Central-European vegetation types and their optima along successional gradient

Optima středoevropských typů vegetace na sukcesním gradientu

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Although the identification of plant communities is the basic language of communication, studies that focus on the classification of vegetation in successional series are rather rare, mainly because it is difficult to identify different types of vegetation. Thanks to formalized algorithms of machine learning, we were able to assign some of vegetation plots stored in a Database of Successional Series (DaSS) to alliances in the vegetation classification system. Of the samples in DaSS 67.4% were classified into 96 vegetation alliances. Classification of the seral stages was then used to predict optima and intervals of occurrence of 33 main types of vegetation in the first 70 years from the onset of succession. In accordance with general expectations, main types of vegetation were arranged at the time-scale from ruderal and segetal vegetation, across grasslands to shrubby and forest vegetation. Successional optima of particular units of vegetation can be used to roughly predict the successional changes at human-disturbed sites in central Europe.

Keywords: disturbance, Huisman-Olff-Fresco models, succession, temporal gradient, vegetation alliances, vegetation classification

Introduction

Plant communities are commonly classified based on consistent groups of co-occurring species that are generally referred to a particular vegetation type (Mucina 1997). Using these standardized descriptions of vegetation at a broad spatial scale is crucial for understanding the variability of ecosystems and providing a background for basic and applied research (Nicholson et al. 2009). Traditionally, the classification of phytosociological records in terms of vegetation units is done on the basis of the knowledge and observation of experts. Gradually, electronic vegetation databases have been established for various European countries, and later for the whole of Europe (Schamineé et al. 2009, Chytrý et al. 2016). Therefore there is currently a possibility to use a special software to assist vegetation experts in assigning large amounts of vegetation data to pre-existing vegetation classifications (Gégout & Coudun 2012, Oliver et al. 2013). Recently several automated systems for assigning plots to predefined types of vegetation were developed (Kočí et al. 2003, De Cáceres & Wiser 2012, Landucci et al. 2015, Mucina et al. 2016 etc.).

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Natural or near-natural vegetation (sensu Leuschner & Ellenberg 2017) is composed predominantly of spontaneously growing sets of species of plants the composition of which is shaped by natural ecological processes (van der Maarel 2005). Big changes in the landscape structure and ecosystem management, accelerated in the second half of the 20 century (e.g. logging, livestock grazing, urbanization, agriculture and mining activities) greatly affected natural ecological processes and increased the proportion of synanthropic vegetation occurring at disturbed or post-disturbed sites (Leuschner & Ellenberg 2017). However, there are very few large-scale classifications of vegetation at various disturbed sites, where successional processes are ongoing, although it may provide an additional source of information for understanding spatio-temporal dynamics of ecosystems (Chytrý et al. 2016) and potentially improve our predictions of the dynamics.

Phytosociological knowledge is important for nature conservation and landscape management (Mucina et al. 1993). There is also an increasing use of assignment of vegetation to predefined units in planning optimal restoration strategies for various disturbed habitats (van Andel & Aronson 2012). Restorationists usually want to know when a particular type of vegetation should occur in a restoration process, especially in a case of passive restoration, which relies on spontaneous succession (Holl & Aide 2011). Moreover, analyses of plant communities, documented by vegetation plots over several decades, could constitute a basis for evaluating changes in vegetation caused by various disturbances including widespread human activities such as mining, agriculture, construction of roads etc. (Prach et al. 2016).

While studies on the classification of natural and near-natural vegetation are rather common, the vegetation recorded in artificial, irregularly disturbed or damaged sites, harbouring a low number of diagnostic species, are often systematically disregarded when analysing data (Gégout & Coudun 2012). Traditional syntaxonomical research is mainly based on species-rich plots (Podani 1984, Margules & Austin 1994, Lepš & Šmilauer 2007, Roleček et al. 2007, Michalcová et al. 2011), i.e. plots of which exact location is a subjective expert decision. Studies comparing types of vegetation in disturbed habitats over large geographical and time-scales are rather scarce and thus the potential of a phytosociological approach in comparative studies seeking general trends in succession is poorly explored (Faber-Langendoen et al. 2014, Meyer et al. 2015). Vegetation on temporarily changing post-disturbance sites has only been formally phytosociologically classified for a few habitats (e.g. Pyšek et al. 2004, Lososová et al. 2006).

This study offered a unique opportunity to analyse 20 types of successional series recorded in the Czech Republic (Prach et al. 2014) and identify the types of vegetation during the course of succession. We predict the optima and time from the last disturbance of the occurrence of the main vegetation units. To be consistent, we assigned vegetation plots to alliances automatically using a machine learning method. As a knowledge base for assigning plots stored in the Database of Successional Series (DaSS) we used an independent set of classified plots from the Czech National Phytosociological Database (CNPD).

Material and methods

Database of Successional Series (DaSS)

The database contains a total of 3492 vegetation plots with geographical coordinates and information on time since the start of succession. The vegetation data includes 20 successional series for various primary and secondary successions (namely spoil heaps of coal mines, uranium mines, stone quarries, sand and gravel pits, extracted peatland, urban ruderal sites, sedimentary basins, abandoned fields, burnt forests, cleared forests, forests destroyed by air pollution, river gravel bars; see Prach et al. 2014). About 29% of the plots were considered as permanent (sampled mostly two times but sometimes repeatedly over a long period of time). The database mainly covered the first 70 years of the successions. Therefore, any older successional stages were not included in the analysis. The plot size ranged from 10 to 400 m^2. Different sizes of plots are likely to have influenced the absolute number of species in each plot, but not the overall patterns (see Chytrý 2001, Prach et al. 2014).

Assignment of DaSS plots to particular types of vegetation

The original expert system developed for the Vegetation of the Czech Republic project (Chytrý 2007–2013) is not suitable for classifying the DaSS vegetation plots, as few of them were assigned to the correct vegetation type because this system was developed for assigning well-developed vegetation to associations. For plots, which were not assigned by the original expert system, we used an automated tool for assigning vegetation to higher ranks in the classification system; the GRIMP method (Group IMProvement method; Tichý et al. 2019). The GRIMP method is a machine learning algorithm, which utilizes (i) a training dataset of vegetation plots with known vegetation type, (ii) pre-defined set of groups of discriminating species, where one group is a set of species, which indicate a particular vegetation type, and (iii) a priori classification of all plots of training data, which is used for the optimization of discriminating species groups. This method reduces the list of discriminating species within groups reciprocally to fit a posteriori assignment of training data to their a priori classification. The plot is assigned to the given vegetation type based on the highest total percentage cover of the discriminating species. Once optimized, groups of so-called discriminating species indicating particular vegetation types (alliances) are then applied to a test dataset.

As a training dataset, we used 30,115 of the plots in the Czech National Phytosociological Database (CNPD; Chytrý & Rafajová 2003, Chytrý &Tichý 2018). Initially the groups of discriminating species for each individual alliance considered all species, which increased the probability $P < 0.01$ (Fisher's exact test) of the species occurring in plots belonging to a particular alliance. Each plot of the training dataset was a priori classified to associations, hence also to superior types of vegetation at the level of alliances ($n = 137$).

This initial set of discriminating species was then optimized using the GRIMP method. As a result, we obtained lists of species that optimally discriminate vegetation alliances. The main criterion for assigning a plot to a vegetation alliance was the total percentage cover (Fischer 2015) of the discriminating species of a particular vegetation alliance. In addition, the total cover of all species of trees in plots assigned to forest vegetation had to be higher than 25%, and that of shrubs in plots assigned to shrubby vegetation higher than 15%; non-forest vegetation was not included in either of these two categories. A plot was assigned to the alliance whose species had the highest total combined percentage cover, i.e. theoretical ideal combination of the covers of individual discriminating species within the plot. If the calculated cover was the same for two or more alliances, the plot remained unclassified.

The process of searching for species, which optimally discriminate alliances, is iterative, thus the application of the GRIMP method to the same data can produce a slightly different result. Therefore, the GRIMP was ran independently 10×. A plot was assigned to a particular alliance if it was assigned to some vegetation unit by the original expert system, or assigned at least 3× out of 10 runs to the same alliance.

Types of vegetation in successional gradients

We approximately modelled affiliations of particular types of vegetation with successional age using logistic growth functions as described by Huisman et al. (1993; Huisman–Olff–Fresco models), because these models are particularly suited for describing affiliations in time. Instead of species, we analysed analogically derived optima and the temporal distribution of particular vegetation types (mostly alliances). We used those vegetation types with a frequency equal to or higher than 15 plots in at least two series in the DaSS database. However, some rare alliances with ecologically and physiognomically similar vegetation were merged into broader vegetation types (numbers of seres in DaSS in which the given vegetation type occurs are in parentheses)): Weed vegetation *(Caucalidion* – 13, *Veronico-Euphorbion* – 6, *Scleranthion annui* – 17, *Arnoseridion minimae* – 2, *Oxalidion fontanae* – 12); *Galio-Urticetea* (*Senecionion fluviatilis* – 3, *Petasition hybridi* – 3, *Impatienti noli-tangere-Stachyion sylvaticae* – 13, *Geo urbani-Alliarion petiolatae* – 12, *Aegopodion podagrariae* – 10); *Calluno-Ulicetea* (*Nardion strictae* – 5, *Nardo strictae-Agrostion tenuis* – 3, *Violion caninae* – 6, *Nardo strictae-Juncion squarrosi* – 12, *Euphorbio cyparissiae-Callunion vulgaris* – 1, *Genisto pilosae-Vaccinion* – 7); Aquatic vegetation (*Lemnion minoris* – 1, *Hydrocharition morsus-ranae* – 5, *Potamion* – 5, *Ranunculion aquatilis* – 2, *Eleocharition acicularis* – 9, *Sphagno-Utricularion* – 6); *Salicetea purpureae* (*Salicion triandrae* – 1, *Salicion elaeagno-daphnoidis* – 8, *Salicion albae* – 6); *Robinia* woodlands (*Chelidonio majoris-Robinion pseudoacaciae* – 21, *Balloto nigrae-Robinion pseudoacaciae* – 11, *Euphorbio cyparissiae-Robinion pseudoacaciae* – 3); *Alnetea glutinosae* (*Alnion glutinosae* – 29, *Salicion cinereae* – 14); *Quercetea pubescentis* (*Quercion pubescenti-petraeae* – 9, *Quercion petraeae* – 6).

Following Schröder et al. (2005), an interval between two inflexion points in the response function, which is called the $M_{0.5}$-interval, where the function reached at least half of the maximum probability of the occurrence, was considered important. The optimum interval is graphically described in Fig. 1. The data were analysed using the JUICE program (Tichý 2002), which is freely available at https://www.sci.muni.cz/botany/juice.

Characteristics of the modelled vegetation types

Many plots of initial stages of succession are species-poor and their assignment to vegetation types (mainly associations) is problematic due to the lack of characteristic species.

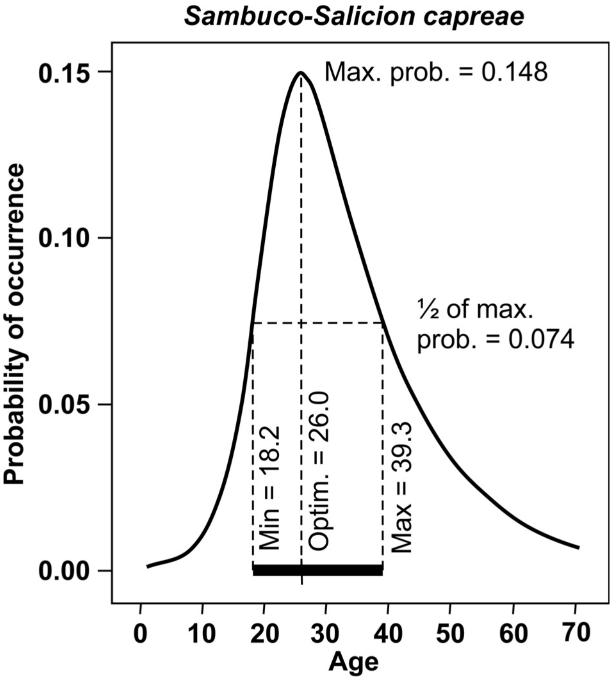

Fig. 1. – An example of the response curve defined by logistic growth functions (HOF models; Huisman et al. 1993) for one vegetation alliance and definition of the optimum (tinny bar crossing the range) and optimum interval (thick bar between Min and Max values) used in Fig. 2.

They can only be assigned to higher ranks of the classification system. Therefore, we compared the basic characteristics of the modelled vegetation types based on the DaSS database with those based on the CNPD database. For both assigned plots in DaSS and CNPD databases, we calculated the mean number of species and their total cover per plot, and the number, percentage ratio and total cover of diagnostic species (Chytrý 2007–2013).

Results

Approximate modelled optima and intervals on a chronosequence gradient were estimated based on 2355 plots sampled in previously disturbed habitats (67.4% of all the plots in the DaSS database) and assigned to 96 of 138 vegetation alliances recorded in the Czech Republic. The 33 most frequent vegetation types are listed in Fig. 2. The most and second-most frequent alliances recorded in previously disturbed habitats were *Dauco carotae-Melilotion* and *Fragarion vescae* (18.9% and 7.5% of classified plots, respectively). These two pioneer, ruderal types were identified at 41% of plots sampled early (1–10 years) after disturbance. Ruderal vegetation occurred in 32% of the plots (mean time 12.2 years of the succession), grassland vegetation in 23% (24.3 years), wetland vegetation in 12% (23.3 years) and shrubby and forest vegetation in 30% of the classified plots (38.3 years). Comparing the modelled vegetation within DaSS and CNPD

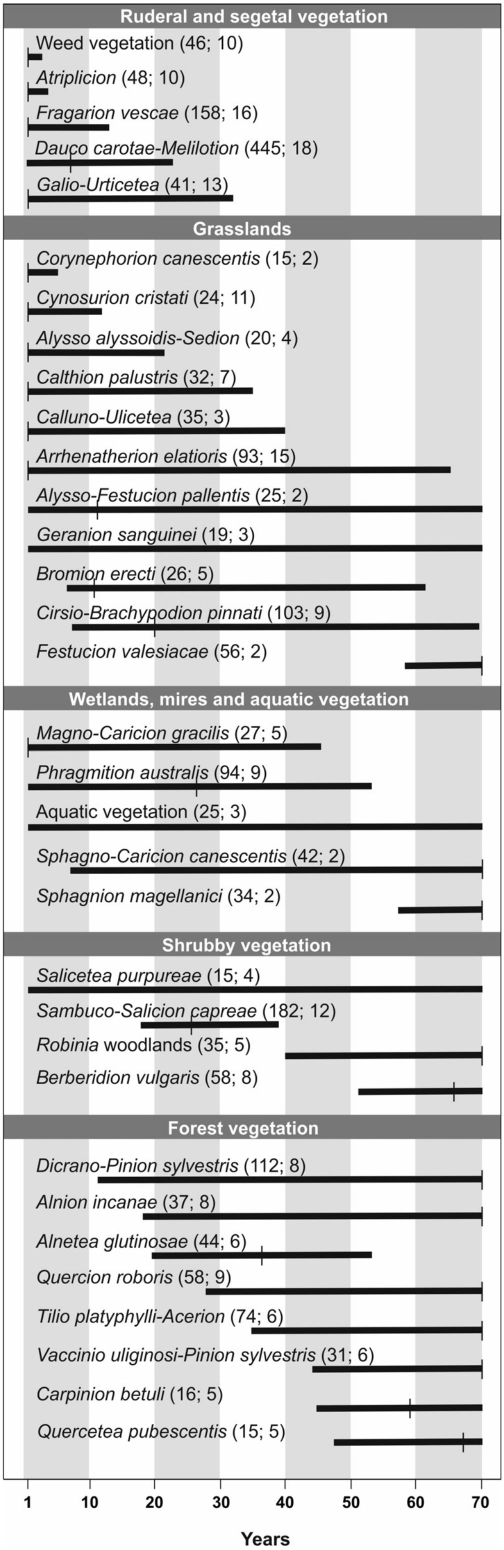

Fig. 2. – List of 33 most frequent vegetation types and their modelled distributions in a post-disturbance successional gradient in the first 70 years. Thick black bars are the ranges of vegetation presence during succession, where the predicted probability of occurrence is more than 0.5 × the maximum predicted probability (see Fig. 1). If a modelled optimum exists, it is marked by a vertical bar crossing the range. Numbers of vegetation plots and the number of series in the DaSS database for which the vegetation type was identified are in parentheses.

Table 1. – Differences between the mean number and total cover of species, and relative presence and cover of diagnostic species in 33 modelled vegetation types (Fig. 2) sampled in post-disturbance habitats (DaSS) and in vegetation sampled for the purpose of vegetation classification (CNPD). Diagnostic species for aggregated vegetation units were not defined.

	DaSS Database								CNPD Database							
				All species		Diagnostic species					All species		Diagnostic species			
Vegetation type	Number of plots	Relative number of plots (%)	Number of series	Mean number per plot	Total cover per plot (%)	Mean number per plot	% of all species	Total cover per plot (%)	Number of plots	Relative number of plots (%)	Mean number per plot	Total cover per plot (%)	Chytrý 2007–2013	Mean number per plot	% of all species	Total cover per plot (%)
Ruderal and segetal vegetation																
Weed vegetation	46	2.0	10	18.8	42	–	–	–	1834	6.1	23.7	62	–	–	–	–
Atriplicion	48	2.0	10	14.3	56	3.2	22	40	441	1.5	11.4	57	11	4.1	36	61
Fragarion vescae	158	6.7	16	15.6	45	1.4	9	15	320	1.1	17.6	81	6	2.9	16	29
Dauco carotae-Melilotion	445	18.9	18	16.5	39	0.8	5	6	737	2.4	16.8	73	5	1.5	9	38
Galio-Urticetea	41	1.7	13	19.0	60	1.2	6	16	1524	5.1	14.9	83	5	2.0	14	38
Grassland vegetation																
Corynephorion canescentis	15	0.6	2	19.5	26	2.1	11	11	95	0.3	11.0	77	12	4.1	37	35
Cynosurion cristati	24	1.0	11	24.0	38	0.5	2	3	414	1.4	21.1	81	2	1.3	6	34
Alysso alyssoidis-Sedion	20	0.8	4	14.5	24	3.4	23	11	54	0.2	28.3	52	23	6.9	24	37
Calthion palustris	32	1.4	7	18.1	57	0.5	3	4	1652	5.5	27.5	79	5	2.8	10	25
Calluno-Ulicetea	35	1.5	3	13.3	54	0.3	2	4	584	1.9	19.3	79	2	0.9	5	20
Arrhenatherion elatioris	93	3.9	15	25.8	58	2.3	9	14	1202	4.0	31.2	69	9	5.4	17	29
Alysso-Festucion pallentis	25	1.1	2	15.7	26	3.2	21	14	140	0.5	16.1	57	17	6.0	37	30
Geranion sanguinei	19	0.8	3	22.6	48	4.0	18	8	132	0.4	26.5	65	5	2.7	10	45
Bromion erecti	26	1.1	5	23.3	45	3.0	13	13	149	0.5	49.2	77	23	11.2	23	51
Cirsio-Brachypodion pinnati	103	4.4	9	19.7	44	2.8	14	16	394	1.3	35.5	79	31	12.6	35	55
Festucion valesiacae	56	2.4	2	19.4	46	6.7	34	19	326	1.1	30.4	64	28	10.3	34	56
Wetlands, mires and aquatic vegetation																
Magno-Caricion gracilis	27	1.1	5	13.0	69	1.0	8	23	1043	3.5	7.2	82	3	1.0	14	55
Phragmition australis	94	4.0	9	9.6	56	0.6	6	11	2326	7.7	4.2	70	3	0.7	16	37
Aquatic vegetation	25	1.1	3	13.4	45	–	–	–	3555	11.8	3.0	78	–	–	–	–
Sphagno-Caricion canescentis	42	1.8	2	10.9	49	2.5	23	26	290	1.0	15.5	67	10	4.2	27	35
Sphagnion magellanici	34	1.4	2	6.8	56	2.5	37	43	197	0.7	8.1	45	10	4.7	58	50
Shrubby vegetation																
Salicetea purpureae	15	0.6	4	24.5	78	4.9	20	56	128	0.4	22.9	87	22	7.8	34	81
Sambuco-Salicion capreae	182	7.7	12	18.2	74	1.8	10	55	107	0.4	15.6	85	4	1.9	12	51
Robinia woodlands	35	1.5	5	17.4	83	–	–	–	287	1.0	18.8	87	–	–	–	–
Berberidion vulgaris	58	2.5	8	20.0	83	2.3	12	47	220	0.7	19.9	79	8	2.6	13	48
Forest vegetation																
Dicrano-Pinion sylvestris	112	4.8	8	13.1	66	4.2	32	55	317	1.1	9.8	72	7	3.0	30	37
Alnion incanae	37	1.6	8	24.2	86	4.9	20	49	473	1.6	30.8	87	24	10.1	33	71
Quercion roboris	58	2.5	9	22.3	74	4.2	19	48	213	0.7	20.8	82	17	8.1	39	76
Alnetea glutinosae	44	1.9	6	14.3	76	2.9	20	37	147	0.5	26.4	94	24	8.7	33	75
Tilio platyphylli-Acerion	74	3.1	6	24.4	82	5.5	22	56	546	1.8	26.1	85	23	10.3	39	70
Vaccinio uliginosi-Pinion sylvestris	31	1.3	6	11.8	67	2.6	22	41	121	0.4	13.9	83	15	7.0	51	71
Carpinion betuli	16	0.7	5	28.9	82	5.3	18	41	629	2.1	30.0	89	43	16.7	56	81
Quercetea pubescentis	15	0.6	5	22.2	79	3.2	14	22	289	1.0	36.4	85	49	16.2	45	77

databases (Table 1), the mean number of species per plot was 12% lower and mean total cover 23% lower in DaSS. The ratio and cover of diagnostic species were generally about half that in post-disturbance habitats.

Discussion

Successional series in central Europe start with vegetation types with prevailing annuals, followed by perennial herbaceous plants and graminoids, shrubs and then trees (Moravec 1969, Leuschner & Ellenberg 2017, Prach & Walker 2020; Fig. 2). First years of succession are usually characterized by weed and ruderal vegetation (Walker & del Moral 2003). Our data indicate that this period might last up to 30 years following disturbance but usually is much shorter. It is very dependent on the conditions at a site. Weed and ruderal vegetation is replaced by grassland. Under dry conditions it is usually broad-leaved semi-dry grasslands of *Cirsio-Brachypodion pinnati* and *Bromion erecti* alliances, which may appear in their species-poor form even in the first decade after disturbance. The narrow-leaved dry grasslands of the alliance *Festucion valesiacae* develop more slowly, usually not before two decades after disturbance (Prach et al. 2007), probably because they often appear at localities with the most extreme conditions. Mesophilous grasslands of the alliance *Arrhenatherion elatioris* prevail in mesic environments (Chytrý 2007–2013). *Arrhenatherum elatius*, which is typical of this vegetation, is competitive and currently spreading (Pyšek et al. 2012).

Occurrence of shrubby and forest vegetation types along the chronosequence gradient is usually late and depends on site moisture, as they are absent or only develop slowly at very wet and very dry sites (Prach et al. 2007, Řehounková et al. 2018). However, there is one clear exception: the most frequently recorded forest vegetation *Dicrano-Pinion sylvestris* (4.8% – DaSS database), typical of both dry and wet sandy soils, can occur even in the first decades of succession but in an impoverished form. Seedlings of *Pinus sylvestris* appear early after a disturbance and even well-developed pine vegetation on acid bedrock is naturally species-poor in central Europe and usually contains species of open habitats (Chytrý 2007–2013). Therefore, this type of vegetation can occur even in the initial stages (Řehounková & Prach 2006), i.e. chronosequentially much earlier than other shrubby and forest vegetation types.

The DaSS database was primarily sampled as a source of data for the description of the successional variability along a temporal-spatial gradient (Prach et al. 2014, 2016). It contains many transitional stages between vegetation types, species-poor plots and plots dominated by generalists, with low numbers of diagnostic species useful for vegetation classification. Therefore, some parts of the DaSS database can only be classified as a central type of vegetation of higher rank (Dierschke 1981). Missing diagnostic species are probably the reason why some alliances of vegetation in late-successional stages were obviously underestimated. Typical examples of such vegetation are beech forests. While *Fagus sylvatica* occurred in 183 plots in the DaSS database (in 19 as subdominant or dominant species), the classification identified only five plots as *Luzulo-Fagion sylvaticae* due to the lack of other typical diagnostic species. Therefore, this and other similar types were not considered in the modelling. Vegetation types delimited by phytosociological units may alternatively represent subsequent post-disturbance habitats, which are usually defined by a range of successional ages or physiognomically by prevailing life-forms or growth-forms (Walker & del Moral 2003). We combined all three of these approaches.

Comparing the basic community characteristics of classified plots in the DaSS database with the same vegetation types in the CNPD database (Table 1), young post-disturbance ruderal habitats were comparable in terms of the number of species and diagnostic species. However, some types of diagnostic species-rich vegetation, such as dry grassland or thermophilous oak forest, frequently have only almost half the species and diagnostic species in the DaSS database. It is a natural situation because seed dispersal of many diagnostic dry grassland and forest species is relatively slow (Novák & Prach 2003). Plots collected for documentation of successional gradients (DaSS database) were sampled relatively shortly after the initial disturbance. Plots sampled for vegetation classification purposes (CNPD database) are usually well preserved over a long period and often blocked by regular management (e.g. mowing or grazing), which resulted in them being naturally enriched. Even though post-disturbance habitats are frequently considered to be potentially interesting new artificial refugia for many endangered species (Řehounková et al. 2020) they are not as well-developed as semi-natural and natural habitats. However, the comparison of databases is not completely objective as DaSS may reflect the proportion of species differently from CNPD. This is because DaSS contains rather high proportion of fixed permanent plots, whereas many plots in the CNPD database were sampled because they contained a high proportion of diagnostic species and vegetation specialists and low proportion of generalists (Roleček et al. 2007). Successional series in the DaSS database are frequently from spatially restricted areas and, therefore, some geographically important species may not be included.

The data presented have some obvious limitations. The variability among the series is high (for details see Prach et al. 2014) and here we considered only the first seven decades of succession. Succession certainly proceeds further, with many optima occurring after 70 years. In an earlier study (Prach et al. 2016) we predicted that successions take at least two centuries on average to reach the respective potential natural vegetation. Consequently, the real optima of late-successional types of vegetation occur later than after 70 years. Another limitation can be due to using the machine learning classification method. It indicated that about 85% of plots of the training dataset were classified correctly. Therefore, at least 15% of plots were misclassified. However, after the expert check most of the misclassified plots were assigned to a similar alliance. We also presume that the a priori classification used for evaluating the validity of the a posteriori classification has some internal problems, because it works, for example, without distinguishing the layer of vegetation cover.

Despite this and bearing in mind the possible problems with individual vegetation types, we consider all classified data used in our study sufficiently representative of seral vegetation in central Europe. Various phytosociological units (often alliances) were used in the past to describe particular successions using simple and intuitive box diagrams, often without exact dating (e.g. Pyšek 1977, Ellenberg 1988). Our approach is the first to quantify the occurrence of vegetation units in a high number of successional series and stages in a formalized way. The temporal optima obtained, when particular vegetation units characterize the seral vegetation, can be used for an approximate prediction of successional changes in central Europe and as a tentative guide in restoration projects.

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Souhrn

Identifikace rostlinných společenstev je jedním z nutných předpokladů porozumění fungování ekosystémů a nezbytným základním dorozumívacím nástrojem pro aplikovaný výzkum. Přesto jsou však studie vegetační klasifikace disturbovaných stanovišť poměrně vzácné. Je to dáno zejména obtížností identifikace vegetačních typů v rámci sukcesních sérií. Protože algoritmy strojového učení nově umožňují formálně zařadit do vegetačních svazů větší část fytocenologických snímků databáze sukcesních sérií (DaSS), porovnali jsme v tomto článku zastoupení vegetačních svazů v závislosti na čase od poslední disturbance. Pomocí expertního systému Vegetace ČR a metody strojového učení GRIMP se podařilo do svazů jednoznačně zařadit asi dvě třetiny ze všech 3492 snímků DaSS databáze. Následně jsme pro 33 dostatečně zastoupených vegetačních typů pomocí Huisman-Olff-Fresco modelů identifikovali optima a intervaly jejich nejčastějšího výskytu v časovém intervalu 0–70 let od iniciálního narušení substrátu. V souladu s obecnými předpoklady se hlavní vegetační typy na časové ose seřadily od ruderální a segetální vegetace přes trávníky po křovinnou a lesní vegetaci. Zdaleka nejčastějším vegetačním typem identifikovaným v databázi byla ruderální vegetace reprezentovaná svazy *Dauco carotae-Melilotion* a *Fragarion vescae*. Fytocenologické snímky zaznamenané na disturbovaných plochách byly ve srovnání s vegetací dokumentovanou v České národní fytocenologické databázi (CNPD) průměrně o 12 % druhů chudší, měly o 23 % nižší pokryvnost a pouze poloviční počet diagnostických druhů. Získaná data potvrzují, že vegetace vykazuje během sukcesního vývoje nižší druhovou diverzitu. Je také méně fytocenologicky vyhraněná než obdobná vegetace na přirozených a polopřirozených stanovištích, kde vývoj rostlinného krytu často dlouhodobě blokují faktory prostředí nebo lidská činnost (např. sečení nebo pastva). Rozdíly mezi oběma databázemi jsou pravděpodobně ještě zvýrazněny tím, že každá byla pořízena za jiným účelem, a proto i výběr snímkovaných ploch nepodléhal stejným kritériím. Získaná sukcesní optima a přibližná lokalizace jednotlivých vegetačních typů na sukcesním gradientu mohou posloužit například jako nástroj pro přibližnou predikci vegetačních změn, které probíhají během spontánní sukcese na narušených stanovištích střední Evropy.

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