

# From arable land to species-rich semi-natural grasslands: Succession in abandoned fields in a dry region of central Europe



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## ABSTRACT

The area of arable land has decreased considerably in Europe over the last decades. Abandoned fields are potential habitats for restoration of species-rich grasslands of high conservation value, but in specific cases it is unclear whether this can be achieved by spontaneous succession or intervention is needed. In dry areas of eastern-central Europe, spontaneous succession of species-rich steppe grasslands was observed on some abandoned fields located close to ancient grasslands. We studied spontaneous succession on ex-arable land in the warm and dry area of the SE Czech Republic using space-for-time substitution. Vegetation was sampled in 175 plots, for which the time since the abandonment (4–71 years) was determined from historical aerial photographs. All plots were close to ancient dry grasslands. Annual weeds were replaced by perennial species in less than four years after abandonment. Perennial grassland was stable over seven decades, but its species composition changed: native dry-grassland species, including Red-List species, gradually increased, and so did the total number of vascular plants, reaching on average of 30–40 species per 16 m<sup>2</sup> after 40 years. Archaeophytes, including common ruderal species, decreased, while neophytes were insignificant throughout the succession. Scattered shrubs appeared at later stages, but their spread was limited by drought and recently also by nature conservation management. This study suggests that spontaneous succession can be inexpensive yet effective means of dry grassland restoration in dry areas of eastern and central Europe if sources of target species are available in nearby remnants of ancient grasslands.

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## 1. Introduction

Large-scale abandonment of less fertile arable land has been occurring in Europe since the mid-20th century and this trend is expected to continue in the future (Rounsevell et al., 2006). As a result, abandoned fields are widespread in the current European landscape and many of them have potential to become valuable habitats of wild flora and fauna (Tscharntke et al., 2011).

Abandoned fields are classical objects of fundamental research on ecological succession (Buell et al., 1971; Bazzaz, 1975; Inouye et al., 1987; Cramer and Hobbs, 2007; Cramer et al., 2008; Meiners et al., 2008). Studies from temperate regions have demonstrated that in most cases succession on abandoned fields follows a general scheme typical of secondary succession seres: in the initial successional stages vegetation is dominated by annual plants,

then broad-leaved forbs and grasses follow, and shrubs and trees arrive at the end (Glenn-Lewin et al., 1992; Meiners et al., 2008; Prach et al., 2014).

In the last two decades, there has been an increased interest in spontaneous secondary succession as an inexpensive but often very efficient means of ecological restoration (Prach et al., 2001a; Perrow and Davy, 2002; Prach and Walker, 2011). A common restoration target on European ex-arable land is a species-rich semi-natural grassland, a habitat of high conservation value (Veen et al., 2009) which is under legal protection in the European Union (European Commission, 2013). Semi-natural grasslands in eastern-central Europe have been identified as plant communities with the globally highest species richness in plots smaller than 100 m<sup>2</sup> (Kull and Zobel, 1991; Dengler et al., 2012; Merunková et al., 2012; Wilson et al., 2012; Michalcová et al., 2014; Roleček et al., 2014) and many of them are important refugia or rare species (Veen et al., 2009; Hájková et al., 2011). However, there was a drastic decline in their extent over the 20th century, partly due to conversion to arable land, partly due to agricultural intensification of grassland management or abandonment (Poschlod and Bonn, 1998). Recently, arable fields are changing back to the grasslands, but grasslands on ex-arable land rarely harbor

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plant and animal diversity typical of the ancient grasslands, even after many decades (Redhead et al., 2014).

There are two important issues related to restoration of semi-natural grasslands through spontaneous succession. Firstly, it is unclear whether at particular sites spontaneous succession alone can be used to restore habitats of high conservation value or an intervention such as seeding is needed (Pywell et al., 2002; Prach and Hobbs, 2008; Török et al., 2011; Tschardt et al., 2011). Many grassland plants have short lived seed-banks (Fagan et al., 2008) and are dispersal-limited even at distances shorter than 500 m (Novák and Konvička, 2006; Knappová et al., 2012). Therefore re-establishment of semi-natural grasslands on ex-arable land often involves mainly widespread generalist species even at sites close to ancient grasslands (Hutchings and Booth, 1996; Molnár and Botta-Dukát, 1998; Redhead et al., 2014). Generally, spontaneous succession tends to fail in habitats which are either strongly stressed or very productive, while it is often successful in the intermediate section of the productivity-stress gradient (Prach and Hobbs, 2008). There are several examples of successful restoration of semi-natural grasslands on ex-arable land especially from drier areas in eastern-central Europe where ancient semi-natural grasslands are still preserved, e.g., in Saxony-Anhalt (Germany; Stadler et al., 2007), Central

Bohemia (Czech Republic; Osbornová et al., 1990; Jírová et al., 2012), Carpathian flysch zone (Czech Republic; Jongepierová et al., 2004); Hungarian sandy areas (Csecserits and Rédei, 2001; Csecserits et al., 2011; Albert et al., 2014) or the Transylvanian Lowland (Romania; Ruprecht, 2005, 2006).

Secondly, succession on ex-arable land can be fast, with only a transient phase of grassland which is quickly overgrown by shrubs and forest. Most successional seres in central Europe lead to woodland, which may establish after ca. 20 years (Prach et al., 2014). However, there are considerable differences in the rate of succession depending on site moisture. On dry abandoned fields in Central Bohemia, under ca. 550 mm of annual precipitation, dry grasslands with scattered shrubs establish after ca. 20 years and remain stable for several decades, whereas on mesic fields, shrubs establish in ca. 15 years and the succession continues toward forests (Osbornová et al., 1990). In more precipitation-rich areas of central Europe, fast succession toward forest is common, especially if the successional sites are close to forest and exposed to propagule pressure of forest species (Barabasz-Krasny, 2005; Dölle et al., 2008; Prach et al., 2014).

Here we focus on spontaneous succession on abandoned fields in the dry area of the south-eastern Czech Republic (South

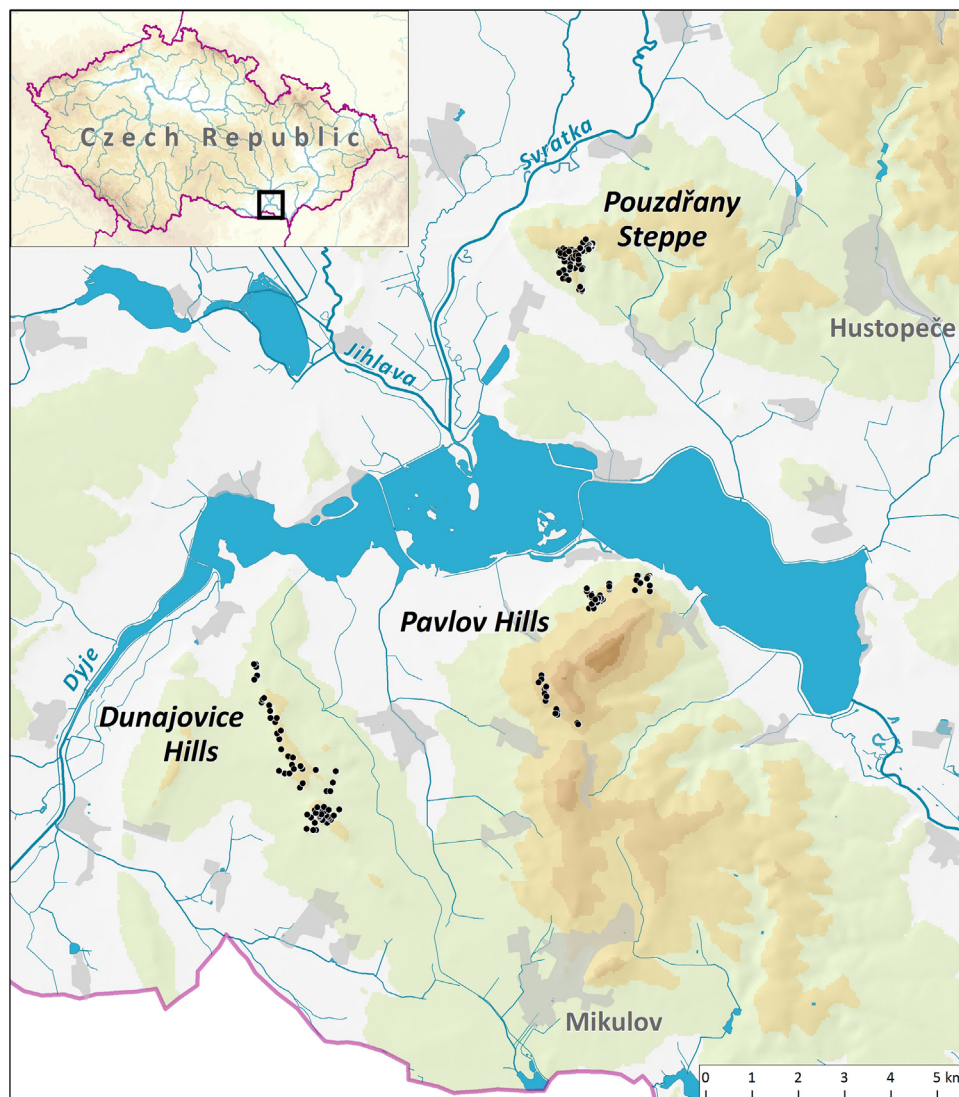


Fig. 1. Three study sites in South Moravia, Czech Republic.

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