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Short communication

Effect of different restoration approaches on two species of newts (Amphibia: Caudata) in Central European lignite spoil heaps

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ABSTRACT

Post-mining sites often offer secondary habitats for various amphibians endangered in common agricultural landscapes. On the other hand, there is a general lack of quantitative studies on the effects of the common restoration practices on colonisation of such artificial freshwater habitats by amphibians. Here, we focus on two newts decreasing in Central Europe, *Lissotriton vulgaris* and *Triturus cristatus*, in pools within lignite (brown coal) spoil heaps in the western Czech Republic. We compared their abundances in pools established by technical reclamation, spontaneous succession, and their combination. In spring 2016, we sampled 29 freshwater pools in five spoil heaps and 10 fishponds in the surrounding agricultural landscape by funnel trapping. We captured 52 *L. vulgaris* and 138 *T. cristatus* in all the studied habitats together. As only two *L. vulgaris* and no *T. cristatus* were caught in fishponds, the high potential of pools in post-mining landscapes was confirmed. Both newt species generally avoided the artificially established pools, but the spontaneously established pools were equally suitable for them in both technically reclaimed and spontaneously developed heaps. *L. vulgaris* preferred more transparent water, higher cover of cattails and the pool placed in the forest, but with fewer trees on the pool banks, whilst *T. cristatus preferred narrower zone of littoral vegetation*, more trees on the pool banks, smaller water bodies and absence of fish. Such habitat preferences fully corroborate with natural habitats. The technical reclamation still prevails in restoration of post-mining sites in many regions. We reveal it is an unsuitable practice for amphibians, if not combined with natural succession processes.

1. Introduction

Various post-mining sites are known to serve as important refuges for numerous freshwater organisms (e.g., Harabiš and Dolný, 2015; Harabiš, 2016; Harabiš et al., 2013; Lewin et al., 2015; Michalik-Kucharz, 2008; Tichanek and Tropek, 2015, 2016), including amphibians (Lannoo et al., 2009; Vojar et al., 2016; Zavadil et al., 2011). Typically, they offer numerous pools of various sizes often characterized by a relatively very low level of eutrophication, which is one of the main causes of the standing freshwater biodiversity decrease in Europe, including amphibians (Zavadil et al., 2011).

The potential of such post-mining sites for biodiversity conservation strongly depends on the applied restoration approach. In Central Europe (Harabiš et al., 2013; Tropek et al., 2010), as well as in many other regions (Prach and Hobbs, 2008), the most common restoration practice is still represented by technical reclamation (i.e. remodelling of the surface by heavy machineries, its covering with fertile topsoils, and final planting of tree monocultures or sowing of species-poor productive grasslands; Prach and Hobbs, 2008; Tropek et al., 2010) and spontaneous succession. Although numerous comparative studies showed that spontaneous succession is much more effective for conservation of the terrestrial biodiversity of post-mining sites' biodiversity than costly technical reclamation (e.g. Prach and Hobbs, 2008; Šebelíková and Řehounková, 2016; Tropek et al., 2010), such knowledge on freshwater habitats is very limited, especially for amphibians. Moreover, a few existing detailed studies of dragonfly communities in lignite spoil heaps (Harabiš et al., 2013; Harabiš and Dolný, 2015; Tichanek and Tropek, 2015, 2016) have revealed that technically reclaimed freshwaters can harbour communities of a high conservation value as well. The situation of the freshwater habitats restoration thus

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seems to be more complicated, and more studies are still urgently needed for any effective restoration planning.

Here we present the first quantitative study on how the restoration approaches influence newts in any post-mining sites. Together with data on *Rana dalmatina* (Vojar et al., 2016), these are the only quantitative studies of amphibians under the target restoration approaches whatsoever. Although both studied newt species partly differ in their preferred microhabitat conditions, they both need rather smaller freshwater oligotrophic pools with sparse vegetation and without fish (Zavadil et al., 2011). *Lissotriton vulgaris* (Linnaeus, 1758) is a relatively common species of lower and middle elevations. Nevertheless, the recent decrease of its populations in Central Europe, especially in agricultural landscapes, has been described (Zavadil et al., 2011). *Triturus cristatus* (Laurenti, 1768) is much rarer and still decreasing in Central Europe (Zavadil et al., 2011). In Czechia, they are considered as nearly threatened and endangered, respectively, because of continuous destruction to their breeding habitats related mainly to water eutrophication, successional overgrowing followed by desiccation (terrestrification) of smaller water bodies, and intensification of fishpond management in the past decades (Zavadil et al., 2011). Both of them are protected by Czech legislation; *T. cristatus* is also included in the Annex II of the European Habitat Directive (i.e. "Natura 2000"). Although breeding or presence of both species in various post-mining and some other man-made sites has been documented repeatedly (e.g., Vojar et al., 2016; Zavadil et al., 2011), any knowledge on how they are influenced by restoration practices is very limited. The only existing study (Vojar et al., 2016), focussing on the effects of the two main restoration approaches on amphibians, does not include any abundance data on newts, which weakens its results. Moreover, its authors applied an oversimplified classification of restoration practices which could cause partly misleading interpretations (as we will discuss later).

In this study, we focus on abundances of the two newt species (as the only two amphibians in the study area effectively detectable by funnel-trapping) in freshwater pools in lignite spoil heaps formed by technical reclamation, spontaneous succession, and their combination. Abundances of both species in post-mining freshwater pools are also compared with fishponds in the adjoining landscape to assess the relative importance of the studied disturbed sites for them. Subsequently, we analysed also environmental characteristics of the pools preferred by the two newt species. Using a robust quantitative and standardised approach offers better generalisation of our results, important for the planning of effective post-mining landscapes restoration.

2. Methods

Our study was performed in the North Bohemian lignite basin, western Czechia, a lowland area historically covered by deciduous forests supplemented by relatively common open fens. Since the 19th century the basin has been substantially influenced by opencast lignite mining, resulting in more than 100 km^2 of large opencast mines and 150 km^2 of spoil heaps of presumably tertiary clays (Prach et al., 2011). More detailed information on the study area can be found in Hendrychová and Kabrna (2016). As a consequence of long-term intensive agriculture and industry, (semi)natural freshwater habitats are almost missing in the region; the most common small and middle-sized freshwater bodies in the whole area are represented by intensive fishponds in the common landscape and pools in (post)mining areas.

Amphibians were sampled in 29 freshwater pools in five lignite spoil heaps (Table 1) from 15 to 21 May 2016. From the seven amphibian species known from the studied spoil heaps (Vojar et al., 2016) only the two newt species entered our funnel traps.

Table 1
Summary of studied pools in the individual spoil heaps according to the applied restoration approach.

Spoil heap	GPS position	Habitat type	Studied pools	Range of habitat characteristics						*L. vulgaris* mean abundance	*T. cristatus* mean abundance
				Surface (m^2)	Littoral vegetation (m)	Banks inclination (%)	Fish[a]	pH	Water transparency (cm)		
Hornojiřetínská	N 50.5775°, E 13.5817°	*Spontaneous*	4	425–1476	0.5–21	0–70	2	8.5–8.7	30–50	0.0	12.0
Kopistská	N 50.5410°, E 13.6061°	*Semi-spontaneous*	3	446–4563	0.5–2	40–90	2	8.6–8.7	25–35	0.0	23.3
		Semi-spontaneous	2	1608–3446	2–3	10–40	1	8.8–8.9	40	3.0	4.0
Radovesická	N 50.5429°, E 13.8220°	*Spontaneous*	6	558–8432	0.5–2.5	0–90	0	8.5–9.1	30–52	1.5	0.8
Růžodolská	N 50.5822°, E 13.6227°	*Semi-spontaneous*	4	1229–4599	1–3	20–60	3	8.9–9	20–48	0.3	0.0
		Artificial	5	1186–32306	1.5–5	0–90	4	8.3–8.8	20–45	3.4	0.0
		Semi-spontaneous	2	501–3678	1.5–2	20–70	0	8.4–8.7	25–50	3.5	3.5
Velebudická	N 50.4908°, E 13.6088°	*Artificial*	1	777	0.5	80	1	8.3	22	0.0	0.0
		Artificial	2	7854–12965	1–3	50–60	2	8.6–8.9	40–45	0.0	0.0
Fishponds	–	*Fishponds*	10	1320–115304	0.1–3	0–90	10	8.6–9.4	8–45	1.2	0.0

[a] Number of pools with fish.