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Ecological requirements of wild service tree (*Sorbus torminalis* [L.] CRANTZ.) and service tree (*Sorbus domestica* L.) in relation with their utilization in forestry and landscape

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ABSTRACT: Environmental conditions in sites with service tree and wild service tree are assessed and some ecological differences between them are also identified. Both species are regarded as prospective woody plants with a possibility of wider utilization in forestry and landscape arrangements. They are tolerant to direct sunlight and short-time water deficit in the soils, therefore they are suitable for the afforestation of arid and warm sites (even clear unstocked areas). They prefer soils with favourable physical characteristics and adsorbing complex with acid to neutral soil reaction. Both the mentioned taxa have valuable timber, so the potential of their utilization in forestry is also in conditions of oak and beech-oak forests. They should be used as valuable admixture in oak forests or substitute the sensitive beech in drier sites of oak-beech forests.

Keywords: service tree; wild service tree; ecology; soils; aridity; utilization

Regarding the expected changes of global climate (Minďáš, Škvarenina 1994), much effort has recently been focused on rare woody plants, especially those that tolerate higher temperatures and water deficit. Ecology, intraspecific variability, timber production are investigated as well as other aspects important for their economic utilization. The wider use of these plants is assumed in woodlands, possibly as a substitution of some more sensitive woody species. The wild service tree (*Sorbus torminalis* [L.] CRANTZ.) and service tree (*Sorbus domestica* L.) represent such tolerant woody plants under conditions of the Slovakia.

The present occurrence of both species was affected by human activities, mainly by the transformation of oak forests to agricultural land. Information about ecological requirements is sporadic as a consequence of their rare occurrence in landscape. In the Slovakia both the mentioned woody plants are native to southern regions.

MATERIAL AND METHODS

In 1997–2001 the study of the wild service tree was carried out in 34 localities and the service tree was studied in 24 localities. The analysis of environmental conditions (altitude, exposure, ecological-climatic amplitude and soil representatives) enabled to evaluate the occurrence range of these taxa under conditions of the Slovakia.

Altitudinal data on the analyzed localities were obtained from stand maps of forest management units at a scale 1:10,000, which were elaborated by the company Lesoprojekt in Zvolen. The exposure of each locality was determined with a compass. The classification of climate-geographic types and subtypes was done according to Tarábek (1980) and Špánik et al. (1999). Mean temperatures and sums of precipitation were obtained from a digital database in Škvarenina and Minďáš et al. (2003).

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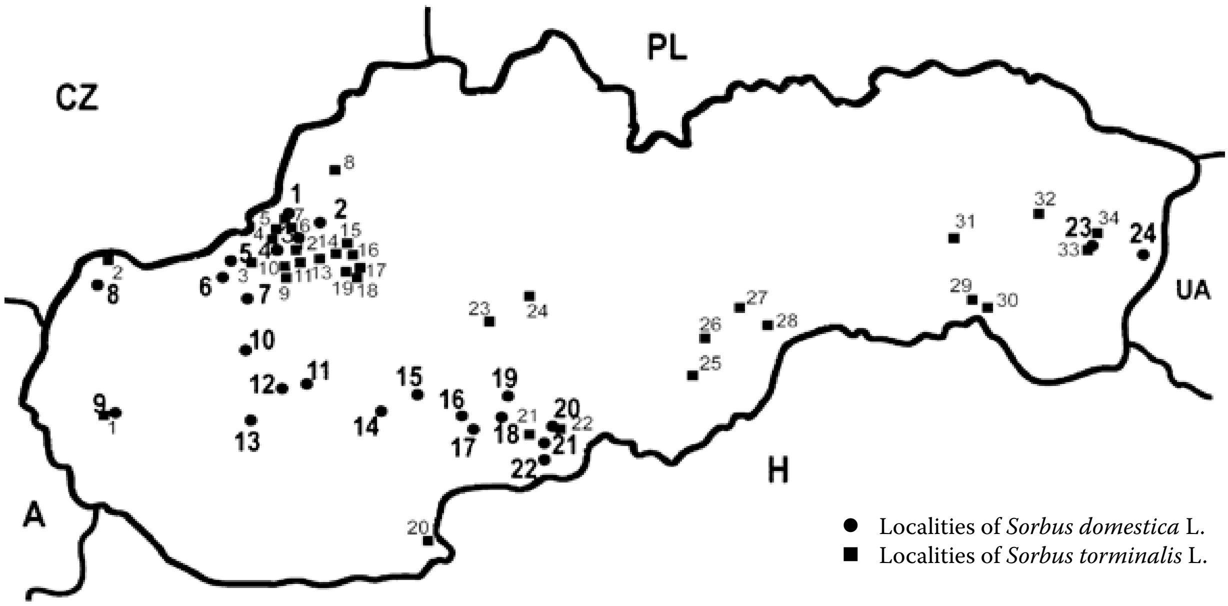

Fig. 1. Distribution of wild service tree and service tree on the territory of Slovakia

The identification of soil representatives was done according to the map of soils in Šály and Šurina (2002). The classification of geomorphological units was done according to the Geomorphological Classification of the SSR and CSSR at a scale 1:500,000 (Kolektív 1986).

The particular localities were classified into groups according to site altitude, exposure, climate-geographic types and soil representatives. Afterwards, the analysis of the value range for each environmental characteristic was done in groups as well as within all analyzed sites for both taxa and their mutual comparison.

RESULTS

Characteristics of analyzed localities

The distribution of 34 localities with wild service tree and 24 localities with service tree is illustrated in Fig. 1. The overwhelming majority of localities with wild service tree (97%) were in forest stands and only two localities (6%) were situated in a forest-steppe stand in former fruit orchards, already covered by the natural seeding of forest woody plants.

In contrast, up to 96% of service trees were found in vineyards, fruit orchards and scarcely on grazing

Table 1. Localities of wild service tree (*Sorbus torminalis* [L.] CRANTZ.) and service tree (*Sorbus domestica* L.) classified according to altitude

Altitude (m)	*Sorbus torminalis*		*Sorbus domestica*	
	N	(%)	*N*	(%)
200–250	2	6	8	33
251–300	8	23	8	33
301–350	4	12	3	13
351–400	7	20	3	13
401–450	5	15	1	4
451–500	3	9	1	4
501–550	1	3		
551–600	3	9		
601–650				
651–700				
701–750	1	3		
Total	34	100	24	100

land, whilst only in two cases some of them grew in a neighbouring forest. Just one locality was found directly in a forest crop. While in sites with wild service tree other forest woody plants also occurred, in sites with service tree *Quercus dalechampii* TEN., *Pyrus pyraster* (L.) BURGSD., *Acer campestre* L., *Sorbus torminalis* (L.) CRANTZ., *Cerasus avium* (L.) MOENCH., *Malus sylvestris* MILL., *Quercus cerris* L. were quite frequent whereas *Quercus pubescens* WILLD., *Sorbus aria* (L.) CRANTZ., *Tilia cordata* MILL., *Sorbus aucuparia* L., *Acer platanoides* L., *Carpinus betulus* L. occurred less frequently. Common representatives of shrubs were mainly *Cornus mas* L., *Prunus spinosa* L. and *Rosa* L. sp.

Evaluation of localities according to site altitude

Considering the influence of site altitude on environmental conditions, localities of the analyzed species were classified into groups (Table 1). The altitude difference of the groups was 50 m.

Collected data has shown that at the lower altitudes (201–250 m) the number of sites with wild service tree is the lowest (6%) while sites with service tree are more abundant up to 33%. Localities of service tree were the most frequent (66%) at the altitudes 201–300 m while sites with wild service tree represented only 29% at the mentioned altitudinal range.

From the overall group of 24 service tree localities, the majority (92%) occurred up to the altitude of 400 m while the percentage of wild service tree sites at this altitude was only 61% (Table 1).

The maximum altitude of sites with service tree was 490 m, the highest occurrence of wild service tree was found at the altitude of 720 m. The majority of service tree localities was at lower altitudes, with the narrower range of vertical distribution (200 to 400 m), and the higher concentration of sites (79%) was at the altitudes of 201–350 m. Localities of wild service tree had a wider vertical range of distribution (within the altitudinal range 220–720 m). Their occurrence was evenly distributed at the altitudes of 251–500 m (79% of all sites).

Evaluation of localities according to exposure

Localities were classified into groups according to the site exposure (Table 2). The collected data show that no sites with satisfactory occurrence of both the analyzed woody plants were found on northern exposure.

The majority of localities with wild service tree were found on south-east exposures (35%), quite abundant they were also on south-west exposures (26%) and on east exposures (15%). On north-east and south exposures there were identically 9% of sites and the lowest number of localities was found on western exposure (6%).

Generally, up to 70% of wild service tree localities occurred in south-exposed sites (SE, S, SW) and *vice versa* only 15% in north-exposed sites (NW, NE).

The majority of service tree localities (38%) were on south exposures. Quite abundant they were on south-east exposures (33%) and on south-west exposures (25%).

Out of the total 24 localities of service tree even 96% were in south-exposed sites and just 1 locality was in a west-exposed site.

According to the prevailing occurrence of localities in south-exposed sites (SE, S, SW), both the analyzed species have conspicuous requirements for sunlight and higher temperatures. Regarding the absence of north-exposed localities with service tree we can assume even higher demands of this woody plant on the mentioned environmental conditions in comparison with wild service tree.

Table 2. Localities of wild service tree (*Sorbus torminalis* [L.] CRANTZ.) and service tree (*Sorbus domestica* L.) classified into groups according to exposure

Exposure	*Sorbus torminalis*		*Sorbus domestica*	
	N	(%)	*N*	(%)
NE	3	9		
E	5	15		
SE	12	35	8	33
S	3	9	9	38
SW	9	26	6	25
W			1	4
NW	2	6		
Total	34	100	24	100

Evaluation of localities according to climatic characteristics

The sites of both species were classified into climate-geographic types and subtypes (Tarábek 1980) for the analysis of their ecological-climatic amplitude. Data on the mean temperatures and annual sums of precipitation were acquired from a digital database (Škvarenina, Minďáš et al. 2003).

The climate-geographic type of plain climate (the climate is arid to slightly humid with moderate inversion of air temperatures) covers just 12% of wild service tree localities, but 42% of sites with service tree (Table 3).

The climate-geographic type of fold climate (the climate is arid to humid with high inversion of air temperatures) includes 27% of sites with wild service tree and 25% of service tree localities, which can be regarded as the nearly identical representation of both species.

The climate-geographic type of mountain climate (the climate is moderately humid to humid with small inversion of air temperatures) represents 61% of sites with wild service tree and 32% of service tree localities.

The highest number of sites with wild service tree (38%) was in the subtype of moderately warm mountain climate. In the other subtypes, there were just small differences in the number of localities (8–15%).

The highest number of service tree localities (42%) was in the subtype of predominantly warm plain climate and quite a high number of sites was also in the subtype of warm fold climate (25%). The other subtypes represent a low number of sites (8–12%).

Both taxa have the majority of sites in the moderately warm and warm subtype of plain, fold and mountain climate. Only 3 localities of wild service tree (8%) occurred in the subtype of moderately cold mountain climate and one locality with service tree in the subtype of cold mountain climate.

Within the group of all wild service tree localities, the average January temperature (T I) ranges from –1.5°C to –4.0°C, the average July temperature (T VII) from 16.0°C to 19.5°C. The average annual temperature (T I–XII) is 6.0–9.3°C. However, the average annual temperature does not reach 8.0°C in almost 60% of the wild service tree sites, in 30% of the sites it is above 8.0°C and in nearly 10% of the sites the average annual temperature is above 9.0°C. The annual sum of precipitation is in the range of 580–900 mm (Table 4).

Within the group of localities with service tree, the average January temperature (T I) ranges from –1.8°C to –5.0°C, in July the average temperature (T VII) is 16.5–20.0°C and the average annual temperature (T I–XII) is 7.5–9.0°C. The average annual temperature in 10% of the sites reaches only 7.5°C and 60% of sites have the average annual temperature up to 8°C. Almost 30% of the sites reach the value of 9°C. The annual sum of precipitation ranges from 610 mm to 790 mm.

Pedological characteristics of sites

Within the analyzed localities 8 soil units were classified in sites with wild service tree and 6 soil units were identified in localities with service tree (Šály, Šurina 2002). The overview is given in Table 5.

In the analyzed localities of both evaluated species, 9 soil units were classified, among which 5 soil units were identical (R_1, H_1, H_5, K_1, K_3).

The most abundant soil units were Eutric Cambisols (K_1, K_2, K_3) occurring in 53% of wild service tree sites and in 45% of service tree sites. These soils are considered as fertile, sufficiently deep with fa-

Table 3. Localities of wild service tree (*Sorbus torminalis* [L.] CRANTZ.) and service tree (*Sorbus domestica* L.) classified according to climate-geographic types and subtypes

Type	Subtype	*Sorbus torminalis*		*Sorbus domestica*	
		N	(%)	*N*	(%)
Plain climate	Predominantly Warm climate (PW)	4	12	10	42
Fold climate	Warm climate (W)	5	15	6	25
Fold climate	Moderately Warm climate (MW)	4	12		
Mountain climate	Warm climate (W)	5	15	2	8
Mountain climate	Moderately Warm–Warm climate (MW–W)			2	8
Mountain climate	Moderately Warm climate (MW)	13	38	3	12
Mountain climate	Moderately Cold climate (MC)	3	8		
Mountain climate	Cold climate (C)			1	4
Total		34	100	24	100

Table 4. Climate characteristics of the localities of *Sorbus torminalis* (L.) CRANTZ. and *Sorbus domestica* L.

Climate-geographic type/subtype	*Sorbus torminalis*					*Sorbus domestica*				
	altitude (m)	T I (°C)	T VII (°C)	T I–XII (°C)	precipitation (mm)	altitude (m)	T I (°C)	T VII (°C)	T I–XII (°C)	precipitation (mm)
Plane/PW	250–350	(−2.0)–(−2.8)	17.8–19.0	8.1–9.3	600–780	200–300	−1.8–3.5	18.8–19.5	8.3–9.0	610–650
Fold/W	260–420	(−2.5)–(−3.5)	17.0–18.5	7.0–8.6	630–750	250–380	(−2.0)–(−2.5)	18–20	8.1–8.55	620–700
Fold/MW	220–380	(−2.5)–(−3.9)	17.5–18.7	7.9–9.3	650–670					
Mountain/W	300–500	(−1.5)–(−2.8)	17.8–19.5	6.2–8.9	580–700	300	−2	18–18.5	8.3	620–650
Mountain/MW–W						230–350	(−2)–(−3.8)	17.5–19.5	8.1–9	650
Mountain/MW	300–560	(−1.7)–(−3.8)	16.5–18.8	6.1–8.9	670–850	220–450	(−3.0)–(−4.0)	16.5–17.5	7.7–9	645–750
Mountain/MC	580–720	(−3.5)–(−4.0)	16.0–17.0	6.2–7.7	880–900					
Mountain/C						490	−5	16.5	7.5	790

PW – predominantly warm, W – warm, MW – moderately warm, MC – moderately cold, C – cold

vourable physical properties and with suitable, even very good form of humus and sufficient supply of nutrients (C/N ratio = 10–11, degree of sorptive saturation [V] 50–70% and soil reaction within the main rhizosphere 5.5–6.5). Among these soils it is also possible to classify Dystric Cambisols (K6) (6% of sites with wild service tree), at lower altitudes they have similar qualitative traits like Eutric Cambisols (with soil reaction 4.8–5.5, C/N ratio 11–13).

Rendzinas ($R_{1,}$ R_2) are the second most frequent soil unit occurring in 35% of wild service tree sites and in 17% of service tree localities. The soils have a favourable adsorbing complex. They are skeletal and shallow with low humus content, with good penetration of water and low water-bearing capacity. There is a high content of minerals, but the uptake of nutrients by plants is often influenced by water deficit. The abundance of minerals is rather one-sided (prevalence of Ca, Mg, while other nutrients K, P, can be deficient). Because of the water deficit, mainly at lower altitudes, and one-sided soil reaction, rendzinas are considered to be low fertile (C/N ratio 9–11, pH 7.2–8). Chromi-Rendzic Leptosols (9% of sites with wild service tree) have slight sorptive saturation with soil reaction pH 6–7, usually with higher rain capacity than other rendzinas. If they are medium deep and medium skeletal, they are considered to be quite favourable soils.

Haplic Luvisols ($H_{1,}$ $H_{4,}$ H_5) had significantly different representation in localities of wild service tree (6%) and in sites with service tree (38%). Haplic Luvisols belong to the most fertile soils with moderately acid or even neutral soil reaction in the top soil layers. The soils are rich in minerals, with quality mull humus and lower water supply. With regard to the lower water supply and possibility of drying, the mentioned nutrients are partially unavailable (C/N ratio is 10–11, degree of sorptive saturation (V) is 60–70%).

It is necessary to remind that the soils in sites with service tree were Leptosols and often eroded soils because some localities were originally used as vineyards, orchards or arable land and later abandoned.

Generally, the soils in the above-mentioned localities can be regarded as physically favourable, sorptive saturated, fertile and very well supplied with nutrients (Haplic Luvisols and Cambisols), or some of them are rich in minerals but the soil chemistry is one-sided and therefore they are mostly little fertile (Rendzinas). According to the values of soil reaction (pH) which range from 4.8 to 5.5 (Dystric Cambisols), through 5.5–6.5 (Eutric Cambisols) up to pH 7.2–8 (Rendzinas), favourable conditions for the growth of rhizosphere (of both species) can be

Table 5. Soil units identified on localities of wild service tree (*Sorbus torminalis* [L.] CRANTZ.] and service tree (*Sorbus domestica* L.)

	Soil type	*S. torminalis*		*S. domestica*	
		N	(%)	*N*	(%)
R_1	Rendzic leptosols and Eutric Cambisols associated with Rendzi-Lithic Leptosols	9	26	4	17
R_2	Rendzic Leptosols and Chromi-Rendzic Leptosols	3	9		
H_1	Haplic Luvisols, local eroded and Calcaric Regosols	1	3	5	22
H_4	Albi-Haplich Luvisols and Albic Luvisols fom loess loams			3	12
H_5	Stagni Haplic Luvisols, Luvic Stagnosols and Planosols	1	3	1	4
K_1	Eutric Cambisols to Dystric Cambisols, associated with Leptosols and with Stagnic Cambisols	10	29	8	33
K_2	Eutric Cambisols associated with Stagni Eutric Cambisols	1	3		
K_3	Eutric Cambisols, associated with Rendzic Leptosols and Calcaric Cambisols	7	21	3	12
K_6	Dystric Cambisols and Cambic Umbrisols associated with Leptosols	2	6		
Total		34	100	24	100

defined as the area of acid, moderately acid, neutral and slightly even medium alkaline soils. The favourable soil reaction for the service tree rhizosphere is shifted more to moderately acid or even neutral soils.

With reference to water in the soils, Cambisols have sufficient water supply (wild service tree 53% of sites, service tree 45% of sites). Haplic Luvisols have lower water supply with a possibility of drying out (wild service tree 6% of sites, service tree 36% of sites). Rendzinas (occurring on 35% of sites with wild service tree and 17% of sites with service tree) are mostly loose soils, permeable for water. Regarding the shallow soil profile and lower rain capacity, and the good permeability of parent rock, rendzinas have high water losses caused by leaching, so the water supply is usually low (Šály 1998).

DISCUSSION

The wild service tree and service tree are regarded as South European and Central European taxa, while the wild service tree has a wider area of distribution than the service tree – it reaches into the Caucasus, in the north to Poland and South of England. In this territory, both areas are markedly similar and both species often grow in the same site (Kausch 1994, 2000).

In Slovakia both species grow in the southern regions from the lowest altitudes up to 800 m (wild service tree) or up to 610 m (service tree) (Blattný, Šťastný 1959; Michalko 1961; Benčať 1995).

The sites with wild service tree were predominantly at the altitudes of 220–720 m and the localities with service tree were mostly at the altitudes of 200–490 m. Generally, out of the total number of 34 localities with wild service tree 85% was at the altitude up to 500 m and 97% of them occurred up to 600 m. Out of the total 24 localities of service tree, 92% of them were found up to the altitude of 400 m. In comparison with the wild service tree, which occurred scarcely (6%) at the lowest altitudes (200–250 m), the service tree was more abundant there (33% of sites).

The comparison of the data shows that the majority of service tree sites was at lower altitudes with the narrower vertical range of 200–400 m and higher concentration, whilst 66% of sites were at the altitudes of 201–300 m. Sites of wild service tree had the wider vertical range (220–720 m) and even distribution whilst 70% of sites were at the altitudes of 251–450 m.

This information is consonant with the data reported from the whole area of their common natural distribution. According to them, the wild service tree appears at higher altitudes than the service tree (Kausch 1994, 2000).

The service tree is explicitly regarded as a light-demanding woody plant (Michalko 1961; Májovský 1992; Brütsch, Rotach 1993; Wilhelm 1998). This opinion is also supported by our own findings; according to them the service tree grows in 96% of sites as solitary tree in vineyards and fruit orchards. In two localities some service trees grew in an adjacent forest and one locality was found directly in the forest crop. In forests, the service tree always grew in the upper crown canopy or above this main forest storey. In all mentioned cases the service trees grew under nearly full sunlight.

The wild service tree is mostly evaluated as a semi-shade loving woody plant (Aas et al. 1993), sometimes even as a light-demanding woody plant (Zeitlinger 1990). At a young age the wild service tree is tolerant to shading, but the requirement for sunlight increases with age (Ellenberg 1979; Lobžanidze et al. 1991; Májovský 1992; Aas et al. 1993; Wilhelm 1998). As for the crown competition, the wild service tree has quite a low power, however it is higher in warm and arid sites (Aas et al. 1993). The relatively higher occurrence of wild service tree on arid and warm slopes is determined by the lower competition of other woody plants (mainly beech) (Namvar, Spethmann 1988; Schrötter 1992; Ewald et al. 1994) and its better tolerance to shading on rich and freshly humid soils (Schrötter 1992; Ewald et al. 1994).

According to the findings from Lorraine (Plateau Lorrain) the service tree grows under the crown canopy of the highest trees in conditions of coppice with standards or in the upper forest storey of these stands. It creates a 20 m wide huge crown similarly like oaks. Already at a young age the service tree is not tolerant to any shading. The service tree dies down without full sunlight similarly like the pear, however, the wild service tree is tolerant even to stronger shading. The wild service tree is able to grow under the dense crown canopy of oaks. It creates a shading habit with long, thin and sparsely foliaged branches and grows into crowns of light-demanding trees (mainly oak) (Wilhelm 1998). According to our own findings (Bajtava locality), several individuals of wild service tree grew in the second forest storey under the oak crown canopy. However, the majority of evaluated plants were growing in the oak and beech crown storey.

The distribution of sites with wild service tree and service tree according to exposure supports requirements of these taxa for light and warmth. Data given by Geiger (1961) show that northern slopes get just a half sum of the absolute light emission in comparison with southern slopes.

No site on northern exposure was found within our research. Sites on north-east and north-west exposures were rather scarce (15%). The highest number of localities was found in warmer south-exposed sites (SE = 35%, S = 9%, SW = 25%).

Similar findings from Romania were reported by Dinca (2000), where at least (4%) of wild service trees were growing in sites with north exposure and the highest number of individuals (57%) was found in south-exposed sites. According to the findings from Brandenburg, the majority of the wild service tree sites were in the plain, quite frequent were sites on southern and south-western slopes and just one site was on a partly north-exposed slope (Ewald et al. 1994).

Within our own research nearly all localities with service tree were in south-exposed sites (S = 38%, SE = 33%, SW = 25%), just one was found in the site with west exposure. According to findings from Switzerland (Brütsch, Rotach 1993) even 74% of service tree individuals occurred in south-exposed sites.

According to the above-mentioned data, the service tree has higher requirements for light and warmth in comparison with the wild service tree.

It is evident from the climatic characteristics of sites with wild service tree and service tree that their climate-geographic amplitude is quite broad from the plain climate through fold climate to mountain climate. Distinctive differences between both taxa are evident from the classification of their localities into climate-geographic subtypes.

Quite a high number of sites with service tree (42%) and only 12% of wild service tree localities belong to the climate-geographic type of plain climate prevalently warm (the climate is arid or slightly humid with the moderate inversion of air temperatures).

The climate-geographic type of fold climate prevalently warm to warm (the climate is arid to humid with the high inversion of air temperatures) includes 27% of sites with wild service tree and 25% of service tree localities, which can be regarded as the nearly identical representation of both species.

The majority of sites with service tree (61%) and only 32% of sites with wild service tree belong to the climate-geographic type of mountain climate moderately warm to warm (the climate is moderately humid to humid with the small inversion of air temperatures). Only 8% of sites with wild service tree belong to the subtype of moderately cold mountain climate and just one locality with service tree to the subtype of cold mountain climate.

Data on the average temperatures and annual sums of precipitation were obtained from a digital database (Škvarenina, Minďáš et al. 2003).

Within the group of all wild service tree localities, the average January temperature (T I) ranges from −1.5°C to −4.0°C, the average July temperature (T VII) from 16.0°C to 19.5°C. The average annual temperature (T I–XII) is 6.0–9.3°C. However, the average annual temperature does not reach 8.0°C at almost 60% of the wild service sites, in 30% of sites it is over 8.0°C and in nearly 10% of sites the average annual temperature is above 9.0°C. The annual sum of precipitation is in the range of 580–900 mm.

Within the group of localities with service tree, the average January temperature (T I) ranges from –1.8 °C to –5.0°C, in July the average temperature (T VII) is 16.5–20.0°C and the average annual temperature (T I–XII) is 7.5–9.0°C. The average annual temperature in 10% of sites reaches only 7.5°C and 60% of sites have the average annual temperature up to 8°C. Almost 30% of sites reach the value 9°C. The annual sum of precipitation ranges from 610 mm to 790 mm.

The localities of service tree have higher values of all climatic characteristics in comparison with the sites of wild service tree except for two localities where the average annual temperature ranges between 7.5 and 7.7°C. According to the acquired data, the service tree can be evaluated as a woody plant with higher requirements for warmth. Our own findings correspond with the information from other areas of the service tree natural distribution.

In Switzerland (Brütsch, Rotach 1993), the service tree is regarded as a thermophilic taxon occurring mainly in warmer regions with the average annual temperature of about 8.5°C at least. Among regions with the occurrence of service tree in Switzerland, the warmest is Genf with the average annual temperature 9.1°C and average monthly air temperatures during winter above 0°C. The coldest region with service tree is Schaffhausen with the average annual temperature 7.2°C and where the average monthly air temperature in winter is below 0°C and in January it drops to –2°C. In Germany (Saxony-Anhalt federal state) on the northern border of the service tree natural distribution, the average annual temperature is 8.0–9.0°C (Steffens 2000).

The annual sum of precipitation in localities with wild service tree ranges from 580 mm to 900 mm and in sites with service tree it ranges from 610 mm to 790 mm

According to data from Plateau Lorrain (Wilhelm 1998), where the wild service tree is quite abundant and the service tree is rare in woodlands, at altitudes of about 200–400 m the annual sum of precipitation ranges from 750 mm to 850 mm and it is quite equally distributed during the year.

Regions in Switzerland with the occurrence of service tree are considered to be poor in rainfall. The lowest annual sum of precipitation 790 mm is in the region Basel and the highest sum of precipitation is in the region Genf. These regions including Schaffhausen with a relatively low sum of precipitation and high temperatures are considered to be very suitable for the growth of the thermophilic service tree (Brütsch, Rotach 1993). In the Saxony-Anhalt federal state, on the northern border of the natural distribution of service tree, the annual sum of precipitation is 550–650 mm and this area is evaluated as poor in rainfall, partially with symptoms of the continental climate (Steffens 2000).

According to the climatic water balance of vegetation (Škvarenina et al. 2002), the first three altitudinal zones (oak, beech-oak and oak-beech), which include all service tree localities and 94% of the sites with wild service tree in Slovakia, are arid in the vegetation period (March–September). They have a negative climatic water balance, the potential evapotranspiration is higher than the amount of fallen precipitation with the deficit of precipitation ranging from 100 mm to 300 mm. The forest ecosystems are compelled to use the winter water supply in the soil. The fourth altitudinal zone (beech) containing only two localities with wild service tree have equalized water balance. According to the reported information, service tree and wild service tree are able to grow on drier sites with water deficit during the vegetation period.

In the area of Plateau Lorrain the wild service tree and service tree grow on the parent rock of mussel limestone. There are deep terra fusca and shallow rendzinas with different humidity degrees from very fresh to arid soils. More or less deep Vertic Cambisols with water deficit during summer are prevalent on keupers. Generally, these soils are regarded as well or even very well supplied with nutrients (Wilhelm 1998).

The wild service tree grows best on fresh deep soils well supplied with nutrients (Namvar, Spethmann 1985; Schrötter 1992; Aas et al. 1993); however, under the influence of interspecific competition it is forced out from optimum to poor soils (Aas et al. 1993). It also grows successfully on drier or moderately fresh soils (Aas et al. 1993).

In Slovakia nine soil units were identified in the evaluated sites ($R_1, R_2, H_1, H_4, H_5, K_1, K_2, K_3, K_6$), among them five soil units occurred in the sites of both taxa (R_1, H_1, H_5, K_1, K_3).

The most frequent were Eutric Cambisols (53% of localities with wild service tree and 45% with service tree). The second frequent group of soils was Rendzinas (35% of sites with wild service tree and 17% of localities with service tree). The more distinctive differences were found in the representation of Haplic Luvisols. These soils were found in 38% of sites with service tree and just in 6% of sites with wild service tree.

In general, the soils in sites with wild service tree have favourable physical characteristics and adsorbing complex, they are fertile and well supplied with minerals (Haplic Luvisols, Cambisols) or some of them are rich in minerals but the soil chemistry is one-sided and therefore they are mostly little fertile (Rendzinas). According to the values of the soil reaction (pH) ranging in these soil representatives from 4.8–5.5 (Eutric Cambisols) to 7.2–8 (Rendzinas) it is possible to define the area of the acid (4.8–5.5), moderately acid (5.5–6.5), neutral (6.5–72) or alkaline (7.2–8) soils as suitable for the root systems of both taxa (Šály 1998).

The favourable soil reaction for the service tree rhizosphere is shifted more towards moderately acid or neutral soils. Localities with service tree were more frequent on Haplic Luvisols (with a higher content of nutrients) than on Rendzinas.

According to information from Eastern Austria (Mayer 1984 in Kristis 1992), the service tree has lower requirements for the water content of soils but quite high requirements for nutrients. In the Wiener Wald (parts Merkenstein and Mettau), the service tree occurs on the limestones and dolomite parent rocks, where moderately fresh Rendzinas as well as very arid Rendzinas on dolomites are predominant (Steiner 1995). In Switzerland the service tree occurs mainly on arid, alkaline shallow and often skeletal soils, however in Schaffhausen also in sites with acid soils (Brütsch, Rotach 1993).

With reference to the water in soils, Cambisols have sufficient water supply (53% of sites with wild service tree and 45% with service tree). Low water supply is on Rendzinas (35% of localities with wild service tree and 17% of sites with service tree), which have high water losses caused by leaching (Šály 1998). Haplic Luvisols have lower water supply with a possibility of drying out (wild service tree 6% of sites, service tree 36% of sites).

CONCLUSION

Within the study of the wild service tree and service tree in Slovakia, the attention was paid to the requirements for specific environmental conditions. Basic data were obtained from the analysis of ecological characteristics (site altitude, exposure, climate-geographic type and soil type) of the localities with both taxa. Information allowed a brief assessment of the requirements of both taxa for environmental conditions and identification of some ecological differences between them.

The majority of sites with service tree occurred at lower altitudes with the narrower vertical range of 200–400 m and higher concentration, whilst 66% of them were at altitudes of 201–300 m. Sites with wild service tree had the wider vertical range (220–720 m a.s.l.) and more equalized distribution, whilst even 70% of the localities were at altitudes of 251–450 m.

The service tree requirements for light were confirmed also by our own findings, in 96% of sites this woody plant grew as a solitary tree in vineyards and fruit orchards. Just in three localities it grew in the forest and always in the main forest storey.

The wild service tree grew in all localities in oak or beech forests. It mostly occurred in the upper canopy or it grew into the main storey. Just in one locality it grew in the second storey under oaks and created a shading habit with quite long, thin and sparsely foliaged branches.

All service tree localities were on warm exposures (S, SE, SW, W). Similarly, the majority of the sites with wild service tree were on warm exposures, however 15% of them were in north-exposed localities (NE, NW). The presented data document the higher service tree requirements for light.

Within the classification of the sites into climate-geographic types and subtypes, 42% of sites with service tree belonged to the climate-geographic subtype of plain climate with the mild inversion of air temperatures (this climate is arid to moderately humid). Just 12% of sites with wild service tree were classified into the plain climate-geographic type. 61% of wild service tree sites and 32% service tree sites were classified into the climate-geographic type of mountain climate with the low inversion of air temperatures (the climate is moderately humid to humid). The number of sites classified into the climate-geographic subtype of fold climate (arid even humid) with the high inversion of air temperatures was nearly the same for both taxa (27% wild service tree, 25% service tree).

In general, in sites of both analyzed taxa, the soils have favourable physical characteristics and adsorbing complex, they are fertile and well supplied with nutrients (Haplic Luvisols and Cambisols) or some of them are rich in minerals but the soil chemistry is one-sided and therefore they are mostly little fertile (Rendzinas). The favourable conditions for the rhizosphere of wild service tree can be defined as the area of acid to neutral soils. The favourable soil reaction for the service tree rhizosphere is shifted more to moderately acid or neutral soils.

According to the acquired information about ecological requirements of the analyzed taxa, both of them can be regarded as prospective woody plants with a possibility of wider utilization in forestry and landscape arrangements.

They are tolerant to direct sunlight and short-time water deficit in the soils, therefore they are suitable for the afforestation of arid and warm sites (even clear unstocked areas). In such extreme ecotopes the wild service tree and service tree can extend the species diversity of original plant communities.

Both mentioned taxa have valuable timber, so the potential of their utilization in forestry is also in larger-scale planting and growing in conditions of oak and beech-oak forests. They should be used as valuable admixture in oak forests or substitute the sensitive beech in drier sites of beech-oak forests.

In the woodlands as well as in the landscape, both taxa give fruits important for the nourishment of animals and birds. The wild service tree and service tree are stable components of dispersed greenery due to their huge habit which they achieve as solitary trees. It is possible to realize their potential as main (skeletal) trees in the windbreaks and game refuges for wildlife.

The study of the ecological variability of both taxa and selection of their provenances suitable for changed environmental conditions are preconditions for successful plantings in forests and landscape. With respect to the wider utilization of service tree and wild service tree it is important to work out effective methods of fruit harvesting and seed extraction as well as of the production of good quality planting stock. It is necessary to produce older plants at least twice transplanted or saplings. The protection of young plantings with fencing and shelter of shrubs against browsing by the wildlife is essential.

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Ekologické nároky jarabiny brekyňovej (*Sorbus torminalis* [L.] CRANTZ.) a jarabiny oskorušovej (*Sorbus domestica* L.) vo vzťahu k ich uplatneniu v lesnom hospodárstve a v krajine

ABSTRAKT: Zhodnotili sa podmienky prostredia na stanovištiach jarbiny oskorušovej a jarabiny brekyňovej a identifikovali sa ekologické rozdiely medzi týmito drevinami. Obidva taxóny sa považujú za prespektívne dreviny s možnosťou širšieho využitia v lesnom hospodárstve a krajinárskych úpravách. Tolerujú priame slnečné žiarenie a krátkodobý vodný deficit v pôde. Sú preto vhodné pre zalesňovanie suchých a teplých stanovíšť (aj holín). Uprednostňujú pôdy s priaznivými fyzikálnymi vlastnosťami, sorpčne nasýtené s kyslou až neutrálnou pôdnou reakciou. Obidva taxóny majú hodnotné drevo a potenciál ich využitia v lesnom hospodárstve je aj v podmienkach dubových a dubovo-bukových lesov. Môžu sa použiť ako hodnotná prímes alebo náhrada citlivejšieho buka na suchších stanovištiach bukovo-dubových lesov.

Kľúčové slová: jarabina oskorušová; jarabina brekyňová; ekológia; pôdy; sucho; uplatnenie

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