ECOLOGY AND DISTRIBUTION OF SERVICE TREE *Sorbus domestica* (L.) IN SLOVAKIA

VIERA PAGANOVÁ

Faculty of Horticulture and Landscape Engineering, Slovak Agricultural University, Tulipánová 7, 949 01 Nitra, Slovak Republic; e-mail: Viera.Paganova@uniag.sk

Abstract

Paganová V.: Ecology and distribution of service tree *Sorbus domestica* (L.) in Slovakia. Ekológia (Bratislava), Vol. 27, No. 2, p. 152–167, 2008.

Service tree *Sorbus domestica* L. is one of the rare autochthonous woody plants. There are analysed data from 24 localities with service tree in Slovakia. They were found mainly in agricultural land (242 individuals) and just on 5 forest stands (22 individuals). Service tree stands were found on south-east, south and south-west exposures. More than 90% of them were on altitudes up to 400 m. The majority of the stands were found in the subtype of mostly warm plain climate, as well as in the subtypes of warm and moderate warm fold climate and mountain climate. In our country service tree grows on soils with favourable physical characteristics and adsorbing complex. The soils are fertile, well supplied with nutrients (Luvisols, Cambisols) on 96% of analysed stands. Some localities (4%) have soils rich in minerals, but the soil chemistry is one-sided, so they are mostly little fertile (Rendzinas). Regarding the water content in soils generally, Cambisols have sufficient water-supply. The Luvisols have lower water supply with possibility of their aridization. Rendzinas are mostly loose soils with good permeability, regarding their shallow profile with lower water capacity and good drainage of the parent rock they have usually less water supply. According to obtained data, it is possible to evaluate service tree as light demanding woody plant with requirements on higher temperatures and higher content of nutrients in soil. This woody plant is able to grow on drier soils with infrequent occurrence of water deficit. Regarding the expected changes of global climate, service tree should substitute some tender woody plants with higher sensitivity to drought within the landscape arrangements.

Key words: service tree, environmental conditions, distribution, soil, population

Introduction

Service tree is one of the rare autochthonous woody plants not only in Slovakia, but also in the whole area of the natural distribution. It is aboriginal plant especially in the Mediterranean area and the centre of its occurrence is on Balkan and Apennine peninsula. The area of natural distribution reaches north part of Asia Minor and Africa. North border of the natural distribution crosses North Rhine-Westphalia, Lower Saxony, Saxony-Anhlat,

Thüringen, Bavaria, (the northernmost occurrence of the service tree in Federal Republic of Germany is approximately at latitude 51° of north width) (Haeupeler, Schönfelder, 1988), then continues to South Moravia and Slovakia, Hungary, Romania and Crimea Mt.

Benčať (1995) elaborated map of the service tree distribution in Slovakia. He used data given by Kárpáti (1960 *ex* Michalko 1961) and Michalko (1961) and also findings from own enquiry examination. According to the mentioned map, the possible north border of the area of distribution shoots in white Carpathians from Horné Sŕnie eastward around Trenčianske Teplice, Kšinná, Rudno upon Hron, Očová, Klenovec, Revúca to Vinné and Podhoroď, with separate appearance near Plavnica. Vertical limit of the service tree distribution is at the altitude of 610 m.

Concerning the rare occurrence of the service tree, this plant was marked as "unknown quantity", however at any case it was unheeded woody plant (Brütsch, Rotach, 1993). The first description of this taxon was done by Theophrastos, already at ancient era in years 371–285 B.C. It is assumed, that service tree was cultivated as fruit woody plant already 2000 years ago in Mediterranean region (Kausch, 1992).

Recently in network EUFORGEN the service tree is considered not to be only an endangered specimen, but also to be a prospective woody plant for timber production. In 1993 the service tree was declared "tree of the year" in Germany and since that time, special meetings have been running there. They are focused on variability of this woody plant, its growth abilities, biology, ecology and utilization of the fruits and timber. Service tree like a single autochthonous woody plant was registered in red book in a group of the most endangered plants with the highest degree of care. According to the available information, at present time are registered about 50 older trees in Luxembourg, in Switzerland 500, in Austria and in South Moravia about 500, in Germany 6000 and in ex-Yugoslavia and Greece about 10 000 of older service tree individuals. The occurrence of service tree is more abundant in Hungary, Bulgaria, Romania, Turkey, but especially in France and Italy (Kausch, 2000).

Concerning future larger utilization of the service tree in Slovak forests, environmental conditions of the stands, where service tree grows on our territory were analysed, apart from other studies.

Situation assessment

At present, with respect to the expected changes of global climate (Minďáš, Škvarenina, 1994), service tree is a woody plant, whose importance rises up. Following the present information about the ecology and growth abilities, the service tree should have higher representation in woodland and in the landscape.

Service tree is considered to be a light demanding woody plant, with requirements of higher temperatures. However, according to information from Crimea and also from the other locations, service tree successfully got over the frosts to -30 °C. This plant grows well on all soils with rich mineral content, on loamy soils and humic soils with favourable aeration and good balance of water regime in period between blooming and fruit maturation (Májovský, 1992; Sokolov, 1954; Namvar, Spethmann, 1985).

In Switzerland in regions Schaffhausen and Basel, the woodlands with service tree in species structure were classified into phytocenologic units (Ellenberg, Klotzli, 1972 ex Brütsch, Rotach, 1993) and their rate was folloving: in total about 59% of the plants were in communities *Pulmonario-Fagetum Mellitetosum* (with 47 individuals) and *Carici albae-Fagetum* (with 54 individuals). About 13% of the service trees were in each of the communities *Pulmonario-Fagetum typicum*, *Galio sylvatici-Carpinetum* and *Coronillo coronatae-Quercetum*. One tree was registered in *Galio odorati-Fagetum typicum* and *Arabidi turritae-Quercetum pubescentis*.

Following the ecological characteristic of these communities with service tree (requirements on soil moisture, content of nutrients and basic components) the ecological scheme was elaborated. It provides a review about ecological and stand conditions of the service tree in Switzerland (Brütsch, Rotach, 1993).

As it flows from the ecological scheme, service tree in Switzerland occurs mainly in alkaline arid regions. A considerable quality is high hardiness of the service tree to low soil moisture. Because of this fact, service tree can survive in arid conditions of the warm communities with pubescent oak, which are often on limit border of the forest living potential. Single plants of the service tree were found also in communities of the *Galio odorati-Fagetum typicum***,** although beech is for service tree very competitive plant. The occurrence of the service tree in the community of the hornbeam-beech mixed forest is in moderate acid area at the ecological scheme. Also calcium is contained in the parent rock in all studied area (Brütsch, Rotach, 1993).

In Germany, the service tree belongs to *Querceto-Lithospermetum*, alternatively to *Quercion pubescentis* and warm *Carpinion* communities according to phytocoenological classification. The most frequent accessory woody plants are *Quercus pubescens*, *Cornus mas, Sorbus aria*, *S. torminalis*, *Viburnum lantana (*Namvar, Spethmann, 1985). Similarly in Slovakia, according to Kárpáti (1960 *ex* Michalko 1961) the service tree has quite broad ecological amplitude. Its occurrence is connected more with communities of the oak forests at the lower altitudes and with higher quality of soils in communities *Lithospermo-Quercetum*, *Melico* (*uniflorae*)-*Quercetum petraeae* etc. Michalko (1961) confirmed information given by Kárpáti, but according to his opinion, the service tree grows at higher altitudes only in extreme communities *Corneto-Quercetum* (*pubescentis* and *petraeae*) and occurs even in beech woods *Corneto-Fagetum* and in relict pinewoods on limestone and dolomite parent rock.

Service tree does not appear on acidic stands in the brand of forests with communities *Deschampsio flexuosae-Quercetum petraeae*, *Vaccinio-Quercetum petraeae*, *Calluno-Quercetum petraeae*, *Luzulo-Quercetum (petraeae)* etc. This woody plant was not found on acidic stands either in communities *Festuco (heterophyllae)-Quercetum petraeae* (have mixed floristic structure with various species of the association *Quercion pubescentis-petraeae* (Michalko, 1961).

The information about requirements on environmental conditions of the service tree are rather stray, what results from rare occurrence of this plant in all area of natural distribution. Generally the ecology of the service tree is mentioned as very close or identical with the ecological conditions that are favourable for vine production.

Material and methods

In years 1996–2000 a study of the several characteristics of the service tree (*Sorbus domestica* L.) was done in Slovakia. The data were obtained from 24 localities. According to analysis of the altitude, exposure, ecological-climate amplitude and soil representatives on stands with service tree, there was considered the range of environmental conditions where this plant occurs in Slovakia.

Information about altitude of the analysed stands were obtained from "Stand maps of the management-plan area" in scale of M 1:10 000, which were elaborated by LESOPROJEKT in Zvolen. The exposure of the each stand was identified with compass. The climate-geographic types and subtypes were classified according to Tarábek (1980) and Špánik et al. (1999). Mean temperatures and annual sum of precipitation were obtained from the digital database (Škvarenina et al., 2003). The identification of the soil representatives was done according to map of soils (Šály, Šurina, 2002). The classification of the geomorphological units was done according to Geomorphological classification of the SSR and CSSR Geomorphological classification of SSR in scale of 1:500 000, Slovak cartography Bratislava (Collective, 1986)

The particular localities with service tree were classified according to their altitude, exposure, climate-geographic units and soil representatives in order to detailed evaluation of the environmental conditions.

Results

Characteristics of the analysed localities

There were found 24 localities with the service tree. Their distribution is illustrated on Fig. 1. and brief characteristics is given in Table 1. The majority of the analysed localities (50%) were found in the area of vineyards and fruit orchards (localities 10, 11, 12, 13, 14, 15, 16,

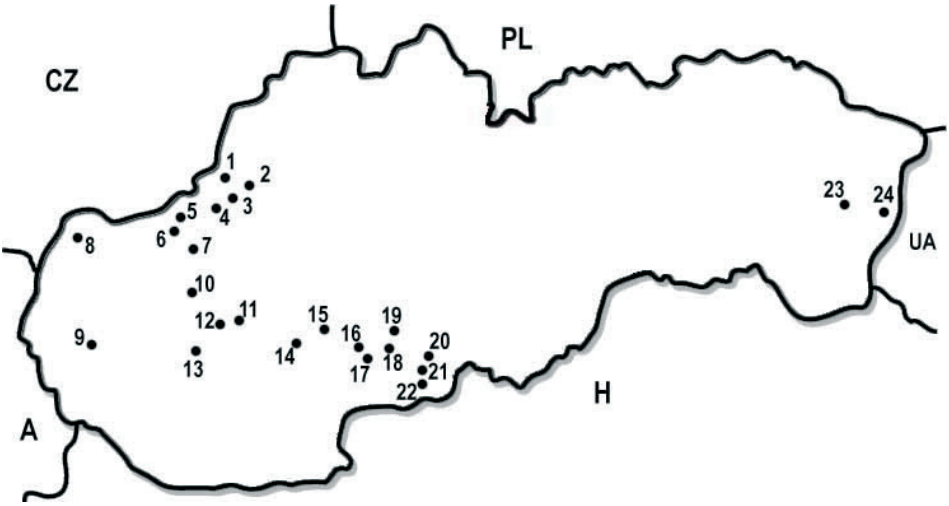

Fig. 1. The arrangement of stands with service tree in Slovakia.

T a b l e 1. Characteristics of the localities with *Sorbus domestica* L.

No.	Locality	Geomorphological unit	Forest Enterprise	Exposure	Altitude	Description of stand and species structure
1	Predpoloma	Biele Karpaty Lopenícka hornatina	Nové M.n.Váhom	SE	490	grazing lands, abandoned orchards
2	Dolná Súča Dúbrava Hulvák	Považské podolie Bielokarpatské podhorie	Dolná Súča	SW	300	orchards, grazing lands, baulks and forest crop, *Quercus petraea, Acer campestre, Pyrus* sp., *Cerasus, Fraxinus excelsior*
3	Zemianske Podhradie	Považské podolie Bielokarpatské podhorie	Nové M.n.Váhom	SW	370	grazing lands, orchards
4	Drietoma Chocholná	Biele Karpaty Bošácke bradlá	Drietoma	W	380	grazing land. *Pyrus, Acer campestre, Cerasus, Rosa* sp., *Prunus spinosa*
5	Zabudišová	Biele Karpaty Bošácke bradlá	Nové M.n.Váhom	S-SE	450	orchards, fields, forest crop, *Quercus petraea, Fagus sylvatica*, *Acer* sp., *Pyrus* sp., *Malus* sp., *Sorbus torminalis, Sorbus aria*
6	Haluzice	Biele Karpaty Bielokarpatské podhorie	Nové M.n.Váhom	SE	320	forest steppe stand, *Quercus petraea*, *Quercus cerris*
7	Beckov	Považský Inovec Inovecké predhorie	Beckov	SW-W	250-300	orchards, baulks, grazing land
8	Holíč Oskorušský les	Chvojnická pahorkatina Unínska pahorkatina	Holíč	SE	300	forest crop, *Quercus petraea, Quercus cerris, Carpinus betulus*, *Acer platanoides*, *Cerasus, Sorbus torminalis, Tilia* sp.
9	Modra	Malé Karpaty	Pezinok	S, SE,SW	210	vineyards, orchards, *Pyrus* sp., *Malus* sp., *Acer campestre*, *Cerasus*, *Juglans Morus*
10	Bojná	Podunajská pahorkatina Bojnianska pahorkatina	Bojná	SE	250	vineyards, orchards, *Quercus petraea*, *Pyrus*, *Prunus spinosa*, *Rosa* sp.
11	Velčice	Žitavská pahorkatina	Velčice	S	260	vineyards, orchards, *Quercus petraea*, *Pyrus, Malus*, *Prunus spinosa*, *Rosa* sp.
12	Jelenec	Podunajská pahorkatina Tríbeč	Tríbeč	S-SE	230	vineyards *Quercus, Carpinus betulus, Acer campestre, Prunus spinosa, Cornus mas*

T a b l e 1. Characteristics of the localities with *Sorbus domestica* L. (continued)

No.	Locality	Geomorphological unit	Forest Enterprise	Exposure	Altitude	Descripbtion of stand and species structure
13	Dolné Obdoko-vce	Podunajská pahorkatina Žitavská pahorkatina	Zobor	S-SE	220	vineyards, fields, *Acer campestre*, *Pyrus*
14	Hronský Beňadik	Pohronský Inovec	N. Baňa	S	230	orchards
15	Nová Dedina	Podunajská pahorkatina Čajkovská zníženina	Devičany	S-SE	300	vineyards, orchards, *Quercus petraea, Acer campestre, Sorbus torminalis, Pyrus* sp., *Malus* sp.
16	Bátovce	Podunajská pahorkatina Bátovská pahortkatina	Bohunice	S-SW	250	vineyards, orchards
17	Žemberovce	Podunajská pahorkatina Bátovská pahorkatina	Bohunice	S-SE	230	vineyards, orchards
18	Sebechleby	Podunajská pahorkatina Sebechlebská pahorkatina	Ladzany	S	250	vineyards, orchards
19	Devičie	Krupinská planina Bzovícka pahorkatina	Krupina	SE	300	orchards
20	Plachtince	Krupinská planina Modrokamenské úbočie	Modrý Kameň	S-SE	260	grazing land, former fruit orchards
21	Príbelce	Krupinská planina Modrokamenské úbočie	Modrý Kameň	S	320	vineyards, orchards, grazing land
22	Kosihovce	Juhoslovenská kotlina Čebovská pahorkatina	Nová Ves	S-SE	250	vineyards, orchards, *Quercus petraea,, Sorbus torminalis, Pyrus* sp., *Malus* sp.
23	Vinné	Východoslovenská pahor-katina Podvihorlatská pahor-katina	VLM	SW	200	forest crop, orchard
24	Koňus	Vihorlatské vrchy Popriečny	Sobrance	SW	350	forest crop, orchard

17, 18, 19, 21, 22). Several localities (46%) were in abandoned fruit orchards or grazing lands (localities 1, 2, 3, 4, 5, 6, 7, 19, 20). In two cases a few service trees appeared also in neighbourhood woodland (on localities 23 and 24) and one locality with service tree (8) was found in woodland (4%).

As far as on these localities appeared typical forest plants, quite frequent were following species (*Quercus dalechampii* T e n., *Pyrus pyraster* (L.) B u r g s d., *Acer campestre* L., *Sorbus torminalis* (L.) C r a n t z., *Cerasus avium* (L.) M o e n c h., *Malus sylvestris* M i l l., *Quercus cerris* L.. Rarely there occurred *Quercus pubescens* W i l l d., *Sorbus aria* (L.) C r a n t z., *Tilia cordata* M i l l., *Sorbus aucuparia* L., *Acer platanoides* L., *Carpinus betulus* L., and *Fagus sylvatica* L.. Among shrub plants there were frequent mainly *Cornus mas* L., *Prunus spinosa* L. and *Rosa* L..

Classification of the localities according to stand altitude

There were created 6 groups of the localities with service tree according to stand altitude. They are divided with 50 meters of the altitude difference. The classification of the stands with service tree is given in Table 2.

The majority of the localities 33% was on altitude 201–250 m, as well as 251–300 m. Less frequent about 13% there were stands with service tree on altitude 301–350 m, as well as on altitude 351–400 m. Only one locality was found on altitude 401–450 m, as well as on altitude 451–500 m.

More than 90% of the 24 analysed localities with service tree were found on altitude 400 m. Only two localities (under 10% of total) were found on altitude up to 500 m.

T a b l e 2. Survey of the *Sorbus domestica* L. stands according to altitude.

Altitude [m]	Occurrence of service tree – own findings			Occurrence given by Benčať (1995)	
	Locality identification number	n	%	n	%
101–150				26	13.00
151–200				61	29.00
201–250	9, 10, 12, 13, 14, 17, 18, 23	8	33.00	67	32.00
251–300	2, 7, 11, 15, 16, 19, 20, 22	8	33.00	20	9.00
301–350	6, 21, 24	3	13.00	18	8.00
351–400	3, 4, 8	3	13.00	9	4.00
401–450	5	1	4.00	1	0.50
451–500	1	1	4.00	5	2.00
501–550				2	1.00
551–600				2	1.00
600 <				1	0.50
Total		24	100.00	212	100.00

T a b l e 3. Survey of the stands with *Sorbus domestica* L. according to exposure.

Exposure	Locality number	n	%
SE	1, 5, 6, 8, 10, 13, 17, 19,	8	33
S	9, 11, 12, 14, 15, 18, 20, 21, 22	9	38
SW	2, 3, 7, 16, 23, 24	6	25
W	4	1	4

Classification of the localities with service tree according to exposure

The distribution of the localities according to stand exposure is given in Table 3.

Any suitable locality with service tree was found on north-west, north, north-east neither on east exposures as it is seen from these basic data.

The majority of the stands with service tree (38%) were found on south exposures. Quite frequent they were also on south-east (33%) and south-west (25 %) exposures. Only one locality was found on west exposure.

Locality with the highest stand altitude (490 m) was on south-east exposure.

Given data support opinion that service tree has quite high requirement on sunny and warm stand conditions.

Climatic characteristic of the analysed stands with service tree

The stands with service tree were classified into climate-geographic types and subtypes (Tarábek, 1980) for analysis of their ecological-climatic amplitude. Data of the mean temperatures and of the annual sum of precipitation were obtained form digital data base of the project Škvarenina, Minďáš et al. (2003) (Table 4).

The highest number of localities (10–42%) belongs to climate-geographic type of plane climate (NK) and to the subtype of mostly warm climate (PT) (this climate is arid or slightly humid with mild inversion of the air temperatures). The average temperature in January (T.I.) ranges from -1.8 to -3.5 °C, the average temperature in July (T VII) ranges from 18.8 to 19.5 °C and the average annual temperature from 8.3 to 9.0 °C. The annual sum of precipitation (Z) is 610–650 mm.

The lowest number of localities with service tree (6–25%) belongs to type of fold climate (KK) with quite high inversion of the air temperatures and climate is arid even humid. One locality (7 Beckov) belongs to subtype of warm climate (T) with average January temperature (T I.) -2.0 °C and average July temperature (TVII) 20.0 °C. The average annual temperature is 8.5 °C and the annual sum of precipitation is 620 mm. The other five localities (4,6,20,21,22) belong to the subtype of moderately warm climate (MT), with average January temperatures (TI.) from -2.3 ° to -2.5 °C and with the average July temperatures (TVII) from 18.0 °C to 18.5 °C. The annual average temperature is 8.1–8.5 °C and the annual sum of precipitation 620–700mm.

T a b l e 4. Climatic characteristic of the localities with *Sorbus domestica* L. in Slovakia.

No.	Locality	Exposure	Altitude [m]	Climatic characteristics					
				T I. [°C]	T VII. [°C]	Average temperature [°C]	Sum of precipitation [mm]	Type	Subtype
8	Holíč	SE	300	-2.0	19.0	8.4	640	NK	PT
10	Bojná	SE	250	-1.8	19.2	8.8	650	NK	PT
11	Velčice	S	260	-1.8	19.2	8.8	650	NK	PT
12	Jelenec	S-SE	230	-1.9	19.5	9.0	645	NK	PT
13	Dolné Obdokovce	S-SE	220	-1.9	19.5	9.0	645	NK	PT
15	Nová Dedina	S-SE	300	-1.8	18.8	8.3	620	NK	PT
16	Bátovce	S-SW	250	-1.9	19.5	9.0	640	NK	PT
17	Žemberovce	S-SE	230	-1.9	19.5	9.0	640	NK	PT
18	Sebechleby	S	250	-1.9	19.5	9.0	640	NK	PT
23	Vinné	SW	200	-3.5	19.5	8.8	610	NK	PT
7	Beckov	SW-W	280	-2.0	20.0	8.5	620	KK	T
4	Drietoma	W	380	-2.5	18.5	8.1	700	KK	T
6	Haluzice	SE	320	-2.5	18.5	8.2	650	KK	T
20	Plachtince	S-SE	260	-2.5	18.5	8.5	620	KK	T
21	Príbelce	S	320	-2.3	18.0	8.1	640	KK	T
22	Kosihovce	S-SE	250	-2.5	18.5	8.5	620	KK	T
2	Dolná Súča	SW	300	-2.0	18.0	8.3	650	HK	T
19	Devičie	SE	300	-2.0	18.5	8.3	620	HK	T
14	Hronský Beňadik	S	230	-2.0	19.5	9.0	650	HK	MT-T
24	Koňuš	SW	350	-3.8	17.5	8.1	650	HK	MT-T
3	Zem. Podhradie	SW	370	-3.5	71.5	8.0	700	HK	MT
5	Zabudišová	S-SE	450	-4.0	16.5	7.7	750	HK	MT
9	Modra	S-SW	220	-3.0	19.5	9.0	645	HK	MT
1	Predpoloma	S-V	490	-5.0	16.5	7.5	790	HK	CH

Notes: NK – plain climate, KK – fold climate, HK – mountain climate, T – subtype of warm climate, MT – subtype of moderately warm climate, PT – subtype of mostly warm climate, CH – subtype of cold climate

8 localities (33%) were classified in the type of mountain climate (HK) with mild inversion of the air temperatures. This climate is rather humid. Two of mentioned localities (2, 19) belong to the subtype of warm climate (T) with the average January temperature (TI.) -2.0 °C and the average July temperature (T VII) 8.3 °C. The average annual temperature is 8.3 °C and the annual sum of precipitation 650 and 620 mm.

Two localities (14, 24) belong to the subtype of moderately warm even warm climate. The average temperatures in January (TI.) range from -2.0 to -3.8 °C and the average temperatures in July (TVII) from 19.5 to 17.5 °C. The annual sum of precipitation is 650 mm.

Three localities (3, 5, 9) belong to the subtype of moderately warm climate with the range of the average temperatures in January (TI.) -3.0 and -4.0 °C and the average July temperatures (T VII) range from 16.5 to 19.5 °C. The average annual temperatures are 7.7–9.0 °C and the annual sum of precipitation ranges from 645 to 750 mm.

One locality was classified in the subtype of mountain climate with average January temperature (TI) -5.0 °C and average July temperature (T VII) 16.5 °C. The average annual temperature is 7,5 °C and annual sum of precipitation 790 mm.

According to the recent climatic evaluation (Škvarenina et al., 2003), the annual average temperature of the majority of localities with service tree is above 8 °C, except two of the analysed localities (1 and 5), where the annual average temperature ranges from 7.5 to 7.7 C. The average value of the annual sum of precipitation for majority of localities is 610–700 mm, except two mentioned localities, where this characteristic reaches 790 and 750mm. The potential evapotranspiration of the majority of analysed stands was 600–750 mm during one year. Considering the annual average sum of precipitation 610–700 mm, it is possible to expect, that service tree during main vegetal period has to get enough moisture mainly from the water resources in soil. The summer deficit of rain appears on the majority of the stands with this woody plant.

The big role in creation of the arid microclimate and mezzo-climate of mentioned localities also play warm and arid south-east, south, south-west even west exposures of these stands. According to the climatic classification of Slovakia (Špánik et al., 1999), the analysed localities with service tree were on stands with warm even moderately warm, moderately humid even mild arid climate characteristics.

Soil characteristics

Within the analysed localities with service tree there were identified 6 soil representatives. The obtained data are given in Table 5.

According to the soil representatives, which appear on analysed localities it is possible to say, that soils there are often erosive or cultivated. In past, these localities were exploited as orchards, arable lands or grazing-lands and later they were abandoned.

The highest number of the soil representatives were Eutric Cambisols which occurred on 11 stands (46%) of total number of analysed localities. Quite frequent there were also Luvisols (9 stands, 37%) among them the Calcic Luvisols from loess were predominant on 5 stands. The other 4 stands (17%) were on Rendzinas.

T a b l e 5. Survey of the soil representatives on *Sorbus domestica* L. localities in Slovakia.

	Soil representative	Locality number	n	%
R_1	Rendzic Leptosols and Eutric Cambisols from weathering solid carbonate rocks	3, 5, 6, 7	4	17
H_1	Calcic Luvisols from loess	10, 11, 12, 13, 15	5	22
H_4	Albi-Haplic Luvisols from loess loams	16, 17, 22	3	12
H_5	Stagni-Haplic Luvisols from deeply decalcificated loess loams and slope loams	8	1	4
K_1	Eutric Cambisols, saturated from weathering non-calcareous rocks	9, 14, 18, 19, 20, 21, 23, 24	8	33
K_3	Eutric Cambisols and Calcaric Cambisols from weathering silicate-calcareous rocks	1, 2, 4	3	12
Total			24	100

The soils have favourable physical characteristics and adsorbing complex, they are fertile, well supplied with nutrients (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) which range within these soil representatives from 5.5–6.5 (Eutric Cambisols) to 7.2–8 (Rendzinas) it is possible to define area of the soils suitable for root system of the service tree. They are soils with moderately acid (5.5–6.5), neutral (6.5–7.2) and moderately alkaline (7.2–8) reaction (Šály, 1988, 1996).

Discussion

When studying the variability of the service tree in Slovakia, there were obtained data, which besides the other information allowed at least brief assessment of its requirements on environmental conditions. The evaluation was based on the analysis of the ecological characteristics of the localities with service tree.

In Slovakia, the service tree occurs on the lower and warmer stands in the south regions. According to Májovský (1992), the service tree belongs among plants with higher demands on light and high temperatures (it is European, sub-Mediterranean element). Service tree is planted especially in the uplands on sunny stands with south and southwest exposure. The vertical distribution of this plant is mentioned from the altitude 109 m (Benčať, 1995) or 175 m (Michalko, 1961) up to the altitude 610 m (Michalko, 1961; Benčať, 1995). The distribution of localities confirmed occurrence of the service tree on lower altitudes. The lowest stand with service tree was found at the altitude 200 m (locality Vinné) and the highest stand was found at the altitude 490 m (locality Predpoloma). Within the total number 24 localities, about 60% were at the altitude within 201–300 m and 26% of them were at the altitude 301–400 m. Single localities were found at the altitudes 401–450 m and 451–500m. Above 90% of the localities were on stands with altitude up to 400 m.

Apart form own findings, there was done also analysis of the service tree occurrence on 212 localities according to data given by Benčať (1995). He used information from the other authors (Kárpáti 1960 *ex* Michalko 1961 and Michalko, 1961) and also from enquiry correspondence. According to these data, the 13% of the service tree localities were at the altitude 101–150 m, the most of them (above 61%) at the altitude 151–250 m and 21% localities were at the altitude 251–400 m. In total, above 95% of the localities with service tree were from the altitude up to 400 m and only 5% of them were from the altitude up to 610 m. It means, the service tree grows mainly from lower stands up to the altitude 400 m in Slovakia and the occurrence of this woody plant at the altitude above 500 m is rare.

The service tree occurs in south regions of its natural distribution, for example in Spain at the altitudes up to 1400 m, in Greece up to 1350 m, in Turkey to 1300 m, in south Bulgaria occurs on altitude from 300 to 800 m, in Slovenia up to 500 m (Kausch, 2000). In south Italy (Mt. Vesuvius), service tree occurs from the sea-bank up to the altitude 800 m (Bignami, 2000). In the north regions of its natural distribution service tree grows for example at the Plateau Lorraine in forest crops on altitude 200–400 m (Wilhelm, 1998).

In Switzerland service tree occurs within the altitude 384 m in Basel region and 675 m in Schaffhausen region (Brütsch, Rotach, 1993). In south-east part of the Wiener Wald in the area of Merkenstein, service tree appears up to the altitude 550 m (Steiner,1995). At the north border of its natural distribution in Germany in the region Sachsen-Anhalt, the service tree occurs on the altitude from 140 m to 310 m, mostly within altitudes 161–240 m (Steffens, 2000), in the south parts of Germany it can appear on the altitude 800 m (Kausch, 2000).

The service tree is definitely regarded as a light demanding woody plant (Brütsch, Rotach, 1993; Májovský, 1992; Michalko, 1961; Pagan, 1996; Wilhelm, 1998).

These information are supported also with own findings, according them, the service tree occurred on more than 96% of the analysed stands as a solitary plant in vineyards and in abandoned fruit orchards. On two localities a few trees were found also in a neighbouring woodland area, only one locality with service tree was in forest crop, where the service tree occurred in the general level of the upper canopy, or slightly above it. At all of the mentioned localities the crowns of service tree individuals were not exposed to the competition of the other woody plants and they were growing nearly with full light supply.

Wilhelm (1998) mentioned the similar findings from woodlands of the Plateau Lorraine, where service tree grows in the conditions of the coppice with standards under the highest trees, or in the general level of the upper canopy. Service tree creates above 20 m broad crown, comparable with oak-trees. Already in early young age this plant is intolerant to shading. Alike as pear, without the minimum light supply it falls quickly.

The opinion about its high demand to light and warm climate is supported also with analysis of the localities with service tree according their exposure. According to measurements of Geiger (1961) the north exposed slope obtains just half of the absolute sum of light emission on south exposed slope. Neither of the own localities with service tree was on north exposure (north-west, north, north-east). The majority of localities (38%) were on south exposure, many localities were also on south-east exposure (33%) and south-west (25%) exposure. One locality (4%) was on west exposure. In Switzerland, even 74% of the localities with service tree were on south exposure (Brütsch, Rotach, 1993).

It is evident from the climatic characteristic of the analysed stands, that their ecological-climatic amplitude is quite broad from the plane to the mountain climate. The most frequent are stands with prevalence of the warm subtype of plane as well as temperate warm subtype of fold and mountain climate. Only one locality was found in the subtype of cold mountain climate. Within the whole complex of the analysed stands, the January average temperatures range from -1.8 to -5.0 °C, the average July temperatures range from 16.5 to 20.0 °C and average annual temperatures range from 7.5 to 9.0 °C, while only in two cases they were under 8 °C.

According to information from Switzerland (Brütsch, Rotach, 1993), the service tree is considered to be a thermophilic taxon, which occurs in warmer regions with average annual temperature 8.5 °C. In Switzerland, the warmest region where service tree appears is Genf with average annual temperature 9.1 °C. In this region the average air temperatures in winter months do not fall under 0 °C. The coldest region is Schaffhausen, with average annual temperature 7.2 °C, where average temperatures in December, January and February are under 0 °C and January average temperatures fall on -2 °C. In south-east part of Wiener Wald the average annual temperature is 8 °C (Steiner, 1995). At the north border of service tree natural distribution in Germany in the region Saxony-Anhalt, the average annual temperature ranges from 8.0 to 9.0 °C (Steffens, 2000).

On stands with service tree in Slovakia the annual sum of precipitation are from 610 to 790 mm. In Switzerland the regions with appearance of service tree are considered to have low sum of precipitation. The lowest annual sum of precipitation 790 mm is in the Basel region and the highest annual sum of precipitation is in the Genf region. The mentioned areas as well as region Schaffhausen with less sum of precipitation and relatively higher temperatures are considered to be very suitable for thermophilic service tree (Brütsch, Rotach, 1993). In the area of Plateau Lorraine the annual sum of precipitation ranges from 750 to 850 mm (Wilhelm, 1998), in the south-east part of the Wiener Wald it is 700 mm (Steiner, 1995). In the Bundesland Saxony-Anhalt on north border of the service tree natural distribution the annual sum of precipitation is 550–650 mm and this area is considered to have less sum of precipitation with a temperate indication of the continentality (Steffens, 2000).

According to the brief pedological characteristic of the service tree stands in Slovakia, it is possible to assume that these soils have favourable physical characteristics, good saturation, they are well fertile (Orthic-Luvisols, Cambisols), or there are soils well supplied with nutrients (Rendzinas), but their chemistry is one-sided and therefore they are mostly little fertile. According to the values of the soil reaction (pH) it is possible to allocate area of the soils with moderately acid neutral till moderately alkaline reaction for root system of the service tree.

Cambisols have generally sufficient water supply, Orthic-Luvisols have less water supply with possibility of their aridization. Water deficiency is on Rendzinas as a result of the water penetration, so their water supply is usually low. (Šály, 1988).

According to Wilhelm (1998), in the area of Plateau Lorraine the service tree grows on the mussel limestone and on keuper sediments. There are soils well or very well supplied with the nutrients. On the mussel limestones on north and basal parts of the slopes there

are deep terra fusca, and on the upper parts of the slopes there are shallow Rendzinas. On the keuper there are abundant more or less deep Vertic Cambisols with water deficiency during summer.

In the east Austria the service tree occurs as a solitary plant in oak forests. It is a tree of the upland zone, with less demands on soil humidity, but with quite high demands on nutrient content of the soils. (Mayer 1984 *ex* Kristis, 1992). In the Wiener Wald (Steiner, 1995) in its part Merkenstein and Mettau, the service tree appears on limestone and dolomite parent rock, where mild fresh Rendzinas as well as very dry Rendzinas are abundant

According to Landolt (1977 *ex* Brütsch et Rotach, 1993) in Switzerland the service tree occurs mainly on arid soils with less skeleton and rich of bases.

Brütsch, Rotach (1993) from detailed study of the service tree stands in Canton Genf refer about occurrence of this woody plant on medium deep and deep skeletal Cambisols and Luvisols with slower water penetration and there can appear also symptoms of the water logging. In region Bassel the service tree grows (according to the slope inclination) on Rendzinas, or Lithosols, which are shallow and extreme skeletal soils. Their water capacity is very low. On plane stands the deeper Orthic Luvisols rarely appear with less skeleton and higher water capacity. In the Schaffhausen about 92% of the service tree plants grow on limestones and the rest stands are gravels of the high terrace which belong to Riss. In the deeper strata there are limestones which are part of the morena and gravels. On these parent rocks can appear various, also acid soils on small areas. According to Brütsch (1993) these information show possibly wider scale of the service tree stands than it is expected**.**

Brütsch, Rotach (1993) generalize obtained information about service tree. According them in Switzerland service tree is abundant on very shallow soils. 93% of the studied individuals grow on stands with soil depth up to 0.3 m. Also in the regions with medium deep and deep soils the service tree occurs on stands with shallow soils. This fact is in connection with competition of the other plants, especially beech has lower growth rate and dimensions on these stands. As it resulted from the research of growth rate, service tree has the best increments on medium deep and deep soils. This woody plant survives also on shallow and little fertile stand, but its growth rate is slower as it is seen on the service tree individuals from extreme shallow and little fertile soils of the stands with pubescent oak (*Quercus pubescens*) (Brütsch, Rotach, 1993).

The service tree is considered to be a woody plant with growth optimum in environmental conditions of the vineyards (Brütsch, 1993; Čížková, Mana, 1996; Májovský, 1992; Namvar, Spethmann, 1985; Steiner, 1995).

Conclusion

The study of service tree occurrence in Slovakia was done on 24 localities within the area of distribution. The analysis of environmental conditions on service tree stands (altitude, exposure, ecological-climate amplitude and soil representatives).

The service tree grows mostly (96% of the stands) as a solitary tree in the vineyards, fruit orchards on the baulks and grazing lands. The rest of stands were found on the forest crops, where service tree individuals had crowns in the main forest storey, or slightly above this level with full light income. All service tree stands were found on south-east, south and south-west exposures, more than 90% of them were on altitudes up to 400 m and less than 10% of them were on altitudes up to 500 m. The majority of the stands were found in the subtype of mostly warm plain climate as well as in the subtypes of warm and moderate warm fold climate and mountain climate. These data confirmed high demand of the service tree on light and higher temperatures.

Within all analysed localities of service tree the average January temperatures range from -1.8 to -5.0 °C, the average July temperatures range from 16.5 to 20.0 °C. Within 96% of the analysed localities the average annual temperature is above 8.0 °C (min. 7.5 °C), the average annual sum of precipitation is 610–700 mm (max. 790 mm). The potential evapotranspiration on majority of analysed stands was 600–750 mm during one year. Considering the annual average sum of precipitation 610–700 mm, it is possible to expect, that service tree during main vegetal period has to get enough moisture mainly from the water resources in soil, because the summer deficit of rain appears on the majority of the stands with this woody plant. The big role in creation of the arid microclimate and mezzo-climate of mentioned localities also play warm and arid south-east, south, south-west even west exposures of these stands. The analysed localities with service tree are on stands with warm even moderately warm, moderately humid even mild arid climate characteristics.

There were found 6 soil representatives on the analysed localities with service tree. These soils have favourable physical characteristics and adsorbing complex, they are fertile, well supplied with nutrients (Luvisols, Cambisols) on 96% of the analysed stands. Some localities (4%) have soils rich in minerals, but the soil chemistry is one-sided, so they are mostly little fertile (Rendzinas). According to the values of the soil reaction (pH) which range within these soil representatives from 5.5–6.5 pH Eutric Cambisols to 7.2–8.0 pH (Rendzinas) it is possible to define area of the soils suitable for root system of the service tree. They are soils with moderately acid (5.5 –6.5), neutral (6.5–7.2) and moderately alkaline (7.2–8) reaction.

Regarding water content in soils generally, Cambisols have sufficient water-supply. The Luvisols have lower water supply with possibility of their aridization. Rendzinas are mostly loose soils with good permeability, regarding their shallow profile with lower water capacity and good drainage of the parent rock they have usually less water supply. According to obtained data it is possible to evaluate service tree as light demanding woody plant with requirements on higher temperatures and higher content of nutrients in soil. This woody plant is able to grow on drier soils with infrequent occurrence of water deficit.

Regarding the expected changes of global climate, service tree should substitute some tender woody plants with higher sensitivity to drought within the landscape arrangements. The higher number of service tree plants in forest crops can considerably increase their ecological stability in the changing environmental conditions.

Translated by the author

Acknowledgements

Research program of Service tree in Slovakia is realised thanks to the financing of the grant projects VEGA 1/0626/03 and VEGA 1/3466/06.

References

Benčať, F., 1995: Distribution and originality of *Sorbus domestica* L. in Slovakia (in Slovak). Zb. ref.“ Výsledky botanických záhrad a arborét pri záchrane domácej dendroflóry a II. Dendrologické dni“.Vyd. TU vo Zvolene, Zvolen, p. 136–149.

Bignami, C., 2000: Der Speierling in Süditalien: Erforschung der Hänge des Vesuvs (Kampanien). Bovenden. Corminaria, *14*: 7–10.

Brütsch, U., 1993: Der Speierling, ein Vielfältiger Baum mit Zukunft. Wald und Holz, 13:8–11.

Brütsch, U., Rotach, P., 1993: Der Speierling (*Sorbus domestica* L.) in der Schweiz: Verbreitung, Ökologie, Standortsansprüche, Konkurrenzkraft und waldbauliche Eignung. Schweiz. Z. Forswes., *144*, 12: 967–991.

Collective, 1986: Geomorphological classification of SSR and CSSR. Geomorphoological Classification of SSR, in scale 1: 500 000 (in Slovak). Vyd. Slovenská kartografia. Bratislava.

Čížková, L., Mana, V., 1996 : Distribution and cultivation of the service tree in Germany and in our country (in Czech). Lesnická Práce , *11*: 392–393.

Ellenberg, H., Klotzli, F. 1972: Waldgesellschaften und Waldstandorte der Schweiz. Mitt. Schweiz. Anst. Forst. Versuchswes, *48* : 587–930.

Geiger, R., 1961: Das Klima der bodennahen Luftschicht. Ed. 4. Vieweg and Sohn, Braunschweig, 646 pp.

Haeupeler, H., Schönfelder, P., 1988: Atlas der Farn-und Blütenpflanzen der Bundesrepublik Deutschland. Eugen Ulmer Verlag, Stuttgart, 95 pp.

Kausch, W., 1992: Der Speierling. Goltze-Druck & Co. GmbH., Göttingen, 224 pp.

Kausch, W., 2000: Der Speierling. Eigenverlag , Bovenden, 184 pp.

Kristis, T., 1992: Der Speierling – Die seltensteeinheimische Baumart. Österreichische Forstzeitung, *10*: 55–56.

Májovský, J., 1992: *Sorbus* L. emend. Crantz. In Bertová L. (ed.), Flora of Slovakia, IV/3. (in Slovak) Veda, Bratislava, p. 405–408.

Michalko, J., 1961: Originality of the service tree (*Sorbus domestica* /L./) in oak communities of the Carpathian Mountains (in Slovak). Biológia, Bratislava, *16*, 4: 241–248.

Minďáš, J., Škvarenina, J., 1994: Supposed impacts of climatic changes on forest ecosystems (in Slovak). Národný klimatický program Slovenskej republiky, zv. 1. Bratislava, p. 57–82.

Namvar, K., Spethmann, W., 1985: Die Baumarten der Gattung Sorbus: Vogelbeere, Mehlbeere, Elsbeere und Speierling. Sonderdruck aus Allgemeine Forst Zeitschrift Nr.36/1985.

Pagan, J., 1996: Forestry dendrology: lecture notes (in Slovak). Vyd. TU vo Zvolene, Zvolen, 378 pp.

Sokolov, S. Ja., 1954: Service tree (*Sorbus domestica* L.) (in Russian). Derevja i kustarniky SSSR, Vol III. Moskva – Leningrad : Izd. AN SSSR, 871 pp.

Steffens, R., 2000: Der Speierling in Sachsen-Anhalt – Verbreitung, Ökologie und genetische Variation. Bovenden. Corminaria, *14*: 14–17.

Steiner, M., 1995: Seierlingskartierung im südöstlichen Wienerwald. Österreichische Forstzeitung, *6*: 50–51.

Šály, R., 1988: Pedology and microbiology (in Slovak). Vyd. VŠLD Zvolen, 378 pp.

Šály, R., 1996 : Pedology (in Slovak). Vyd. TU vo Zvolene, Zvolen, 177 pp.

Šály, R., Šurina, B., 2002 : Soils. Map no. 78. Atlas of the country SR. SAŽP, Banská Bystrica, 344 pp.

Škvarenina, J., Minďáš, J. et al., 2003: Regionalisation of the climatic conditions and pollutant load according to forest zones and geomorphological units (in Slovak). Záverečná správa. Projekt APVT.

Špánik, F., Antal, J., Tomlain, J., Škvarenina, J., Repa, Š., Šiška, B., Mališ, J., 1999: Applied agrometeorology. (in Slovak). Vyd. SPU, Nitra, 194 pp.

Tarábek, K., 1980: Climate-geographic types. (in Slovak). In Atlas SSR. Slovenský úrad geodézie a kartografie, Bratislava, 64 pp.

Wilhelm, G. J., 1998: Im Vergleich mit Elsbeere und Speierling Beobachtungen zur Wildbirne. AFZ. Der Wald, *16*: 856–859.