

COMPARISON OF BUTTERFLY DIVERSITY (LEPIDOPTERA: PAPILIONOIDEA) OF THE PČINJA AND PREŠEVO VALLEYS (SOUTH SERBIA)

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(Received January 16, 2025; Accepted May 16, 2025)

ABSTRACT. Due to the influence of the Mediterranean climate from the southern part of the Balkan Peninsula, the southernmost regions, the Pčinja and Preševo valleys, are the warmest in Serbia. This warm sub-Mediterranean climate affects the area's specific animal diversity, particularly contributing to a unique butterfly diversity. Based on the available literature data and our surveys of butterfly diversity in these two valleys since 2005, 144 butterfly species and three species complexes were recorded, corresponding to 74.13% of all butterfly species recorded in Serbia. In the Pčinja Valley, 138 species and three species complexes were recorded, while 112 species and three species complexes were recorded in the Preševo Valley. Six of the recorded species are listed in Annex II and/or IV of the EU Habitats Directive, while 27 are strictly protected in Serbia.

Keywords: Rhopalocera, *Anthocharis gruneri*, *Tarucus balkanicus*, diversity, sub-Mediterranean

INTRODUCTION

The valleys of Pčinja and Preševo are located in the southernmost region of Serbia, south of the region's largest city and administrative center, Vranje (Fig. 1). The dividing line between these two valleys runs along the ridge of Mount Rujan. The Pčinja Valley encompasses the entire valley of the Pčinja River and its main tributaries. The boundaries of the Pčinja Valley are based on TRIFUNOSKI (1964). In the west, it includes the eastern slopes of Mount Rujan and Mount Starac and extends south to the state border between the Republic of Serbia and the Republic of North Macedonia (demarcated by the ridge of Mount Kozjak). In the west, it includes the basins of the Lesnička and Tripušnica rivers, which converge in the town of Trgovište. To the north, it follows the slopes of the Zladovačka, Koćurska, and Motina hills in an almost straight-line west of the village of Donji Stajevac (TRIFUNOSKI,

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1964). The southwestern part of the valley is a protected area in the Republic of Serbia, officially designated as the Outstanding Natural Landscape "Dolina Pčinje" (NEŠIĆ, 2018). The Preševo Valley stretches north to the town of Bujanovac, with its western border formed by the slopes of Skopska Crna Gora (Mount Karadag) (MILIĆ, 1967). In the south, the valley reaches the state border between the Republic of Serbia and the Republic of North Macedonia, and in the east, it includes the western slopes of Mount Rujan with the peaks of Turkašev rid, Blizanci, Rujan and Beli kamen (MILIĆ, 1967).

The entire southern part of Serbia, including the Pčinja and Preševo valleys, is one of the most important centers of biodiversity in the country (NEŠIĆ, 2018). The flora of these valleys represents a mixture of floral elements from both continental Serbia and sub-Mediterranean North Macedonia. The lower altitudes, between 300 and 700 meters, are mainly covered by Hungarian oak and Turkish oak forests (*Quercetum frainetto-cerris* Rudski, 1949). Higher altitudes above 700 meters are mainly covered by montane beech forests (*Fagetum moesiacaе montanum* B. Jov, 1953) (NEŠIĆ, 2018). The predominant biome type is the biome of sub-Mediterranean deciduous forests and shrubs (JAKŠIĆ, 2016).

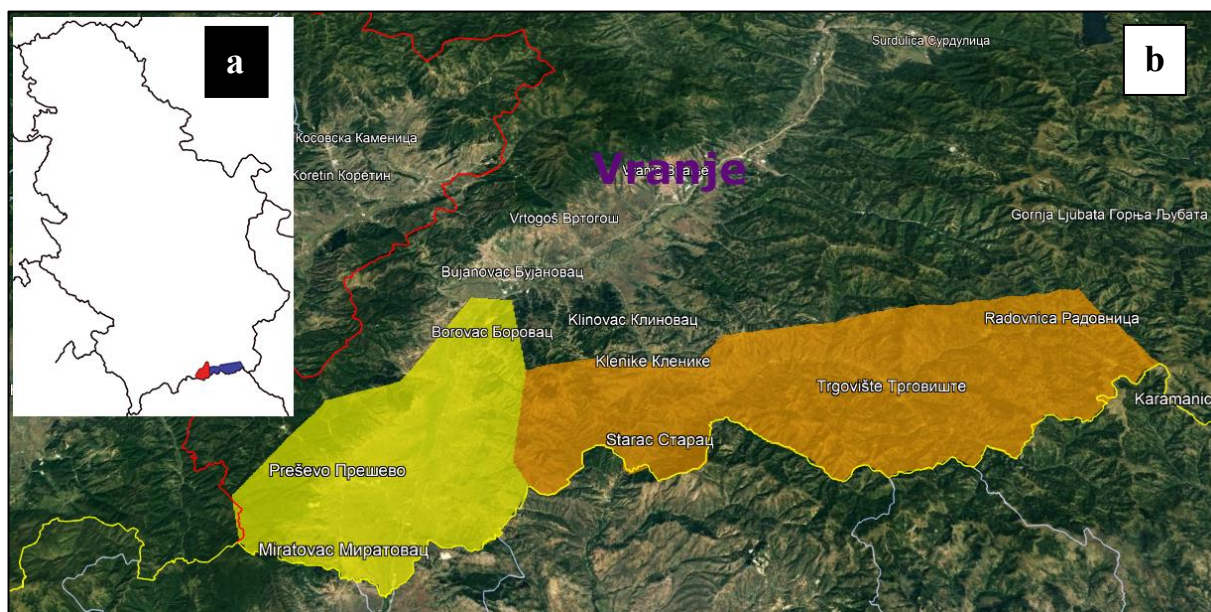


Figure 1. Map of the study area: (a) location of the Pčinja (in blue) and Preševo (in red) valleys in Serbia; (b) location and shape of Pčinja (in orange) and Preševo (in yellow) valleys.

The valleys of Pčinja and Preševo are characterized by a mild, temperate, mesothermal climate, with significant precipitation during all seasons (JAKŠIĆ, 2016). Winters are dry, with the average precipitation of the driest winter month being less than a tenth of the average precipitation of the wettest summer month. Due to the specific sub-Mediterranean climate and geological surface, the southernmost region of Serbia plays an important role as a refuge and corridor for animal species within the country (MATVEJEV, 1961; MATVEJEV and PUNCER, 1989; CRNOBRNJA-ISAIOVIĆ and ALEKSIĆ, 1999; TOMOVIĆ *et al.*, 2019). These valleys are unique in Serbia, as their warm sub-Mediterranean climate creates the necessary conditions for the survival of some Mediterranean animal species, which do not occur anywhere else in Serbia. Mediterranean reptile species, for example, include the lizards *Podarcis erhardii* (Bedriaga, 1882) and *Lacerta trilineata* Bedriaga, 1886, the snakes *Platyceps najadum* (Eichwald, 1831) and *Elaphe quatuorlineata* Lacepede, 1789 and the Greek tortoise *Testudo graeca* Linnaeus, 1758 (DŽUKIĆ, 1995; CRNOBRNJA-ISAIOVIĆ and ALEKSIĆ, 1999; TOMOVIĆ *et al.*, 2019; ANĐELKOVIĆ *et al.*, 2022), can only be found in these two valleys.

Among the Mediterranean insects, the Pčinja and Preševo valleys are home to the weevil species – *Brachycerus sinuatus* A.G. Olivier, 1807 (PEŠIĆ *et al.*, 2020), the blister beetle *Muzimes collaris* (Fabricius, 1787) (VUKAJLOVIĆ *et al.*, 2022), while the longhorn beetle *Phytoecia vittipennis* Reiche, 1877 can only be found in the Preševo Valley (ĐURĐEVIĆ and ĐURIĆ, 2011). The Preševo Valley is the only remaining place where the endangered bush cricket *Bradyporus dasypus* (Illiger, 1800) regularly occurs in Serbia (IVKOVIĆ *et al.*, 2016).

As for the butterfly fauna, TOT *et al.* (2021) recorded a Mediterranean species in the southernmost part of the Pčinja Valley (Čivčije village), the little tiger blue *Tarucus balkanicus* (Freyer, 1845), which is the only locality of this species in Serbia. POPOVIĆ and VEROVNIK (2018) also mention several other Mediterranean and/or thermophilic butterfly species from the Preševo and Pčinja valleys: *Carcharodus orientalis* Reverdin, 1913, *Pyrgus cinarae* (Rambur, 1839), *Spialia phlomidis* (Herrich-Schäffer, 1845), *Anthocharis gruneri* Herrich-Schäffer, 1851, *Melitaea ornata* Christoph, 1893 and *M. arduinna* (Esper, 1783).

Driven by interesting data on insect diversity in the southernmost part of Serbia (ĐURĐEVIĆ and ĐURIĆ, 2011; IVKOVIĆ *et al.*, 2016; PEŠIĆ *et al.*, 2020; TOT *et al.*, 2021; VUKAJLOVIĆ *et al.*, 2022), this study aimed to summarize all existing literature sources as well as our original unpublished data on butterfly diversity of the Pčinja and Preševo valleys. Based on all this data, we provide a comprehensive overview of butterfly diversity in the Pčinja and Preševo valleys. Both valleys have a similar climate and are located at almost the same latitude, so a similar diversity can be expected.

MATERIALS AND METHODS

The information on butterfly diversity in the Pčinja and Preševo valleys comes from the published literature and the original field research conducted by the HabiProt association between 2005 and 2023. The association's fieldwork was particularly intensive in 2021 and 2022, covering the period from April to September each year. Certain key sites were surveyed frequently and repeatedly, while others were explored less frequently. This approach allowed for a comprehensive survey of multiple habitats, leading to a better understanding of butterfly diversity in the areas concerned.

The Pčinja Valley (Fig. 2) covers a total area of 412.19 square kilometers. The distribution of data sets collected during the study is also shown in Fig. 2. The collected data originates from altitudes between 319 meters and 1389 meters a.s.l. The Preševo Valley is smaller and covers a total area of 244.39 square kilometers (Fig. 3). During the study, about 15 macrolocalities were investigated at altitudes between 398 and 936 meters a.s.l.

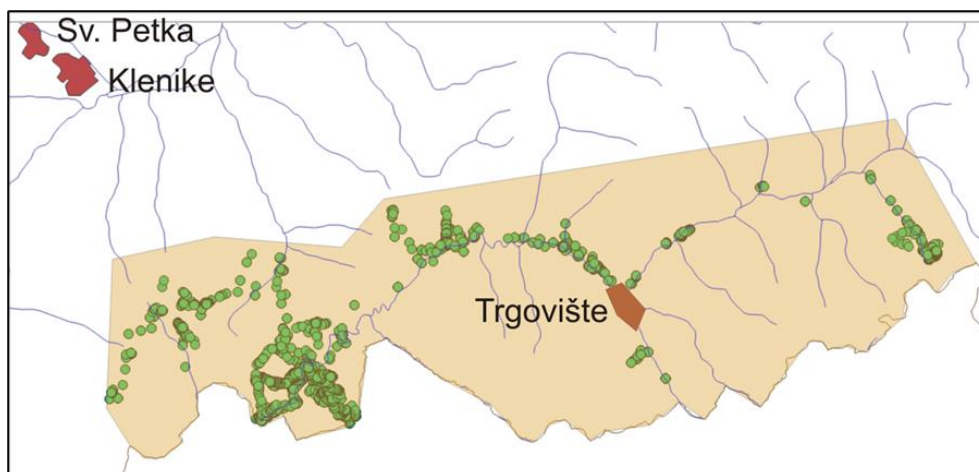


Figure 2. The borders of the Pčinja Valley with the surveyed localities (green dots).

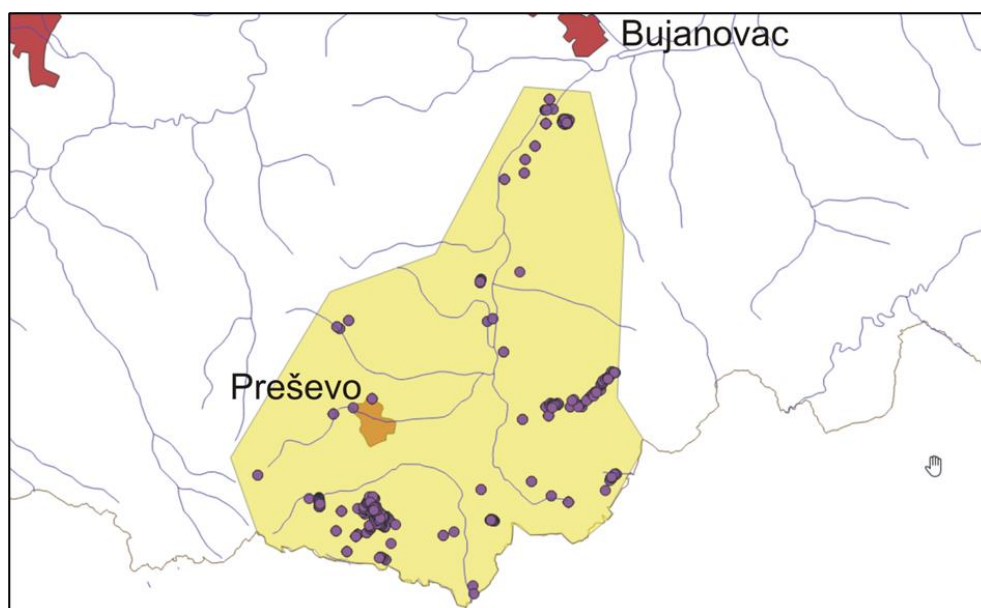


Figure 3. The borders of the Preševo Valley with the surveyed localities (purple dots).

Butterfly specimens were collected, identified, and released on the site. Some specimens were sampled and later identified using various field guides (TOLMAN and LEWINGTON, 2008; POPOVIĆ and ĐURIĆ, 2011). *Carcharodus orientalis* Reverdin, 1913 was identified from the dissected genitalia of males, and these results were published in POPOVIĆ and VEROVNIK (2018). In our work, we also summarized data from previously published findings of some rare butterflies from these two valleys (POPOVIĆ and MILENKOVIĆ, 2012; POPOVIĆ *et al.*, 2014; POPOVIĆ and VEROVNIK, 2018; VUJIĆ *et al.*, 2020; TOT *et al.*, 2021). Specimens of protected species were sampled according to permits of the Ministry of Environmental Protection of the Republic of Serbia (353-01-1149/2015-17, 353-01-960/2016-17, 353-01-239/2019-04, 353-01-1947/2021-04 and 353-01-2861/2022-04). All records were georeferenced and entered into the Alciphron database of insects of Serbia (MILJEVIĆ *et al.*, 2014–2024). The taxonomic classification and nomenclature correspond to those of WIEMERS *et al.* (2018).

The maps showing the boundaries of the surveyed areas (Fig. 1–3) were created using Google Earth Pro software. The exact list of butterflies recorded in each valley was created using QGIS version 3.24.2-Tisler. The same software was also used to calculate the area of both valleys.

RESULTS

Over the course of almost 20 years of research, 4671 observations from the Pčinja and 1580 observations from the Preševo Valley, a total of 144 butterfly species and three species complexes were recorded in the surveyed area (Tab. 1), which corresponds to 73.76% of all butterfly species recorded in Serbia (POPOVIĆ and VEROVNIK, 2018; MILOJKOVIĆ *et al.*, 2021; TOT *et al.*, 2021; VUKAJLOVIĆ *et al.*, 2025). In the Pčinja Valley, 138 species and three species complexes were recorded (71.14% of all species occurring in Serbia), distributed across 70 genera, 17 subfamilies and all six European butterfly families (Tab. 1). In the Preševo Valley, 112 species and three species complexes were recorded (58.21% of all species occurring in Serbia), covering 65 genera, 15 subfamilies, and all six European butterfly families (Tab. 1).

Table 1. Butterfly species (Lepidoptera: Papilionoidea) recorded in the valleys of Pčinja and Preševo and their conservation status in Europe and the Republic of Serbia.

List of species	Pčinja Valley	Preševo Valley	ERL ¹	Serbia ²	HD ³
Family Hesperidae Latreille, 1809					
Subfamily Pyrginae Burmeister, 1878					
1 <i>Carcharodus lavatherae</i> (Esper, 1780)		+	NT		
2 <i>Carcharodus alceae</i> (Esper, 1780)	+	+	LC		
3 <i>Carcharodus floccifera</i> (Zeller, 1847)	+	+	NT		
4 <i>Carcharodus orientalis</i> Reverdin, 1913	+		LC		
5 <i>Erynnis tages</i> (Linnaeus, 1758)	+	+	LC		
6 <i>Pyrgus malvae</i> (Linnaeus, 1758)	+	+	LC		
7 <i>Pyrgus serratulae</i> (Rambur, 1839)	+	+	LC		
8 <i>Pyrgus armoricanus</i> (Oberthür, 1910)	+	+	LC		
9 <i>Pyrgus alveus</i> (Hübner, 1803)	+		LC		
10 <i>Pyrgus cinarae</i> (Rambur, 1839)	+	+	LC		
11 <i>Pyrgus sidae</i> (Esper, 1784)	+	+	LC	Ann. I	
12 <i>Spialia orbifer</i> (Hübner, 1823)	+	+	LC		
13 <i>Spialia phlomidis</i> (Herrich-Schäffer, 1845)		+	LC	Ann. I	
Subfamily Heteropterinae Aurivillius, 1925					
14 <i>Carterocephalus palaemon</i> (Pallas, 1771)	+		LC		
Subfamily Hesperinae Latreille, 1809					
15 <i>Thymelicus acteon</i> (Rottensburg, 1775)	+	+	NT		
16 <i>Thymelicus lineola</i> (Ochsenheimer, 1808)	+	+	LC		
17 <i>Thymelicus sylvestris</i> (Poda, 1761)	+	+	LC		
18 <i>Hesperia comma</i> (Linnaeus, 1758)	+	+	LC		
19 <i>Ochlodes sylvanus</i> (Esper, 1777)	+	+	LC		
Family Papilionidae Latreille, 1802					
Subfamily Papilioninae Latreille, 1802					
20 <i>Iphiclides podalirius</i> (Linnaeus, 1758)	+	+	LC		
21 <i>Papilio machaon</i> Linnaeus, 1758	+	+	LC	Ann. I	
Subfamily Parnassiinae Duponchel, 1835					
22 <i>Zerynthia polyxena</i> (Denis & Schiffermüller, 1775)	+	+	LC	Ann. I	Ann. IV
23 <i>Zerynthia cerisy</i> (Godart, 1824)	+	+	NT		
24 <i>Parnassius mnemosyne</i> (Linnaeus, 1758)	+	+	NT	Ann. I	Ann. IV
Family Pieridae Swainson, 1820					
Subfamily Dismorphiinae Schatz, 1887					
25 <i>Leptidea duponcheli</i> (Staudinger, 1871)	+	+	LC		
26 <i>Leptidea sinapis/juvernica</i> complex	+	+	LC		
Subfamily Pierinae Swainson, 1820					
27 <i>Aporia crataegi</i> (Linnaeus, 1758)	+	+	LC		
28 <i>Pieris rapae</i> (Linnaeus, 1758)	+	+	LC		
29 <i>Pieris mannii</i> (Mayer, 1851)	+	+	LC		
30 <i>Pieris ergane</i> (Geyer, 1828)		+	LC		
31 <i>Pieris napi</i> (Linnaeus, 1758)	+	+	LC		
32 <i>Pieris balcana</i> Lorković, 1969	+	+	LC		
33 <i>Pieris brassicae</i> (Linnaeus, 1758)	+	+	LC	Ann. I	

Table 1. continued

List of species	Pčinja Valley	Preševo Valley	ERL ¹	Serbia ²	HD ³
34 <i>Euchloe ausonia</i> (Hübner, 1804)		+	LC	Ann. I	
35 <i>Anthocharis cardamines</i> (Linnaeus, 1758)	+	+	LC		
36 <i>Anthocharis gruneri</i> Herrich-Schäffer, 1851		+	LC		
37 <i>Pontia edusa</i> (Fabricius, 1777)	+	+	LC		
Subfamily Coliadinae Swainson, 1827					
38 <i>Colias croceus</i> (Geoffroy, 1785)	+	+	LC		
39 <i>Colias hyale/alfacariensis</i> complex	+	+	LC		
40 <i>Gonepteryx rhamni</i> (Linnaeus, 1758)	+	+	LC		
Family Lycaenidae (Leach, 1815)					
Subfamily Theclinae Swainson, 1831					
41 <i>Favonius quercus</i> (Linnaeus, 1758)	+	+	LC		
42 <i>Thecla betulae</i> (Linnaeus, 1758)	+		LC	Ann. I	
43 <i>Callophris rubi</i> (Linnaeus, 1758)	+	+	LC		
44 <i>Satyrium acaciae</i> (Fabricius, 1787)	+	+	LC	Ann. I	
45 <i>Satyrium ilicis</i> (Esper, 1779)	+	+	LC		
46 <i>Satyrium pruni</i> (Linnaeus, 1758)	+		LC		
47 <i>Satyrium spini</i> (Denis & Schiffermüller, 1775)	+		LC		
48 <i>Satyrium w-album</i> (Knoch, 1782)	+		LC	Ann. I	
Subfamily Lycaeninae Leach, 1815					
49 <i>Lycaena phlaeas</i> (Linnaeus, 1760)	+	+	LC		
50 <i>Lycaena dispar</i> (Haworth, 1802)	+		LC	Ann. I	Ann. II/IV
51 <i>Lycaena virgaureae</i> (Linnaeus, 1758)	+		LC		
52 <i>Lycaena candens</i> (Herrich-Schäffer, 1844)	+		LC		
53 <i>Lycaena alciphron</i> (Rottenburg, 1775)	+	+	LC		
54 <i>Lycaena thersamon</i> (Esper, 1784)	+	+	LC		
55 <i>Lycaena tityrus</i> (Poda, 1761)	+	+	LC		
Subfamily Polyommatae Swainson, 1827					
56 <i>Tarucus balkanicus</i> (Freyer, 1844)	+		LC		
57 <i>Lampides boeticus</i> (Linnaeus, 1767)		+	LC		
58 <i>Leptotes pirithous</i> (Linnaeus, 1767)	+	+	LC		
59 <i>Cupido alcetas</i> (Hoffmansegg, 1804)	+	+	LC		
60 <i>Cupido argiades</i> (Pallas, 1771)	+	+	LC		
61 <i>Cupido decoloratus</i> (Staudinger, 1886)	+		NT		
62 <i>Cupido osiris</i> (Meigen, 1829)	+	+	LC		
63 <i>Cupido minimus</i> (Fuessly, 1775)	+	+	LC		
64 <i>Phengaris arion</i> (Linnaeus, 1758)	+		EN	Ann. I	Ann. II/IV
65 <i>Iolana iolas</i> (Ochsenheimer, 1816)	+	+	NT	Ann. I	
66 <i>Glaucopsyche alexis</i> (Poda, 1761)	+	+	LC		
67 <i>Celastrina argiolus</i> (Linnaeus, 1758)	+	+	LC		
68 <i>Scolitantides orion</i> (Pallas, 1771)	+	+	LC		
69 <i>Pseudophilotes vicrama</i> (Moore, 1865)	+	+	NT	Ann. I	
70 <i>Kretania sephirus</i> (Frivaldzky, 1835)	+	+	NT		
71 <i>Plebejus argus</i> (Linnaeus, 1758)	+	+	LC		
72 <i>Plebejus idas</i> (Linnaeus, 1760)	+	+	LC		

Table 1. continued

List of species	Pčinja Valley	Prešovo Valley	ERL ¹	Serbia ²	HD ³
73 <i>Plebejus argyrognomon</i> (Bergsträsser, 1779)	+	+	LC	Ann. I	
74 <i>Aricia artaxerxes</i> (Fabricius, 1793)	+	+	LC		
75 <i>Aricia agestis</i> (Denis & Schiffermüller, 1775)	+	+	LC		
76 <i>Aricia anteros</i> (Freyer, 1838)	+		NT	Ann. I	
77 <i>Cyaniris semiargus</i> (Rottemburg, 1775)	+	+	LC		
78 <i>Polyommatus amandus</i> (Schneider, 1792)	+	+	LC		
79 <i>Polyommatus dorylas</i> (Denis & Schiffermüller, 1775)	+		NT		
80 <i>Polyommatus thersites</i> (Cantener, 1835)	+	+	LC		
81 <i>Polyommatus icarus</i> (Rottemburg, 1775)	+	+	LC		
82 <i>Polyommatus eros</i> (Ochsenheimer, 1808)	+		NT	Ann. I	Ann. II/IV
83 <i>Polyommatus daphnis</i> (Denis & Schiffermüller, 1775)	+	+	LC		
84 <i>Polyommatus admetus</i> (Esper, 1783)	+		LC		
85 <i>Polyommatus ripartii</i> (Freyer, 1830)	+	+	LC		
86 <i>Lysandra bellargus</i> (Rottemburg, 1775)	+	+	LC		
87 <i>Lysandra coridon</i> (Poda, 1761)	+	+	LC		
Family Riodinidae Grote, 1895					
Subfamily Hamearinae Clench, 1955					
88 <i>Hamearis lucina</i> (Linnaeus, 1758)	+	+	LC		
Family Nymphalidae Rafinesque, 1815					
Subfamily Libytheinae Boisduval, 1833					
89 <i>Libythea celtis</i> (Laicharting, 1782)	+	+	LC		
Subfamily Satyrinae Boisduval, 1833					
90 <i>Kirinia roxelana</i> (Cramer, 1777)	+	+	LC		
91 <i>Pararge aegeria</i> (Linnaeus, 1758)	+	+	LC		
92 <i>Lasiommata maera</i> (Linnaeus, 1758)	+		LC		
93 <i>Lasiommata megera</i> (Linnaeus, 1767)	+	+	LC		
94 <i>Coenonympha arcania</i> (Linnaeus, 1760)	+	+	LC		
95 <i>Coenonympha glycerion</i> (Borkhausen, 1788)	+		LC		
96 <i>Coenonympha leander</i> Esper, 1784	+	+	LC		
97 <i>Coenonympha pamphilus</i> (Linnaeus, 1758)	+	+	LC		
98 <i>Pyronia tithonus</i> (Linnaeus, 1771)	+	+	LC		
99 <i>Maniola jurtina</i> (Linnaeus, 1758)	+	+	LC		
100 <i>Aphantopus hyperantus</i> (Linnaeus, 1758)	+		LC		
101 <i>Erebia medusa</i> (Denis & Schiffermüller, 1775)	+	+	LC		
102 <i>Erebia ligea</i> (Linnaeus, 1758)	+		LC		
103 <i>Chazara briseis</i> (Linnaeus, 1764)	+	+	NT		
104 <i>Brintesia circe</i> (Fabricius, 1775)	+	+	LC		
105 <i>Hipparchia volgensis/semele</i> complex	+	+	LC	Ann. I	
106 <i>Hipparchia fagi</i> (Scopoli, 1763)	+	+	NT		
107 <i>Hipparchia syriaca</i> (Staudinger, 1871)	+	+	LC		
108 <i>Hipparchia statilinus</i> (Hufnagel, 1766)	+	+	NT		
109 <i>Arethusana arethusa</i> (Denis & Schiffermüller, 1775)	+	+	LC		
110 <i>Satyrus ferula</i> (Fabricius, 1793)	+		LC	Ann. I	
111 <i>Melanargia galathea</i> (Linnaeus, 1758)	+	+	LC		

Table 1. continued

List of species	Pćinja Valley	Preševo Valley	ERL ¹	Serbia ²	HD ³
112 <i>Melanargia larissa</i> (Geyer, 1828)	+	+	LC	Ann. I	
Subfamily Apaturinae Boisduval, 1840					
113 <i>Apatura iris</i> (Linnaeus, 1758)	+		LC	Ann. I	
114 <i>Apatura ilia</i> (Denis & Schifferrmüller, 1775)	+		LC	Ann. I	
Subfamily Limenitidinae Behr, 1864					
115 <i>Limenitis camilla</i> (Linnaeus, 1764)	+		LC		
116 <i>Limenitis reducta</i> Staudinger, 1901	+	+	LC		
117 <i>Neptis rivularis</i> (Scopoli, 1763)	+		LC		
118 <i>Neptis sappho</i> (Pallas, 1771)	+	+	LC		
Subfamily Nymphalinae Swainson, 1827					
119 <i>Araschnia levana</i> (Linnaeus, 1758)	+	+	LC		
120 <i>Vanessa atalanta</i> (Linnaeus, 1758)	+	+	LC		
121 <i>Vanessa cardui</i> (Linnaeus, 1758)	+	+	LC		
122 <i>Polygonia c-album</i> (Linnaeus, 1758)	+	+	LC		
123 <i>Aglais io</i> (Linnaeus, 1758)	+	+	LC		
124 <i>Aglais urticae</i> (Linnaeus, 1758)	+	+	LC		
125 <i>Nymphalis polychloros</i> (Linnaeus, 1758)	+	+	LC		
126 <i>Nymphalis antiopa</i> (Linnaeus, 1758)	+	+	LC	Ann. I	
127 <i>Nymphalis vaualbum</i> (Denis & Schifferrmüller, 1775)	+		LC	Ann. I	Ann. II/IV
Subfamily Heliconiinae Swainson, 1822					
128 <i>Fabriciana niobe</i> (Linnaeus, 1758)	+	+	LC		
129 <i>Fabriciana adippe</i> (Denis & Schifferrmüller, 1775)	+	+	LC		
130 <i>Argynnis paphia</i> (Linnaeus, 1758)	+	+	LC		
131 <i>Argynnis pandora</i> (Denis & Schifferrmüller, 1775)	+	+	LC	Ann. I	
132 <i>Speyeria aglaja</i> (Linnaeus, 1758)	+		LC		
133 <i>Brenthis hecate</i> (Denis & Schifferrmüller, 1775)	+	+	LC		
134 <i>Brenthis daphne</i> (Bergsträsser, 1780)	+	+	LC		
135 <i>Issoria lathonia</i> (Linnaeus, 1758)	+	+	LC		
136 <i>Boloria euphrosyne</i> (Linnaeus, 1758)	+		LC		
137 <i>Boloria dia</i> (Linnaeus, 1767)	+	+	LC		
138 <i>Melitaea phoebe</i> (Denis & Schifferrmüller, 1775)	+	+	LC		
139 <i>Melitaea ornata</i> Christoph, 1893	+		LC		
140 <i>Melitaea didyma</i> (Esper, 1778)	+	+	LC		
141 <i>Melitaea arduinna</i> (Esper, 1783)	+	+	LC		
142 <i>Melitaea trivia</i> (Denis & Schifferrmüller, 1775)	+	+	LC		
143 <i>Melitaea diamina</i> (Lang, 1789)	+		LC	Ann. I	
144 <i>Melitaea cinxia</i> (Linnaeus, 1758)	+	+	LC		
145 <i>Melitaea aurelia</i> Nickerl, 1850	+	+	NT	Ann. I	
146 <i>Melitaea athalia</i> (Rottemburg, 1775)	+	+	LC		
147 <i>Euphydryas aurinia</i> (Rottemburg, 1775)	+		LC		Ann. II

ERL¹ – European Red List of Butterflies, based on VAN SWAAY *et al.* (2010): LC – least concern; NT – near threatened; EN – endangered.

Serbia² – According to the Rulebook on the declaration and protection of strictly protected and protected wild species of plants, animals and mushrooms (ANONYMOUS, 2016).

HD³ – Habitats Directive by THE COUNCIL OF THE EUROPEAN COMMUNITIES (1992).

The family Nymphalidae had the highest number of recorded species in both Pčinja (59 species) and the Preševo Valley (44 species), with a total of 59 species (Tab. 2). This was followed by the family Lycaenidae with 46 in the Pčinja Valley, 33 species in the Preševo Valley, and a total of 47 species.

Table 2. Number of butterfly species and species complexes of the Pčinja and Preševo Valleys by families.

Family	Number of species and species complexes		
	Pčinja Valley	Preševo Valley	Common species
Hesperiidae	17	16	14
Papilionidae	5	5	5
Pieridae	13	16	13
Lycaenidae	46	33	32
Riodinidae	1	1	1
Nymphalidae	59	44	44
Papilionoidea	141	115	109

Of the species recorded, *Euphydryas aurinia* is listed in Annex II, while *Zerynthia polyxena* and *Parnassius mnemosyne* are listed in Annex IV of the EU Habitat Directive (Tab. 1) (THE COUNCIL OF THE EUROPEAN COMMUNITIES, 1992). Meanwhile, *Lycaena dispar*, *Phengaris arion* and *Polyommatus eros* are listed in both Annex II and Annex IV of the EU Habitats Directive (Tab. 1). *Phengaris arion* is endangered, while 15 other species are considered Near Threatened in Europe (VAN SWAAY *et al.*, 2010). In addition, 27 species are strictly protected in the Republic of Serbia (ANONYMOUS, 2016) (Tab. 1).

DISCUSSION

Our study provides an insight into the rich and diverse butterfly fauna of the southernmost region of Serbia – the valleys of Pčinja and Preševo. The current list of recorded butterfly species in these two valleys includes a total of 144 butterfly species and three species complexes. The number of recorded species is quite impressive, as it accounts for about three-quarters of all species in Serbia (POPOVIĆ and VEROVNIK, 2018; MILOJKOVIĆ *et al.*, 2021; TOT *et al.*, 2021). If we compare them with nearby, well-studied protected areas in southern Serbia, these two valleys are well-researched in terms of butterfly diversity. For example, the most diverse butterfly area in Serbia is the Stara Planina Nature Park, where 166 species have been recorded (POPOVIĆ and ĐURIĆ, 2014). Other well-studied areas are the Jelašnica Gorge Nature Park with 125 recorded butterfly species (ĐURIĆ and TOT, 2020) and the Vlasina Outstanding Natural Landscape with 116 recorded butterfly species (TOT *et al.*, 2017).

The Pčinja and Preševo valleys are the only known sites in Serbia for three butterfly species: *P. cinarae*, *A. gruneri*, and *T. balkanicus*. *Pyrgus cinarae* was recorded for the first time in Serbia in 2014, almost simultaneously in the valleys of Pčinja and Preševo. This species has been recorded only in these two valleys and nowhere else in Serbia (POPOVIĆ *et al.*, 2014; POPOVIĆ and VEROVNIK, 2018; MILJEVIĆ *et al.*, 2014-2024). The only place where *A. gruneri* has been recorded so far in Serbia is the Preševo Valley, more precisely, the surroundings of the village of Miratovac (POPOVIĆ and MILENKOVIĆ, 2012). Its larval food plant, *Aethionema saxatile* (L.) R.Br. (family Brassicaceae) is even more common in the Pčinja Valley, but this butterfly species has never been encountered there. For many years, *T. balkanicus* was expected to occur in Serbia, but it was only detected in 2021 (TOT *et al.*, 2021). With the help of the local citizens, potential habitats for the butterfly with the larval

host plant *Paliurus spina-christi* Mill. were explored in April 2021. Finally, the butterfly was found in August of the same year. Similar attempts in the Preševo Valley were unsuccessful.

Three of the recorded species are rare in Serbia. *Spialia phlomidis* was recorded in the Preševo Valley on only two occasions. Similar habitats in the Pčinja Valley have been investigated several times, but so far in vain. *Carcharodus orientalis* is rare in Serbia and its known distribution is sporadic (POPOVIĆ and VEROVNIK, 2018; MILJEVIĆ *et al.*, 2014–2024). There are a few records from the Pčinja Valley, but none from the Preševo Valley, despite the existence of larval host plants, *Stachis* spp. This could be partly due to difficulty in distinguishing it from the similar *C. floccifera* (Zeller, 1847). *Melitaea ornata* has been recorded in the Pčinja Valley, but not in the Preševo Valley (VUJIĆ *et al.*, 2020). Apart from the Pčinja Valley, the species has been recorded in Serbia on Stara Planina Mountain and Rudina Mountain in the east of the country.

The Pčinja and Preševo valleys have a similar climate (JAKŠIĆ, 2016) and the same latitude (Fig. 1), so it was to be expected that the butterfly diversity encountered would be quite similar. In the Pčinja Valley, 138 species and three species complexes were found, while in the Preševo Valley, 112 species and three species complexes were found, including 109 common species. Apart from the above-mentioned rare species, differences in the recorded butterfly diversity of the analyzed neighboring valleys can also be observed in some more widespread species. The valley of the Pčinja River is narrower and surrounded by several mountains (Rujan, Starac and Kozjak mountains), which affects the occurrence of *P. alveus*, *L. candens*, *P. eros*, *B. euphrosyne*, and *E. aurinia* in the Pčinja Valley, but not in the Preševo Valley. All these species are found exclusively or mainly in alpine habitats at higher altitudes, at least in Serbia and the Balkans.

The importance and richness of the fauna of these two valleys can be seen from the high number of protected species recorded. Of the 50 strictly protected butterfly species in Serbia, 27 species can be found in these two valleys. Furthermore, the Pčinja and Preševo valleys should be included in the future NATURA 2000 network in Serbia, as six recorded butterfly species are listed in Annexes II and/or IV of the EU Habitats Directive (THE COUNCIL OF THE EUROPEAN COMMUNITIES, 1992).

In addition to the recorded species, it is expected that several new species for Serbia can be found in these two valleys. POPOVIĆ and VEROVNIK (2018) mention that the best candidates are *Erynnis marloyi* (Boisduval, 1834), *Muschampia tessellum* (Hübner, 1803), *Pieris krueperi* Staudinger, 1860, *Gonepteryx farinosa* (Zeller, 1847), *Hipparchia senthes* (Fruhstorfer, 1908) and *Pseudochazara amalthea* (Frivaldszky, 1845). These species occur in the northern part of the Republic of North Macedonia, not far from the valleys of Pčinja and Preševo.

JAKŠIĆ (2016) developed a zoogeographic regionalization of Serbia based on the affinity of local butterfly faunas. Based on his regionalization, the Pčinja and Preševo valleys represent a fragmentary region in Serbia, which is classified as the Sub-Aegean Province. According to JAKŠIĆ (2016), typical butterfly species in this province are *P. cinarae*, *A. gruneri*, *E. ausonia*, *L. duponcheli* and *Polygonia egea* (Cramer, 1775). The first two species occur only in these two valleys, while there are no recent records of *Polygonia egea* in Serbia. Based on our results, *T. balkanicus*, *S. phlomidis* and *C. orientalis* should be added to this list.

CONCLUSION

Based on the available literature data and during the field research conducted from 2005 to 2023 (especially in 2021 and 2022), a total of 144 butterfly species and three species complexes (almost three quarters of the total Serbian butterfly fauna) were recorded in the Pčinja and Preševo valleys, of which 138 species and three species complexes occurred in the

Pčinja Valley and 112 species and three species complexes in the Preševo Valley, while 109 species were common in both valleys. Six of the recorded species are listed in Annex II and/or IV of the EU Habitats Directive. *Phengaris arion* is endangered, and 15 other species are considered near threatened in Europe, while 27 species are strictly protected in the Republic of Serbia. Although the butterflies of the Preševo and Pčinja valleys have been well researched, much remains to be done. In the future, it is necessary to establish continuous monitoring of butterflies in these valleys, especially for the species that do not occur anywhere else in the country (*P. cinarae*, *A. gruneri* and *T. balkanicus*). It is expected that several new species for Serbia can be found in these two valleys in the future.

Acknowledgments

The authors thank the colleagues from the Dolina Pčinje Landscape of Outstanding Features and the Eparchy of Vranje of the Serbian Orthodox Church. The contribution of those who participated in the research of the two valleys is also significant: Dejan Stojanović, Bojana Nadaždin, Ivan Marjanović, Vidak Lakušić, Snežana Pešić, Snežana Panjković, Slobodan Panjković and Aleksandra Husarik. We would also like to thank the reviewers for their comments and constructive and helpful suggestions. Part of this research was funded by the Dolina Pčinje Landscape of Outstanding Features and the Eparchy of Vranje of Serbian Orthodox Church as the administrator of this protected area (Agreement Nos. 37/2021 and 87/2022) and the Ministry of Education, Science and Technological Development of the Republic of Serbia (Agreements No. 451-03-47/2023-01/200122, 451-03-65/2024-03/200122 and 451-03-137/2025-03/ 200122).

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