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Vegetation succession in extensive abandoned tall-trunk cherry orchards: a case study on Kaňk Mountain near Kutná Hora (Czech Republic)

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Key words: secondary succession, land use abandonment, extensive tall-trunk orchards, arable soil, medieval ore extraction.

Ključne besede: sekundarna sukcesija, opuščanje rabe tal, ekstenzivni visokodebelni sadovnjaki, obdelana tla, srednjeveško izkoriščanje rude.

Abstract

Extensive tall-trunk orchards, an important element of the central European landscape since the Middle Ages, conserve potential for the future regarding their biodiversity, land use policy and agricultural value. For these reasons, extensive tall-trunk orchards are interesting with regard to nature conservation. Once the management of these low-productivity vegetation sites ceases, the habitat is threatened by successive overgrowth by shrub vegetation. Taking abandoned tall-trunk cherry orchards with dry/mesophilous grassland undergrowth in the locality of Kaňk as an example, the degree of colonization of orchards by woody species and differences in the structure of vegetation cover in different periods after abandonment were monitored. The results showed that the cover of cherry trees in orchards abandoned before 1990 was approximately 30% lower than in orchards abandoned after 2000. The cover of the herb layer in orchards abandoned before 1990 was approximately 60% lower than in orchards abandoned after 2000. The species diversity of orchards abandoned before 1990 was statistically significantly lower than that of orchards abandoned after 2000. The total cover of all species in habitat in areas of medieval ore extraction was approximately 50% lower than that in land originally used for farming.

Izvleček

Ekstenzivni visokodebelni sadovnjaki že od srednjega veka predstavljajo pomemben element srednjeevropske krajine in potencial za prihodnost zaradi svoje biotske pestrosti, rabe tal in kmetijske vrednosti. Zato so visokodebelni sadovnjaki pomembni za naravovarstvo, saj opuščanje gospodarjenja s temi nizko produktivnimi rastišči pomeni ogroženost habitata zaradi zaraščanja z grmiščno vegetacijo. Kot objekt spremljanja stopnje zaraščanja z lesnatimi vrstami in sprememb v strukturi vegetacije v različnih obdobjih po opustitivi, smo izbrali visokodebelne češnjeve sadovnjake s suhimi/mezofilnimi travišči v podrasti na območju Kaňk. Rezultati kažejo, da je pokrovnost češnjevih dreves v sadovnjakih, opuščenih pred letom 1990, manjša za 30% v primerjavi s sadovnjaki, opuščenimi po letu 2000. Pokrovnost zeliščne plasti v sadovnjakih, opuščenih pred 1990 je bila 60% manjša, kot v sadovnjakih, opuščenih pred letom 2000. Vrstna pestrost sadovnjakov, opuščenih pred letom 1990 je bila statistično značilno nižja kot pri sadovnjakih, opuščenih pred letom 2000. Skupna pokrovnost vseh vrst v habitatih, kjer so v srednjem veku kopali rudo, je bila približno 50% manjša kot na območjih, ki so jih izvorno uporabljali za kmetovanje.

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1. Introduction

Traditional cultural landscapes managed under less intensive agriculture and forestry exhibit a high diversity of habitats and therefore high biodiversity (McCollin et al. 2000, Agnoletti 2014). Past land cover may persist as a memory or legacy for a very long time in ecosystems, potentially influencing ecosystem responses, productivity and biodiversity. On the other hand, land use / land cover changes ultimately affect biodiversity from a long-term perspective (Heubes et al. 2011, Bürgi et al. 2017). Vačkář et al. (2012) suggested that high biodiversity at both species and landscape heterogeneity levels are correlated with the intermediate human impact in the Czech Republic.

In recent decades, in the context of socio-economic changes linked to the mechanization and modernization of agricultural production technology, there has been both intensification and abandonment of formerly more extensively used less fertile farmland (Antrop 2005). Abandoned areas are currently at different stages of succession. Considerable attention is given to vegetation succession in abandoned farmland in terms of its importance for forest production, nature conservation and landscape diversity (e.g., Benjamin et al. 2005, Benayas et al. 2007, Verburg & Overmars 2009, Ustaoglu & Collier 2018). Recent studies have mainly investigated vegetation dynamics in abandoned arable land or meadows (e.g., Jensen et al. 2001, Cramer & Hobbs 2007, Hobbs 2012). In the Czech Republic, long-term research in abandoned fields in the Protected Landscape Area of Český kras has been carried out (see Osbornová et al. 1990). However, little attention has been paid to studying vegetation changes in tall-trunk orchards after abandonment (e.g., Debussche et al. 1982, Milton et al. 1997).

Extensive tall-trunk orchards are one of the traditional land cover types and landscape structures that have seriously decreased because of agricultural development during previous periods. Orchards on slopes those are less suitable for intensive agricultural management have been a part of the Central European cultural landscape since the Middle Ages. The orchard grounds are usually covered by grasslands that are used for sheep or goat grazing. Plots of orchards or fruit trees can be mixed with small fields (Lange 1993, Schultze & Gertsberger 1993, Maděra et al. 2014, Špulerová et al. 2015, Forejt et al. 2017). Tall-trunk orchards are important ecological and cultural landscape features. Although these orchards are human-introduced land cover, they fulfil several ecological services (Kay et al. 2018, Špulerová et al. 2018) and conserve higher potential for the future regarding their biodiversity, land use policy and agricultural value (Janeček et al. 2019).

For example, a combination of extensive planting of tall-trunk orchards and semi-dry grasslands forms a biotope to which a number of plant and animal species are found that are rare in the other habitats (e.g., Blab 1993, Reck 1993, Duchoslav 2009, Horák & Šafářová 2010). For breeding birds, both extensive tall-trunk orchards and orchards in the early stage of abandonment are important habitats. On the other hand, intensively managed short-trunk orchards have significantly lower ecological value (Kajtoch 2017). Horák et al. (2013) compared orchards with other land cover types (grasslands and woods) and proved that the presence of orchards is significant for butterflies, land snails, plants, and birds. For these reasons, orchards are interesting for nature conservation. However, when the management of these habitats ceases, they are threatened by successive overgrowth by shrub vegetation, and they gradually disappear.

Surprisingly, orchards are a relatively dynamic land use category. Generally, we can assume that their area slightly increased during the 19th and 20th centuries but decreased markedly from the 1990s to the present in the Czech Republic (Bičík et al. 2010). Several sources are available and are often used for studying land cover changes in the central European landscape. Old medium- and large-scale maps are available from the late 18th to the late 19th centuries, and aerial photographs are available for the 20th century that allow us to study not only the extent but also the quality of identified land cover patches (Skaloš et al. 2011, Šantrůčková et al. 2015, Forejt et al. 2017).

The aim of this work is to describe the degree of colonization of orchards by woody species and differences in the composition of vegetation cover in different periods after abandonment based on the example of tall-trunk cherry orchards with dry grassland undergrowth in the locality of Kaňk near Kutná Hora.

Methods

Study area

The study was performed on Kaňk Mountain, situated approximately 2 km northeast of the city of Kutná Hora (Czech Republic). Kutná Hora region was famous by its orchards in the 20th century. Orchards on the Kaňk Mountain are interested among the others because some of them were founded on the plots of the medieval ore extraction. Extensive abandoned tall-trunk orchards are mainly located on southward-exposed slopes at approximately 300 m a.s.l. (Figure 1). The geological bedrock of Kaňk Mountain is formed by Palaeozoic or Precambrian rocks (gneiss, micacites, migmatites, and migmatitised orthogneiss) and partly by Mesozoic rocks (marlstones

and siltstones). The Quaternary cover is composed of sands and gravels; there are also diluvial sediments on Kaňk Mountain slopes and on the foothills. The soils are categorized as brown earth (Tomášek 2000). The main metal-bearing minerals are native Ag and high-quality ores with minerals such as tetrahedrite, freibergite, argentite, proustite, pyrargyrite, galenite, and sulphides of Fe, Zn, As, Cu, Pb. Because of long-term mining and smelting activities, the soils of the model area are strongly contaminated, mainly by As and Cd, and a high concentration of Hg may or may not be connected with the mining process (Horák & Hejcman 2013, 2016a, 2016b).

The mean annual air temperature in the area is 9 °C, and the mean annual precipitation rate is 584 mm. The mean temperature in January ranges from –2 to –3 °C, and the total precipitation amount during the winter period ranges between 200 and 300 mm. The mean temperature in June is 18–19 °C, and the total precipitation during the growing season ranges between 350 and 400 mm (Quitt 1971).

According to the map of potential natural vegetation (Mikyška 1968, 1972, Neuhäuslová et al. 2001), the natural vegetation in most of the area would consist of oak-hornbeam and lime-oak woodlands (*Carpinion* Issler 1931), especially oak-hornbeam woodland with *Melampyrum nemorosum* (ass. *Melampyro nemorosi-Carpinetum* Passarge 1962).

Cherry orchards were planted in former arable soil and at the sites of medieval ore extraction, which took place mainly in the period from the 13th to the 16th centuries. The undergrowth of orchards is formed by grassland communities that are classifiable at the boundary of mesic *Arrhenatherum* meadows (*Arrhenatherion elatioris* Luquet 1926) and dry grassland (*Bromion erecti* Koch 1926). In dry habitats, the communities are formed by characteristic species such as *Brachypodium pinnatum*, *Bromus erectus*, *Festuca rupicola*, *Salvia pratensis*, *Eryngium campestre*, *Scabiosa ochroleuca*, *Onobrychys viciifolia*, *Cirsium acaule,* rarely occur *Stipa capillata*, *Anthericum ramosum*, *Bothriochloa ischaemum* or *Elytrigia intermedia*. The presence of critically endangered *Stachys germanica* is of particular note.

The gradual abandonment of orchard undergrowth management (mostly moving) is associated with overgrowth by woody species, especially by *Crateagus* sp., *Cornus sanguinea*, *Rosa* sp., *Ligustrum vulgare*, *Cornus mas* and *Prunus mahaleb*.

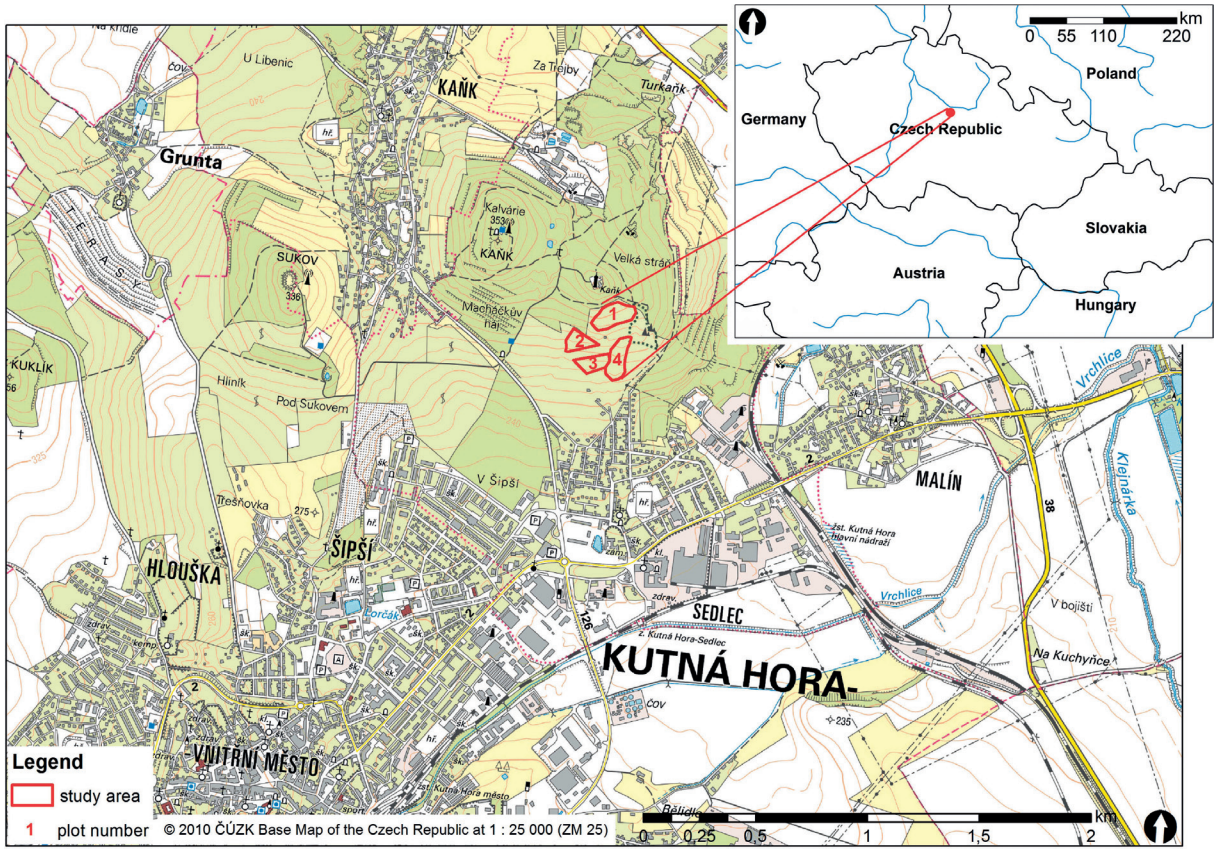

Figure 1: The study area.
Slika 1: Preučevano območje.

Land cover analysis

Old maps and aerial photographs were used for analysing land cover and orchard changes over the past 250 years. The available old maps include first military maps (1763–1783, approximately 1 : 28800), stable cadastral maps (1838, 1 : 2880), second military maps (1842–1852, 1 : 28800), and third military maps (1874–1880, 1 : 25000). The oldest aerial photographs are available from the 1930s. The whole area of former Czechoslovakia was photographed regularly every 10 years from the early 1950s onward and more often beginning in the 1990s. We used the 3 oldest aerial photographs of the model area (1938, 1947, 1954) and then aerial photographs taken at approximately 10-year intervals (i.e., 1963, 1972, 1983, 1993, 2004, 2013, 2018) to study land cover and orchard changes.

The land cover categories distinguished in the study area include arable land (ploughed fields), permanent grassland (meadow or pasture), regular orchards (extensive tall-trunk orchards with regular management), and abandoned orchards (tall-trunk orchards where management is irregular or absent). Because the main aim of the study was to examine plant succession in abandoned orchards, we distinguished three phases of orchard abandonment: stage 1 – beginning of spontaneous overgrowth by woody plants, occasional cherry harvesting, regular orchard raster still clear; stage 2 – continuous spontaneous overgrowth by woody plants, regular orchard raster less visible; stage 3 – spontaneous woody plants prevail, no regular raster (Table 1). Succession in some plots progressed quickly, so the phases of orchard abandonment did not flow smoothly from 1 to 3. The GIS software ArcGIS 10.6.1 was used for data processing.

Table 1: Land cover in old maps and aerial photographs.
Tabela 1: Prostorski podatki na starih kartah in aeroposnetkih.

Plot No.	1763–1783	1838	1842–1852	1874–1880	1938	1947	1954	1963	1972	1983	1993	2004	2013	2018
1	arable land	arable land	arable land	arable land	regular orchard	regular orchard	regular orchard	regular orchard	regular orchard	regular orchard	abandoned orchard: stage 1	abandoned orchard: stage 1	abandoned orchard: stage 3	abandoned orchard: stage 3
2	arable land	arable land	arable land	arable land	arable land	arable land	regular orchard	regular orchard	regular orchard	regular orchard	regular orchard	abandoned orchard: stage 1	abandoned orchard: stage 2	abandoned orchard: stage 2
3	arable land	arable land	arable land	arable land	arable land	arable land	arable land	arable land	regular orchard	regular orchard	regular orchard	regular orchard	abandoned orchard: stage 1	abandoned orchard: stage 1
4	arable land	grass-land	grass-land	grass-land	regular orchard	regular orchard	regular orchard	regular orchard	regular orchard	regular orchard	abandoned orchard: stage 1	abandoned orchard: stage 1	abandoned orchard: stage 3	abandoned orchard: stage 3

Data collection and analysis

A system of plots of 10 m × 10 m in size was used to sample vegetation data. In July 2010, we examined tall-trunk cherry orchards planted in arable soil at the following sites characterized by different lengths of abandonment: (1) area abandoned after the year 2000 – 5 plots; (2) area abandoned in the period of 1990–2000 – 5 plots; and (3) area abandoned before the year 1990 – 5 plots. In addition, 5 plots were examined in a cherry orchard planted at a site influenced by medieval ore extraction and abandoned before 1990 (Table 1). A 3 × 3 grid was used to divide each plot into 9 smaller subplots. In each subplot, the percentage of vegetation cover of all species and each individual species, including the cherry plantation, was estimated in mid-July (top of the growing season). In this way, a more precise estimate of cover for each species was obtained for the entire plot, including the mean value and standard deviation. The Shannon-Wiener index of species diversity (Pielou 1966) was calculated for every plot. All cover values and diversity data were evaluated using the program Statistica v. 9.0 (StatSoft Inc. 2009). Differences between different stages of abandonment were tested using ANOVA and Tukey's test or the Kruskal-Wallis test. To reveal the main gradients in vegetation samples, unimodal-based ordinations using CANOCO (Ter Braak & Šmilauer 2012) were employed.

The nomenclature of vascular plants follows Kubát et al. (2002).

Results and discussion

Vegetation changes in abandoned orchards established on farmland

Results of the changes in basic vegetation characteristics during succession in the studied cherry orchards established on arable land are presented in Table 2 and

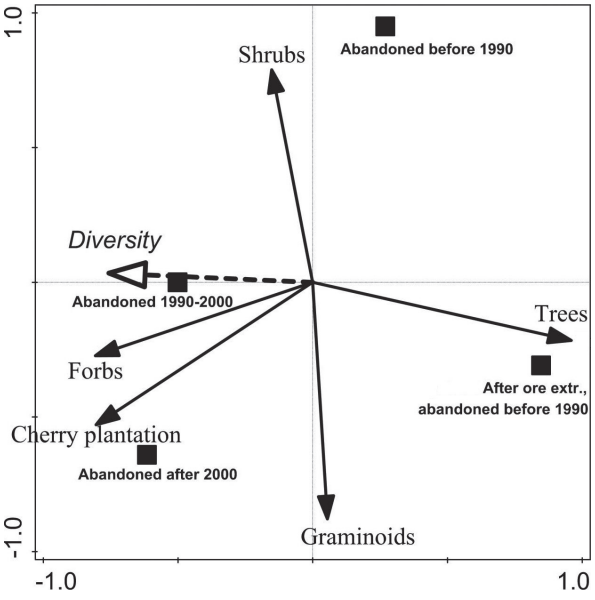

Figure 2: Indirect PCA gradient analysis of vegetation characteristics (the first two axes capture 84% of data variability) in relation to the length of abandonment and type of habitat. The length of abandonment and type of habitat are indicated with black squares.

Slika 2: Indirektna PCA gradientna analiza vegetacijskih značilnosti (prvi dve osi pojasnjujeta 84% variabilnosti) v odnosu do časa od opustitve rabe in vrsto habitata. Obdobje od opustitve gospodarjenja in vrsta habitata sta prikazana s črnimi kvadrati.

Figure 2. During the study period, the cover of cherry plantations was considerably decreasing, which was caused (in addition to the natural ageing of adult trees) by gradually increasing competitive pressure from growing woody species and by their increasing representation in the overall cover. This situation was also demonstrated by the results of indirect gradient analysis (Figure 2). In connection with the growing woody plant stands, the height and cover of the herb layer, especially forbs, was continuously decreasing considerably. Graminoids were also more abundant in the later period of succession on the area of medieval ore extraction.

The relations of specific plant species (for the list of species, see the Appendix) to the individual studied succession stages were shown by indirect gradient analysis (Figure 3). Areas abandoned after the year 2000 (Figure 4a) and in the period of 1990–2000 (Figure 4b) were associated with the presence of herbs that formed original mown grassland, especially *Agrostis* sp., *Arrhenatherum elatius, Festuca rubra, Galium spurium, Lathyrus pratensis, Lotus corniculatus, Trifolium medium* and *Taraxacum officinale*. This situation can be explained by a considerable proportion of original mown grasslands. In later period of succession, *Calamagrostis epigejos* prevailed. *Brachypodium pinnatum,* which belongs to the expansive tall grasses colonizing abandoned habitats of former dry grassland

Table 2: Differences in vegetation variables between individual stages of succession after abandonment of extensive tall-trunk cherry orchards established on arable soil and comparison of vegetation of abandoned extensive tall-trunk cherry orchards established on arable soil and on the habitat after medieval ore extraction.

Tabela 2: Razlike med vegetacijskimi spremenljivkami med posameznimi sukcesijskimi stadiji po opustitvi ekstenzivnih visokodebelnih češnjevih sadovnjakov na obdelanih tleh in primerjava vegetacije opuščenih sadovnjakov, zasajenih na obdelanih tleh s tistimi na jalovini srednjeveških rudnikov.

Characteristic	Abandonment period				
	after 2000	1990–2000	before 1990		
	established on arable soil	established on arable soil	established on arable soil	established in the area of medieval ore extraction	significance
Species diversity	3.74[a]	4.31[a]	3.26[b]	3.06	n.s.
Vegetation cover – sum of all species cover [%]	155[a]	174[a]	114[b]	161	**
Woody species cover – sum of all woody plants cover [%]	27[b]	65[a]	76[a]	72	n.s.
Proportion of woody species cover [%]	17[c]	37[b]	67[a]	45	**
Cover of cherry plantations [%]	34[a]	22[ab]	5[b]	5	n.s.
Shrub species cover – sum of all shrub species cover [%]	26[b]	63[a]	72[a]	38	*
Proportion of shrub species cover [%]	17[c]	36[b]	63[a]	25	**
Height of shrub layer [m]	3.3[c]	4.9[b]	5.8[a]	6.4	n.s.
Height of herb layer [m]	0.88[a]	0.76[a]	0.52[b]	0.82	n.s.
Cover of herb layer [%]	83[a]	47[b]	23[c]	57	**

Legend: Different letters indicate statistically significant difference on p = 0.05; n.s. – statistically non-significant difference between vegetation on arable soil and vegetation in the area of medieval ore extraction; * – significant difference p = 0.05; ** – significant difference p = 0.01.

(Partzsch 2011), presents also a significant relation with the habitats of later period of succession (also in areas of medieval ore extraction), as shown in Figure 3.

Woody plants predominate in the areas abandoned before 1990 (Figure 3, 4c), including species such as *Acer pseudoplatanus, Acer platanoides, Cornus mas, Ligustrum vulgare* and *Crataegus oxyacantha*. The woody plants initially took root under the old planted cherry trees.

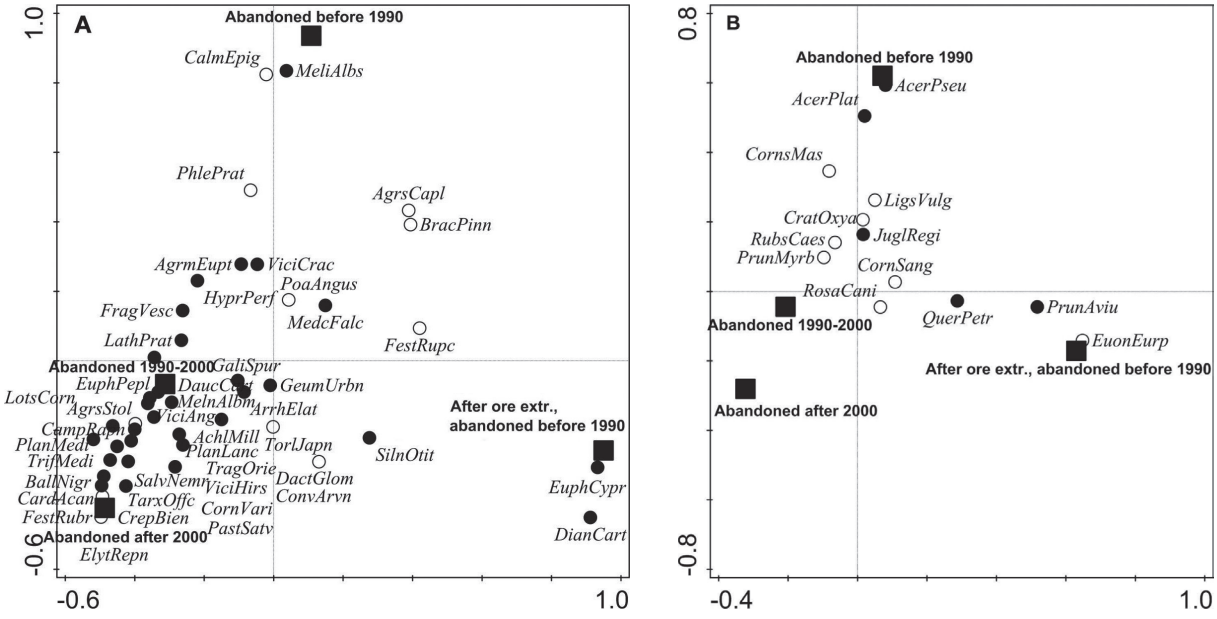

Figure 3: Indirect DCA gradient analysis of plant species (the first two axes capture 30% data variability) in relation to the length of abandonment and type of habitat. Individual species are indicated with small spots (empty – shrubs and graminoids, black – trees and forbs). Only species occurred in more than 2 plots were plotted. The length of abandonment and type of habitat are indicated with black squares. Species abbreviations are based on four letters for the genus and species (see Appendix). A – Herbs, B – Woody plants.

Slika 3: Indirektna DCA gradientna analiza rastlinskih vrst (prvi dve osi pojasnjujeta 30% variabilnosti) v odnosu do časa od opustitve rabe in vrsto habitata. Posamezne vrste so prikazane z majhnimi točkami (prazne – grmovnice in trave, črne – drevesa in zeli). Prikazane so samo vrste, ki se pojavljajo vsaj v dveh ploskvah. Obdobje od opustitve gospodarjenja in vrsta habitata sta prikazana s črnimi kvadrati. Okrajšave vrst so prikazane s štirimi črkami za rod in vrsto (glej prilogo). A – zeli, B – lesnate rastline.

Figure 4a: Tall-trunk cherry orchard in former arable land abandoned after 2000.

Slika 4a: Visokodebelni češnjev sadovnjak na nekdanjih obdelanih tleh, opuščen po letu 2000.

Figure 4b: Tall-trunk cherry orchard in former arable land abandoned during period 1990–2000.

Slika 4b: Visokodebelni češnjev sadovnjak na nekdanjih obdelanih tleh, opuščen v obdobju 1990–2000.

These results correspond to the conclusion made by Debussche & Lepart (1992) that the best conditions for the development of tree seedlings with pulpy fruits occur at the edge of large tree crowns. The interplay of seed propagation by birds and a suitable environment for the development of seedlings near woody plants leads to the expansion of shrubs from trees to the grasslands. This tree propagation mechanism has also been reported by Jordano (1994) and Milton et al. (1997).

In the initial period of secondary succession, significantly higher values of species diversity were recorded, which was probably due to the increase in the number of woody species and the occurrence of new herb species for which favourable conditions were created. During the next period, however, the values of diversity decreased as a result of the degradation of dry grasslands, which was caused by the growth of bushes. Decreasing species richness in connection with the gradual overgrowth of abandoned orchards was also documented by Milton et al. (1997).

Figure 4c: Tall-trunk cherry orchard in former arable land abandoned before 1990.
Slika 4c: Visokodebelni češnjev sadovnjak na nekdanjih obdelanih tleh, opuščen pred letom 1990.

Figure 4d: Tall-trunk cherry orchard in the area of medieval ore extraction abandoned before 1990.
Slika 4d: Visokodebelni češnjev sadovnjak na območju jalovine srednjeveških rudnikov, opuščen po letu 2000.

Differences in the composition of vegetation occurring on farmland and in habitats in areas of medieval ore extraction

The results of the comparison of orchard vegetation produced in former arable lands (Figure 4c) and in areas of medieval ore extraction (Figure 4d) that were abandoned before 1990 are presented in Table 2 and Figure 2 and 3. The total cover of all plant species in the stand was significantly higher in areas of medieval ore extraction. In contrast, the proportion of woody species cover within total vegetation cover was higher in the case of stands growing in former arable land. This situation occurs because the habitats in areas of medieval ore extraction become overgrown less evenly.

The cause of this phenomenon is probably relatively high heterogeneity of terrain morphology and differences in soil substrate quality, which is not favourable for woody plant growth in some places. Open space without shrubs provides a greater opportunity for self-seeding and subsequent growth of woody plants, especially cherry trees (see Figure 3). The greater number of grids that are not covered with woody plants is also related to the fact that in the plots in areas of medieval ore extraction, there is statistically significantly greater cover of the herb layer (Table 2). However, the herb layer is significantly degraded in most of these plots, especially in the undergrowth of trees (specifically, cherry seedlings). This degradation is also associated with a significant decline in species diversity (see Figure 2). *Euphorbia cyparissias, Dianthus carthusianorum* and *Silene ottites* presents a significant relation with the habitats in areas of medieval ore extraction, as shown in Figure 3. This can be explained by a considerable proportion of extreme habitat conditions that support development and prosperity of these xerothermic species.

Conclusions

The main results of the study of secondary succession in abandoned cherry orchards in the locality Kaňk near Kutná Hora can be summarized as follows:

1) The cover of cherry trees in orchards abandoned before 1990 was approximately 30% lower than that in orchards abandoned after 2000.

2) The shrub vegetation in orchards abandoned before 1990 was approximately 2.5 m higher than that in orchards abandoned after 2000. The cover of the shrubs was higher by approximately 50%.

3) The herb layer covers in orchards abandoned before 1990 was approximately 60% lower than that in orchards abandoned after 2000. The height of herbs was approximately 50% lower.

4) The species diversity in orchards abandoned before 1990 was statistically significantly lower than that in orchards abandoned after 2000.

5) The share of woody species covers within the total vegetation cover in habitat in areas of medieval ore extraction was approximately 30% lower than in land used originally for farming.

6) The total cover of all species in habitat in areas of medieval ore extraction was 50% lower than in land used originally for farming.

7) The vegetation in habitat in areas of medieval ore extraction extends beyond the succession line observed in former arable land.

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Stable cadastral maps, State Administration of Land Surveying and Cadastre

Aerial photographs

State Administration of Land Surveying and Cadastre and Military Geographic and Hydrometeorologic Office Dobruška

Appendix

List of species found at the investigated plots

Acer campestre
Acer platanoides
Acer pseudoplatanus
Agrimonia eupatoria
Agrostis capillaris
Agrostis stolonifera
Achillea millefolium
Anthericum ramosum
Arrhenatherum elatius
Asparagus officinalis
Ballota nigra
Brachypodium pinnatum
Calamagrostis epigeos
Campanula rapunculoides
Carduus acanthoides
Carex hirta
Carex muricata
Carex sylvatica
Centaurea jacea
Cichorium intybus
Cirsium arvense
Cirsium eriophorum
Cirsium vulgare
Concolvulus arvensis
Cornus mas
Heracleum sphodyllium
Hieracium pilosella
Hieracium sabaudum
Hypericum perforatum
Juglans regia
Knautia arvensis
Koeleria macrantha
Lactuca serriola
Lamium album
Lathyrus pratensis
Ligustrum vulgare
Lotus corniculatus
Malus domestica
Medicago falcata
Medicago lupulina
Melandrium album
Melilotus albus
Mentha piperita
Pastinaca sativa
Phleum pratense
Plantago lanceolata
Plantago media
Poa angustifolia
Potentilla argentea
Potentilla intermedia
Cornus sanguinea
Coronilla varia
Crataegus oxyacantha
Crepis biennis
Dactylis glomerata
Daucus carota
Dianthus carhusianorum
Echinops sphaerocephalus
Echium vulgare
Elytrigia intermedia
Elytrigia repens
Eryngium campestre
Euonymus europaea
Euphorbia cyparissias
Euphorbia peplus
Festuca rubra
Festuca rupicola
Fragaria vesca
Fragaria viridis
Fraxinus excelsior
Galium molugo
Galium spurium
Geranium pratense
Geum urbanum
Hedera helix
Potentilla reptans
Prunus avium
Prunus mahaleb
Prunus myrobalana
Prunus sp.
Prunus spinosa
Quercus petraea
Ribes rubrum
Robinia pseudoacacia
Rosa canina
Rubus caesius
Rumex acetosella
Salvia nemorosa
Sambucus nigra
Scabiosa ochroleuca
Silene otites
Solidago canadensis
Taraxacum offcinale
Thymus pullegioides
Torilis japonica
Tragopogon orientalis
Trifolium medium
Vicia angustifolia
Vicia cracca
Vicia hirsuta