

DISTRIBUTION OF *SPHAGNUM QUINQUEFARIUM* IN THE CARPATHIAN BASIN ON THE BASIS OF LITERATURE AND HERBARIUM DATA

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Abstract: We have found *Sphagnum* colonies on 10 October 2010 near Parádfürdő village, at the entrance of Ilona valley in northeast Hungary. The species was determined as *Sphagnum quinquefarium* (Lindb. ex Braithw.) Warnst. (five-ranked bog-moss), a protected species (on the basis of the 66/2015. (X. 26.) FM regulations) which was not until now described in the area of the Mátra Mountains. This species became known only from a few localities in Hungary, but was more frequent on the edge of the Carpathian Basin and in part of the outside border of our country. We collected the relevant data for the *S. quinquefarium* from the largest Herbarium database in Hungary and the countries of the Carpathian Basin and used the available botanical literature database. The peat moss species studied is very common in the High Tatras of Slovakia and throughout the Carpathian Mountains of Romania. This present paper summarises the recent distributional knowledge about *S. quinquefarium* distribution in the Carpathian Basin, outside of Hungary, on the basis of herbarium and literature data.

Keywords: peat moss, chorology, habitats, moorlands, herbarium data, literature data.

Introduction

We have found several *Sphagnum* colonies of different size on 10 October 2010 near Parádfürdő village in Hungary, at the entrance to the protected Ilona valley. The species was determined as *Sphagnum quinquefarium* (Lindb. ex Braithw.) Warnst. (five-ranked bog-moss) which was not until now known from the area of the Mátra Mountains (Misik and Misik-Bartók 2010, 2011). Our paper, which presents the distribution of the *S. quinquefarium* in the Carpathian Basin, in the neighbouring countries, focuses on this species.

Similar to the other inland peat mosses *S. quinquefarium* is protected, with an ecological value of 5000 HUF (66/2015. (X. 26.) FM regulations). The species studied is recognised in the Red List of Hungarian Bryophytes as having Vulnerable status (Papp et al. 2010), and as well in the recent version of the Red Data Book of European Bryophytes (Hodgetts 2015).

Peat mosses and their habitats are very rare in Hungary; this studied species was known up until now from only a few localities. It was first published from Hungary by Pócs (1958) in the Vend (Hungarian Slovenes) country near Szakonyfalu. In the 1960s it was recorded from the Vas ridge from Farkas-forest of Petőmihályfa and also along the Kemence brooklet in North-Hungary (Boros 1968). On the basis of the studies in recent years researchers were able to find a

small *S. quinquefarium* patch by Kishuta in Zemplén Mountains in North-eastern Hungary. The species is not common in western Hungary either, but is generally known from the area of Vend country, Őrség, Kőszeg Mountains and Vas ridge (Szurdoki 2005). The volume of “Protected plant species of Hungary” (Farkas 1999) described only four assured habitats of this peat moss: (1) Zemplén Mountains (valley of the Kemence brooklet); (2) Kemeneshát (Petőmihályfa); (3) some points of Vend country and (4) Őrség (Szarvaskend).

It occurs in many countries of Central and Western Europe. For example, the species is relatively common in the pre-Alpine zone of Alps at 450–1900 m a.s.l. in Switzerland (Feldmeyer-Christe *et al.* 2001). It is prevalent too in the boreal forests of Norway (Økland 1994) and has been found in the Netherlands (Dirkse *et al.* 1988). In the Faroe Islands at over 300 m a.s.l. five-ranked bog-moss colonies occur particularly (Lange 1984). The species is more frequent on the edge of the Carpathian Basin and in part of the outside border of Hungary. It is common in the North-west and North (High Tatra) Carpathians and the whole of the Romanian Carpathians.

The aim of this study is to summarize the herbarium and literature collections of the distribution of *S. quinquefarium* in the Carpathian Basin.

Material and Methods

S. quinquefarium is a medium-sized species, with capitula parrot-green, yellowish-green, or less commonly, largely or all deep red. It is typical of five-ranked bog-moss that scattered leaves stand in five lines along the stem; almost all fascicles have three spreading branches. The capitula of the moss have a wide triangular form, only 1 mm in length. It is a sterile species in Hungary. The moss occurs in acidophilous beech forests, on wet andesite rocks and in wet coniferous forests (Farkas 1999). Compared to other species in the *Sphagnaceae* family all fascicles of *S. quinquefarium* have 3 spreading branches, normally two in the other species. It is commonly confused with red bog-moss (*Sphagnum capillifolium* (Ehrh.) Hedw.), but that species usually has only two spreading branches per fascicle. This species has a flatter capitulum and stem leaves with the basal part parallel-sided (Atherton *et al.* 2010).

We collected the relatively scanty literature data on *S. quinquefarium* by means of the largest scientific database and searching programme. The relevant herbarium databases for the Carpathian Basin were collected from the Herbarium of Eszterházy Károly University in Eger (EGR), the Herbarium of Hungarian Natural History Museum (BP) in Budapest, Herbarium of the University of Debrecen (DE), Herbarium of the University of Pécs (JPU), Herbarium of the Alexandru Borza Botanical Garden (CL) at Babeş-Bolyai University of Cluj-Napoca, Herbarium of the Tatra National Park (TNP) in Tatranska Lomnica, Herbarium of the BZ Univerzity Komenského Bratislava in Pracovisko Blatnici (BBZ-K), personal Herbarium of D. Blanár (DB) and Herbarium of the Department of Botany in the Comenius University in Bratislava (SLO). The herbarium sheets were submitted for us and determined by Tamás Pócs and András Vojtkó from Eger, Erzsébet Szurdoki from Budapest, Attila Molnár V. from Debrecen, János Csiky from Pécs, Mihai Puşcaş, Irina Goia from Cluj-Napoca and Rudolf Šoltés, Katarína Mišíková in Slovakia. Relevant herbarium sheets for the peat moss were not recorded from the following important institutions: Herbarium of Eötvös Loránd University in Budapest, Herbarium of University of Sopron, Herbarium of Szent István University, Herbarium of Bakony Natural History Museum in Zirc, Móra Ferenc Museum of Szeged, Matra Museum of Gyöngyös, Savaria

Museum of Szombathely, Herbarium of the Institute of Biology ZRC SAZU in Ljubljana, Herbarium of the Institute of Ecology of the Carpathians of NAS of Ukraine.

Sándor Molják (Innorégió Knowledge Centre of the Eszterházy Károly University) prepared a distributional map of the literature and herbarium data (Figure 1) using ArcGis software on the basis of the habitat's EOVC coordinates.

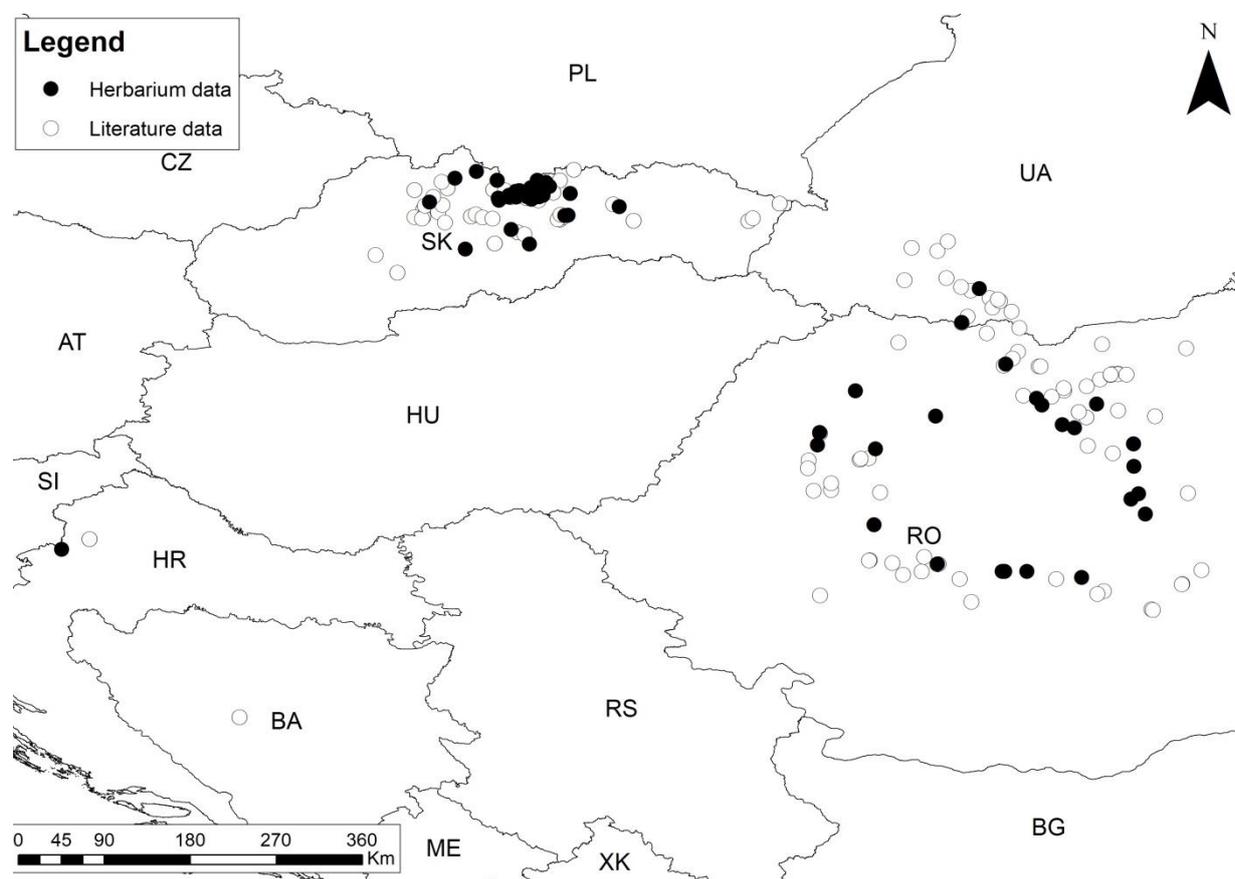


Fig. 1: Herbarium and literature data for the species *Sphagnum quinquefarium* in the Carpathian Basin (ed. Sándor Molják 2019)

Results

The peat moss studied is a frequent species with many habitats in Romania (i.a. Maramureş, Călimani and Făgăraş Mountains) Ukraine (Kárpátalja and Eastern Beskids Mountains) and Slovakia (i.a. High Tatra and Belanian Tatra Mountains); a few data are known from Czech Republic, outside of the Carpathian Basin. It cannot be found in Serbia, but at present the exploration of the potential moss habitats is underway (Sabovljević, pers. comm. 2018). It is known in Bosnia-Herzegovina from only one locality by Babin potok (on the basis of Sabovljević, pers. comm. 2018). In Croatia *S. quinquefarium* was found on granite and silicate rocks within beech woods in *Blechno-Fagetum* stands (Antun & Vedran 2010). In Slovenia *S. quinquefarium* is a common peat-moss species, but only in the Julian Alps, Karavanks mountain range, Pohorje Mountains and Kamnik-Savinja Alps (Martinčič 2003, 2010, 2012; Kutnar & Martinčič 2008; Kutnar 2013).

Romania - Literature data (mostly synthesized by Mohan 1998 and Plămadă 1998) are as follows (Figure 1): The species was found in the *Maramureş Mountains*: Pop Ivan Peak, Serban

(Boros & Vajda 1969), Tîjla Valley to Borşa Băi (Ştefureac 1958), Tăul Obcioarei (Goia *et al.* 2018); *Rodnei (Radnai) Mountains*: Pietrosul Peak, Piciorul Moşului, Ineu-Roşu Peak, Lala Lake (Ştefureac 1958); *Bîrgăului Mountains*: Grădiniţa peatbog (Silaghi & Ştefureac 1969), Cucureasa Forest (Ştefureac *et al.* 1976); *Călimani Mountains*: peatbog near Fântânele Monastery (Ştefureac 1958), Poiana Ştampei peat bog (Ştefureac 1965, 1967), Drăgoiasa peatbog (Ştefureac 1962), Vatra Dornei (Breidler 1890; Papp 1934), Cristişor peatbog (Lungu 1973) by Poiana Puturosu (Büdös Tisztás) and by Jézer Lake (Erzberger *et al.* 2012); *Obcina Mestecănişului Mountains*: Lucina, Camionica Valley (Ştefureac 1958); *Rarău (Ráró) Mountains*: Codrul Secular Slătioara to "Latoace" stones and Ion Valley (Papp 1969; Ştefureac 1941, 1958), Pietrele Doamnei (Breidler 1890) Plaiul Todirescu (Ştefureac & Raclaru 1978); *Giuralău (Gyamaló) Mountains*: Poiana Iţcani (Ştefureac 1958); *Ceahlău Mountains* (Papp 1934); *Nemira (Nemere) Mountains*: Slănic Valley (Papp 1957); *Penteleu (Pintyiló) Mountains*: Tisa Valley (Ştefureac 1958); *Siriu Mountains*: Buzăului Gorge, Lunca Băilor, Bocârnea Peak (Dihoru 1975), Giurgeului Depression (Lungu & Raţiu 1975); *Iezer-Păpusa (Jézer) Mountains* (Mohan 1978); *Bucegi (Bucsecs) Mountains* by Lăptici (Ştefureac 1958); *Cozia (Kozia) Mountains*: Cozia Peak (Dihoru 1990); *Lotrului Mountains*: Repedea Valley (Ştefureac 1958; Ştefureac *et al.* 1959); *Cindrel Mountains*: Ciban (Borza 1959), Cotoreşti, Crinţ, Găuşoara, Iujbea, Săroi (Gündisch 1977), Păltiniş, Beşineu Mt. (Gündisch 1977; Röhl 1903); *Şureanu Mountains*: Sebeş Valley (Ştefureac 1958; Borza 1959), Prigoana, Oaşa, Şureanu Peak (Borza 1959); *Retezat (Retyezát) Mountains*: Gemenea Valley, Dosul Bârlei, Turcului Valley, Negru Lake, Şesele ridge (Plămadă 1975); *Apuseni Mountains*: Someşul Cald Gorges (Szamosbázár) (Goia & Mătase 2001), Arieşul Mare basin (Goia and Schumacker 2002), Ponor, Cetăţile Ponorului, Gabena Valley, Pîrcanul (Ştefureac 1958), Vidra, Găina Massive, Drăganului Valley (Péterfi 1908), Someşul Rece-Mtele Mare, Dobrinu (Reketó) (Pop 1960), Răcăţau (Schedulae ad floram Romaniae Exsiccata 1921).

Romania - Herbarium data are as follows (Figure 1): *Călimani Mountains*: Piatra Orban, Colibiţa (Kolibica) to Bistiţa Bîrgăului (Bogóbeszterce) (Jávorka 1942 BP), Stânceni (Gödemesterháza) (Vida 1955 BP), Dragoiasa (Vajda 1972 BP), Lunca Bradului (Demeter 1886 CL), Mureşeni Bârgăului (leg. Forstner, det. Ştefureac 1946 CL); *Rodnei (Radnai) Mountains*: Corongiş (Korongyis) (Gürtler 1913 CL), Feketevíz (Vajda 1972 BP); *Făgăraş Mountains (Fogarasi-Alps)*: Arpaşelul and Şerbota (Pócs 1955 EGR, 1955 EGR), Sîmbăta Valley (Pócs 1956 EGR); *Cindrel Mountains*: Păltiniş (Vajda 1968 EGR); *Apuseni Mountains*: Drăganului Valley (Nagysebes, Dregán valley) (Boros 1941 EGR, CL and DE), Vlădeasa – Zîrna valley (leg. Gergely, det. Plămadă, 1968 CL), Someşul Mic (Györffy 1903 CL), Someşul Rece near Betlen Stone (Györffy 1903 CL), Răcăţau (Péterfi 1921 CL), Dobrin (Anon. CL), Măgura (Györffy 1902 CL); *Harghita Mountains*: Săndominic (Csíkszentdomokos by Pásztorbük) (Pócs 1955 EGR), Sîntimbru Băi (Büdösfürdő) and Sîncrăieni (Csíkszentkirály) (Vajda 1970 EGR, 1970 EGR); *Bodoc Mountains*: Ciomatu Massive - Tusnád: Kokojszás, Szent Anna lake (Vajda 1962 BP), Tusnád: Kokojszás, Szent Anna lake (Vajda 1965 BP) and Roşu valley (Péterfi 1918 CL).

Ukraine - Literature data are as follows (Figure 1): *Kárpátalja*: Berlebászka, Brusztura: Urja, Hoverla (Hóvár), Mala Hoverla, Pozyzewska, Terebesfejpatak, Czarnahora (Csornahora) (Wilczek 1931, Kozij 1934, Szafran 1936), Bliznica, Kisgorgán, Mencsul, Pietros (Boros and Vajda 1969); *Eastern Beskids Mountains, Ukrainian Carpathians Mountains*: Breskul, Pop Iwan pol. (Wilczek 1931, Kozij 1934, Szafran 1936), Grofa (Pozynych and Savitska 2010), Prykarpattia, Zakarpattia Oblast, Svidovec, Chyvchyny (carpaty.net 2019).

Ukraine - Herbarium data are as follows (Figure 1): *Kárpátalja*: Kőrösmező (Boros 1934 EGR), Trebusafejérpatak (Boros 1942 EGR).

Slovakia - Literature data are as follows (Figure 1): The species was detected in the *High Tatra Mountains*: Skalnaté pleso (Györffy 1909), Žabej Bielowodskej doline (Hadač *et al.* 1986); *Poprad Basin*: Kežmarské Žľaby, Nová Polianka, Gerlacov, Tatranské Matliare (Pilous 1971), Belanský potok (Šoltés 2006); *Low Tatra Mountains*: Demänovská Dolina (Pilous 1971), Ludarov kar under Ďumbier, Vyšná Boca and Branisko – Smrekovice, Stratenska hornatina - Veľký Kysel' and Suchá Belá (Šmarda 1948), Korytnica (Degen *et al.* 1923), Veľký Sokol (Pilous 1971); *Belanian Tatra Mountains*: (Györffy 1909); *Beskids Mountains*: Oravské Beskydy (Pilous 1971), Bukovské vrchy (Herben *et al.* 1980); *Slovak Ore Mountains*: Slovenský raj (Šmarda 1948), Muránska planina (Peciar 1974), Muránska Vysočina, Klenovesky Vepor and Veporské vrchy (Pilous 1971), Veľka Stožka – Kľak hill (Herben and Soldán 1987); *West Tatra Mountains*: (Šmarda 1948), Spišská Magura (Šmarda 1952), Kamenistá dolina (Pilous 1971); *Veľká Fatra Mountains*: Malá Fatra (Šmarda 1952), Branisko (Pilous 1971), Selenec - Čertova brána (Pilous 1980), Tlstá (Uhlířová & Bernátová 1986), Haľamova kopa, Skalná, Smrekovica, Ostré brdo (Šoltés *et al.* 2004), Ľubochňa (Jurko and Peciar 1963); *Vihorlat-Gutin*: Vihorlatské vrchy (Peciar 1970), Sninský Kameň (Pilous 1971); *Orava Magura*: Dolný Kubín (Uhlířová *et al.* 2015); The study of Peciar (1955) described the species in the *Pieniny Mountains*. On the basis of the Boros publication (1961) in *Prešovský kraj* Košická kotlina was assigned the habitat for the five-ranked bog-moss. Hlaváček (1957) transmitted the *Štiavnické Mountains*.

Slovakia - Herbarium data are as follows (Figure 1): *High Tatra Mountains*: Nagykorpalak (Vajda 1961 EGR), Kamzik & Nagy-Tarpatak (Vajda 1962, 1962 BP), Bielowodská dolina (Sofron 1975 TNP), Malá Svišťovka, Javorová dolina, Štrbské Pleso Furkotská dolina, Kriváň, Surovec, Machy, Uhlíčatka (Šoltés 1977, 1983, 1984, 1987, 1987, 1987, 1997, 2004 TNP), Velická dolina, Žabia Bielowodská dolina (Šoltésová 1981, 1982 TNP), Kôprová dolina (Rajcová 1986 TNP), Dlhý les kežmarský and Tatranská Polianka (Viceníková 1991, 1992 TNP), Zelené pleso and Trojrohé pleso (Jiroušek 2016 person. herbarium); *Veľká Fatra Mountains*: Krackov, Ľubochňa (Vajda 1967 EGR és BP); *Belanian Tatra Mountains*: Skalné vráta (Šoltés 1981 TNP), Monkova dolina (Šoltés 1993 TNP, Kulová 1993 TNP); *Podtatranská brázda Furrow*: Podspády-Bor, Peciská (Šoltés 1989, 1992 TNP); *West Tatra Mountains*: Oravice Mountains - Árvai Magura and Jedlini-Trstena (Vajda 1968, 1971 BP), Krížna dolina (Moravčíková 1986 TNP), Tichá dolina, Osobitá (Šoltés 1988, 1992 TNP); *Polana*: Kluka (Janisová 1995 TNP); *Slovak Ore Mountains*: Chyžnianska rokľa (Peciar 1972 SLO), Muránska planina (Blanár 1999 DB, Kochjarová 2000 BBZ-K); *Branisko Mountains*: Šindliar (Dostál 1986 SLO); *Žilinský kraj region*: Tatra Magna: Potocky, Pribilina (Vajda 1971 BP), Tatra Magna: Podbanské and Potocky prope Hotel Esperanto Pribilina (Vajda 1972, 1972 BP); *Prešovský kraj region*: Szepesamásfalva (Boros 1958 EGR), Káposztafalva, Roth-canyon (Boros 1961 EGR).

Croatia - Literature data are as follows (Figure 1): The species has some habitats in the *Medvednica Mountains*, near the capital city Zagreb (Sabovljević 2006 & Sabovljević pers. comm. 2018). In the study of Pichler (1928) described in Samobor: Ludvić potok and Lipovečka Gradna as the moss habitats at 200–250 m a.s.l. In *Požega-Slavonia county* Ellis *et al.* (2016) and (2018) reported the species from the Papuk Mountains, situated in the mainly lowland area of NE Croatia in *Fagus sylvatica* L. – *S. quinquefarium* forest stand. In the other part of the

Papuk Mountains this peat-moss was for the first time observed and described in 2015 (Alegro *et al.* 2015).

Croatia - Herbarium data are as follows (Figure 1): *Zagreb county*: Zagreb, Samobor (Boros 1966 EGR). *Požega-Slavonia county*: Papuk, Sokolina (Csiky 2015 JPU).

Discussion

On the basis of literature and relevant herbarium data *S. quinquefarium* has become known only from a few habitats in Hungary, but is more frequent on the edge of the Carpathian Basin and in part of the outside border of our country. This moss species, which typically prefers upland stands and well-drained spruce-forests, especially was prevalent in the range of the Carpathian Mountains. It is most common and frequent in the High Tatras of Slovakia and throughout the Carpathian Mountains of Romania. Farther south it is rarer; in Croatia it was reported only in couple of sites around the capital Zagreb, whereas in Serbia it has not yet been recorded, although researchers estimate that it may occur. In the Balkan Peninsula this peat moss will probably emerge in gaps revealed by precise habitat mapping.

Acknowledgements: First, thanks are due to Irina Goia of Babeş-Bolyai University, Cluj-Napoca for advice and, in the results section, herbarium and literature data from Romania. We especially thank János Csiky from the University of Pécs in Hungary, Rudolf Šoltés from the University of Žilina in Slovakia, Katarína Mišíková from Comenius University in Bratislava of Slovakia, Patrícia Ďurčanová and Tomáš Peterka from Masaryk University in Czech Republic, Mihai Puşcaş from the Alexandru Borza Botanical Garden, Cluj-Napoca in Romania, Marko S. Sabovljević from the University of Belgrade in Serbia and Vasyl' Sabadosh from Uzhhorod University in Ukraine, for a substantial number of literature and herbarium data and additions.

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DISTRIBUȚIA SPECIEI *SPHAGNUM QUINQUEFARIUM* ÎN BAZINUL CARPATIC PE BAZA DATELOR DIN LITERATURĂ ȘI DIN HERBARE

(Rezumat)

S-au găsit colonii de *Sphagnum* în data de 10 octombrie 2010 lângă localitatea Parádfürdő, la intrarea de pe valea Ilona, în nord-estul Ungariei. Specia a fost determinată ca *Sphagnum quinquefarium* (Lindb. ex Braithw.) Warnst., o specie protejată (pe baza legii FM 66/2015 (X. 26.)), care nu a mai fost descrisă din zona Munților Mátra. Specia se cunoștea doar din câteva localități din Ungaria, dar era mai frecventă la limita bazinului carpatic și parțial înafara granițelor țării noastre. Datele relevante pentru *S. quinquefarium* au fost colectate din cea mai mare bază de date de herbar din Ungaria și țările bazinului carpatic și din bazele de date botanice din literatura disponibilă. Specia studiată este foarte comună în zona înaltă a munților Tatra din Slovacia și în Munții Carpați din România. Acest studiu arată distribuția actuală a speciei *S. quinquefarium* în bazinul carpatic, înafara Ungariei, pe baza datelor de herbar și din literatură.