CHANGES IN MOLLUSC SPECIES COMPOSITION IN THE MINING LANDSCAPE ON THE EXEMPLE OF THE EXTINCT POND SYSTEM TERRITORY

ZMĚNY V DRUHOVÉM SLOŽENÍ MĚKKÝŠŮ V HORNICKÉ KRAJINĚ NA PŘÍKLADU ÚZEMÍ ZANIKLÉHO RYBNIČNÍHO SYSTÉMU

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Abstract

The development of the industry in last two centuries, and especially intensive coal mining activities definitely changed the local landscape character. It led to the destruction of indigenous biotopes with natural flora and fauna communities. Many ecological studies use a group of molluscs as indicators of changes in the landscape. The advantage of this group is a relatively small number of taxa, relatively simple determination and very good knowledge of ecological requirements and distribution of individual species. The territory of Loucké ponds represents an interesting area in the industrial landscape of Karvinsko, where based on the above aspects of malacocenosis, it is possible to use and compare historical data of their incidence as well as to compare the data with current research. The pond system affected by the declension has an important function in the landscape today. The first malacological researches in the Loucké ponds territory were conducted in 1954 and 1955 (Brabenec, 1954, Ložek, 1964). Detailed survey was conducted by Macha (1978, 1979) who found 29 aquatic species (12 Bivalvia and 17 Gastropoda) and 19 land species of molluscs. This research was followed by the authors' survey in 2006, 2007 and 2013 which confirmed the presence of 48 molluscs species altogether (42 Gastropoda and 6 Bivalvia), from which 21 species were aquatic molluscs and 27 species were land molluscs.

Abstrakt

Vývoj průmyslu v posledních dvou stoletích, především pak intenzivní těžba uhlí, definitivně změnil místní krajinný systém. To vedlo k destrukci původních biotopů s přirozenými společenstvy rostlin a živočichů. V mnoha ekologických studiích se jako indikátory změn v krajině používá skupina měkkýšů. Výhodou této skupiny je poměrně nízký počet taxonů, poměrně jednoduchá determinacene a velmi dobré znalosti ekologických nároků a rozšíření jednotlivých druhů. Území Loucký rybníků představuje zajímavou oblast v průmyslové krajině Karvinska, kde lze uvedených vlastností malakofauny využít a také srovnat historická data o jejich výskytu a srovnat je se současnými průzkumy. První malakologické výzkumy na Loucký rybnících byly provedeny v roce 1954 a 1955 (Brabenec, 1954, Ložek, 1964). Podrobný průzkum provedl Mácha (1978, 1979), který nalezl 29 druhů vodních (12 druhů mlžů a 17 druhů plžů) a 19 druhů suchozemských měkkýšů. Na tento výzkum, navazuje práce autorů v letech 2006, 2007 a 2013, která potvrdila přítomnost 48 druhů měkkýšů (42 Gastropoda, 6 Bivalvia), z toho 21 vodních druhů a 27 suchozemských druhů.

Key words: molluscs, vegetation, bioindication, mining landscape

1 INTRODUCTION

Karvinsko is one of the regions with the most disturbed environment in the Czech Republic. The development of the industry in last two centuries and especially intensive mining activities accompanied by the rise of anthropogenic forms of the relief definitely changed the local landscape character. It led to the destruction of indigenous biotopes.

Changes in these outstanding site conditions lead regularly to the species structure changes. There is a vegetation (the appearance of phytocoenosis, the dominance and the abundance of plant species), traditionally

used for the ecosystem characterization and their relevant changes. However, also the animal components are very important in an ecosystem. Many animals, thanks to their mobility or close ecological valence, react to the human erosion of the site conditions much faster than the vegetation.

Molluscs are applied in many ecological studies evaluating the environment quality and thus they can be used for evaluating changes in site conditions of selected landscape parts. Molluscs are an animal group explored in detail, with its advantage of a quite low number of taxa, relatively simple determination and especially very good knowledge of ecological requirements of the individual species and their distribution. Their sensitivity to environmental changes, low vagility and the presence of receptacle on their bodies make molluscs a very interesting group of bioindicators. The indication of biotope erosion can be very often performed just only on the basis of the presence and the absence of important bioindicator species.

2 HABITAT CONDITIONS OF TERRITORY

Geomorphologically the territory belongs to a geomorphological district Ostravská niva, which consists of quarternary fluvial sediments. The southern part of the territory belongs to Hornožukovská pahorkatina with flysh sandstones and claystones, teschenites and quarternary sediments. A consequence of deep mining is the deformation of the earth's surface (Demek et al, 1987).

Geologically the territory belongs to the Bohemian massif of the carboniferous age, which consists of bedrock of the whole Karviná district. There are significant quarternary sediments with a bad depth of up to 20 m (Weissmannová, 2004).

Soils are represented by fluvisols, pseudogleys, luvisols, and antroposols. There is the disruption of the natural soil mantle in many places caused by mining operations (Weissmannová, 2004).

Climate of the territory belongs to the climatic region MT 10 with slightly warm, dry winter with frequent inversions and long, slightly warm, dry summer (Quitt, 1971).

Hydrologically the territory belongs to the Olza partial basin and the Mlýnka stream flows through. There are ponds supplied by the Mlýnka stream as important hydrological and ecological elements (Kupka et Kašovská, 2011).

Vegetation of the territory belongs to the Ostrava basin area phytogeographical district with monotonous flora and prevailing oak – a beech vegetation zone (Skalický, 1988). The potential natural vegetation includes especially waterlogged oak – beech forests (association *Carici brizoides – Quercetum)* that are maintained insularly in the west Silesia only. There are alluvial bird – cherry – ash forests (association *Pruno Fraxinetu*m) and wetland alder woods (alliance *Alnion glutinoseae)* in river floodplains. Hhardwood floodplain forests are represented by elm – oak forests (association *Querco – Ulmetum)* (Neuhäuslová, 1998). There are saved lime - oak – hornbeam forests (association *Tilio – Carpinetum*) on slopes and also herb rich beech forests (suballiance *Eu – Fagenion*) and acidophilous beech forests (alliance *Luzulo – Fagion*).

The construction of ponds in 17th century led to an increase in diversity of habitats and plant species. New plant communities as reed swamps or tall sedges and communities of natural eutrophic and mesotrophic lentic water appeared in the landscape. Kantorek, Simanov (1982) show a rare communities occurrence as vegetation eutrophic and mesotrophic lentic water with *Utricularia sp.* (alliance *Utricularion vulgaris)* and vegetation of a water table with *Salvinia sp.* and *Spirodela sp.* (alliance *Salvinio – Spirodeletum*). These communities are not here today any more. Recent phytocoenosis of the territory are represented by reed beds and tall sedges of alliances *Phragmition australis, Phalaridion arundinaceae, Magnocaricion elatae*, and the vegetation of annual nitrophilous hygrophytes (alliance *Bidention tripartita).* Plant communities of mesotrophic and eutrophic water are represented by the alliance *Lemnion minoris*. Lentic water especially in shallow depressions is colonized by species from the alliance *Ranunculion aquatilis* or the alliance *Oenanthion aquaticeae.* We can find also wetland willow woods (alliance *Salicion cinereae*) and wetland alder woods (alliance *Alnion glutinoseae*).

Zoogeographically the territory belongs to a Polish province characterised by not very rich fauna and consequently geological and geomorphological conditions as well (Culek, 1995). However, aquatic animals are abundantly represented, which is used in this study.

In 1979, a research was conducted (Mácha, 1982) which proved there the occurrence of 48 species of molluscs (19 land species, 29 aquatic species). There were very prominent taxa between them, e.g. *Viviparus contectus, Aplexa hypnorum, Musculinum lacustre* and 9 species of genus *Pisidium*. This is why the Loucké ponds represent an interesting area in the Karvinsko industrial landscape where is possible to do the comparison with present conditions and to evaluate mining activity consequences on malacocenosis. The ponds system affected by the declension has its important function in the landscape today.

History of land use and fundamental habitats: There was the biggest development of fish-pond cultivation in Těšínsko in 16th century. At that time, the Loucké ponds were established in the alluvial plain of the Olza River. In spite of the industry development as well as the urbanization (e.g. in 1781 a railway was built

near the pond), this area saved the pure nature character. Because of that, the Loucké ponds were proclaimed the State Nature Reserve (SPR) (in the land register of the Louky nad Olší community, on the area of 32, 98 ha in 1970). The reserve consisted of a flood-plain forest and the system of 15 ponds in the alluvial plain of the Olza River. As a result of the area devastation (caused by mining activities), the reserve was vitiated in 1987.

2 MATERIAL AND METHODS

Watter molluscs were acquired by metal sieve (washing submerged vegetation and sediment). When emerging, the found species including the empty receptacles were (if necessary) taken away and determined under the binocular magnifying glass. Collecting the aquatic molluscs was completed by collecting land mollusc species. The land molluscs were collected by hand.

Ecological classification: 1: strictly forest species (SI), 2: predominantly forest species (SIMS – mesophilic, Sith – shrubwood) , 3: species of alluvial and wetland forests (Sih), 5: silvifobic species, species of open areas (PT – transitional), 7: mesohygrophilous and mostly euryecious species (MS - mesicolae), 8: species with high moisture demands, but not confined to wetlands (HG - hydricolae), 9: species with high moisture demands which confined to wetlands (PD - paludicolae), 10: aquatic species (PD, PDt – periodic wetlands, RV – rivicolae, SG stagnicolae, SG(RV), SG-PD, SG-PDt, SG-RV, SGRV- transitional biotopes).

Exposure to danger: NE – Not Evaluated, NT – Near Threatened, LC – Least Concern, VU – Vulnerable, EN – Endangered.

Categories of the relative strength populations: VO – very sporadic occurrence, O – sporadic occurrence, R – scattered occurrence, H – plentiful occurrence, VH – very plentiful occurrence. Results of collecting in 1954 – 1955 and 1979: + (presence), ~ (absence).

3 RESULTS

In the territory of the previous SPR of the Loucké ponds, during the research period (June and October 2006, March 2007 and May 2013), 48 molluscs species altogether were found (42 Gastropoda and 6 Bivalvia), from which 21 species were aquatic molluscs and 27 species were land molluscs. The summary of all the founded species, including the ecological division and exposure to danger is stated in Tab. 1.

Tab.1: List of species found in the Loucké ponds, the last natural reserve, their ecological classification (according to Ložek 1964 and Lisický 1991, adapted), conservation status (Beran et al., 2005), and relative abundance.

Ecological classification		Species	Exposure to danger	1954	1955	1979	2006	2007	2013
1.	SI	*Daudebardia brevipes* (Draparnaud, 1805)	EN	~	~	+	~	~	~
		Daudebardia rufa (Draparnaud, 1805)	NT	~	~	~	~	~	O
2.	SI (MS)	*Fruticicola fruticum* (O. F. Müller, 1774)	LC	~	~	~	H	H	H
		Arion subfuscus (Draparnaud, 1805)	LC	~	~	+	O	O	O
		Alinda biplicata (Montagu, 1803)	LC	~	~	+	H	H	R
		Monachoides incarnatus (O. F. Müller, 1774)	LC	~	+	+	VH	VH	VH
	Sith	*Helix pomatia* (Linnaeus, 1758)	LC	~	~	+	H	H	H
3.	Sih	*Deroceras precox* (Wiktor, 1966)	NT	~	~	~	~	O	O
5.	PT	*Vallonia pulchella* (O. F. Müller, 1774)	LC	~	~	~	O	O	O
7.	MS	*Euconulus fulvus* (O. F. Müller, 1774)	LC	~	~	+	~	~	~
		Boetgerilla pallens (Simroth, 1912)	LC	~	~	+	~	~	O
		Deroceras reticulatum (O. F. Müller, 1774)	LC	~	~	+	~	~	R
		Plicuteria lubomirskii (Slósarskii, 1881)	LC	~	~	+	O	O	~
		Trochulus hispidus (Linnaeus, 1758)	LC	~	~	~	VH	VH	VH
		Oxychillus celarius (O. F. Müller, 1774)	LC	~	~	+	~	O	R
		Oxychilus draparnaudi (Beck, 1837)	LC	~	~	~	~	~	O
		Vitrina pelucida (O. F. Müller, 1774)	LC	~	+	~	~	O	O
		Cochlicopa lubrica (O. F. Müller, 1774)	LC	~	+	+	H	H	R
		Arion distinctus (Mabille, 1868)	LC	~	~	+	~	R	R
		Arion vulgaris (Moquin-Tandon, 1855)	LC	~	~	~	~	~	H
		Perpolita hammonis (Ström, 1765)	LC	~	+	+	~	O	R
		Punctum pygmaeum (Draparnaud, 1801)	LC	~	~	~	~	O	R
8.	HG	*Succinella oblonga* (Draparnaud, 1801)	LC	~	+	~	~	~	~
		Deroceras laeve (O. F. Müller, 1774)	LC	~	~	+	~	~	R
		Perpolita petronella (L. Pfeiffer, 1853)	EN	~	~	+	~	~	~
		Carychium tridentatum (Risso, 1826)	LC	~	~	~	O	O	R
Ecological classification		Species	Exposure to danger	1954	1955	1979	2006	2007	2013
9.	PD	*Carychium minimum* (O. F. Müller, 1774)	LC	~	+	+	~	R	H
		Euconulus praticola (Reinhardt, 1883)	VU	~	~	~	~	R	R
		Oxyloma elegans (Risso, 1826)	NT	~	+	+	VH	H	H
		Zonitoides nitidus (O. F. Müller, 1774)	LC	~	+	+	VH	VH	VH
		Succinea putris (Linnaeus, 1758)	LC	+	+	+	H	H	VH
10.		*Radix ampla* (Hartmann, 1821)	NT	~	~	+	~	~	~
	PD	*Segmentina nitida* (O. F. Müller, 1774)	VU	+	+	+	~	~	~
		Musculinum lacustre (O. F. Müller, 1774)	NT	+	+	+	O	O	O
	PDt	*Aplexa hypnorum* (Linnaeus, 1758)	NT	~	+	+	R	H	R
		Anisus leucostoma (Millet, 1813)	LC	+	+	+	O	O	O
		Pisidium obtusale (Lamarck, 1818)	NT	~	+	+	~	O	~
	RV	*Pisidium amnicum* (O. F. Müller, 1774)	EN	~	+	+	~	~	~
	RV(SG)	*Anodonta anatina* (Linnaeus, 1758)	LC	~	~	~	VH	VH	VH
		Anodonta cygnea (Linnaeus, 1758)	VU	~	~	+	~	~	~
		Pisidium henslowanum (Sheppard, 1823)	LC	+	+	+	~	~	~
	RV-PDt	*Pisidium nitidum* (Jenyns, 1832)	LC	~	~	+	~	~	~
		Pisidium casertanum (Poli, 1791)	LC	~	~	+	~	~	R
	SG	*Pisidium personatum* (Malm, 1855)	LC	~	~	+	~	~	R
		Acroloxus lacustris (Linnaeus, 1758)	LC	+	+	+	~	~	O
		Ferrissia clessiniana (Jickeli, 1882)	NE	~	~	~	~	~	O
		Stagnicola corvus (Gmelin, 1791)	LC	+	~	+	O	O	O
		Radix auricularia (Linnaeus, 1758)	LC	+	~	+	O	O	O
		Lymnea stagnalis (Linnaeus, 1758)	LC	+	+	+	VH	VH	H
		Physa fontinalis (Linnaeus, 1758)	NT	~	+	+	~	~	~
		Gyraulus albus (O. F. Müller, 1774)	LC	+	+	+	O	O	R
		Gyraulus crista (Linnaeus, 1758)	LC	~	+	+	~	O	O
		Hippeutis complanatus (Linnaeus, 1758	LC	+	+	+	R	R	R
		Planorbarius corneus (Linnaeus, 1758)	LC	+	+	+	VH	VH	VH
		Pisidium hibernicum (Westerlund, 1894)	EN	+	+	+	~	~	~
	SG(RV)	*Sphaerium corneum* (Linnaeus, 1758)	LC	~	+	+	O	O	VO
	SG-PD	*Viviparus contectus* (Millet, 1813)	NT	~	+	+	~	~	~
		Anisus vortex (Linnaeus, 1758)	LC	+	+	+	VH	H	H
	SG-PD(-t)	*Galba truncatula* (O. F. Müller, 1774)	LC	+	~	+	~	~	R
	SG-RV	*Pisidium milium* (Held, 1836)	VU	~	~	+	~	~	~
		Pisidium substruncatum (Malm, 1855)	LC	+	+	+	H	H	R
	SGRV	*Radix peregra* (O. F. Müller, 1774)	LC	+	~	+	H	H	H
		Physella acuta (Draparnaud, 1805)	NE	~	~	~	VH	VH	VH

From the species of aquatic molluscs, common representatives such as *Anisus vortex*, *Gyraulus albus*, *Hippeutis complanatus*, *Lymnaea stagnalis*, *Musculinum lacustre*, *Planorbis planorbis* were mostly found. According to the exposure to danger of particular species (Beran et al., 2005), the occurrence of only 3 aquatic molluscs from the category Near Threatened: *Aplexa hypnorum*, *Pisidium obtusale* and *Musculinum lacustre* was found.

In terms of the use of molluscs as indicators of change in the mining landscape, we can consider the alliances *Phragmition australis*, *Phalaridion arundinaceae*, *Lemnion minoris*, *Ranunculion aquatilis*, *Oenanthion aquaticeae*, possibly *Bidention tripartita* as fundamental habitats. Phytocoenosis of these habitats consist of submersed and emersed forms of plants with a frequent occurrence of the observed mollusc species. From this perspective, among the most important plants especially Common cattail (*Typha latifolia*), Canebrake (*Phragmites communis*), Reed canary grass (*Phallaris arundinacea*), Canadian pondweed (*Elodea canadensis*), Flowering rush (*Butomus umbellatus*), and Arrowhead (*Sagittaria sagittifolia*) can be included.

4 CONCLUSIONS

Biotopes vitiated by the previous State Nature Reservation (SPR) Loucké ponds are mostly influenced by an extensive declension. This proved, among others, also in the malacofauna composition, especially in a decrease of sensitive species.

The first malacological research in the Loucké ponds territory was conducted by Brabenec (1954) and Ložek in 1955 (Ložek, 1964). At that time, there was found 32 species of molluscs, 9 of them were land species and 23 were aquatic species. This research was focused on aquatic species of molluscs. Later in 1978-1979, Mácha dealt with the locality. This research described the situation of the Loucké ponds malacofauna before its cancellation and destruction at 17 localities, 13 of which were various character stretches of water (watercourse and stationary ditchwater). This research was unambiguously focused on aquatic species of molluscs. Mácha found the occurrence of 19 land species and 27 aquatic species (12 Bivalvia and 15 Gastropoda). We can expect that the difference between the previous researches and collections and Mácha research (24 years later) is caused by a more detailed research performed mainly due to selecting a wider territory.

The present malacozoological research proved an expressive decrease of all mollusc species. Except some usual species, the recent research has not proved the occurrence of this sensitive molluscs species yet: *Daudebardia brevipes*, *Perpolita petronela*, *Viviparus contectus*, *Physa fontinalis*, *P. henslowanum*, *P. hibernicum*, *P. amnicum*, *P. milium* and *P. nitidum*. These species are mostly aquatic species, which are quite exacting on water cleanness and which are very sensitive to negative interferences to biotopes. All previously found species of molluscs from the category endangered (4 species) probably died out there (*Daudebardia brevipes*, *Perpolita petronella*, *Pisidium amnicum*, *Pisidium hibernicum*). On the contrary, following from the results that in the investigated territory, the species took root very well, which live in human-influenced and changed areas, and species with a wide ecological valence, such as *Helix pomatia* or *Fruticicola fruticum*, and the introduced species (*Physella acuta* and *Ferrissia clessiniana*). From rare species of molluscs, there lives a quite strong population of *Alexa hypnorum* in the territory which inhabits exclusively periodic pools and wet grounds, and *Pisidium obtusale*, inhabiting minute ditchwaters. On the contrary, there were new species, imported.

In conclusion we can say that mollusc fauna in the Loucké ponds is the consequence of the destruction of previous site conditions considerably impoverished. Despite of all the extreme load of environment, there lives an interesting and also rich guild of molluscs (42 Gastropoda and 6 Bivalvia) in the area.

The research results suggest the influence of changes in ecosystems caused by mining activities on molluscs, along with other current research that will be used in the characterization of the mollusc mining landscape. A comparison of the results, especially with the results by Macha will offer us interesting information about the development and changes in the character of the landscape in the last 50 years.

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RESUMÉ

Karvinsko patří k regionům s nejvíce poškozeným životním prostředím v ČR, zejména v důsledku hornické a hutnické činnosti. Vážným důsledkem hornické činnosti je především destrukce původního reliéfu a jeho náhrada antropogenními tvary. S tím úzce souvisí i zásadní změna ekologických podmínek a narušení původních ekosystémů a společenstev, které je osidlují.

Ekologické podmínky a jejich změny jsou charakterizovány jednak vegetací (výskyt společenstev, početnost druhů a jejich dominance, druhová pestrost), avšak velmi důležitá je rovněž živočišná složka ekosystému. Mnoho živočichů reaguje na změny v ekosystému rychleji než rostliny díky své pohyblivosti a nižší schopnosti tolerance. Jako významný bioindikátor je z tohoto důvodu používána skupina měkkýšů, kteří se vyznačují vysokou senzitivitou ke změnám a nízkou vagilitou.

Jako modelové území byl zvolen systém Loucký rybníků – bývalé státní přírodní rezervace, která je od 70. let 20. století silně narušena poddolováním. Sběry měkkýšů byly provedeny v červnu a říjnu 2006 a březnu 2007 a v květnu 2013. Pozornost byla věnována zejména vodním druhům, zemní druhy byly determinovány jako doplňkové. Druhové spektrum bylo srovnáno s nálezy z let 1954, 1955 a 1979 a rovněž byla sledována vazba na základní biotopy, rostlinná společenstva a konkrétní rostlinné druhy.

Na daném území bylo nalezeno celkem 48 druhů měkkýšů (42 plžů, 6 mlžů). Mezi vodní měkkýše náleží 21 druhů, 27 druhů bylo suchozemských. Seznam všech druhů včetně jejich zařazení do ekologické skupiny a stupně ohrožení (dle Beran et al., 2005) je uveden v tab. 1. Z druhů vodních měkkýšů, které byly v území nejčastěji nalezeny, uvádíme např. *Anisus vortex*, *Gyraulus albus*, *Hippeutis complanatus*, *Lymnaea stagnalis*, *Musculinum lacustre*, *Planorbis planorbis*. Z hlediska ohrožení byly nalezeny 3 druhy z kategorie téměř ohrožený (NT): *Aplexa hypnorum*, *Pisidium obtusale* a *Musculinum lacustre*.