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Small natural features with large ecological roles in ancient agricultural landscapes of Central Europe - history, value, status, and conservation

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ABSTRACT

Throughout history traditional land uses have created small natural features (SNFs) that can serve as biodiversity hotspots or remnants in agricultural landscapes that may otherwise support little biodiversity. SNFs in these landscapes include field and pasture margins, forest fringes, hedges, hollow ways (sunken lanes), stone walls, sand and gravel pits, and quarries. Many of these SNFs were established thousands of years ago as humans began to establish agricultural practices in Europe and other parts of the world. In some cases, these SNFs are old enough to have allowed unique ecological communities to develop or even new species to evolve. The consolidation of lands and intensification of agriculture and mining practices, however, have eradicated many of these SNFs; this decline started in the 19th century and has accelerated in recent years. Conservation practices that aim to maintain these anthropogenic SNFs are increasing, largely due to the growing recognition of their conservation value. New government initiatives, agro-environmental schemes, and greenways and ecosystem networks are being implemented with some success. These efforts, however, are far from perfect; much more work on management, restoration, and re-creation of anthropogenic SNFs is required to ensure that they persist and continue to support biodiversity in highly modified landscapes.

1. Introduction

Throughout history, conventional farming, mining, and other traditional land uses have created small natural features (SNFs) that can serve as biodiversity hotspots or remnants in agricultural or other anthropogenic landscapes that may otherwise support little biodiversity. These features can include arable field (Ruthsatz and Otte, 1987) and pasture margins (Husicka and Vogel, 1999), forest fringes (Dierschke, 1974; Ruthsatz, 1984), hedges and their fringes (Schmelz, 2001) or single trees (Blab, 1993), hollow ways (sunken lanes), stone walls in vineyards and fields (Linck, 1954), ditches (Weiss et al., 1992; Remy, 1998), road and railroad embankments, dykes (Schwab, 1994; Stottele, 1995), artificial ponds (Konold, 1987; Poschlod, 2016; Philippi, 1969), and sand and gravel pits and quarries (Dingethal et al., 1998; Poschlod, 1997). Often these features were created unintentionally, resulting in semi-natural vegetation left along borders between fields or along country roads or intentionally established as hedges to protect fields against wind or soil erosion. SNFs can have widths of only a few meters (e.g., pasture margins) or can occupy many hectares (e.g., pits and quarries or ponds). Although they are of anthropogenic origin these features are still considered SNF examples as they were created by humans using natural elements and emulate true natural features (Hunter, 2017–in this issue). Despite their small size, these SNFs often provide the only oases of semi-natural vegetation or specific ecosystem services in otherwise degraded landscapes and therefore, have an ecological impact that is disproportionate to their size, analogous to the concept of keystone species (Hunter, 2017–in this issue). For example, abandoned pits and quarries provide surprisingly important aquatic and rocky habitat for many amphibians, birds, and plants in areas where these features are extinct or rare. Additionally, because of the age of some of these features, they can develop unique species assemblages or even contribute to the evolution of new species (Poschlod, 2015).

Ancient anthropogenic landscapes exist all over the world, and most have SNFs of value to conservation (e.g. arable field margins in Asia or forest margins in Africa or Latin America; Kreisel et al., 2004, Perfecto et al., 2007, Jung et al., 2008). In this paper we focus on specific examples from Central Europe, where agriculture and mining began during the Neolithic Age around 7500 years ago. This scope allows us to provide concrete examples of SNFs deriving from traditional agriculture and mining, and to describe their ecological significance, threats to persistence, and strategies for conservation in a level of detail that would be impossible to do with a broader geographic scope. In particular, we focus on agricultural landscapes and mining pits and quarries. We do

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not include road and railroad embankments and dykes because they are of relatively recent origin, and human plantings in these areas consist mainly of standardized seed mixtures containing often non-autochthonous seed material or even non-indigenous species (Seitz et al., 2007; Müller and Kirmer, 2009).

2. Origin of small natural features in anthropogenic landscapes in Central Europe

2.1. Agriculture

The oldest SNFs in Central European agricultural landscapes are probably forest fringes, some of which first developed when forests were cut and mosaics of arable fields, grasslands, and forests were created around the first villages during the Neolithic Age (Table 1). Most examples of this SNF probably stem from relatively open forests (i.e., that is dominated by light-demanding trees and shrubs, such as oak [*Quercus* spp.], lime [*Tilia* spp.], and hazelnut [*Corylus avellana*]), which were still present at the beginning of the Neolithic Age but are now rare relicts. These species assemblages expanded to cover larger scales at the end of the 18th and beginning of 19th century when grazing of forests was forbidden (Poschlod, 2015).

Fringes and hollow ways in vineyards (unpaved roads that are significantly lower than the land on either side, occurring especially in loess regions) were established during the period of the Roman Empire, roughly 0–400 CE (Table 1). Some stone walls were also constructed during the Roman period, but most originated during medieval times (1000–1400 CE) (Volk, 1993; Gilles, 1999; Ulrich, 2012).

Although they probably existed locally starting during the Neolithic Age, arable field margins were widely established to mark field borders when the three-field crop rotation system was implemented at the beginning of medieval times. Hedges were created during the Roman times — they were even described by Julius Caesar (Schönberger, 1999) — to protect orchards from roaming livestock (Willerding, 1999). However, they were used on a large scale only during medieval and modern times, when they were established around common pastures, and later expanded when lands were apportioned to individuals and families and laws required fences and hedges around private fields in some places (Fig. 1) (Müller, 1989; Lorenzen-Schmidt and Pelc, 2000; Riis, 2009; Kurz et al., 2011). Thus, most hedgerows in Central Europe were created only relatively recently — i.e., within the past 400 years.

Pasture margins are similarly recent creations. Until the beginning of 19th century, livestock freely roamed the region. People started to fence pastures in the 19th century, after which time pasture margins began to establish (Poschlod, 2015).

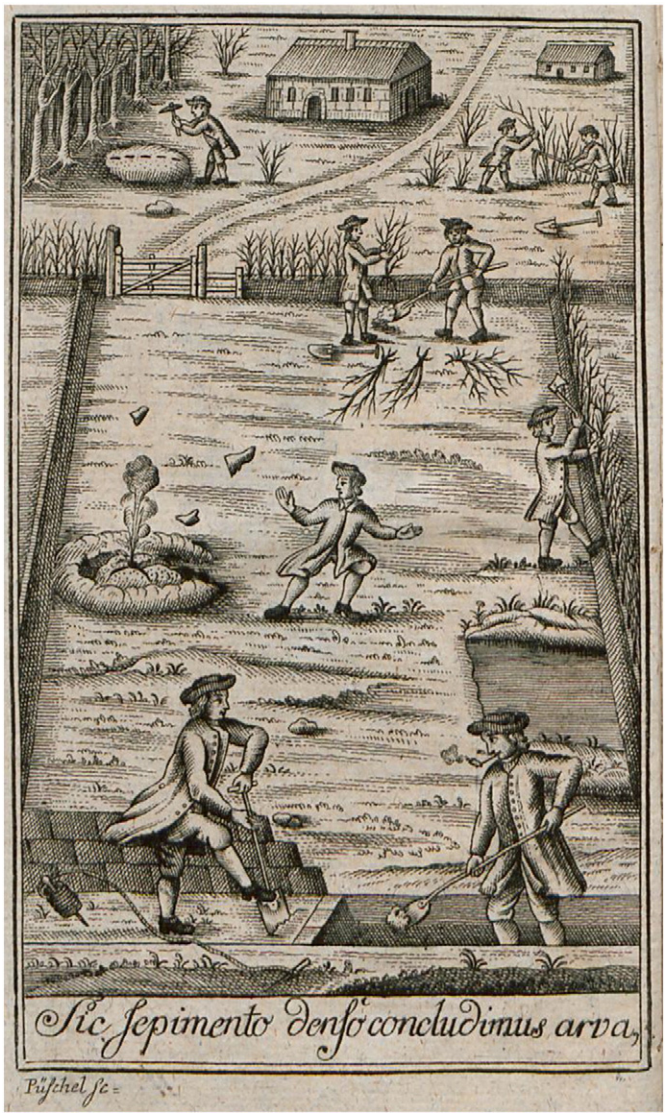

Fig. 1. Presentation of a hedge construction from 1767 (Oest, 1767). "…in such a way we surround a field with a dense fence". © University and Regional Library of Saxony-Anhalt.

2.2. Mining (sand and gravel pits, small quarries)

Sand or gravel pits and quarries in Central Europe were created during Roman times but may have existed locally much earlier. However, following the invention of cement at the beginning of the 19th century, people began creating new pits and quarries to extract sand, gravel, and stones at large scales. Extraction of sand and gravel increased again in the 20th century with the construction of roads and larger buildings (Poschlod, 1997; Dingethal et al., 1998).

Table 1
Origin and development of SNFs in the anthropogenic landscape of Central Europe since the Neolithic Age. Bright grey – non-widespread or declining (modern times); dark grey – widespread or strongly increasing. NA – Neolithic Age (5500–2200 BCE), BA – Bronze Age (2200–800 BCE), IA – Iron Age (800–0 BCE), RT – Roman times (0–400 CE), eM – early medieval times (including migration period, 400–1000 CE), lM – late medieval times (1000–1500 CE).

Time period	NA	BA	IA	RT	eM	lM	Modern times							
Year							–1700	–1750	–1800	–1850	–1900	–1950	–1970	1970–
Arable field margins														
Forest fringes														
Hedgerows	?	?	?											
Vineyard–hollow ways														
Quarries														
Sand pits														
Vineyard–walls, stairs														
Pasture margins														
Gravel pits														