				
OSMYLIDAE				
Osmylus fulvicephalus (Scopoli, 1763)	Gornji Grad VI. 55	Osmylus chrysops L.	4 ind	corr
Osmylus fulvicephalus (Scopoli, 1763)	Bistričica pod Krvavcem VII.1955 Carn. leg	Osmylus chrysops L.	2 ind	corr
CHRYSOPIDAE				
Hypochrysa elegans (Burmeister, 1839)	Bohinj V.1956 Mich. leg.	Hypochrysa nobilis Schneid.	2 ind	corr
Nineta flava (Scopoli, 1763)	Ljubljana 30. VIII. 1957	C. flava	2 ind	corr
Nineta flava (Scopoli, 1763)	Bohinj 7.-10. VIII. 1959	-	1 ind	-
Nineta flava (Scopoli, 1763)	Dolina Triglavskih jezer 7.-10. VIII. 1959	-	1 female	-
Nineta vittata (Wesmael, 1841)	Bohinj, Savica	Chrysopa vittata Wesm.	1 ind	corr
Nineta vittata (Wesmael, 1841)	Gornji Grad VI.1955	Chrysopa vittata Wesm.?	1 ind	corr
Nineta vittata (Wesmael, 1841)	Bohinj-Savica 26/27.VIII.1957	-	3 female	-
Nineta pallida (Schneider, 1846)	Dolina Triglavskih jezer 7.-10. VIII. 1959	-	1 ind	-
Chrysopidia ciliata (Wesmael, 1841)	Krvavec 21.VIII.	C. alba L.?	1 male	corr

Chrysopa perla (Linnaeus, 1758)	Posavje, Mich. leg.	C. perla L.	5 ind	corr
Chrysopa perla (Linnaeus, 1758)	Bohinj Komna Mich. leg.	C. perla	1 ind	corr
Chrysopa perla (Linnaeus, 1758)	Komarča, 1300 m, 2.VII.1956	Chrysopa perla	2 ind	corr
Chrysopa perla (Linnaeus, 1758)	Rakovnik 26. V. 1959	-	2 ind	-
Chrysopa perla (Linnaeus, 1758)	Ljubljana VII. 1957	C. perla	1 ind	corr
Chrysopa perla (Linnaeus, 1758)	Kamniška Bistrica V.1955	C. perla	1 ind	corr
Chrysopa perla (Linnaeus, 1758)	Ljubelj 2.VI.1958		2 ind	
Chrysopa walkeri McLachlan, 1893	Solkan 22.V.1959	-	2 ind	-
Chrysopa abbreviata Curtis, 1834	Ljubljana 30.VIII.1957	C. abbreviata Curt.	1 ind	corr
Chrysopa formosa Brauer, 1851	Ljubljana 15. VI. 1955	-	1 ind	-
Chrysopa formosa Brauer, 1851	[Montenegro] Rijeka Crnojevića V.1957	C. abbreviata Curt.	1 ind	incorr
Chrysopa cf. *nigricostata* Brauer, 1851	[Croatia] Rovinj 4.-15.IX.1956	C. (tenella) nigrocostata	1 ind	-
Chrysopa pallens (Rambur, 1838)	Ljubljana VII. 1957	C. septempunctata	1 ind	corr
Chrysopa pallens (Rambur, 1838)	Ljubljana VII.1955	C. septempunctata Wesm.	1 ind	corr
Chrysopa pallens (Rambur, 1838)	Ljubljana 1956	C. septempunctata	2 ind	corr
Chrysopa pallens (Rambur, 1838)	Ljubljana 30.VIII.1957	C. septempunctata	1 ind	corr
Chrysopa pallens (Rambur, 1838)	Ankaran 20-30.VI.1957	-	3 ind	-
Chrysopa pallens (Rambur, 1838)	Ankaran 1.-7- IX. 1958	-	1 ind	-
Chrysopa pallens (Rambur, 1838)	[Croatia] Rovinj 4.-12.IX.1955	C. septempunct?	1 ind	corr
Chrysopa gibeauxi (Leraut, 1989)	Trenta 28. VII.-1. VIII.	-	1 ind	-
Chrysopa sp.	Trenta 28.VII.-1.VIII.???? 1956?	- unidentified	6 ind	-
Pseudomallada prasinus (Burmeister, 1839)	Bohinj 7.-10. VIII. 1959	-	1 ind	-
Pseudomallada zelleri (Schneider, 1851)	Nanos 4.-6.VII.1959	-	1 ind	-
Pseudomallada zelleri (Schneider, 1851)	[Croatia] Dubrovnik V.1957	C. aspersa Wesm.	3 ind	incorr

Pseudomallada zelleri (Schneider, 1851)	[Montenegro] Kotor V.1957	C. aspersa Wesm	1 ind	incorr
Pseudomallada sp.	Ankaran 1.-7- IX. 1958	- unidentified	3 ind	-
Pseudomallada sp.	Ankaran 20-30.VI.1957	- unidentified	3 ind	-
Pseudomallada sp.	Trenta 28.VII.-1.VIII.???? 1956?	- unidentified	4 ind	
Chrysoperla carnea (Stephens, 1836) s.l.	Ankaran 20-30.VI.1957	-	1 ind	-
Chrysoperla carnea (Stephens, 1836) s.l.	Bohinj 2.-4.VII.1956	C. vulgaris	2 ind	corr
Chrysoperla carnea (Stephens, 1836) s.l.	Bohinj – Savica 11. VII. 1957	C. microcephala Br.	1 ind	corr
Chrysoperla carnea (Stephens, 1836) s.l.	Dolina Triglavskih jezer [Dol. trigl. j.] 1.-10- VII. 1958	-	5 ind	-
Chrysoperla carnea (Stephens, 1836) s.l.	Dolina Triglavskih jezer /date missing/	C. vulgaris	1 ind	corr
Chrysoperla carnea (Stephens, 1836) s.l.	Ljubljana 1855	C. vulgaris	7 ind	corr
Chrysoperla carnea (Stephens, 1836) s.l.	Ljubljana 15. VI. 1955	-	3 ind	-
Chrysoperla carnea (Stephens, 1836) s.l.	[Croatia] Rovinj 4.-12.IX.????	C. vulgaris	3 ind	corr
Chrysoperla carnea (Stephens, 1836) s.l.	Trenta 28.VII.-1.VIII.???? 1956?	-	5 ind	-
Chrysoperla lucasina (Lacroix, 1912)	Ljubljana 15.VI.1955	-	1 ind	-
Cunctochrysa albolineata (Killington, 1935)	Bohinj 7.-10. VIII. 1959	-	1 ind	-
HEMEROBIIDAE				
Hemerobius humulinus Linnaeus, 1758	Dolina Triglavskih jezer 7.-10.VIII.1959	-	1 ind	-
Hemerobius humulinus Linnaeus, 1758	Trenta 28.VII.-1.VIII.???? 1956?	-	1 male 2 females	-
Hemerobius simulans Walker, 1853	Ljubljana VII. 1955	Hem. simulans	1 ind	corr
Hemerobius stigma Stephens, 1836	Trenta 28. VII.-1. VIII.	-	2 ind	-
Hemerobius pini Stephens, 1836	Dolina Triglavskih jezer 7.-10. VIII. 1959	-	3 ind	-
Hemerobius nitidulus Fabricius, 1777	Trenta 28.VII.-1.VIII.???? 1956?	- (now in coll Devetak)	1 female	-

Hemerobius handschini Tjeder, 1957	Bohinj 7.-10. VIII. 1959	-	1 ind	-
Hemerobius handschini Tjeder, 1957	Dolina Triglavskih jezer 7.-10.VIII.1959	-	1 ind	-
Hemerobius handschini Tjeder, 1957	Trenta 28.VII.-1.VIII.???? 1956?	-	3 males	-
Hemerobius micans Olivier, 1793	Bohinjsko jezero 22.IV.1957	Hemer. micans Oliv.	1 male	corr
Hemerobius micans Olivier, 1793	Bohinj-Savica 11.VIII.1056	Hemerobius micans Oliv.	1 ind	corr
Hemerobius micans Olivier, 1793	[Julian Alps] Črno jez. 1300-1500 m	Hemerobius nitidulus	2 ind	incorr
Hemerobius micans Olivier, 1793	Ljubljana X.1959	-	1 ind	-
Hemerobius micans Olivier, 1793	Trenta 28.VII.-1.VIII.???? 1956?	-	1 ind	-
Hemerobius lutescens Fabricius, 1793	Dolina Triglavskih jezer 7.-10.VIII.1959	-	1 male 1 female	-
Hemerobius sp.	Dolina Triglavskih jezer 2.VI.1957	Hemerobius stigma - unidentified	1 ind	-
Wesmaelius concinnus (Stephens, 1836)	Dolina Triglavskih jezer [Dol. Trigl. j.] 1500-1700 m	-	1 ind	-
Wesmaelius quadrifasciatus (Reuter, 1894)	Krvavec VII.1957	Boriomyia quadrifasc.	1 ind	corr
Wesmaelius quadrifasciatus (Reuter, 1894)	Krvavec 5. VII. 1957	-	4 ind	-
Wesmaelius quadrifasciatus (Reuter, 1894)	Vršič – Kr. Gora 16. VII. 1957	Boriomyia quadrifasciata	1 ind	corr
Wesmaelius fassnidgei (Killington, 1933)	Dolina Triglavskih jezer7.-10.VIII.1959	- [genital preparation in coll Devetak]	1 female	-
Wesmaelius nervosus (Fabricius, 1793)	Krvavec 21.VIII.1955 Carn. leg.	Boriomya subnebulosa [genital preparation in coll Devetak]	1 f	incorr
Wesmaelius malladai (Navás, 1925)	Krvavec VII. 1957 1300 m	Boriomyia nervosa	4 ind	incorr
Wesmaelius tjederi (Kimmins, 1963)	Bohinj-Savica 26.VIII.1959	[genital preparation in coll Devetak]	2 females	-
Wesmaelius tjederi (Kimmins, 1963)	Dolina Triglavskih jezer7.-10.VIII.1959	-	2 males 1 female	-
Wesmaelius subnebulosus (Stephens, 1836)	Log-Trenta 7.VII.1956 Mich.	Boriomya subnebulosa Steph.	1 female	corr
Wesmaelius sp.	Krvavec 5. VII. 1957	- unidentified	2 ind	-

Sympherobius pygmaeus (Rambur, 1842)	Ljubljana 3.VIII.1957	Sympherobius elegans Steph.	1 ind	incorr
Megalomus tortricoides Rambur, 1842	Bohinj 7.-10. VIII. 1959	-	7 ind	-
Megalomus tortricoides Rambur, 1842	Dolina Triglavskih jezer 7.-10.VIII.1959	-	1 m	-
Megalomus tortricoides Rambur, 1842	Trenta 28.VII.-1.VIII.???? 1956?	-	1 male 1 female	-
Megalomus sp.	Log v Trenti 25.VII.1954	Megalomus hirtus - unidentified	1 ind	-
Drepanepteryx phalaenoides (Linnaeus, 1758)	Ljubljana 18.VII.1955	Drepanopteryx phalaenoides	1 ind	corr
Micromus variegatus (Fabricius, 1793)	Trenta 28. VII.-1. VIII.	-	1 ind	-
Micromus paganus (Linnaeus, 1767)	Bohinj 7.-10. VIII. 1959	-	1 ind	-
Micromus paganus (Linnaeus, 1767)	Bohinj 2.-4.VII.1956	Micromus paganus L.	1 ind	corr
Micromus paganus (Linnaeus, 1767)	Krvavec VII.1957 1300 m	Boriomya coccina Steph	1 ind	incorr
Micromus paganus (Linnaeus, 1767)	Krvavec 5. VII. 1957	-	2 ind	-
MANTISPIDAE				
Mantispa styriaca (Poda, 1761)	Bled 11.-30. VII. 1957 Hadži leg.	Mantispa styriaca Poda	1 ind	corr
MYRMELEONTIDAE				
Palpares libelluloides (Linnaeus, 1764)	[Montenegro] Črna gora Bar VII.1955	-	1 ind	-
Myrmeleon formicarius Linnaeus, 1767	Bohinj 7.-10.VIII.1959	-	1 ind	-
Myrmeleon formicarius Linnaeus, 1767	Ljubljana 1956 Mich. leg.	Myrmeleon formicarius	1 ind	corr
Myrmeleon formicarius Linnaeus, 1767	Ljubljana ?	-	1 ind	-
Myrmeleon formicarius Linnaeus, 1767	Nanos 4.-6. VII. 1959	-	1 ind	-
Myrmeleon formicarius Linnaeus, 1767	Trenta, 28.VII.-1.VIII.????	- [wings only]	1 ind	-
Distoleon tetragrammicus (Fabricius, 1798)	[Croatia] Crikvenica 1-4. VII. 1957 Carnelutti J. leg.	Formicaleo tetragrammicus F.	1 ind	corr

Distoleon tetragrammicus (Fabricius, 1798)	[Croatia] Rovinj 25.VII/3.VIII.	-	2 ind	-
Creoleon plumbeus (Olivier, 1811)	[Croatia] Rovinj 4.-18. IX. 1955	Acanthaclisis sp.	1 ind	incorr
Gymnocnemia variegata (Schneider, 1845)	[Croatia] Rovinj date?	-	1 ind	-
		Total number of individuals:	184 ind	

ACTA ENTOMOLOGICA SLOVENICA

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NINE SLOVENIAN NEUROPTEROLOGICAL EXPEDITIONS TO THE BALKAN PENINSULA

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Abstract – In the past, the knowledge on the fauna of Neuropterida in the Balkan Peninsula was sparse. A brief historical review of the faunal research in the area is presented. In a period 2011–2019, zoologists from the Department of Biology of the University of Maribor organized nine Balkan neuropterological expeditions in Albania, Bosnia and Herzegovina, North Macedonia, and Serbia. The study of the neuropterid fauna of these countries resulted in a series of papers which, in general, doubled the known number of species at the country checklist level.

KEY WORDS: Neuropterida, Raphidioptera, Megaloptera, Neuroptera, fauna, Balkan Peninsula, expeditions

Izvleček – DEVET SLOVENSKIH NEVROPTEROLOŠKIH ODPRAV NA BALKANSKI POLOTOK

Poznavanje mrežekrilcev (Neuropterida) Balkanskega polotoka je bilo v preteklosti skromno. Za območje podajamo kratek zgodovinski pregled raziskav. Zoologi Oddelka za biologijo Univerze v Mariboru so v obdobju 2011–2019 izpeljali devet balkanskih nevropteroloških odprav, in sicer v Albanijo, Bosno in Hercegovino, Severno Makedonijo in Srbijo. Na osnovi terenskih raziskav mrežekrilcev v omenjenih deželah so objavili izsledke, kjer so se števila znanih vrst na vrstnih seznamih na nivoju držav v splošnem podvojila.

KLJUČNE BESEDE: Neuropterida, Raphidioptera, Megaloptera, Neuroptera, favna, Balkanski polotok, odprave

Introduction

For a period before 1980, when the monograph on the Neuropterida (Raphidioptera, Megaloptera, Neuroptera) in Europe (Aspöck et al. 1980) was published, the knowledge of the lacewings in the Balkan Peninsula was poor. Only two countries, Bulgaria and Romania were well explored. And even later, the distribution of lacewings on most of the peninsula was insufficiently known, documented mainly with sporadic data. Here, the Balkan Peninsula is regarded in the sense of physical geography (for detailed definition, see Popov 1992).

In a period 2011–2019, zoologists from the Department of Biology, Faculty of Natural Sciences and Mathematics, University of Maribor, organized nine neuropterological expeditions to the Balkan Peninsula with the aim of improving the knowledge of less investigated Balkan countries – Albania, North Macedonia, Serbia and Bosnia and Herzegovina. The aim of the collecting trips was to emend the species lists of Neuropterida for the Balkan countries. The next goal was to study neuropterids from a nature conservation and ecological point of view. In the present paper, details of the expeditions and the results of the field work are summarized.

Knowledge of the neuropterid fauna in the Balkan Peninsula before 2010

In a period between 1980 and 2010, further data on the occurrence of lacewings in the Balkan countries were accumulated. Known distribution of the neuropterids in the West Palaearctic was summarized in a catalogue published in 2001 (Aspöck et al. 2001). Later, Popov and Letardi (2010) reviewed the knowledge and compared the fauna in the Apennine and Balkan peninsulas.

Already in the 1980s, the two best-investigated Balkan countries were **Romania** and **Bulgaria**, mainly due to the activity of B. Kis and A. Popov. A monograph on Neuroptera of Romania (Kis et al. 1970) recognized as one of the first modern works on the order in Europe was an excellent foundation for early studies of the Balkan fauna. Bulgarian neuropterid fauna is probably the best investigated in the Peninsula; many data were published in a series of papers by Popov (for a review of papers, see Popov 2007; Dobosz & Popov 2018).

Despite of the fact that **Slovenia** was relatively well investigated, the Balkan part of the country representing one third of its area still remains under-explored. **Croatia** with a larger part in the Balkans was and still is relatively sufficiently studied (see for e.g., Saure 1989; Devetak 1992; Žanić and Igrc-Barčić 1996; Aistleitner 2007; Rausch and Weißmair 2007; Ábrahám 2008; Ivković and Weißmair 2011; Devetak et al. 2015b; Thierry and Canard 2015; Vilenica et al. 2018).

In the period 1980–2010, the Neuropterida in **Albania**, **North Macedonia**, and **Serbia** were almost unexplored. Only sporadic data were published (e.g., for N Macedonia: Pieper and Willmann 1980; Saure 1989; Popov 1997, 2004; Smiljkov et al. 2005; review: Hristovski et al. 2015; for Serbia: Malicky 1984; Stevanović and Bjelić 1985; Perić et al. 2009). For these countries, there were mostly older, sometimes unreliable data and some papers were published even more than a century ago (for bib-

liography, see: for Albania Devetak and Rausch 2016; for North Macedonia Hristovski et al. 2015; for Serbia Podlesnik et al. 2019). **Kosovo** which was in the past a part of former Yugoslavia, later unilaterally declaring independence from Serbia, is faunistically moderately well researched (Devetak and Jakšić 2003).

One of the least examined Balkan countries is **Bosnia and Herzegovina**. Due to the fact that after the Bosnian War (1992–1995) some areas of the country remain contaminated with unexploded ordnance representing a great threat and danger, collecting insects without the support of the locals can be risky.

Greece is well explored due to the intensive research in a period 1969–1993, when Austrian entomologists – Horst Aspöck, Ulrike Aspöck, Ernst Hüttinger, Hubert Rausch, Renate Rausch, Franz Ressl and Peter Ressl conducted a number of expeditions to different Balkan countries, with the main focus on Greek snakefly fauna (Rausch and Rausch 2004; see also Saure 1989).

Before 2010, there was a moderate knowledge on the neuropterid fauna of **Montenegro**; the only thoroughly studied area of the country was the Durmitor National Park (Devetak 1991; for a provisional checklist of the country, see Devetak and Jakšić 2019).

European part of Turkey was moderately well-studied country of the Balkans (Onar and Aktaç 2002; Onar 2007).

Nine Slovenian neuropterological expeditions to the Balkan Peninsula

In the period from 2011 to 2019, zoologists from the Department of Biology, University of Maribor conducted 9 neuropterological expeditions to the Balkans. Detailed information on the expeditions is presented in Table 1, superficial information with photo gallery one can find in URL site http://zooexpeditions.fnm.um.si/. The field trips were supported by 7 research funds and a number of companies (Table 2). In four countries (Albania, Bosnia and Herzegovina, North Macedonia, Serbia) 18 protected areas – national parks, natural parks and nature reserves were surveyed for lacewings at least superficially (Table 3). The long-term goal of the expeditions is to compile standard checklists and prepare publications of interactively generated neuropterid faunas for selected Balkan countries as part of the *Lacewing Digital Library's* World Neuropterida Faunas series (Oswald 2021).

From 2012 to 2014 three field trips were conducted in **Albania**. Up to that time, only about 39 Neuropterida species were known for the country. Since 2012, 51 species and two families (Coniopterygidae, Mantispidae) were reported for Albania for the first time. Most of these species were collected during Slovenian Balkan expeditions – see Devetak and Rausch 2016; for other species records see Sziráki 2014; Dvořák 2016; Devetak et al. 2020). Antlions were collected in the country with the aim to study their distributional pattern and predatory behaviour. Albania is characterized by rich flora and fauna, and a wide array of ecosystems considering its diverse relief (Figs. 1–9). A noteworthy finding was the discovery of a snakefly *Phaeostigma thaleri* (Aspöck & Aspöck, 1964) exactly one hundred years after collecting the first individual. In Albania (in Divjakë-Karavasta National Park) was confirmed the nort-

Table 1. A list of Slovenian neuropterological expeditions in the Balkan Peninsula in the period 2011–2019.

Year	Expedition with details	Results: published papers
2011	**First Balkan Neuropterological Expedition:** Macedonia (=FYROM) (now: North Macedonia). Period: 5–12 July 2011. Participants: Franc Janžekovič, Meta Janžekovič, Dušan Devetak, Vesna Klokočovnik. Tour: Multi-Purpose Area Jasen: Kula, Lake Kozjak, Blizansko, Vlaka, Nova Breznica, Rudine, Selište, Boro Pole, Karadžica, Gorna Belica; Treska, Katlanovo, Skopje.	Devetak and Klokočovnik 2011; Devetak et al. 2013a; Klokočovnik 2013; Devetak and Arnett 2015; Devetak et al. 2015a; Hristovski et al. 2015.
2012	**Second Balkan Neuropterological Expedition**: Albania. Period: 16–25 July 2012. Participants: Dušan Devetak, Franc Janžekovič, Meta Janžekovič, Vesna Klokočovnik, Jan Podlesnik. Tour: Tiranë, Berat, Çorovoda, River Osumi valley, Këlcyra, Gllava pass, River Vjosa valley, Fir of Hotovë-Dangelli National Park, Frashëri, Përmeti, Divjakë-Karavasta National Park, Apollonia.	Devetak and Janžekovič 2012; Devetak et al. 2012; Devetak et al. 2013b; Klokočovnik 2013; Devetak and Rausch 2016; Podlesnik et al. 2016; Devetak 2019.
2013	**Third Balkan Neuropterological Expedition:** Bosnia and Herzegovina and Albania. Period: 21–28 June 2013. Participants: Dušan Devetak, Tina Klenovšek, Vesna Klokočovnik, Jan Podlesnik; in Bosnia and Herzegovina also Mirza Dautbašić and Osman Mujezinović joined the team. Tour: Bosnia and Herzegovina: Blidinje area: Blidinje Nature Park, lake Blidinje jezero, Čvrsnica Mountain, Montenegro: Nikšić, Podgorica: river Zeta; Albania: Shkodër, Bjeshkët e Nemuna (=Prokletije) Mountains: Bogë – Theth National Park; Krujë, Berati, Divjakë-Karavasta National Park, Droboniku, Zhitomi, Poliçani.	Klokočovnik et al. 2014; Devetak and Rausch 2016; Devetak 2019.
2014	**Fourth Balkan Neuropterological Expedition:** Albania. Period: 25 June–2 July 2014. Participants: Dušan Devetak, Franc Janžekovič, Tina Klenovšek, Vesna Klokočovnik, Jan Podlesnik. Tour: Tiranë, Elbasani, Lake Ohrid, Korça, Fir of Drenovë National Park, Gramoz Mountains, Erseka, Gërmenji, River Vjosa valley, Butrint National Park.	Devetak and Rausch 2016; Klokočovnik et al. 2016; Podlesnik et al. 2016; Devetak et al. 2018, Devetak 2019; Devetak et al. 2019b.
2015	**Fifth Balkan Neuropterological Expedition:** Serbia. Period: 21–28 June 2015. Participants: Dušan Devetak, Franc Janžekovič, Tina Klenovšek, Vesna Klokočovnik, Jan Podlesnik. Tour: Pirot, Special Nature reserve (SNR) Jerma, Zvonačka Banja, Dimitrovgrad, Vidlič Mt., Niš, SNR Jelašnička river gorge, Tara National Park, Perućačko jezro. Reference: Klokočovnik and Devetak 2015.	Canard and Thierry 2017; Podlesnik et al. 2017; Devetak et al. 2019b; Podlesnik et al. 2019.
2016	**Sixth Balkan Neuropterological Expedition:** Serbia. Period: 3–10 July 2016. Participants: Dušan Devetak, Predrag Jakšić, Franc Janžekovič, Tina Klenovšek. Tour: Niš, Special Nature reserve (SNR) Suva Planina, Vidlič Mt., Nature Park Stara Planina: Balkan Mountains, Đerdap National Park - river Donava (the Danube) area, SNR Deliblatska peščara (Deliblato sands), Beograd (Belgrade).Reference: Devetak 2016.	Devetak et al. 2019a; Podlesnik et al. 2019; Ivajnšič and Devetak 2020.

2017	**Seventh Balkan Neuropterological Expedition:** North Macedonia. Period: Part I: 2–9 July 2017; Part II: 5–10 September 2017. Participants: Dušan Devetak, Franc Janžekovič, Tina Klenovšek, Jan Podlesnik, Slavcho Hristovski, Vladimir Krpač. Tour: Part I (DD, FJ, TK, JP, SH): Tetovo, Mavrovo National Park (Korab Mt., Janche), Struga, lake Ohridsko ezero, Galičica National Park, Pelister National Park, Mariovo mountains, Prilep, Skopje. Part II (DD, VKr): Skopje, Treska, Shar Planina Mountains, Pchinja Valley, Veles. Reference: Devetak et al. 2017.	Devetak and Zeqiri 2018; Devetak et al. 2019b; Devetak et al. 2021.
2018	**Eighth Balkan Neuropterological Expedition:** North Macedonia. Period: 31 May–6 June 2018. Participants: Franc Janžekovič, Boža Janžekovič, Slavcho Hristovski. Tour: Skopje, Veles, Kochani, Ovche Pole, Shtip, Demir Kapija, Josifovo, Negortsi, Kozhuf planina Mt., lake Dojransko ezero, Pelister National Park, lakes Prespansko ezero and Ohridsko ezero. Reference: Janžekovič et al. 2018.	
2019	**Ninth Balkan Neuropterological Expedition:** North Macedonia, Greece, and Bosnia and Herzegovina. Period: Part I (North Macedonia, Greece): 19–26 June 2019; Part II (Bosnia and Herzegovina): 5–7 August 2019. Participants: Part I: Dušan Devetak, Franc Janžekovič, Tina Klenovšek, Vesna Klokočovnik, Vladimir Krpač, Jan Podlesnik; Part II: Dušan Devetak. Tour: Part I: N. Macedonia (DD, TK, VK, JP, VKr): Demir Kapija, Gradsko-Stobi, valleys of rivers Vardar and Pchinja, Gjopčeli, Dojransko Ezero, Dojran, Gevgelija: river Konska, Prilep – Pelagonija, lake Prespansko Ezero, Galičica National Park, lake Ohridsko Ezero, Shar Planina Mt.; Greece (only FJ): Peloponnese: Kalogria-Metochi – Panachaiko Mountain – Mount Erymanthos – Mount Aroania (Helmos). Part II: Bosnia and Herzegovina (only DD): River Neretva valley, Mostar, Prenj Mt., confluence of rivers Buna and Neretva, Trebižat river: Nature reserve Kravica: Kravica waterfalls. Reference: Devetak et al. 2019c.	Devetak et al. 2019c; Devetak et al. 2021.

Table 2. Research funds and companies supporting the field trips in the Balkan Peninsula.

RESEARCH PROGRAMMES (*RProg*) / RESEARCH PROJECTS (*RProj*) / GRANTS (*GR*)	
Name	Acronym
RProg Biodiversity Research Programme (Slovenian Research Agency - SRA)	P1-0078
RProg Computationally Intensive Complex Systems (SRA)	P1-0403
RProg Infrastructure Research Programme, 2012–2017	IP-0552
RProg Infrastructure Research Programme CORE@UM, 2018–2021	I0-0029
RProj Biodiversity of the Neuropterida in the Balkan	RP BioDiv Neuropterida Balkan – ALBH 2013
RProj Biodiversity of the green lacewings (Neuroptera: Chrysopidae) in Serbia	RP BioDiv CHRYSER 2015
GR Erasmus+ grant	-
COMPANIES	
Name	Place (site)
AJM okna-vrata-senčila d.o.o.	Pesnica pri Mariboru
ATTEMS storitve d.o.o.	Slovenska Bistrica
BIOTEH d.o.o.	Radomlje

CARRERA Optyl d.o.o.	Ormož
CIZERL d.o.o.	Maribor
DOGŠA d.o.o.	Lendava-Lendva
EBLA d.o.o.	Maribor
GOLOB d.o.o.	Muta
KAMBIČ Laboratorijska oprema d.o.o.	Semič
LABORA d.o.o.	Maribor
MESSER d.o.o.	Ruše
MIKRO+POLO d.o.o.	Maribor
M PLUS podjetje za trženje d.o.o.	Maribor
OPTIKA ARENA d.o.o.	Maribor
ORGANIC NUTRIENTS, Bojan Kujavec s.p.	Maribor
PERGER 1757 d.o.o.	Slovenj Gradec
ROMIKS Didaktična oprema Sterkuš Robert s.p.	Laporje
ROTO Slovenija d.o.o.	Puconci
SIRARNA ČUŠ d.o.o.	Orehova vas
SNOPJE, proizvodnja in storitve d.o.o.	Ljutomer
TEHNOOPTIKA SMOLNIKAR d.o.o.	Ljubljana-Črnuče
TRATNJEK servis in trgovina d.o.o.	Murska Sobota

Table 3. Protected areas – national parks, nature parks and nature reserves visited during field trips in the period 2011–2019.

Country	Protected area; year(s) of visit
Albania	Butrint National Park; 2014 Divjakë-Karavasta National Park; 2012, 2013 Fir of Drenovë National Park; 2014 Fir of Hotovë-Dangelli National Park; 2012 Theth National Park; 2013
Bosnia and Herzegovina	Blidinje Nature Park; 2013 Nature reserve Kravica; 2019
North Macedonia	Galičica National Park; 2017, 2019 Mavrovo National Park; 2017 Multi-Purpose Area Jasen; 2011 Pelister National Park; 2017, 2018
Serbia	Đerdap National Park; 2016 Nature Park Stara Planina; 2016 Special Nature reserve Deliblatska peščara (Deliblato sands); 2016 Special Nature reserve Jerma; 2015 Special Nature reserve Jelašnička river gorge; 2015 Special Nature reserve Suva Planina; 2016 Tara National Park; 2015

Figs. 1–9: Albania. Fig. 1: Sand dunes in the Divjakë-Karavasta National Park, a place of rare antlions (*Myrmeleon hyalinus* Olivier, *Acanthaclisis* Rambur and *Synclisis* Navás). Fig. 2: Tirana, 25 June 2014. From left to right: F. Janžekovič, D. Devetak, V. Klokočovnik, T. Klenovšek, J. Podlesnik. Fig. 3: Bjeshkët e Nemuna (=Prokletije) Mountains: Bogë surroundings. Fig. 4: River banks with fine sand, a typical habitat of *Cueta lineosa* (Rambur); Osumi river near Berat. Fig. 5: Fir of Hotovë-Dangelli National Park: first mantidflies in Albania were found on a single maple tree. Fig. 6: Dry meadows in Qafa e Gllavës, a place of *Deleproctophylla* Lefèbvre. Fig. 7: Dry parts of the riverbed of Albanian rivers is a habitat of *Cueta*-larvae; river Vjosa near Tepelenë. Fig. 8: In the Fir of Drenovë National Park were collected a few rare or interesting snakeflies (e.g., *Phaeostigma thaleri* /Aspöck et Aspöck/, *P. pilicollis* /Stein/). Fig. 9: Forest edge of the mixed forest in the Fir of Drenovë National Park, a place of *Parvoraphidia microstigma* (Stein).

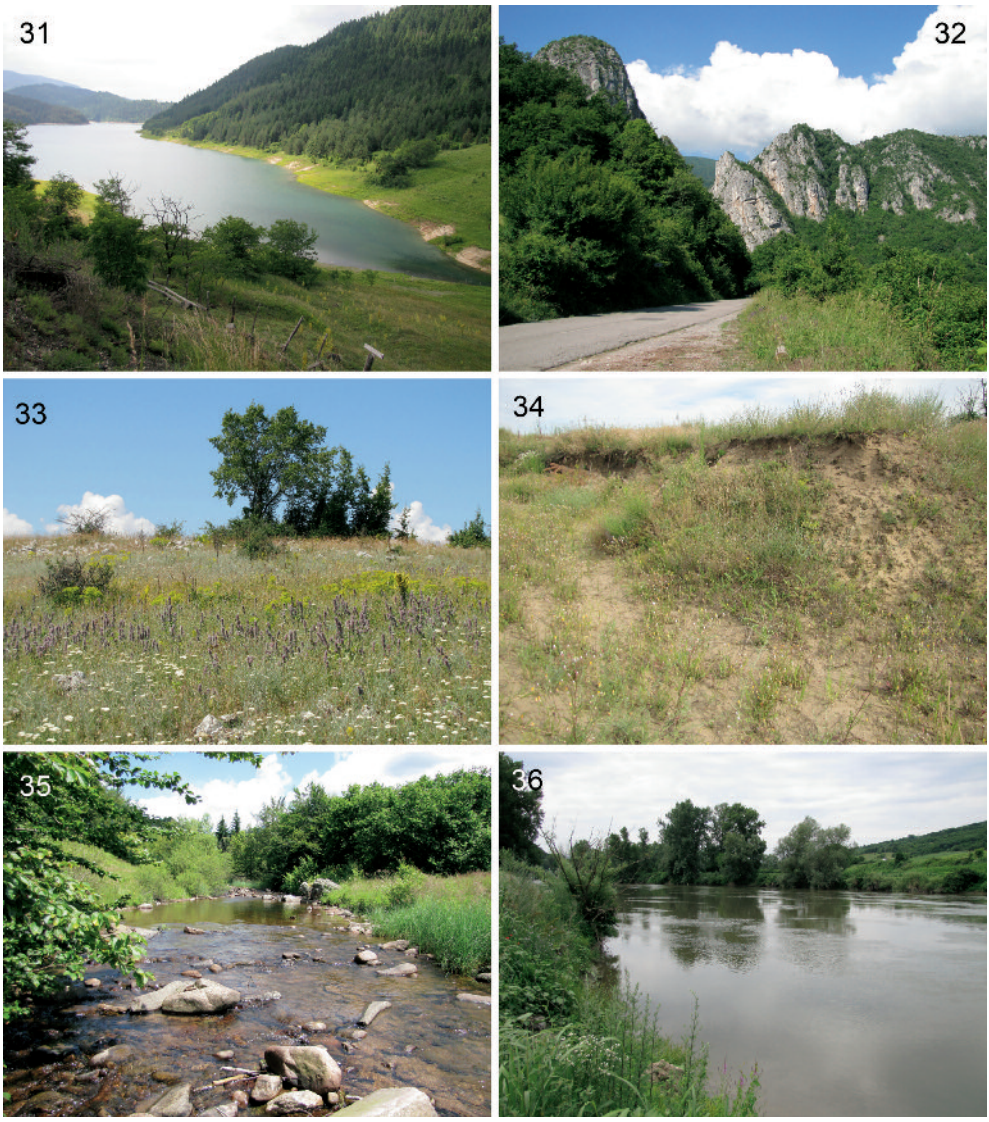
Figs. 10–16: Bosnia and Herzegovina. Fig. 10: Blidinje Nature Park, 22 June 2013. From left to right: Osman Mujezinović, T. Klenovšek, V. Klokočovnik, J. Podlesnik. Fig. 11: Lake Perućac on the Drina River was the first collecting place of *Sisyra nigra* (Retzius) in Bosnia. Fig. 12: Čvrsnica in the Blidinje Nature Park is the highest mountain in Herzegovina. Figs. 13 and 14: Two places in Herzegovina with spongillaflies: Buna River (Fig. 13) and Kravica waterfalls on the Trebižat River (Fig. 14). Fig. 15: Prenj is a mountain range in the Dinaric Alps. Fig. 16: Bosnian pine (*Pinus heldreichii* var. *leucodermis* /Antoine/ Markgr. ex Fitschen) is endemic for the Balkans; Prenj.

Figs. 17–28: North Macedonia. Fig. 17: Shar Mountains (Šar Planina), Popova Šapka, 24 June 2019. From left to right: J. Podlesnik, V. Klokočovnik, Vladimir Krpač, T. Klenovšek. Fig. 18: Slandol area, 8 July 2017. From left to right: F. Janžekovič, J. Podlesnik, T. Klenovšek, Slavčo Hristovski. Fig. 19: Multi-Purpose Area Jasen, 8 July 2011. F. Janžekovič and V. Klokočovnik. Fig. 20: Jasen Area: Lake Kozjak is in the background. Fig. 21: Korab mountain, above the Zhirovnica village. Figs. 22 and 23: Two places in North Macedonia with spongillaflies: Pchinja River near Veles (Fig. 22) and Crna Reka River between Shtavica and Vitolishte (Fig. 23). Fig. 24: Rudine in the Multi-Purpose Area Jasen is a plateau where two snakeflies, *Phaeostigma pilicollis* and *P. setulosa setulosa* (Aspöck et Aspöck) occur. Figs. 25 and 26: The brown lacewing *Hemerobius schedli* Hölzel was only recently confirmed for two mountains: Planina Baba mountain in the Pelister National Park (Fig. 25) and Shar Mountains (Fig. 26). Fig. 27: Fine sand in dry riverbed of the Konska River is a convenient substrate for antlion larvae. Fig. 28: Slandol area, central North Macedonia, is the driest part of the country.

hernmost Balkan locality of an antlion *Myrmeleon hyalinus* Olivier, 1811 (Devetak et al. 2013b; Devetak and Rausch 2016). Albania (Devetak 2019) was the first Bakan country with completed interactively generated fauna as part of the *Lacewing Digital Library's* World Neuropterida Faunas series (Oswald 2021).

There is only a handful of data from **Bosnia and Herzegovina** in the past, scattered in – mainly the old – literature (e.g., Klapálek 1898, 1899, 1900; Navás 1932; Aspöck et al. 1977, 1991). In 2013 and 2019, two short collecting trips were organized to the Blidinje Nature Park, Prenj Mountain, and the Neretva valley (Figs. 10–16). In these

Figs. 29–36: Serbia. Fig. 29: Suva planina, 4 July 2016. From left to right: T. Klenovšek, F. Janžekovič and Predrag Jakšić. Fig. 30: The Danube is the second-longest river in Europe; in the background is the Romanian bank of the River. Fig. 31: Typical landscape in the surrounding of the Lake Zaovine in the Tara National Park. Fig. 32: Jerma gorge is a protected river valley in southeast of Serbia. Fig. 33: Vidlič mountain is known for *Libelloides lacteus* (Brullé) and *Mantispa* spp. Fig. 34: Grassland habitats in the Special Nature reserve Deliblato Sands are endangered due to the overgrowing process. Fig. 35: Along the Dojkinačka reka River is one of a few places in Serbia with *Nevrorthus*-adults. Fig. 36: Zapadna Morava River, where *Sisyra terminalis* Curtis was surveyed. Photos: D. Devetak.



trips, besides some rare lacewings, spongillaflies (Sisyridae) were recorded in the country for the first time (in Neretva river basin and Drina river sub-basin; Podlesnik et al. 2017 and unpublished). This least surveyed Balkan country deserves more attention due to interesting discoveries in the two trips.

Before 2011, numerous papers dealing with Neuropterida in **North Macedonia** have been published, mostly containing only sporadic data (for review, see Hristovski et al. 2015, Devetak and Zeqiri 2018). Among old authors, the most famous is Doflein (1921) who published a magnificent book on natural and cultural heritage of the

country. Doflein's "Mazedonien" was a fundamental monograph on the Macedonian fauna in the period before WWII, a chapter of the book is devoted to antlions. Among recent publications reviewing knowledge at the family level has a great value a monograph on owlflies of the peninsula (Popov 2004) with distributional data for 4 species in the country. In 2011 and 2017–2019, four Balkan expeditions were conducted in North Macedonia (Figs. 17–28). Collecting trips in the country and support of local zoologists offered opportunity to survey a rich material of lacewings both deposited in the Macedonian Museum of Natural History in Skopje (Devetak and Zeqiri 2018) and collected in the field. On the other hand, additional neuropterids were submitted to the author by other entomologists (P. Jakšić, V. Krpač, A. Nahirnić-Beshkova, S. Beshkov, I. Sivec, V. Slavevska-Stamenković; Devetak et al. 2016, 2020). The field trips increased the species list of Neuropterida for the country from 53 to 107 species (Table 4). Three antlion species reported in 2013 (Kačírek 2013) which were not attributed to the expeditions were also added up in Table 4. However, North Macedonia is characterized by relatively high number of species, considering its relatively small area. The country is – following Bulgaria, Romania and Greece – the fourth Balkan country regarding the species numbers of Neuropterida.

Past records of Neuropterida in **Serbia** are scattered in numerous papers (review Podlesnik et al. 2019), some of them with a limited value due to the fact that the basic taxonomic questions at that time have not yet been resolved. Two expeditions (2015, 2016) increased the species list of Neuropterida for Serbia from 37 to 84 species (Table 4). The focus of the field trips in the landlocked country was the survey of the fauna in protected areas (Table 3), including lowland and montane habitats (e.g., Special Nature reserve Deliblato sands, Tara National Park; Figs. 29–36). In the future, a conservation status (extinct, endangered) should be verified for those antlion species which were reported for the country a century ago (Ivajnšič and Devetak 2020). With 84 neuropterid species only about two-thirds of the species to be expected for Serbia are known.

Unfortunately, the COVID-19 pandemic prevented the planned expedition in the Balkan Peninsula in 2020. Further collecting trips will add more species to the country checklists.

Conclusion

In the period 2011–2019 four less investigated Balkan countries (Albania, Bosnia and Herzegovina, North Macedonia, Serbia) were surveyed for Neuropterida. Collecting effort yielded 119 neuropterid species. Rich biodiversity of Neuropterida in the Balkan Peninsula is the result of the complex interactions of geomorphology, climate and vegetation creating a wide variety of ecoregions (Olson et al. 2001). While the first checklist on Albanian Neuropterida has already been published (Devetak and Rausch 2016), North Macedonia is among the four surveyed countries which has been the most thoroughly studied during the expeditions. Checklists of neuropterids of North Macedonia and Serbia are in preparation. Undoubtedly, further collecting trips will yield more species.

Table 4. Summary of the known species numbers of Neuropterida in three countries sorted by families.

Country	Albania		North Macedonia		Serbia (without Kosovo)	
	Known species number		Known species number		Known species number	
Time period	before 2011	present knowledge	before 2011	present knowledge	before 2011	present knowledge
Raphidioptera						
RAPHIDIIDAE	7	12*[1]	9	10	4	6
INOCELLIIDAE	0	1	1	1	0	0
Total Raphidioptera	7	13	10	11	4	6
Megaloptera						
SIALIDAE	0	1*[2]	1	2	2	3
Total Megaloptera	0	1	1	2	2	3
Neuroptera						
NEVRORTHIDAE	1	1	1	1	1	1
OSMYLIDAE	1	1	1	1	1	1
CHRYSOPIDAE	9	25	12	28	10	25
HEMEROBIIDAE	7	17	2	21	5	20
SISYRIDAE	0	0	0	2	0	2
CONIOPTERYGIDAE	0	6	9	14	1	9
DILARIDAE	1	1	1	1	0	0
MANTISPIDAE	0	3	2	3	0	2
BEROTHIDAE	1	1	1	1	0	0
NEMOPTERIDAE	0	0	1	1	0	0
MYRMELEONTIDAE	9	17	8	17*[3]	12	13
ASCALAPHIDAE	3	4	4	4	1	2*[4]
Total Neuroptera	32	76	42	94	31	75
Sum Neuropterida (Meg., Raph., Neur.)	39	90	53	107	37	84

*[1]Sziráki 2014 reported on three snakefly species.
*[2]Dvořák 2016.
*[3]Three antlion species listed by Kačírek (2013) are also included in the country list.
*[4]Report on an additional owlfly species by Petrović 2013 is also included.

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STATUS OF BUTTERFLIES (LEPIDOPTERA, PAPILIONOIDEA) IN THE ŠAR MOUNTAINS IN THE REPUBLIC OF NORTH MACEDONIA

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Abstract – We focused on the Macedonian part of the Šar mountain range, by gathering and checking literature data, including data from two entomological collections, and adding the results and observations from our recent intensive field research on the butterfly fauna performed during the last 6 years (2014-2019). As a result, 179 species are reported in the Šar Mountains. They belong to 6 families: Hesperiidae with 21 species, Papilionidae with 6 species, Pieridae with 20 species, Riodinidae with 1 species, Lycaenidae with 51 species and Nymphalidae with 80 species. We selected 39 of them as key species for the protection of this national natural heritage. The data of these species are detailed in the paper. These species can be monitored in the future to foresee the trend of the evolution of the biodiversity in this mountain range. In addition, it is a tool to contribute to the zoning of the most important areas to be protected within the Šar Mountains.

KEY WORDS: Butterflies, Šar Mountains, check-list, indicators, endemism.

Izvleček – STANJE METULJEV (LEPIDOPTERA, PAPILIONOIDEA) NA ŠAR PLANINI V SEVERNI MAKEDONIJI

Z zbiranjem in preverjanjem podatkov iz literature, vključno s podatki iz dveh entomoloških zbirk, smo se osredotočili na makedonski del pogorja Šar planine in dodali rezultate in opazovanja nedavnih intenzivnih terenskih raziskav favne metuljev, opravljenih v zadnjih 6 letih (2014 – 2019). Posledično je na Šar planini zabeleženih 179 vrst iz 6 družin: Hesperiidae z 21 vrstami, Papilionidae s 6 vrstami, Pieridae z 20 vrstami, Riodinidae z 1 vrsto, Lycaenidae z 51 vrstami in Nymphalidae z 80 vrstami. Med njimi smo jih 39 izbrali kot ključne vrste za varstvo te nacionalne naravne dediščine. Podatki o njih so podrobno opisani v prispevku. S spremljanjem teh vrst v prihodnosti je mogoče predvidevati trend spreminjanja biotske raznovrstnosti v tem gorskem območju. Poleg tega so orodje, ki prispeva k določanju najpomembnejših območij, ki jih je treba zaščititi v pogorju Šar planine.

KLJUČNE BESEDE: Metulji, Šar planina, seznam vrst, kazalci, endemizem.

Introduction

Butterflies (Lepidoptera, Papilionoidea) are represented by 204 species in the Republic of North Macedonia. We focused on the species present in the Macedonian part of the Šar mountain range. From a faunistic point of view, the Šar Mountains are characterized by a high degree of diversity with many beautiful and different natural landscapes. The impact of the two climates (moderate Mediterranean and continental), the presence of numerous plant communities as well as the diversity of biotopes, have contributed to the emergence and presence of abundant and varied animal life. There are a greater number of species, especially in the world of butterflies which, with their various shapes and colours, particularly attract human attention.

In the early stages, most of the research on butterfly fauna in the Republic of North Macedonia was partial, with scarce information about their distribution. The first summary has been done by Thurner who gathered all previous data for Macedonia and published them in the book printed in 1964: "Die Lepidopterenfauna Jugoslavisch Mazedoniens – I. Rhopalocera, Grypocera und Noctuidae". More than two decades later, in 1989, Paul Schaider and Predrag Jakšić published a book with data, illustrations and distribution maps for the whole country: "Die Tagfalter von jugoslawisch Mazedonien".

The first butterfly records from the Šar Mountains were published just before the World War I by Rebel (1913). Then, the following authors have published their records from the studied region: Doflein (1921), Rebel and Zerny (1931); Daniel et al. (1951); Lorković (1953); Michieli (1963). Thurner (1964), Dufay (1973, 1977), Arnscheid and Arnscheid (1980); De Freina (1983); Schaider (1980, 1984); Jakšić (1988; 1989, 1998a, 1998b, 2001); Schaider and Jakšić (1989); Kocak (1989); Beshkov (1996); Melovski (2003, 2004); Abadjiev (2006); Krpač et al. (2008); Kolev (2010); Huemer et al. (2011); Krpač and Darcemont (2012); Krpač et al. (2013); Abdija et al.

(2013a; 2013b; 2013c; 2013d; 2017; 2019a; 2019b); Louy et al. (2013; 2014); Varga (2014), Melovski and Božinovska (2014).

During 6 years, we performed a research on the Šar Mountains butterflies (2014-2019) to assess the current status of the butterfly's fauna in this mountain range.

Materials and methods

We included in this paper data from two entomological collections (Macedonian Museum of Natural History - SKO and Institute of Ecology and Technology - IET), data from the literature and the results of our field research.

Under the term "Authors unpublished data" are all the data collected in-situ during our 6 years study 2014-2019.

The following abbreviations used in this paper are: v. (village) and r. (river)

Concerning the literature, some names of localities and some erroneous data have been corrected.

During our research, we used the classic avio-entomofauna hunting method with an entomological net (catcher) (Fig. 1). All the material captured was deposited in the Macedonian Museum of Natural History (SKO) or in the collection of the Institute of Ecology and Tehnology (IET), for a total of 4380 butterflies.

For a few species, genitalia were checked (*Leptidea sinapis/juvernica, Hipparchia semele/volgensis, Melitaea athalia/aurelia,* etc.). We still have ambiguous literature

Fig. 1. Collecting with entomological net

data for records anterior to the description of some close species, and in this paper we have chosen to keep old data potentially ambiguous.

The coordinates of the localities are given in Annex II and the location on a map can be done using http://geem06.free.fr/SharMt/localities.html

The butterfly systematics is in accordance with Wiemers et al. (2018). The synonyms of the species have been corrected and clarified as well.

The endangerment of each species is given in accordance with IUCN European Red List, Van Swaay et al. (2010), Maes et al. (2019, 2020) and Macedonian Red List by Krpač and Darcemont (2012).

Area of investigation

The Šar Mountains are located in the northwest part of Republic of North Macedonia. The massif extends northeast-west-southwest direction in length of 80 km,

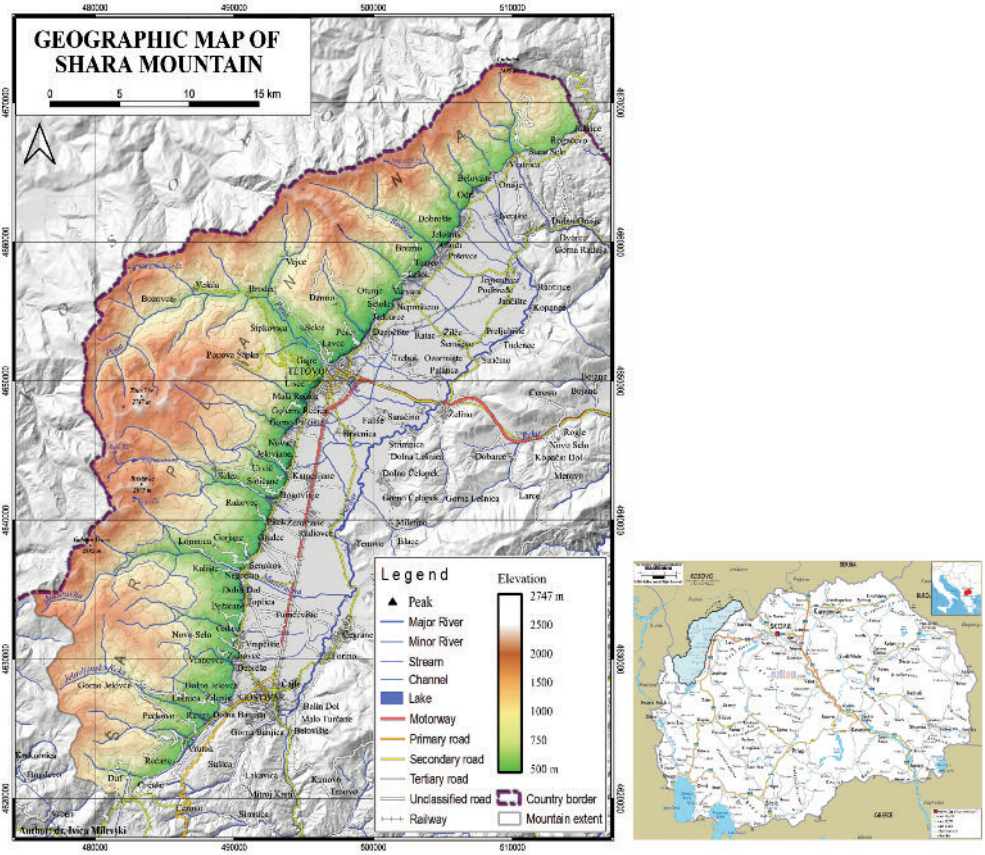

Fig. 2. Area of investigation located in north-west of the Republic of North Macedonia.

over an area of 1600 km^2 (Fig. 2).This mountain range has a large number of peaks over 2000 m above sea level, and about twenty over 2500 m.

The Šar Mountains extend also in Kosovo, with large number of peaks on the border between the two countries. In this paper, under the name ″Šar Mountains″, we will refer to Macedonian part of the massive.

The Šar Mountains form a region of a particular natural beauty. It is known in Europe as a hotspot of biological diversity.

The vegetation is composed of elements of sub-Mediterranean and subarctic flora. The vegetation storeys are of the south-alpine type, with a predominance of mountain and subalpine belts, up to 2700 m above sea level, the highest point of these mountains.

The Šar Mountains can be divided into three belts: up to 1000-1200 m, there are traditional agricultural lands, fields with hedges, and deciduous forests of oak, beech and chestnut (foothills belt). Above this belt and up to a height of about 1700 m, it is the mountain belt, composed of clearings and edges of deciduous or mixed forests (beech-fir), hay grasslands, wet and mesophilic meadows, drier pastures often grazed. Still above and up to the highest peaks, we are in the subalpine belt. This higher altitudinal belt covers a significant part of the Šar mountain range. Above 1800 m, more or less grazed pastures are predominant. In some places, they form macro-mosaics with mainly thickets with *Juniperus communis nana* or heaths with *Vaccinium myrtillus*. There is enough water on all the mountains and the overflows of the high lakes favour the formation of small more humid areas where grows a more dense herbaceous vegetation.

The fauna and flora differ according to the altitude and some of their representatives are very characteristic of these different vegetation belts.

Results

In total 179 species of butterflies (Lepidoptera, Rhopalocera) are recorded from the Šar Mountains, which is 88% of the total number of the known species (204) in the Republic of North Macedonia. The list of the taxa is given in Annex I.

The 41 butterfly species detailed below are threatened (according to Macedonian Red List) and some of them have a low ecological valence (relationship with specific biotopes) and can indicate the current quality of habitats of the area and could be used among the tools to determine the zoning of the future protected area within the Šar Mountains.

Fam. Hesperiidae Latreille, 1809

1. *Carcharodus floccifera* (Zeller, 1847)

syn. *Carcharodus altheae* (Hübner, 1803) in Daniel et al (1951); Thurner (1964)

In IUCN Red List Europe: Near Threatened (NT), in Macedonian Red List: NT.

Present in foothills and montane zones, in meadow, rocky meadow, mesophilic grassland, forest edge or clearing habitats.

Literature data: Šar Mountains, v. Brodec (Pena r.), v. Lešok as *Carcharodus altheae* in Daniel et al. (1951); v. Brodec, Crn Vrv as *Carcharodus altheae* in Thurner

(1964: 49); Jakšić (1988); Šar Mountains, Kocak (1989); v. Brodec, Jakšić (1998a); Mavrovo Radika r. Abdija (2013d); Gorno Lukovo Pole, Krpač et al (2013).

Collection data (IET): v. Staro Selo, 817 m, 01.07.2013; 1♂ 1♀; v. Rakovec, 962 m, in 2013; Bistrica, (v. Tearce), 769 m, in 2013; v. Gajre - v. Lisec, 1204 m, in 2013; v. Belovište, 785 m, in 2013, (leg. Xh. Abdija).

Authors unpublished data: northeast of v. Vratnica near Kosovo border, 725 m, 25.06.2012, meadows.

2. *Muschampia proto* (Ochsenheimer, 1808)

syn. *Sloperia* (*Hesperia*) *proto* (Ochsenheimer, 1808) in Thurner (1964)

In Macedonian Red List: Near Threatened (NT).

Only one old datum in foothills zone reported at Vratnica (700 m asl) by Josef Thurner (1964). This datum (from Franz Daniel) is very old but undated. The current presence of the species on the Šar Mountains has not been confirmed. We cannot use this species as indicator for this area.

Literature data: v. Vratnica, 700 m, (leg. F. Daniel) as *Sloperia* (*Hesperia*) *proto* in Thurner (1964); in Jakšić (1988).North_est of v.

3. *Pyrgus andromedae* (Wallengren, 1853)

In Macedonian Red List: Near Threatened (NT).

Present in subalpine zone in meadow, rocky meadow, and low shrubbery habitats.

Literature data: Jakšić (1988); Meanče, Jakšić (1998a); Šar Montanes, Kolev (2010); Borislavec, Abdija et al (2013d).

Collection data (IET): Crno Lake, 2122 m, in 2013; Borislavec, 1679 m, in 2013, (leg. Xh. Abdija).

4. *Spialia phlomidis* (Herrich and Schäffer, 1845)

In Macedonian Red List: Near Threatened (NT).

Present in foothills zone, in meadow and rocky meadow habitats.

Literature data: v. Jažince (668) in Abdija (2013d: 49).

Collection data (IET): v. Jažince, 677 m, 26.06.2012, 1♂ 1♀; v. Jažince, 720 m, 26.07.2013, (leg. Xh. Abdija).

Authors unpublished data: northeast of v. Vratnica near Kosovo border, 725 m, 25.06.2012; v. Vratnica, 742 m, 25.07.2013.

5. *Carterocephalus palaemon* (Pallas, 1771)

In Macedonian Red List: Near Threatened (NT).

Present in foothills and montane zones, in forest edge or clearing habitats.

Literature data: Jakšić (1988).

Authors unpublished data: v. Brodec, 1040 m, 12.06. 2019.

Fam. Papilionidae Latreille, 1802

6. *Zerynthia polyxena* ([Denis and Schiffermuller], 1775)

as *Zerynthia polyxena demnosia* Freyer, 1833 in Daniel et al (1951)

In Macedonian Red List: Near Threatened (NT), in Bern Convention appendice II and Habitat directive annex IV.

Present in foothills and montane zones, in mesophilic grassland, forest edge or clearing and riparian vegetation habitats.

Literature data: v. Vratnica, Lešok Monastery, as *Zerynthia polyxena demnosia* Daniel et al (1951); Jakšić (1988); v. Gajre, v. Lisec, Abdija et al (2019); Gostivar, v. Vrutok, springs of Vardar r. Krpač et al (2013).

Collection data (IET): Lešok Monastery, 600 m, 02.08.2011. (leg. V. Krpač); v. Stenče, 575 m, 01.06.2012, 2♂ 4♀; v. Jelovjane, 1142 m, in 2013; Mazdrača v. Lomnica, 750 m, in 2013; above v. Vratnica, 910 m, in 2013, (leg. Xh. Abdija)

.

7. *Zerynthia cerisy* (Godart, [1824])

as *Zerynthia cerisy ferdinandi* in Daniel et al (1951)

In IUCN Red List Europe: Near Threatened (NT), in Macedonian Red List: NT.

Present in foothills and montane zones, in mesophilic grassland, forest edge or clearing habitats.

Literature data: Tetovo, v. Lešok as *Zerynthia cerisy ferdinandi* in Daniel et al (1951); Tetovo, v. Orašje, v. Lešok, v. Vratnica in Thurner (1964); Jakšić (1988); v. Vratnica, v. Lešok Jakšić (1998a); v. Gajre, v. Lisec in Abdija et al (2019).

Collection data (SKO): v. Varvara, 850 m, 06.06.1978. (leg. J. Čingovski).

Collection data (IET): v. Nerašte, 536 m, 20.05.2012, 1♂ 1♀; v. Jelovjane, 1142 m, in 2013; Mazdrača v. Lomnica, 750 m, in 2013; v. Rakovec, 962 m, in 2013; v. Vratnica 910 m, in 2013, (leg. Xh. Abdija);v. Lisec, 1188 m, 24.05.2019, 1 ex (leg. V. Krpač).

Authors unpublished data: v. Vrutok, 710 m, 24.05.2010; v. Vratnica, 700 m, Lešok Monastery, 600 m, spring of Vardar r, 710 m, 24.05.2010.

8. *Parnassius mnemosyne* (Linnaeus, 1758)

as. *Parnassius mnemosyne bureschi* in Daniel et al (1951); *Parnassius mnemosyne parvasi* in Thurner (1964)

In IUCN Red List Europe: Near Threatened (NT), in Macedonian Red List: NT, in Bern Convention appendices II and IV, in Habitat directive annex IV.

Present in foothills zone, in mesophilic grassland and forest edge or clearing habitats.

Literature data: Ljuboten Rebel (1913); Ljuboten Rebel and Zerny (1931); v. Lisec as *Parnassius mnemosyne bureschi* in Daniel et al (1951); in the area of Šar Mountains as ssp. *parvasi* in Thurner (1964); Jakšić (1988); Ljuboten near mountain refuge, Jelak - Crn Vrv Melovski (2002); Radika r. Lukovo Pole, Mavrovi Anovi to v. Vrben, Crn Kamen Lukovo Pole Krpač et al (2013); Mazdrača Abdija (2017); v. Gajre, v. Lisec Abdija et al (2019).

Collection data (SKO): Radika r. Lukovo Pole 25.05.1995. (leg. V. Krpač).

Collection data (IET): Lukovo Pole, 1527 m, 26.05.2010. (leg. Krpač); v. Pirok, 645 m, 25.05.2012; v. Belovište, 785 m, in 2013; Borislavec, 1679 m, in 2013; v.

Kalište, 728 m, in 2013; Popova Šapka, 1436 m, in 2013; v. Rakovec, 962 m, in 2013, (leg. Xh. Abdija).

Authors unpublished data: v. Vrben, 1335 m, 18.06.2010; road to v. Vrben, 1350 m, 18.06.2010; near Kosovo border, 1530 m, 18.06.2010; Crn Kamen, 1536 m, 18.06.2010; Popova Šapka, 1719 m, 26.06.2013; near v. Šipkovica, 1208 m, 09.06.2014.

9. *Parnassius apollo* (Linnaeus, 1758) ssp. *macedonicus* Bollow, 1931

as. *Parnassius apollo dardanus* in Rebel and Zerny (1931); *Parnassius apollo macedonicus* in Daniel et al (1951)

In IUCN Red List: Near Threatened (NT), in Macedonian Red List: Vulnerable (VU), in Bern Convention appendices II and IV, in Habitat directive annex IV, in CITES list.

Present in montane and subalpine zones, in meadow, rocky meadow, low shrubbery, mesophilic grassland and forest edge or clearing habitats.

Literature data: Kobilica, Ljuboten Rebel (1913); as *Parnassius apollo dardanus* in Rebel and Zerny (1931); as *Parnassius apollo macedonicus* in Daniel et al (1951); Šar Mountains Radika r. Michieli (1963); Crn Vrv, Kobilica, Ljuboten Thurner (1964); Radika r. v. Trnica Dufay (1973); Jakšić (1988); Ljuboten, Kobilica in Jakšić (1998a); v. Melovo near the river Bistrica, Ljuboten over v. Staro Selo, Čaušica, Ljuboten over Elezova Rupa, Jelak – Crn Vrv, Jelak Mountain Lodge Melovski (2002); Radika valley around bridge 10 km NNW Sveta Voda Huemer et al (2011); canyon of Radika r. v. Trnica, Radika r. Pilana, Radika r., v. Ničpur, Strezimirska River near Sveta Voda, Adžina River II, canyon of Radika r. close to Sveta Voda Krpač et al (2013).

Collection data (SKO): Ceripašina, 2500 m, 26.07.1952. (leg. J. Čingovski); Radika r., 942 m, 12.07.1975. (leg. S. Jakonov); Ljuboten, 2460 m, 28.08.1976. (leg. S. Jakonov); Radika r. upper course, 1527 m, 04.07.1995; v. Ničpur, 986 m, 11.08.2004; Kobilica Gornovica, 2450 m, 26.07.2007; above Sveta Voda, 1573 m, 14.08.2011. (leg. V. Krpač).

Collection data (IET): v. Vešala, 23.06.2012; Popova Šapka, 1436 m, in 2013; v. Staro Selo, 1655 m, in 2013; v. Brodec, 1090 m, in 2013, (leg. Xh. Abdija); Popova Šapka, 1745 m, 23.07.2016; under Karanikoličko Lake, 1766 m, 04.08.2017; Dolna Lešnica, 1476 m, 18.08.2018; Jelak, 1823 m, 08.08.2019. (leg. V. Krpač).

Authors unpublished data: v. Ničpur, 1086 m, 11.08.2004; Kobilica, 2360 m, 26.07.2007; Kobilica Gornovica, 2450 m, 26.07.2007; Radika r. v. Trnica, 942 m, 21. 07.2009; Radika r. Lukovo Pole, 1550 m, 26.05.2010; Mavrovo, 1750 m, 16.06.2010; Mavrovo - mountain northwest of v. Ničpur, 2105 m, 20.08.2010; Mavrovo - mountain northwest of v. Ničpur, 1945 m, 20.08.2010; Šar Mountains south 1540 m, 22.08.2010; Mavrovo Adžina River II - north mountain of v. Brodec, 1540 m, 22.08.2010; spring of Strezimirska River near Sveta Voda, 1247 m, 01.08.2012; mountain above Popova Šapka Ceripašina, 2382 m, 05.08.2012; Ljuboten, 1960 m, 06.08.2012; Ljuboten, 1963 m, 06.08.2012; Jelak 1780 m, 22.07.2016; Lešnica,1432 m, 24.07.2016; Plat mountain, 1820 m, 24.07.2016; near Lešnica, 1820

m, 24.07.2016; Krivošija, 2139 m, 27.07.2016; road to Tri Vodi, 1614 m, 08.07.2017; Gorna Lešnica, 1776 m, 15.07.2017; Gorna Lešnica, 2018 m, 03.08.2017; Krivošija, 1880 m, 03.08.2017; road to Karanikola, 1754 m, 04.08.2017; Jelak - Crn Vrv, 1752 m, 11.08.2019.

Fam. Pieridae Swainson, 1820

10. *Pieris krueperi* Staudinger, 1860

In Macedonian Red List: Near Threatened (NT), in Bern Convention appendix II.

Present in foothills zone, in meadow, rocky meadow, low shrubbery habitats.

Collection data (IET): close to v. Jažince, 677 m, 25.06.2012, 1ex (leg. V. Krpač).

Authors unpublished data: near v. Jažince, 739, 25.06.2012; northeast of v. Vratnica near the Kosovo border, 725 m, 25.06.2012.

11. *Anthocharis gruneri* Herrich-Schäffer, 1851

In Macedonian Red List: Near Threatened (NT).

Present in foothills and montane zones, in meadow, rocky meadow, low shrubbery, forest edge or clearing habitats.

Literature data: Schaider and Jakšić (1989); v. Nerašte, Abdija (2013a); Adžina River Torbeški Most 1390 m, Adžina River, 1549 m, in Krpač et al (2013).

Collection data (SKO): v. Vratnica, 715 m, 29.06.1975, 1ex (leg. S. Jakonov).

Collection data (IET): v. Radiovce, 515 m, 17.04.2013, 2♂ (leg. Xh. Abdija).

Authors unpublished data: Radika r. Lukovo Pole, 1550 m, 26.05.2010; Torbeški Most - Adžina River, 1390 m, 26.05.2010; Ljuboten, 1963 m, 06.08.2012.

12. *Colias caucasica* Staudinger, 1871 ssp. *balcanica* Rebel, 1903

In Macedonian Red List: Near Threatened (NT).

Present in montane zone, in meadow, low shrubbery, mesophilic grassland, forest edge or clearing, riparian vegetation habitats.

Literature data: Jakšić (1988); v. Gorno Jelovce (Dedel Beg), v. Gorno Jelovce, Bojkov Kamen Melovski (2002); v. Ničpur 986 m, Mavrovi Anovi to v. Vrben, Mavrovi Anovi from v. Bogdevo to v. Krakornica, Crn Kamen Lukovo Pole, Crn Kamen Dolno Lukovo Pole Krpač et al (2013).

Collection data (SKO): v. Ničpur, 986 m, 11.08.2004, 1ex; v. Bogdevo – v. Krakornica, 1412 m, 18.06.2010, 1ex; Crn Kamen Lukovo Pole, 1536 m, 18.06.2010, 1ex (leg. V. Krpač).

Authors unpublished data: Radika r. Lukovo Pole, 1550 m, 26.05.2010; v. Vrben, 1335 m, 18.06.2010; Dolno Lukovo Pole Crn Kamen, 1539 m, 03.07.2010; road after v. Vrben, 1380 m, 18.06.2010; proximity to the Kosovo border, 1530 m, 18.06.2010.

13. *Gonepteryx farinosa* (Zeller, 1847)

In Macedonian Red List: Near Threatened (NT).

There are only two old reports observed by De Freina, published by Schaider (1980), and De Freina (1983): 2 males found the 15 and 16 July 1979 above Vratnica between 1000 and 1100 m asl (foothills zone). We cannot use this species as indicator because its preferred biotopes are outside this area.

Literature data: Ljuboten, v. Vratnica Shaider (1980); v. Lešok De Freina (1983); Jakšić (1988); Schaider and Jakšić (1989).

Fam. Lycaenidae Leach, 1815

14. *Thecla betulae* (Linnaeus, 1758)

as *Zephyrus betulae* Linnaeus 1758 in Daniel et al (1951)

In Macedonian Red List: Near Threatened (NT).

Present in foothills and montane zones, in forest edge or clearing, riparian vegetation habitats.

Literature data: Crn Vrv, as *Zephyrus betulae* Daniel et al (1951); Crn Vrv, Thurner (1964); Jakšić (1988); Kobilica, in Jakšić (1998a); Popova Šapka, Abdija (2013).

Collection data (IET): Popova Šapka, 1056 m, 19.08.2011, 1♂ 1♀; Bistrica (v. Tearce), 769 m, in 2013; v. Gajre - v. Lisec, 1204 m, in 2013, (leg. Xh. Abdija).

15. *Satyrium pruni* (Linnaeus, 1758)

In Macedonian Red List: Near Threatened (NT).

Present in foothills zone, in low shrubbery, forest edge or clearing habitats.

Literature data: v. Negotino - v. Lomnica Abdija (2013c); Mazdrača Abdija et al (2017).

Collection data (IET): v. Kalište, 729 m, 12.06.2012, 1♂ (leg. Xh. Abdija).

16. *Lycaena dispar* ([Haworth], 1802) ssp. *rutila* (Werneburg, 1864)

In IUCN Red List Europe: Near Threatened (NT), in Macedonian Red List: NT, in Bern Convention appendices II and IV, in Habitat directive annex II and annex IV.

Present in foothills and montane zones, in mesophilic grassland and riparian vegetation habitats.

Literature data: v. Pršovce, 475 m, Abdija (2013c); Mazdrača, Abdija et al (2017); v. Gajre, v. Lisec, Abdija et al (2019).

Collection data (IET): v. Pršovce, 475 m, 01.08.2011, 1♂1♀; v. Jažince, 720 m, 26.07.2013; v. Vrutok, 787 m, in 2013; Mazdrača v. Lomnica, 750 m, in 2013; v. Rakovec, 962 m, in 2013; Bistrica (v. Tearce), 769 m, in 2013; v. Gajre - v. Lisec, 1204 m, in 2013; Kalište, 728 m, in 2013; above v. Vratnica, 910 m, in 2013; Popova Šapka, 1436 m, in 2013, (leg. Xh. Abdija).

17. *Phengaris alcon* ([Denis and Schiffermüller], 1775) ssp. *rebeli* (Hirschke, 1904)

as *Glaucopsyche* (*Maculinea*) *alcon sevastios* in in Daniel et al (1951); in Thurner (1964); as *Maculinea alcon* in Jakšić (1998a)

In Macedonian Red List: Near Threatened (NT).

Present in montane and subalpine zones, in meadow, low shrubbery, mesophilic grassland, forest edge or clearing habitats.

Literature data: Crn Vrv, as *Glaucopsyche* (*Maculinea*) *alcon sevastios* in Daniel et al (1951); Crn Vrv, Ljuboten, as *Maculinea alcon* sevastios in Thurner (1964); Jakšić (1988); Ljuboten, as *Maculinea alcon* in Jakšić (1998a); v. Ničpur Sveta Voda, Reč springs of Strezimirska River, valley of Radika r. Pilana in Krpač et al (2013).

Collection data (SKO): v. Ničpur Sveta Voda, 980 m, 03.07.2010; 1ex; Reč springs of Strezimirska River, 1254 m, 22.08.2010, 1ex (leg. V. Krpač).

Collection data (IET): Crno Lake, 2284 m, 22.06.2016, 1 ex (leg. V. Krpač).

Authors unpublished data: Strezimirska River, 1254 m, 03.07.2010.Reč springs of Strezimirska River, 1234 m, 03.07.2010;Reč, 1232 m, 01.08.2010.

18. *Phengaris arion* (Linnaeus, 1758)

as *Lycaena arion* (L.) in Rebel and Zerny (1931); as *Glaucopsyche* (*Maculinea*) *arion antension* in Daniel et al (1951) and Thurner (1964); *Maculinea arion* in Jakšić (1998a); Abdija et al (2013c; 2017)

In IUCN Red List Europe: Endangered (EN), in Macedonian Red List: Near Threatened (NT), in Bern Convention appendices II and IV, in Habitat directive annex IV.

Present in all vegetation belts (foothills, montane and subalpine), in meadow, rocky meadow, low shrubbery mesophilic grassland and forest edge or clearing habitats.

Literature data: Ljuboten, as *Lycaena arion* (L.) in Rebel and Zerny (1931); v. Brodec, Crn Vrv as *Glaucopsyche* (*Maculinea*) *arion antension* in Daniel et al (1951); v. Brodec, v. Vratnica as *Maculinea arion* antensionin Thurner (1964); Jakšić (1988); v. Vratnica, v. Brodec, as *Maculinea arion* in Jakšić (1998a); Radika valley around bridge 10 km NNW Sveta Voda, Huemer et al (2011); v. Negotino – v. Lomnica, as *Maculinea arion* in Abdija et al (2013c); Mazdrača, as *Maculinea arion* in Abdija et al (2017); Reč springs of Strezimirska River, Krpač et al (2013).

Collection data (IET): v. Negotino, 668 m, 02.06.2012, 2♂ 1♀ (leg. Xh. Abdija).

Authors unpublished data: Reč springs of Strezimirska River, 1234 m, 03.07.2010.

19. *Agriades optilete* (Knoch, 1781)

as *Polyommatus* (*Vacciniina*) *optilete* in Daniel et al (1951); as *Vacciniina optilete* in Michieli (1963); Arnscheid and Arnscheid (1980); Jakšić (1998a)

In Macedonian Red List: Near Threatened (NT).

Present in montane and subalpine zones, in mesophilic grassland, forest edge or clearing habitats.

Literature data: Crn Vrv, as *Polyommatus* (*Vacciniina*) *optilete* in Daniel et al (1951); Crn Vrv, as *Vacciniina optilete* in Thurner (1964); Ceripašina, as *Vacciniina optilete* in Michieli (1963); Šar Mountains, as *Vacciniina optilete* in Arnscheid and

Arnscheid (1980); Jakšić (1988); Piri Beg, Popova Šapka, Jelak, Jakšić (1998a); Popova Šapka, as *Vacciniina optilete* in Jakšić (1998a).

Collection data (SKO): Popova Šapka, 1700 m, 24.07.1975, 1ex (leg. S. Jakonov).

Collection data (IET): Popova Šapka, Ambasadorska Livada, 1525, 08.07.2017, 1ex; Gorna Lešnica, 1776 m, 15.07.2017, 7ex (leg. V. Krpač).

20. *Agriades dardanus* (Freyer, 1843)

In IUCN Red List Europe: Near Threatened (NT), in Macedonian Red List: NT.

This species is insufficiently studied. We did not find it recently. So far, only one site is known. This species occurs in subalpine zone, in rocky meadow habitats. Despite the lack of data, we keep this species as indicator for this area and recommend to increase the study effort on these slopes.**Literature data:** under Karabunar, Jakšić (1988) and Shaider and Jakšić (1989).

21. *Polyommatus eros* (Ochsenheimer, 1808) ssp. *eroides* (Frivaldszky, 1835)

In IUCN Red List Europe: Near Threatened (NT), in Macedonian Red List: NT.

Present in foothills and montane zones, in meadow, rocky meadow and mesophilic grassland habitats.

Literature data: Crn Vrv, Daniel et al (1951); Crn Vrv, Ljuboten, Thurner (1964); Jakšić (1988); Ljuboten, Jakšić (1998a); Popova Šapka, Abdija (2013c).

Collection data (IET): Popova Šapka, 1436 m, in 2013, 1ex (leg. Xh. Abdija); Popova Šapka, 1947 m, 22.06.2016, 1♂; Popova Šapka, 1719 m, 07.07.2016, 1ex (leg. V. Krpač).

22. *Polyommatus ripartii* (Freyer, 1830)

as *Agrodiaetus ripartii* in Melovski (2002)

In Macedonian Red List: Near Threatened (NT).

Present in the three vegetation belts, in meadow, rocky meadow, low shrubbery and forest edge or clearing habitats.

Literature data: Ljuboten, as *Agrodiaetus ripartii* in Melovski (2002); v. Rakovec – Borislavec, Abdija (2013c); v. Ničpur, Radika r., v. Trnica, Strezimir Reč, in Krpač et al (2013).

***C*ollection data (SKO):** v. Ničpur, 986 m, 11.08.2004, 1ex; v. Ničpur, 1086 m, 11.08.2004. 2ex; Radika r., 942 m, 21.07.2009, 1ex (leg. V Krpač).

***C*ollection data (IET):** v. Pirok, 637 m, 27.07.2012, 2ex; v. Rakovec, 962 m, in 2013,(leg. Xh. Abdija); Bogovinjsko Lake, 1949 m, 24.09.2016, 1ex (leg. V. Krpač).

Authors unpublished data: Ljuboten, 1963 m, 06.08.2012; Ljuboten Mountain Lodge, 1623 m, 06.08.2012; Bogovinjsko Lake, 1950 m, 24.09.2016.

Fam. Nymphalidae Rafinesque, 1815

23. *Kirinia climene* (Esper, 1783)

In Macedonian Red List: Vulnerable (VU).

Present in foothills zone, in forest edge or clearing habitats. *K. climene* has been mentioned only in one locality over v. Vrapčište. Despite the lack of data, we keep this species as indicator for this area.

Literature data: over v. Vrapčište in Jakšić (1988); Schaider and Jakšić (1989).

24. *Erebia epiphron* (Knoch, 1783) ssp. *roosi* Arnscheid & Sterba, 1978

as *Erebia epiphron otientalis* in Doflein (1921); as *Erebia epiphron retyetzatensis* in Daniel et al (1951); Jakšić (1998a)

In Macedonian Red List: Near Threatened (NT).

Present in subalpine zone, in meadow and rocky meadow habitats.

Literature data: Kobilica as *Erebia epiphron otientalis* Doflein (1921); Kobilica as *Erebia epiphron retyetzatensis* in Daniel et al (1951); Titov Vrv, Michieli (1963); Jakšić (1988); Piribeg as *Erebia epiphron retyetzatensis* in Jakšić (1998a); Kučibaba under Kule, v. Melovo near the river Bistrica, Melovski (2002).

Collection data (SKO): Ljuboten 2460 m, 28.08.1976, 1 ex. (leg. S. Jakonov); Kobilica Gornovica, 2450 m, 26.07.2007, 1ex (leg. V Krpač).

Collection data (IET): Karabunar, 2382 m, 31.07.2014, 1♂ 1♀, (leg. Xh. Abdija); Karabunar, 2490, 31.07.2014, 1ex; Gorna Lešnica, 1820 m, 15.07.2017, 1ex; under Karanikoličko Lake, 1754 m, 04.08.2017, 5ex (leg. V. Krpač).

Authors unpublished data: Karabunar – Titov Vrv, 2373 m, 31.07.2014; Titov Vrv, 2747 m, 02.08.2014.

25. *Erebia albergana* (Prunner, 1798)

In Macedonian Red List: Near Threatened (NT).

Present in montane and subalpine zones, in meadow and forest edge or clearing and riparian vegetation habitats.

Literature data: Jakšić (1988); Ljuboten over Elezova Rupa, Čaušica, v. Melovo near the river Bistrica, Melovski (2002).

Collection data (IET): Ljuboten, 1945 m, in 2013, (leg. Xh. Abdija).

26. *Erebia gorge* (Hübner, [1804])

In Macedonian Red List: Near Threatened (NT).

This species occurs in rocky open habitats of the Šar Mountains in subalpine belt.

Literature data: Jakšić (1988); Mala Vraca, Jakšić (1998a); Šar Mountains, Varga (2014).

Collection data (SKO): Ceripašina, 1700-2000 m, 26-28.07.1952, 1ex (leg. T. Petkovski).

Collection data (IET): Karabunar,2382 m, in 2013, (leg. Xh. Abdija); Titov Vrv Karabunar, 2373 m, 31.07.2014, 1ex (leg V. Krpač).

Authors unpublished data: Karabunar - Titov Vrv, 2373 m, 31.07.2014; Titov Vrv, 2747 m, 02.08.2014.

27. *Erebia rhodopensis* Nicoll, 1900

In Macedonian Red List: Near Threatened (NT).

This species occurs in open mesic habitats of the Šar Mountains in subalpine belt: mesic meadows, high mountain pastures.

Literature data: Kobilica, as *Erebia typhon* f. *rhodopensis* Doflein (1921); Kobilica, Daniel et al (1951); Kobilica, Ljuboten, Thurner (1964); Jakšić (1988); Ljuboten, Schaider and Jakšić (1989); Ljuboten, Mala Vraca, Kobilica, Popova Šapka, Jelak, Jakšić (1998a); Piribeg, Jakšić (1998a); Čaušica, Dedel Beg, Idrizova Rupa, Melovski (2002); Popova Šapka, Abdija et al (2013b); Šar Mountains, Varga (2014).

Collection data (IET): Popova Šapka, 1966 m, 21.07.2012, 3ex; Crno Lake, 2200 m, in 2013; Karabunar, 2382 m, in 2013, (leg. Xh. Abdija); Titov Vrv, Karabunar, 2373 m, 31.07.2014, 1ex; Crno Lake, 2177 m, 24.06.2016, 2ex (leg. V. Krpač).

Authors unpublished data: Titov Vrv, 2747 m, 02.08.2014.

28. *Erebia pronoe* (Esper, 1780)ssp. *fruhstorferi* Warren, 1933

as *Erebia pronoe fruhstorferi* in Daniel et al (1951); Michieli (1963); Thurner (1964)

In Macedonian Red List: Near Threatened (NT).

Present in subalpine zone, in meadow, mesophilic grassland and forest edge or clearing habitats.

Literature data: Kobilica, Doflein (1921); Kobilica, as *Erebia pronoe fruhstorferi* in Daniel et al (1951); Titov Vrv, as *Erebia pronoe fruhstorferi* Michieli (1963); Jakšić (1988); Kobilica, as *Erebia pronoe fruhstorferi* in Thurner (1964); Kobilica, Jakšić (1998a).

Collection data (IET): Borislavec, 1509 m, 17.07.2012, 1ex; Karabunar, 2382 m, in 2013, (leg. Xh. Abdija).

Authors unpublished data: Karabunar - Titov Vrv, 2373 m, 31.07.2014; Titov Vrv, 2747 m, 02.08.2014.

29. *Erebia pandrose* (Borkhausen, 1788)

as *Erebia pandrosa lappona* in Thurner et al (1964)

In Macedonian Red List: Near Threatened (NT).

Present in montane and subalpine zones, this species occurs in open and semi-open mesic habitats of the Šar Mountains such as meadows, clearing or edge of beech or spruce forests.

Literature data: Ljuboten, as *Erebia pandrosa lappona* Thurner et al (1964); Jakšić (1988); Ljuboten, Jakšić (1998a); Čaušica, Ljuboten, Jelak Mountain Lodge, Melovski (2002).

Collection data (SKO): Šar Mountains, 1700, 28.07.1939. (leg. A. Fadeev).

Collection data (IET): Titov Vrv, Karabunar, 2488 m, 22.06.2016; Crno Lake, 2177 m, 24.06.2016, 5ex; Ambasadorska Livada, 1525 m, 08.07.2017, 4ex; Gorna Lešnica, 1820 m, 15.07.2017, 6ex (leg. V. Krpač).

Authors unpublished data: towards Titov Vrv, 1949 m, 22.06.2016.

30. *Limenitis populi* (Linnaeus, 1758)

In Macedonian Red List: Near Threatened (NT).

Present in montane zone, in forest edge or clearing, and riparian vegetation habitats.

Literature data: Jakšić (1988); v. Gorno Jelovce, Šarski Vodi around the Mountain Lodge, beetwin v. Brezno - Tri Vodi, Melovski (2002); Mavrovi Anovi, Trnica, Krpač et al (2013); v. Lisec, Abdija et al (2019).

Collection data (IET): near stream v. Lisec, 1160 m, 24.06.2019, 1ex (leg. V. Krpač).

Authors unpublished data: Mavrovi Anovi, 1272 m, 16.06.2010; Trnica, 1003 m, 16.06.2010.

31. *Neptis rivularis* (Scopoli, 1763)

as *Limenitis rivularis* in Daniel et al (1951).

In Macedonian Red List: Near Threatened (NT).

In montane zone, in riparian vegetation habitats. However it is only mentioned in literature data (collected by Walter Forster in July 1939, from 1000 to 1500 m, near rivers). This species has to be searched to confirm if it is still present. The data being so old, we cannot use this species as indicator for this area.

Literature data: v. Brodec (Pena r.), Crn Vrv, as *Limenitis rivularis* in Daniel et al (1951).

32. *Neptis sappho* (Pallas, 1771)

In Macedonian Red List: Vulnerable (VU).

Present in foothills and montane zones, in forest edge or clearing and riparian vegetation habitats.

Literature data: over v. Tearce near the river Bistrica Melovski (2002); v. Stenče, Abdija et al (2013b).

Collection data (IET): v. Pirok, 645 m, 13.08.2012, 2♂; v. Rakovec, 962 m, in 2013 (leg. Xh. Abdija).

33. *Araschnia levana* (Linnaeus, 1758)

In Macedonian Red List: Near Threatened (NT).

Present in foothills and montane zones, in mesophilic grassland, forest edge or clearing and riparian vegetation habitats.

Literature data: Tri Vodi around the Mountain Lodge Melovski (2002); Kučibaba (Tri Vodi), Melovski (2004); v. Tearce, Abdija et al (2013b); Mazdrača, Abdija et al (2017), v. Gajre, v. Lisec, Abdija et al (2019).

Collection data (IET): v. Kalište, 729 m, 30.04.2012, 1♂; v. Kalište, 728 m, in 2013; above v. Vratnica, 910 m, in 2013; Borislavec, 1679 m, in 2013; Popova Šapka, 1436 m, in 2013 (leg. Xh. Abdija); road to v. Lisec, 1160 m, 23.07.2016, 1♀ (leg. V. Krpač).

34. *Nymphalis xanthomelas* ([Denis & Schiffermüller], 1775)

In Macedonian Red List: Near Threatened (NT).

Present in foothills zone, in forest edge or clearing and riparian vegetation habitats.

Literature data: v. Pirok, Abdija et al (2013b); Adžina River, Krpač et al (2013).

Collection data (IET): v. Tearce, 759 m, 18.03.2012, 1♀; v. Vratnica, 910 m, in 2013, (leg. Xh. Abdija).

35. *Brenthis ino* (Rottemburg, 1775)

In Macedonian Red List: Near Threatened (NT).

Present in montane zone, in meadow, mesophilic grassland, forest edge or clearing habitats.

Literature data: Jakšić (1988).

Authors unpublished data: Ski resort road north of v. Lisec, 1420 m, 31.07.2011.

***Boloria pales* ([Denis & Schiffermüller], 1775)**

as *Argynis pales contempta* in Doflein (1921); as *Argynis* (*Brenthis*) *pales contempta* in Daniel et al (1951)

In Macedonian Red List: Near Threatened (NT).

Present in subalpine zone, in meadow, rocky meadow, high altitude pasture habitats.

Literature data: Kobilica as *Argynis pales contempta* in Doflein (1921); Ljuboten, in Rebel and Zerny (1931); Crn Vrv, as *Argynis* (*Brenthis*) *pales contempta* in Daniel et al (1951); Ceripašina, Michielli (1963); Crn Vrv, Thurner (1964); Jakšić (1988); Bistravec, Abdija et al (2013b); Šar ms, Varga (2014).

Collection data (IET): Borislavec, 1679 m, 08.08.2012, 1♂; Borislavec, 1679, in 2013; Crno Lake, 2200, in 2013, (leg. Xh. Abdija).

37. *Boloria graeca* (Staudinger, 1870)

as *Argynis* (*Brenthis*) *graeca balcanica* in Rebel and Zerny (1931); as *Boloria graeca balcanica* in Daniel et al (1951); Michielli (1963); Jakšić (1998a); as *Boleria* (*Argynis*) *graeca balcanica* in Thurner (1964)

In Macedonian Red List: Near Threatened (NT).

Present in subalpine zones, in high altitude pastures.

Literature data: Ljuboten, Kobilica, as *Argynis* (*Brenthis*) *graeca balcanica* in Rebel and Zerny (1931); Crn Vrv, Kobilica, as *Boloria graeca balcanica* in Daniel et al (1951); Popova Šapka (1800-2000) as *Boloria graeca balcanica* in Michielli (1963); Crn Vrv, Kobilica, Ljuboten as *Boleria* (*Argynis*) *graeca balcanica* in Thurner (1964); Šar Mountains in Arnscheid and Arnscheid (1980); Popova Šapka, Jakšić (1988); Šar Mountains Piribeg, as *Boloria graeca balcanica* in Jakšić (1998a); Ljuboten, Kobilica, Jelak, Jakšić (1998a); Ljuboten, Ljuboten over Elezova Rupa, Ljuboten near mountain refuge, Jelak - Crn Vrv, Melovski (2002); Borislavec, Abdija et al (2013b); Šar Mountains, Varga (2014).

Collection data: (SKO) Ceripašina, 2500 m, 26.07.1952, 3ex (leg. T. Petkovski); Ljuboten, 2460 m, 28.08.1976, 7ex (leg. S. Jakonov).

Collection data (IET): Borislavec, 1679 m, 08.08.2012, 1♂; Crno Lake, 2200 m, in 2013, (leg. Xh. Abdija); Popova Šapka, 1745 m, 12.07.2016, 1ex; Krivošija, 1766 m, 27.07.2016, 1♂; under Karanikoličko Lake, 1754 m, 04.08.2017, 2 ex (leg. V. Krpač).

Authors unpublished data: Mavrovo - mountain northwest of v. Ničpur, 2105 m, 20.08.2010, Popova Šapka Ceripašina, 2382 m, 05.08.2012; Crno Lake, 2174m, 07.08.2012, Crno Lake, 2284 m, 07.08.2012; Titov Vrv, 2747 m, 02.08.2014; Popova Šapka, 1719 m, 12.07.2016; Krivošija 2139 m, 27.07.2016, under Karanikoličko Lake, 1754 m, 04.08.2017.

38. *Melitaea arduinna* (Esper, 1783) ssp. *rhodopensis* Freyer, 1836

In Macedonian Red List: Near Threatened (NT).

Present in montane and subalpine zones, in meadow, low shrubbery and mesophilic habitats.

Literature data: Mavrovi Anovi, from v. Bogdevo to v. Krakornica, 1412 m, Krpač et al (2013); v. Lakavica, 585 m, Abdija et al (2013b).

Collection data (IET): v. Lakavica, 585 m, 30.06.2012, 1♂, (leg. Xh. Abdija).

Authors unpublished data: v. Vrben, 1335 m, 18.06.2010; v. Bogdevo – v. Krakornica, 1412 m, 18.06.2110; Crn Vrv, 936 m, 01.06.2013.

39. *Melitaea aurelia* Nickerl 1850

In IUCN Red List Europe: Near Threatened (NT), in Macedonian Red List: NT.

Present in foothills and montane zones, in meadow, rocky meadow, low shrubbery and mesophilic grassland habitats.

Literature data: v. Pršovce, Abdija et al (2013b).

Collection data (IET): v. Pršovce, 475 m, 08.09.2011, 1♂ 1♀; Mavrovo, 1026 m, 05.05.2012, 1ex; v. Negotino, 668 m, 03.06.2012, 4ex; v. Jažince, 720 m, 26.07.2013; v. Vrutok, 787 m, in 2013; Mazdrača v. Lomnica, 750 m, in 2013; v. Rakovec, 962 m, in 2013;v. Belovište, 785 m, in 2013; v. Jelovjane, 1142 m, in 2013; Bistrica (v. Tearce), 769 m, in 2013; Gajre - v. Lisec 1204 m, in 2013; v. Kalište, 728 m, in 2013; v. Vratnica, 910 m, in 2013; Popova Šapka, 1436 m, in 2013, (leg. Xh. Abdija).

Authors unpublished data: v. Lisec (1188) 24.05.2019.

40. *Euphydryas aurinia* (Rottemburg, 1775) ssp. *bulgarica* (Fruhstorfer, 1917)

In Macedonian IUCN Red List: Near Threatened (NT), in Bern Convention appendix II.

Present in all vegetation belts, in meadow, low shrubbery mesophilic grassland and forest edge or clearing habitats.

Literature data: Bunec, Adžina Reka, Melovski (2002); Mavrovi Anovi to v. Vrben, Krpač et al (2013); Mavrovo, Abdija et al (2013b).

Collection data (SKO): v. Vratnica, 21.07.1971, 16ex (leg. J. Čingovski); v. Vratnica, 26.07.1971, 14ex (leg. J. Čingovski).

Collection data (IET): Šar Mountains Mavrovo, 991 m, 05.05.2012, 1♂ 1♀, (leg. Xh. Abdija); Ulivérica, 1750 m, 25.05.2019, 2ex (leg. M. Černila, V. Krpač).

Authors unpublished data: mountain above Mavrovi Anovi, 1680 m, 16.06.2010; Mavrovo, 1270 m, 16.06.2010; mountain above Mavrovo, 1750 m, 16.06.2010; road to v. Vrben, 1350 m, 18.06.2010; v. Vrben, 1335 m, 18.06.2010; road between v. Vrben and v. Bogdevo, 1550 m, 18.06.2010; v. Vrben proximity to the Kosovo border, 1530 m, 18.06.2010; Šar Mountains south, 1540 m, 22.08.2010; Uliverica, 1790 m, 25.05.2019.

41. *Euphydryas maturna* (Linnaeus, 1758)

as *Euphydryas maturna macedonica* in Dufay (1977)

In IUCN Red List Europe: Vulnerable (VU), in Macedonian Red List: VU, in Bern Convention appendices II and IV.

Present in foothills zone, in forest edge and riparian vegetation habitats.

Literature data: Radika r. v. Trnica, Dufay (1973); Radika r. v. Trnica as *Euphydryas maturna macedonica* in Dufay (1977); Jakšić (1988); Radika r., Jakšić (1998a); Radika r. near v. Trnica, Radika r. v. Ničpur Sveta Voda, Krpač et al (2013).

Collection data (SKO): Radika r., 942 m, 12.07.1975, 2ex (leg. S. Jakonov); Radika r. v. Ničpur Sveta Voda, 980 m, 03.07.2010, 1ex (leg. V. Krpač).

To the above list, we could add ***Nymphalis vaualbum* (Denis & Schiffermüller, 1775)**, found in the country and published after the publication of the Red list for North Macedonia. It was found the 14 July 2009 at Lešnica, at 1500 m elevation, at the edge of beech forest and published in 2014 (Dime Melovski and Emilija Božinovska). This species has to be searched for along the Pena river, at lower altitude, to confirm if it is still present, or the individual caught was a vagrant.

Among the 41 species on the Red list for Macedonia, reported in this area, we kept 38 species as indicators to monitor the evolution of the biodiversity of this area. At these 38 species, we added *N. vaualbum*, considered up to now with a data deficient status for the country.

Conclusion

According to the species richness of butterflies of the Šar Mountains (179 taxa) with 39 species important for the valorization of the investigated area, we can confirm that the Šar mountain range is a hot spot of biodiversity in the Republic of North Macedonia.

The species richness, or at least, the 39 target species listed in this paper can be monitored in the future to foresee the trend of the evolution of the biodiversity in this mountain range. In addition, it is a tool to contribute to the zoning of the most important areas to be protected within the Šar Mountains.

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ANNEX I
Check-list of butterflies in the Šar Mountains

Fam. Hesperiidae Latreille, 1809

Carcharodus alceae (Esper, 1780)
Carcharodus floccifera (Zeller, 1847)
Carcharodus orientalis Reverdin, 1913
Erynnis tages (Linnaeus, 1758)
Muschampia proto (Ochsenheimer, 1808)
Pyrgus malvae (Linnaeus, 1758)
Pyrgus serratulae (Rambur, 1839)
Pyrgus armoricanus (Oberthür, 1910)
Pyrgus alveus (Hübner, [1803])
Pyrgus cinarae (Rambur, 1839)
Pyrgus sidae (Esper, 1784)
Pyrgus carthami (Hübner, [1813])
Pyrgus andromedae (Wallengren, 1853)
Spialia orbifer (Hübner, [1823])
Spialia phlomidis (Herrich and Schäffer, 1845)
Carterocephalus palaemon (Pallas, 1771)
Thymelicus acteon (Rottemburg, 1775)
Thymelicus lineola (Ochsenheimer, 1808)
Thymelicus sylvestris (Poda, 1761)
Hesperia comma (Linnaeus, 1758)
Ochlodes sylvanus (Esper, 1777

Fam. Papilionidae Latreille, 1802

Zerynthia polyxena ([Denis and Schiffermuller], 1775)
Zerynthia cerisy (Godart, [1824])
Parnassius mnemosyne (Linnaeus, 1758)
Parnassius apollo (Linnaeus, 1758)
Iphiclides podalirius (Linnaeus, 1758)
Papilio machaon Linnaeus, 1758

Fam. Pieridae Swainson, 1820

Leptidea duponcheli (Staudinger, 1871)
Leptidea sinapis (Linnaeus, 1758)
*Leptidea juvernica*Williams 1946
Aporia crataegi (Linnaeus, 1758)
Pieris krueperi Staudinger, 1860
Pieris rapae (Linnaeus, 1758)
Pieris mannii (Mayer, 1851)
Pieris ergane (Geyer, [1828])

Pieris napi (Linnaeus, 1758)
Pieris balcana Lorković, [1979]
Pieris brassicae (Linnaeus, 1758)
Pontia edusa (Fabricius, 1777)
Euchloe ausonia (Hübner, [1804)]
Anthocharis cardamines (Linnaeus, 1758)
Anthocharis gruneri Herrich-Schäffer, 1851
Colias crocea (Geoffroy, 1785)
Colias alfacariensis Ribbe, 1905
Colias caucasica Staudinger, 1871
Gonepteryx rhamni (Linnaeus, 1758)
Gonepteryx farinosa (Zeller, 1847)

Fam. Riodinidae Grote, 1895

Hamearis lucina (Linnaeus, 1758)

Fam. Lycaenidae Leach, 1815

Favonius quercus (Linnaeus 1758)
Thecla betulae (Linnaeus, 1758)
Callophrys rubi (Linnaeus, 1758)
Satyrium acaciae (Fabricius, 1787)
Satyrium ilicis (Esper, 1779)
Satyrium spini ([Denis and Schiffermüller], 1775)
Satyrium w-album (Knoch, 1782)
Satyrium pruni (Linnaeus, 1758)
Lycaena phlaeas (Linnaeus, [1760])
Lycaena dispar ([Haworth], 1802)
Lycaena candens (Herrich-Schäffer, 1844)
Lycaena thersamon (Esper, 1784)
Lycaena alciphron (Rottenburg, 1775)
Lycaena virgaureae (Linnaeus, 1758)
Lycaena tityrus (Poda, 1761)
Lampides boeticus (Linnaeus, 1767)
Leptotes pirithous (Linnaeus, 1767)
Cupido alcetas (Hoffmannsegg, 1804)
Cupido argiades (Pallas, 1771)
Cupido decoloratus (Staudinger, 1886)
Cupido osiris (Meigen, 1829)
Cupido minimus (Fuessly, 1775)
Iolana iolas (Ochsenheimer, 1816)
Glaucopsyche alexis (Poda, 1761)
Phengaris alcon([Denis and Schiffermüller], 1775)
Phengaris arion (Linnaeus, 1758)
Celastrina argiolus(Linnaeus, 1758)
Scolitantides orion (Pallas, 1771)
Pseudophilotes vicrama (Moore, 1865)
Kretania sephirus (Frivaldzky, 1835)
Plebejus argus (Linnaeus, 1758)
Plebejus idas (Linnaeus, [1760])
Plebejus argyrognomon (Bergsträsser, 1779)
Agriades optilete (Knoch, 1781)
Agriades dardanus(Freyer, 1843)
Eumedonia eumedon (Esper, 1780)
Aricia agestis (Denis and Schiffermüller, 1775)
Aricia artaxerxes (Fabricius, 1793)
Aricia anteros (Freyer, 1838)
Cyaniris semiargus(Rottemburg, 1775)
Polyommatus amandus (Scheider, 1792)
Polyommatus dorylas ([Denis and Schiffermūller], 1775)
Polyommatus icarus (Rottemburg, 1775)
Polyommatus thersites (Cantener 1835)
Polyommatus eros (Ochsenheimer, 1808)
Polyommatus daphnis ([Denis and Schiffermüller], 1775)
Polyommatus ripartii (Freyer, 1830)
Polyommatus admetus (Esper, 1783)
Polyommatus damon ([Denis and Schiffermuller], 1775)
Lysandra bellargus (Rottemburg, 1775)
Lysandra coridon (Poda, 1761)

Nymphalidae Rafinesque, 1815

Libythea celtis (Laicharting, 1782)
Kirinia roxelana (Cramer, 1777)
Kirinia climene (Esper, 1783)
Pararge aegeria (Linnaeus, 1758)
Lasiommata maera (Linnaeus, 1758)
Lasiommata petropolitana (Fabricius, 1787)
Lasiommata megera (Linnaeus, 1767)
Coenonympha arcania (Linnaeus, [1760])
Coenonympha leander (Esper, 1784)
Coenonympha pamphilus (Linnaeus, 1758)
Coenonympha rhodopensis Elwes, 1900
Pyronia tithonus (Linnaeus, 1771)
Maniola jurtina (Linnaeus, 1758)
Hyponephele lycaon (Kühn, 1774)
Hyponephele lupina (Costa, 1836)
Aphantopus hyperantus(Linnaeus, 1758)

Erebia ligea (Linnaeus, 1758)
Erebia euryale (Esper, 1805)
Erebia epiphron (Knoch, 1783)
Erebia albergana (Prunner, 1798)
Erebia medusa ([Denis & Schiffermüller], 1775)
Erebia gorge (Hübner, [1804])
Erebia rhodopensis Nicoll, 1900
Erebia neleus(Freyer, 1832)
Erebia ottomana Herrich & Schaffer, 1847
Erebia melas (Herbst, 1796)
Erebia pronoe (Esper, 1780)
Erebia oeme (Hübner, [1804])
Erebia pandrose (Borkhausen, 1788)
Chazara briseis(Linnaeus, 1764)
Brintesia circe (Fabricius, 1775)
Hipparchia semele (Linnaeus,1758)
Hipparchia volgensis (Mazochin-Porshnjakov, 1952)
Hipparchia fagi (Scopoli, 1763)
Hipparchia syriaca (Staudinger, 1871)
Hipparchia statilinus (Hufnagel, 1766)
Arethusana arethusa ([Denis & Schiffermüller], 1775)
Satyrus ferula (Fabricius, 1793)
Melanargia galathea (Linnaeus, 1758)
Melanargia larissa (Geyer, [1828])
Apatura ilia ([Denis & Schiffermüller], 1775)
Apatura iris (Linnaeus, 1758)
Limenitis populi (Linnaeus, 1758)
Limenitis reducta Staudinger, 1901
Neptis rivularis (Scopoli, 1763)
Neptis sappho (Pallas, 1771)
Araschnia levana(Linnaeus, 1758)
Vanessa atalanta (Linnaeus, 1758)
Vanessa cardui (Linnaeus, 1758)
Polygonia c-album (Linnaeus, 1758)
Polygonia egea (Cramer, 1775)
Aglais io (Linnaeus, 1758)
Aglais urticae(Linnaeus, 1758)
Nymphalis polychloros (Linnaeus, 1758)
Nymphalis xanthomelas ([Denis & Schiffermüller], 1775)
Nymphalis vaualbum ([Denis & Schiffermüller], 1775)
Nymphalis antiopa (Linnaeus, 1758)
Fabriciana niobe (Linnaeus, 1758)
Fabriciana adippe ([Denis & Schiffermuller], 1775)
Speyeria aglaja (Linnaeus, 1758)
Argynnis paphia (Linnaeus, 1758)
Argynnis pandora ([Denis & Schiffermuller], 1775)
Brenthis ino (Rottemburg, 1775)
Brenthis daphne ([Denis & Schiffermüller], 1775)
Brenthis hecate ([Denis & Schiffermüller], 1775)
Issoria lathonia (Linnaeus, 1758)
Boloria euphrosyne (Linnaeus, 1758)
Boloria dia (Linnaeus, 1767)
Boloria pales ([Denis & Schiffermüller], 1775)
Boloria graeca (Staudinger, 1870)
Melitaea phoebe ([Denis & Schiffermüller], 1775)
Melitaea arduinna (Esper, 1783)
Melitaea didyma (Esper, 1778)
Melitaea trivia ([Denis & Schiffermüller], 1775)
Melitaea diamina (Lang, 1789)
*Melitaea aurelia*Nickerl 1850
Melitaea athalia (Rottemburg, 1775)
Melitaea cinxia (Linnaeus, 1758)
Euphydryas aurinia (Rottemburg, 1775)
Euphydryas maturna (Linnaeus, 1758)

ANNEX II
Geographic coordinates of localities

Name	**Latitude**	**Longitude**
Adžina Reka	41.818021	20.648169
Am Crni vrh	42.09819444	20.9215
Ambasadorska Livada	42.0233333	20.9016667
Baschina (Bašina planina)	42.0958333	20.85
Belovište	42.1399860	21.099774
Bistrica (Tearce)	42.0953220	21.041878
Bojkov Kamen	41.789394	20.813086
Borislavec	41.923298	20.835234
Bozovce	42.0521111	20.8170833

Bogovinjsko lake (Bogovinjsko Ezero)	41.9538889	20.7922222
Brodec	42.059781	20.883884
Brodeč, (Pena river)	42.0569444	20.8905556
Čaušica	42.124232	21.00078
Ceripašina Planina	42.0152778	20.8565556
Crni vrh	42.1022222	20.9302778
Crno Lake (Crno Ezero)	41.9255000	20.7906944
Dolna Lešnica	42.021	20.7961667
Gajre-Lisec	42.0200600	20.918916
Gorna Lešnica	42.0247222	20.8594444
Gorno Jelovce	41.807343	20.790089
Gorno Jelovce (Dedel Beg)	41.809733	20.786726
Idrizova Rupa	41.83446	20.741049
Jažince	42.1443580	21.127964
Jelak	42.0323333	20.8595278
Jelak - Crn Vrv	42.035166	20.860434
Jelak – Vrn Vrv	42.0305556	20.8575000
Jelak, pl. Dom	42.02764	20.86508
Jelovjane	41.9563400	20.89228
Kalište	41.8796340	20.868623
Karabunar	41.9837070	20.805233
Karabunar pod Titov Vrv	41.9850000	20.6680556
Karanikola	42.0755556	20.6805556
Karanikoličko lake (Ezero)	42.0733333	20.7922222
Kobeliza (Kobilica Šar planina)	42.096	20.885
Krivošija	42.075	20.7958333
Kučibaba, under Kule	42.103417	20.995722
Lesak	42.0668889	21.028
Leshnitsa (Lešnica)	42.0276389	20.7883056
Leshok	42.0604278	21.0326278
Lešok Monastery	42.066619	21.27459
Lisec	42.0007222	20.9151389
Ljuboten	42.1932500	21.1283333
Ljuboten over Elezova Rupa	42.183968	21.13967
Ljuboten over Staro Selo	42.158355	21.123783
Ljuboten, near mountain refuge	42.184981	21.127322
Lukovo Pole	41.8547222	20.6266667
Mavrovo: r. Radika, s. Trnica	41.7322917	20.6703417
Mavrovo: s. Ničpur	41.743825	20.6729472
Mazdrača (Lomnica)	41.8912020	20.852505
Melovo near the river Bistrica	42.112759	21.003119
Negotino	41.880430	20.878472
Nerašte	42.111455	21.097749
Ničpur Sveta Voda	41.743993	20.673012

Pirok	41.913087	20.905845
Plat Mt	42.0320833	20.8301944
Popova Šapka	42.0131667	20.8848333
Radika	41.7322917	20.6703444
Radika: Goren tek	41.8525306	20.622625
Radika: Lukovo Pole	41.8525306	20.622625
Rakovec	41.9179560	20.892557
Šar Planina south	41.8480278	20.6229722
Šarski Vodi	41.803607	20.802555
Šipkovica	42.0211111	20.9208333
Spring of Vardar river	41.764169	20.836941
Staro Selo	42.1830110	21.138322
Tearce near the river Bistrica	42.089179	21.05147
Titov Vrv	41.9920000	20.7983333
Tri Vodi	42.109377	21.002286
Varvara	42.063440	21.016557
Vešala	42.0658333	20.8333333
Vratnica	42.1470720	21.098746
Vrben	41.7105556	20.7330556
Vrutok	41.7643333	20.8375000

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NOVEJŠE RAZISKAVE PODZEMELJSKE FAVNE HROŠČEV V JAMAH ŠENTVIŠKE PLANOTE

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Izvleček – V letih 2013, 2014, 2015, 2016 in 2020 je avtor prispevka opravil biološke raziskave v petih jamah (Krasnica, Zidanica v Žlebeh, Jama v Griču, Kuhinja in Jama v Brlatovem robu) Šentviške planote. Ugotovljena je bila prisotnost trinajstih vrst podzemeljske favne hroščev. Za naše poznavanje podzemeljske favne hroščev tega področja so posebej pomembne najdbe naslednjih vrst: *Anophthalmus annamariae* Bognolo 2002 (Carabidae), *Anophthalmus schmidti gspani* Reitter, 1918 (Carabidae), *Sphaerobathyscia hoffmanni* Motschoulsky, 1856 (Leiodidae) in *Tarattostichus stussineri* Reitter, 1891 (Curculionidae).

KLJUČNE BESEDE: Coleoptera, Carabidae, Trechinae, Leiodidae, Cholevinae, Curculionidae , endemična favna, nova najdišča, Slovenija

Abstract – NEW FINDINGS OF THE HYPOGEAN BEETLE FAUNA ON THE PLATEAU ŠENTVIŠKA GORA

In the years 2013, 2014, 2015, 2016 and 2020 some biological research activities were performed in five caves (Krasnica, Zidanica v Žlebeh, Jama v Griču, Kuhinja and Jama v Brlatovem robu) on the plateau Šentviška planota. Thirteen species of the subterranian beetle fauna in all were found. Very important contribution to our knowledge about the subterranian beetle fauna in this area are findings of the following species: *Anophthalmus annamariae* Bognolo, 2002 (Carabidae), *Anophthalmus schmidti gspani* Reitter,1918 (Carabidae), *Sphaerobathyscia hoffmanni* Motschoulsky, 1846 (Leiodidae) and *Tarattostichus stussineri* Reitter, 1891 (Curculionidae).

KEY WORDS: Coleoptera, Carabidae, Trechinae, Leiodidae, Cholevinae, Curculionidae, endemic fauna, new records, Slovenia

Uvod

Šentviška planota se nahaja v zahodnem delu Slovenije. Na severnem delu jo omejuje reka Bača, na južnem pa reka Idrijca. Kraška pokrajina Šentviške planote je prepredena s številnimi jamami in brezni, ki so med entomologi dobro poznane zlasti zaradi njihove endemične podzemeljske favne hroščev. Endemični hrošči tega območja so springerjev brezokec (*Anophthalmus ravasinii springeri*), ausmeierjev ploskonožec (*Oryotus ausmeieri*) in kahlenov jajčar (*Aphaobius kahleni)*. Vsi so bili opisani po primerkih, najdenih v jami Krasnica. Springerjevega brezokca je opisal Müller leta 1931 (Müller, 1931), ausmeierjevega ploskonožca Perreau leta 2003 (Perreau, 2003), kot zadnjega sta kahlenovega jajčarja leta 2010 opisala Bognolo in Vailati (Bognolo & Vailati, 2010).

Da bi dopolnil vedenje o pestrosti podzemeljske favne hroščev tega področja, se je avtor prispevka odločil za biološke raziskave v petih jamah tega področja: Krasnici, Zidanici v Žlebeh, Jami v Griču, Kuhinji in Jami v Brlatovem robu. Krasnica je daleč najbolj znana jama tega področja. Nahaja se blizu Ponikev na nadmorski višini 460 m, dolga je 197 m in globoka 26 m. Jama je občasni bruhalnik. Ob spomladanskih in jesenskih deževjih voda popolnoma poplavi njene spodnje dele in onemogoči vstop vanjo. Zidanica v Žlebeh se nahaja v težko dostopnem ostenju nedaleč od Krasnice na nadmorski višini 486 m, dolga je 39 m in globoka 10 m. V burnih obdobjih so okoliški prebivalci prav zaradi težke dostopnosti in manjšega, a stalnega vodnega toka v jami, uporabljali plato pred jamo za svoje začasno pribežališče. Ostale tri jame se nahajajo v okolici Šentviške Gore. Jama v Griču se odpira na nadmorski višini 810 m, dolga je 79 m in globoka 9 m. Blizu nje je na nadmorski višini 818 m vhod v 13 m dolgo, vodoravno izvirno jamo Kuhinja. Jama v Brlatovem robu se nahaja nadmorski višini 690 m ob naselju Šentviška Gora, dolga je23 m in globoka 3 m.

Biološke raziskave

V jamah je avtor raziskoval v letih 2013, 2014 in 2015, 2016 in 2020. Glavna metoda lova so bile pasti s trohnečim mesom ali sirom in konzervirno tekočino, ki jih je porazdelil po celotni dolžini jam. Da je preprečil masovne ulove najpogostejšega prebivalca jam, hrošča vrste *Laemostenus schreibersi,* je večino pasti prekril s kovinsko mrežico, ki je bila dovolj gosta, da je preprečevala prehod te vrste in dovolj redka, da je omogočila prehod ostalim manjšim vrstam. Ulovljene osebke je pobiral v jesenskem in spomladanskem času. Ob obisku jam je tudi redno pregledoval stene in tla, ter obračal kamne, vendar s to metodo nabiranja ni našel veliko primerkov. Ročno je ulovil le nekaj primerkov vrste *Laemostenus schreibersi*, 1 primerek vrste *Anophthalmus schmidti gspani*, 1 primerek vrste *Anophthalmus annamariae* in 2 primerka vrste *Anophthalmus ravasinii springeri.*

Vzorčenja so bila opravljena z dovoljenjem Agencije Republike Slovenije za okolje št. 35601 – 30/2010-7, 35601-39/2015-4 in 35601-58/2020-5. Ulovljeni osebki so shranjeni v zbirki avtorja (Zbirka CBKS, Bojan Kofler , Škofja Loka)

Rezultati in razprava

Krasnica, kat. št.: 806 (Kataster jam, 2020)

Ulov:

Anophthalmus annamariae Bognolo, 2002: 14.3. – 23.8.2015, 1 ♂,1 ♀. Leg., det., coll. B. Kofler. (Slika 1).

Anophthalmus ravasinii springeri Müller, 1931: 14.3.2015, 1 ♂, 1♀; 14.3, - 23.8.2015, 3 ♂, 2 ♀. Leg., det., coll. B. Kofler.

Laemostenus schreibersi Küster, 1846: 14.3. – 23.8.2015, 2 ♂, 4 ♀. Leg., det., coll. B. Kofler.

Aphaobius kahleni Bognolo & Vailati, 2010: 14.3. – 23.8.2015, 1 ♂, 3 ♀. Leg., det., coll. B. Kofler.

Oryotus ausmeieri Perreau, 2003: 14.3. – 23.8.2015, v velikem številu. Leg., det., coll. B. Kofler.

Sl. 1: *Anophthalmus annamariae.* Naravna velikost: 5,9 mm. Foto: Miroslava Kofler

Zidanica v Žlebeh, kat. št.: 805 (Kataster jam, 2020)

Ulov:

Anophthalmus ravasinii springeri Müller, 1931: 14.3. -23.8.2015, 1 ♂, 3 ♀. Leg., det., coll. B. Kofler.

Laemostenus schreibersi Küster, 1846: 14.3. – 23.8.2015, 2 ♂, 3 ♀. Leg., det., coll. B. Kofler.

Oryotus ausmeieri Perreau, 2003: 14.3. – 23.8.2015, 6 ♂, 10 ♀. Leg., det., coll. B. Kofler.

Catops subfuscus Kellner, 1846: 14.3. – 23.8.2015, 1 ♂, 2 ♀. Leg., det., coll. B. Kofler.

Jama v Griču (Tenacova jama), kat. št.: 1641(Kataster jam, 2020)

Ulov:

Anophthalmus annamariae Bognolo, 2002: 15.9.2013 – 26.7.2014, 1 ♂, 1 ♀; 19.3. – 5.10.2015, 1 ♂. Leg., det., coll. B. Kofler.

Anophthalmus schmidti gspani Reitter, 1918: 5.10.2015, 1 ♂. Leg., det., coll. B. Kofler. (Slika 2)

Sl. 2: *Anophthalmus schmidti gspani.* Naravna velikost: 7 mm. Foto: Miroslava Kofler.

Anophthalmus ravasinii springeri Müller, 1931: 9.6. – 15.9.2013, 1♂; 15.9.2013 – 26.7.2014, 1 ♂, 3♀; 19.3. – 5.10.2015, 4 ♀. Leg., det., coll. B. Kofler.

Laemostenus schreibersi Küster, 1846: 9.6. – 15.9.2013, 3 ♂, 3 ♀. Leg., det., coll. B. Kofler.

Sphaerobathyscia hoffmanni Motschoulsky, 1856: 9.6. – 15.9.2013, 1 ♂, 2♀; 15.9.2013 – 26.7.2014, 1 ♂; 19.3. – 5.10.2015, 2 ♂, 3 ♀. Leg., det., coll. B. Kofler.

Aphaobius kahleni Bognolo & Vailati, 2010: 9.6. – 15.9.2013, 1 ♂. Leg., det., coll. B. Kofler.

Bathyscia montana montana Schiödte, 1848 (Leiodidae): 19.3. – 5.10.2015, 1 ♂, 1 ♀. Leg., det., coll. B. Kofler.

Oryotus ausmeieri Perreau, 2003: 9.6. – 15.9.2013, 2 ♂; 15.9.2013 – 26.7.2014, 6 ♂, 4 ♀; 19.3. – 5.10.2015, 4 ♂, 12 ♀. Leg., det., coll. B. Kofler.

Catops subfuscus Kellner, 1846: 19.3. – 5.10.2015, 1 ♂, 2 ♀. Leg., det., coll. B. Kofler.

Kuhinja, kat. št.: 1639 (Kataster jam, 2020)

Ulov:

Laemostenus schreibersi Küster, 1846: 19.10.2014 – 29.3.2015, 2 ♂, 3 ♀; 29.3. – 5.10.2015, 2 ♂, 1 ♀. Leg., det., coll. B. Kofler.

Trechus croaticus Dejean, 1831: 29.3. – 5.10.2015, 1 ♂. Leg., det., coll. B. Kofler.

Sphaerobathyscia hoffmanni Motschoulsky, 1856: 29.10.2014 – 29.3.2015, 4 ♂, 6 ♀; 29.3. – 5.10.2015, v velikem številu. Leg., det., coll. B. Kofler. (Slika 3)

Catops subfuscus Kellner, 1846: 29.3. – 5.10.2015, 1 ♂, 2 ♀. Leg., det., coll. B. Kofler.

Apocatops nigrita Erichson, 1837: 29.3. – 5.10.2015, 1 ♂, 3 ♀. Leg., det., coll. B. Kofler

Jama v Brlatovem robu (Brlatova jama), kat. št.: 1635 (Kataster jam, 2020)

Ulov:

Anophthalmus annamariae Bognolo, 2002: 29.3. – 28.9.2015, 3 ♂, 2 ♀; 28.9.2015 – 19.3.2016, 1♀; 19.3. – 11.9.2016, 1 ♂, 1 ♀; 8.3. – 10.10.2020, 2 ♂, 3 ♀. Leg., det., coll. B. Kofler.

Anophthalmus ravasinii springeri Müller, 1931: 29.3. – 28.9.2015, 1 ♂; 19.3. – 11.9.2016, 2 ♀. Leg., det., coll. B. Kofler.

Anophthalmus schmidti gspani Reitter, 1918: 29.3. – 28.9.2015, 1 ♂. Leg., det., coll. B. Kofler.

Laemostenus schreibersi Küster 1846: 29.3. – 28.9.2015, 3 ♂, 3 ♀; 28.9.2015 – 19.3.2016, 1 ♂, 1♀; 18.3. – 10.102020, 1♂, 2 ♀. Leg., det., coll. B. Kofler.

Trechus croaticus Dejean, 1831: 29.3. – 28.9.2015, 2 ♀; 19.3. – 11.9.2016, 4 ♂, 1 ♀. Leg., det., coll. B. Kofler.

Sphaerobathyscia hoffmanni Motschoulsky, 1856: 29.3. – 28.9.2015, v velikem številu; 28.9.2015 – 19.3.2016: v velikem številu; 19.3. – 11.9.2016, v velikem številu; 18.3. – 10.10.2020, v velikem številu. Leg., det., coll. B. Kofler. (Slika 3).

Sl. 3: *Sphaerobathyscia hoffmanni.* Naravna velikost: 1,2 mm. Foto: Miroslava Kofler

Apocatops nigrita Erichson, 1837: 19.3. – 11.9.2016, 1♂. Leg., coll. B. Kofler, det. M. Kahlen.

Catops subfuscus Kellner, 1846: 29.3. – 28.9.2015, 1 ♂, 1♀. Leg., det., coll. B. Kofler.

Nargus brunneus Sturm, 1839: 18.3. – 11.9.2016, 1 ♂. Leg., det., coll. B. Kofler.

Bathyscia montana montana Schiödte, 1848: 28.9.2015 – 19.3.2016, 1 ♂, 1♀. Leg., det., coll. B. Kofler.

Tarattostichus stussineri, Reitter, 1891: 29.3. – 28.9.2015, 1 osebek. Leg., det., coll. B. Kofler. (Slika 4)

Raziskave so, kot je bilo pričakovano, potrdile veliko pestrost podzemeljske favne hroščev v jamah Šentviške planote. Ugotovljena je bila prisotnost trinajstih vrst, ki pripadajo trem družinam: Carabidae (*Anophthalmus annamariae*, *Anophthalmus ravasinii springeri, Anophthalmus schmidti gspani, Laemostenus schreibersi, Trechus croaticus*), Leiodidae (*Aphaobius kahleni, Oryotus ausmeieri, Sphaerobathyscia hoffmanni, Bathyscia montana montana, Catops subfuscus, Apocatops nigrita, Nargus brunneus*) in Curcilionidae (*Tarattostichus stussineri*). Za boljše poznavanje podzemeljske favne tega področja so bile zlasti pomembne najdbe naslednjih vrst: *Anophthalmus annamariae*, *Anophthalmus schmidti gspani*, *Sphaerobathyscia hoffmanni* in *Tarattostichus stussineri*. Izstopa zlasti najdba dosedaj redke vrste *Anophthalmus annamariae* v kar treh (Krasnica, Jama v Griču, Jama v Brlatovem robu) od petih raziskovanih jam tega področja. Vrsta je bila do teh raziskav znana samo iz njenega tipskega nahajališča (Ledenica v Dolu pri Predmeji, kat. št.: 751), ki se nahaja približno 20 kilometrov južneje. Tam poseljuje dno globoke vrtače pred jamo in vhodne dele jame (Bognolo, 2002). Na Šentviški planoti je bila ulovljena v začetnih delih raziskovanih jam, kar potrjuje dosedanje vedenje, da živi plitvo v tleh. Se pa v talne pasti, ki so bile postavljene v bližini raziskovanih jam, ni ulovil noben primerek te vrste.

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Sl. 4: *Tarattostichus stussineri.* Naravna velikost: 2,1 mm. Risba: Bojan Kofler

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SOME FAMILIES OF DIPTERA FROM BEER TRAPS IN BALATON HIGHLAND, HUNGARY

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Abstract – Faunistic records for 41 Diptera species from nine families (Anisopodidae, Drosophilidae, Dryomyzidae, Heleomyzidae, Lauxaniidae, Platystomatidae, Sciomyzidae, Syrphidae and Ulidiidae) collected at six sites at Felsőörs and Lovas in the Balaton Highland, Hungary are presented. Amongst the material, the species *Drosophila suzukii* (Matsumura, 1931) (Drosophilidae) and *Callopistromyia annulipes* (Macquart, 1855) (Ulidiidae) belong to invasive pest species. Thermophilous species are represented by interesting records, namely *Suillia gigantea* (Meigen, 1830), *S. lurida* (Meigen, 1830), *S. variegata* (Loew, 1862) (all Heleomyzidae), *Minettia subvittata* (Loew, 1847), *Peplomyza discoidea* (Meigen, 1830) (both Lauxaniidae), and *Otites lamed* (Schrank, 1781) (Ulidiidae). Furthermore, the disease vector role of *Phortica variegata* (Fallén, 1823) (Drosophilidae) is also discussed.

KEY WORDS: beer traps, Diptera, faunistics, Hungary

Izvleček – NEKAJ DRUŽIN DVOKRILCEV IZ PIVSKIH PASTI NA BALATONSKEM VIŠAVJU NA MADŽARSKEM

Predstavljeni so favnistični podatki o 41 vrstah dvokrilcev iz devetih družin (Anisopodidae, Drosophilidae, Dryomyzidae, Heleomyzidae, Lauxaniidae, Platystomatidae, Sciomyzidae, Syrphidae in Ulidiidae), zbranih na šestih krajih pri vaseh Felsőörs in Lovas na Balatonskem višavju na Madžarskem. Med temi sta vrsti *Drosophila suzukii* (Matsumura, 1931) (Drosophilidae) in *Callopistromyia annulipes* (Macquart, 1855) (Ulidiidae), ki sta invazivni vrsti škodljivcev. Toploljubne vrste so

zastopane z zanimivimi najdbami, kot so *Suillia gigantea* (Meigen, 1830), *S. lurida* (Meigen, 1830), *S. variegata* (Loew, 1862) (vse Heleomyzidae), *Minettia subvittata* (Loew, 1847), *Peplomyza discoidea* (Meigen, 1830) (obe Lauxaniidae) in *Otites lamed* (Schrank, 1781) (Ulidiidae). Poleg tega je obravnavana vloga vrste *Phortica variegata* (Fallén, 1823) (Drosophilidae) kot prenašalke bolezni.

KLJUČNE BESEDE: pivske pasti, Diptera, favnistika, Madžarska

Introduction

Many Diptera species are important pests and disease vectors. While climate change triggers the northward spread of mosquito (Medlock et al. 2012) and sandfly vectors (Fischer et al. 2011), long-distance transport results in the rapid, intercontinental spread of such invasive agricultural pest taxa as e.g., *Drosophila suzukii* (Walsh et al. 2011, Örsted & Örsted 2019). Many species, especially of Anisopodidae, Dryomyzidae, Heleomyzidae, Lauxaniidae, Platystomatidae and Ulidiidae, prefer the moist, shady habitats, because larvae most of them develop in such decaying materials as rotten fruits and fungi or carrion, so that they play an important role in decomposition. Sciomyzidae larvae are aquatic predators or terrestrial parasitoids of moluscs. Although most species breed in a decaying plant and fungal material, larvae of a few species, such as *D. suzukii*, can also feed on fresh fruits. *Drosophila* species can act as passive vectors of various pathogenic bacteria and fungi (Gilbert 1980).

The aim of the study was to study the Diptera assemblages of the Balaton highland using simple method (beer trap) which can bring interesting results differing from those obtained by more standard methods, such as sweeping and using Malaise or Moericke traps.

Methods

Study area. The Balaton Highland is the southern part of the Bakony Mountain Range which is bordered by the lake Balaton from the south. The distance of the collecting sites from lake Balaton is 3 to 4 km. The bedrock is composed of Triassic-age carbonates. There are several karst springs in the area. Mesophilous oak-forest communities form the characteristic vegetation (Fig.1).

The description of the environment of the trapping sites is as follows:

All localities are wet and shaded, they were chosen because of preferences by studied families.

1. Alkút spring: a cold headspring (helocren) with an associated marsh at the north-east slope of the Kereszt hill, 47°0'31"N, 17°57'16"E. *Eriophorum angustifolium* (Honck., 1782) as glacial relict species can be found in this refuge.

2. Watercourse of Alkút spring at the north slope of the Kereszt hill; the direction of the valley is east to west, 47°0'31"N, 17°57'8"E. *Carpinus betulus* (L.) can be

Fig. 1: Position of the studied area in Central Europe (yellow spot) and the localities of the trapping points in Felsőörs and Lovas.

found at this site; some orchid species are represented, however *Pulmonaria officinalis* (L.) is a common herbaceous species.

3. Stream of Malom spring, site I; *C. betulus*, *Staphylea pinnata* (L.) and *Acer campestre* (L.) are characteristic tree species; the direction of the valley is north to south, 47°0'34"N, 17°56'59"E. A cold and shaded biotope in the bottom of the valley. *Asarum europaeum* (L.) occurs in the undergrowth.

4. Stream of Malom spring, site II; a much more open and warmer part of the Malom valley than the Malom I site, 47°0'41"N, 17°56'51"E. With a row of buildings at the right and broad meadow at the left side of the stream; *Salix* species occur at the stream coasts.

5. Stream of Király-kút spring; this site lies at the eastern slope of a hill, on the borderline of a forest and a cattle pasture, 47°0'18"N, 17°56'58"E. The forest is rather mesophilic (*Acer* species are common trees). Planted stands of *Pinus nigra* (J.F. Arnold, 1785) can be found in the higher parts of the hill on the western side of the broad valley.

6. Aranyos spring: similar to the previous site, 47°0'12"N, 17°56'59"E. A bit more humid – *Equisetum arvense* (L.) and *Petasites hybridus* ((L.) Gaertn. & al., 1801) can be found there. Cows come to drink water from the spring.

In the Result section, the localities are abbreviated by the above-mentioned six numbers (1–6).

Respective parts of Figure 2 show the vegetation habitus pictures of Alkút spring, stream of Király-kút spring, stream of Malom spring and Aranyos spring.

Trapping method. We used the fermented mixture of beer and sugar, which contained about four teaspoons of sucrose (~24 g), a 1/2 can of light beer (0.25 l) and about 1 coffee spoon of yeasts (~5-8 g). The material was inoculated with yeast. The fermented material was filled into uncapped plastic bottles and they were hung in the woods at head height. Traps were operated at the six sites of Felsőörs and Lovas (about 47.00° N, 17.95° E). All traps were installed in three periods. In the Result

section, these periods are abbreviated as A (29. 4. 2017–16. 5. 2017), B (13.–22. 7. 2017), and C (23.–30. 8. 2017). The trapped flies were conserved in ethyl-alcohol in plastic vials.

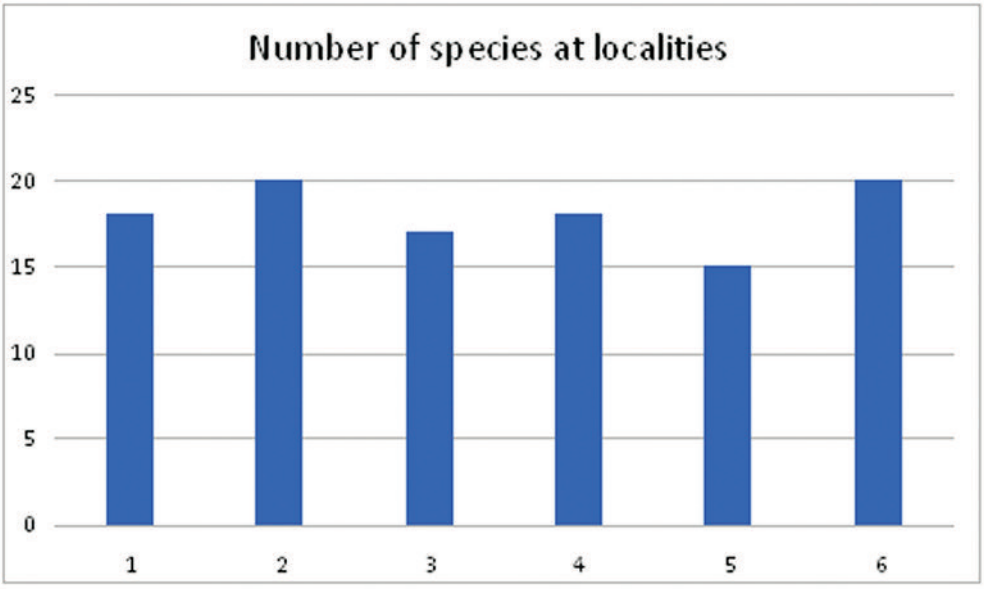
Proceeding of the paper. All the material was collected by A. J. Trájer, L. Dvořák sorted out the material. The following families were identified and commented by L. Dvořák (Anisopodidae, Platystomatidae, Syrphidae, and Ulidiidae), K. Dvořáková

Fig. 2: Vegetation habitus of four collecting sites. Photo: A. J. Trájer.

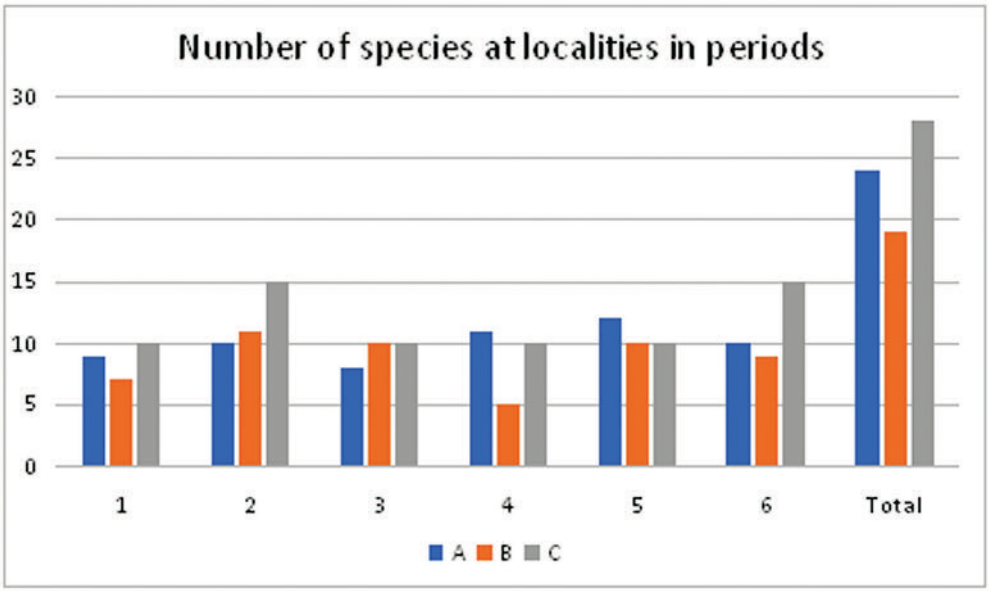
(Dryomyzidae, Heleomyzidae, Lauxaniidae, and Sciomyzidae) and J. Máca (Drosophilidae). The voucher specimens are deposited in the private collections of the authors who made the identification. In the Discussion, comments were made for the species not listed in the Checklist of the Diptera of Hungary (Papp 2001) and for some remarkable species. We are using the nomenclature of the portal https://fauna-eu.org, with following exceptions: the genus *Otites*, family Dryomyzidae, and family Lauxaniidae, where we comply to the newest papers of Kameneva & Korneyev (2019), Semelbauer (2016), and Mathis & Sueyoshi (2011), repectively.

Results

During the 2017 season, 1229 specimens of 41 species were captured of studied families of Diptera. The number of species at localities was rather similar and varied between 15 and 20 species (graph 1), unlike the number of species in three periods (graph 2). 28 species were identified in the third period (=C, 23.–30. 8.), 24 in the first period (=A, 29. 4.–16. 5.), and only 19 in the second period (=B, 13.–22. 7.). The highest numbers of species were found in the localities and periods 2C and 6C followed by 5A, 2B, and 4A (all more than 10 species). In contrast with this, the most of specimens (692) were trapped in the period B, (300 in C and 237 in A), in individual localities and periods (graph 3), the highest numbers were identified from 3B (243 specimens), 2B (171 spec.), 2C (122 spec.), and 6B (112 spec.); the numbers were lower than 100 specimens in other localities and periods. Nine species (Drosophilidae and Heleomyzidae) were found in all localities, *Dryomyza anilis* in

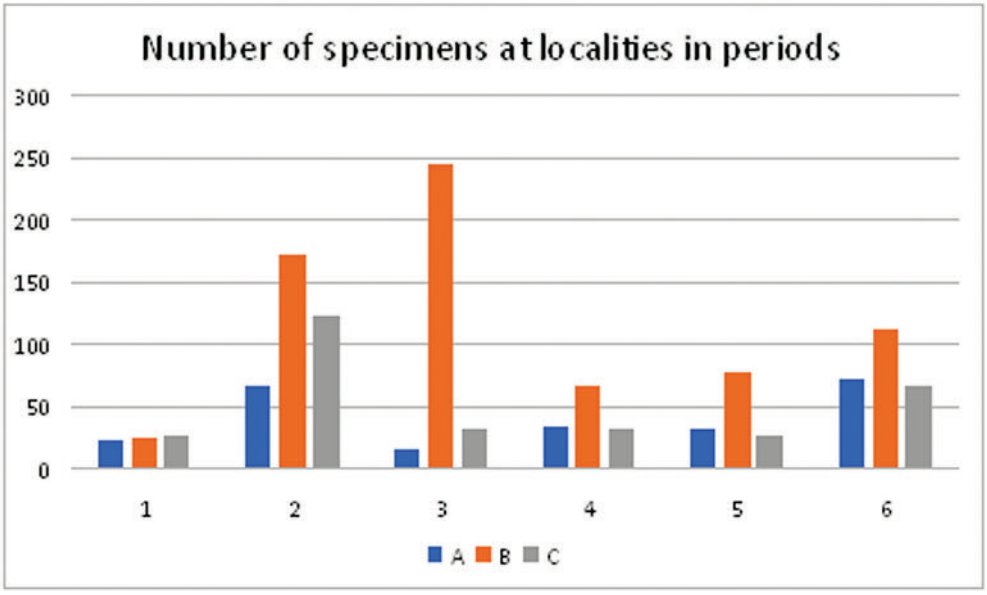


Graph 1: Number of species at localities 1–6.



Graph 2: Number of species at localities 1–6 in the periods A, B and C.

all traps. *Suillia affinis* has the most of specimens (280), of which 87 in one trap (3B). Some other species from families Dryomyzidae, Drosophilidae and Heleomyzidae were also caught in the mass numbers.



Graph 3: Number of specimens at localities 1–6 in the periods A, B and C.

List of species

Anisopodidae
Sylvicola punctatus (Fabricius, 1787)
Material examined – 4A: 1♂, 1♀; 5A: 3♀♀.

Drosophilidae
Drosophila histrio Meigen, 1830
Material examined – 2C: 1♀; 6A: 1♂, 3♀♀.

Drosophila immigrans Sturtevant, 1921
Material examined – 2C: 2♂♂, 1♀; 3C: 1♀.

Drosophila kuntzei Duda, 1924
Material examined – 1A: 1♀; 1B: 1♀♀; 2A: 2♂♂; 2B: 22♂♂, 7♀♀; 2C: 4♂♂, 1♀; 3A: 1♂; 3B: 38♂♂, 11♀♀; 3C: 1♀; 4C: 2♂♂; 5A: 1♂, 1♀; 5B: 12♂♂, 1♀; 5C: 1♂, 1♀; 6A: 10♂♂, 2♀; 6C: 4♂♂, 6♀♀.

Drosophila melanogaster Meigen, 1830
Material examined – 1C: 1♀; 3C: 2♂♂, 9♀♀.

Drosophila obscura Fallén, 1823
Material examined – 4A: 1♀; 6C: 3♂♂, 2♀♀.

Drosophila phalerata Meigen, 1830
Material examined – 1B: 1♂; 2A: 9♂♂, 4♀♀; 2B: 20♂♂, 11♀♀; 2C: 2♂♂, 5♀♀; 3A: 1♀; 3B: 32♂♂, 22♀♀; 3C: 2♀♀; 4A: 7♂♂, 1♀; 4C: 2♀♀; 5A: 2♂♂; 5B: 24♂♂, 7♀♀; 6A: 4♂♂, 2♀♀.

Drosophila simulans Sturtevant, 1919
Material examined – 3C: 1♂, 5♀♀; 6C: 1♀.

Drosophila subobscura Collin in Gordon, 1936
Material examined – 1A: 4♂♂, 1♀; 2A: 1♂; 3A: 2♂♂; 3C: 1♂, 3♀♀; 4A: 2♀♀; 4C: 1♂; 5A: 1♂, 3♀♀; 6A: 1♂, 1♀; 6C: 1♀.
A west-Palaearctic species with a globally increasing range due to international transport of goods. It is habitat-tolerant, occurring at forest edges, wetlands, bushes etc., also in gardens, houses and canning factories, where it supports spreading of decay; it can develop in the sap flow of injured trees as well as in decaying fruit.

Drosophila suzukii (Matsumura, 1931)
Material examined – 1C: 1♀; 4C: 1♂.
The Asian cherry fly, which infests ripening cherries and other soft-skin fruits, is native roughly to the south-eastern half of Asia. Recently – mostly after the onset of

this millenium – it has invaded Europe (also reached Turkey, NW Iran and Morocco), North and South America, Kenya, and some oceanic islands such as Hawaii, French Polynesia, Madeira, Azores and Réunion (Calabria et al. 2012, Chabert et al. 2012, Poyet et al. 2014, Örsted & Örsted 2019). *D. suzukii* causes severe economic losses (Cini et al. 2012). In Hungary, it was first recorded in the year 2012 from the locality Táska, some 10 km to the south of Balaton lake (Kiss et al. 2013); several Hungarian localities are known at present.

Drosophila testacea von Roser, 1840
Material examined – 1A: 1♀; 1B: 1♀; 1C: 1♂; 2A: 3♂♂, 1♀; 2B: 20♂♂, 11♀♀; 2C: 4♂♂, 9♀♀; 3A: 1♂; 3B: 10♂♂, 4♀♀; 4A: 1♀; 4C: 1♂; 5A: 1♀; 5B: 4♂♂; 6A: 2♂♂; 6C: 3♂♂.

Drosophila transversa Fallén, 18230
Material examined – 2B: 1♀; 2C: 1♂; 3B: 1♂, 1♀; 4C: 1♀.

Drosophila unimaculata Strobl, 1893
Material examined – 3A: 2♂♂; 3B: 2♀♀.

Hirtodrosophila confusa (Stžger, 1844)
Material examined – 3B: 3♀♀; 5A: 1♂, 1♀; 5B: 1♀; 5C: 1♂.

Leucophenga maculata (Dufour, 1839)
Material examined – 5B: 1♂, 2♀♀; 5C: 1♂; 6A: 1♀; 6C: 1♂.

Phortica variegata (Fallén, 1823)
Material examined – 4A: 1♀.
West-Palaearctic species, recently introduced to North America. It is an intermediate host of the nematode *Thelazia callipaeda* (Railliet and Henry, 1910) under natural conditions (Otranto et al. 2006a). This zoophilic fruit fly can be collected in the highest number during July to August in Europe (Otranto et al. 2006b). Larvae of the nematode are transmitted by secretophagous flies into the conjunctival sac and surrounding tissues of wild and domestic mammals, as well as humans (reviewed in Otranto & Traversa 2005). Thelaziasis occurred originally in southeast Asia (e.g., Yang et al. 2006; Krishnachary et al. 2014; Kosin et al. 1989); more than thirty years ago it was first observed in Europe and now it has been recorded from many European countries including Hungary (Otranto & Dutto 2008, do Vale et al. 2020).

Scaptodrosophila deflexa (Duda, 1924)
Material examined – 1A: 1♀; 1B: 1♂.

Dryomyzidae
Dryomyza anilis Fallén, 1820

Material examined – 1A: 1♂; 1B: 9♂♂, 5♀♀; 1C: 3♀♀; 2A: 3♂♂, 14♀♀; 2B: 6♂♂, 9♀♀; 2C: 8♂♂, 14♀♀; 3A: 4♂♂, 2♀♀; 3 B: 7♂♂, 5♀♀; 3C: 1♂, 1♀; 4A: 5♂♂, 3♀♀; 4B: 11♂♂, 9♀♀; 4C: 11♂♂, 4♀♀; 5A: 3♂♂, 4♀♀; 5B: 7♂♂, 3♀♀; 5C: 2♂♂, 1♀; 6A: 3♂♂, 1♀; 6B: 10♂♂, 12♀♀; 6C: 10♂♂, 7♀♀.

Dryope flaveola (Fabricius, 1794)
Material examined – 2A: 1♂; 2C: 1♂; 4A: 1♂; 6B: 2♂♂; 6C: 3♂♂, 1♀.

Heleomyzidae
Suillia affinis (Meigen, 1830)
Material examined – 1B: 1♂, 2♀♀; 1C: 3♂♂, 4♀♀; 2A: 1♂, 1♀; 2B: 23♂♂, 7♀♀; 2C: 31♂♂, 13♀; 3A: 1♀; 3 B: 47♂♂, 40♀♀; 4B: 22♂♂, 11♀♀; 4C: 5♂♂, 1♀; 5A: 1♂; 5B: 6♂♂, 6♀♀; 5C: 1♂; 6A: 5♂♂, 6♀♀; 6B: 24♂♂, 9♀♀; 6C: 6♂♂, 3♀♀.

Suillia bicolor (Zetterstedt, 1838)
Material examined – 3 C: 1♀.

Suillia gigantea (Meigen, 1830)
Material examined – 1B: 2♀♀; 1C: 1♀; 2A: 1♂; 2B: 14♂♂, 13♀♀; 2C: 4♂♂, 2♀♀; 3 B: 6♂♂, 7♀♀; 3C: 1♂, 1♀; 4B: 3♂♂, 4♀♀; 4C: 1♀; 5A: 2♂♂, 1♀; 5B: 1♂; 5C: 3♂♂, 2♀♀; 6A: 25♂♂, 3♀♀; 6B: 15♂♂, 17♀♀; 6C: 4♂♂.
Thermophilous species, common in Hungary in suitable conditions.

Suillia lurida (Meigen, 1830)
Material examined – 6B: 1♂, 1♀.
Larvae develop in garlic, onion, and other related plants, they are ranked as not important agriculture pests.

Suillia pallida (Fallén, 1820)
Material examined – 2C: 1♂, 2♀♀; 6B: 2♂♂, 5♀♀; 6C: 1♂.

Suillia ustulata (Meigen, 1830)
Material examined – 2C: 1♂.
This species is known from several European countries, but it is collected only individually; the larvae develop in dead alder stems.

Suillia variegata (Loew, 1862)
Material examined – 1A: 1♂; 1C: 6♂♂, 1♀; 2B: 1♂, 2♀♀; 2C: 6♂♂, 5♀♀; 3 B: 3♂♂, 4♀♀; 4B: 1♂, 2♀♀; 5B: 1♂; 5C: 4♂♂, 2♀♀; 6B: 1♀; 6C: 4♂♂, 2♀♀.
Thermophilous species, common in Hungary in suitable conditions.

Tephrochlamys flavipes (Zetterstedt, 1838)
Material examined – 6C: 1♂.

Lauxaniidae

Meiosimyza decempunctata (Fallén, 1820)

Material examined – 1C: 1♂, 1♀; 2B: 1♂, 1♀; 2C: 3♀♀; 3C: 1♀; 4B: 1♂, 1♀; 4C: 1♂; 5B: 1♀; 5C: 2♂♂, 1♀; 6B: 5♂♂, 7♀♀; 6C: 1♀.

Meiosimyza rorida (Fallén, 1820)

Material examined – 5C: 3♀♀; 6C: 1♂.

Minettia subvittata (Loew, 1847)

Material examined – 1B: 2♂♂.

Thermophilous species, common in Hungary in suitable conditions.

Peplomyza discoidea (Meigen, 1830)

Material examined – 2B: 1♂.

Thermophilous species, common in Hungary in suitable conditions.

Pseudolyciella sp.

Material examined – 1C: 1♀.

There are three species of the genus *Pseudolyciella* known from Hungary, all identifiable according to the male terminalia only. However, there are crosses between these taxa and also according to the wing shape morphometric analyses it is probable that the genus *Pseudolyciella* includes only one morphoplastic species (Semelbauer 2016).

Tricholauxania praeusta (Fallén, 1820)

Material examined – 5C: 1♂.

Platystomatidae

Platystoma seminatione (Fabricius, 1775)

Material examined – 1A: 7♂♂, 3♀♀.

Sciomyzidae

Euthycera chaerophylli (Fabricius, 1798)

Material examined – 1C: 1♀; 2C: 1♂.

Syrphidae

Volucella inflata (Fabricius, 1794)

Material examined – 4A: 2♀♀; 5A: 1♀.

Ulidiidae

Callopistromyia annulipes (Macquart, 1855)

Material examined – 1A: 1♀.

This species was not included in the checklist of Papp (2001), its first records from Hungary were published by Kameneva & Pekarsky (2016). It is an invasive

species in Europe, first published from Europe by Merz (2007). For the present distribution see e. g., Dvořák et al. (2019).

Otites lamed (Schrank, 1781)
Material examined – 1A: 1♀.

Otites levigata (Loew, 1873)
Material examined – 2A: 19♂♂, 4♀♀; 4A: 2♂♂, 1♀.
A species known mainly from south-eastern Europe – in a relatively small area bordered by Italy, Slovakia, and Bulgaria.

Otites ornata (Meigen, 1826)
= *O. bacescui* (Gheorghiu, 1987)
Material examined – 4A: 3♂♂, 1♀; 5A: 4♂♂, 1♀.
A south European species occurring from France to Bulgaria. This species was not included to the Hungarian checklist (Papp 2001), although Kameneva (1997) reported the material from Hungary. We confirm the occurrence for Hungary.

Otites ruficeps (Fabricius, 1805)
= *O. formosa* (Panzer, 1798)
Material examined – 2A: 1♂; 3A: 1♂; 6A: 1♂.

Discussion

Many of studied species are psychrophilous or rather psychrophilous, so that they can occur more often at the beginning and the end of season, which explains the smaller number of species in the middle of the season. Moreover, in August, the summer and autumn aspects meet. The mass occurrence of some species in the middle of the season can be explained by their retreatment to the shaded valleys during the hottest time of the year.

The beer traps are catching different species spectrum than other traps or sweeping, as we found in previous surveys (for example Dvořáková 2008, Dvořák et al. 2019). It is not always clear why this is the case. For example, regular high incidence of mycetophagous *Suillia* species is surprising. Adults, in contrast with larvae, probably prefer fermenting juice. More detailed comparison of various types of traps would require special research in terrain or meta-research of published results.

Conclusions

During the survey using beer traps in Balaton highlands in 2017, altogether 41 Diptera species from nine families were identified: Anisopodidae (one species), Drosophilidae (16 species), Dryomyzidae (two species), Heleomyzidae (eight species), Lauxaniidae (six species), Platystomatidae (one species), Sciomyzidae (one species), Syrphidae (one species), and Ulidiidae (five species).

Common and widespread species prevailed in the material. Among others, we caught several thermophilous species, as *Suillia gigantea*, *S. variegata* (Heleomyzidae), *Minettia subvittata*, *Peplomyza discoidea* (Lauxaniidae) and *Otites lamed* (Ulidiidae).

The species *Callopistromyia annulipes* (Ulidiidae) and *Drosophila suzukii* (Drosophilidae) are imported invasive fly species. The second one, as well as *Suillia lurida* (Heleomyzidae), are ranked as agriculture pests.

Some species of *Drosophila* (e. g. *D. immigrans*, *D. melanogaster*, *D. subobscura*) are noxious in the food industry.

One species, *Phortica variegata*, is a species of medical importance.

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PRVA NAJDBA ČRNE TRTNE UŠI (*APHIS ILLINOISENSIS* SHIMER, 1866) V SLOVENIJI (HEMIPTERA, APHIDOIDEA: APHIDIDAE)

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Izvleček – V jeseni leta 2020 je bilo prvič ugotovljeno pojavljanje nearktične črne trtne uši (*Aphis illinoisensis* Shimer) v Sloveniji. Kolonije uši, ki so jih živahno obiskovale dvobarvne travniške mravlje (*Lasius emarginatus* [Oliver]), so se pojavile na opuščenem trsu vinske trte v Šempetru pri Gorici. Podane so osnovne informacije o morfoloških značilnostih in bionomiji te nove vrste, podprte z barvnimi slikami. Ker bi lahko postala opazen škodljivec vinske trte, bi bilo smiselno njeno nadaljnje spremljanje v Sloveniji.

Ključne besede: vinska trta, *Aphis illinoisensis*, Slovenia

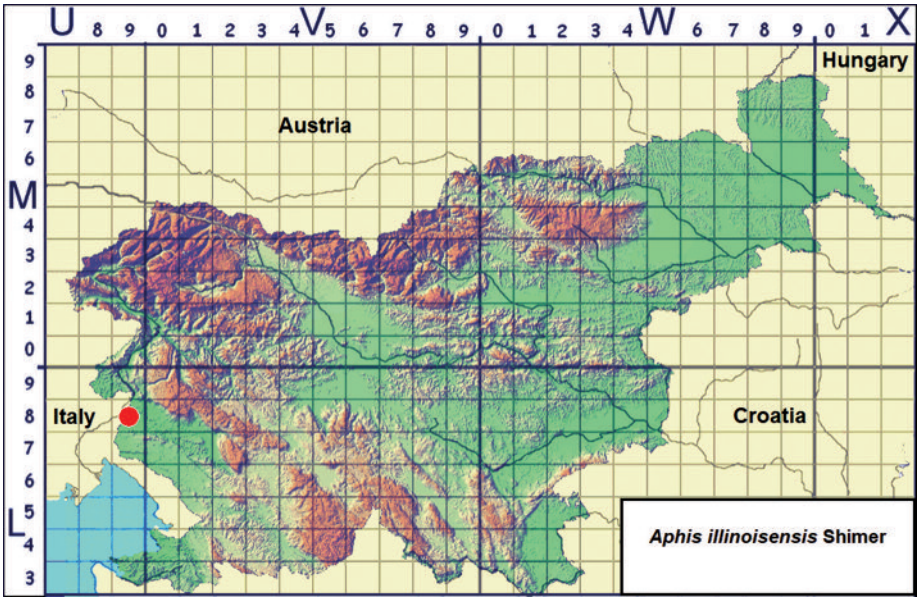
Abstract – FIRST RECORD OF GRAPEVINE APHID (*APHIS ILLINOISENSIS* SHIMER, 1866) IN SLOVENIA (HEMIPTERA, APHIDOIDEA: APHIDIDAE)

In autumn 2020 the occurrence of the Nearctic grapevine aphid (*Aphis illinoisensis* Shimer) was detected for the first time in Slovenia. Colonies of aphids actively visited by ants *Lasius emarginatus* (Olivier) were found on an abandoned plant of *Vitis vinifera* in Šempeter pri Gorici (western Slovenia). Basic information on morphological features and bionomics of this new species are provided and documented with colour figures. This species, probably, merits further surveys in Slovenia because of its potential ability to become a notable pest of grapevine.

Key words: Grapevine, *Aphis illinoisensis*, Slovenia

Podatki o pojavu črne trtne uši (*Aphis illinoisensis* Shimer) v Sloveniji (slika 1):

Šempeter pri Gorici, koordinate 45°55'50,82" N 13°38'23,6" E; 13.10.2020; gostiteljska rastlina *Vitis vinifera* L. Kolonije ličink in nimf različnih razvojnih stopenj ter nekrilatih in krilatih odraslih uši na bujnih poganjkih in mladih listih vinske trte. Kolonijo so živahno obiskovale dvobarvne travniške mravlje (*Lasius emarginatus*



Sl. 1: *Aphis illinoisensis* – mesto prve najdbe v Sloveniji
Fig. 1: *Aphis illinoisensis* – site of first finding in Slovenia

[Olivier, 1792]; Formicidae). Vavčer vzorec (mikroskopski preparat dveh odraslih nekrilatih in dveh krilatih osebkov) je shranjen v avtorjevi zasebni zbirki žuželk.

Črna trtna uš - *Aphis (Aphis) illinoisensis* Shimer, 1866 (Hemiptera, Aphidoidea: Aphididae) je splošno razširjena v vzhodnem in osrednjem delu ZDA ter v Srednji in južni Ameriki. Njene gostiteljske rastline so vinikovke (Vitaceae), predvsem predstavniki rodov *Vitis, Parthenocissus, Ampelocissus* in *Cissus* (Blackman & Eastop, 2020). V izvornih območjih jo poznajo kot občasnega škodljivca vinske trte, ki se ga navadno zatira v sklopu obvladovanja drugih škodljivcev vinske trte. V primeru močnejšega napada se uši naselijo tudi na grozde in lahko povzročajo venenje pecljevine in zgodnje odpadanje jagod, ko so te še zelene (Backer, 1917; McGrew & Steel, 1979).

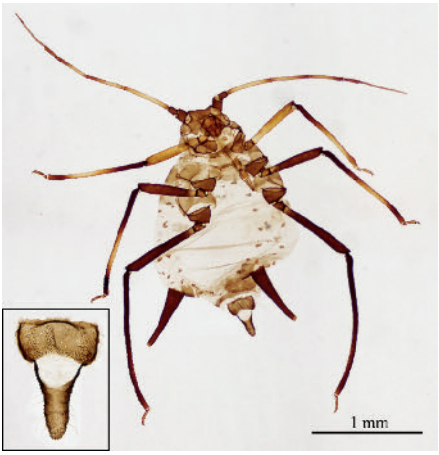
Na Staro celino je bila vrsta očitno zanesena povsem naključno. Najprej je bila odkrita v Turčiji (Remaudière in sod. 2003), a so jo pozneje zaznali še drugje v sredozemskih državah: Grčiji (Tsitsipis et al., 2005), Severnem Cipru (Kocadal & Ulusoy, 2006), Tuniziji (Kamel-Ben Halima & Mdellel, 2010), Črni Gori (Petrović-Obradović in sod., 2010), Alžiriji (Laamari & Coeur d'Acier, 2010), Izraelu (Barjadze & Ben-Dov, 2011), Libiji (Havelka in sod., 2011), Malti (Mifsud & Pérez Hidalgo, 2011), Španiji (Pérez Hidalgo in sod., 2011), Albaniji (EPPO, 2011) in Italiji (EPPO, 2012). To bodisi priča o njenem hitrem širjenju na tem območju, ali pa morda tudi le o njenem zgoščenem odkrivanju in prepoznavanju. Po zunanjosti so ji namreč zelo podobne nekatere domorodne polifagne vrste uši, ki se občasno pojavljajo na vinski trti. Take so npr. *Aphis fabae* Scopoli (črna fižolova

Sl. 2: *Aphis illinoisensis* – kolonija uši na spodnji strani lista vinske trte in mravlje vrste *Lasius emarginatus*.

Fig. 2: *Aphis illinoisensis* – a colony of aphids on the leaf lower side of grapevine visited by ants *Lasius emarginatus*.

Sl. 3: *Aphis illinoisensis* – krilata (zgoraj) in nekrilata viviparna samica (v sredini) ter nimfa (spodaj).

Fig. 3: *Aphis illinoisensis* – winged (above) and wingless viviparous female (middle) and a nymph (below).

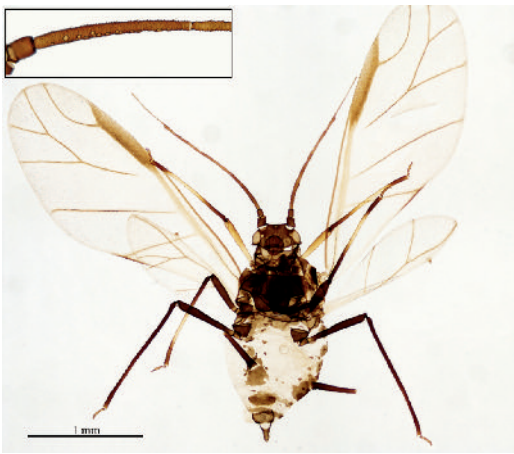


Sl. 4: *Aphis illinoisensis* – mikroskopski preparat nekrilate viviparne samice (v okvirju povečan repek – cauda)

Fig. 4: *Aphis illinoisensis* – microscopic slide of a wingless viviparous female (in frame enlarged cauda)

uš), *A. gossypii* Glover (bombaževčeva uš), *A. spiraecola* Patch (medvejkina uš) in *A. craccivora* Koch (Petrović-Obradović in sod., 2010; Barjadze & Ben-Dov, 2011).

Nekrilate in krilate uši se v mešanih kolonijah pojavljajo prek cele rastne dobe vinske trte (slika 2). Nekrilate odrasle uši (apterae) so velike od 1,6–2,1 mm, precej spremenljive barve, od svetleče rdečerjave do povsem črne (slika 3). Od prej omenjenih sorodnih domorodnih vrst se razlikuje predvsem po tem, da ima črna trtna uš povsem črne goleni zadnjih nog (sliki 3 in 4), medtem ko so te pri domačih vrstah povsem svetle ali takšne vsaj v sredini zadnje goleni. Sprednje in srednje goleni pa so tudi pri tej vrsti v srednjem delu svetle. Črno trtno uš odlikujejo tudi razmeroma dolgi črni sifoni, ki so rahlo nagnjeni navzven. Telo krilatih uši je navadno malenkost manjše, podobne barve kot nekrilatih; krila so prozorna s temno rjavo stigmo in v dolžino merijo od 2,4 do 2,7 mm (sliki 3 in 5).



Sl. 5: *Aphis illinoisensis* – mikroskopski preparat krilate viviparne samice (v okvirju povečan 3. člen tipalk s čutnimi jamicami – rhinaria)

Fig. 5: *Aphis illinoisensis* – microscopic slide of a winged viviparous female (in frame enlarged 3rd antennal segment with rhinaria)

Na vinski trti naseljuje mlade poganjke v bujni rasti in mlade liste. Po podatkih iz literature se pri močnem napadu pojavljajo tudi na grozdju, ko so jagode še zelene (BACKER, 1917). Na listih se uši zadržujejo predvsem na spodnji strani vzdolž debelejših žil. Kolonije uši pogosto obiskujejo mravlje. V našem primeru so bile to dvobarvne travniške mravlje (*Lasius emarginatus*).

Črna trtna uš je v izvornih območjih v Ameriki dvodomna diecična in holociklična vrsta z glavnim gostiteljem *Viburnum prunifolium* L., na katerem prezimuje kot jajčece in razvije nekaj spomladanskih partenogenetskih rodov. V začetku maja se začne preseljevati na drugotne gostitelje, predvsem na vinsko trto in druge vrste iz družine vinikovk. Jeseni se vrnejo na primarnega gostitelja, kjer se razvije spolni oviparni rod, čemur sledi odlaganje zimskih jajčec (BACKER, 1917). Vse kaže, da na novih območjih, zaradi odsotnosti primarnega gostitelja, nima popolnega razvojnega kroga kot ga ima v Severni Ameriki, pač pa se neprekinjeno partenogenetsko razmnožuje, prek zime tudi na alternativnih gostiteljih (BLACKMAN & EASTOP, 2020; MORAITI in sod., 2012).

Glede na ta dejstva ima črna trtna uš razmeroma skromne možnosti, da se pri nas trajneje ustali in razvije večje populacije, razen morda na toplih legah v obmorskih predelih Slovenske Istre, kjer bi morda lahko prezimila kot viviparna samica in ličinke. Zelo verjetno se bo občasno pojavljala že zaradi naleta iz toplejših območij Sredozemlja. Tudi ta pozen pojav v Šempetru pri Gorici na trti, ki raste ob hišnem zidu, je morda le epizodična naselitev. Kljub temu kaže biti nanjo pozoren v primeru, da bi se začele listne uši pogosteje in bolj množično pojavljati na vinski trti. Doslej je bilo namreč pojavljanje listnih uši na vinski trti sporadično ter brez opaznih gospodarskih in okoljskih posledic.

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CONTRIBUTION TO THE KNOWLEDGE ON DISTRIBUTION OF OWL-FLY *LIBELLOIDES MACARONIUS* (SCOPOLI, 1763) IN SLOVENIA, NEW RECORDS FROM THE ŠENTVID PLATEAU, NW SLOVENIA

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Abstract – Two new records of the owl-fly *Libelloides macaronius* are presented. The specimens were found on the Šentvid plateau, NW Slovenia.

KEY WORDS: *Libelloides macaronius,* owl-fly, distribution, Slovenia

Izvleček - PRISPEVEK K POZNAVANJU RAZŠIRJENOSTI METULJČNICE *LIBELLOIDES MACARONIUS* (SCOPOLI, 1763) V SLOVENIJI, NOVA PODATKA S ŠENTVIŠKE PLANOTE, SZ SLOVENIJA

Predstavljena sta dva nova podatka o metuljčnici *Libelloides macaronius.* Osebka sta bila najdena na Šentviški planoti, SZ Slovenija.

KLJUČNE BESEDE: *Libelloides macaronius,* metuljčnica, razširjenost, Slovenija

The known distribution of owl-fly *Libelloides macaronius* (Scopoli, 1763) in Slovenia is in the submediterranean region and the continental part of Slovenia (Devetak, 2007; Devetak et al., 2002; Klokočovnik et al., 2010; Popov, 2004). The species is endangered in the Republic of Slovenia due to natural succession of meadows, pastures and other grassland ecosystems. In the IUCN classification is estimated as vulnerable (V). Two morphs are recognized in Europe and were found in Slovenia. In the morph *macaronius* veins in dark spots in forewings are yellow and, in the morph *kolyvanensis* veins in dark spots in forewings are dark. The continental part of Slovenia and particularly areas at higher altitudes are inhabited by the morph *macaronius*, and the submediterranean region by *kolyvanensis* (Devetak, 2007).

Fig. 1. Photograph of the specimen found on 11. 6. 2011 (photo: G. Torkar)
Sl. 1. Fotografija osebka najdenega dne 11. 6. 2011 (foto: G. Torkar).

Two new records of the owl-fly *L. macaronius*, morph *macaronius*, from the Šentvid plateau, NW Slovenia, are reported here.

On 11. 6. 2011 at 13.10 one *L. macaronius* female was discovered on the meadow with sparsely distributed small bushes, WGS84 coordinates: 46,109100° N, 13,880181° E (Šentviška Gora, Municipality of Tolmin), at approximately 680 m a.s.l. (Fig. 1 and Fig. 2). According to the locals, the meadow is mowed at least twice a year.

On 26. 7. 2020 at 15.30 one owl-fly was discovered on pavement of the road near dry meadow, WGS84 coordinates: 46,132241° N, 13,886701° N (Police, Municipality of Idrija), at approximately 790 m a.s.l. Natural succession is seen on the edges of the meadow and nearby is a water spring which is very rare on this karst plateau. Because the specimen flew away quickly, photo documentation was not possible.

Two records nine years apart testify to the species' continual presence in the Šentvid plateau. The sites are closest to Idrija - Scopoli (1763) described the species from the Idrija area. As these are the first data on the species in NW Slovenia, there is a need for further systematic research.

Fig. 2. Meadow near village Šentviška Gora where the specimen was found (photo: G. Torkar).

Sl. 2. Travnik blizu vasi Šentviška Gora, kjer je bil osebek najden (foto: G. Torkar).

Acknowledgments

I would like to thank Dr. Dušan Devetak for comments on the manuscript.

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TYPHONIA MELANA (FRIVALDSZKY, 1837) V SLOVENIJI (LEPIDOPTERA: PSYCHIDAE)

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Izvleček – Potrjena je prisotnost vrečkarja *Typhonia melana v* Sloveniji. Poleg *T. ciliaris* (Ochsenheimer, 1810) je to zdaj druga vrsta iz rodu *Typhonia*, ki se pojavlja v Sloveniji.

KLJUČNE BESEDE: Psychidae, *Typhonia melana*, favna, Slovenija

Abstract – *TYPHONIA MELANA* (FRIVALDSZKY, 1837) IN SLOVENIA (LEPIDOPTERA: PSYCHIDAE).

The bagworm moth *T. melana* is confirmed for the first time for Slovenia. In addition to *T. ciliaris* (Ochsenheimer, 1810), this is now second species of the genus *Typhonia*, occuring in Slovenia.

KEY WORDS: Psychidae, *Typhonia melana*, fauna, Slovenia

T. melana je bila prvotno opisana kot ločena vrsta *Euprepia melana* Frivaldszky, 1837, toda taksonomskega statusa vrste starejši raziskovalci niso upoštevali in so jo večinoma smatrali za podvrsto ali aberacijo k splošno poznani *T. ciliaris* (= *Melasina lugubris*). Dolgoletno zmedo v entomološki literaturi so uredili šele v novejšem času, ko so *T. melana* vzpostavili najprej kot podvrsto *T. ciliaris* (Hättenschwiler, 2000, Sobczyk, 2011), nato pa kot samostojno vrsto (Arnscheid in Weidlich, 2017, Bertaccini in Zilli, 2017). Zaradi nove taksonomske kategorizacije je *T. melana* tako nov takson za favno metuljev Slovenije.

Carnelutti (1978) poroča o "*M. melana* v višjih legah Ratitovca", vendar pozneje v svojem rdečem seznamu Makrolepidopterov Slovenije navaja samo *M. lugubris* (Carnelutti, 1992a). Lesar in Govedič (2010) pripisujeta vse literaturne navedbe o rodu *Typhonia* v Sloveniji vrsti *T. ciliaris*, ki je bila takrat obravnavana kot en takson.

Sl. 1: Samec *T. melana*, e.l. 24. 6. 2014 (vrečke nabrane 12. 1. 2014). Gračnica pri Rimskih Toplicah.

Sl. 2: Stara, pritrjena vrečka izleženega metulja *T. melana* (rdeča puščica). 12. 1. 2013, Gračnica pri Rimskih Toplicah.

Sl. 3: Habitat vrste *T. melana*. 12. 1. 2013, Gračnica pri Rimskih Toplicah.

T. melana je v Evropi najbolj razširjena vrsta iz svojega rodu, kateri pripadajo vse populacije v Južni in Jugovzhodni Evropi (Arnschied in Weidlich, 2017). Razširjena je na Pirenejskem polotoku, v Švici, Italiji, Avstriji, na Balkanu, v Romuniji, na Madžarskem in na Slovaškem (Arnscheid in Weidlich, 2017, Bertaccini in Zilli, 2017), našli so jo v Turčiji (Kemal s sod., 2019). Glede na prisotnost vrste v vseh sosednjih državah je bila najdba *T. melana* pri nas pričakovana.

Toploljubne gosenice se hranijo z različnimi nizkimi zelmi, ki rastejo na sončnih rastiščih, kot so cestne brežine, melišča, robovi kamnolomov, travnata in skalnata ali s presvetljenim gozdom in grmovjem delno zaraščena pobočja. Metulji so v naravi aktivni podnevi, največ zgodaj popoldne. Pojavljajo se od konca junija do začetka septembra, z vrhuncem pojavljanja konec julija in v začetku avgusta. Gosenice, ki živijo v iz peska izdelanih vrečkah predvsem peščene barve, najdemo skozi vse leto.

Več primerkov obeh spolov smo vzgojili iz gosenic, ki smo jih nabrali v strmem, termofilnem, peščenem pobočju nad železnico v Gračnici pri Rimskih Toplicah (UTM: WM10), 237 m. 15. 1. 2011 so bile nabrane stare vrečke, 4 gosenice z dolžino vrečk 20–22 mm, e.l. 1♂, 12. 6. 2011, 1♂, 14. 6. 2011. 12. 1. 2014 nabrane 3 stare vrečke dolžine 32–37 mm z ostanki dveh eksuvijev, 4 mlade gosenice z dolžino

vrečk 18–32 mm, e.l. 1♀, 14. 6. 2014, 1♀, 19. 6. 2014, 1♂, 22. 6. 2014, 1♂, 24. 6. 2014. 10. 12. 2014 nabrane 4 stare vrečke dolžine 30–34 mm, 10 mladih gosenic z dolžino vrečk 10–21 mm, e.l. 3♂ in 4♀, 15.–24. 7. 2015. 25. 10. 2015 nabrane 4 stare vrečke dolžine 26–33 mm, eksuvij, mladi gosenici z dolžino vrečk 22 mm in 24 mm, e.l. 1♂, 3. 8. 2016.

Nomenklatura je povzeta po delu Arnscheid in Weidlich (2017). Primerki so shranjeni v zbirki avtorja.

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GERANIUM BRONZE, *CACYREUS MARSHALLI* BUTLER, 1897 – NEW BUTTERFLY SPECIES FOR FAUNA OF SERBIA (PAPILIONIDEA: LYCAENIDAE)

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Abstract – Butterfly species *Cacyreus marshalli* was recorded on October 1, 2020 in the city of Niš, which represents the first record in the territory of Serbia. It is also the first allochthonous butterfly species in Serbia and its discovery brought the number of species in Serbian fauna to 200. The specimen was identified from the photograph submitted to a Facebook group, which indicates significance of such social network groups which bring together insect lovers and enthusiasts of citizen science, especially regarding registering of invasive and allochthonous species.

Key words: allochthonous species, citizen science, Lycaenidae, social networks

Izvleček – PELARGONIJEV BAKRENČEK, *CACYREUS MARSHALLI* BUTLER, 1897 – NOVA VRSTA METULJA V FAVNI SRBIJE (PAPILIONIDEA: LYCAENIDAE)

Metulj *Cacyreus marshalli* je bil zabeležen 1. oktobra leta 2020 v mestu Niš, kar je prva najdba na ozemlju Srbije. Je tudi prva tujerodna vrsta metulja v Srbiji in njegovo odkritje zvišuje število vrst v srbski favni na 200. Primerek je bil določen s fotografije, objavljene v Facebook skupini, kar kaže na pomen takšnih družabnih omrežnih skupin, ki združujejo ljubitelje žuželk in navdušence za ljudsko znanost, posebno pri beleženju invazivnih in tujerodnih vrst.

Ključne besede: tujerodne vrste, ljudska znanost, Lycaenidae, družabna omrežja

Cacyreus marshalli Butler, 1897 is an African butterfly species from the family Lycaenidae, native to Mozambique, South Africa, Lesotho, Swaziland, Zambia and Zimbabwe (Clark & Dickson 1971; Heaths et al. 2002). The first record of the species in Europe came from England in 1978, when caterpillars were found (Heaths et al.

2002). The first adult *C. marshalli* was recorded in Balearic Islands in 1990 and after that it spread over a large part of the continent, primarily in Mediterranean region (Sarto i Monteys 1992). For countries in vicinity of Serbia it was recorded in Slovenia and Croatia in 2008, while in Bosnia and Herzegovina and Montenegro it was recorded just in 2016 (Kosmač & Verovnik 2009; Verovnik et al. 2011; Kučinić et al. 2014; Glavendekić et al. 2016; Koren & Kulijer 2016; Franeta 2018). Actually *C. marshalli* was observed in Montenegro already in 2015, but that record remained unpublished (Stojanović D. Z., pers. comm.).

Caterpillars of this butterfly feed primarily on *Pelargonium* spp., and those are commonly cultured decorative plants both in Serbia and Europe. Quacchia et al. (2008) examined if there was a possibility for that species to become a threat to autochthonous *Geranium* spp. feeding butterflies, and concluded that *C. marshalli* larvae could develop on these plants, and that in absence of *Pelargonium*, they lay eggs on *Geranium*. *C. marshalli* could therefore potentially compete with autochthonous species such as *Aricia nicias* Meigen, 1830 and *Eumedonia eumedon* (Esper, 1780) (Quacchia et al. 2008).

On October 21, 2020, the first author, Slađana Milojković uploaded photos of *C. marshalli* to Facebook group "Лептири Србије (Leptiri Srbije, Butterflies of Serbia)". Photographs were taken 20 days earlier in Niš, one of Serbian cities. Once specimen was identified from the photograph, other authors contacted the first author and inform her it was an invasive species, not previously recorded in Serbia. The discovery of this invasive species, but also numerous other invasive and unrecorded species being reported on social networks indicate significance of social network groups that bring together amateurs, enthusiasts, photographers, and all other people interested in certain group of organisms (Gonella et al. 2015; Skejo et al. 2016; Rahayu & Rodda 2019). The record was entered into Alciphron database (Miljević et al. 2014).

Cacyreus marshalli (Fig. 1).

The first record in Serbia: Niš, Palilula, near Gymnasium Svetozar Marković (Decimal Degrees: Latitude: 43.312538 Longitude: 21.886389), 1.10.2020., specimen photographed by S. Milojković, on green area. In the vicinity of the place where the specimen was photographed, Gymnasium garden, old cemetery and numerous green areas are present. As in other parts of Serbia, *Pelargonium* spp. are common and often cultivated plants.

A single specimen was photographed on flowers of invasive plant *Erigeron annuus* (L.) Pers., in the urban part of Niš, largest city in southern Serbia. Previously there were 199 butterfly species registered in Serbia, so recording of this species brought the total to 200 (Popović & Verovnik 2018). This is also the first allochthonous butterfly species recorded in Serbia. Possibility of appearance of *C. marshalli* in Serbia was predicted by many, and specifically was mentioned in Glavendekić & Čavlović (2019) based on the research of damage this butterfly caused in Montenegro. *C. marshalli* is a thermophilous species so it is likely it will not be able to form stable pop-

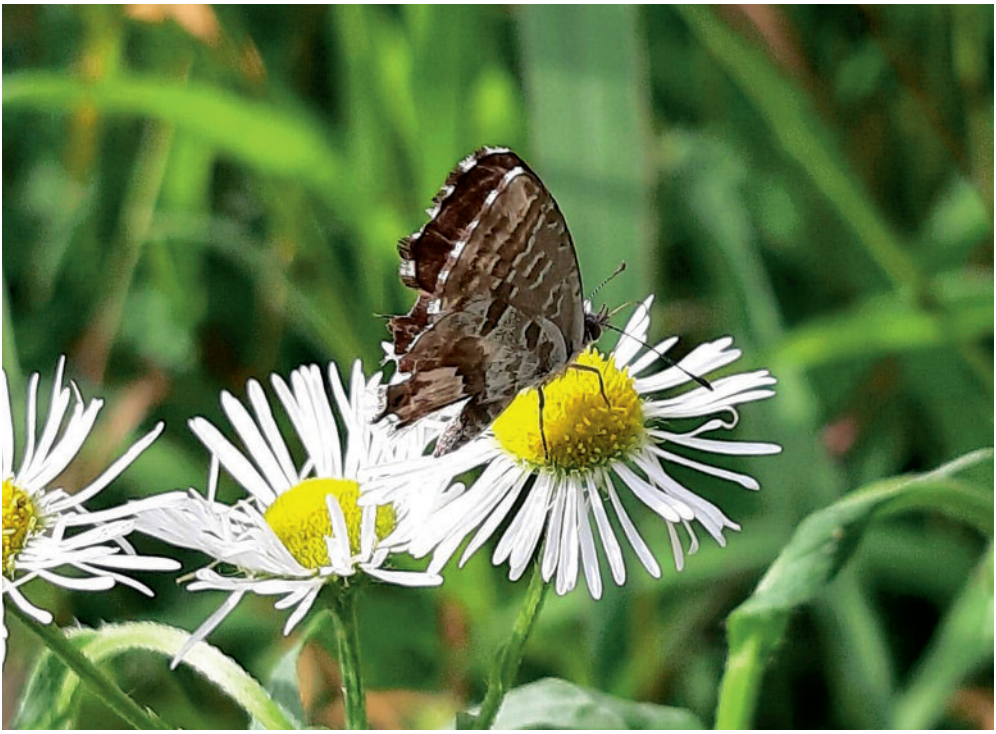

Figure 1: First specimen of *Cacyreus marshalli* registered in Serbia from the city of Niš (photo: S. Milojković).

ulations under continental climate of Serbia. Butterfly's host plants, *Pelargonium* spp. are however very common decorative plants in Serbia, in most cases cultivated indoors during winter.

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