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BUTTERFLIES FAUNA BIODIVERSITY IN THE POST-MINING LANDSCAPE

1. Introduction

Northwestern Bohemia countryside passed many changes in the last 100 years. Some of them were so radical that there occured complete destruction of vegetation. The original ecosystems in a large territory which is called the North Czech Coal Basin (NCCB) were totally destroyed. The predominant cause of radical change in the surface was surface mining of brown coal in the vicinity of towns Most, Litvinov, Sokolov, Chomutov and Kadan [13].

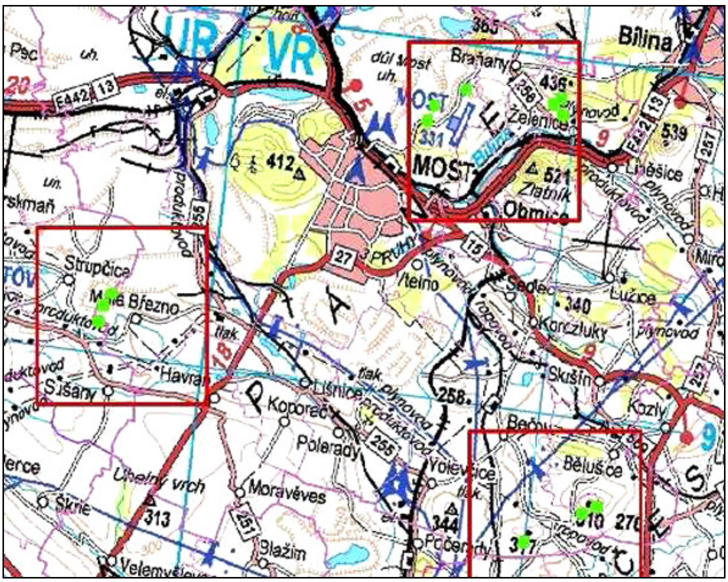

Fig. 1. Localities observed in NCCB area

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Area of Most is fulfilled with surface mines and dumps, which are related to the mining activity. There is also a great loss of land and mining affects in entire country. Mining had an impact on surrounding landscape since its beginnings. The development of mining (especially in the 20th century) has resulted in the landscape reshaping. It caused destroying of the original hydrological conditions and produced completely different situation [5]. Together with the landscape structure changing, there came also great changes in the composition of plant and animal communities. One of the significantly affected animal groups, which are in close contact with the soil, and especially with phytocenoses are diurnal butterflies (*Rhopalocera*). They are also very sensitive to changes in management of (agro) ecosystems. These are reasons why can be butterflies used as a good bioindicator of an actual countryside condition [4, 6]. Besides this bioindicative function, butterflies are also considered as so-called umbrella species. Due to their monitoring is possible to protect also other less conspicuous types of organisms.

A few miles east from the town Most, there concurs the Most Basin and the western part of Landscape protected area České středohoří (LPA). Territory of the LPA got great changes in local ecosystems during the 20th century as well as NCCB. In this case the reason of changes was not the extraction of raw materials, but a change in a landscape management because of a job opportunities decrease in rural areas (intensification of agriculture), job opportunities increase in cities (due to industrialization) and the subsequent outflow of population from rural areas to cities. Simultaneously with these phenomena came also progressive loss of livestock which was grazing the hills of the LPA. And the hills started to overgrow with shrubs. This processes changes the scenery and ecosystem functions, which are highly species-specific and diverse [1].

Because these two countries are contiguous and they are very close historically, we assume that their ecosystems would have to be close, too. If the strategy of development will be appropriate, these sites should enrich each other and help to the stabilization of ecosystems. Butterflies are very sensitive to environmental changes. They are able to draw attention to ecosystem issues earlier then for example vertebrates. This research is based on the mapping of the butterfly fauna in selected areas. The aim is to design an optimal management for biodiversity of butterflies as bioindicators and umbrella species.

2. Metodology

The data were collected at sites in the LPA České středohoří and in the North Czech Coal Basin (NCCB). There were selected four localities (three study plots for each of these) with different management and habitat types. Each habitat has an area of 100 × 100 m. Two sites are located LPA and the other two in NCCB.

We have selected localities with three different types of management in both areas — mesophilus meadow (with regular mowing and no management), xerophytus grassland and shrub habitats.

The research was conducted at twelve sites in total. 2 meadows in LPA (Milá, Kaňkov), 2 meadows on the dump (Malé Březno, Střimická), 2 × crops with small bushes in the LPA (Milá, Kaňkov), 2x crops with bushes on the dump (Malé Březno, Střimická), 2 plots with trees in the LPA (Milá, Kaňkov), 2 plots with trees at dumps (Malé Březno, Střimická) (Fig. 1).

Mesophilus grassland habitats (in the LPA) are once a year mowed for hay production and major part of xerofytic lawns are during the season at least partially grazed with sheep. Sheep grazing proceeds also on one of the sites with shrub vegetation on Kaňkov hill. In reclaimed areas of the NCCB, there were selected habitats as similar as possible to natural plant habitats in LPA. There was not found any reclaimed land with sheep or other livestock grazing. An important analogy may be grazing of hoofed game animals and disturbance caused by the presence of wild boars.

The research was based on a survey of butterflies in the selected areas. We are comparing the effects of different management on in total 12 study plots. Each of them is covering an area of one hectare with southern exposition and xeric plant communities. Each habitat was visited for four times during the season 2009 (from May to September). Visits were done always between 9 am and 5pm. We used "sightings per unit effort" method [11]. Each habitat was observed for 45 minutes by one person during every visit. In addition to information about diversity and abundance of butterflies there was observed nectar plants incidence and also local conditions as is exposition site, temperature, wind intensity and vegetation type. During the season 2009 there took a place four mapping visits of the butterfly fauna diversity and abundance at each study plot. Obtained data were analyzed using multivariate statistical data analysis during winter 2009–2010. From April to September 2010 there were due to inappropriate weather, made only two series of mapping visits.

The data were processed using Canonical correspondence analysis (CCA), which detected differences between numbers of butterfly species in different habitats. We used a split-plot design, with which the occurrence of butterflies was separately compared in different habitats during the visits. Habitats were loosely variable during the design proccess and time was fixed in the time series. To calculate these analyses, we used Canoco program package for Windows 4.5 (ter Braak & Šmilauer 2002) with 999 Monte Carlo permutations test.

3. Results

We confirmed the presence of butterflies 40 species at our selected study plots during the season 2009. In total 1618 individuals was determined, 781 (48%) was found at the reclaimed areas of the NCCB and 837 (52%) in sites at the LPA České středohoří. With these results we can say that there is not a big difference in the number of individuals at seminatural sites and at reclamations. This result is very positive for the reclamation practices used in the study area. However, we noticed the difference in the representation of individual species in these habitats. A higher number of species was found in the LPA (39) and lower (27) at dump reclamations.

The largest number of species was recorded for mesophilic meadows and also on the spontaneous succession plots (Tab. 1, Fig. 2). In the LPA there was also found more endangered species than on the reclaimed areas.

TABLE 1

Occurence, strategie and observed species threat during sesons 2009 and 2010

Latin species name	Strategy, threat				LPA localities		Dumploc localities	
	Mi	Li	E	CE	M	K	Mb	SV
Anthocharis cardamines		x				x		
Aphantopus hyperantus	x	x			x	x		x
Aporia crataegi	x		x		x	x		x
Araschnia levana		x			x			
Aricia agestis		x			x	x		
Boloria dia		x			x	x		x
Callophrys rubi		x			x	x		
Cupido minimus		x			x	x	X	x
Coenonympha arcania		x			x	x		x
Coenonympha pamphilus		x			x	x	X	x
Colias sp.					x	x	X	
Erebia medusa		x			x	x		x
Erynnis tages		x			x	x	X	x
Glaucopsyche alexis			x		x	x		x
Gonepterix rhamni		x			x	x		x
Inachis io		x			x	x	X	x
Iphiclides podalirius			x		x	x		
Issoria lathonia	x	x			x	x		
Maniola jurtina		x			x	x	X	x
Melanargia galathea		x			x	x	X	x
Leptidea reali		x			x	x		
Lycaena phleas		x				x	X	x
Pieris brassicae	x	x			x	x	X	x
Pieris napi		x			x	x	X	x
Pieris rapae		x			x	x	X	x
Plebejus sp.					x	x	X	x
Polyommatus amandus		x			x	x	X	x

Latin species name	Strategy, threat				LPA localities		Dumploc localities	
	Mi	Li	E	CE	M	K	Mb	SV
Polyommatus coridon	x	x			x	x		x
Polyommatus daphnis			x		x			
Polyommatus dorylas				x	x			
Polyommatus icarus		x			x	x	X	x
Pontia daplidice					x	x		x
Pyrgus malvae		x					X	
Satyrium acaciae			x		x	x		
Satyrium pruni		x			x			
Satyrium spini			x		x			
Spalia setorius			x		x	x		
Thymelicus sylvestris	x	x			x		X	
Vanessa atalanta	x	x			x		X	
Vanessa cardui	x	x			x	x	X	x

Legend:
M = Milá, K = Kaňkov, Mb = Malé Březno, SV = Střimická výsypka
Mi = Migrant; LI = Low Interest; E = Endangered; CE = Critically Endangered

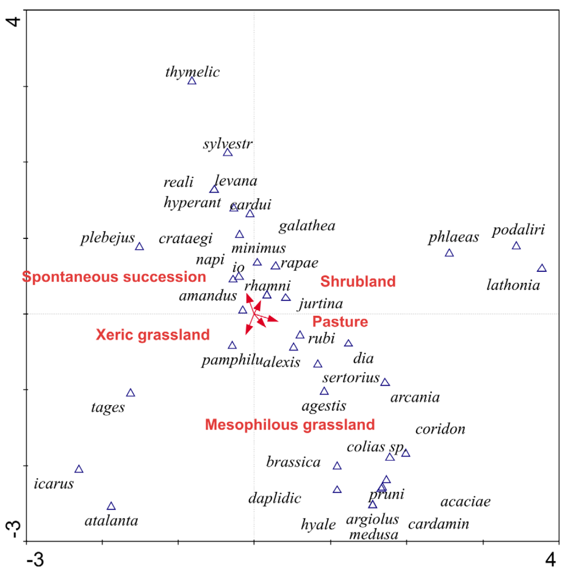

Fig. 2. Ordination plot showing butterflies biotop preferences in habitats with different management. Abbreviations are derived from butterfly species names

4. Discussion

There is currently proved a decline of butterflies in Europe [10, 19]. Butterflies preservation seems to be necessary, especially when one considers that one third of Czech butterflies is seriously endangered in Czech Republic. 18 species of these invertebrates living in this territory in the history has already died out [3]. Unlike other insects, butterflies are well documented, easily recognizable and popular with the public [14].

For butterflies, it is important to have sufficient food sources for caterpillars and adults. We need to focus on species diversity and representation of flowering plants in the habitat [8].

Localities should have a minimum size (which is different for each species) and should not be too far apart from each other to prevent populations from isolation. Only like that they will be able to function properly and maintain the necessary number of individuals and genetic diversity, which is necessary for theirs sustainable development [8]. Important is the proper landscape management that such localities don´t overgrow by vegetation, shrubs and trees [9].

We have to realize that today is not enough to maintain a traditional way of farming, such as is for example mowing grass in reserves. Because the entire landscape changed to the intensively cultivated fields and dense forests, there is a need to place everything that lived in past, in the surrounding countryside, into small areas. If we want to get the effect of previous complex agricultural management, we must include all types of farming systems in these small areas [12].

It was found that vegetation on technically reclaimed dumps develops differently than at localities retained to spontaneous succession. In the second case there was found significantly higher species diversity. In the oldest reclamation localities with spontaneous succession there was determined up to double number of species than on technically reclaimed sites [7].

Tropek and Konvička [16] showed that quarries can replace rare habitat xeric localities. Tropek et al. [17] showed that post-industrial habitats with spontaneous succession (without any technical reclamation) can host more vulnerable species than nearby national park.

Elevation on post-mined areas is changing fast between environmentalists and conservationists during last few years. Sensitive protection with help of spontaneous succession can alter such habitats into centers of biodiversity in the middle of anthropogenic regions. Active recovery of post-mining sites should be limited to maintain early successional stages, instead of accelerating succesion [17].

Mining activities do not jeopardize the occurrence of butterflies and can be a form of habitat creation. It should be possible to provide that (1) mining company officials will promote diversity of the habitats in quarries, (2) xeric sites in the area will be preserved and adequately maintained, and (3) will not be adversely affected any other phenomena important for the protection of habitats [2].

5. Acknowledgements

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