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IMPORTANCE OF HETEROGENEOUS MOSAIC LANDSCAPE FOR CONSERVATION OF HIGH BUTTERFLY DIVERSITY (LEPIDOPTERA: PAPILIONOIDEA) OF RURAL ENVIRONMENT – EXAMPLE OF GORENJA VAS, POLJANSKA VALLEY, SLOVENIA

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Abstract With the advancement in agriculture we sophisticated the exploitation of land, but consequently started reducing the richness of the otherwise highly heterogeneous cultural landscapes. This began to impact the diversity of certain animal and plant groups bound to specific habitat types. In order to investigate the importance of heterogeneous mosaic landscapes in rural areas, a 2 years survey, including 31 individual counts of butterflies in two habitat-diverse locations, was performed. Based on these observations we conclude, that even a relatively small areas of highly diverse landscape, with a handful of different micro-habitats, can sustain relatively high number of butterfly species (54). Among those, 7 species are of conservation importance: 5 were found on the localities in smaller numbers (*Plebejus idas*, *Parnassius mnemosyne*, *Melitaea diamina*, *Euphydryas aurinia* and *Lycaena alciphron*), while two were more numerous (*Lycaena hippothoe* and *Pyrgus armoricanus*). Another interesting find was *Brenthis hecate*, which is very rare in the studied region. Protection of such environments, within otherwise intensive agricultural rural landscapes, is thus vital for maintaining high habitat richness and the survival of diverse flora and fauna.

KEY WORDS: Monitoring, habitat heterogeneity, farmland, extensive grassland

Izvleček POMEN HETEROGENE MOZAIČNE KRAJINE ZA OHRANJANJE VISOKE PESTROSTI DNEVNIH METULJEV (LEPIDOPTERA: PAPILIONOIDEA) V KULTURNI KRAJINI – PRIMER GORENJE VASI V POLJANSKI DOLINI, SLOVENIJA

Z razvojem kmetijstva smo izboljšali rabo izbranih površin, a smo posledično začeli zmanjševati raznolikost sicer heterogene kulturne krajine. To je vplivalo na

diverziteto posameznih živalskih in rastlinskih skupin, ki so vezane na določene habitate. Pomen heterogene mozaične krajine podeželja je bil zato raziskan s pomočjo 2 letne analize števila in vrstne pestrosti metuljev. V ta namen je bilo izvedenih 31 posameznih vzorčenj na dveh habitatno raznolikih lokacijah. Rezultati kažejo, da že nekaj različnih mikro-habitatov lahko vzdržuje veliko število vrst dnevnih metuljev (54). Od tega je bilo zabeleženih 7 vrst, ki so naravovarstveno pomembne: 5 je bilo najdenih na lokacijah v manjšem številu (*Plebejus idas*, *Parnassius mnemosyne*, *Melitaea diamina*, *Euphydryas aurinia* in *Lycaena alciphron*), medtem ko sta bili 2 vrsti številčnejši (*Lycaena hippothoe* in *Pyrgus armoricanus*). Zanimiva je tudi najdba *Brenthis hecate*, ki je zelo redka vrsta v severozahodni Sloveniji. Zaščita takih okolji, v sicer intenzivni kmetijski krajini, je zato nujna, saj omogoča ohranjanje raznolikih habitatov ter visoke pestrosti rastlinskih in živalskih vrst na teh območjih.

KLJUČNE BESEDE: Monitoring, habitatna heterogenost, kmetijska krajina, ekstenzivni travniki

Introduction

With the advancement of technology, implementation of intensive agricultural methods (such as use of fertilizers and pesticides), huge monoculture plantations and degradation of certain habitats, coupled with the abandonment of mowing and grazing in certain areas, the once diverse rural landscapes are becoming more and more depleted of its former heterogeneity. Once highly fragmented mosaic landscapes are making way to more uniform types of intensive grasslands, fields and forests, while also becoming more homogenous on larger scales (Frélichová and Fanta 2015; Ribeiro and Hribar 2019). Smaller heterogeneous areas are being replaced and transformed into larger uniform units to improve agricultural efficiency, or simply because of absence of farming and overgrowing associated with it. And while these changes are welcomed from the perspective of everyday consumers and farmers on a short term, they are devastating from the perspective of natural diversity, especially the fauna and flora bound to specific habitats (van Swaay and Warren 2006; Zupan et al. 2020).

Despite the fact that most rural areas have been unsuitable for some animals, like large carnivores, for at least a hundred years (Breitenmoser 1998), other smaller animals, such as butterflies, were permitted to flourish. This is mostly due to the fact that smaller animals require only small patches of suitable habitat to sustain their populations. Thus, in the case of fragmented mosaic landscapes, consisting of otherwise human-dominated micro-habitats, the rural wildlife diversity could remain surprisingly high. However, with the intensification of agriculture, especially in the last two decades, the diversity of smaller animals started to decline as well (Nilsson et al. 2013; Frélichová and Fanta 2015; Ribeiro and Hribar 2019).

In this article, the importance of diverse mosaic landscape has been studied in a small heterogeneous area near Gorenja vas, Poljanska Valley, Slovenia. In 2019 and 2020, more than 30 surveys were conducted on two localities, counting the individ-

ual butterflies in the process. The butterfly species found were later linked to their corresponding larval host plants, as additional indicators of richness of these fragmented landscapes.

Geographical characteristics of the region

Gorenja vas is a village in the centre of Poljanska Valley in the northwestern part of central Slovenia. The wider area represents a typical Slovenian rural environment consisting of larger and smaller villages, scattered throughout the river valley and nearby slopes, with a noticeable agricultural activity (Perpar and Kovačič 2002). The main area around Gorenja vas, including its surrounding villages, has a population of around 1800 inhabitants and is one of the most highly populated area in the valley (Portal GOV.SI 2021). Its altitude of roughly 400-450 m (Geodetski Zavod Slovenije et al. 2005), coupled with typical continental climate with high annual rainfall (1600-1800 mm) (ARSO 2021), average July temperatures of 15-20 °C and average year temperatures of 8-10 °C (Perko et al. 2020), provides excellent conditions for farming, especially for the cultivation of different crops.

The valley floor consists mainly from fluvio-periglacial accumulation of gravel, silts, sandstones, and conglomerates (Šifrer 1982), while the upper parts of the valley consist mainly of dolomite and Carbon silts (Ilešič 1938). The uninhabited parts of the valley's basin are mostly used for cultivation of grasslands and fields, while the slopes of the valley are dominated by forests, grasslands and occasional pastures. The latter are used for grazing of cows and, to some extent, goats, and occupy only a small percentage of the cultivated area. Duo to the high annual rainfall, the valley and its surrounding hills are also interspersed with smaller rivulets and streams, dominated by river Sora, flowing through the centre of the valley. Consequently, humid grasslands and marshes were once widespread, which is even hinted by some local area names (e.g. ″Blate″ – ″Muds″), but are now found only locally in few isolated places. In general, the area is rich with diverse habitat types: from mixed forests, overgrown riverbanks, extensive and intensive wet, humid, and dry grasslands, to orchards, fields and urban gardens.

The mixed forests, which are found predominantly at the outskirts of the valley, consist mainly of beech and spruce, while oak, ash, chestnut, fir, and pine are rarer, but not uncommon. The only forest-like habitat type found in the valley floor is the river fringe vegetation, which is dominated by willows, ash and beech, among others. The largest part of the uninhabited valleys basin is covered either in grasslands or fields. The intensive managed grasslands consist almost entirely of grasses (*Lolium* spp.) and dandelion, are mowed at least three to four times per year and heavily fertilised, while the monocultural fields consist mainly of corn and sometimes oats. The smaller fields, on the other hand, found mainly on the outskirts of the valley, are cultivated predominantly with corn, potatoes and vegetables from the *Brassica oleracea* provenance. The dry, humid, and marshy extensive grasslands are found almost exclusively on the outskirts of the valley, mostly on elevated areas. The marshes are almost non-existing, and can be found only very locally, usually near the

smaller springs. Also important for the habitat diversity are smaller orchards and gardens, which additionally enrich the otherwise already rich flora of the area.

Another distinctive feature of the landscape is its high habitat fragmentation. This is especially true for the valley's outskirts, where the most diverse seminatural habitats can be found, like extensive grasslands, forest clearings and marshes. The central part of the valley is somehow more uniform, but even here the landscape is divided by river Sora, while fields and grasslands are occasionally interrupted by hedgerows.

Methods

Most butterflies were recorded without disturbance either by observation or photography, while few were determined by catch-and-release technique, using specialised butterfly net. The butterflies were determined using a butterfly field guide (Tolman and Lewington 2008), while the plants were determined similarly (Martinčič 2007; Spohn and Aichele 2011).

While the butterfly counting method used in this study is somehow reminiscent of the standard transect monitoring method described by van Swaay et al. (2008), as well as the time counts method used by UK Butterfly Monitoring Scheme (2021) and point-count method used by Henry et al. (2015), it could best be described as the mixture of them all, where the specimens were counted across the entire locality B for a whole hour. In order to eliminate the possibility of counting the same individuals twice, the survey was done following a certain path, where each micro-habitat was inspected only once. Basically, the monitoring was performed on a semi ″transect rout″ across the entire locality, where at each micro-habitat a point-count was performed for a few minutes. As the main goal of the survey was mostly to discover as much butterfly species as possible, and not to count the exact number of individuals present at the time of each survey, only the approximate number of specimens of each species per survey are given (table 1). The weather conditions (wind speed, temperature, % of clouds) varied between observations, but the surveys were predominantly done during warm, sunny days, mostly between 10:00 and 18:00. In contrast to the locality B, the locality A was only surveyed in order to record possible supplementary species missing from the locality B. Thus, the surveys performed on locality A were not systematic.

In total, 31 surveys were conducted, 4 in March, 2 in April, 4 in May, 5 in June, 7 in July, 2 in August, 5 in September and 2 in October (each survey was always conducted on both localities). For each month at least one survey was carried out in the first half, and at least one in the second half of the month, the only exception being October, where both surveys were conducted in the first half of the month. The number of surveys conducted in each month slightly varies, since the weather conditions in some of the months were not always ideal (e.g. unusual amount of rainy days in August 2019 and 2020, and very high temperatures (≈20 °C) in March 2020).

Results

List and description of localities

Exact locality and details regarding coordinates (WGS 84 Web Mercator projection; ePSG:3857), altitude, and habitat types are given. Since both localities cover wider area, coordinates are given only for the one chosen observation spot on the locality (coordinates are given for the spots marked with latter A and B – see Figure 1).

Locality A: coordinates: X: 46.099622, Y: 14.144107; 400-410 m; mostly intensive grassland, with some patches of dry extensive grassland on the slopes, and a

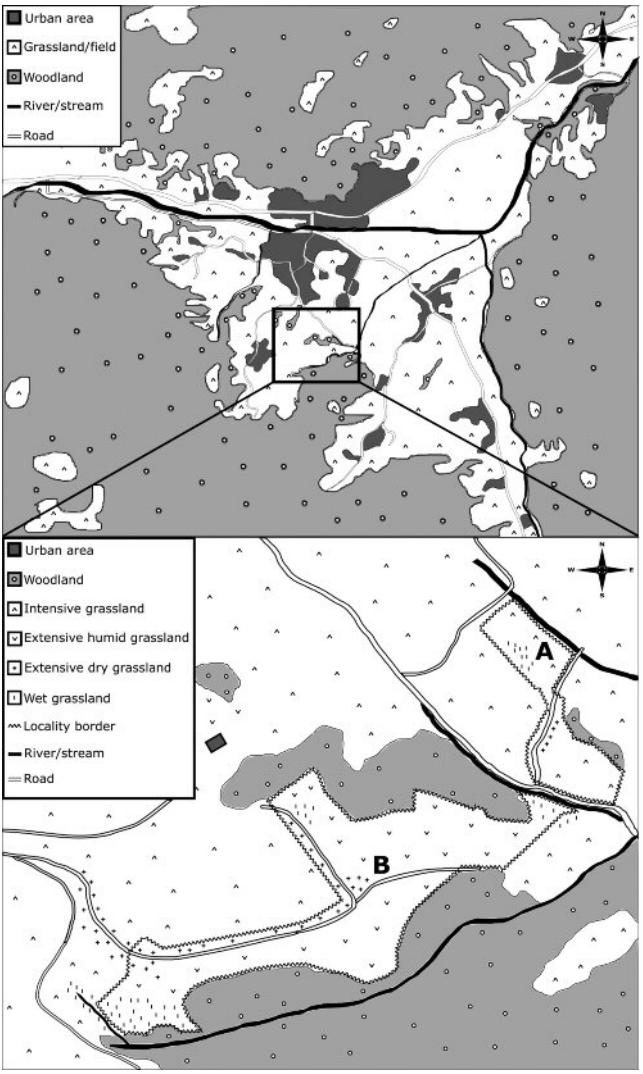

Figure 1: Map of wider Gorenja vas area in Poljanska Valley (above) and a small map segment including both sampling localities (below): The locality A was included for convenience and addition of a few missing species only, while locality B served as the main sampling locality.

Slika 1: Zemljevid širše okolice Gorenje vasi v Poljanski dolini (zgoraj) in majhen segment z obema lokacijama vzorčenja (spodaj): lokacija A je bila vključena zgolj zaradi priročnosti in možnosti najdbe manjkajočih vrst, lokacija B pa je predstavljala glavno lokacijo vzorčenja.

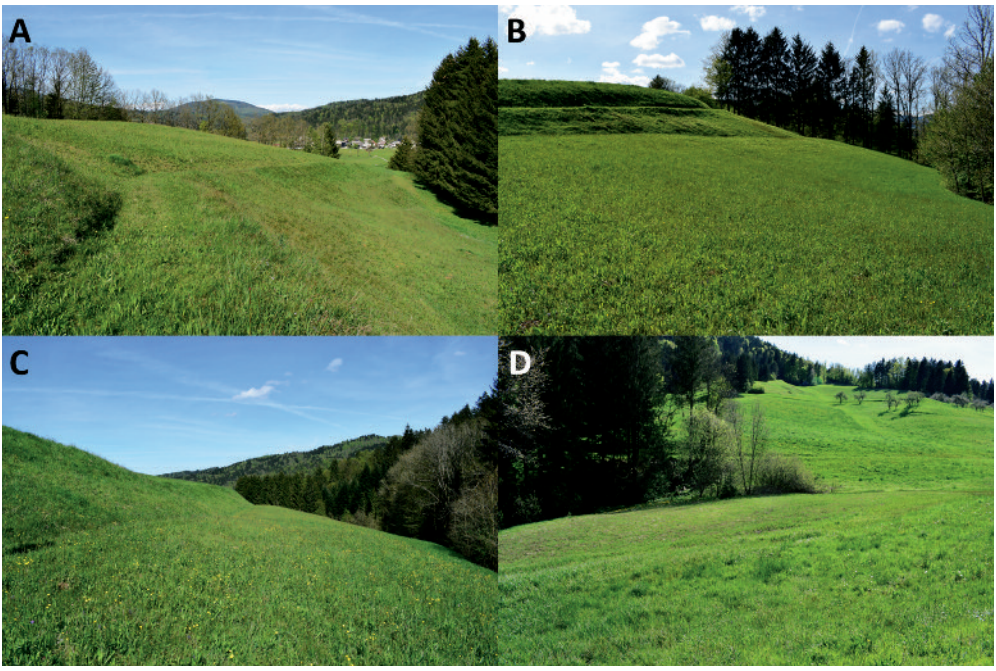

Figure 2: Different sections of locality B: A) Middle section, photographed a few meters southwest of the given locality coordinates; B) The northernmost tip of the middle section, including a small patch of wet grassland located in front of the conifers in the background; C) section with the dry extensive grassland (left side of the picture, above the track); D) South westernmost section with the biggest patch of wet grassland and a small orchard in the background (already outside of the locality). All pictures taken on 8.5.2021.

Slika 2: Različni deli lokalitete B: A) Osrednji del, slikano nekaj metrov jugozahodno od navedenih koordinat lokalitete; B) Najbolj severna točka osrednjega dela, vključujoč manjšo zaplato mokrotnega travnika, ki se nahaja tik pred iglavci v ozadju; C) Del s suhim ekstenzivnim travnikom (levi del slike, nad kolovozom); D) Najbolj jugozahodni del z največjo zaplato mokrotnega travnika in manjšim sadovnjakom v ozadju (že zunaj lokalitete). Vse slike so bile posnete 8. 5. 2021.

smaller area with wet grassland. The locality borders on a smaller bushy area with a few trees near the northeast boarder, a small stream to the north, and is mostly encircled with intensive grasslands and fields. An urban settlement is located nearby, further northwest. The intensive and wet grassland on the locality are mowed at least trice per year and fertilised with cow faeces, while the extensive grassland is mowed once per year or not at all, and is never fertilised.

Locality B: coordinates: X: 46.098019, Y: 14.142588; 410-440 m; mostly humid or dry extensive grasslands, with some areas of wet grasslands on the lower southwest and northeast points, as well as in the raised centre of the locality. The dry

extensive grassland is mostly limited to the slopes. The locality borders with mixed forests to the north and south, intensive grasslands to the northwest, west and east, and a couple of small streams at the southwest and northeast border. A smaller urban settlement with gardens is located close to the northwest border, including a small orchard. The entire locality is mowed twice per year, once in the summer and once in the middle of September, while no part of the locality is ever fertilised.

List of species

The nomenclature and taxonomy are in accordance with Verovnik (2019).

Table 1: List of butterfly species at locality B with abundance classes indicated for each month of the survey.

Tabela 1: Seznam vrst dnevnih metuljev na lokaciji B s podatki o razredih številčnosti po mesecih vzorčenja.

Family	Species	Month found							
		MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
Papilionidae	*Iphiclides podalirius*			A		A			
	Papilio machaon	A	A	B		A		B	
	Parnassius mnemosyne			A					
Pieridae	*Anthocharis cardamines*		A	B					
	Colias crocea			B	A	B	B	B	C
	Gonepteryx rhamni	C	C	C	A	B		A	B
	Leptidea sp.	B	C	C	C	C	C	B	
	Pieris bryoniae			A		A			
	Pieris napi		A	B		A		C	B
	Pieris rapae		B	B	A	C	A	C	C
Lycaenidae	*Aricia agestis*				*	A			
	Callophrys rubi			A					
	Celastrina argiolus		B			*			A
	Cupido argiades			*			A	A	
	Cyaniris semiargus				*				
	Lycaena alciphron			A	B				
	Lycaena hippothoe			B		A	B	*	A
	Lycaena phlaeas			A		A	A	B	B
	Lycaena tityrus		A	B	B	B	B	A	
	Lysandra bellargus						A	A	
	Plebejus argus			C	C	C	A		
	Plebejus idas				A		A		
	Polyommatus icarus			C	C	C	C	C	C

Nymphalidae	*Aglais io*					*		A	
	Aglais urticae	B	A	B					
	Arachnia levana		A	A		A			
	Argynnis paphia							B	
	Boloria dia		C	C	C	C	C	C	
	Brenthis daphne				A	A			
	Brenthis hecate				A	A			
	Brintesia circe					A		A	
	Coenonympha arcania				*	*			
	Coenonympha pamphilus		B	C	C	C	C	C	B
	Euphydryas aurinia			B	A				
	Fabriciana adippe							A	
	Issoria lathonia	A							
	Maniola jurtina			A	C	C	C	C	
	Melanargia galathea				C	C	B		
	Melitaea athalia			C	C	C	C	C	
	Melitaea diamina				B	B	A	A	
	Melitaea didyma			B	B	A	C		
	Melitaea phoebe			A	B		A		
	Neptis rivularis					A			
	Pararge aegeria							A	B
	Speyeria aglaja						*		
	Vanessa atalanta		A	*					B
	Vanessa cardui			A	C	C		B	B
Hesperiidae	*Erynnis tages*			B		B			
	Hesperia comma					A	B		
	Ochlodes sylvanus				B	B			
	Pyrgus armoricanus			A		A	B	B	
	Pyrgus malvae	A	B	C	A				
	Thymelicus lineola				C	B			
	Thymelicus sylvestris				B	C			
Total species	54	6	14	32	28	36	22	25	12

Number of individuals found/sampling day: A – 1 (rare); B – 2-5 (occasional); C – >5 (common); * – specimen found only on the locality A;

Število posameznih osebkov najdenih/dan vzorčenja: A – 1 (redek); B – 2-5 (občasen); C – >5 (pogost); * – osebek najden zgolj na lokaciji A;

Altogether 54 species were observed in 31 surveys, conducted between March and October 2019 and 2020, on the localities A and B. Out of 54 species, 3 species

were found only on the locality A (*Cyaniris semiargus*, *Coenonympha arcania* and *Speyeria aglaja*), while 51 were recorded on the locality B at least once (Table 1). Among those, 17 species were observed on the locality B in larger numbers (>5) during at least one survey, while for 18 species at least two (but not more than 5) individuals were seen on the same day at least one time. Four species were observed only once as a solitary specimen (*Callophrys rubi*, *C. semiargus*, *Issoria lathonia,* and *S. aglaja*), and one was spotted only as a dead individual caught in the spider web (*Fabriciana adippe*). *F. adippe*, was otherwise common in 2020 on other grasslands around Gorenja vas (own observations). Statistically, family Papilionidae was the least represented, including only 3 species (5.6 %), while family Nymphalidae was the most numerous, including 24 species (44,4 %) of those observed. Families Pieridae and Hesperiidae were represented by the same number of species, namely 7 (13 %), while the second most numerous family by species representation, Lycaenidae, included 13 different species (24.1 %).

Table 2: Important larval host plants for the species of butterflies observed on the localities, and their presence at the locality B.

Tabela 2: Pomembne larvalne rastline za vrste dnevnih metuljev, ki so bili opaženi na lokacijah, in njihova prisotnost na lokaciji B.

Plant (family/genus/species)	Observed	Larval butterfly species host
Apiaceae	Yes	*P. machaon*
Brassicaceae	Yes	*A. cardamines, P. bryoniae, P. napi, P. rapae*
Fabaceae	Yes	*C. croceus, Leptidea sp., C. argiolus, C. argiades, P. argus, P. idas, P. icarus*
Poaceae	Yes	*B. circe, C. arcania, C. pamphilus, M. jurtina, M. galathea, P. aegeria, H. comma, O. sylvanus, T. lineola, T. sylvestris*
Rosaceae	Yes	*C. argiolus; I. podalirius*
Rutaceae	No	*P. machaon*
Anthyllis spp.	No	*C. croceus*
Aruncus spp.	Yes	*N. rivularis*
Cardamine spp.	Yes	*P. bryoniae*
Cardus spp.	No	*V. cardui*
Centaurea spp.	Yes	*M. phoebe*
Chamaecytisus spp.	Yes	*C. rubi*
Cirsium spp.	Yes	*V. cardui*
Corydalis spp.	No	*P. mnemosyne*
Erodium spp.	No	*A. aegestis*
Filipendula spp.	Yes	*B. hecate*
Fragaria spp.	Yes	*P. armoricanus, P. malvae*
Genista spp.	Yes	*C. rubi*
Geranium spp.	No	*A. aegestis*
Helianthemum spp.	No	*A. aegestis, P. armoricanus*
Lathyrus spp.	Yes	*Leptidea sp.*
Lotus spp.	Yes	*C. croceus, Leptidea sp., C. argiades, E. tages*
Malva spp.	No	*V. cardui*
Plantago spp.	Yes	*M. athalia, M. didyma*
Polygonum spp.	No	*L. hippothoe, L. phlaeas*

Potentilla spp.	Yes	*P. armoricanus, P. malvae*
Rhamnus spp.	No	*G. rhamni, C. rubi*
Rhinanthus spp.	Yes	*M. athalia, M. didyma*
Rubus spp.	Yes	*B. daphne, P. malvae*
Rumex spp.	Yes	*L. alciphron, L. hippothoe, L. phlaeas, L. tityrus*
Trifolium spp.	Yes	*C. croceus, C. argiades, C. semiargus*
Valeriana spp.	Yes	*M. diamina; M. didyma*
Veronica spp.	Yes	*M. athalia, M. didyma*
Viola spp.	Yes	*A. paphia, B. dia, F. adippe, I. lathonia, S. aglaja*
Frangula alnus	Yes	*G. rhamni, C. argiolus, C. rubi*
Hippocrepis comosa	No	*L. bellargus, E. tages*
Prunus spinosa	No	*I. podalirius*
Scabiosa columbaria	Yes	*E. aurinia*
Succisa pratensis	Yes	*E. aurinia*
Urtica dioica	Yes	*A. io, A. urticae, A. levana, V. atalanta*

The selection of plant taxa is based on the description of important larval host plants for each observed butterfly species, according to Polak (2009) and Verovnik et al. (2012).

Različne taksonomske skupine rastlin so bile izbrane na podlagi opisa pomembnih larvalnih rastlin za posamezno vrsto metulja, po navedbah Polaka (2009) ter Verovnika in sod. (2012).

Discussion

Before the beginning of the surveys, great care was taken to choose a locality, which would reflect a typical and common enough rural landscape. This way, it would be possible to assess how much butterfly richness this kind of landscape can support, without including the richest hotspots, which became relatively rare and thus not good representatives of the countryside, or the monocultures, which are unimportant from the biodiversity perspective. As the main area (locality B), a small fragment of mosaic landscape was selected, which contained different types of extensive grasslands, while intensive grasslands, orchards, woodlands, and streams could be found on its border. To supplement the locality, another area (locality A), covering mostly intensive grasslands, was selected, to add a few species missing at the main site. Considering both localities, around 40 species of butterflies were expected to be found, out of 181 occurring in Slovenia (Verovnik 2019), based on the previous observations on the localities A and B, as well as on other similar localities around Gorenja vas.

Among the butterflies observed, the most interesting are those with the status of threatened species (*Lycaena alciphron*, *Lycaena hippothoe*, *Melitaea diamina*, *Plebejus idas* and *Pyrgus armoricanus*) (van Swaay et al. 2010), and especially the two also being protected by the national ″Regulation on protected wild animal species″ law (*Euphydryas aurinia*, *Parnassius mnemosyne*) (Uradni list RS, št. 57/93, 61/93 – popr., 69/00, 98/02 in 46/04 2004). However, despite the exceeded

number of expected butterfly species, some common ones weren't observed. Among those are *Aphantopus hyperantus* and *Carterocephalus palaemon*, which were both found on a habitat-wise similar locality in Gorenja vas during summer of 2020 (own observations). Despite both species being considered as woodland ones, the proximity of the forest on localities B would suggest their observation. The same could be said about *Polygonia c-album*, a very common butterfly which also inhabits the forest edge and was previously already recorded in this part of the valley (Verovnik et al. 2012).

It is important to note, that for most butterflies, the suitable larval host plants were observed at the localities or in their vicinity as well (Table 2), confirming the importance of the area for their continuous survival (Spohn and Aichele 2011; Verovnik et al. 2012). Still, for some species, the corresponding larval host plants could not be located, despite most of the wider area around localities being searched (even the nearby forest). Those 3 species are *Parnassius mnemosyne*, *Lysandra bellargus* and *Aricia agestis*. Expectedly, those butterflies were observed on the localities only once or twice, confirming that the chosen areas did not include a sufficient habitat for their larval development. Thus, the butterflies were most likely observed only as the passing-by guests or searching for nectar. Among the potential ″guests-only″ are also the species which were found only once or twice, like *Pieris bryoniae*, *Callophrys rubi*, *Cyaniris semiargus*, *Speyeria aglaja* and *Coenonympha arcania*.

Expectedly, the biggest surprises were mostly the same butterflies as mentioned previously – *Pieris bryoniae*, *Coenonympha arcania*, *Hesperia comma*, *Plebejus idas*, *Brenthis hecate*, *Parnassius mnemosyne* and *Euphydryas aurinia*.

P. bryoniae is predominantly found at higher altitudes, so it was indeed surprising that it was recorded at 410 m. On the other hand, *H. comma* and *C. arcania* are typical for hilly areas under 1000 m, being most widely distributed between 300-500 m (Verovnik et al. 2012). Yet in Poljanska Valley they were observed in larger numbers only above 800 m, especially on Blegoš and Slajka (Šturm et al. 2021; own observations), while only few were observed on the studied localities. Anyhow, all three species are usually absent from agriculturally dominated landscapes, so they were deemed as an unexpected find. But while there was a lack of suitable habitat for *C. arcania* and *P. bryoniae*, the habitat was suitable for *H. comma*. It might be, that only a small colony of this species still endures on this locality, since *H. comma* is known to sometimes be found only in smaller numbers (Verovnik et al. 2012). Thus, while *H. comma* can be included as an important species for the locality, *C. arcania* and *P. bryoniae* can be counted only as a stray *imagines*, which flew down from the nearby hill Javorč or its vicinity.

Euphydryas aurinia and *Parnassius mnemosyne,* were previously not observed by the author on this locality, so their discovery was a big surprise. *P. mnemosyne* was seen on only two occasions as single individuals, while several individuals of *E. aurinia* (3) were spotted on the same day. This should be expected, however, since Škofjeloško Hills represents one of its strongholds in Slovenia (Verovnik et al. 2012). Additionally, its larval host plants, *Succisa pratensis* and *Scabiosa columbaria* (Polak 2009), were found on the extensive wet and dry grasslands, respective-

ly. On the contrary, larval host plants of *P. mnemosyne*, *Corydalis cava* (Polak 2009), were not observed anywhere on or near the locality (not even inside the near forest, where this plant would be expected). The butterflies have most probably only visited the flowering meadows to drink nectar, and later flew back to their reproductive territory. Thus, this species cannot be counted among the important ones for this locality, but can be deemed important for the conservation of wider area.

Another unexpected butterfly was *Plebejus idas*, as this species is rare in this part of Slovenia (Verovnik et al. 2012). Here, it is known mostly from small fragmented colonies, despite its larval host plants (Fabaceae, *Calluna vulgaris*) being very common. The species was previously already found in Gorenja vas (Withrington 1984), but as some of its smaller colonies across Slovenia are becoming extinct (Verovnik et al. 2012), the confirmation was unexpected.

Of all the species observed, the most surprising discovery was the observation of *Brenthis hecate*, which is present mostly in the southwest Slovenia (Verovnik et al. 2012). A species, typical for warm, dry extensive grasslands, is found only where *Filipendula ulmaria* and *Filipendula vulgaris*, its two larval host plants, are found (Polak 2009; Verovnik et al. 2012). The butterfly was observed in Gorenjska region only twice in the last decade, once in 2014 near Zgornja Bavšica (CKFF 2021) and once in Strmec na Predelu inside Triglav National park in 2012 (Observation.org 2021), both localities from the upper southwest corner of the country. In Gorenja vas, its last presence was noted more than three decades ago, when Withrington (1984) observed it in 1980/81/82. The locality of the find is still the only one in a 20 km radius, the other closest being Topol pri Medvodah to the east (Verovnik et al. 2012; CKFF 2021) and Šentviška Gora to the west (Torkar et al. 2013). Other rare known finds from Gorenjska (mostly around Kranj, Trstenik and Bled) are older than 10 years (CKFF 2021). Despite not yet being listed as threatened, its colonies in the entire northern Slovenia are very local and might soon disappear altogether, as its suitable habitats are slowly disappearing (Verovnik et al. 2012). Unfortunately, the species was observed only twice, always as a single individual. Yet, as its larval food plants were found as well, some hope of its extended survival in this region still remains.

Among the commoner species found, on the other hand, it is necessary to mention the *Vanessa cardui*, which was observed during the 2019 surveys in enormous numbers. As reported, that year the butterflies migrated from the Northern Africa *via* Spain, Italy, Middle East and even Mediterranean Sea to other parts of the Eurasia, overwhelming the meadows and parks of most European countries (Dobronosov 2019). Otherwise a common butterfly throughout Europe, usually present in low to medium numbers, it can become numerous during mass migrations like the ones in 2009, 2014 and the one in 2019 (Verovnik et al. 2012; Dobronosov 2019). Consequently, during the June and July surveys that year, it was observed in vast numbers, outnumbering almost every other species. It was abundant even at the end of the summer in September and even as late as October. As a great contrast, in 2020 only a single *imago* was observed, despite 19 surveys conducted during the entire year from March to September.

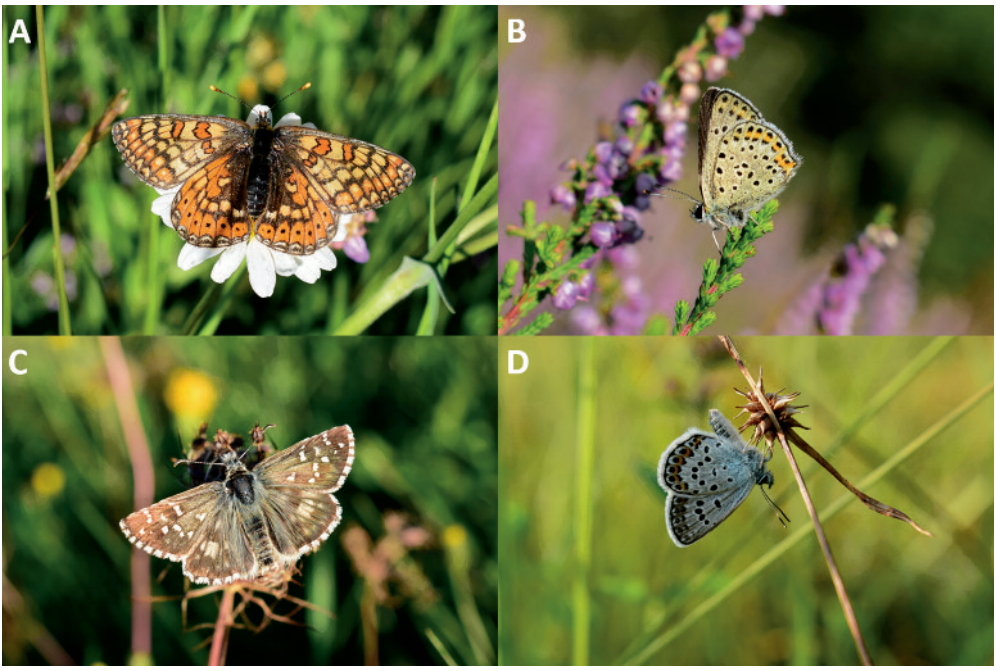

Figure 3: Some of the butterfly species found at the locality B: A – *Euphydryas aurinia*; B – *Lycaena tityrus*; C – *Pyrgus armoricanus*; D – *Plebejus argus*
Slika 3: Nekaj vrst metuljev najdenih na lokaciji B: A – *Euphydryas aurinia*; B – *Lycaena tityrus*; C – *Pyrgus armoricanus*; D – *Plebejus argus*

From the conservation point of view butterfly species from the genus *Lycaena* and *Pyrgus* are most important as they were found in larger numbers throughout the year. This indicates favourite status of extensive grassland habitats on the locality, with the abundance of different flora (Schmitt and Rákosy 2007; Nilsson et al. 2013). The importance of preserving dry extensive grasslands and wet grasslands on the locality B is further corroborated by the diverse flora found in the area (Table 2). Most importantly, for almost all butterfly species found, at least one larval host plant was determined on the localities – even if only in low abundance (Verovnik et al. 2012).

The observations at localities A and B are good indication, that even relatively small mosaic areas can host high number of species. However, despite high richness of butterfly species and plant taxa on the chosen localities, most of the valley's landscape is not as diverse. In fact, as mentioned before, most of the non-inhabited and non-wooded areas are covered with either fields of monocultures or highly intensive grasslands. The latter are all fertilised few times a year, mostly with compost, and mowed at least 4-times during every season. Consequently, very few flowering plants, besides dandelion, can survive. In such landscape, even common species,

such as *Coenonympha pamphilus*, whose caterpillars require grasses (*Poa* spp.) as larval host plants (Polak 2009), are unable to survive, since the grass is mowed too frequently for the caterpillars to end their life cycle. This has strong influence on the diversity of the entire butterfly community as well as on other organisms (Börschig et al. 2013; Nilsson et al. 2013). Lack of flowering plants on such grasslands is also problematic, as the adult butterflies have no nectar sources.

Therefore, to retain the high richness of the rural environment, the mosaic landscapes with extensively managed grasslands need to be preserved on a larger scale, not only in isolated areas.

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