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Petr Maděra, Soňa Tichá, Radomír Řepka

Distribution and ecological requirements of *Sorbus torminalis* (L.) Crantz in the Czech Republic

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Abstract: This study addresses the distribution of the wild service tree *Sorbus torminalis* (L.) Crantz in the Czech Republic by drawing on publicly available databases and herbarium records. In the Czech Republic, this tree occurs in stands at a proportion greater than 1% in 4350.32 ha of forests; the reduced area of the species is 86.42 ha. However, mapping the biotopes for Natura 2000 showed 3627 segments of biotopes, with the wild service tree occurring in a total area of 31274.4 ha. There are approximately 220179 wild service tree individuals in the Czech Republic. This tree is found at altitudes from 175 to 760 m a.s.l., with the centre between 250 and 450 m a.s.l. It shows no preference for slope orientation and is mostly located at sites with rich, and frequently humus-enriched, soils; however, it is often found at extreme sites with shallow soils in the 1st –5th forest altitudinal zones. In the Czech Republic, the wild service tree clearly prefers plant communities of cl. *Querco-Fagetea*; however, its occurrence was recorded in 10 other classes (20 alliances) of the phytocoenological system. In the conditions of the Czech Republic, natural regeneration of the wild service tree occurs in approximately 55% of the stands in which it is present.

Additional key words: wild service tree, abundance, presence in plant communities

Address: P. Maděra, S. Tichá, R. Řepka. Department of Botany, Dendrology and Geobiocoenology Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic e-mail: petrmad@mendelu.cz

Introduction

The subgenera *Torminaria* contains 1–3 species, including *S. torminalis*. These species have a set of morphological characters that make them completely different from other European species of the genus, and they are therefore quite dissimilar (Warburg and Kárpati 1968, Kovanda 1992, Aldasoro et al. 2004).

The wild service tree, *Sorbus torminalis* (L.) Crantz, is distributed across western, central and southern Europe, northwest Africa and southwest Asia. The wild service tree is both scarce and valuable with regard to its timber and its roles in soil and biodiversity protection, the landscape and ecological plasticity. In the past four decades, most European countries have become interested in the ecology and silviculture of the wild service tree, and many studies have been published (Nicolescu et al. 2009). The wild service tree is a useful indicator of ancient woodlands and hedgerows and has a marked preference for two soil types: those derived from clays and those derived from harder limestones (Roper 1993). The distribution and use of the wild service tree have drastically decreased since the conversion from coppice-with-standards to high forest and the replacement of wood by other materials (Zeitlinger 1990,

Kausch-Blecken von Schmeling 1994). Therefore, the wild service tree is an almost forgotten tree species that has recently been "rediscovered" for economic and natural conservation reasons (Ewald et al. 1994). It has been of economic interest for a long time only in France (Wilhelm 1993). In Turkey, it is used as a medicinal plant (Kültür 2007). However, stands that include wild service trees in a high proportion are rare (Müller et al. 2000). The wild service tree is a light-demanding woody plant, requiring high temperatures and high contents of soil nutrients. It can grow in dry soils because it is tolerant of water deficits. Under future climate change conditions, the wild service tree should replace some tender woody plants that are sensitive to drought (Paganová 2007). In Central Europe, populations of *S. torminalis* are scattered, often small (100 individuals) and spatially isolated (Hoebee et al. 2007). For example, in the Czech Republic (CR), this tree is classified as an endangered species (Úradníèek et al. 2010), and in Poland, it is protected by law (Bednorz 2007b).

This study describes the distribution and abundance of the wild service tree in the CR in detail using available databases, data from the literature and herbarium records and the authors' knowledge. Another aim was to evaluate the ecological requirements of the tree in regards to site conditions, its occurrence in plant communities and phytogeographic units.

Methods

Distribution of the wild service tree in the Czech Republic

We used the following databases for evaluating the wild service tree distribution: the National Forest Inventory – 104 records of occurrence; the Department of Forest Typology, Forest Management Institute – 1115 records; the Czech National Phytosociological Database – 1027 records (Chytrý and Rafajová 2003); the Forest Management Plan database (FMP) – 1210 records; a database of the Agency for Nature Conservation and Landscape Protection of the Czech Republic (ANCLP) – 3727 records and floristic databases (Danihelka et al. 2011) – 406 records; works by Zahradová (1988) – 316 records; and J. Čáp's private database – 58 items. The oldest record was from 1826, and most of the data were from the past century; a large number of records were recent and originated from the biotope mapping within Natura 2000 and the creation of forest management plans that were no more than ten years old.

All of the databases include geographic coordinates, which were used to create a map of the wild service tree distribution in the CR. Furthermore, the map was supplemented with excerpts from the literature, records from the largest institutional herbaria of the CR and the authors' personal finds, totalling 395 records. The distribution map with floristic mapping squares was created in the GIS package ArcInfo and contained 8358 database occurrence records for the wild service tree.

Individual records were classified into units based on the phytogeographical divisions of the CR (Skalický 1988) and natural forest regions (Plíva, Žlábek 1986). Records that were less than 100 m from each other were combined for the purposes of phytogeographical evaluation; thus, 6396 locations were used.

Abundance of wild service tree in the Czech Republic

Only selected databases were used for the abundance estimation. We first used the FMP database, which contains the following data: the area of the stands where the wild service tree occurred, its proportion, with a minimum of 1%, the stocking and the age of the stand. The number of wild service tree individuals was calculated based on the area, proportion, stocking and age of the stand. We referred to growth tables for oak, which has growth properties similar to those of the wild service tree.

$$N_1 = P_a * Z * K * N_{GTa},$$

where N_1 = the number of wild service tree specimens in the stand, P_a = the area of the stand in a particular age class [ha], Z = the proportion of wild service trees [%], K = the stand stocking and N_{GTa} = the number of trees per hectare based on growth tables for oak and the particular age class.

The total number of specimens in stands where the proportion of wild service trees was greater than 1% N_{FMP} was calculated as follows:

$$N_{FMP} = \Sigma N_1 \ldots\ldots N_{1210}$$

The second database that was available for an estimation of abundance was from the ANCLP database. The final estimate of wild service tree abundance in the Czech Republic was produced based on the hypothesis that stands with a recorded proportion of wild service trees over 1% in the FMP database were also recorded in the ANCLP database; that is, because the wild service tree occurred in some areas at proportions of less than 1%, the ANCLP database had more records than the FMP database. The abundance derivation was conducted using areas within particular natural forest regions (NFRs). According to the FMP database, there were an average of 9 wild service tree individuals per hectare in all stands with a proportion of 1% (i.e., stands of all age classes with various stockings). To convert the area of biotopes with wild service tree proportions of less than 1% into the

number of individuals, we estimated that there was an average of four trees per a hectare.

$$N_{ANCLP} = (P_{ANCLP} - P_{FMP})*4,$$

where N_{ANCLP} = the number of specimens in the area of biotopes where the proportion of the wild service tree was lower than 1%, P_{ANCLP} = the area of biotopes in the ANCLP database, P_{FMP} = the area of biotopes in the FMP database.

The final estimation of abundance (N_T) was the sum of the number of specimens in the FMP database and the number of specimens in biotopes where the wild service tree proportion was less than 1%.

$$N_T = N_{FMP} + N_{ANCLP}$$

Evaluation of ecological requirements of wild service tree in the Czech Republic

The selected databases also included data on characteristics of the biotope (area, altitude, altitudinal zone, slope orientation, edaphic categories and ecological series, age of stands, syntaxon, forest type), which were assessed in Microsoft Excel.

Wild service tree regeneration

The regeneration of the wild service tree in the CR was evaluated using the data on its distribution in the E1 synusia in phytocoenological relevés from the above-mentioned databases.

Results

Distribution of the wild service tree in the Czech Republic

Based on 8358 database items with geographical coordinates of wild service tree occurrences, a map of the tree's distribution in the CR was created (Fig. 1). The map showed that the tree had two significant centres of occurrence in the CR: one in south Moravia and another in central and north Bohemia. Both centres were more or less functionally connected in scattered locations along alluvial plains of the Svitava, Orlice and Labe rivers. The analysis of the accessible data (phytochoria according to Skalický 1988 containing 6396 locations) showed that the wild service tree was mostly present in the Mesophyticum (55.25%, Mesophyticum Massivi Bohemici 2783 locations and Mesophyticum Carpaticum 750 locations), occurred less often in the Thermophyticum (44.72%, Thermobohemicum 1719 and Pannonicum 1141 locations) and was sporadic in the Oreophyticum (0.03%). The tree's occurrence was confirmed in 68 of the 99 phytogeographical districts (PD) of the CR. The tree was highly abundant in thermophytic areas and warmer mesophytic areas of central Bohemia in PDs 4. Lounsko-labské středohoří (605 locations), Český kras (709) and 32. Křivoklátsko (1055). The wild service tree was common and abundant in the Pannonian part of south Moravia; however, its occurrence in low-

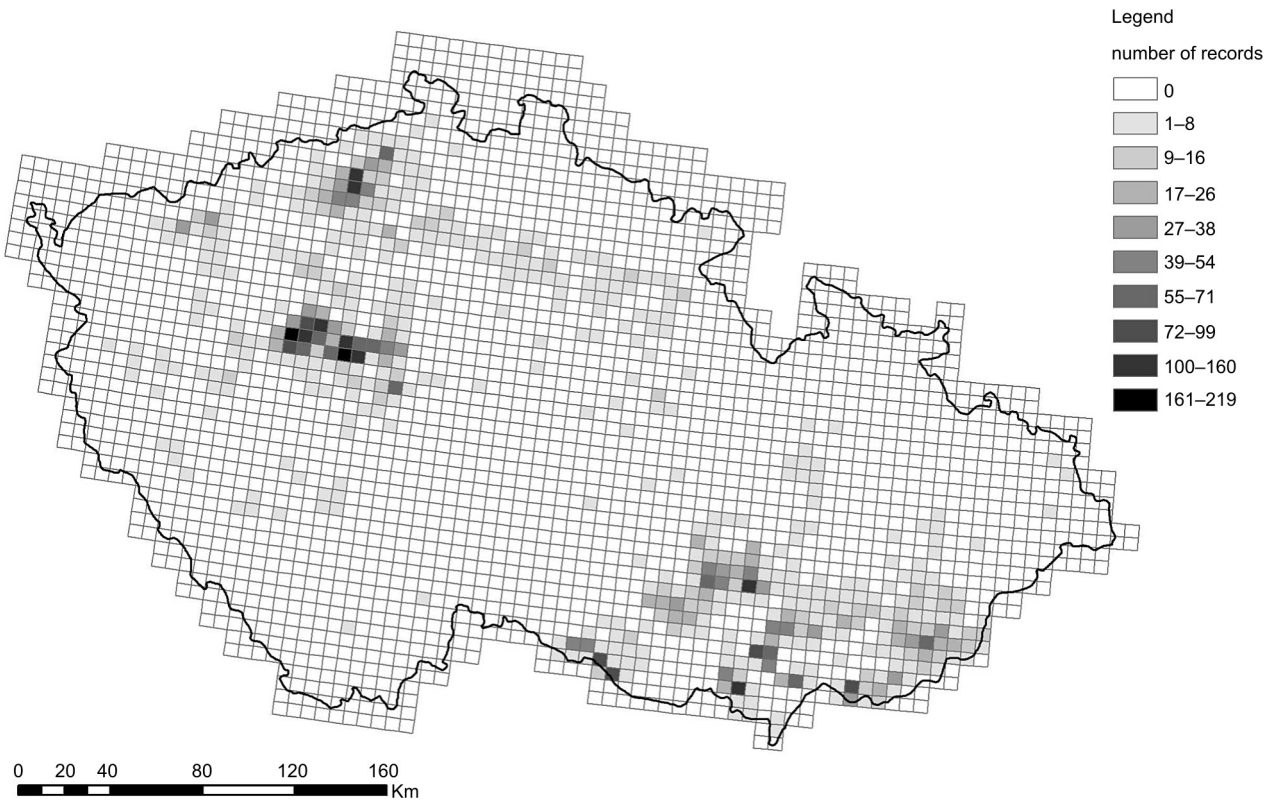

Fig. 1. Distribution of the wild service tree in the Czech Republic in the squares of floristic mapping

Table 1. Distribution and degree of abundance (DA) of the wild service tree in phytochoria of the Czech Republic

No.	Phytochorion (phytogeographical subregion and district)	DA
	BOHEMIAN THERMOPHYTICUM	
1	Doupovská pahorkatina	✯
2	Střední Poohří	●
3	Podkrušnohorská pánev	✯
4	Lounsko-labské středohoří	ᚿ
5	Terezínská kotlina	●
6	Džbán	✯
7	Středočeská tabule	✯
8	Český kras	ᚿ
9	Dolní Povltaví	✯
10	Pražská plošina	✯
11	Střední Polabí	●
12	Dolní Pojizeří	✯
13	Rožďalovická pahorkatina	✯
14	Cidlinská pánev	✯
15	Východní Polabí	✯
	PANNONIAN THERMOPHYTICUM	
16	Znojemsko-brněnská pahorkatina	ᚿ
17	Mikulovská pahorkatina	ᚿ
18	Jihomoravský úval	✯
19	Bílé Karpaty stepní	ᚿ
20	Jihomoravská pahorkatina	ᚿ
21	Haná	✯
	CARPATHIAN MESOPHYTICUM	
76	Moravská brána	✯
77	Středomoravské Karpaty	ᚿ
78	Bílé Karpaty lesní	ᚿ
79	Zlínské vrchy	ᚿ
80	Střední Pobečví	●
81	Hostýnské vrchy	✯
82	Javorníky	✯
83	Ostravská pánev	●
84	Podbeskydská pahorkatina	●

ᚿ rarely (1–10 locations), ● scattered (11–159 locations), ✯ frequently (> 160 locations)

land PD 18. Jihomoravský úval was surprising, and its occurrence in the aeolian sands of the Hodonínská Doubrava forest near Hodonín town was ecologically exceptional. In the Carpathian part of Moravia, its abundance his highest in PDs 77. Středomoravské Karpaty, 78. Bílé Karpaty lesní and 79. Zlínské vrchy (Table 1).

Abundance of the wild service tree in the Czech Republic

Based on the data from the FMP records, the wild service tree appeared in stands at a proportion greater than 1% in 4350.32 ha of forest (approximately 0.16% of the forest area in the CR); the reduced area of the wild service tree was 86.42 ha. The distribution of the area of these stands within the NFRs is presented in Table 2 and by age classes in Table 3. In reality, the proportion of the wild service tree in the CR forests was greater because the forest management plans did not contain stands where the wild service tree proportion was less than 1%. The results of the biotope mapping within Natura 2000 gave us an idea of the area of these stands. The mapping revealed 3627 segments where the wild service tree occurred, with a total area of 31274.4 ha (Table 2). After deducting the area of biotopes where the wild service tree proportion was greater than 1%, we obtained 26924.08 ha in which the wild service tree proportion was less than 1%. The total number of wild service trees growing in the Czech Republic was estimated to be 220179 (Tabs 2 and 3). The wild service tree occurred in 29 of the 41 NFRs (Table 2).

Altitudinal evaluation of the distribution of the wild service tree in the Czech Republic

In the CR, the wild service tree grew at altitudes of 175 to 760 m a.s.l., with the greatest occurrence at 250 to 450 m a.s.l. (Fig. 2); from the perspective of forest typology, these altitudes correspond to the 1st through 5th forest altitudinal zones. Nearly all of the sites were located in the 1st through the 3rd altitudinal zones. It was highly exceptional for the tree to occur in the 4th and 5th forest altitudinal zones and the 0th zone, which represents relict pinewoods with an azonal distribution.

Slope orientation

The distribution of the sites in relation to the slope orientation is presented in Figure 3. The wild service tree in the CR preferred northern and southern exposures more than eastern and western slopes. No relationship between the slope orientation and altitude has been found.

Soil ecological features

The wild service tree was found predominantly at sites with rich soils of limestone, loess and loess loam (64.5%), including humus-enriched soils (19.0%); furthermore, the species was present at extreme sites with shallow soil (8.0%) and was less abundant at sites with mineral-poor soils with low pH (6.25%). Its occurrence was negligible at gleying sites (2.0%) and sites affected by flowing water (0.25%), and it did not occur in peat and waterlogged soils.

Phytocoenological characteristics

In the CR, the wild service tree occurred in a wide range of forest and non-forest plant communities

Table 2. The total stand area (SA), reduced stand area (RA) and number of specimens (NoS) according to the Forest Management Plan (FMP) database and Agency for Nature Conservation and Landscape Protection of the Czech Republic (ANCLP) database with a proportion of the wild service tree in natural forest regions

No. and name of Natural Forest Region	FMP database			ANCLP database		Total NoS
	SA [ha]	RA [ha]	NoS [pcs]	SA [ha]	NoS [pcs]	
1. Krušné hory				142.20	569	569
2. Podkrušnohorské pánve				16.11	64	64
4. Doupovské hory	22.11	1.13	454	496.15	1896	2350
5. České støedohoří	503.08	23.39	8516	2003.61	6002	14518
6. Západočeská pahorkatina				68.48	274	274
7. Brdská vrchovina				28.18	113	113
8. Křivoklátsko a Český kras	2386.97	35.72	33935	6220.37	15334	49269
9. Rakovnicko-kladenská pahorkatina	18.93	0.87	148	462.70	1775	1923
110. Středočeská pahorkatina	7.63	0.33	101	697.94	2760	2861
12. Předhoří Šumavy a Novohradských hor				29.01	116	116
16. Českomoravská vrchovina	0.93	0.28	2765	0.50	0	2765
17. Polabí	19.56	0.26	239	1392.83	5493	5732
18. Severočeská pískovcová plošina a Český ráj	0.99	0.01	13	120.32	477	490
19. Lužická pískovcová vrchovina				7.75	31	31
23. Podkrkonoší	21.98	0.47	1054	8.10	0	1054
24. Sudetské mezihoří				1.89	8	8
26. Předhoří Orlických hor				31.66	127	127
28. Předhoří Hrubého Jeseníku				6.17	25	25
30. Drahanská vrchovina	257.12	5.94	3374	2697.02	9760	13134
31. Českomoravské mezihoří				269.22	1077	1077
33. Předhoří Českomoravské vrchoviny	70.34	0.94	3031	5170.56	20401	23432
34. Hornomoravský úval	0.22	0.002	22	327.82	1310	1332
35. Jihomoravské úvaly	397.93	9.26	51627	2482.66	8339	59966
36. Středomoravské Karpaty	291.58	3.76	2821	2394.63	8412	11233
37. Kelečská pahorkatina				18.89	76	76
38. Bílé Karpaty a Vizovické vrchy	339.48	3.88	3367	5943.07	22414	25781
39. Podbedskydská pahorkatina	5.47	0.11	663	88.18	331	994
40. Moravskoslezské Beskydy				0.01	1	1
41. Hostýnské vrchy a Javorníky	5.97	0.06	28	148.35	570	598
Total	4350.32	86.42	112424	31274.4	107755	220179

(Table 4). Its occurrence has been recorded in 20 alliances of 11 phytocoenological system classes (Moravec 1988), with 90% in the class *Querco-Fagetea*. Of these occurrences, 41.5% were from communities of the alliance *Quercion pubescenti-petraeae* (6.3% relevés were recorded from *Sorbo torminalis Quercetum* association), 35.5% were from the *Carpinion* alliance, 7.5% were from communities of the *Fagion* alliance, 5% were from the *Tilio-Acerion* alliance, 3.8% were from the *Genisto germanicae-Quercion* alliance and 0.5% were from the *Dicrano-Pinion* alliance. The wild service tree occurred at the edges of thermophilic oak stands of the class *Trifolio-Geranietea sanguine*, bushes of the class *Rhamno-Prunetea* and at clearing stages of the class *Epilobietea angustifolii* in approximately 1% of the records. Interestingly, its occurrence has also been recorded outside forests in non-forest communities and, more abundantly, in communities of the class *Festuco-Brometea*.

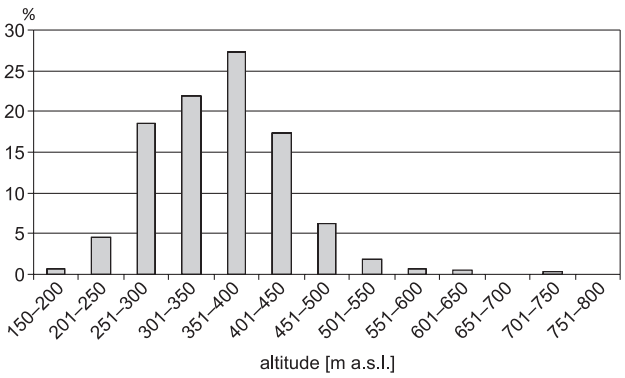

Fig. 2. Percentage of occurrence of the wild service trees at different altitudes

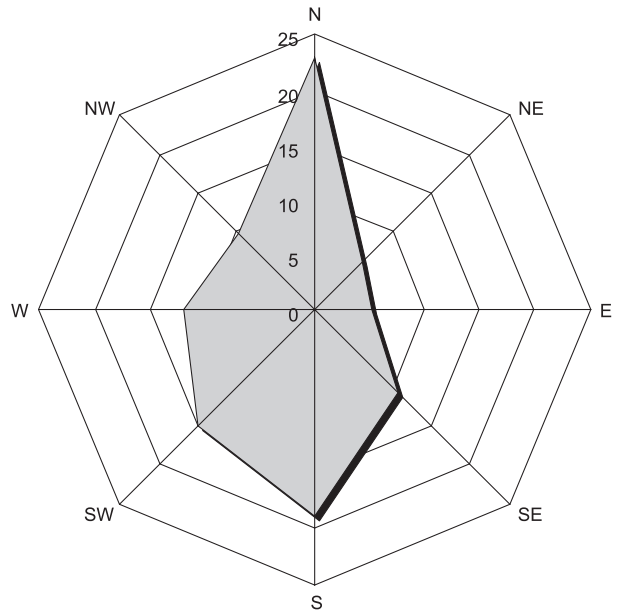

Fig. 3. Percentage of occurrence of the wild service trees at different slope orientations

Table 3. Estimation of tree numbers, stand area and reduced stand area (stand with abundance of the wild service tree higher than 1%) by age classes

Age class [years]	No of stands [No]	No of trees [No]	Stand area [ha]	Reduced stand area [ha]
10	164	64624	150.6	7.7
20	52	12267	89.4	1.4
30	48	5360	76.7	1.8
40	50	2296	108.4	2.0
50	48	2060	145.6	2.1
60	31	1001	122.6	1.4
70	111	4245	464.2	6.5
80	109	4194	439.5	8.4
90	136	5848	620.7	14.8
100	108	3558	429.8	9.8
110	156	2036	313.0	6.8
120	82	1503	311.3	6.0
130	43	1096	151.2	4.6
140	50	450	185.3	3.2
150	18	238	99.2	1.3
160	32	471	217.8	2.7
170	34	468	223.3	2.5
180	17	190	80.0	1.0
190	13	314	76.6	1.7
200	3	33	20.2	0.2
200+	7	172	27.1	1.0
	1312	112424	4353.0	87.0

Table 4. The number of cases of phytocoenological relevés with occurrence of the wild service tree being classified into syntaxons of the phytocoenological system

Syntaxon (class and alliance)	No.	No.
MOLINIO-ARRHENATHERETEA		1
Arrhenatherion	1	
NARDO-CALLUNETEA		1
Vaccinion	1	
SEDO-SCLERANTHETEA		1
Hyperico perforati-Scleranthion perennis	1	
FESTUCO-BROMETEA		17
Alysso-Festucion pallentis	3	
Seslerio-Festucion pallentis	3	
Festucion valesiacae	7	
Bromion erecti	4	
TRIFOLIO-GERANIETEA SANGUINEI		13
Geranion sanguinei	10	
Trifolion medii	3	
RHAMNO-PRUNETEA		17
Berberidion	13	
Prunion spinosae	4	
QUERCO-FAGETEA		929
Carpinion	369	
Tilio-Acerion	53	
Fagion	77	
Quercion pubescenti-petraeae	430	
QUERCETEA ROBORI-PETRAEAE		40
Genisto germanicae-Quercion	40	
VACCINIO-PICEETEA		5
Dicrano-Pinion	5	
ROBINIETEA		1
Chelidonio-Robinion	1	
EPILOBIETEA ANGUSTIFOLII	5	9
Carici piluliferae-Epilobion angustifolii	1	
Sambuco-Salicion capreae	3	

Regeneration of the wild service tree

Table 3 shows that the highest proportions of the wild service tree were found in stands that were 70 to 110 years old. In older stands, the tree frequency dropped as the area decreased. Additionally, the proportion of the wild service tree in stands that were 11 to 60 years old was lower. During the period after World War II, the socialist forest management turned to high forests and the clear-felling system with artificial regeneration. The threefold increase in the proportion of wild service trees in stands less than 10 years of age reflects the change in forestry after the collapse of communism in 1989 and is indicative of the significance gradually allotted to natural regeneration. In the youngest age class, approximately twice

the stand area was regenerated during the past ten years compared with the previous decade; however, the reduced stand area of the wild service tree expanded more than four times. Therefore, the stand groups containing the wild service tree were relatively small but have a relatively high proportion of the tree. Additionally, the data from phytocoenological relevés (2160 records) revealed a 55% presence of the wild service tree in the herb layer, which represents natural regeneration.

Discussion

The evaluation of its detailed distribution revealed that the wild service tree was relatively abundant in the CR; however, in 10- to 60-year-old stands, it was only half as abundant as in older stands. This distribution has led Úradníček et al. (2010) to consider the species to be vulnerable in the CR. In Poland, this species has even been granted legal protection (Bednorz 2007b). A detailed and complex description of the distribution of the wild service tree in the CR has not yet been published. There is a short summary of its occurrence in compendium Květena ČR (Kovanda 1992), which confirms the presence of the species in 41 phytogeographical districts of the CR; however, we have reported its occurrence in 68 phytogeographical districts. Some occurrences were exceptional in the phytochorion (1 record), and in many cases, they may have belonged to a planted specimen (e.g., its occurrence in PDs 11. Střední Polabí, 39. Třeboňská pánev and both records from the phytogeographical region Oreophyticum). The studies published to date that mention the species are surprisingly few, and they either simply note the occurrence of the wild service tree (Velička 1993, Čeřovský et al. 2007, Dostál, 2002, Fiedler 1974, Hofmeister 2001, Kovanda 2000, Lepší et al. 2009, Sedláčková and Lustyk 1999) or describe the distribution of the wild service tree in a limited area (Šefl 2007, Zahradová 1988). Studies assessing the species from a forestry perspective have been published only rarely (Prudič 1998, Hurt and Kantor 2004).

In other European countries, the tree is considered a rare woody plant with small, isolated populations (Hoebee et al. 2007, 2006, Rasmussen and Kollmann 2004b, 2007, Oddou-Muratorio et al. 2005, Belletti et al. 2008, Kausch-Blecken von Schmeling 1994, Roper 1993, Bednorz et al. 2006, Paganová 2008, Demesure et al. 2000). This species was originally scattered in the natural landscape, but traditional human forest management since medieval times has favoured light-demanding forest species (Wohlgemuth et al., 2002). The wild service tree is an indicator of primary woodlands and ancient hedgerows (Roper 1993). The main reason for its decline is the conversion of the coppice management system (coppice or coppice with standards) to high forests, which are managed by clear-felling and artificial regeneration (Bradshaw 2004, Rasmussen and Kollmann 2008, 2007, Angelone et al. 2007, Oddou-Muratorio et al. 2004, Rasmussen 2007, Müller et al. 2000, Kausch-Blecken von Schmeling 1994, Collet et al. 2008). According to the most recent inventory in Poland, the wild service tree occurs at 73 natural sites, and its population does not exceed 2500 individuals (regeneration not counted). Local populations are small, and there are only 8 sites with more than 100 trees (Bednorz 2007b).

In agreement with the findings of Bednorz (2007a, 2010), Paganová (2007), Rassmussen and Kollmann (2004a), the wild service tree occurred in a wide range of plant communities in the CR, including oak-pine forests of the *Dicrano-Pinion* alliance, oak forests *Quercetalia robori-petraeae* and *Quercetalia pubescenti-petraeae*, oak-hornbeam forests of the *Carpinion* alliance and beech forests of the *Fagion* alliance. The species was also associated with high shrubs of the class *Rhamno-Prunetea* and dry turfs of the class *Festuco-Brometea*, where it grew as a shrub as it does in Poland, Switzerland, Denmark and Germany. The species most often appeared in oak-hornbeam stands and thermophilic oak stands, but because of shading, it gradually retreats to stand edges, which is significant for species diversity (Škodová and Gajdoš, 2011). The wild service tree is a woody plant that is highly suitable to be planted in biocorridors and other linear elements in the lowlands and uplands (Úradníček 2004, Jelínek and Úradníček 2010).

With regard to the ecological requirements of the species, the wild service tree can be considered a light-demanding woody plant that requires high temperatures and high levels of soil nutrients and is able to grow in dry soils that infrequently experience water deficits (Paganová 2007, 2008, Roper 1993, Kausch-Blecken von Schmeling 1994). Its distribution and altitude dependence differ in various parts of Europe. Although the altitudinal limit in Britain is 300 m (Roper 1993), Belletti et al. (2008) reported the wild service tree at 100–1000 m a.s.l. in Italy. Saravi et al. (2008) and Tabandeh (2007) found the species at 1600–2300 m a.s.l. in northern Iran. At the northern limits of its range in Denmark, however, it occurs at 1–60 m a.s.l. (Rasmussen and Kollmann 2007). Paganová 2007 found an altitudinal limit in Slovakia (720 m a.s.l.) similar to those in the records from the Czech databases (760 m a.s.l.) and the literature (726 m a.s.l.; Kovanda 1992), with the centre of its occurrence being in the first three altitudinal zones (Paganová 2007, Prudič 1998). However, there were no consistencies concerning slope orientation. Most wild service tree sites in Slovakia are of southern orientation (Paganová 2007), yet in the CR, no significant dependence on slope orientation has been found.

The natural regeneration from seeds, which ripen starting in August and decrease in October (Bednorz and Urbaniak 2005), can be endangered by competition from faster-growing woody plants (Collet et al. 2008), massive feeding on seeds by rodents (Velička 1993) and browsing by ungulates (Biedenkopf et al. 2007, Collet et al. 2008), although Boulanger et al. (2009) classify the wild service tree among the plants least endangered by browsing. In the CR, phytocoenological relevés proved that at more than half of the sites studied, the wild service tree regenerates. The growth of saplings seems to be more troublesome because it is likely limited by browsing and an insufficient supply of light under closed canopies.

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