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## ***Taraxacum* sect. *Erythrosperma* (Asteraceae, Cichorioideae) in Slovakia IV. Distribution of *T. erythrospermum* and synonymisation of *T. slovacum***

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### Abstract

The group of lesser dandelions (*Taraxacum* sect. *Erythrosperma*) is represented by more than 215 species growing in mostly xerothermic habitats throughout Europe. The only known species with sexual reproduction in this section is the diploid *T. erythrospermum*. It occurs in southern parts of Europe and reaches its northern limit in central Europe. In this study, we aimed at a detailed mapping of the species distribution in Slovakia in order to understand the spatial distribution at its northern range limits. We found that it is the most common xerothermous species in Slovakia, growing on various substrates such as limestone, dolomite, travertine, volcanic rocks and sands, while it is less common on brown soils and ruderal biotopes. It is a characteristic species of the class *Festuco-Brometea* with an altitudinal range extending from 120 to 650 m above sea level. We delimited the northern distribution and documented its highest occurrence at approximately ca 1500 m a.s.l. Two taxa, *T. slovacum* and *T. punctatum*, were described from the territory of Slovakia and we discuss their relationships to *T. erythrospermum*, with which *T. slovacum* is synonymised here for the first time. We also present new data on the genome size of *T. erythrospermum* in Slovakia, which range from 1.529 to 1.604 pg with a mean of 1.554 pg ( $\pm 0.024$  SD), and provide chorological data on a remarkable morphological variant with grey-coloured achenes.

**Key words:** apomixis, central Europe, chorology, dry grassland, lesser dandelions

### Introduction

The genus *Taraxacum* Wiggers (1780: 56), known for its taxonomic complexity, comprises approximately 2,800 taxa classified in at least 60 sections and phylogenetic groups (Kirschner *et al.* 2015). The genus has a global distribution, with the highest diversity in Asia and Europe, where different reproductive modes (mainly diplosporous apomixis and allogamy) vary between taxa and populations (den Nijs & Menken 1994, Verduijn *et al.* 2004, Majeský *et al.* 2017). A total of 39 sections are known in Europe and adjacent regions (Kirschner *et al.* 2007+), and one of the largest is the group of lesser dandelions, *T.* sect. *Erythrosperma* (Lindberg 1908: 18) Dahlstedt (1921: 36). It is characterised by phyllary apices mostly minutely corniculate, often reddish-coloured achenes, but varying between red, brown and fulvous (Doll 1973, Štěpánek & Kirchner 2022, Wolanin *et al.* 2023). This section lists more than 215 accepted species (with about 40 synonymous names) occurring in most parts of Europe and the Middle East (Štěpánek & Kirschner 2012, 2022).

The major European sections usually consist of one (or a few) sexual diploid species and a high number of apomictic polyploids (Majeský *et al.* 2017). The distribution of sexual diploid and apomictic polyploid *Taraxacum* taxa in Europe is a clear example of geographic parthenogenesis (van Dijk 2003, Hörandl 2016). While apomicts grow throughout the range of *Taraxacum* as far north as Iceland, sexuals are restricted to lower latitudes and altitudes. In Europe, the distribution of sexuals extends as far north as Belgium, with a few occurrences in the Netherlands (on the southern slopes of polders), Germany, Czechia and Slovakia (den Nijs & van der Hulst 1988, den Nijs *et al.* 1990, den Nijs & Menken 1994, Uhlemann 2001).

The only single diploid species ( $2n = 2x = 16$ ) of *T. sect. Erythrosperma* is *T. erythrospermum* Andr. in Besser (1822: 75). It is widely distributed in southwestern Europe (Iberian Peninsula, southern France and Switzerland), central Europe (Pannonian Basin, Carpathians), (south)eastern Europe (Balkan Peninsula) and European Turkey (den Nijs & van der Hulst 1988; den Nijs 1997; Vašut 2003, Štěpánek & Kirschner 2012, Šuvada *et al.* 2012, Gurdal *et al.* 2017). Although the species was known from numerous localities in Slovakia, a general overview of its distribution in the country is still lacking. It was first documented by Richards (1970) from Devínska Kobyla Hills and Kováčovské kopce Mts, but under different names (*T. punctatum*, *T. danubium*, etc.), for which diploid chromosome numbers were recorded. In the map of the cytogeographical survey of *T. sect. Erythrosperma* by den Nijs & van der Hulst (1988), the occurrence of diploid sexuals is limited to south-western Slovakia (3 localities), and only Devín being specifically mentioned. Similarly, Kirschner & Štěpánek (1995) mentioned the occurrence of the species in Slovakia (with more than 10 known localities), but without a list of then known localities. Additional information on diploid *T. erythrospermum* in Slovakia comes from the biosystematic study of Mártonfiová *et al.* (2010) and the chromosome number survey (Marhold *et al.* 2007).

Diploid *Taraxacum* species usually show a great morphological variation, and *T. erythrospermum* is no exception (Vašut 2003, Šuvada *et al.* 2012). Within its range, several described taxa may be synonyms, and recently two taxa described from Central Europe have been considered identical with diploid species: *T. austriacum* Soest (1966: 434) and *T. punctatum* Richards (1970: 111) (see e.g. Kirschner & Štěpánek 2014). Another taxon described from the region remains unresolved, *T. slovacum* Klášterský (1938: 1).

In this article, which is the fourth part of the notes on *T. sect. Erythrosperma* in Slovakia (following the previous parts, i.e. Dudáš 2019, Dudáš *et al.* 2020 and Dudáš & Vašut 2022), we aim to summarise the knowledge on the distribution of the species in Slovakia (including its grey-fruited form) based on the revision of herbarium specimens and intensive field observations. Particular attention is paid to the delimitation of the northern range of the species. During the intensive field study and mapping of the *T. sect. Erythrosperma* species, and the monitoring of xerothermic habitats in southern and eastern Slovakia, many new localities of this group were recorded. The aim of this study is (1) to provide a detailed map of the distribution of *T. erythrospermum* in Slovakia, (2) to describe the northern limit of its natural occurrence in Slovakia, (3) to measure the genome size, and (4) to discuss the species nomenclature.

## Material and methods

### Collecting chorological data

The study and field research were mainly carried out in the years 2011–2022. As a source of species records, we used especially revised herbarium specimens from Slovak, Czech and Hungarian public herbaria, including BBZ, BP, BRA, BRNM, BRNU, HLO, KO, LTM, MP, NI, OL, OLM, OP, PL, PMK, PR, PRC, SAV, SLO, SMBB, SNV, TM, ZV and Richards' type collection deposited in Oxford, UK (OXF). Herbarium acronyms follow Thiers (2020+). The map was created using ArcGis version 9.2. The mapping grid follows the traditionally used CEBA (Central European Basic Area) grid template described by Niklfeld (1971). A list of revised specimens and other records is given below. The taxonomy and nomenclature of *Taraxacum* follows Kirschner & Štěpánek (1995) and Vašut (2003). The phytogeographical division of Slovakia follows Futák (1984). A digital microscope Olympus DSX-1000 was used for high-resolution pictures of achenes (deposited in Department of Zoology, Pavol Jozef Šafárik University, Košice).

### Genome size estimation

We assessed the genome size in nine individual plants of *T. erythrospermum* collected from three different localities in eastern Slovakia (1. Podhradská kotlina basin, Spišské Podhradie, Spišský hrad castle, grassland on travertine, N and NW slope under walls, ca 610 m a.s.l., 49°00'03.4"N 20°46'03.9"E; 2. Slovenský kras Mts, Zádielské Dvorníky, hill Zemné Hradisko, field road at the E foothill, grassland on limestone, c. 230 m above sea level, 48°36'27.2"N 20°49'03.5"E; 3. Zemplínske vrchy, Veľká Bara, Piliš hill, around the transmitter on the top, volcanic substrate, 278 m above sea level, 48°25'43.1"N 21°42'35.5"E) (three single plants per site). A flow cytometry sample was prepared from leaf parts of the target species and the internal reference standard *Solanum lycopersicum* L. 'Stupicke polni rane' (2C = 1.96 pg; Doležel *et al.* 1992, 2007), chopped with razor blade in 1 mL of ice-cold GPB buffer (Loureiro *et al.* 2007) supplemented with PVP-40 (3 mg.mL<sup>-1</sup>). The sample was filtered through a 42 µm nylon filter, incubated with RNase (30 µg.mL<sup>-1</sup>), PI (30 µg.mL<sup>-1</sup>) and β-mercaptoethanol (2 µL) for at least 15 min and then analysed using a

Partec CyFlow ML flow cytometer and FloMax 2.70 software (Partec GmbH, Münster, Germany). The number of nuclei recorded for both *T. erythrospermum* and the internal reference standard exceeded 1300 per individual peak (minimum 5000 nuclei recorded per sample). Although the variation of the peaks was considerable (CV values were in the range of 2.65–3.91% and 3.21–5.17% for *S. lycopersicum* and *T. erythrospermum*, respectively), the between-day variation of the samples was only 0.69–1.41%, allowing all measurements to be retained in the final analyses. DNA content was calculated from flow cytometry histogram data gated on a SSC vs. FL dot plot based on G<sub>0</sub>/G<sub>1</sub> peak mean values according to the following formula: DNA content of sample (pg, 2C value) = DNA content of standard (pg, 2C value) × [(G<sub>0</sub>/G<sub>1</sub> peak mean of sample)/(G<sub>0</sub>/G<sub>1</sub> peak mean of standard)] (Doležel & Bartoš 2005). Three independent measurements per individual plant were made on three different days and then averaged.

### ***Vegetation data processing***

We collected 105 own non-forest phytosociological relevés on a unified area (4 × 4 m) with a confirmed occurrence of *T. erythrospermum* from south and south-east part of Slovakia in the years 2018–2022, which were stored in a TURBOVEG database (Hennekens & Schaminée 2001) and exported into JUICE (Tichý 2002). The recording followed the Zürich-Montpellier approach using the adapted nine-point Braun-Blanquet cover-abundance scale (Barkmann *et al.* 1964). For classification of these relevés we used the electronic Expert system for identification of habitats of Slovakia (Šuvada 2023) with the Frequency-Positive Fidelity Index (Tichý 2005), and the results were shown in the Detrended correspondence analysis (DCA; log-transformed percentage abundances) using the program Canoco for Windows 4.5 (Ter Braak & Šmilauer 1998). To determine the ecological demands of the identified types of habitats, the Ellenberg-type indicator values for light, temperature, moisture, nutrients and reaction of the soil (Tichý *et al.* 2023) were added as passive vectors to the DCA analysis.

## **Results**

### ***Taxonomic treatment***

***Taraxacum erythrospermum*** Andr. in Besser (1822: 75).

Type:—UKRAINE. “In Volhynia et Podolia frequens” (lectotype LE, designated by Shiyan *et al.* (2012)).

= *Taraxacum corniculatum* f. *pusillum* Dvořák (1928: 27).

Type:—Not designated.

= *Taraxacum slovacum* Klášterský (1938: 8), **syn. nov.**

Type:—SLOVAKIA. “Slovenia austro-orientalis, Slovenský Kras, silvis apertis Zadielský Kámen dictis in declivibus meridionalibus supra cotam 271 prope Zádiel”, 06.1933, *I. Klášterský & M. Deyl* (lectotype PRC! #487724, left plant in the middle of the specimen, designated here) (Fig. 1).

= *Taraxacum austriacum* Soest (1966: 434).

Type:—AUSTRIA. „Nieder-Oesterreich: Wegraine südlich Petronell“, 11.05.1944, *K. H. Rechinger* (lectotype W #1998-01081, designated by Kirschner & Štěpánek (2014); isolectotype W #1998-01080).

= *Taraxacum austriacum* f. *achyrocarpum* Soest (1966: 436).

Type:—AUSTRIA. „Wienerwald, Bierhauseberg bei Rodaun“, 12.05.1911, *Korb* (holotype W).

= *Taraxacum punctatum* Richards (1970: 111) ≡ *Taraxacum austriacum* var. *punctatum* (A.J.Richards) Doll (1973: 22).

Type:—SLOVAKIA. Kováčovské kopce, 05.1965, *D. M. Valentine* (holotype OXF #54689).

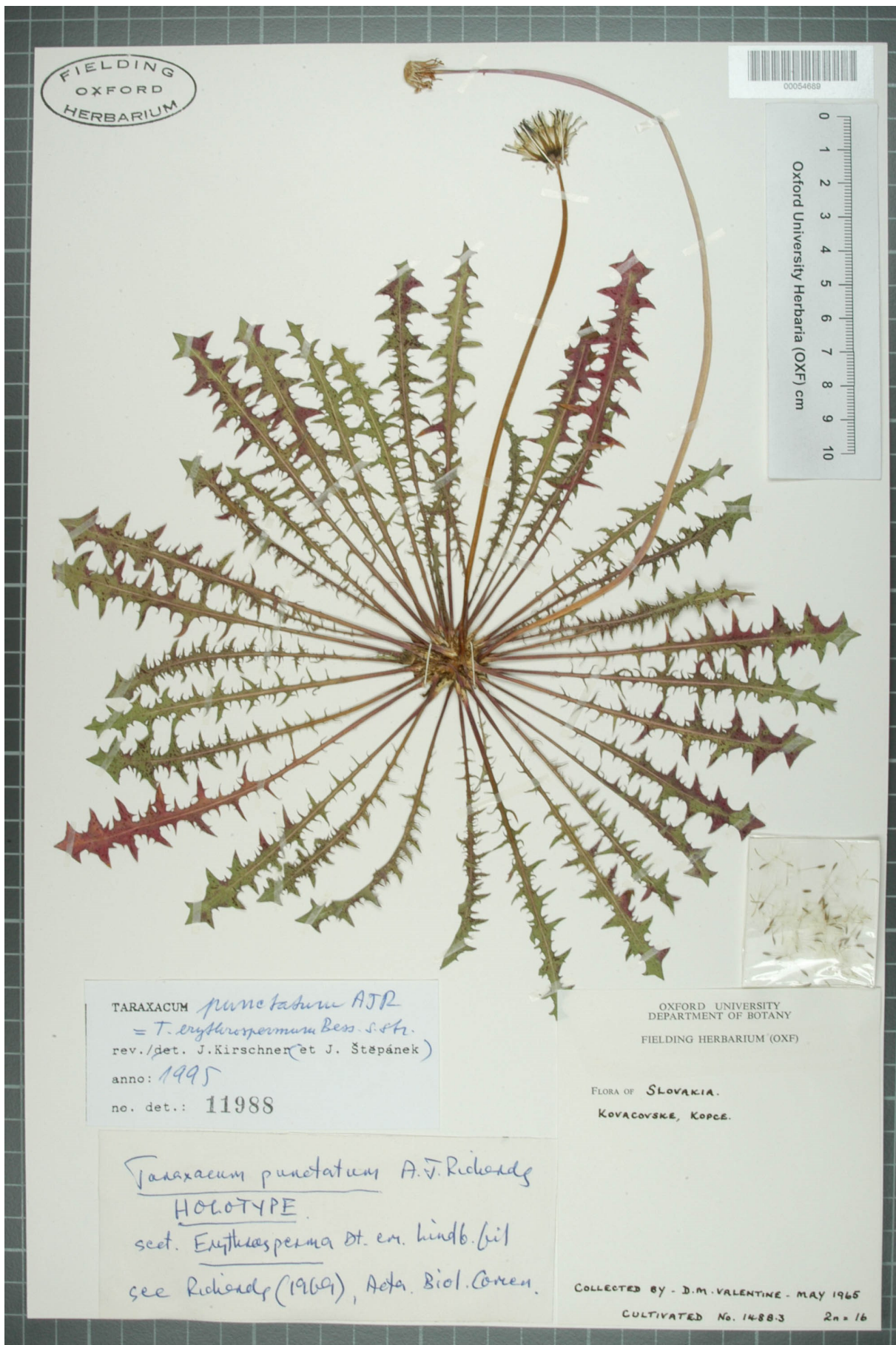
*Taraxacum erythrospermum* is a small plant usually only up to 10 cm tall, with a tunic of withered leaves at the base of a rich leaf rosette, mostly with deeply dissected and lacinate leaves. Leaves are greenish or greyish-green, glabrous, 3–10 (–15) cm long and (0.5–)0.7–1.5(–2.0) cm wide with 3–5 very variable lateral lobes, usually narrow, often linear, obtuse at the apex and denticulate; the terminal lobe is regular and triangular (outer leaves) to trilobate and linear (inner leaves). Petiole narrow, greenish to violet, sometimes lanate at the base. Scapes many (up to 30), usually equalling leaves, base gradually narrowed (V-like shaped); outer bracts tightly to not tightly adpressed, rarely suberect, usually (7–) 9–11, narrowly lanceolate to ovate, greyish-green, occasionally reddish, with a hyaline margin, up to 0.5 mm wide, corniculate at the apex; capitulum concave (styles exserted), pale yellow, small, 10–15 mm in diameter; outer ligules striped pale greyish-yellow to reddish brown; styles usually yellow or greenish-yellow; pollen present, pollen grains ca 27 µm in diameter, not varying in size (but sporadically of different size). Achenes are usually red, rarely greyish (Fig. 3), small, 1.8–4.3 mm long, achene body densely spinulose above, cone 0.2–1.5 mm long.





FIGURE 1. Holotype specimen of *Taraxacum slovacum* (PRC! #487724).





FIELDING  
OXFORD  
HERBARIUM

00054689

0 1 2 3 4 5 6 7 8 9 10  
Oxford University Herbaria (OXF) cm

TARAXACUM *punctatum* AJR  
= *T. erythrospermum* Bess. s. str.  
rev./det. J. Kirschner et J. Štěpánek  
anno: 1995  
no. det.: 11988

OXFORD UNIVERSITY  
DEPARTMENT OF BOTANY  
FIELDING HERBARIUM (OXF)

FLORA OF SLOVAKIA.  
KOVACOVSKÉ, KOPCE.

*Taraxacum punctatum* A.J. Richards  
HOLOTYPE  
sect. *Erythrosperma* St. em. Lindb. fil  
see Richards (1969), Acta Biol. Comen.

COLLECTED BY - D.M. VALENTINE - MAY 1965  
CULTIVATED No. 14883 2n = 16

FIGURE 2. Holotype specimen of *Taraxacum punctatum* (OXF #54689).

As *T. erythrospermum* is a sexually reproducing species, it has a large morphological variation, unlike in apomictic microspecies (Vašut 2003, Šuvada *et al.* 2010, Majeský *et al.* 2015). Some distinct morphologic variants were described as forms, such as the form with greyish achenes (Soest 1966; Fig. 3), or dwarf forms collected on the serpentinites (Dvořák 1928). Although they might appear distinct, they do not represent taxonomically important variants. The morphotype with grey-coloured achenes—known as *f. achyrocarpum* Soest (1966: 436; e.g. adopted by Vašut 2003; Mártonfiová *et al.* 2010; Dudáš *et al.* 2013)—is scattered throughout the distribution area of the species (Figs. 4 and 5). The growth-size of plants strongly depends on the environmental condition and vary considerably, therefore describing tiny plants as a distinct form does not make any taxonomic importance. An image of the plant described by R. Dvořák as *T. corniculatum f. pusillum* looks like typical *T. erythrospermum* (Dvořák 1928, pl. I, fig. 4).



FIGURE 3. Variation of the achene colour of *Taraxacum erythrospermum*. Left: typical form; right: greyish form. Bar scale = 1 mm.

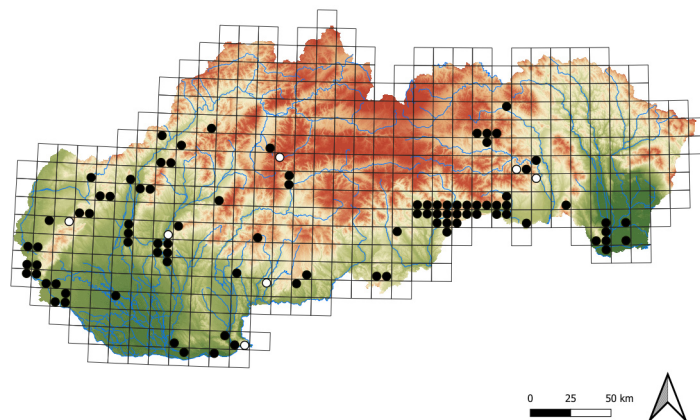


FIGURE 4. Distribution of *Taraxacum erythrospermum* in Slovakia (full dots); empty circles: *T. cf. erythrospermum*.

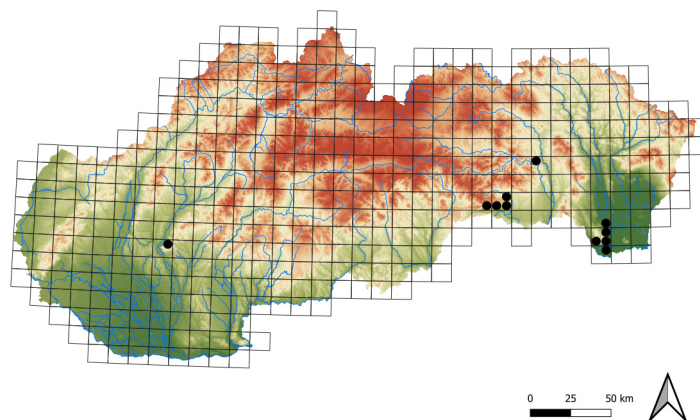


FIGURE 5. Distribution of *Taraxacum erythrospermum* with grey-coloured achenes in Slovakia.



### Notes on *Taraxacum slovacum*

The holotype specimen (Fig. 1) represents a young plant lacking well-developed inner leaves, and it was therefore difficult to interpret the taxon. The plant on the holotype specimen has clearly compressed outer bracts (phyllaries), which are narrow and tiny, a thin stem below the capitulum, and apparent remnants of dried leaves at the base of the leaf rosette—these are unambiguous characters of the diploid species *T. erythrospermum*. Unfortunately, there was no flowering with pollen, which would have confirmed either sexual or apomictic reproduction.

There were doubts about the leaf shape, and the apomictic species *T. pudicum* Vašut & Majeský (2015: 244) superficially resembled the leaves of the left plant on the holotype specimen. Intensive field surveys confirmed the frequent occurrence of diploid *T. erythrospermum* at the *locus classicus*, often with the (unusual) triangular terminal lobe, as is the feature of the plant on the type specimen. The only apomictic species at the putative classical locality was *T. prunicolor* Schmid *et al.* (2004: 221). However, combining the facts that the plant on the holotype falls within the morphological variation of *T. erythrospermum*, and that only diploids are the common taxon at the classical site, we consider *T. slovacum* a synonym of *T. erythrospermum*.

### Distribution in Slovakia

Our results show that *T. erythrospermum* is the most frequent species of *T. sect. Erythrosperma* in Slovakia. In total, we recorded the species presence in 24 phytogeographical regions and sub-regions (out of 31). In the area of the Carpathian flora (*Carpaticum*) it occurs in 16 phytogeographical districts and subdistricts, while in the area of the Pannonian flora (*Pannonicum*) it occurs in all 8 districts, as shown on the distribution map (Fig. 4). The northern limit of its occurrence is delimited by the line between cities of Ilava – Banská Bystrica – Revúca – Rožňava – Gelnica – Trebišov – Kráľovský Chlmec. Isolated but frequent occurrences are known on xerothermic travertine hills around the town of Spišské Podhradie. The morphotype with grey-coloured achenes was found in the Slovenský kras and the Východoslovenská nížina lowlands in the Pannonian region and in the Tribeč Mountains and the Stredné Pohornádie valley in the Carpathian region (Fig. 5).

### Ecology and cenology

Based on the classification of our own phytocenological records with the confirmed occurrence of *T. erythrospermum* (Fig. 6), we can conclude that this species mostly prefers dry, perennial rocky grasslands on carbonate substrates, which we classify according to the Catalog of Habitats of Slovakia in category TRB08, and it includes communities of the alliance *Bromo pannonici-Festucion pallentis*.

The species is also often found in dealpine calciphile pale fescue grasslands, which are represented by the alliance *Diantho lumnitzeri-Seslerion* (habitat TRB09) and which are often situated in a mosaic with pioneer vegetation of the alliance *Alyso alyssoidis-Sedion albi* (PIP05). In dry steppe grasslands, it also finds suitable stands in the vegetation of the alliance *Festucion valesiacae* (TRB03) and in the more nutrient-rich thermophilic meadows of the alliances *Cirsio-Brachypodium pinnati* and *Bromion erecti* (TRB01). In more mesophilic habitats, the species grows less often in the hay meadows of the alliance *Arrhenatherion elatioris* (LKP01) and in the mesic permanent pastures of the alliance *Cynosurion cristati* (LKP03).

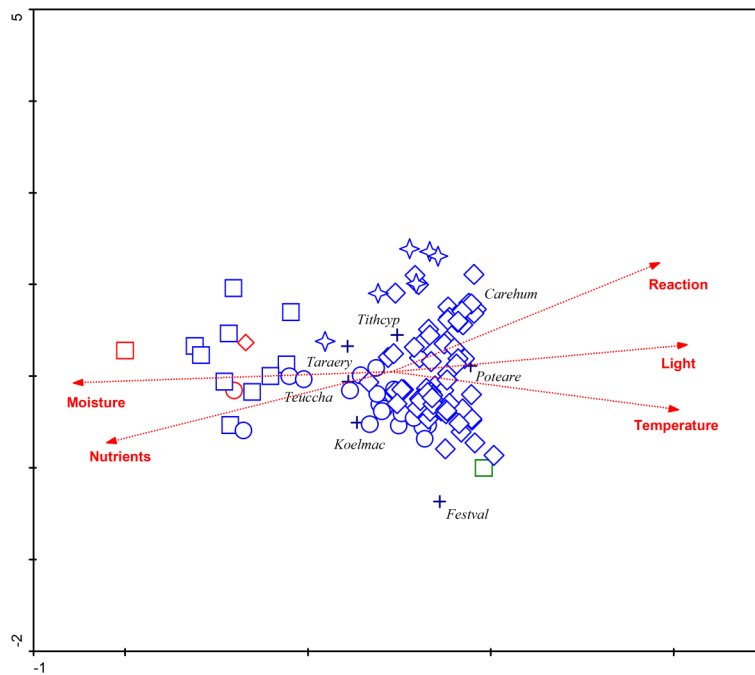
It is quite interesting that the species also rarely occurs in lowland to montane, dry to mesic mat-grass swards with a vegetation of the alliance *Violion caninae* (LKP10a). Especially in the Slovenský kras, this is the vegetation that occurs in areas that were intensively grazed in the past, which is located in a complex with the thermophilic vegetation mentioned above.

The species can also be found along tourist paths, on hills with roadside crosses, on castle hills, in stone-pits and on hilltops around transmitters, rarely on the edges of light oak and white agate forests. Its altitudinal range extends from 120 to 650 m above sea level, rarely at altitudes from 700 to 900 m; the maximum altitude was recorded in the top parts of the Mt. Ohnište (ca 1500 m) in the Nízke Tatry Mts (without an exact number and exact location).

### Genome size

The genome size (2C value) measured per individual *T. erythrospermum* plant ranged from 1.529 pg (Spišský hrad population) to 1.604 pg (Zádielské Dvorníky), with a mean value of 1.554 pg ( $\pm 0.024$  SD). This variation represents a 4.93% difference in genome size. Low between day variation allows to test for interindividual genome size variation, which was found statistically significant (ANOVA, genomes size ~ individual plant,  $F_{8,26} = 23.72$ ,  $p < 0.001$ ). Further based on Tukey's post hoc test, we have revealed three statistically homogeneous groups, i) a group with mean genome size of  $2C = 1.54$  pg ( $\pm 0.007$  SD, six individuals in range of 1.529–1.548 pg), ii) a group of two samples (from different localities) with identical genome size of  $2C = 1.573$  pg, and iii) single sample with  $2C = 1.604$  pg.





**FIGURE 6.** Detrended correspondence analysis of 105 phytosociological relevés with confirmed occurrence of the diploid species *Taraxacum erythrospermum* classified to habitat type with the Ellenberg-type indicator values displayed as a passive vectors. Blue square—TRB01 (*Cirsio-Brachypodium pinnati* and *Bromion erecti*), blue circle—TRB03 (*Festucion valesiacae*), blue diamond—TRB08 (*Bromo pannonici-Festucion pallentis*), blue star—TRB09 (*Diantho lumnitzeri-Seslerion*), green square—PIP05 (*Alysso alyssoidis-Sedion albi*), red square—LKP01 (*Arrhenatherion elatioris*), red circle—LKP03 (*Cynosurion cristati*), red diamond—LKP10a (*Violion caninae*). Ordination scores of the displayed species (species weight range) are more than 0.35, *Taraery*—*Taraxacum erythrospermum*, *Carehum*—*Carex humilis*, *Festval*—*Festuca valesiaca*, *Koelmac*—*Koeleria macrantha*, *Poteare*—*Potentilla arenaria*, *Teuccha*—*Teucrium chamaedrys*, *Tithcyp*—*Tithymalus cyparissias*. Axis eigenvalues: 0.529 and 0.239; DCA1 (abscissa) axis length: 4.034; DCA2 (ordinate) axis length: 2.390.

## Discussion

*Taraxacum erythrospermum* is very variable species in many morphological characters in leaves and flower parts. Two distinct morphotypes described as forms from Central Europe (*T. austriacum* f. *achyrocarpum* Soest and *T. corniculatum* f. *pusillum* R. Dvořák) are considered synonymous with the species, as they never occur alone, but only rarely add to the morphological variation of the whole population. Another species, *T. punctatum*, was described before *T. erythrospermum* was accepted as a sexually reproducing species with a wide morphological variation. Its holotype specimen collected by D. M. Valentine in 1965 in the Kováčovské kopce Mts. was marked with a diploid number of chromosomes by the author himself. In the description of the taxon, Richards (1970) gave two ploidy levels, which cannot be accepted with respect to the present taxonomic concept of the section. The name *T. punctatum* is, in accordance with the diploid chromosome number of the holotype, and having pollen grains of regular size, included among the synonyms of *T. erythrospermum*.

Den Nijs *et al.* (1990) mentioned the distribution of diploid *Taraxacum* species with its centre in southern Slovakia. Branches of the diploid area follow the river valleys (e.g. Váh, Nitra, Hron) and reach some of the intra-Carpathian valleys (e.g. Hornádska kotlina basin). Within this area, diploids are found in a variety of habitats, from dry to mesophilous. Outside this region, a rapid decline of diploids can be observed, and diploid plants are restricted to dry, sunny, often stressed habitats along roads and in villages and towns.

The first distribution map of *T. erythrospermum* in Slovakia was published by Šuvada (2008: 26, map 5.1), but this map was based on the author's own recent distribution data, mainly from the Slovenský kras Mts., without using voucher specimens in public herbaria. Later, Šuvada (2010: 53, Fig. 1) published a distribution map of *T. erythrospermum* in the Pannonian Plain using recent distribution data and data from several public herbaria. The distribution map of

neighbouring Moravia (in Czechia) was published by Vašut (2003: 317, fig. 3), while the distribution of this species in Hungary is still unknown.

The genome size estimate differs from the values recorded in the Czech Republic, with records ranging from 1.41 pg (Šmarda *et al.* 2019) to 1.75 pg (Macháčková *et al.* 2019). These differences are due to different standardisation of the measurements and because of a bias due to different internal standards (and thus recalculation).

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## Appendix 1. List of examined herbarium specimens and location data

### *Pannonicum*

(*Matricum*). **1. Burda Hills:** Štúrovo [Parkan]: Kováčovské kopce, southern slopes over Dunaj [Danube] (J. Šmarda 5.V.1950 BRNU #68839, ut *T. laevigatum*, *T. corniculatum*, rev. by J. Štěpánek no. det. 16968). – Kováčovské kopce near Štúrovo, dry slopes over Kamenica in *Fest. pseudodalmat.* (J. Májovský 23.IV.1969 SLO, ut *T. laevigatum* (4 sheets), rev. by A. J. Richards ut *T. brunneum*, *T. slovacum* and *T. austriacum*). – Štúrovo: steppe side on S slope of Kováčovské kopce above Kamenice n. Hr. [Kamenica nad Hronom] (F. Černoch 30.IV.1962 BRNM #399966, (3 plants), ut *T. laevigatum*). – Kováčovské kopce, distr. Štúrovo (A. J. Richards & J. Májovský 3.V.1968 OXF #54691, ut *T. punctatum*, ISOTYPUS). – Kamenica nad Hronom, xerothermous hillside 0,5 km north from village (Šuvada *et al.* *Folia Geobot.* 47: 88, 2012). – Kováčovské kopce, Kováčov, hillside, 203 m (R. Šuvada 13.IV.2008 KO #30643). – Kováčovské kopce (D. M. Valentine V.1965 OXF #54689 (Fig. 2), ut *T. punctatum* (HOLOTYPUS), cultivated plant, 2n=16; A. J. Richards & J. Májovský 1968 OXF). – Comit. Hont. In declivibus graminosis inter Garamkövesd et Kovácsptak, ca 200 m (Z. Kárpáti 16.IV.1939 BP #400245). – Kováčovské kopce Mts., xerothermic slopes above the railway between villages Hronská Kamenica and Kováčov (E. Mencl 1937 PL; *T. cf. erythrospermum*). **2. Ipeľsko-ri mavská brázda Region:** Levice, Horša (V. Pospíšil 14.V.1956 SAV ut *T. laevigatum*, rev. by A. J. Richards ut *T. punctatum*). – Krupinská planina, Plášťovce, Babica (303 m), SE slopes with bushes, 273 m (E. Smetanová 22.IV.2010 LTM). – Plášťovce, Šípka, 280 m (R. Šuvada 14.IV.2007 KO #30683). – Plášťovce, Brezovo, 368 m (E. Smetanová 22.IV.2015 LTM, *T. cf. erythrospermum*). – Krupinská planina, Plášťovce, Čongrád-332 m, forest-steppe on andesite, exp. SW-S, 200-300 m (E. Smetanová 19.IV.2011 LTM). – Čebovce, forest-steppe over village, 297 m (R. Šuvada 14.IV.2007 KO #30651). – Modrý Kameň, along path towards Kalvária, 405 m (R. Šuvada 4.V.2008 KO #30644). – Šurice, Soví hrad, 233 m (R. Šuvada 22.IV.2008 KO #30629). – Hajnáčka, sightseeing rocky point W from Pohanský hrad along red tourist path, 577 m (M. Dudáš 15.IV.2016 OL). – Hajnáčka, pasture below hill Szarkö (J. Futák 29.VI.1947 SLO ut *T. laevigatum*, rev. by A. J. Richards ut *T. austriacum*). – Drienčany, pasture W from village, 256 m (R. Šuvada 7.IV.2007 KO #30638). – Kameňany, SW slope of Hill 369 (J. Kliment 12.IV.1977 SAV). – Šivetice, Muteň hill, 380 m (R. Šuvada 13.IV.2007 KO #30668). – Jelšavská Teplica, Muteň, forest-steppe (J. Kliment 18.IV.1977 SAV ut *T. laevigatum*). **3. Slovenský kras Mts.:** Gemerská Teplica, Teplická stráň, xerothermic vegetation over village, 423 m (R. Šuvada 13.IV.2007 KO #30669). – Gemerská Teplica, Stráňa (K. Fabianková & O. Hubová 19.III.1975 SAV). – Štítnik, Železná vráta, 710 m (R. Šuvada 9.IV.2008 KO #30626). – Kunova Teplica, Dubník hill, 680 m (R. Šuvada 9.IV.2008 KO #30625). – Pašková, Plešivská planina, slope over village, 486 m (R. Šuvada 16.III.2007 KO #30614). – Plešivec, Koniarska planina, Pod Strážnym hrebeňom, 420 m (R. Šuvada 16.III.2007 KO #30627). – Sl. kras: Koniar, under top, from Plešivec (J. Malý 12.IV.1990 BRNU #662884, ut *T. slovacum*). – Plešivec, Plešivská planina, hillside over village, 405 m (R. Šuvada 16.IV.2007 KO #30624). – Vidová, Plešivské stráne over village, 436 m (R. Šuvada 20.III.2007 KO #30649). – Slavec, Plešivská planina, Slavecká stráň, 584 m (R. Šuvada 15.III.2007 KO #30612). – Brzotín, NPR [nature reserve] Brzotínske skaly, 636 m (R. Šuvada 15.III.2007 KO #30661, 30685; M. Dudáš 2018 not.). – Slovak karst, Brzotín, left side of Slaná River, 200 m from river in forest, on rubble, exp. W, 60°, limestone, 320 m, *Tilio-Aceretum* (J. Hajdúk IV.1982 BRA, ut *T. laevigatum*). – Domické škrapy, 361 m (R. Šuvada 28.III.2007 KO #30639). – regio Slov. Kras: in planitie carstica supra specum Domica, in locis fruticosis, 450 m (J. Dostál IV.1933 PRC #402304, 402305). – Domica, slopes above the cave (J. Futák 30.IV.1947 SLO ut *T. laevigatum*; J. Májovský 9.IV.1969 SLO ut *T. laevigatum*; O. Hubová 17.IV.1975 SAV). – Plešivec, Domica, calcareous xerothermic slopes [in collibus calcareis prope cavam Domica procul oppidum Plešivec] (I. Klášterský 1935 PR). – Kečovo, Domicové škrapy [= NPR Kečovské škrapy] (J. Malý 9.V.2008 BRNU #662886, ut *T. slovacum*; R. Šuvada 13.IV.2007 KO #30675). – Silická Brezová, stone-pit, 552 m (R. Šuvada 13.IV.2007 KO #30674). – Silica, Silická planina, Nature Reserve Sokolia skala, 508 m (R. Šuvada 13.IV.2007 KO #30653). – Silica, Silická planina, Fabiánka hill, 605 m (R. Šuvada 13.IV.2007 KO #30646). – Silická planina (J. Malý 12.IV.1990 BRNU #662898, ut *T. schizophyllum*). – Jovice, Dievčenská skala, 660 m (R. Šuvada 15.III.2007 KO #30650; Dudáš 2018 not.). – Krásnohorská Dlhá Lúka, rocks over village, 591 m (R. Šuvada 12.IV.2007 KO #30622). – Hrušov, Hrušovská lesostep, hillside over village, 549 m (J. Futák 6.V.1947 SLO ut *T. laevigatum*, rev. by A. J. Richards ut *T. brunneum*; R. Šuvada 22.III.2007 KO #30663). – Rožňava: Silická planina, slopes at road from Lipovník to Jablonov n. T. [Jablonov nad Turňou], 480 m (M. Součková 9.V.1950 BRNM #37084, ut *T. corniculatum*, rev. by J. Štěpánek, no. det. #16973). – Drnava, xerothermic vegetation S from Drieňovec hill, 702 m (R. Šuvada 21.III.2007, 14.IV.2009 KO #30665). – Soroška above Jablonov nad Turňou (J. Májovský 14.V.1965 SLO ut *T. slovacum*). = Juhoslovenský kras: Jablonov nad Turňou, Soroška (M. Michálek 4.V.1965 BRA ut *T. laevigatum*). – over train station Jablonov [Jablonov nad Turňou] (V. Mikoláš 13.IV.1997 KO

#18083, 18084, 18117, 18118, 18120-18122, 18127-18130, 18132, 18140, 18141, 18143, 18148-18150, 18152-18154, al ut *Taraxacum* sect. *Erythrosperma*). – Jablonov n. Turňou, side N from village, 531 m (R. Šuvada 19.IV.2007 KO #30652). – Hrhov, Hrhovský amfiteáter, 382 m (R. Šuvada 19.IV.2007 KO #30637). – Hrhov, Okružle hill, 319 m (R. Šuvada 19.IV.2007 KO #30618). – Horný vrch above Hrhov, exp. S (unknown 30.IV.1965 BRA ut *T. laevigatum*). – (Zádielské) Dvorníky village, Zemné hradisko nature reserve, 252 m (R. Šuvada 19.IV.2007 KO #30641, 2.V.2008 BRA #7/083, NI, SAV; M. Dudáš 29.IV.2012 KO, 15.IV.2016 OL). – Juhoslovenský kras, hill 273 between Dvorníky and Zádiel (J. Futák 1.V.1947 SLO ut *T. laevigatum*). – steppe slope above Dvorníky near Turňa nad Bodvou, 270 m (F. Černoch 5.V.1956 BRNM #399900). – Host'ovce, Dlhý vrch, xerotherm near stone-pit, 407 m (R. Šuvada 10.IV.2008 KO #30660). – Zádiel, sightseeing point Na skale (631 m), 630 m (M. Dudáš 2.IV.2017 KO #34069). – Zádiel -Turňa (A. Vojtúň 3.V.1970 KO #3032, ut *T. laevigatum*). – Zádielske plató (M. Jasičová 21.IV.1965 SAV ut *T. laevigatum*; A. Vojtúň 28.IV.1965 KO #3392, ut *T. slovacum*). – Zádiel, xerothermic vegetation at path over village, 496 m (R. Šuvada 12.IV.2007, 1.IV.2008 KO #30616). – Zádiel, along paths on calcareous rocks above the Zádiel valley [Szádelö – locus classicus *T. slovacum*] (R. J. Vašut & M. Vašutová 30.IV.2004 OL). – Slovenský kras, silvis apertis Zadielský Kámen dictis in declivibus meridionalibus supra cotam 271 prope Zádiel (I. Klášterský & M. Deyl VI.1933 PRC #487724, holotypus!). – Slov. Kras. Turňanské plateau. around Zad. Kameň and on road towards Ku Vyhlídce, margin of canyon (Brym 29.IV.1928 PRC #401001, 401002 ut *T. laevigatum*). – region Slov. Kras: in *Carpineto* in rupibus calcareis Zadielský vyhlídka dict. supra opp. Turňa, alt. 600 m, solo calcareo (J. Dostál 16.V.1933 PRC #402294, 402296). – Zádiel, Strážne hill, 268 m (R. Šuvada 12.IV.2007 KO #30620). – Háj, Hájska stráň, 433 m (R. Šuvada 3.IV.2007 KO #30621). – Háj, Hájska planina, rocks over village, 571 m (R. Šuvada 21.III.2007 KO #30615). – Juhoslovenský kras, Šamodské plató over Hájska dolina (J. Futák 4.V.1947 SLO ut *T. laevigatum*, rev. by A. J. Richards ut *T. brunneum*). – Háj, Zádielska planina, W edge, 755 m (R. Šuvada 1.IV.2007 KO #30645). – Háj, E slopes over village at blue tourist path (M. Dudáš 2.IV.2017 KO #34070). – Turňa nad Bodvou, Turniansky hradný vrch, 320 m (E. Sitášová 1988 VSM; R. Šuvada 22.IV.2008 KO #30664; M. Dudáš 29.IV.2012 OL). – Turňa nad Bodvou, near the parking place below the Turňanský hrad castle ruins (R. J. Vašut & M. Vašutová 30.IV.2004 OL). – Slov. Kras: in declivibus stepposis arcis Turňa n/B. [Turňa nad Bodvou] (V. Skřivánek 17.V.1932 BRNM #571485, ut *T. laevigatum*). – Turňa nad Bodvou, xerothermic grasses on rocky slopes and along paths near the castle ruins (J. Malý 8.V.2003 BRNU #662890; R. J. Vašut & M. Vašutová 2004 OL). – Drienovec, under Tvarohová skala, 335 m (R. Šuvada 19.IV.2007 KO #30613). – Drienovec, slopes over village on right side (V. Mikoláš 5.IV.1995 KO #34116). – distr. Košice-okolie, Debraď, xerothermic pasture N to the village (P. Mártonfi 27.IV.1991 KO #9466 ut *T. laevigatum*; M. Dudáš 3.V.2017 KO #34060, 34129). – Jasov, limestone rocks over village (unknown 20.V.1950 SAV ut *T. laevigatum*). – Jasov, xerotherms 150 m SW from the entrance to the cave, S from castle (M. Dudáš 3.V.2017 KO #34061, two sheets). – distr. Košice-okolie, Moldava nad Bodvou, Výhľad hill, frequent on field road towards transmitter (M. Dudáš 3.V.2017 KO #34055, 34131). – Slovenský kras, Nagyvárád (H. Petránová, E. Kmeťová & O. Hubová 1.IV.1966 SAV, ut *T. laevigatum*). (*Eupannonicum*). **4. Záhorská nížina Lowland:** Between towns of Stupava and Lozorno, near road, sands (A. Hlaváček 1969 SAV). – Malacky, sands E from the city, 207 m (R. Šuvada 12.IV.2008 KO #30684). – Záhorie, Zohor, roadside (E. Kmeťová 5.VI.1969 SAV). **5. Devínska Kobyla Hills:** Devín, Sandberg, 197 m (J. A. Bäumler s. dato BP; R. Šuvada 12.IV.2008 KO #30659). – In declivibus siccis graminosis (septentr.) montis Děvín (Devény) apud Bratislava (F. A. Novák 23.IV.1922 PRC #402302 ut *T. laevigatum*). – Devínska Kobyla (K. Ptačovský IV.1922 SAV ut *T. laevigatum*, rev. by A. J. Richards ut *T. punctatum*; J. Mikeš IV.1933 PRC #402298, 402303, 403131, ut *T. corniculatum*; V. Nábělek VI.1936 SAV ut *T. laevigatum*; F. Nábělek 10.IV.1946 SAV ut *T. laevigatum*; J. Michalko 26.IV.1957 SAV ut *T. laevigatum*, rev. by A. J. Richards ut *T. punctatum*; L. Bertová 13.IV.1971 SAV ut *T. laevigatum*; H. Kothajová 11.IV.1989 SAV, rev. by J. Štěpánek, no. det. 12552). – Devínska Kobyla, Donová-Devín, oak-hornbeam forest (J. Májovský & E. Krippel 26.V.1954 SLO ut *T. laevigatum*, rev. by A. J. Richards ut *T. brunneum*). – Devínska Kobyla, towards S from Devín church, above orchards (F. Kvapilík 1948 OLM). – Devín castle (E. Kmeťová 7.V.1969 SAV). – Devínske Karpaty, southern slopes of Devínska hradná skala (H. Kothajová & A. Kovarik 23.IV.2014 SAV ut *T. sect. Erythrosperma*). – Devínska Nová Ves, sunny slopes above village (J. Dvořák 1949 OP, 6.IV.1951 BRNM #86282). – Dúbravská hlavica, meadows (R. Letz 1.IV.1994 SAV ut *T. erythrospermum* agg.). – Devínska Kobyla, Šibeničník (V. Feráková 6.IV.1976 SLO ut *T. laevigatum*). **6. Podunajská nížina Lowland:** Bratislava, Podhradie (Vydrica), rocks under parliament over Žižkova Street (R. Letz 9.IV.1993 SAV, ut *T. erythrospermum* agg.). – Podunajská nížina, Čunovo, Ostrovné lúčky (E. Gojdičová 23.IV.1983 SLO, ut *T. purpleomarginatum*; V. Feráková & E. Gojdičová 5.V.1983 SLO, ut *T. danubium*). – Biskupice pri Dunaji (F. Nábělek 23.III.1946 SAV, ut *T. laevigatum* = *T. corniculatum*). – Biskupice pri Dunaji, towards Kötölec puszta (J. Futák 21.IV.1945 SLO, ut *T. laevigatum*, rev. by A. J. Richards ut *T. brunneum*). – Júr near Bratislava - Šúr (J. Berta & L. Bertová 6.IV.1974 SAV, ut *Taraxacum*, mixed specimen). – Žitný ostrov, pastures between Kalinkovo and Jánošíková, near the dam (M. Jasičová 17.IV.1957 SAV). – Žitný ostrov,



Nové Košariská near Kalinkovo (T. Krippelová 22.IV.1964 SAV ut *T. laevigatum*). – Žitný ostrov, Šamorín, pastures S from villages, near dam, 120-130 m (M. Jasičová 27.IV.1957 SAV, ut *T. laevigatum*, rev. by A. J. Richards ut *T. austriacum* × *punctatum*). – Šamorín, ca 300 m [in pratis prope vicum Šamorín procul urbem Bratislava] (I. Klášterský 1935 PR; I. Klášterský & M. Deyl 1935 PR). – Tomášikovo, sands (Excursion 25.VI.1954 SLO). – Hlohovec, Dvorníky, xerothermic slopes, ca 300 m (Horák 1958 MP). – Koplastovce, calcareous rocky slopes S of villages (V. Feráková 27.IV.1964 SLO, ut *T. laevigatum*). – Hlohovec, Sedlisko, *Caricetum humilis* (V. Feráková 18.IV.1964 SLO ut *T. laevigatum*, rev. by A. J. Richards ut *T. austriacum*). – Chotín, sandy grasses (A. J. Richards 3.V.1968 OXF). – Chotín [Hetény], semirudeal grasses on sands near the parking place in vicinity of the Nature Reserve (R. J. Vašut 1.V.2003 OL). – distr. Komárno, in silvis */Robinia pseudoacacia/* prope cotam 131, in situ austr.-orient. a pago Marcelová, ca. 120 m (J. Chrtek, B. Křísa & Z. Slavíková 24.V.1970 PRC #402294). – Marcelová, Piesočný diel, along forest road in coniferous-deciduous forest, sandy soil (Cs. Juhászová 9.IV.1989 PMK). – Nitra, Kalvária, 170 m (R. Šuvada 12.IV.2008 KO #30662). – Nitra, Kalvária, xerothermic vegetation around quarry, *Fest. vales.* [*Festucion valesiacae*] (J. Májovský 9.IV.1967 SLO ut *T. laevigatum*). – Čenkov: in forest with *Robinia pseudoacacia*, on sands (J. Májovský 2.V.1965 SLO, rev. by A. J. Richards ut *T. austriacum*; P. Kusák 15.V.1988 OLM #159949). – Čenkov (J. Májovský 28.IV.1962 SLO, ut *T. laevigatum*, rev. by A. J. Richards ut *T. austriacum*; A. J. Richards 3.V.1968 OXF). – Čenkov, Bažantnica (E. Vartíková 24.IV.1972 SLO, ut *T. laevigatum*). – meadows near Kamendín [= Kamenín] towards Kamenné Ďarmoty [= Kamenný Most] (J. Futák 12.IV.1946 SLO, det. by A. J. Richards ut *T. purpureomarginatum*).

**7. Košická kotlina Basin:** Hrhov, Veľký Paklán hill, 240 m (R. Šuvada 10.IV.2008 KO #30670). – Žarnov, xerothermic pasture near village, 228 m (R. Šuvada 10.IV.2008 KO #30672). – Vyšný Lánec, S from hill Agátový vrch, 264 m (R. Šuvada 10.IV.2008 KO #30671). **8. Východoslovenská nížina Lowland:** Malá Trňa, Šimonov vrch, 329 m (R. Šuvada 18.IV.2008 KO #30623; M. 23.IV.Dudáš 2016 OL). – distr. Kráľ. Chlmec, Černochoh, slopes above village, ca 250 m (J. Futák & D. Magic 14.IV.1964 SAV, ut *T. laevigatum*, rev. by A. J. Richards ut *T. purpureomarginatum*). – pastures and vineyards over Černochoh (J. Májovský & Tatárová 29.IV.1964 SLO). – Veľká Bara, Piliš hill, top, 262 m (R. Šuvada 6.IV.2007 KO #30667; M. Dudáš 4.V.2013 KO #31070, 9.IV.2016 OL, 8.IV.2017 KO #34066, 8.IV.2017 BRNU #656704). – Veľká Bara, Piliš hill, field road in vineyards on E slope (M. Dudáš 8.IV.2017 KO #34062). – Malá Bara, field roadside S from village, 171 m (R. Šuvada 18.IV.2008 KO #30628). – Malá Bara, Brezina hill, xerothermic meadow, 190 m (M. Dudáš 26.IV.2012 KO #31072, 9.IV.2016 OL). – hills over Ladmovce (J. Májovský 10.IV.1960 SLO, det. by A. J. Richards ut *T. punctatum*). = Ladmovce, Nature Reserve Kašvár, xerothermic vegetation, 100-145 m (A. Vojtúň 20.IV.1976 KO #2861, ut *T. laevigatum*; R. Šuvada 6.IV.2007 KO #30658; R. J. Vašut 2010 OL; M. Dudáš 17.IV.2010 KO #31074; M. Dudáš 18.IV.2015 SAV, 17.IV.2016 OL). – Zemplínske pahorky, Ladmovce - S converging range of Kašvár, 100 m (s. coll. 5.V.1969 SAV, ut *T. laevigatum*). – in pascuis ad Ladmóc [Ladmovce], Zemplin (A. Margittai 14.IV.1930 PRC #402325). – Ladmovce, site Tardika, xerothermic hill (M. Dudáš IV.2017, observation). – Pastures on Baba west from Ladmovce, o. Kr. Chlmec (Futák 9.IV.1953 SAV ut *T. laevigatum*, rev. by A. J. Richards ut *T. punctatum*). – Hatfa, calcareous rocks above gamekeeper's cottage and calcareous hill towards Viničky under Borsuk hill (J. Májovský 22.IV.1964 SLO (two sheets) ut *T. laevigatum*, rev. by A. J. Richards ut *T. austriacum* and *T. punctatum*). – o. Kráľ. Chlmec, meadows above vineyards at Viničky, andesite, south, ca 200 m (J. Futák 7.IV.1959 SAV ut *T. laevigatum* rev. by A. J. Richards ut *T. austriacum*). – Borsuk, andesites (Viničky), *Festucetum valesiacae* on deeper soil (J. Májovský 8.V.1962 SLO, ut *T. laevigatum*, rev. by A. J. Richards ut *T. austriacum*). – Sírnik, Hill 238,5, near transmitter (M. Dudáš 26.IV.2012 KO # 31071; 9.IV.2016 OL). – Brehov, hill Veľký vrch, hilltop, 272 m (M. Dudáš 4.V.2013 KO #31069, 9.IV.2016 OL). – o. Kráľ. Chlmec [Kráľovský Chlmec], Veľký vrch over Brehov, rocky pastures, S, andesite, ca 150 m (J. Futák 8.IV.1959 SAV, ut *T. laevigatum*, rev. by A. J. Richards ut *T. brunneum*). – Brehov, Veľký vrch, stone-pit (M. Dudáš 9.IV.2016 OL). – in pascuis Lada, Zemplin (A. Margittai 14.IV.1930 PRC #402325 ut *T. laevigatum*). – Somotor, Vrch hill (150 m), field road towards transmitter, NW side, 146 m (M. Dudáš 9.IV.2017 KO #34067, 9.IV.2017 BRNU #656703). – Tarbucka (V. Peciar & J. Záborský 2.VI.1959 SLO, ut *T. laevigatum*, rev. by A. J. Richards ut *T. austriacum*; J. Malý 15.IV.1993 BRNU #662887, ut *T. isophyllum*). – Východoslov. nížina, Streda nad Bodrogom, NW slope of Tarbucka (R. Šuvada 18.IV.2008 KO #30617; M. Dudáš 24.IV.2012 KO #31075, A. Šimková & M. Dudáš 5.IV.2016 OL). – Veterné piesky under Tarbucka (J. Májovský 11.IV.1960 SLO, rev. by A. J. Richards ut *T. austriacum*). – rock over Talyba [Tajba nature reserve] and S slope of Tarbucka, in *Festuceto valesiacae* and around rock (J. Májovský 26.IV.1964 SLO, ut *T. laevigatum*). – Malý Kamenec, Tarbucka hill, SW slope, 255 m (R. Šuvada 6.IV.2007, 18.IV.2008 KO #30642). – in pascuis ad Királyhelmece, Zemplin (A. Margittai 1.V.1929 BP #186382 ut *T. laevigatum*, 1.V.PRC #402326; M. Dudáš 28.IV.2012 KO #31083, 10.IV.2016 OL). – Veľký Kamenec, castle ruin, 111-142 m (R. Šuvada 18.IV.2008 KO # 30619; R. J. Vašut 2010 OL; M. Dudáš 4.V.2013 KO #31073, 19.IV.2015 SAV, 10.IV.2016 OL, 1.IV.2017 KO #34075). – on the way from Veľ. [Veľký] Kamenec through vineyards into Streda nad Bodrogom (J. Májovský 15.IV.1960 SLO, rev. by A. J. Richards ut *T.*

*austriacum*). – Veľký Kamenec (okr. Trebišov), on slope under castle Hečke (J. Májovský 15.IV.1965 SLO ut *T. laevigatum*, rev. by A. J. Richards ut *T. isophyllum* and *T. austriacum* (3 sheets)). – Beša, wet meadows towards Latorica (J. Májovský 11.IV.1961 SLO, det by A. J. Richards ut *T. isophyllum*). – Kráľovský Chlmec, Kráľovské kopce, SW slopes between vineyards W from quarry above Horeš, *Festucetum valesiacae*, andesite (J. Májovský 24.IV.1964 SLO ut *T. laevigatum*, rev. by A. J. Richards ut *T. austriacum* and *T. punctatum* (two sheets)). – in pascuis Tarbucka ad N. Kovesd, Zemplin [= Nagy Kövesd, Veľký Kamenec] (A. Margittai 1.V.1933 BP #186430). – sands above Kráľovský Chlmec beside new water plant (J. Májovský 11.V.1962 SLO ut *T. laevigatum*, rev. by A. J. Richards ut *T. austriacum*). – distr. Trebišov, Kráľovský Chlmec, Veľký kopec, xerotherms over abandoned stone-pit, 216 m (M. Dudáš 11.IV.2017 KO #33925). – Král. [Kráľovský] Chlmec, in stepposis (J. Buček 4.IV.1931 BRNM #571484, ut *T. laevigatum*). – Král. [Kráľovský] Chlmec (s. coll. s. dato BRNM #45810, rev. by J. Štěpánek, no. det. 21558).

#### *Carpaticum occidentale*

(*Praecarpaticum*). **9. Biele Karpaty Mts. (southern part):** Branč, slope at ruin of castle (M. Jasičová 13.VI.1969 SAV). **10. Malé Karpaty Mts.:** Myslenice, grassy sites between vineyards above village (F. Čvančara 14.V.1968 SLO ut *T. laevigatum*). – Smolenice: M. Lateršarna, limestone rocks (M. Jasičová & K. Zahradníková 5.V.1966 SAV). – SW slope of Pristodolok hill in massif of Vysoká, over hunting castle Vývrat, 450 m (O. Hubová 9.IV.1972 SAV ut *T. laevigatum*, rev. by A. J. Richards ut *T. punctatum*). – Malý Raštún hill, limestone rocks, 400 m (F. Černoch 1952 BRNM; *T. cf. erythrospermum*). – Bílé Karpaty: limestone rocks on Ostrý Kameň, 450-600 m (F. Černoch 3.V.1962 BRNM #399965 ut *T. laevigatum*). – Pohanská hora (E. Krippel 18.V.1955 SLO ut *T. laevigatum*). – Plavecký hrad, dry meadows under castle (J. Májovský 17.IV.1969 SLO ut *T. laevigatum*). – Plavecký hrad, Hradište, 400 m (K. Ptačovský IV.1929 SAV ut *T. laevigatum*, rev. by A. J. Richards ut *T. purpleomarginatum*). – Malé Karpaty: Trstín, Holý vrch (J. Medovič 9.V.1956 SLO, det. by A. J. Richards ut *T. brunneum*). – Dobrá Voda, limestone rocks opposite to quarry behind the cemetery (J. Májovský 28.IV.1971 SLO ut *T. laevigatum*). – Pustá Ves (K. Zahradníková & M. Jasičová 7.V.1973 SAV). – Lančor (R. Vavro 13.V.1985 HLO ut *T. laevigatum*). – M. Karpaty, Šterusy, PR Orlie skaly, ca 380-400 m (P. Eliáš jun. 8.VI.2016 NI). – Čachtice, xerothermic grasses on rocky slopes in vicinity of the castle ruins (R. J. Vašut 25.IV.2008 OL; P. Eliáš jun. 1.V.2009 NI, mixed specimens with *T. parnassicum* and *T. cristatum*). **11. Považský Inovec Mts.:** Lúka, xerothermic slopes W from village, 237 m (M. Dudáš 14.IV.2017 KO #34074). – Tematín (P. Sillinger IV.1930 PRC #401058). – Nové Mesto nad Váhom, Tematín [in locis aridis arcis Tematín] (V. Skřivánek 4.V.1947 BRNM #571487). (F. Weber 1925 PR; Skřivánek 1947 BRNM). – Modrovka village in Tematín hills [in collinia Tematínské, ad pag. Modrovka] (F. Weber 1933 OLM). – Strážovská hornatina, Mnichová Lehota, supra stationem viae ferrae in declivi meridionali-orientali collis Tlstá Hora in prato inter frutices et arbores (*Quercus*) un *Biscutella laevigata* et *Potentilla* sparse, set frequent, c 420 m (E. Schidlay 12.IV.1953 SAV ut *T. laevigatum*). – [Trenčianske] Jastrabie, E from railway, cca 360 m (E. Schidlay 1941 BRA ut *T. laevigatum*). **12. Tribeč Mts.:** Dražovce, Church of St. Michael the Archangel, trampled dry grassland (M. Dudáš 14.IV.2017 KO #34068). – Dražovce, field road over garden settlements, NNE above village (M. Dudáš 14.IV.2017 KO # 34072). – Nitra, Plieška hill, at tourist path towards hill Meškov vrch, 357 m (M. Dudáš 14.IV.2017 KO #34058, 14.IV.2017 BRNU #656708). – Nitra, hill Meškov vrch, exp. SSE (M. Dudáš 14.IV.2017 KO #34063). – Nitra, Lupka, path in grassy steppe (V. Pospíšil 3.V.1956 BRNM #82385, ut *T. laevigatum*; M. Dudáš 15.IV.2017 KO #34073). – Nitra, Zoborská lesostep, over cave Svoradova jaskyňa, exp. S (M. Dudáš 15.IV.2017 KO #34064). – Tribeč, Žibrica E, rocky slopes under quarry (K. Hegedúšová, J. Májovský & J. Uhríková 18.IV.1986 SAV, ut *T. laevigatum*). – Podhorany-Mechenice, Hôrka hill, field road towards top, 292 m (M. Dudáš 15.IV.2017 KO #34065, 15.IV.2017 BRNU #656702). – Zobor Mt., shrubs and rocks at the top, 560-588 m (M. Deyl 1935 PR). – steppe slope on Zobor (J. Futák 30.IV.1943 SLO, ut *T. laevigatum*, rev. by A. J. Richards ut *T. purpleomarginatum*). – Zobor, clearing on top, near path (Osvald 2.V.1965 HLO ut *T. laevigatum*). – Tribečské pohorie: Zobor over Dražovce (T. Schwarzová 5.V.1974 SLO, ut *T. laevigatum*). – Tribeč, rocky (forest)steppe, W slope of hill Zobor (588 m), limestone, under black pine (P. Kusák 8.V.1982 OLM #159951). – distr. Nitra, Zobor, hilltop rocks, limestone, 588 m (M. Dudáš 15.IV.2017 KO #34059; M. Tetera 24.V.1995 PRC #402344, *T. cf. erythrospermum*). – Tribeč: hill Veľká skala (503) SE from village Oponice, top of hill, the clearing, ca 490 m (Kováčiková 18.IV.1975 SAV, ut *T. laevigatum*). – Tribeč, Oponice, hill Veľká skala, 490 m (P. Eliáš jun. 6.V.2009 NI, *T. cf. erythrospermum*). – distr. Nitra, Tribečské pohorie, degraded pasture above village Súľovce, ca 300 m (M. Blehová IV.1978 BRNU # 484675, ut *T. laevigatum*, rev. by J. Štěpánek, no. det. 31060). **13. Strážovské and Súľovské vrchy Mts.:** Trenč. [Trenčianske] Teplice, left side, Baračka, meadow, 270 m (E. Schidlay 14.V.1969 BRA, ut *T. laevigatum*). – Strážovská hornatina, village Podskalie, Veľké bralá, hillside, exp. S, dolomite, 500 m (J. Futák 20.VI.1967 SAV ut *T. laevigatum*). **14b. Vtáčnik Mts.:** sunny hill W from Buchlov (s. coll. 17.IV.1911 SAV, ut *T. officinale (glaucescens) corniculatus*). **14c. Kremnické vrchy Mts.:** Kremnické vrchy, Malachov-Stupy,

dolomite rocks over village (A. Hallonová 12.V.1981 SMBB, ut *T. laevigatum*, *T. austriacum*). **14e. Štiavnické vrchy Mts.:** Štiavnické Bane, Kalvária (D. Klokner 10.V.1980 PMK). **15. Slovenské Rudohorie Mts.:** Jelšava, Tri peniažky, forest-steppe (J. Kliment 6.IV.1976 SAV ut *T. laevigatum*). – Gemerské rudohorie, Jelšava, forest steppe on Cíger hill E from village, 320 m (s. coll. 28.VI.1971 SAV ut *T. hoppeanum* ssp. *eu-hoppeanum*). – region Slov. Kras: in locis stepposis in decliv. occid. montis Slovenská skála supra opp. Jelšava, alt. 300 m s.m., colo calcareo-argilloso, in *Festuceto vallesiacaе* (J. Dostál 11.V.1933 PRC #402297, ut *T. simile*, rev. by Doll). = regio montana Gemerské rudohorie, opp. Jelšava, pagus Jelšavská Teplica, mons Slovenská skála (622 m): in declivitate situ merid.-orient. a cota (D. Blanár 15.IV.2005 PRC #402300). **18. Stredné Pohornádie Valley:** Folkmárska skala (Nižňanská s. dato SNV; V. Mikoláš 11.V.1997 KO, *T. cf. erythrospermum*). – Košická Belá, Sivec Mt., rocks on the top, 770 m (M. Dudáš 13.V.2015 OL). – Kysak (J. Futák 10.IX.1946 SLO). – In monte Hradova ad opp. Kassa. Com. Abauj-Torna (L. de Thaisz 16.V.1908 BP #186427 ut *T. laevigatum*, *T. cf. erythrospermum*!). – Košice, Hradová hill, field road under sightseeing tower, 350 m (M. Dudáš 26.IV.2015 OL). – Veľká Lodina, Humenec, oak forest-steppe, SE part (V. Mikoláš 6.5.1987 KO #33599; M. Dudáš 18.V.2015 OL, SAV; V. Mikoláš 20.V.2017 KO #35288). – Spišská Nová Ves, (Korytné) small rocks in top of the pass Branisko, Chvalabohu hill, ca 750 m (R. J. Vašut 1998 OL; M. Dudáš IV.2020 observation.). **19. Slanské vrchy Mts.:** Slanec, castle ruin (Majeský *et al.* Plant Syst. Evol. 301: 2120, 2015). – Vehec, slopes of Kamenná hill (E. Dostál V.1975 SLO ut *T. laevigatum*; locality destroyed with mining activities). (*Eucarpaticum*). **21c. Veľká Fatra Mts.:** Ostrá Mt., limestone over site Konský dol (D. Bernátová 1987 BBZ sec. Kliment *et al.*, 2008: 280). – above the chalet near Kráľová studňa, pastures, 1310 m (K. Kolláriková 29.V.1953 SAV ut *T. laevigatum*; *T. cf. erythrospermum*!). **22. Nízke Tatry Mts.:** Banská Bystrica, Baranovo, southern slopes of Baranová over Sásovská dolina, meadows, c. 500 m (A. Hallonová 26.V.1982 SMBB, ut *T. laevigatum*). – Nízke Tatry, Ohnište, from side of Svätajánska dolina (F. Dočolomanský 9.VII.1959 BRA, ut *T. laevigatum*).

(*Intracarpaticum*). **26b. Spišské kotliny Basins:** Sivá Brada (F. Nábělek 8.V.1950 SAV, det. A. J. Richards ut *T. austriacum*; J. Májovský 18.V.1964, 8.V.1950 SLO). – Spišské Podhradie village (near Levoča town), lawn at road not far from Sivá Brada travertine spring (B. Trávníček 1.V.2014 BRNM #774157). – Spišské Podhradie, Sivá Brada, xerothermic slopes over travertine spring, ca 400 m (T. Marciová 20.V.1997 SAV ut *T. laevigatum*; R. J. Vašut 12.V.1998, 2010 OL; Dudáš Zborník Spiš 8: 221, 2016; M. Dudáš 29.IV.2018 KO #35201). – Spišská kotlina: above thermal baths Sivá Brada, travertine, south (J. Michalko 1.VI.1963 SAV). – Spiš: Spišské Podhradie, Sivá Brada, on grassy slopes between travertine spring and Chapel of St. Cross on the top of Sivá Brada (R. Hendrych 8.VII.1953 PRC #402292, ut *T. laevigatum*; E. Mitskeová 17.IX.1968 SNV, ut *T. laevigatum*; Majeský *et al.* Plant Syst. Evol. 301: 2120, 2015; M. Dudáš 27.IV.2016 OL). – Spišské Podhradie, Krížová hora, Chapel of St. František Xaverský (M. Dudáš 27.IV.2016 OL). – Spišské Podhradie, castle Spišský hrad, travertine castle hill (M. Dudáš 27.IV.2016 OL). – Spišské Podhradie, hill Ostrá hora, sightseeing point S from castle, 609 m (M. Dudáš 27.IV.2016 OL). – Žehra, Dreveník, along yellow path on plain towards quarry, 559 m (P. Pitoniak 29.IV.1966 SNV, ut *T. laevigatum* (right plant); M. Dudáš 27.IV.2016 OL). – Levoča: Spišské Podhradie, Hill 615 north from Dreveník (M. Součková 15.V.1950 BRNM #68920 ut *T. laevigatum* (= *T. corniculatum*), rev. by J. Štěpánek no. det. 16967).

(*Beschidicum occidentale*). **27a. Biele Karpaty Mts. (northern part):** Dolná Súča, Mt. Krasín, hilltop, 516 m (M. Dudáš 27.IV.2018 observation.).

(*Beschidicum orientale*). **30c. Čergov Mts.:** distr. Sabinov, Kamenica, Kamenický hrad, castle ruin, SW part, 703 m (M. Dudáš 5.V.2017 KO #34056).



## Appendix 2 Distribution of morphotype *T. erythrospermum* f. *achyrocarpum* with grey-coloured achenes.

### *Pannonicum*

(*Matricum*). **3. Slovenský kras Mts.:** Zádielske Dvorníky, Zemné Hradisko hill, eastern foothill, field road (M. Dudáš 15.IV.2016 OL; IV.2020 observation). – Turňa - Zádiel (J. Malý 8.V.2003 BRNU #662882). – Turňa nad Bodvou, castle hill (R. J. Vašut V.2003 observation). – distr. Košice-okolie, Moldava nad Bodvou, Výhľad hill (M. Dudáš 3.V.2017 KO #34054). – Jasov, Jasovský hrad, sightseeing point on the top (M. Dudáš, M. Pizňak & E. Chernikova 10.V.2018 KO #35200).

(*Eupannonicum*). **8. Východoslovenská nížina Lowland:** Ladmovce, NPR Kašvár (M. Dudáš 27.IV.2012 KO #31084, 18.IV.2015 OL) – Malá Bara, xerothermic vegetation along field road towards Hatfa, 900 m NE from village, on S slope of Brezina hill, 195 m (M. Dudáš 28.IV.2012 OL, 26.IV.2013 KO #31072). – Veľká Bara, Piliš hill, grassy vegetation around transmitter, 278 m (M. Dudáš 26.IV.2012 KO #31067, 28.IV.2013 KO # 31068, 26.IV.2012 OL). – Brehov, Veľký vrch, grassy vegetation on the top around transmitter, 272 m (M. Dudáš 26.IV.2012 KO #31066, 9.IV.2016 OL). – Sirmík, transmitter on hilltop of Hill 238,5, grassy vegetation (M. Dudáš 27.IV.2012 KO #31065, 27.IV.2012 OL). – Veľký Kamenec, castle ruins, 111 m (M. Dudáš 27.IV.2012 KO #31081, 27.IV.2012 OL). – Streda nad Bodrogom, NPR [nature reserve] Tarbucka, field road, sands (M. Dudáš 24.IV.2012 KO #31080, 24.IV.2012 OL). – Malý Kamenec, Tarbucka, grassy vegetation around transmitter on the top, 278 m (M. Dudáš 28.IV.2012 OL).

### *Carpathicum occidentale*

(*Praecarpaticum*). **12. Tribeč Mts.:** Nitra, Meškov vrch (M. Dudáš 14.IV.2017 KO #34071). **18. Stredné Pohornádie Valley:** Veľká Lodina, forest-steppe Humenec (V. Mikoláš 1.V.1998 KO #22322; M. Dudáš 18.V.2015 OL).