

# INFLUENCE OF THE LANDSCAPE STRUCTURE ON THE BUTTERFLY (Lepidoptera, Hesperioidea and Papilionoidea) AND BIRD (Aves) TAXOCOENOSSES IN VEĽKÉ LEVÁRE (SW SLOVAKIA)

HENRIK KALIVODA<sup>1</sup>, FRANTIŠEK PETROVIČ<sup>2</sup>, EVA KALIVODOVÁ<sup>1</sup>,  
ALEXANDER KÜRTHY<sup>3</sup>

<sup>1</sup> Institute of Landscape Ecology of the Slovak Academy of Sciences, Štefánikova 3, P.O.Box 254, 814 99 Bratislava, Slovak Republic; e-mail: henrik.kalivoda@savba.sk

<sup>2</sup> Department of Ecology and Environmental Studies, Faculty of Natural Sciences, Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 949 74 Nitra, Slovak Republic; e-mail: fpetrovic@ukf.sk

<sup>3</sup> Bilíkova 20, 841 01 Bratislava, Slovak Republic; e-mail: kurthy@e-svet.biz

## Abstract

Kalivoda H, Petrovič F, Kalivodová E., Kürthy, A. Influence of the landscape structure on the butterfly (Lepidoptera, Hesperioidea and Papilionoidea) and bird (Aves) taxocoenoses in Veľké Leváre (SW Slovakia). *Ekológia (Bratislava)*, Vol. 29, No. 4, p. 337-359, 2010.

The paper offers the view of the landscape structure development of Veľké Leváre village (SW Slovakia) in three time horizons (year 1842, 1960, and 2008), in the relation with biodiversity of the surveyed area as well as butterfly and bird (Aves) taxocoenoses development. From the half of the 19<sup>th</sup> century, when the village used to have the character of agricultural country, the landscape structure of Veľké Leváre has undergone huge changes. The main changes appeared in the forest vegetation. Oak forests with pine tree additions (with 42% area) have been changed into coniferous cultures during the century. Permanent grasslands that achieve near the 6% of the cadastre area have experienced the largest surface decrease. Even 94 species of butterflies and 169 bird species have been recognized in the monitored model groups of animals. Landscape structure changes highly affected butterfly and bird taxocoenoses in meadows and forests and in wetland habitats, in the case of birds as well.

*Key words:* Veľké Leváre, landscape structure, changes, butterflies, birds

## Introduction

The application of zoological research in landscape ecology is not equal even if the landscape evaluation on the basis of the selected groups of animals is involved in Act 24/2006 Coll. on the environmental impact assessment (EIA). The biggest problem of the abiotic and biotic

research results evaluation – animal research concretely – is the lack of older data dealing with the participation and diversity of the individual groups of animals in the evaluated areas from the first half of the 20<sup>th</sup> century, i.e. before the greatest interventions of human beings in nature. While the landscape structure could be interpreted during the last 200 years on the basis of historical maps, parallel knowledge about animals is missing. Evaluation of the negative influences on the animal communities connected with the landscape structure transformation in consequence of the agricultural collectivization, amelioration, meadows and balks ploughing, etc., is possible on the basis of the “scientific assumption” arising from the knowledge about the demands of the individual taxonomic groups and animal communities on the environment, or from the results of the zoological research made in similar areas. Velké Leváre is an environment which had been changed following the mentioned influences.

We tried to summarize butterfly and bird taxocoenoses in dependence on changes in land use within the longer time horizon on the basis of the comparison of changes in the secondary landscape structure.

We have evaluated village landscape structure on the basis of historical maps. It has been compared with the present situation. Historical maps and aerial shots utilization are the standard methods evaluating landscape structure development and offering exact and spatially localizable results, is confirmed by the works of several authors (Boltižiar, Mojses, 2008; Feranec et al., 2004; Holúbek, Jančovič, 2009; Ivanová, 2003; Izakovičová, Moyzeová 1999; Mišovičová, Pucherová, 2008; Olah, 2009; Olah, Boltižiar, 2009; Petrovič, 2005). Butterflies and birds have been chosen as the model groups for the change studies regarding the historical landscape structure. They used to be observed in the village in a few isolated cases.

There is no complex work dealing with butterfly fauna from the observed area. Only other discoveries on the more important and rare species have been published (migrants during the observation of drawing butterfly species from the 60s and the 70s of the last century) (Felix et al., 1978; Hrubý, 1964; Reiprich, Okáli, 1989; Švestka, 1992).

Results of the present research on butterflies connected with the Velké Leváre area have been already published in some works (Gavlas, Kalivoda, 2001; Kalivoda, 2008; Kalivoda, Grendár, 2001; Kalivoda et al., 2000; Kulfan, Kalivoda, 2003).

Birds of the observed area have not been determined yet. Avifauna of the National Nature Reserve Abrod has been processed after 1990 (Darolová, 2003). Some of the older unpublished data from the second half of the 20<sup>th</sup> century have been partially recorded in a few works dealing with the birds from the Morava river and its flowage area (Kalivodová, Kürthy, 2001a; Kalivodová et al., 1994, 1996; Zuna–Kratky et al., 2000), or the pine-wood (Kalivodová, Kürthy, 2001b) and drift sands area in Velké Leváre (Kalivodová et al., 2008).

## Study area

Velké Leváre village is situated in the Borská nížina lowland, Malacky region, near the Slovak–Austrian border. Habitats of floodplain forests and inland drift sands intersect in the village cadastral area. The village importance is being emphasized by the habitats and localities of European importance (Natura 2000 – Abrod, Gajar alluvial of the river Morava and Rudava river alluvium) situated in the cadastre. Alluvium of the river Morava in the former frontier zone that had been inaccessible from 1948 to 1990. The western part of the cadastre in the pine-wood area intervened Záhorie, the military district accessible from 1990. The National Nature Reserve Abrod was the only freely accessible area. Soil intersection connected with ameliorations and meadows ploughing during the collectivization in the second half of the last century, affected the village as well as other Slovak localities.

## Methods

Historical landscape structure has been interpreted by use in two time horizons – in 1842 and 1960. Land use in 1842 was developed according to the materials of the second Austro-Hungarian military mapping in the scale 1:28 800. Precision and content of the mentioned maps fulfil the strict research criteria needed for the correct interpretation and evaluation of the basic and applied research with historical, geographical and landscape-ecological character. They contain the information about certain categories of land use that are being represented by the forms of land use, such as arable land, permanent grassland, forest areas, built-up areas of residential, producing and traffic character. The year 1960 was evaluated on the basis of archive military topographical maps in the scale 1:25 000. The present land use (year 2008) has been interpreted by the basic maps of the Slovak Republic in the scale 1:10 000 as well as by orthophotos in the scale 1:5 000 from 2002/2003 (Orthophotomap © Geodis Slovakia, Ltd, 2003, aerial shots and digital orthophotomap © Eurosense, Ltd, 2003), verified by field research. Creation of the landscape structure maps was done in the area of the geographical information systems “programme ArcView GIS 3.1”. We have been interpreting the whole change of land use as well as trends of change types in land use from 1960 up to 2008 in terms of the following works of Bičík, Jeleček, Štěpánek (2001), Ořahel et al. (2004) and Cebecauerová (2007).

Butterfly research was realized in two phases. The individual habitats were visited irregularly in July and August in 1983–1992. The qualitative element of taxocoenoses with the emphasis on the rare and endangered butterfly species had been observed in the mentioned period. The Transect method was used in 1992 within the field work. The individual habitats were visited systematically in 30-day intervals from April to September. It was not possible to identify the type of individual habitat in the case of older published data (the locality was mentioned as the name of Velké Leváre village, only). Individual species were connected with the habitats on the basis of knowledge and information of the authors and literature (Beneš et al., 2002; Slamka, 2004).

Sporadic data about birds before 1990 is the result of the irregular research in the agricultural biotope, along watercourses and meadows mainly. We have been regularly monitoring birds since 1990, when the frontier zone at the Morava river was made available and easier entry into the military district Záhorie was allowed. Line methods were used from 1990–2000 in bird observation. It was completed by 30 minute long stationary observation. We were oriented to the determination of the birds as well as to the coenological characteristics with the aim to evaluate the influence of landscape structure changes on their populations. The research of the Morava river flowage area and the forward pine-wood was realized in the nidification period lasting from 2000 to 2006. In the nidification period lasting from 2007 to 2009, all evaluated habitats were explored.

## Results and discussion

Just 48 landscape elements have been identified in the present landscape structure of Velké Leváre village. We have generalized them into 19, easily identified in the historical maps (Table 1), on the basis of the landscape structure changes identification. We have emphasized discovery of their area and percentage representation. Butterflies and birds were monitored in detail in ten evaluated landscape elements. Eight of them were common for both groups. The next two, wet meadows (butterflies) and water habitats (birds) were chosen in term of the ecological demands on the presence of the certain group in the evaluated area.

### *Landscape structure*

#### *Landscape structure in 1842*

The landscape structure of Velké Leváre village in the first half of the 19<sup>th</sup> century (the year 1842) confirms the agricultural orientation dependent on the appropriate soil and climatic conditions (Fig. 1). More than half part of the cadastre area consisted of different forms of arable land and grassland. Their localization was influenced by the morphometric characteristics of the area and availability from the residence. The highest concentration of the arable land was in the plain western part of the cadastre and in the northeastern part of the village. The arable land formed 35% of the cadastre area. The grasslands, in the form of meadows mainly, creating 19.5% of cadastre, cover the northwestern part at the edge of Moravský Svätý Ján and Závod villages, surrounded by the rivers Rudava, Starý kanál and the Šimkovský kanál. The huge concentration of meadows was in the southwestern part of the town's residential area in which part of meadows was populated by the wood species. Forests were the second largest landscape element (42% of the cadastre area). The deciduous forests, mainly with the pine tree addition, covered the eastern part of the cadastre in the huge continuous complex. Small groups of bank vegetation (0.8%) were in the surroundings of the Rudava and water channels. We identified gardens at the houses, farm-out buildings, the church and chapel near the residence or in its surroundings. The built-up area formed 0.7% of the cadastre, only. The important landscape element in the village is the manor house surrounded by the park. The park consists of two forms: grassland, the area of which is almost 9.5 ha, and forest crop, with an area of 7 ha. We also identified places where the clay used to be mined for the neighbouring brick factories, in the central part of the cadastre, at the contact edge of the arable land and the forest. Localization of three water mills at the artificial water port (mill-race)- flowing in parallel with the original water course of the Rudava and serving for the grown products processing – indicates the agricultural character of the area.

#### *Landscape structure in 1960*

It is possible to distinguish the clear difference in land use in one hundred years time (year 1960) (Fig. 2). The changes were mainly realized in the specific composition of forest communities.. Deciduous forests were replaced by coniferous cultures. From the original 1956.08 ha of mainly deciduous forests (with the addition of pine trees), 313.94 ha remained in 1960

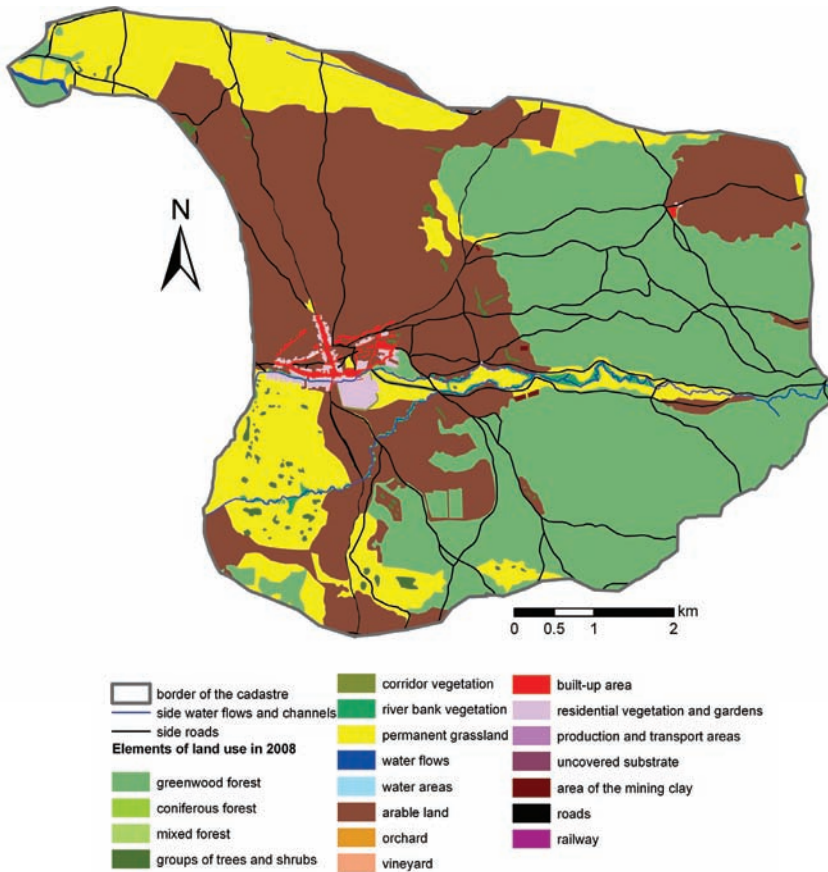


Fig. 1. Landscape structure in 1842.

(a decrease from 42 to 6.7%). Coniferous forests, forming the eastern part of the cadastre compact area and the huge area in the southwestern part at the contact point with Kostolište village, created 2257.87 ha that used to be, from a size factor, more than the whole rate of forests in 1842 (48.5% of the cadastre). Arable land was the second largest landscape element in 1960. It was in the western part of the cadastre and formed 24.1% of its area (1124.04 ha). We have noted a decrease of more than 10% in comparison with 1842. The largest change happened in the northeastern part of the cadastre area, near Nivky with the coniferous forest planted out in the most of the arable land. On the contrary, the largest increase was in the northwestern part of cadastre, in the area of “Diely”, towards the Morava river. The observable decrease was also achieved by the permanent grasslands. The total decrease of

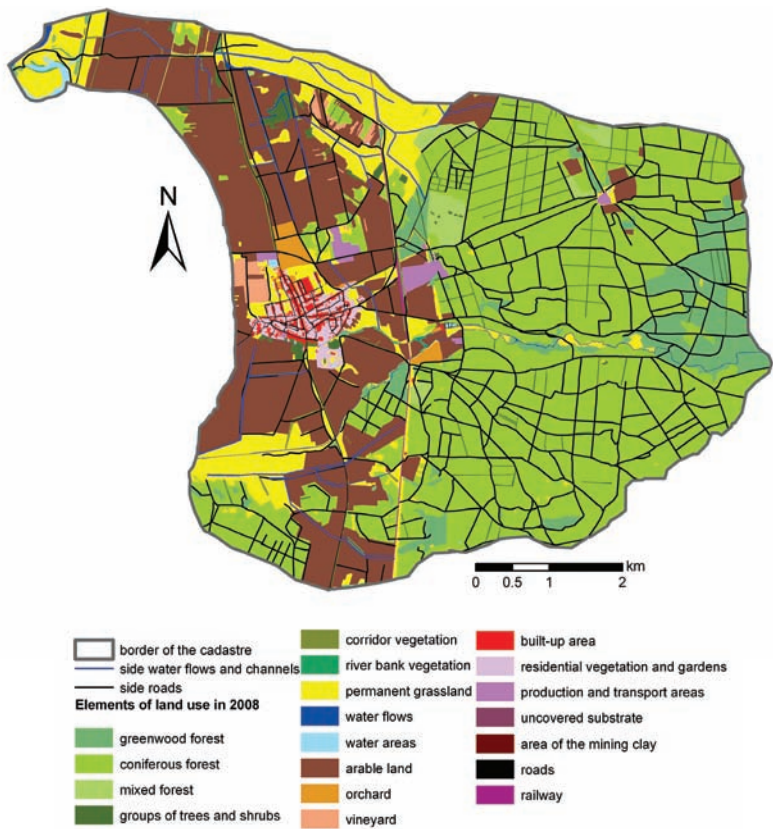


Fig. 2. Landscape structure in 1960.

more than 7% of the area (at the 11.7% of cadastre area) is obvious in the surroundings of the Rudava river, at the eastern part of the cadastre area that gradually grows over, and the northwestern part of the cadastre area, where the permanent grasslands have been changed into arable land. Quite a high vegetation of orchards and vineyards connected with the gardens at the houses was situated near the village residential area. The line vegetation surrounding the road network covers about 1% of cadastre area.

#### *Landscape structure in 2008*

The permanent increase of coniferous forests in the areas originally covered by deciduous and mixed forests was obvious in 2008 (Fig. 3). Their present total area covers almost 53% of the cadastre area. The largest increase was in the eastern part of the cadastre area in which

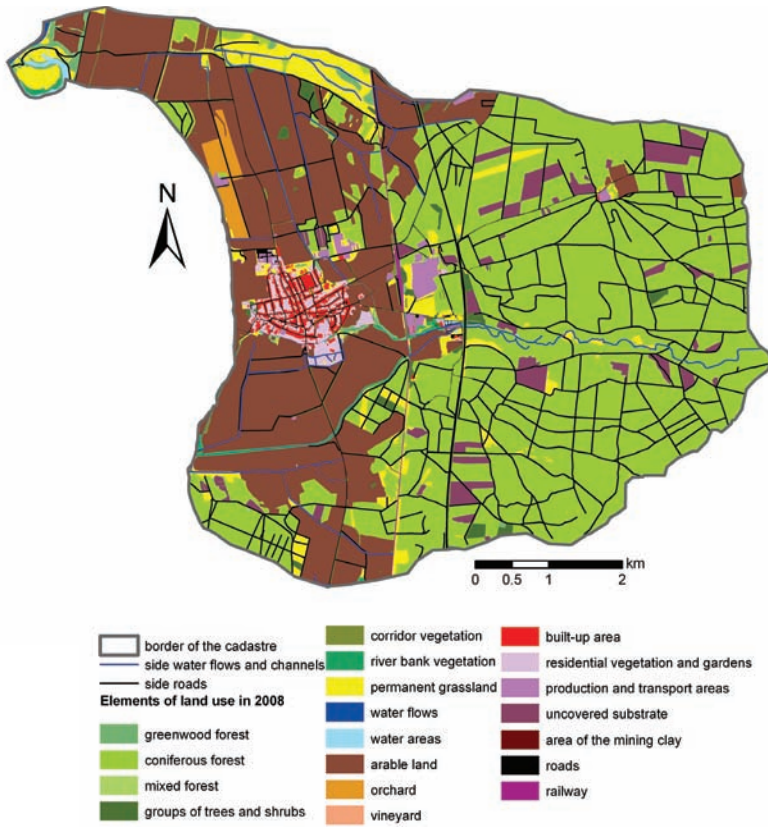


Fig. 3. Landscape structure in 2008.

the coniferous forests form one huge complex. The intensive forest management in this area confirms the 3.5% rate of uncovered substratum (drift sands), primarily in the places of extraction. The second largest present landscape element is the arable land that covers more than 29% of the cadastre area. We have observed a mild increase (5%) caused by the change of the grasslands utilization into arable land in the northern part of the cadastre area in comparison with 1960. The larger complexes have been preserved in the National Nature Reserve Abrod as well as mainly in the flooding area of the Morava river. The built-up residency area was practically doubled into the 50.62 ha in comparison with 1960. Rates of industrial and agricultural areas in the residence (42.5 ha) increased moderately.

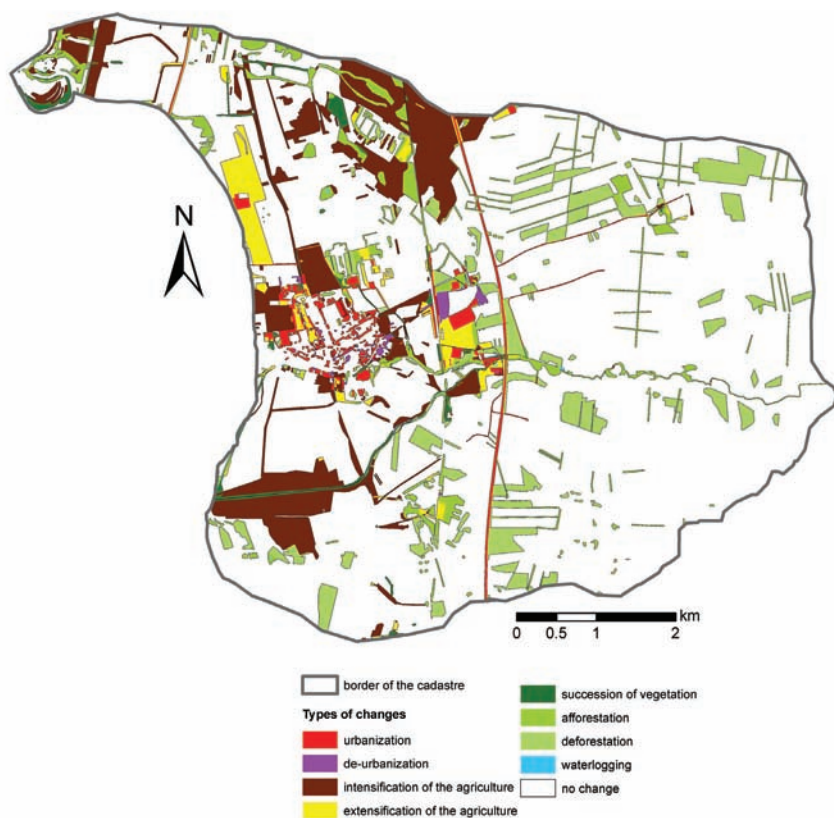


Fig. 4. Types of changes in land use.

### *Land use in three time horizons*

Comparison of land use changes in the second half of the last century and at the beginning of this century – i.e. in 50 year period from 1960 to 2008 – demonstrates the fact that forest communities in the eastern part of the cadastre area (Henrichov les forest, Levársky les forest) and the arable land (big blocked) in the western part of the cadastre area are relatively stable. Deciduous forest has been changed into coniferous.. Part of the grasslands has been changed into arable land in the central and the western part of the cadastre area (localities: Tõň, eastern part of the Abrod National Nature Reserve, Merklóvská). A new form of communication – highway – grew in the central part of the cadastre area.

We have identified eight types of land use changed (deforestation, afforestation, intensification of agriculture, extensification of agriculture, urbanisation, de-urbanisation, ingrowths, flooding) (Table 2) within the land use and change type evaluation (Fig. 4).



Table 1. Land use elements in the cadastre of the Velké Leváre village.

Land use elements	Area in ha (year)			Area in % (year)		
	1842	1960	2008	1842	1960	2008
Deciduous forests	1956.08	313.94	40.56	42.0	6.7	0.9
Coniferous forests	-	2257.87	2451.88	-	48.5	52.7
Mixed forests	-	66.47	-	-	1.4	-
Groups of trees and shrubs	33.12	32.92	45.18	0.7	0.7	1.0
Corridore vegetation	6.01	38.33	33.28	0.1	0.8	0.7
River bank vegetation	36.98	9.75	30.92	0.8	0.2	0.7
Permanent grassland	909.95	542.62	249.32	19.5	11.7	5.4
Water flows	5.95	35.62	11.7	0.1	0.8	0.3
Water areas	-	13.57	9.41	0.0	0.3	0.2
Arable land	1616.7	1124.04	1353.17	34.7	24.1	29.1
Orchards	-	32.48	42.86	-	0.7	0.9
Vineyards	-	33.47	-	-	0.7	-
Built-up areas	30.62	31.83	50.62	0.7	0.7	1.1
Residential vegetation and gardens	41.89	52.66	65.88	0.9	1.1	1.4
Production and transport areas	-	34.17	42.5	-	0.7	0.9
Roads and other areas	15.79	26.91	54.82	0.3	0.6	1.2
Railway and other areas	-	9.14	10.91	-	0.2	0.2
Uncovered substrate	-	-	162.78	-	-	3.5
Areas of the mining clay	2.7	-	-	0.1	-	-
Total	4655.79	4655.79	4655.79	100.0	100.0	100.0

About 76.60% of the cadastre area has been formed without the change of land use. We have not made provision for the change of the deciduous forest crop into a coniferous one, since the area used to be utilized as the forest crop during both periods. The largest unchanged areas were in the western and the southern part of the cadastre area.

The large change – 8.7% of the cadastre area, was represented by perennial grassland transformation of the arable land. It was evident in the northern and western part of the

Table 2. Types of changes in land use in the cadastre of the Velké Leváre village.

Types of changes	Area	
	ha	%
Deforestation	183.37	3.94
Afforestation	265.32	5.70
Urbanization	76.47	1.64
De-urbanization	11.89	0.26
Agriculture intensification	404.89	8.70
Agriculture extensification	105.43	2.26
Succession of vegetation	39.85	0.86
Waterlogging	2.06	0.04
No change	3566.51	76.60

cadastre area, in which the grasslands had been changed into the arable land. Extensification of the agriculture in the cadastre area (2.26%) happened in the surroundings of the village residential area, in which the change from arable land into grassland occurred.

Deforestation was realized in the area of 5.7% in the western part of the cadastre, the part of forests which had been mined. The area is not being used at the present (uncovered substratum). Afforestation was realized in the surroundings of the Rudava and Morava rivers, as well as in some of the original grasslands in the northwestern part of the cadastre area (3.94%). Growth of bushes was present in the surroundings of watercourses, channels and communications (0.86%). The village residential area has been enlarged by urbanization (1.64%). It was evident in the highway construction. De-urbanization was realized in the part of the settlement in which a certain part of houses were destroyed (0.26%).

### Butterflies

We observed butterflies in nine types of habitats centrally (from 19 evaluated landscape elements). In fact, 94 species of butterflies have been identified up until now (Table 3). Most of them (81) were found in the meadows, and at least (5) in the coniferous forests. Seven of identified species are being integrated into NATURA 2000: *Zerynthia polyxena*, *Maculinea arion*, *M. teleius*, *M. nausithous*, *Lycaena dispar*, *Nymphalis vau-album* and *Euphydryas aurinia*. The 18 butterfly species have not been confirmed since 1960, and 5 species since 1985. At present, there are 71 butterfly species in the cadastre of Velké Leváre village.

Table 3. Butterflies of the Velké Leváre cadastre.

Species	Ex	Forests		Habitats in open landscape					VRA	
		G	C	GTS	RB	WM	DM	A	RV	B
<b>HESPERIOIDEA</b>										
<b>Hesperiidae</b>										
<i>Erynnis tages</i> (Linnaeus, 1758)	-	+	-	+	+	+	+	-	-	-
<i>Spialia sertorius</i> (Hoffmannsegg, 1804)	ex1960	-	-	-	-	-	+	-	-	-
<i>Pyrgus alveus</i> (Hübner, 1803)	ex1960	-	-	-	-	-	+	-	-	-
<i>Pyrgus malvae</i> (Linnaeus, 1758)	-	-	-	-	-	+	+	-	-	-
<i>Heteropterus morpheus</i> (Pallas, 1771)	-	+	-	-	-	+	-	-	-	-
<i>Carterocephalus palaemon</i> (Pallas, 1771)	-	-	-	-	-	+	+	-	-	-
<i>Thymelicus acteon</i> (Rottemburg, 1775)	ex1960	-	-	-	-	-	+	-	-	-
<i>Thymelicus lineola</i> (Ochsenheimer, 1808)	-	-	-	-	-	+	+	-	-	-
<i>Thymelicus sylvestris</i> (Poda, 1761)	-	-	-	-	-	+	+	-	-	-
<i>Ochlodes sylvanus</i> (Esper 1777)	-	-	-	-	-	+	+	-	-	-
<i>Hesperia comma</i> (Linnaeus, 1758)	-	+	-	-	-	+	+	-	-	-
<b>PAPILIONOIDEA</b>										
<b>Papilionidae</b>										

Table 3. (Continued)

Species	Ex	Forests		Habitats in open landscape					VRA	
		G	C	GTS	RB	WM	DM	A	RV	B
<i>Zerynthia polyxena</i> (Denis et Schiffermüller, 1775)	-	-	-	-	-	-	+	-	-	-
<i>Iphiclides podalirius</i> (Linnaeus, 1758)	-	-	-	-	+	+	+	-	+	+
<i>Papilio machaon</i> Linnaeus, 1758	-	-	-	-	-	+	+	-	+	+
<b>Pieridae</b>										
<i>Leptidea sinapis</i> (Linnaeus, 1758)	-	-	-	-	-	+	+	-	-	-
<i>Anthocharis cardamines</i> (Linnaeus, 1758)	-	+	-	+	+	+	+	-	-	-
<i>Pieris brassicae</i> (Linnaeus, 1758)	-	-	-	+	+	+	+	+	+	+
<i>Pieris napi</i> (Linnaeus, 1758)	-	-	-	+	+	+	+	+	+	+
<i>Pieris rapae</i> (Linnaeus, 1758)	-	-	-	+	+	+	+	+	+	+
<i>Pontia daplidice</i> (Linnaeus, 1758)	-	-	-	-	-	+	+	+	+	-
<i>Colias crocea</i> (Fourcroy, 1785)	-	-	-	-	+	+	+	-	+	-
<i>Colias erate</i> (Esper, 1805)	-	-	-	-	+	+	+	+	+	+
<i>Colias hyale</i> (Linnaeus, 1758)	-	-	-	-	-	+	+	+	+	-
<i>Colias chrysotheme</i> (Esper, 1781)	ex1960	-	-	-	-	-	+	-	-	-
<i>Gonepteryx rhamni</i> (Linnaeus, 1758)	-	+	+	+	-	+	+	+	+	+
<b>Nymphalidae</b>										
<i>Libythea celtis</i> (Laicharting, 1782)	ex1985	+	-	-	-	-	-	-	-	-
<i>Apatura ilia</i> (Denis et Schiffermüller, 1775)	-	+	-	-	-	-	-	-	-	-
<i>Neptis rivularis</i> (Scopoli, 1763)	ex1985	+	-	-	-	-	-	-	-	-
<i>Nymphalis polychloros</i> (Linnaeus, 1758)	-	+	-	-	-	-	-	-	-	+
<i>Nymphalis vau-album</i> (Denis et Schiffermüller, 1775)	ex1960	+	-	-	+	-	-	-	-	-
<i>Nymphalis xanthomelas</i> (Denis et Schiffermüller, 1775)	ex1960	+	-	-	+	-	-	-	-	-
<i>Vanessa atalanta</i> (Linnaeus, 1758)	-	+	-	+	+	+	+	-	+	+
<i>Vanessa cardui</i> (Linnaeus, 1758)	-	-	-	+	+	+	+	+	+	+
<i>Inachis io</i> (Linnaeus, 1758)	-	+	-	+	+	+	+	+	+	+
<i>Aglais urticae</i> (Linnaeus, 1758)	-	-	-	-	+	+	+	+	+	+
<i>Polygona c-album</i> (Linnaeus, 1758)	-	+	+	+	-	-	-	-	-	-
<i>Araschnia levana</i> (Linnaeus, 1758)	-	+	-	+	+	+	+	-	-	-
<i>Argynnis aglaja</i> (Linnaeus, 1758)	-	-	-	-	+	+	+	-	-	-
<i>Argynnis paphia</i> (Linnaeus, 1758)	-	+	-	-	-	+	+	-	-	-
<i>Argynnis pandora</i> (Denis et Schiffermüller, 1775)	ex1960	-	-	-	-	-	+	-	-	-
<i>Argynnis niobe</i> (Linnaeus, 1758)	-	-	-	-	-	+	+	-	-	-
<i>Issoria lathonia</i> (Linnaeus, 1758)	-	-	-	-	-	+	+	-	-	+
<i>Brenthis daphne</i> (Denis et Schiffermüller, 1775)	-	+	-	-	-	+	-	-	-	-
<i>Boloria selene</i> (Denis et Schiffermüller, 1775)	-	-	-	-	+	+	+	-	-	-
<i>Boloria dia</i> (Linnaeus, 1767)	-	-	-	-	-	+	+	-	-	-
<i>Boloria euphrosyne</i> (Linnaeus, 1758)	-	-	-	-	-	+	-	-	-	-
<i>Melitaea athalia</i> (Rottemburg, 1775)	-	-	-	-	-	+	+	-	-	-
<i>Melitaea cinxia</i> (Linnaeus, 1758)	-	-	-	-	-	+	+	-	-	-
<i>Melitaea diamina</i> (Lang, 1789)	ex1960	-	-	-	-	+	-	-	-	-
<i>Melitaea didyma</i> (Esper, 1778)	ex1960	-	-	-	-	-	+	-	-	-
<i>Melitaea aurelia</i> (Nickerl, 1850)	ex1960	-	-	-	-	-	+	-	-	-
<i>Melitaea britomartis</i> (Assmann, 1847)	ex1960	-	-	-	-	-	+	-	-	-
<i>Euphydryas aurinia</i> (Rottemburg, 1775)	ex1985	-	-	-	-	+	+	-	-	-

Table 3. (Continued)

Species	Ex	Forests		Habitats in open landscape					VRA	
		G	C	GTS	RB	WM	DM	A	RV	B
<b>Satyridae</b>										
<i>Melanargia galathea</i> (Linnaeus, 1758)	-	-	-	-	+	+	+	-	-	+
<i>Hipparchia alcyone</i> (Denis et Schiffermüller, 1775)	-	-	+	-	-	-	-	-	-	-
<i>Hipparchia semele</i> (Linnaeus, 1758)	-	-	+	-	-	-	-	-	-	-
<i>Hipparchia statilinus</i> (Hufnagel, 1767)	ex1960	-	-	-	-	-	+	-	-	-
<i>Minois dryas</i> (Scopoli, 1763)	-	-	-	+	+	+	+	-	-	-
<i>Brintesia circe</i> (Fabricius, 1775)	-	-	-	-	-	-	+	-	-	-
<i>Arethusana arethusana</i> (Denis et Schiffermüller, 1775)	-	-	-	-	-	-	+	-	-	-
<i>Maniola jurtina</i> (Linnaeus, 1758)	-	-	-	-	+	+	+	-	+	+
<i>Aphantopus hyperanthus</i> (Linnaeus, 1758)	-	-	-	+	+	+	+	-	-	-
<i>Coenonympha glycerion</i> (Borkhausen, 1788)	-	+	-	-	+	+	+	-	-	-
<i>Coenonympha pamphilus</i> (Linnaeus, 1758)	-	-	-	+	+	+	+	+	+	+
<i>Lasiommata maera</i> (Linnaeus, 1758)	-	-	-	-	-	+	+	-	-	-
<i>Lasiommata megera</i> (Linnaeus, 1767)	-	-	-	-	-	+	+	-	-	-
<b>Lycaenidae</b>										
<i>Hamearis lucina</i> (Linnaeus, 1758)	-	+	-	+	-	-	-	-	-	-
<i>Lycaena alciphron</i> (Rottemburg, 1775)	-	-	-	-	-	+	-	-	-	-
<i>Lycaena dispar</i> (Haworth, 1803)	-	-	-	-	+	+	-	-	-	-
<i>Lycaena hippothoe</i> (Linnaeus, 1761)	-	-	-	-	-	+	-	-	-	-
<i>Lycaena phlaeas</i> (Linnaeus, 1761)	-	-	-	-	-	+	+	-	-	-
<i>Lycaena tityrus</i> (Poda, 1761)	-	-	-	-	-	+	+	-	-	-
<i>Lycaena virgaureae</i> (Linnaeus, 1758)	ex1960	+	-	+	-	+	-	-	-	-
<i>Thecla betulae</i> (Linnaeus, 1758)	-	-	-	+	-	-	-	-	-	-
<i>Callophrys rubi</i> (Linnaeus, 1758)	-	-	-	-	-	-	+	-	-	-
<i>Cupido argiades</i> (Pallas, 1771)	-	-	-	-	+	+	+	-	-	-
<i>Cupido minimus</i> (Fuessly, 1775)	-	-	-	-	-	+	+	-	-	-
<i>Cupido decoloratus</i> (Staudinger, 1886)	-	-	-	-	-	+	+	-	-	-
<i>Celastrina argiolus</i> (Linnaeus, 1758)	-	+	-	+	+	-	-	-	-	-
<i>Scolitantides orion</i> (Pallas, 1771)	ex1960	-	-	-	-	-	+	-	-	-
<i>Glauopsyche alexis</i> (Poda, 1761)	ex1985	-	-	-	-	-	+	-	-	-
<i>Maculinea arion</i> (Linnaeus, 1758)	ex1960	-	-	-	-	-	+	-	-	-
<i>Maculinea nausithous</i> (Bergsträsser, 1779)	-	-	-	-	-	-	+	-	-	-
<i>Maculinea teleius</i> (Bergsträsser, 1779)	-	-	-	-	-	-	+	-	-	-
<i>Plebeius argyrognomon</i> (Bergsträsser, 1779)	-	-	-	-	-	+	+	-	-	-
<i>Plebeius idas</i> (Linnaeus, 1761)	ex1985	-	-	-	-	-	+	-	-	-
<i>Plebeius argus</i> (Linnaeus, 1758)	ex1960	-	-	-	-	-	+	-	-	-
<i>Aricia agestis</i> (Denis et Schiffermüller, 1775)	-	-	-	-	-	+	+	-	-	-
<i>Polyommatus semiargus</i> (Rottemburg, 1775)	ex1960	+	-	-	-	-	-	-	-	-
<i>Polyommatus amandus</i> (Schneider, 1792)	-	-	-	-	-	+	-	-	-	-
<i>Polyommatus dorylas</i> (Denis et Schiffermüller, 1775)	-	-	-	-	-	-	+	-	-	-
<i>Polyommatus bellargus</i> (Rottemburg, 1775)	-	-	-	-	-	-	+	-	-	-
<i>Polyommatus icarus</i> (Rottemburg, 1775)	-	-	-	-	+	+	+	+	+	+
<i>Polyommatus coridon</i> (Poda, 1761)	ex1960	-	-	-	-	-	+	-	-	-

Notes: G – greenwoods forests, C – coniferous forests, GTS – groups of trees and shrubs, RB – river bank forests, WM – wet meadows, DM – dry meadows and pastures, A – arable land, VRA – village residential area, RV – residential vegetation and gardens, B – built-up areas, Ex – extinct species, ex1960 – extinct species after 1960, ex1985 – extinct species after 1985.

## *Relation of the butterflies species and the landscape*

The huge amount of mapped landscape elements shows the habitat's diversity enabling the broad range of butterfly occurrence.

**Permanent grasslands** (wetlands and dry meadows) are the most important habitats in the observed area regarding the butterflies (Lepidoptera). It offers ideal conditions for the development of many species. A few of the important and the endangered species have been noted (*Heteropterus morpheus*, *Zerynthia polyxena*, *Maculinea teleius*, *M. nausithous*, *Lycaena dispar*, *L. alciphron*, *Polyommatus amandus*). These were the habitats with the greatest decrease of species in the last 50 years. 14 species have been eliminated from taxocoenoses since 1960 (*Spialia sertorius*, *Pyrgus alveus*, *Thymelicus acteon*, *Colias chrysotheme*, *Argynnis pandora*, *Melitaea diamina*, *M. didyma*, *M. aurelia*, *M. britomartis*, *Hipparchia statilinus*, *Scolitantides orion*, *Maculinea arion*, *Plebeius argus*, *Polyommatus coridon*), and another three butterfly species since 1985 (*Euphydryas aurinia*, *Plebeius idas*, *Glaucopteryx alexis*). These changes fully correspond with the area decrease of the mentioned habitats in the observed environment. The total area of the perennial grassland in the cadastre has been reduced fourfold (from 19.5% of the total area in 1842 to 11.7% in 1960 and to 5.4% in 2008).

**Deciduous forests** that used to cover the larger area in the evaluated locality in the past are important in term of the butterflies. *Gonepteryx rhamni*, *Celastrina argiolus*, *Polygonia c-album*, *Araschnia levana* and *Apatura ilia* belong to the dominant butterfly species of this habitat. The original place covered by deciduous forests has been replaced by coniferous forests. Four butterfly species connected with the habitat have not been registered since 1960 (*Nymphalis vau-album*, *N. xanthomelas*, *Lycaena virgaureae*, *Polyommatus semiargus*), and another two species since 1985 (*Libythea celtis*, *Neptis rivularis*).

**Coniferous forests** have only marginal meaning for butterflies. Two endangered species have been identified: *Hipparchia alcyone*, *Hipparchia semele*. These are species connected with open areas of drift sands. They have appropriate conditions for their existence in some of the open places in coniferous forests.

**Groups of woody species and bushes** have less importance in terms of the butterflies in the observed area. We can mention the significant species – *Thecla betulae* – that was recognized in this habitat, only.

**The bank vegetation** was largely covered by butterflies. It is related with the floridity of vegetation used as a source of food by butterflies. This habitat is important for some of the hygrophilous species (*Lycaena dispar*).

**Fields** are not very important habitats from the view of butterflies, since the species with the wide ecological valency (e.g. *Pieris rapae*, *Coenonympha pamphilus*) are capable of permanent existence only. They are important for the birds as feeding grounds.

**Village residential area vegetation** (parks, gardens, and cemetery) is the significant habitat in the observed area regarding the butterflies. It offers ideal developmental conditions for some of the species as are e.g. *Papilio machaon* and *Iphiclidides podalirius*.

**The built-up area** – butterflies with wide ecological valency were dominant here (e.g. *Pieris rapae*, *Inachis io*, *Coenonympha pamphilus* as well as species with high flying activity,

e.g. *Vanessa atalanta*, *V. cardui* or *Iphiclides podalirius*). Fauna of butterflies and structure in this habitat are influenced by the neighbourhood (gardens, meadows); the individuals fly from there occasionally but they do not live there permanently.

#### *Assumed changes in the populations of butterflies*

We have interpreted change of specific structure of surveyed groups of animals on the basis of landscape structure changes. We can mention the changes in the composition of butterfly and bird taxocoenoses in some of the landscape elements despite the lack of trustworthy data from the era before the largest intervention into the village landscape structure. We can partially use 50 year old data about butterflies dealing with the entire region of Slovakia (Hrubý, 1964), and the additional information from the end of the last century (Reiprich, Okáli, 1989). It is obvious that the main changes in the specific multitude occurred because of agricultural intensification in the process of dewatering, deforestation, afforestation, transformation of the deciduous forest into a coniferous one – even if the mentioned historical data are without concrete localization within the cadastre area and they are only connected with the village. Such principles influence and change the ecological conditions of butterflies. The huge changes and quantity depression in the ornithocoenoses occurred in the community species connected with swamps, damp meadows and water habitats.

From a total number of 94 discovered butterfly species, 18 have not been confirmed since 1960 (Table 3). Regarding the habitat preference, the mentioned species can be divided into two individual groups: 1) species connected with non-forest open country habitats such as meadows, pasture lands and non-forest xerotherm habitats, as well

Table 4. Changes of butterfly species number in the individual time periods and habitats.

	Forests		Habitats in open landscape					VRA	
	G	C	GTS	RB	VM	SM	A	RV	B
All species	22	6	19	26	60	68	12	17	17
Extinct after 1960	4	0	1	2	2	13	0	0	0
Extinct after 1985	2	0	0	0	1	3	0	0	0
Recent	16	6	18	24	57	52	12	17	17

Notes: G – greenwoods forests, C – coniferous forests, GTS – groups of trees and shrubs, RB – river bank forests, VM – wet meadows, SM – dry meadows and pastures, A – arable land, VRA – village residential area, RV – residential vegetation and gardens, B – built-up areas.

as 2) species of deciduous forest and their closer surrounding. Another five butterfly species have been excluded from butterfly fauna since 1985. They can be also divided into open country species and species connected with deciduous forest habitats. All of these species are considered to be ecological specialists with small ecological valency. Such a huge intervention to biotope represents extinction of their population. Many of them belong to the group of rare and protected species (*Thymelicus acteon*, *Colias*

*chrysotheme, Libythea celtis, Neptis rivularis Nymphalis vau-album, N. xanthomelas, Euphydryas aurinia, Melitaea diamina, M. aurelia, M. britomartis, Hipparchia statilinus, Scolitantides orion, Maculinea arion*).

Changes of deciduous forests and perennial grassland areas have influenced the composition of butterfly taxocoenoses in the cadastral area of Velké Leváre since 1960, as it is shown in Table 4. We have not noted any special changes in other types of habitats.

It is not possible to determine butterfly species increasing in taxocoenoses from 1960 or 1985, since we do not have more detailed older information about butterflies from the observed area. It can only be confirmed with certainty in the case of the *Colias erate* species. Its first mention in Slovakia was in 1989. It has spread all over Slovakia since then.

### Birds (*Aves*)

In fact, 169 species of birds have been identified during the present ornithological research (Table 5). Ninety nine of them nested in the area. Nesting was assumed in 15 cases, 31 species were identified in the phase of migration, 6 of them in winter time only, and 17 species flew in from the neighbouring cadastres. The majority of the species have been observed in the expanses of water (83) and in the floodplain forest (71), the least of them in the built-up area. Thirty-three species belong into the group of European important bird species by course of Law No 543/2002 and Annexe No 4, Public Notice No 492/2006. Four species

Table 5. Birds of the Velké Leváre cadastre.

Species	Forest biotopes		Biotopes in open landscape					Intravillain	
	G	C	GTS	RB	WA	MP	A	RV	BA
<i>Tachybaptus ruficollis</i> (Pallas, 1764)	-	-	-	-	B	-	-	-	-
<i>Podiceps cristatus</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	-	-	-	-	H	-	-	-	-
<i>Botaurus stellaris</i> (Linnaeus, 1758)	-	-	-	-	M	-	-	-	-
<i>Ixobrychus minutus</i> (Linnaeus, 1766)	-	-	-	-	B	-	-	-	-
<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	-	-	-	H	H	-	-	-	-
<i>Egretta alba</i> (Linnaeus, 1758)	-	-	-	H	H	H	H	-	-
<i>Ardea cinerea</i> (Linnaeus, 1758)	H	-	H	H	H	H	H	-	-
<i>Ciconia ciconia</i> (Linnaeus, 1758)	B	-	-	H	H	H	H	-	B
<i>Ciconia nigra</i> (Linnaeus, 1758)	B	B?	-	H	H	-	-	-	-
<i>Platalea leucorodia</i> Linnaeus, 1758	-	-	-	-	B?	-	-	-	-
<i>Cygnus olor</i> (Gmelin, 1789)	-	-	-	-	B	H	-	-	-
<i>Anser fabalis</i> (Latham, 1787)	-	-	-	-	W	W	W	-	-
<i>Anser albifrons</i> (Scopoli, 1769)	-	-	-	-	W	W	W	-	-
<i>Anser anser</i> (Linnaeus, 1758)	-	-	-	-	B	B	H	-	-
<i>Branta canadensis</i> (Linnaeus, 1758)	-	-	-	-	M	-	-	-	-
<i>Anas penelope</i> Linnaeus, 1758	-	-	-	-	M	-	-	-	-

Table 5. (Continued)

Species	Forest biotopes		Biotopes in open landscape					Intravillain	
	G	C	GTS	RB	WA	MP	A	RV	BA
<i>Anas strepera</i> Linnaeus, 1758	-	-	-	-	B <sup>1</sup>	-	-	-	-
<i>Anas crecca</i> Linnaeus, 1758	-	-	-	-	M <sup>4</sup>	-	-	-	-
<i>Anas platyrhynchos</i> Linnaeus, 1758	-	-	-	-	B	B	-	-	-
<i>Anas acuta</i> Linnaeus, 1758	-	-	-	-	M	-	-	-	-
<i>Anas querquedula</i> Linnaeus, 1758	-	-	-	-	B	-	-	-	-
<i>Anas clypeata</i> Linnaeus, 1758	-	-	-	-	M	-	-	-	-
<i>Aythya ferina</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Aythya nyroca!</i> (Güldenstädt, 1769)	-	-	-	-	M	-	-	-	-
<i>Aythya fuligula</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Bucephala clangula</i> (Linnaeus, 1758)	-	-	-	-	M	-	-	-	-
<i>Mergus albellus</i> Linnaeus, 1758	-	-	-	-	W	-	-	-	-
<i>Pernis apivorus</i> (Linnaeus, 1758)	M	-	-	-	-	-	-	-	-
<i>Milvus migrans</i> (Boddaert, 1783)	H	-	-	H	-	-	-	-	-
<i>Milvus milvus</i> (Linnaeus, 1758)	H	-	-	H	-	-	-	-	-
<i>Haliaeetus albicilla!</i> (Linnaeus, 1758)	H	-	-	H	-	-	-	-	-
<i>Circus aeruginosus</i> (Linnaeus, 1758)	-	-	-	-	B	H	-	-	-
<i>Circus cyaneus</i> (Linnaeus, 1758)	-	-	-	-	-	M	M	-	-
<i>Accipiter gentilis</i> (Linnaeus, 1758)	H	B?	-	H	-	-	-	-	-
<i>Accipiter nisus</i> (Linnaeus, 1758)	H	B?	H	H	-	H	-	-	-
<i>Buteo buteo</i> (Linnaeus, 1758)	B	B	H	H	-	H	H	-	-
<i>Buteo lagopus</i> (Pontoppidan, 1763)	-	-	-	-	-	W	W	-	-
<i>Falco tinnunculus</i> Linnaeus, 1758	H	-	H	-	-	H	H	-	B?
<i>Falco subbuteo</i> Linnaeus, 1758	B	-	-	H	-	H	-	-	-
<i>Falco peregrinus</i> Tunstall, 1771	-	-	M <sup>3</sup>	-	-	-	-	-	-
<i>Perdix perdix</i> (Linnaeus, 1758)	-	-	-	-	-	-	B*	-	-
<i>Coturnix coturnix</i> (Linnaeus, 1758)	-	-	-	-	-	B	B*	-	-
<i>Phasianus colchicus</i> (Linnaeus, 1758)	-	-	H	H	-	B	B	-	-
<i>Rallus aquaticus</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Porzana porzana</i> (Linnaeus, 1766)	-	-	-	-	B?	-	-	-	-
<i>Porzana parva</i> (Scopoli, 1769)	-	-	-	-	B?	-	-	-	-
<i>Crex crex!</i> (Linnaeus, 1758)	-	-	-	-	-	B*	B?	-	-
<i>Gallinula chloropus</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Fulica atra</i> Linnaeus, 1758	-	-	-	-	B	-	-	-	-
<i>Charadrius dubius</i> Scopoli, 1786	-	-	-	-	B?	-	-	-	-
<i>Vanellus vanellus</i> (Linnaeus, 1758)	-	-	-	-	M	B	M	-	-
<i>Calidris alpina</i> (Linnaeus, 1758)	-	-	-	-	M	-	-	-	-
<i>Calidris ferruginea</i> (Pontoppidan, 1763)	-	-	-	-	M	-	-	-	-
<i>Philomachus pugnax</i> (Linnaeus, 1758)	-	-	-	-	M	-	-	-	-
<i>Gallinago gallinago</i> (Linnaeus, 1758)	-	-	-	-	M	B* <sup>2</sup>	-	-	-
<i>Scolopax rusticola</i> Linnaeus, 1758	M	-	-	-	-	-	-	-	-
<i>Numenius arquata</i> (Linnaeus, 1758)	-	-	-	-	-	B*	-	-	-



Table 5. (Continued)

Species	Forest biotopes		Biotopes in open landscape					Intravillain	
	G	C	GTS	RB	WA	MP	A	RV	BA
<i>Tringa totanus</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Tringa nebularia</i> (Gunnerus, 1767)	-	-	-	-	M	-	-	-	-
<i>Tringa ochropus</i> Linnaeus, 1758	-	-	-	-	M	-	-	-	-
<i>Tringa glareola</i> Linnaeus, 1758	-	-	-	-	M	-	-	-	-
<i>Actitis hypoleucos</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Larus ridibundus</i> Linnaeus, 1758	-	-	-	-	H	-	H	-	-
<i>Larus canus</i> Linnaeus, 1758	-	-	-	-	M	-	-	-	-
<i>Sterna hirundo</i> Linnaeus, 1758	-	-	-	-	M	-	-	-	-
<i>Chlidonias niger</i> (Linnaeus, 1758)	-	-	-	-	M	-	-	-	-
<i>Chlidonias leucopterus</i> (Temminck, 1815)	-	-	-	-	M	-	-	-	-
<i>Columba oenas</i> Linnaeus, 1758	M	-	-	-	-	-	H	-	-
<i>Columba palumbus</i> Linnaeus, 1758	B	-	B	B	-	H	H	B	-
<i>Streptopelia decaocto</i> (Frivaldszky, 1838)	-	-	-	-	-	-	-	B	B
<i>Streptopelia turtur</i> (Linnaeus, 1758)	B	-	B	B	-	H	H	B	-
<i>Cuculus canorus</i> Linnaeus, 1758	B	B?	-	-	B	-	-	-	-
<i>Strix aluco</i> Linnaeus, 1758	B	-	-	-	-	-	H	-	-
<i>Asio otus</i> (Linnaeus, 1758)	B	-	B?	B?	-	H	H	-	-
<i>Apus apus</i> (Linnaeus, 1758)	-	-	-	-	H	-	-	-	B?
<i>Alcedo atthis</i> (Linnaeus, 1758)	-	-	-	-	H	-	-	-	-
<i>Upupa epops</i> Linnaeus, 1758	-	-	B*	-	-	-	-	B?	-
<i>Jynx torquilla</i> Linnaeus, 1758	B	B?	-	B	-	-	-	B?	-
<i>Picus canus</i> Gmelin, 1778	H	B?	-	-	-	-	-	-	-
<i>Picus viridis</i> Linnaeus, 1758	B	B	-	B?	-	-	-	H	-
<i>Dryocopus martius</i> (Linnaeus, 1758)	H	B	-	-	-	-	-	-	-
<i>Dendrocopos major</i> (Linnaeus, 1758)	B	B	H	B	-	-	-	B	-
<i>Dendrocopos syriacus</i> (Hemprich et Ehrenberg, 1833)	-	-	-	-	-	-	-	H	-
<i>Dendrocopos medius</i> (Linnaeus, 1758)	B	-	-	-	-	-	-	B	-
<i>Dendrocopos minor</i> (Linnaeus, 1758)	B?	-	-	H	-	-	-	H	-
<i>Galerida cristata</i> (Linnaeus, 1758)	-	-	-	-	-	-	B*	-	H
<i>Lullula arborea</i> (Linnaeus, 1758)	M	B?	-	-	-	-	-	-	-
<i>Alauda arvensis</i> Linnaeus, 1758	-	-	-	-	-	B	B	-	-
<i>Riparia riparia</i> (Linnaeus, 1758)	-	-	-	-	H	-	-	-	-
<i>Hirundo rustica</i> (Linnaeus, 1758)	-	-	-	-	-	-	-	-	B
<i>Delichon urbica</i> (Linnaeus, 1758)	-	-	-	-	-	-	-	-	B
<i>Anthus trivialis</i> (Linnaeus, 1758)	B	B	-	B?	-	-	-	-	-
<i>Anthus pratensis</i> (Linnaeus, 1758)	-	-	-	-	-	M	-	-	-
<i>Motacilla flava</i> Linnaeus, 1758	-	-	-	-	-	B	-	-	-
<i>Motacilla cinerea</i> Tunstall, 1771	-	-	-	-	B	-	-	-	-
<i>Motacilla alba</i> Linnaeus, 1758	-	-	-	-	B	H	-	-	B

Table 5. (Continued)

Species	Forest biotopes		Biotopes in open landscape					Intravillain	
	G	C	GTS	RB	WA	MP	A	RV	BA
<i>Bombycilla garrulus</i> (Linnaeus, 1758)	H	H	-	-	-	-	-	-	-
<i>Troglodytes troglodytus</i> (Linnaeus, 1758)	B	-	-	B	-	-	-	-	-
<i>Prunella modularis</i> (Linnaeus, 1758)	B	-	-	-	-	-	-	-	-
<i>Erithacus rubecula</i> (Linnaeus, 1758)	B	B	B	B	-	-	-	B	-
<i>Luscinia megarhynchos</i> Brehm, 1831	B	-	-	B	-	-	-	B	-
<i>Luscinia svecica</i> (Linnaeus, 1758)	-	-	-	B*? <sup>2</sup>	-	-	-	-	-
<i>Phoenicurus ochruros</i> (Gmelin, 1774)	-	-	-	-	-	-	-	B	B
<i>Saxicola rubetra</i> (Linnaeus, 1758)	-	-	-	-	-	B*	-	-	-
<i>Saxicola torquata</i> (Linnaeus, 1766)	-	-	-	-	-	B	-	-	-
<i>Oenanthe oenanthe</i> (Linnaeus, 1758)	-	-	-	-	-	M <sup>1</sup>	-	-	-
<i>Turdus merula</i> Linnaeus, 1758	B	B	B	B	-	-	-	B	-
<i>Turdus pilaris</i> Linnaeus, 1758	W	W	W	W	-	-	-	-	-
<i>Turdus philomelos</i> Brehm, 1831	B	B	-	H	-	-	-	-	-
<i>Turdus iliacus</i> Linnaeus, 1766	M	-	-	-	-	-	-	-	-
<i>Turdus viscivorus</i> Linnaeus, 1758	-	B	-	-	-	-	-	-	-
<i>Locustella naevia</i> (Boddaert, 1783)	-	-	-	-	B	-	-	-	-
<i>Locustella fluviatilis</i> (Wolf, 1810)	-	-	-	B	B	-	-	-	-
<i>Locustella luscinioides</i> (Savi, 1824)	-	-	-	-	B	-	-	-	-
<i>Acrocephalus paludicola!</i> (Vieillot, 1817)	-	-	-	-	M	-	-	-	-
<i>Acrocephalus schoenobaenus</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Acrocephalus palustris</i> (Bechstein, 1798)	-	-	-	-	B	-	-	-	-
<i>Acrocephalus scirpaceus</i> (Hermann, 1804)	-	-	-	-	B	-	-	-	-
<i>Acrocephalus arundinaceus</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Hippolais icterina</i> (Vieillot, 1817)	B	-	-	B	-	-	-	-	-
<i>Sylvia nisoria</i> (Bechstein, 1795)	-	-	H	H	-	M	-	-	-
<i>Sylvia curruca</i> (Linnaeus, 1758)	B	-	B	B	-	-	-	-	-
<i>Sylvia communis</i> Latham, 1787	B	-	B	B	-	-	-	-	-
<i>Sylvia borin</i> (Boddaert, 1783)	B	-	-	B	-	-	-	-	-
<i>Sylvia atricapilla</i> (Linnaeus, 1758)	B	B	B	B	-	-	-	B	-
<i>Phylloscopus sibilatrix</i> (Bechstein, 1793)	B	B	-	-	-	-	-	-	-
<i>Phylloscopus collybita</i> (Vieillot, 1817)	B	B	B	B	-	-	-	B	-
<i>Phylloscopus trochillus</i> (Linnaeus, 1758)	B	-	-	B	-	-	-	-	-
<i>Regulus regulus</i> (Linnaeus, 1758)	M	B	-	-	-	-	-	-	-
<i>Muscicapa striata</i> (Pallas, 1764)	B	-	-	B	-	-	-	-	-
<i>Ficedula albicollis</i> (Temminck, 1815)	B	-	-	H	-	-	-	-	-
<i>Panurus biarmicus</i> (Linnaeus, 1758)	-	-	-	H	B	-	-	-	-
<i>Aegithalos caudatus</i> (Linnaeus, 1758)	B	B	-	H	-	-	-	H	-

Table 5. (Continued)

Species	Forest biotopes		Biotopes in open landscape					Intravillain	
	G	C	GTS	RB	WA	MP	A	RV	BA
<i>Parus palustris</i> Linnaeus, 1758	B	-	-	B	-	-	-	H	-
<i>Parus montanus</i> Baldenstein, 1827	-	-	H <sup>5</sup>	-	-	-	-	-	-
<i>Parus cristatus</i> Linnaeus, 1758	-	B	-	-	-	-	-	-	-
<i>Parus ater</i> Linnaeus, 1758	-	B	-	-	-	-	-	W	-
<i>Parus caeruleus</i> Linnaeus, 1758	B	B	B	B	-	-	-	B	-
<i>Parus major</i> Linnaeus, 1758	B	B	B	B	-	-	-	B	-
<i>Sitta europaea</i> Linnaeus, 1758	B	B	H	B	-	-	-	B	-
<i>Certhia familiaris</i> Linnaeus, 1758	B	B	-	-	-	-	-	-	-
<i>Certhia brachydactyla</i> Brehm, 1820	B	-	-	-	-	-	-	-	-
<i>Remiz pendulinus</i> (Linnaeus, 1758)	B	-	-	B	-	-	-	-	-
<i>Oriolus oriolus</i> (Linnaeus, 1758)	B	-	B	H	-	-	-	H	-
<i>Lanius collurio</i> Linnaeus, 1758	B	-	B	B	-	-	-	B	-
<i>Lanius excubitor</i> Linnaeus, 1758	H	-	B?	H	-	H	H	-	-
<i>Garrulus glandarius</i> (Linnaeus, 1758)	B	-	H	H	-	-	-	-	-
<i>Pica pica</i> (Linnaeus, 1758)	-	-	B	B	-	H	-	-	-
<i>Corvus monedula</i> Linnaeus, 1758	-	-	-	-	-	-	H	-	-
<i>Corvus frugilegus</i> Linnaeus, 1758	H	-	-	H	-	H	H	B?	-
<i>Corvus c. coroneix</i> Linnaeus, 1758	B	-	B	B	-	P	H	H	-
<i>Corvus corax</i> Linnaeus, 1758	H	-	-	H	-	H	-	-	-
<i>Sturnus vulgaris</i> Linnaeus, 1758	B	-	B	B	-	H	H	B	-
<i>Passer domesticus</i> (Linnaeus, 1758)	-	-	-	-	-	-	-	-	B
<i>Passer montanus</i> (Linnaeus, 1758)	B	-	B	B	-	-	-	B	-
<i>Fringilla coelebs</i> Linnaeus, 1758	B	B	B	B	-	-	-	B	-
<i>Fringilla montifringilla</i> Linnaeus, 1758	W	-	W	-	-	-	-	W	-
<i>Serinus serinus</i> (Linnaeus, 1766)	B	-	B	B	-	-	-	B	-
<i>Chloris chloris</i> (Linnaeus, 1758)	B	-	B	B	-	-	-	B	-
<i>Carduelis carduelis</i> (Linnaeus, 1758)	-	-	B	-	-	-	-	B	-
<i>Carduelis spinus</i> (Linnaeus, 1758)	W	-	-	W	-	-	-	-	-
<i>Carduelis cannabina</i> (Linnaeus, 1758)	-	-	B	-	-	-	-	-	-
<i>Loxia curvirostra</i> Linnaeus, 1758	-	H <sup>1</sup>	-	-	-	-	-	-	-
<i>Pyrrhula pyrrhula</i> (Linnaeus, 1758)	H	B?	-	-	-	-	-	H	-
<i>Coccothraustes coccothraustes</i> (Linnaeus, 1758)	B	B?	-	-	-	-	-	H	-
<i>Emberiza citrinella</i> Linnaeus, 1758	B	B?	-	-	-	H	-	-	-
<i>Emberiza schoeniclus</i> (Linnaeus, 1758)	-	-	-	-	B	-	-	-	-
<i>Miliaria calandra</i> (Linnaeus, 1758)	-	-	-	-	B*	B?	-	-	-

Notes: G – greenwood forests, C – coniferous forests, GTS – groups of trees and shrubs, RB – river bank forests, WA – water flows and water areas, MP – meadows, wetlands and pastures, A – arable land, RV – residential vegetation and gardens, BA – built-up areas, B – breeding species, B? – probably breeding, B\* – breeding for 1990, B?\* – probably breeding for 1990, M – migrant, W – wintering (hibernant), H – hospites (temporary occurrence), ! – global threatened species, data from other authors: <sup>1</sup> – Rudolf Jureček, <sup>2</sup> – Zdeněk Laštůvka., <sup>3</sup> – Miroslav Čapek, <sup>4</sup> – Martin Rössler, <sup>5</sup> – Alžběta Darolová (2003), Nomenclature according to Voous (1773, 1777).

(*Aythya nyroca*, *Haliaeetus albicilla*, *Crex crex*, *Acrocephalus paludicola*) belong into the group of globally endangered species. The birds have been monitored in detail in nine the most important cadastre habitats.

### *Relation of the bird species and the landscape*

The huge amount of mapped landscape elements shows the habitat's diversity enabling the broad range of occurrence of monitored birds. The following types are considered to be the most important from the group of 19 habitats existing in the village:

**In deciduous forests** we have registered most of the bird species despite the small area representation. Most of them were concentrated in the flood plain forests in the submersible area of the Morava river, as well as in the surrounded deciduous vegetation of the Rudava river in the eastern part of the village. We have also discovered bird species typical for vegetation of **coniferous cultures**, with the exception of the forest species nesting in the mixed deciduous – coniferous vegetation (*Parus ater*, *P. cristatus*, *Regulus regulus*, *Loxia curvirostra*).

**Groups of woody species and bushes** have great importance for birds since it represents a safe site for the nesting species in the largely managed landscape. It offers nesting possibilities for the bushy bird species mainly, as are e.g. *Luscinia megarhynchos*, *Sylvia atricapilla*, *S. communis*, etc.

**The bank vegetation** contains more than one third of the identified number of bird species. It is being used as nesting, nutritive and restful habitat.

**Water courses and expanses** are important habitats from the ornithological point of view. The Morava river, with the dead river channel Stará Morava and the confluence of the Rudava river – which belongs to the “bird area of alluvial deposits of Morava” – plays an important role. They are important habitats for migratory as well as wintering water bird species (*Anser* spp., *Anas* spp., *Mergus albellus*, etc.). Rattan growth (*Phragmites australis*), with its huge number of cane nestlings (*Acrocephalus* spp., *Emberiza schoeniclus*), is situated in the southern part of the cadastre area that used to be covered with a dense network of small streams in the past.

**Permanent grasslands** is from the ornithological view considered to be an attacked habitat, typical for the high diversity of birdlife indicating the number of identified species in the habitats of damp meadows at the Morava river. The most significant locality is the regularly inundated Lepňa, near Stará Morava, where the nesting attempt of *Platalea leucorodia* has been noted. Geese (*Anser anser*), and ducks (*Anas platyrhynchos*, *A. querquedula*, *A. strepera*, *Crex crex*) used to nest here regularly. We also presume the nesting of *Porzana porzana*, *P. parva*. A similar species was present in the the present National Nature Reserve Abrod.

**Fields** are important for the birds as feeding grounds. The ornithocoenoses structure depends on the composition of agricultural plants. They are generally considered to be trophic habitats for the predacious bird species flying from forest complexes (*Buteo buteo*, *Falco tinnunculus*), with some of them being stopped in the migrating period (*Circus* spp.), as well as the graineating and omnivorous species (*Columba palumbus*, *Streptopelia turtur*, *Passer montanus*, *Sturnus vulgaris*, *Corvus* spp., *Carduelis* spp., etc.). *Perdix perdix*, *Coturnix*

*coturnix*, *Phasianus colchicus*, *Alauda arvensis*, *Saxicola rubetra* and *S. torquata* belong to the group of typical nesting birds of this habitat.

Despite the low number of the identified species, village residential area vegetation (park, gardens, cemeteries) forest bird species, wood peckers (*Dendrocopos* spp.) and small songbirds stay in the parks and gardens.

**The built-up area** is a habitat for the synanthropic species (*Hirundo rustica*, *Delichon urbica*) as well as for species nesting in the habitats out of the village residential area (*Phoenicurus ochruros*, *Motacilla alba*).

#### *Assumed changes in the populations of birds*

The transformation of deciduous forest into coniferous has caused, in the case of birds, a reduced number of species connected with old cavity trees and shrubs. On the other hand, species connected with coniferous vegetation interfered with the area (e.g. *Parus ater*, *P. cristatus*, *Loxia curvirostra*).

A decrease of meadows connected with their dehumidification, influenced the bird species that used to nest here in the past negatively (*Crex crex*, *Numenius arquata*, *Porzana porzana*, *P. parva*, *Gallinago gallinago*). The negative influence on the bird meadow community is also obvious in the last 20 years (from the moment of frontier zone development being characterized by the high diversity of nesting and migratory water bird species). The management transformation, decrement of damp meadows skiving mainly at the Morava river, caused a decrease in bird diversity in Velké Leváre habitats in the last 20 years. The landscape structure changes realized within the evaluated period, reached the populations of water bird species that used to occupy the underflooded habitats in the southern part of the cadastre area. These are presently being changed into the arable land or overgrown area. Water bird species occupy the localities closely connected with the flooding area of the Morava river.

## **Conclusion**

We have evaluated the probable development of butterfly and bird taxocoenoses on the basis of the landscape structure development of Velké Leváre village in three time horizons. Comparison of the evaluated landscape elements within the period of 165 years (from mapping in 1842, up to 2008) demonstrates the largest changes in forest structure. Forests, the oak with the addition of pine trees mainly, covered 42% of the area. The situation in 2008 totally differs from the situation in the 19<sup>th</sup> century. Forest vegetation has been changed from deciduous and mixed to pine monocultures. It covers 52.7% of the cadastre area. More than 50% of the cadastre area consisted of arable land (34.7%) and grasslands (19.5%) in the first evaluated period, while the grassland area has been decreased to 5.4% of the total area. The areas with uncovered substratum (3.5% of the cadastre area) rose in the predominantly monocultural pine forests.

The hugest changes in butterfly taxocoenoses composition have been realized in the habitat of dry and damp meadows and deciduous forests. The basic changes within the area caused the extinction of the ecological specialists with definite demands on quality and conditions of the environment. 17 butterfly species became extinct in the meadow habitat and 6 species in the deciduous forest habitat.

It is not possible to deal with the specific bird species extinction in the evaluated area. Threatened species, nidification of which has not been observed in the last decades (e.g. *Numenius arquapota*, *Porzana* sp., *Gallinago gallinago*), sporadically visit the area during the migration period. Results of the ornithocoenoses evaluation correspond with butterfly evaluation since the greatest changes in ornithocoenoses in the second half of the 20<sup>th</sup> century have been closely connected with nestlings of damp meadows, swamps and fields. Besides the species that used to nest in this area occasionally, the first decade of the 21<sup>st</sup> century is characterized by a decrease of species, e.g. *Crex crex* and *Motacilla flava* as well as a decrease in storks (*Ciconia ciconia*, *C. nigra*), with damp meadows representing a rich food source for them. Such negative phenomenon has been supported by soil reprivatisation and skiving restriction in some of the meadows in the flowage area of the Morava river. Land unification realized in a few decades of the last century caused diversity and decrease in the case of species nesting in the former balks or narrow-banded fields (*Perdix perdix*, *Coturnix coturnix*, *Galerida cristata*, *Saxicola rubetra*, *Miliaria calandra* etc.).

Translated by D. Kanášová  
English corrected by D. Reichardt

#### Acknowledgements

The research has been realized with the support of following projects VEGA No 1/0155/08, 1/0059/08 and 1/0334/08.

#### References

- Act 24/2006 Coll. on the environmental impact assessment (EIA) (in Slovak).
- Beneš, J., Konvička, M., Dvořák, J., Frič, Z., Havelda, Z., Pavlíčko, A., Vrabec, V., Weidenhoffer, Z. (ed.), 2002: Butterflies of the Czech Republic: distribution and conservation I and II. SOM, Praha, 857 pp.
- Bičík, I., Jeleček, L., Štěpánek, V., 2001: Land-use changes and their social driving forces in Czechia in the 19th and 20th centuries. *Land Use Policy*, 18, 1: 65–73. [doi:10.1016/S0264-8377\(00\)00047-8](https://doi.org/10.1016/S0264-8377(00)00047-8)
- Bolტიziar, M., Mojses, M., 2008: Mapping and analyse of present landscape structure of the dry polder Beša (in Slovak). In Špulerová, J., Hrnčiarová, T. (eds), *Ochrana a manažment poľnohospodárskej krajiny. Zborník príspevkov z vedeckej konferencie. ÚKE SAV, Bratislava*, p. 223–228.
- Cebecauerová, M., 2007: Analysis and assessment of changes of landscape structure (case study of selected part lowland Borská nížina and the mountains Malá Karpaty) (in Slovak). *Geographia Slovaca*, 24, 136 pp.
- Darolová, A., 2003: Birds. In Stanová, V., Šeffler, J. (eds), *Biodiversity of Abrod. State, changes and restauration. Daphne, Bratislava*, p. 253–262.
- Felix, V., Pipek, P., Soldát, M., 1978: Observation report about the migratory butterflies in Czechoslovakia in the years 1972–1974, 1975, 1976 (in Czech) *Zprávy ČSSE při ČSAV, Praha*, 14, p. 41–92.
- Feranec, J., Ořáhel, J., Cebecauer, T., 2004: Land cover changes – information source about landscape dynamics (in Slovak). *Geografický Časopis*, 56, 1: 33–47.

- Gavlas, V., Kalivoda, H., 2001: Ensifera, Caelifera, Mantodea and Lepidoptera on the sand dunes in Borská nížina lowland (southwestern Slovakia) (in Slovak). In Halada, L., Olah, B. (eds), Prehľad ekologického výskumu na Slovensku. SEKOS, Banská Štiavnica, p. 86–92.
- Holíubek, I., Jančovič, P., 2009: The using of cost – benefit methods for assesment of environmental (in Slovak). In Problémy ochrany a využívania krajiny – teórie, metódy a aplikácie. Zborník vedeckých prác. Biosféra, Nitra, p. 105–107.
- Hrubý, K., 1964: Prodromus of the Lepidoptera of Slovakia. (in Slovak) Vydavateľstvo SAV, Bratislava, 963 pp.
- Ivanová, Z., 2003: Methods for evaluation of ecological stability in the country's complex land consolidation projects (in Slovak). Acta Horticulturae. et Regiotecturae, 6, 2: p. 36–39.
- Izakovičová, Z., Moyzeová, M., 1999: Example assessment of the current landscape structure in the intensive agricultural landscape (in Slovak). In Izakovičová, Z. (ed.), Zmeny krajiny štruktúry v kontexte trvalo udržateľného rozvoja. Zborník zo seminára. ÚKE SAV, Nitra, p. 39–44.
- Kalivoda, H., Kalivodová, E., Ružičková, H., 2000: Anthropogenic impact on the wetland communities (plants and animals) of the floodplain of the Morava river. World Map of the State of the Environment. Proceedings of the workshop March 22–23 1999, Smolenice, Institute of Landscape Ecology SAS, Bratislava, p. 94–96.
- Kalivoda, H., Grendár, M., 2001: Influence of anthropological factors on diversity of grassland butterfly communities in the Morava river alluvium. Ekológia (Bratislava), 20, Suppl. 3: 217–225.
- Kalivoda, H., 2008: Hesperioidea and Papilionoidea of the Borská nížina lowland (in Slovak). Správy Slovenskej Zoologickej Spoločnosti, 26: 37–43.
- Kalivodová, E., Feriancová-Masárová, Z., Darolová, A., 1994: Birds of the floodplains area of the river Morava (March). Ekológia (Bratislava), 13, Suppl. 1: 189–199.
- Kalivodová, E., Feriancová-Masárová, Z., Darolová, A., Kürthy, A., 1996: Ornithological evaluation of the lower stream part of the alluvium of the river Morava (Slovak-Austrian frontier). Ekológia (Bratislava), 15, 2: 55–71.
- Kalivodová, E., Kürthy, A., 2001a: Birds of the Protected landscape area Záhorie. Ekológia (Bratislava), 20, Suppl. 4: 123–127.
- Kalivodová, E., Kürthy, A., 2001b: Birds of the coniferous forests of the Borská nížina lowland (in Slovak). Správy Slovenskej Zoologickej Spoločnosti, 18: 21–30.
- Kalivodová, E., et al. (Bedrna, Z., Bulanková, E., David, S., Ďugová, O., Fedor, P., Fenda, P., Gajdoš, P., Gavlas, V., Kalivoda, H., Kollár, J., Krištín, A., Kubiček, F., Kürthy, A., Lukáš, J., Magic, D., Olšovský, T., Pastorális, G., Svatoň, J., Szabóová, A., Šteffek, J., Štepanovičová, O., Zaliberová, M.), 2008: Fauna of blown sands (in Slovak). VEDA, vydavateľstvo Slovenskej akadémie vied, Bratislava, 255 pp.
- Kulfan, M., Kalivoda, H., 2003: Butterflies and burnets (Papilionoidea, Hesperioidea and Zygaenoidea). In Stanová, V., Šeffler, J. (eds), Biodiversity of Abrod. State, changes and restoration. Daphne, Bratislava, p. 243–252.
- Mišovičová, R., Pucherová, Z., 2008: The classification of Nitra's town contact area and selected villages in its hinterland. In The problems of landscape ecology, 11, 20: 299–305.
- Olah, B., 2009: Historical maps and their application in landscape ecological research. Ekológia (Bratislava), 26, 2: 143–151. [doi:10.4149/ekol\\_2009\\_02\\_143](https://doi.org/10.4149/ekol_2009_02_143)
- Olah, B., Boltižiar, M., 2009. Land use changes within the Slovak biosphere reserves zones. Ekológia (Bratislava), 28, 2: 127–151. [doi:10.4149/ekol\\_2009\\_02\\_127](https://doi.org/10.4149/ekol_2009_02_127)
- Ořáheľ, J., Feranec, J., Cebecauer, T., Pravda, J., Husár, K., 2004: The landscape structure of the district of Skalica: assessment of changes, diversity and stability (in Slovak). Geographia Slovaca, 12, 19: 123 pp.
- Petrovič, F., 2005: The development of the landscape in the area with dispersed settlement in Pohronský Inovec Mts. and Tribeč Mts. (in Slovak). ÚKE SAV, Nitra, 209 pp.
- Reiprich, A., Okáli, I., 1989: Addition to the Prodromus of Lepidoptera of the Slovakia (in Slovak). 3. zväzok. VEDA, vydavateľstvo SAV, Bratislava, 144 pp.
- Slamka, F., 2004: Die Tagfalter Mitteleuropas – östlicher Teil. František Slamka, 288 pp.
- Švestka, M., 1992: Present faunistic status of the *Lycaena dispar rutilus* W e r n e b u r g 1864 and *Thersamonia thersamon* E s p e r 1784 in the south Moravia (in Czech). Přírodovědný Sborník Západoomoravského Muzea v Třebíči, 17: 105–126.
- Voous, K.H., 1973: List of recent holarctic birds species. Non-passeriformes. Ibis, 115: 612–638.
- Voous, K.H., 1977: List of recent holarctic birds species. Passerines. Ibis, 119: 223–250, 376–406.
- Zuna-Kratky, T., Kalivodová, E., Kürthy, A., Horal, D., Horák, P., 2000: Die Vögel der March-Thaya-Auen im österreichisch-slowakisch-tschechischen Grenzraum. Distelverein, Deutsch Wagram, 285 pp.