Genome size and distribution of *Adenostyles alliariae* in Slovakia

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*Abstract:* *Adenostyles alliariae* (Gouan) A. Kerner (*Asteraceae*) represents a single species of the genus *Adenostyles* in Slovakia. In the paper it is characterized from the point of view of chromosome number, genome size, breeding systems and distribution in Slovakia. Chromosome number $2n = 38$ was confirmed in this study. Flow cytometric analyses resulted showed the genome size 18.19 pg for leaves and 19.4 pg for seeds. The flow cytometric seed screen method proved, on the basis of embryo to endosperm genome size ratio, that the species reproduces sexually. The occurrence of the species is bound to all higher mountain ranges of West Carpathians, above all to the Malá Fatra Mts., the Veľká Fatra Mts., the Nízke Tatry Mts. and Tatry Mts.

*Keywords:* nuclear DNA amount, chromosome number, occurrence, mountain flora, Carpathians.

*Introduction*

The genus *Adenostyles* Cass. (*Asteraceae, Senecioneae*) contains three species: *A. alliariae*, *A. alpina* (L.) Bluff & Fingerh. (with five subspecies) and *A. leucophylla* (Willd.) Rchb. which are distributed across all higher European mountain regions (Dillenberger & Kadereit 2013). Diploid chromosome number, $2n = 38$ was reported for all three species (Tutin et al. 1976). The genus is represented by a single species *Adenostyles alliariae* in the territory of Slovakia.

*Adenostyles alliariae* is a hemicyryptophyte with erect thick branched stem, 60 – 180 cm long, leaves alternate with triangular cordate to reniform blade,
leaf margin unequivocally sharply dentate. Small cylindrical capitula with 2 – 8 flowers forms corymbose inflorescence. Reddish-purple florets are bisexual, gynoecium is syncarpous with two carpels and two stigmas. Fruit is an achene of ovoid shape, about 3 mm long. Flowering period from July to August (Dostál & Červenka 1983). It grows in mountain and subalpine vegetation zone in mountain ranges of the central and the southern Europe, above all in the Alps, the Carpathians, the Pyrenées and Balkan mountains (Dillenberger & Kadereit 2013).

It occurs in mountain and subalpine tall herbaceous and fern meadows, on banks of mountain brooks, in the surrounding of forest and subalpine streams, in mountain forests, in dwarf pine undergrowth, in mountain beech forests and fern spruce forests, mainly in localities with high atmospheric moisture and soils rich in nutrients and humidity (Křísa 2004). In Slovakia it occurs mainly in the comunities of the order Adenostyletalia alliiariae Br. – Bl. 1930 (Kliment & Valachovič 2007). Chromosome number $2n = 38$ is given from the locality Zadné Meďodoly in the Belianske Tatry Mts. (Marhold et al. 2007). This paper presents (1) new data on chromosome number from Slovak population, (2) the data on genome size, which has not been studied so far, (3) the evidence of sexual reproduction mode and (4) the mapping of the occurrence of the species in the territory of Slovakia.

Material and Methods

Plant material

Living plants for flow-cytometric analyses were collected in spring and summer of the years 2014 and 2015, together in four localities in the Stolické vrchy Mts. and one locality in the Slovenský raj Mts. The plants were then cultivated in the Botanical Garden of P. J. Šafárik University in Košice. Seeds were collected in autumn 2015 from two population in the Stolické vrchy Mts. and one from the Nízke Tatry Mts. The seeds were kept in refrigerator at the temperature 4°C. Herbarium specimens of plants used for flow-cytometric analyses are deposited in KO (Herbarium of the Botanical Garden of P. J. Šafárik University, Košice, Slovakia). Complete data on collections and herbarium specimens are given in the Appendix.

Karyological analysis

For karyological analyses root meristems of potted plants and seedlings were used. For a pretreatment, the root tips were transferred to 0.002M aqueous solution of 8-hydroxyquinoline at the temperature of 4°C for 16 hours. Then the root tips were fixed for 1 hour in acetic ethanol (glacial acetic acid and 96% ethanol in the ratio 1: 3), washed in distilled water and hydrolyzed for 3 minutes in 1N HCl at 60°C, then washed in distilled water. The meristems were squashed using cellophane technique (Murín 1960) and stained in 7% Giemsa stain solution in Sörensen phosphate buffer for 3 hours. The slides were then washed in distilled water, dried and observed in a drop of immersion oil. Selected c-metaphase plates were photographed (using a Leica DM 2500 microscope
equipped with camera DFC 290 HD and software Leica application suite version 3.5.0, Switzerland) and the number of chromosomes was counted.

Flow cytometry

The samples for flow cytometry analyses were prepared from leaves and seeds of *Adenostyles alliariae* by a two-step procedure, consisting of nuclear isolation and staining steps, using propidium iodide as DNA intercalator (Loureiro et al. 2007; Doležel & Göhde 1995). To keep offered maximum differences between standard and sample (Suda 2004) we used an internal reference standard: *Vicia faba* subsp. *faba* var. *equina* ‘Inovec’ (2C DNA content = 26.9 pg) (Doležel et al. 1992). The seeds of the standard were acquired from the Institute of Experimental Botany, Olomouc, Czech Republic and grown in the Laboratory of Taxonomy at the Institute of Biological and Ecological Sciences of P. J. Šafářík University in Košice, Slovakia. A method referred to as internal standardization was used (Doležel et al. 2007). Approximately 1 cm$^2$ of young leaf was chopped with a new razor blade in a Petri dish in 1 ml of ice-cold GPB (general purpose buffer: 0.5 mM spermine x 4 HCl, 30 mM sodium citrate, 20 mM MOPS [MOPS = 4-morpholine propane sulfonate], 80 mM KCl, 20 mM NaCl and 0.5% [v/v] Triton X-100, pH 7.0 according to Loureiro et al. 2007) + 3% PVP (polyvinylpyrrolidone) buffer. After the chopping, the samples were filtered through a 42 μm nylon mesh and each sample was stained with 10 μl propidium iodide (PI), 10 μl RNase and 2 μl β-mercaptoethanol. After 20 min of incubation at 4°C, each sample was measured. Three plants from each of the 5 localities were measured 3 times on 3 different days (Greilhuber & Obermayer 1997), making 9 measurements for each locality, 45 in total. Histograms of the data were displayed on a linear scale (x-axis). At least 5 000 nuclei per measurement were collected and the coefficients of variation (CV) of the G0/G1 peaks of both the samples and the internal standards did not exceed 3%.

There were some differences for the genome size analyses from seeds and for flow cytometric seed screening method compared to the genome size analyses from leaves. Ten seeds of *Adenostyles alliariae* were used for each analysis and chopped together with the standard. Five samples from each of the 3 localities were measured once, making 15 measurements in total. At least 1300 nuclei per measurement were collected and the coefficients of variations (CV) did not exceed 5%. These specifications are applicable to the genome size analysis from seeds and for flow cytometric seed screen, too. The other specifications of the analysis remain the same as above.

Absolute DNA contents were measured by Partec CyFlow ML (Partec GmbH, Münster, Germany) flow cytometer, equipped with a green solid state laser operating at 532 nm wavelength and 150 mW, in the Laboratory of Flow cytometry at the Institute of Biological and Ecological Sciences of P. J. Šafářík University in Košice, Slovakia. The data were processed by the FloMax 270 software.

The estimation of DNA amounts of the samples was based on the value of the G1 peak means: DNA amount of the sample = DNA amount of the used standard × [(the sample G1 peak mean)/(the standard G1 peak mean)] (Doležel & Bartoš 2005).
Species distribution mapping

The distribution of the species *Adenostyles alliariae* in Slovakia was completed on the basis of our field studies, studies of herbarium specimens in the following herbaria: BP, BRA, BRNM, BRNU, KO, PR, PRC, SAV, SLO (acronyms of the herbaria are according to Holmgren et al. 1990) and studies of literature data. There are also data originated from the database Comprehensive information and monitoring system (CIMS) available online at [www.biomonitoring.sk](http://www.biomonitoring.sk). These data are cited in the chapter on distribution in shortened form including name of author, the year of record and abbreviation of database (=BIOM). Phytogeographical division is according to Futák (1984). Each datum is followed by the brackets with the number of basic grid cell and the letter of the quadrant of the Central European mapping (Niklfeld 1971). Based on these data a grid distribution map for *Adenostyles alliariae* in Slovakia was designed in the ArcGis program, version 9.2.

Results and Discussion

Chromosome number

From the territory of Slovakia, Uhríková (in Májovský et al., 1970) mentioned a diploid number of chromosomes in somatic cells of 2n = 38 for plants from the site Zadné Medôdoly, Belianske Tatry Mts. We confirmed the same chromosome number, 2n = 38 (Fig. 1) from plants collected from Kohút Mt., Stolické vrchy Mts. (see Appendix).

The results are summarized also in the karyological database Marhold et al. (2007) (available also online: http://www.chromosomes.sav.sk/main/index.php). The same number is also given in the central database of chromosome

![Fig. 1 Somatic chromosomes of *Adenostyles alliariae* somatic cells, 2n = 38 (Kohút Mt., Stolické vrchy Mts.).](image)
numbers, „Chromosome counts database“ (Rice et al. 2015, http://ccdb.tau.ac.il/home/), which summarized several further sources.

**Genome size**

Our measurements of *Adenostyles alliariae* genome size (2C DNA) (Tab. 1) resulted in the value 18,19 ± 0,18 pg for leaf tissues (Fig. 2). From the obtained 2C DNA the number of Mbp in 1C DNA was calculated with the result 8895 ± 88 Mbp (1 pg DNA = 978 Mbp; Doležel et al. 2003).

The analysis of 15 seed samples of *A. alliariae* resulted in genome size of 19,4 ± 0,54 pg (Tab. 1), which is equal to 9487 ± 264 Mbp. This value exceeds the genome size value for leaves by 1,21 pg. Such significant deviation may be caused by the presence of secondary metabolites in leaf tissue which can influence the binding of fluorescence stains to DNA. This can result in fluorescence intensity decrease for the measured sample and in significant distortion of the obtained results (Sliwinska et al. 2005). Further reason for the different values of 2C DNA may be seen in different chromatine structure in leaves and seeds. This can result in different binding of fluorescence stains to DNA (Baluška 1990; Biradar & Rayburn 1994).

Tab. 1 Genome size of *Adenostyles alliariae* from Slovakia from leaves (l) and seeds (s).

| Localitá       | Type of analysis | No. of analysis | Minimum (pg) | Maximum (pg) | Average (pg) | Standard deviation |
|---------------|-----------------|----------------|--------------|--------------|--------------|--------------------|
| *Stolica*     | l               | 9              | 17,91        | 18,46        | 18,16        | 0,201              |
| *Kohút*       | l               | 9              | 17,9         | 18,46        | 18,13        | 0,183              |
| *Ondrejisko*  | l               | 9              | 17,84        | 18,45        | 18,24        | 0,189              |
| *Trsteník*    | l               | 9              | 17,98        | 18,45        | 18,21        | 0,177              |
| *Malý Kohút*  | l               | 9              | 18           | 18,47        | 18,2         | 0,16               |
| **Total**     | l               | 45             | 17,84        | 18,45        | 18,19        | 0,18               |
| *Stolica*     | s               | 5              | 19,07        | 20,82        | 19,52        | 0,736              |
| *Kohút*       | s               | 5              | 18,58        | 19,75        | 19,1         | 0,468              |
| *Nízke Tatry* | s               | 5              | 19,23        | 19,96        | 19,57        | 0,312              |
| **Total**     | s               | 15             | 18,58        | 19,75        | 19,4         | 0,54               |

Flow cytometric analysis of 15 seed samples of *Adenostyles alliariae* proved that sexual reproduction is a common reproduction mode for this species. The ratio of embryo peak median to endosperm peak median was approximately 2:3 for all measurements (Fig. 3.), which is characteristic for sexual reproduction way.

**Distribution in Slovakia**

*Adenostyles alliariae* occurs relatively frequently in the flora of the mountain and subalpine vegetation zones, less often, but not rarely it also occurs in submountain and alpine vegetation zones. It is widely spread in higher mountains in Europe, from the west in the Sierra de Gredos and the Pyrenees across the
central Europe, including the Massif Central, the Vosges, the entire Alps, to the
south in the Apennines, the Dinarides and other minor Balkan mountains, the
Sudetes as the northernmost and the Carpathians as the easternmost mountain
range of its distribution (Dillenberger & Kadereit 2013). Its distribution in Slovakia
is illustrated by the map of distribution (Fig. 4.) and the list of localities (see
Appendix). It grows mainly in central and northern mountain regions of Slovakia
where it forms vital populations continuously connected to those in southern
Poland (Zając & Zając 2001).

The lowermost locality in Slovakia ever recorded lies near the Blatnica village
in the phytogeographical district Turčianska kotlina basin. The species grows
there at an altitude of 460 m a. s. l. The altitudinal maximum reaches 2350 m a.
s. l. below Mačacia veža Mt. in the Vysoké Tatry Mts. (see Appendix). However,
there are further localities for *Adenostyles alliariae* in the Vysoké Tatry Mts.
reaching at least 2000 m a. s. l. The oldest report is dated back to 1823 by Carl,
the newest ones came from our field studies and from the online database www.
bioi0rnitoring.sk (for details see Appendix).

The occurrence of the species was documented from 24 phytogeographic
districts and subdistricts. The centre of its distribution is located in the Central
Carpathians (*Eucarpaticum*). It does not grow in the area of the Pannonian flora
(*Pannonicum*) at all. Most of the records are located in the phytogeographical
districts and subdistricts of the Slovenské rudohorie Mts., the Muránska planina
Mts., the Krivánska Malá Fatra Mts., the Veľká Fatra Mts., the Nízke Tatry Mts.,
the Západné Tatry Mts., the Vysoké Tatry Mts. and the Belianske Tatry Mts. In

![Fig. 2 Flow cytometric histogram of relative fluorescence intensity (propidium iodide)
obtained after simultaneous analysis of nuclei of reference standard (*Vicia faba* subsp. *faba*
var. *equina* ‘Inovec’ (V), 2C = 26,9 pg DNA) and *Adenostyles alliariae* (A) sample studied.]

![Fig. 3 Flow cytometric histogram of relative fluorescence intensity obtained by analysis of nuclei of embryo (Em) and endosperm (En) of *A. alliariae*.]
the Slovenské rudohorie Mts., it occurs mainly in geographical subunits Veporské vrchy Mts. and the Stolické vrchy Mts. Data are missing almost entirely from the geographical subunit Volovské vrchy Mts., where we expected rich abundance. We confirmed its absence in this region by our own field research. This condition could be caused by massive logging activity in the area in the last couple of years, as a consequence many natural habitats were destroyed.

The species has relatively rich abundance also in other phytogeographical districts, mainly in the altitudes above 1100 m a. s. l.. These are primarily the Vtáčnik Mts., the Poľana Mts., the Chočské vrchy Mts., the Spišské vrchy Mts. and the Bukovské vrchy Mts. We have expected greater abundance in the Západné Beskydy Mts., but this can be distorted by missing data and also by destroying habitats by logging activity. The species can be rarely found in the Kremnické vrchy Mts., the Slovenský raj Mts., the Pieniny Mts., the Čergov Mts., the Strážovské and Súlovské vrchy Mts. and the Podtatranské kotlínky basins, where it can sporadically descend from the valleys of Tatry Mts.

The only single record of the occurrence in the Štiavnické vrchy Mts. from Sitno Mt. is old and new data are necessary to obtain.

Fig. 4 Grid map of distribution of the species *Adenostyles alliariae* in Slovakia.

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system (CIMS), available also online at www.biomonitoring.sk. We would also like to thank two anonymous reviewers for their constructive criticism.

References

Baluška F. (1990): Nuclear size, DNA content, and chromatin condensation are different in individual tissues of the maize root apex. – Protoplasma 158 (1): 45–52. DOI: 10.1007/BF01323273

Biradar D. P. & Rayburn A. L. (1994): Flow cytometric probing of chromatin condensation in maize diploid nuclei. – New Phytologist 126 (1): 31–35. DOI: 10.1111/j.1469-8137.1994.tb07526.x

Dillenberger M. S. & Kadereit J. W. (2013): The phylogeny of the European high mountain genus *Adenostyles* (Asteraceae – Senecioneae) reveals that edaphic shifts coincide with dispersal events. – Am. J. Bot. 100 (6): 1171–1183. DOI: 10.3732/ajb.1300060

Doležel J. & Bartoš J. (2005): Plant DNA flow cytometry and estimation of nuclear genome size. – Ann. Bot. 95: 99–110. DOI: 10.1093/aoob/mci005

Doležel J., Bartoš J., Volgmayr H. & Greilhuber J. (2003): Nuclear DNA content and genome size of trout and human. – Cytometry 51: 127–128. DOI: 10.1002/cyto.a.10013

Doležel J. & Göhde W. (1995): Sex determination in dioecious plants *Melandrium album* and *M. rubrum* using high-resolution flow cytometry. – Cytometry 19: 103–106. DOI.org/10.1002/cyto.990190203

Doležel J., Greilhuber J. & Suda, J. (2007): Estimation of nuclear DNA content in plants using flow cytometry. – Nat. Protoc. 21 (9): 2233–2244. DOI: 10.1038/nprot.2007.310

Doležel J., Sgorbati S. & Lucretti S. (1992): Comparison of three DNA fluorochromes for flow cytometric estimation of nuclear DNA content in plants. – Physiol. Plant. 85: 625–631. DOI: 10.1111/j.1399-3054.1992.tb04764.x

Dostál J. & Červenka M. (1983): Veľký kľúč na určovanie vyšších rastlín. Vol. 2. – Slovenské pedagogické nakladateľstvo, Bratislava, p. 1083.

Futák J. (1984): Fytogeografické členenie Slovenska. – In: Bertová, L. (ed.): Flóra Slovenska IV/1. – Veda, Bratislava. pp: 418–420.

Greilhuber J. & Obermayer R. (1997): Genome size and maturity group in *Glycine max* (Soybean). – Heredity 78: 547–551. DOI: 10.1038/sj.hdy.6881690

Holmgren P. K., Holmgren N. H. & Barnett L. C. (eds.) (1990): Index Herbariorum. Part I.: The Herbaria of the world. Ed. 8. – Regnum Veg. 120: 1–394.

Kliment J. & Valachovič M. (2007): Rastlinné spoločenstvá Slovenska. 4. Vysokohorská vegetácia. – Veda, Bratislava. pp: 1–388.

Křísa B. (2004): 36. *Adenostyles* Cass. – havez. – In: Slavík B. & Štěpánková J. & Štěpánek J. (eds.): Květena České republiky 7. – Academia, Praha. pp. 282–283

Loureiro J., Rodriguez E., Doležel J. & Santos C. (2007): Two new nuclear isolation buffers for plant DNA flow cytometry: A test with 37 species. – Ann. Bot. 100: 875–888. DOI: 10.1093/aoob/mcm152

Marhold K., Mártonfi P., Mereďa P. & Mráz P. (2007): Chromosome number survey of the ferns and flowering plants of Slovakia. – Veda, Bratislava. pp: 1650.

Májovský J. (ed.) (1970): Index of chromosome numbers of Slovakian flora Part 2. – Acta Fac. Rer. Nat. Univ. Comen., Bot. 18: 47.

Májovský J. (ed.) (1970): Index of chromosome numbers of Slovakian flora Part 2. – Acta Fac. Rer. Nat. Univ. Comen., Bot. 18: 47.

Májovský J. (ed.) (1970): Index of chromosome numbers of Slovakian flora Part 2. – Acta Fac. Rer. Nat. Univ. Comen., Bot. 18: 47.

Murín A. (1960): Substitution of cellophane for glass covers to facilitate preparation of permanent squashes and smears. – Stain Technol. 35: 351–353.

Niklfeld H. (1971): Bericht über die Kartierung der Flora Mitteleuropas. – Taxon 20: 545–571. DOI: 10.2307/1218258

Rice A., Glick L., Abadi S., Einhorn M., Kopelman N. M., Salman-Minkov A., Mayzel J., Chay O., Mayrose I. (2015): The Chromosome Counts Database (CCDB) – a community
resource of plant chromosome numbers. – New Phytologist 206(1): 19–26. DOI: org/10.1111/nph.13191
Sliwinska E., Zielinska, E. & Jedrzejczyk I. (2005): Are Seeds Suitable for Flow Cytometric Estimation of Plant Genome Size? – Cytometry Part A 64A (2): 72–79. DOI:10.1002/cyto.a.20122
Suda J. (2004): An employment of flow cytometry into plant biosystematics. PhD Thesis, Charles University in Prague
Tutin T. G., Heywood V. H., Burges N. A., Moore D. M., Valentine D. H., Walters S. M. & Webb D. A. (1976): Flora Europaea 4.– Cambridge University Press, Cambridge. 534 pp.
Zając A. & Zając M. (2001): Atlas rozmieszczenia roślin naczyniowych w Polsce. Distribution Atlas of Vascular Plants in Poland. – Pracownia Chorologii Komputerowej Instytutu Botaniki Uniwersytetu Jagiellońskiego. – Krakow. XII + 716 pp.
Appendix

Revised records of Adenostyles alliariae distribution in Slovakia

This chapter gives documents of distribution which were localized to phytogeographical district (number and name), followed by original or shortened description of the locality from original resource, data on collector, collection year and abbreviation of the herbarium (Holmgren et al. 1990) where the specimen is deposited, or, alternatively, abbreviated literature or manuscript citation. Then the code of subsquare of the Central European grid mapping (Niklfeld 1971) is given in brackets. Abbreviations: NR – Nature reserve, NNR – National nature reserve.

Carpaticum occidentale. 13. Strážovské and Súľovské vrchy Mts.: Lietavská Svinná, N valley below Skalky Mt., (Hallonová 1978 SLO) (6878c). – Ostrá Malenica Mt., 49°1’18,61” N, 18°24’24,34” E (Dinga 1989 BIOM) (6976c). 14b. Vtáčnik Mts.: Handel, below Flochová Mt., 48°48’25,28” N, 18°58’20,28” E (Pavlischin 2014 BIOM) (7179d). – Vtáčnik Mt., below the top, 1325 – 1340 m (7377d). – saddle between Vtáčnik Mt. and Homôlka Mt. (all Magic Tábór ochr. prír. 15: tab. 2, 1980) (7377d). – Vtáčnik Mt. (Kmeť 1876 BRA; Futák 1931 SLO) (7377d). – Vtáčnik Mt., Kamenné vráta (7377d-7477b). – site „Maliník”, NW from Kľak village (7377d-7477b).

Carpaticum occidentale. 14c. Kremnické vrchy Mts.: Kremnica, Lúčky, slope near the ski-lift, cca 750 m (Šipošová 1991 SAV) (7279c). – NNW below the spot height Suchá hora, 1080 m (7279d).

14d. Poľana Mts.: Hrochoťská dolina valley, W from Bátová gamekeeper’s house, 620 – 660 m, 48°39’28” N, 19°22’34” E (7382a). – Kyslinky, 48°39’41,71” N, 19°29’31,39” E (Lizoň 2014 BIOM) (7382b). – Staré pole meadow, S slope of Zadná Poľana Mt. (1458), 1411 – 1440 m, 48°38’09” N, 19°29’05” E (7382d). – “Výbohove”, abandoned meadows on SW slope of Zadná Poľana Mt., 1304 – 1364 m, 48°38’01” N, 19°28’39” E (7382d). – “Priehyba” meadows in the saddle between spot heights Predná Poľana (1367) and Zadná Poľana (1458), 1209 – 1280 m, 48°37’55” N, 19°28’21” E (all Janišová et al. Bull. Slov. Bot. Spoločn. 26, Suppl. 13: 26, 2004) (7382d).

14e. Štiavnické vrchy Mts.: Sitno Mt. (Cserey 1890 BRA) (7579c). 15. Slovenské rudohorie Mts.: Skalka Mt., 1200 m (Miadok Preslia 60/3: 261, tab. 3, 1988) (7185c). – Skalka Mt., 1230 m (7185c). – N from the spot height 1286, 1220 m (both Miadok Preslia 60/3: 264, tab. 4, 1988) (7185c). – Hrb Mt., 1225 – 1250 m (Manica 1965 ZV 2625, 2626) (7382d). – Poľana Mt., cca 1200 m (Deyl 1951 PR 292182) (7382d). – Predná Poľana Mt., below the ridge, 1331 m, 48°37’56,82” N, 19°28’7,92” E (Kučera Bull. Slov. Bot. Spoločn. 33/2: 217, tab. 1, 2011) (7382d). – NR Vrchslatina, along Slatina brook, cca 920 m, 48°38’56” N, 19°37’46” E (Janišová et al. Bull. Slov. Bot. Spoločn. 26, Suppl. 13: 26, 2004) (7383d).
Preslia 60/3:p. 267, tab. 5, 1988) (7285a). – N from the main ridge of Lešník Mt., 1225 m (7285a). – N from the spot height 1211, on the ridge, 1250 m (both Miadok Preslia 60/3: 256, tab. 1, 1988) (7285a). – Psica Mt., 1340 m (Miadok Preslia 60/3: 267, tab. 5, 1988) (7285a). – Psica Mt., 1370 m (Miadok Preslia 60/3: 264, tab. 4, 1988) (7285a). – SSE from the spot height Psica, 1335 – 1340 m, 48°47'3'' N, 19°51'22'' E (7285a). – NE from the spot height Javorinka, 1385 – 1390 m, 48°47'8'' N, 19°52'41'' E (both Jančovičová et al. Czech Mycol. 63/2: 229, 2011) (7285a). – Lešník Mt., above Ždiarik, 1320 m (7285a). – Malá Smrekovica Mt., E from the spot height 1319, 1310 m (7285a). – “Rovienky”, N slope of Malá Smrekovica Mt., 1230 m (all Miadok Preslia 60/3: 261, tab. 3, 1988) (7285a). – between Malá Smrekovica Mt. and Fabova hoľa Mt. (Miadok Preslia 60/3: 267, tab. 5, 1988) (7285a). – Fabova Mt., below Fabova meadow, 1237 m, 48°47'4'' N, 19°53'8'' E (Hrivnák et al. Reussia 2/2: 158, tab. 1, 2005) (7285a). – Fabova hoľa Mt. (Pax 1895 BP 165536; Hendrych Acta Univ. Carol. – Biol. 1968/2: 139, 1969; Cvachová & Urbanová Stred. Slov. 4: 47-49, 1985; Burkovský Stred. Slov. 4: 84, 1985) (7285a). – Javorina Mt., cca 900 m (7286b). – Čelo Mt. – Homola Mt., on the ridge, cca 1190 m (7286b). – Šindliarky, below Chata Janka cottage, cca 1000 m (7287a). – Kyprov Mt., W slope, cca 1210 m (7287a). – above cabin in Slánská dolina valley, cca 1000 m (7287a). – Stolica Mt., all slopes around the top, 1250 – 1470 m (all Magic & Májovský Acta Fac. Rer. Natur. Univ. Comen. Bot. 22: 57, 1974) (7287a). – Slanské sedlo saddle, cca 1255 m, 48°47'06,94'' N, 20°11'55,98'' E (7287a). – NW slope of Stolica Mt., cca 400 m above Slanské sedlo saddle, cca 1350 m, 48°46'56,05'' N, 20°12'0,63'' E (both Koprivý 2015 KO) (7287a). – below chata Parajka cabin, cca 1100 m, 48°43'33,06'' N, 20°10'25,66'' E (Koprivý 2015 KO) (7287c). – above slope between chata Parajka cabin and Kohút Mt., 1100 – 1409 m (Mihál et al. Reussia 6/1-2: 6, 2011) (7287c). – Kohút Mt., NW from the spot height 1409, 1310 m, 48°43'58,7'' N, 20°10'46,7'' E (Mihál et al. Reussia 6/1-2: 17, 2011) (7287c). – Klepaná skala, below Malý Kohút Mt., cca 1170 m (not. Koprivý 2015) (7287c). – Malý Kohút Mt., cca 1187 m, 48°43'23,88'' N, 20°10'40,87'' E (7287c). – above chata Kohút saddle, cca 1210 m, 48°43'25,49'' N, 20°11'14,37'' E (both Koprivý 2015 KO) (7287c). – above chata Kohút saddle, spring area, 48°46'19,2'' N, 20°12'1,3'' E, 1330 m (Hrivnák et al. Reussia 2/2: 158, tab. 1, 2005; not. Koprivý 2015) (7287a). – on the ridge Lehotská hoľa, cca 500 m SW from sedlo Harová saddle, cca 1300 m, 48°06'0,84'' N, 20°11'51,8'' E (not. Koprivý 2014) (7287a). – Veľká chyžňanská Mt., on the NW ridge, 1200 – 1345 m (7287a). – Dzdyhavská hora Mt., spring area on the NW slope, cca 890 m (both Magic & Májovský Acta Fac. Rer. Natur. Univ. Comen. Bot. 22: 57, 1974) (7287c). – Tomesové diely, N slope of Kohút Mt., cca 1190 m, 48°44'33,6'' N, 20°11'21,9'' E (Koprivý 2015 KO) (7287c). – below chata Parajka cabin, cca 1100 m, 48°43'33,06'' N, 20°10'25,66'' E (Koprivý 2015 KO) (7287c). – above chata Parajka cabin, cca 1220 m (Magic & Májovský Acta Fac. Rer. Natur. Univ. Comen. Bot. 22: 57, 1974) (7287c). – slope between chata Parajka cabin and Kohút Mt., 1100 – 1409 m (Mihál et al. Reussia 6/1-2: 6, 2011) (7287c). – Kohút Mt., NW from the spot height 1409, 1310 m, 48°43'58,7'' N, 20°10'46,7'' E (Mihál et al. Reussia 6/1-2: 17, 2011) (7287c). – Klepaná skala, below Malý Kohút Mt., cca 1170 m (not. Koprivý 2015) (7287c). – Malý Kohút Mt., cca 1187 m, 48°43'23,88'' N, 20°10'40,87'' E (7287c). – above sedlo Kohút saddle, cca 1210 m, 48°43'25,49'' N, 20°11'14,37'' E (both Koprivý 2015 KO) (7287c). – Kohút Mt., spruce forest, cca 1000 m (Novák, Věda přír. 7: 220 – 221, 1926) (7287c). – NW below Javorina Mt. (1212), above Dlhá dolina valley (7289a). – „Košutova jama” SW below ridge towards Stadielko cottage, cca 1150 m (7289a). – Skalisko Mt. – Baracká skala Mt., 1293 – 1224 m (all Vlčáková & Hajdúk Nat. Carp. 48: 99, 2007) (7289c). – Klenovský Vepor Mt. (Fábry 1852 BRA) (7384b). – Klenovský Vepor Mt., in NW part, 1070 m (7384b). – Klenovský Vepor Mt., W from the spot height 1137, 1150 m (both Miadok Acta Fac. Rer. Natur. Univ. Comen. Bot. 17: tab. 7, 1971) (7384b). – Klenovský Vepor Mt., NE from the spot height 1339, 1250 m (7384b). – on the top of Klenovský Vepor Mt., between two little meadows, 1210 m (7384b). – below NW edge of big meadow on Klenovský Vepor Mt.,
1250 m (7384b). – Klenovský Vepor Mt., above Čierna dolina valley, between spot heights 1339 and 1301, 1230 m (7384b). – Klenovský Vepor Mt., above Čierna dolina valley, below spot height 1301, 1180 m (7384b). – Klenovský Vepor Mt., between spot heights 1301 and 1032 in Čierna dolina valley, 1070 m (all Miadok Biológia 24: 324, tab. 1, 1969) (7384b). 16. Muránska planina Mts.: Malá Stožka Mt. (Hendrych Acta Univ. Carol. – Biol. 1968/2: 196, 1969) (7285b). – Veľká Stožka Mt. and Mochnatá (Májovský 1952 SLO) (7285b). – Veľká Stožka Mt. (Hendrych Acta Univ. Carol. – Biol. 1968/2: 196, 1969; Cvachová & Urbanová Stred. Slov. 4: 64, 1985; Burkovský Stred. Slov. 4: 102, 1985) (7285b). – site „Zadné hory“, ENE from Veľká Stožka Mt., 1240 m, 48°46'51" N, 19°57'18" E (Jančovičová et al. Czech Mycol. 63/2: 229, 2011) (7285b). – site „Zadné hory“ (7285b). – site „Hlinačka“ (7285b). – site „Mochnatá“ (all Hendrych Acta Univ. Carol. – Biol. 1968/2: 196, 1969) (7285b). – site „Mochnatá“, slope to Klátna dolina valley (not. Futák 1970) (7285b). – site „Mochnatá“, couloir E from Zbojnícka jaskyňa cave, 1080 m (7285b). – couloir above Teplá dolina valley, 950 – 980 m (7285b). – couloir above Suchá dolina valley, 1240 m (all Kliment & Turis Výsk. a ochr. prír. Murán. planiny: 76, 2002) (7285b). – N from the spot height Kľak, 1320 – 1325 m, 48°46'57" N, 19°57'52,44'' (Kučera Reussia 5/1–2: 37, 2009) (7285b). – Kľak Mt. (Fábry 1872 BRA; Hendrych Acta Univ. Carol. – Biol. 1968/2: 196, 1969) (7285b). – Kľak Mt., 1385 m, 48°46'43,2'' N, 19°57'52,44" (Kučera Reussia 5/1–2: 37, 2009) (7285b). – Okrúhla Mt. (Hendrych Acta Univ. Carol. – Biol. 1968/2: 111, 1969) (7285b). – between Mochnatá and Studňa, cca 1230 m (Hendrych Acta Univ. Carol. – Biol. 1968/2: 112, 1969) (7285b). – above gamekeeper’s house Studňa, cca 1300 m (Nábělek 1940 SLO) (7285b). – Ostrica Mt. (Hendrych Acta Univ. Carol. – Biol. 1968/2: 196, 1969) (7285b). – site Maretkíná to Tesná skala (all Hendrych Acta Univ. Carol. – Biol. 1968/2: 196, 1969) (7285b). – from Maretkíná to Tesná skala (all Hendrych Acta Univ. Carol. – Biol. 1968/2: 196, 1969) (7285b). – site Maretkíná (Šoltés, Acta Fac. Rer. Natur. Univ. Comen. Bot. 24: tab. 3, 1976) (7286a). 17. Slovenský raj Mts.: NE slope of Trsteník Mt., above Spišský potok brook, below the forest road, cca 1090 m, 48°51'31,7'' N, 20°14'23,7'' E (Koprivý 2015 KO) (7187a). – Ondrejisko Mt. (Mikoláš 1962 KO 13566) (7187b). – Borovniak Mt., cca 150 m below the top, cca 1230 m, 48°51'33,71'' N, 20°15'35,63" E (not. Koprivý 2015) (7187b). – in the saddle between Ondrejisko Mt. and spot height 1222, cca 1170 m, 48°51'09,8'' N, 20°15'16,8'' E (Koprivý 2015) (7187b). – Dobšinská ľadová jaskyňa ice cave, near the cave (Chyzer 1879 BP 731290; Richter 1898 BP 165569, 731279, 731285; Gesell 1901 BP 165573) (7187b). – area of todays dam, between villages Dedinky and Dobšinská Maša, gorge on S slope (Hajdúk Acta Rer. Natur. Mus. Slov. 5: 113, 1959) (7188a). – Knola Mt., 49°3'7,64'' N, 19°59'18,95'' E (Leskovjanská 2015 BIOM) (7188b). 21a. Lúčanská Malá Fatra Mts.: Veterné hole, Flochová chata cottage (Brižický 1941 SLO) (6879c-6979a). – Martinské hole (Brižický 1942 SLO) (6879c-6979a). – Martinské hole, on mountain meadows (Docolomansky 1961 BRA) (6879c-6979a). – Usynaná skala Mt., 49°3'7,64'' N, 18°44'10,89" E (Vyšinsky 2014 BIOM) (6978a). – Martinské hole, Veľká lúka Mt. (Brižický, Futák & Nábělek 1942 SLO) (6978b). – Prieslopská dolina valley, spot height Veterné, 1120 m, 49°4'27,87" N, 18°48'14,56" E (6978b). – Prieslopská dolina valley, Grüń, 1310 m, 49°4'21,14" N, 18°49'36,5" E (6978b). – Prieslopská dolina valley, Žiariky, 1230 m, 49°4’18,” N, 18°49’27,5” E (6978b). – Prieslopská dolina valley, Záložná, 1300 m, 49°4’13,07” N, 18°49’15,18” E (6978b). – Prieslopská dolina valley, spot height Humience, 1328 m, 49°3’57,6” N, 18°49’0,3” E (6978b). – Bystričská dolina valley, spot height Horná lúka, 1255 m, 49°3’58,3” N, 18°47’7” E (6978b). – Bystričská dolina valley, spot height Velký Úplaz, 200 m E from cabin, 1250 m, 49°0’35,08” N, 18°47’36,17” E (6978b). – Bystričská dolina valley, Hlboké, 1260 m, 49°3’51,67” N, 18°49’4,82” E (all Hederová et al. Bull. Slov. Bot. Spoločn. 37/1: 127, 2015)
(6978b). – Kýčera Mt., Blatné, 49°2′25,43″ N, 18°45′22,11″ E (Rizman 2015 BIOM) (6978d). – Klak Mt. (Carl 1823 PRC; Brancsik 1900 BRA; Urbanová Botanika: 11, 2007) (7077b). – Klak Mt., 48°58′55,22″ N, 18°38′22,38″ E (Pavlišin 2014 BIOM; Duchöň 2015 BIOM; Fekiač 2015 BIOM) (7077b). – Kukotová, below Klak Mt., 48°58′41,21″ N, 18°38′14,41″ E (Pavlišin 2014 BIOM) (7077b). – NNR Klak, 48°58′37,05″ N, 18°38′22,93″ E (Pietorová 1997 BIOM) (7077b). – above Horná lúka meadow, 48°57′51,64″ N, 18°38′18,22″ E (Pavlišin 2014 BIOM) (7077b). – Reváň Mt. (Valenta 1937 BRA; Schidlay 1949 BRA; Dýlik 1963 ZAM) (7077b).

21b. Krivánska Malá Fatra Mts.: Veľká Bránica valley – Príslopská dolina valley, 49°13′37,99″ N, 19°0′40,16″ E (Vnuk 2014 BIOM) (6780c). – Vrátna, Kraviarska dolina valley, 49°12′4,43″ N, 19°1′20,95″ E (Rizman 2015 BIOM) (6780c). – Poludňový grúň Mt., 49°12′58,46″ N, 19°3′30,57″ E (Sviteková 2013 BIOM; Pavlišin 2015 BIOM; Šibík 2018 BIOM) (6780c). – Vrátna valley, slope near ski-lift, 49°12′1,47″ N, 19°2′27,11″ E (Uhrin 2015 BIOM) (6780c). – Poludňový Grúň Mt., towards Stohové sedlo saddle, 1390 m, 49°12′46,4″ N, 19°04′16,7″ E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6780c). – below Stoh Mt., 49°13′10,3″ N, 19°4′57,74″ E (Pavlišin 2015 BIOM) (6780c). – Steny ridge, 49°12′2,68″ N, 19°0′40,16″ E (Vyšinský 2015 BIOM) (6780c). – Vrátna dolina valley, fir forest, 680 m (Domin Věda přír. 4: 33, 1923) (6780c). – Vrátna dolina valley, Malý Kriváň Mt. (Brancsik 1898 BRA) (6780c). – Vrátna dolina valley, cca 1200 m (Domin Věda přír. 4: 35-36, 1923) (6780c). – Malý Rozsutec Mt., N slope, 49°13′59,4″ N, 19°05′58,6″ E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6780c). – Veľký Rozsutec Mt., N slope, 49°13′4,43″ N, 19°0′22,38″ E (Šibík et al. Bull. Slov. Bot. Spoločn. 29: 201, 2005; Šibíková et al. Bull. Slov. Bot. Spoločn. 29: 165, 2007) (6880a). – Malý Kriváň Mt., couloir below Sedlo Osnice saddle, 49°11′19,29″ N, 18°59′21″ E (Šibík 2015 BIOM) (6879b). – Prípor I Mt., 49°11′19,23″ N, 18°59′36,04″ E (Figura 2015 BIOM) (6879b). – Michalove dolinky, 49°9′21,21″ N, 18°57′30,5″ E (Pirchala 2013 BIOM) (6879b). – Malý Kriváň Mt., NW slope, end of Belianska dolina valley, 1373 m, 49°11′15,7″ N, 18°59′44,1″ E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 73, 2008) (6879b). – Malý Kriváň Mt., towards sedlo Priehyb saddle, 1503 m, 49°11′0,0″ N, 18°59′14,5″ E (6879b). – Malý Kriváň Mt., Markušov žľab couloir, end of Belianska dolina valley, 1519 m, 49°11′09,1″ N, 18°59′44,2″ E (6879b). – Malý Kriváň Mt., NW slope, between Markušov žľab couloir and Svinský žľab couloir, 1364 m, 49°11′15,2″ N, 18°59′39,4″ E (6879b). – Malý Kriváň Mt., NW slope, Svinský žľab couloir, 1580 m, 49°11′09,8″ N, 18°59′55″ E (all Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6879b). – Malý Kriváň Mt. (Brancsik 1898 BRA; Urbanová Botanika: 11, 2007) (6978d). – Klak Mt., Blatné, 49°2′25,43″ N, 18°45′22,11″ E (Rizman 2015 BIOM) (6978d). – Kýčera Mt., 48°58′55,22″ N, 18°38′22,38″ E (Pavlišin 2014 BIOM; Duchöň 2015 BIOM; Fekiač 2015 BIOM) (7077b). – Kukotová, below Klak Mt., 48°58′41,21″ N, 18°38′14,41″ E (Pavlišin 2014 BIOM) (7077b). – NNR Klak, 48°58′37,05″ N, 18°38′22,93″ E (Pietorová 1997 BIOM) (7077b). – above Horná lúka meadow, 48°57′51,64″ N, 18°38′18,22″ E (Pavlišin 2014 BIOM) (7077b). – Reváň Mt. (Valenta 1937 BRA; Schidlay 1949 BRA; Dýlik 1963 ZAM) (7077b).
49°11'40,72'' N, 19°1'7,77'' E (Flajs 2006 BIOM; Figura 2015 BIOM; Šibík 2017 BIOM) (6880a). – Chrapáky, end of couloir below sedlo Bublen saddle, 1468 m, 49°11'40,4'' N, 19°00'53,6'' E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6880a). – rocky formation between Velký Kriváň Mt. and Pekelník Mt., 1415 m, 49°11'22,3'' N, 19°01'28,2'' E (6880a). – Velký Kriváň Mt. – Pekelník Mt., N slope, near tourist pathway, 1488 m, 49°11'35,7'' N, 19°01'51,8'' E (both Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6880a). – couloir above Studenec valley, between Pekelník Mt. and Velký Kriváň Mt., 1425 m, 49°11'23,5'' N, 19°01'28,4'' E (Šibíková et al. Bull. Slov. Bot. Spoločn. 29:p. 163, 2007) (6880a). – Vrátna dolina valley (Domin Věda přír. 4: p. 36-37, 1923) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1415 m, 49°11'22,3'' N, 19°00'53,6'' E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1425 m, 49°11'23,5'' N, 19°01'28,4'' E (Šibíková et al. Bull. Slov. Bot. Spoločn. 29:p. 163, 2007) (6880a). – Vrátna dolina valley (Domin Věda přír. 4: p. 36-37, 1923) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1415 m, 49°11'22,3'' N, 19°00'53,6'' E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1425 m, 49°11'23,5'' N, 19°01'28,4'' E (Šibíková et al. Bull. Slov. Bot. Spoločn. 29:p. 163, 2007) (6880a). – Vrátna dolina valley (Domin Věda přír. 4: p. 36-37, 1923) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1415 m, 49°11'22,3'' N, 19°00'53,6'' E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1425 m, 49°11'23,5'' N, 19°01'28,4'' E (Šibíková et al. Bull. Slov. Bot. Spoločn. 29:p. 163, 2007) (6880a). – Vrátna dolina valley (Domin Věda přír. 4: p. 36-37, 1923) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1415 m, 49°11'22,3'' N, 19°00'53,6'' E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1425 m, 49°11'23,5'' N, 19°01'28,4'' E (Šibíková et al. Bull. Slov. Bot. Spoločn. 29:p. 163, 2007) (6880a). – Vrátna dolina valley (Domin Věda přír. 4: p. 36-37, 1923) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1415 m, 49°11'22,3'' N, 19°00'53,6'' E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1425 m, 49°11'23,5'' N, 19°01'28,4'' E (Šibíková et al. Bull. Slov. Bot. Spoločn. 29:p. 163, 2007) (6880a). – Vrátna dolina valley (Domin Věda přír. 4: p. 36-37, 1923) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1415 m, 49°11'22,3'' N, 19°00'53,6'' E (Šibík et al. Bull. Slov. Bot. Spoločn. 30: 79, tab.1, 2008) (6880a). – rocky formation between Veľký Kriváň Mt. and Pekelník Mt., 1425 m, 49°11'23,5'' N, 19°01'28,4'' E (Šibíková et al. Bull. Slov. Bot. Spoločn. 29:p. 163, 2007) (6880a). – Vrátna dolina valley (Domin Věda přír. 4: p. 36-37, 1923) (6880a).
18°57'11,03'' E (7079d). – Muráň Mt., 48°55'37,5'' N, 18°58'13,72'' E (7079d). – on the ridge Ostrá Mt. – Báglow kopec Mt., 48°55'37,95'' N, 18°58'39,49'' E (7079d). – Ostrá Mt., above Konský dol valley, 48°55'12,3'' N, 18°58'7,38'' E (7079d). – Ostrá Mt., topmost parts, 48°55'7,32'' N, 18°58'0,21'' E (all lit. Bernátová 1976 BIOM) (7079d). – Horná Hlboká valley, 48°56'1,31'' N, 18°58'4,43'' E (Dupkala 2014 BIOM) (7079d). – Tmavá valley, 48°55'20,7'' N, 18°58'54,32'' E (Vyšinský 2014 BIOM) (7079d). – Žúrďášová dolina valley, W from Chládkové úplazy Mt., 48°54'33,57'' N, 18°58'13,86'' E (7079d). – Suchý Jasienok Mt., topmost parts, 48°54'13,85'' N, 18°58'42,89'' E (7079d). – valley between Suchý Jasienok Mt. and Mohošov grúň Mt., 48°54'2,42'' N, 18°58'37,22'' E (all lit. Bernátová 1976 BIOM) (7079d). – Selenec valley, NW part of NNR Padva, 1009 m, 48°54'5,6'' N, 19°0'29,92'' E (7080c). – Belianska dolina valley, NNR Borišov, 500 m E from the spot height Prirastlé, 1180 m, 48°56'48,1'' N, 19°4'29,1'' E (7080c). – Belianska dolina valley, NNR Borišov, Dolné Štrochy, 1129 m, 48°56'51,6'' N, 19°4'44,7'' E (7080c). – Belianska dolina valley, above the valley, 1170 m, 48°56'50,3'' N, 19°4'48'' E (all Ujházyová et al. Bull. Slov. Bot. Spoločn. 35/2: 182-183, 2013) (7080c). – spot height 1123 between „Uhliská” and Biela skala Mt., 48°55'40,1'' N, 19°3'4,68'' E (7080c). – Skalná dolina valley, 48°54'35,46'' N, 19°0'48,47'' E (7080c). – between mouth of Skalná dolina valley and Padva valley, 48°54'25,12'' N, 19°0'12,06'' E (7080c). – Škap, gamekeeper's house, 48°55'21,5'' N, 19°2'17,52'' E (all lit. Bernátová 1976 BIOM) (7080c). – Vrátna dolina valley, 48°54'38,13'' N, 19°3'49,88'' E (lit. Bernátová 1976 BIOM; Pirchala 2014 BIOM) (7080c). – stripatá skala Mt., 48°54'22,39'' N, 19°0'41,63'' E (7080c). – Dedošová dolina valley, 48°54'21,61'' N, 19°2'17,41'' E (7080c). – Drobková dolina valley, 48°54'44,34'' N, 19°2'21,43'' E (7080c). – Skalná Mt., on the top, 48°54'20,19'' N, 19°1'41,87'' E (all lit. Bernátová 1976 BIOM) (7080c). – Dedošová dolina valley, Predný Drobkov, 750 m E from the spot height Skalná, 1105 m, 48°54'16,1'' N, 19°2'25,2'' E (7080c). – Dedošová dolina valley, 250 m below the spot height Skalná, 1199 m, 48°54'16,3'' N, 19°1'43,6'' E (both Ujházyová et al. Bull. Slov. Bot. Spoločn. 35/2: 182-183, 2013) (7080c). – spot height 1123 between „Uhliská” and Biela skala Mt., 48°55'40,1'' N, 19°3'4,68'' E (7080c). – Skalná dolina valley, 48°54'35,46'' N, 19°0'48,47'' E (7080c). – between mouth of Skalná dolina valley and Padva valley, 48°54'25,12'' N, 19°0'12,06'' E (7080c). – Škap, gamekeeper's house, 48°55'21,5'' N, 19°2'17,52'' E (all lit. Bernátová 1976 BIOM) (7080c). – Vrátna dolina valley, 48°54'38,13'' N, 19°3'49,88'' E (lit. Bernátová 1976 BIOM; Pirchala 2014 BIOM) (7080c). – stripatá skala Mt., 48°54'22,39'' N, 19°0'41,63'' E (7080c). – Dedošová dolina valley, 48°54'21,61'' N, 19°2'17,41'' E (7080c). – between „Škap” and „Drobkov”, 48°54'44,34'' N, 19°2'21,43'' E (7080c). – Skalná Mt., on the top, 48°54'20,19'' N, 19°1'41,87'' E (all lit. Bernátová 1976 BIOM) (7080c). – Dedošová dolina valley, Predný Drobkov, 750 m E from the spot height Skalná, 1105 m, 48°54'16,1'' N, 19°2'25,2'' E (7080c). – Dedošová dolina valley, 250 m below the spot height Skalná, 1199 m, 48°54'16,3'' N, 19°1'43,6'' E (both Ujházyová et al. Bull. Slov. Bot. Spoločn. 35/2: 182-183, 2013) (7080c). – Biela skala Mt., 48°55'6,5'' N, 19°4'15,98'' E (lit. Bernátová 1976 BIOM) (7080c). – Biela skala Mt., on the top (7080c). – Biela skala Mt., small peak near the top (both Bernátová & Kliment Tábor ochr. prír. 18: 78, 1983) (7080c). – Biela skala Mt., E small peak near the top, end of shallow rocky couloir, 1370 m (Kliment Bull. Slov. Bot. Spoločn. 20: 163, tab. 1, 1998) (7080c). – Ostredok Mt., topmost parts, 48°54'7,11'' N, 19°4'45,28'' E (lit. Bernátová 1976 BIOM) (7080c). – Nepcalská dolina valley, Pleskov Mt. (Májovsky 1971 SLO) (7080c-d). – Belianska dolina valley, NNR Borišov, 600 m NE from the saddle below Borišov Mt., 1263 m, 48°56'37,6'' N, 19°6'19,8'' E (7080d). – Nepcalská dolina valley, from Chata pod Borišovom chalet towards dolina Balčierovo valley, 1115 m, 48°55'57,8'' N, 19°5'47,5'' E (both Ujházyová et al. Bull. 165
Slov. Bot. Spoločn. 35/2: 182-183, 2013) (7080d). – Necpalská dolina valley, below Borišov, 48°56'11,04'' N, 19°5'13,51'' E (Dupaľa & Vnuk 2014 BIOM) (7080d). – Minčol Mt., 48°56'38,97'' N, 19°9'20,53'' E (Dupaľa 2014 BIOM) (7080d). – „Uplazy“, 48°56'10,98'' N, 19°6'29,84'' E (Vyšinský 2014 BIOM) (7080d). – „Stádlisko“, 48°55'56,56'' N, 19°6'14,77'' E (Vyšinský 2014 BIOM) (7080d).

– Ploská Mt., 48°56'2,97'' N, 19°7'37,97'' E (Némec 2015 BIOM) (7080d). – Ľubochnianska dolina valley, below Čierny Kameň Mt. (Králik 1973 SLO) (7080d). – Čierny Kameň Mt., 48°56'16,72'' N, 19°8'51,08'' E (Bernátová 2003 BIOM; Šibík 2015 BIOM) (7080d).

– Čierny Kameň Mt., 1350 – 1400 m (Suza Věda přír. 12: 20, 1931) (7080d). – Čierny Kameň Mt., 1400 m (Šoltés Acta Fac. Rer. Natur. Univ. Comen. Bot. 24: tab. 3, 1976) (7080d). – N slope of Čierny Kameň Mt., 1420 m (Šoltésová Acta Fac. Rer. Natur. Univ. Comen. Bot. 23: 3, 1974) (7080d). – Čierny Kameň Mt., cca 1470 m (Valenta 1940 BRA) (7080d).

– Necpalská dolina valley, Rakyníky, W slope below Chyžky, 1175 m, 48°55'40,5'' N, 19°6'3,5'' E (7080d). – Necpalská dolina valley, Chyžky, cca 100 m below the ridge, 1239 m, 48°55'33,3'' N, 19°6'4,9'' E (7080d). – Necpalská dolina valley, Koníarky, 1256 m, 48°55'3'' N, 19°7'19,2'' E (Ujházyová et al. Bull. Slov. Bot. Spoločn. 35/2: 182-183, 2013) (7080d). – below Suchý vrch Mt., 1420 m (Šoltésová Acta Fac. Rer. Natur. Univ. Comen. Bot. 24: tab. 3, 1976) (7080d). – Suchý vrch Mt. (lit. Bernátová 1976 BIOM; Chilová 2015 BIOM) (7080d).

– Skalná dolina valley, 48°59'11,42'' N, 19°11'45,19'' E (Bernátová 2003 BIOM; Dudoň 2015 BIOM; Šibík 2015 BIOM) (7081a). – NNR Skalná Alpa (Żrak & Saniga Acta Fac. For. Zvolen 52/1: 56, 2010) (7081a). – Tanečnica Mt., N slope (Bělohlávková & Fišerová Folia Geobot. Phytotax. 24/1: 18, tab. 4, 1989) (7081a). – Tanečnica Mt., humid, steep couloir, 1420 m (Sillinger Věda přír. 11: 133-134, 1930) (7081a). – Tanečnica Mt., W slope below rocky walls, 1435 m (Klement Bull. Slov. Bot. Spoločn. 20: 163, tab. 1, 1998) (7081a). – Rakytkov Mt., NW slopes, 48°57'54,67'' N, 19°10'52,59'' E (Dučoň 2015 BIOM) (7081a). – Rakytkov Mt., 48°57'40,78'' N, 19°10'31,12'' E (Vantarová 2015 BIOM) (7081a). – valley below Smrekovica Mt., above Vyšné Javoriská, 650 – 700 m (Manica 1963 ZV 223) (7081b). – dolina Mokošov valley, 48°53'58,04'' N, 18°59'4,4'' E (7179b). – Mokošov grúň Mt., topmost parts, 48°53'59,56'' N, 18°59'44,84'' E (7179b). – Rakytkovská dolina valley, 48°53'39,69'' N, 18°58'33,23'' E (7179b). – Drieňok Mt., topmost parts, 48°53'24,23'' N, 18°57'42,31'' E (7179b). – below saddle between Drieňok Mt. and Malý Rakytkov Mt., 48°53'8,44'' N, 18°58'5,04'' E (7179b). – end of Rakytkovská dolina valley, 48°53'11,26'' N, 18°58'27,02'' E (7179b). – Pražená dolina valley, 48°53'14,37'' N, 18°59'6,16'' E (7179b). – Malý Rakytkov Mt., topmost parts, 48°52'26,61'' N, 18°58'19'' E (all lit. Bernátová 1976 BIOM) (7179b). – „Horná Ramžiarka“, 48°51'15,73'' N, 18°58'14,41'' E (Pavlišin 2014 BIOM) (7179b). – Selenec valley, NNR Padva, 20 m above valley, 48°53'28,9'' N, 19°0'39,6'' E, 1045 m (7180a). – Dedošová dolina valley, Veterné, 1097 – 1175 m (7180a). – Dedošová dolina valley, Zadný Drobok, 1251 m, 48°53'51'' N, 19°1'19,7'' E (7180a). – Dedošová dolina valley, Kráľovský Grúň – Košariská, 1169 m, 48°53'12,4'' N, 19°3'10,1'' E (7180a). – Dedošová dolina valley, Krišnianske, Košariská, 1257 m, 48°53'3,9'' N, 19°4'19,8'' E (all Ujházyová et al. Bull. Slov. Bot. Spoločn. 35/2: 182-183, 2013) (7180a). – below „Žiarec“, 48°53'2,66'' N, 19°1'8,28'' E (Pavlišin 2014 BIOM) (7180a). – Smrekov Mt., 48°53'8,58'' N, 19°1'18,82'' E (Bernátová 2003 BIOM) (7180a). – Smrekov Mt., Kráľova studňa Mt., 48°52'57,98'' N, 19°1'57,23'' E (Dučoň 2015 BIOM) (7180a). – Kráľova Studňa Mt., 1380 m (Šoltés Acta Fac. Rer. Natur. Univ. Comen. Bot. 24: 151, tab. 3, 1976) (7180a). – „Košariská“, 48°53'18,41'' N, 19°3'11,25'' E (Dupaľa 2014 BIOM) (7180a). – end of Bystrická dolina valley, near Kráľova studňa lodge (Bohúňová 1956 SMBB
B-00002/00019) (7180a). – Krížna Mt., 1280 m (Šoltés Acta Fac. Rer. Natur. Univ. Comen. Bot. 24: 151, tab. 3, 1976) (7180a). – Krížna Mt. (Truchlý 1889 BRNU 137472; Truchlý 1889 SMBB B-00001/00295; Lengyel 1913 BP 274761; Maloch 1920 KO 13879) (7180a). – Krásky kopec Mt., cca 1200 m (Margittai 1915 BP 483927) (7180a). – Krásky kopec Mt., on the ridge (Michalko 1953 SAV) (7180a). – Bystrická dolina valley (s. coll. 1911 BRA; Mitske 1963 PR 256755) (7180a). – forest near cabin below Úplaz (Činčura 1968 SLO) (7180a). – Ostré Brdo Mt., on the forest limit, cca 1393 m (Michalko 1953 SAV) (7180b). – Prašnické sedlo saddle, 48°53′8,41″ N, 19°7′53,86″ E (Pavlíšin 2015 BIOM) (7180b). – Krížna Mt., Majerova skala Mt. (Truchlý 1889 BRA; Nábělek 1936 SAV) (7180b). – Majerova skala Mt., 1000 – 1200 m (Greštiak 1963 ZV 11704) (7180b).

21d. **Chočské vrchy Mts.**:
- Šíp Mt. (Simonkai 1908 BP 165565) (6881a). – Choč Mt. (Pantocsek 1868 SAV) (6882a-c). – Choč Mt., cca 1300 m (Margittai 1914 BP 483929, 483930) (6882a-c). – Veľký Choč Mt., 49°9′3,09″ N, 19°20′43,37″ E (Šibík 2014 BIOM; Vyšinský 2014 BIOM) (6882a). – Veľký Choč Mt., on the ridge. (Michalko 1953 SAV) (6882a). – valley below Bukov Mt., towards Choč Mt. (Domin 1919 PRC; Domin Věda přír. 3: 196, 1922) (6882a-c). – valley below Bukov Mt. towards Choč Mt., 1150 – 1368 m (Domin Věda přír. 3: 197, 1922) (6882a-c). – Prosiek, ”Senná”, 49°10′32,65″ N, 19°28′41,3″ E (Pavlišin 2015 BIOM) (6882b). – below Choč Mt., 49°8′49,23″ N, 19°21′59,95″ E (Rizman 2015 BIOM) (6882c).

22. **Nízke Tatry Mts.**:
- Poludnica Mt. (Hodoval 1963 BRA) (6983d). – Jánska dolina valley, Poludnica Mt., cca 1300 m  (Fott 1928 PRC) (6983d). – below Iľanovské sedlo saddle, 49°0′7,52″ N, 19°36′34,78″ E (Pavlišin 2014 BIOM) (6983d). – Biela skala Mt., 49°0′33,16″ N, 19°37′34,19″ E (Pavlišin 2015 BIOM) (6983d). – Jánska dolina valley, Smrekovica Mt., NE slope, 1270 m (Fajmonová Preslia 58/1: 44, tab. 1, 1986) (6984c). – Michalovská dolina valley (Kautmanová Príroda Nízkych Tatier 1: 124, 2004) (6984c-7084a). – below hydro-electric plant Čierny Váh (Vartíková Ochr. Prírody 1: 66, 1980) (6985c-d). – Svarín settlement, below spot height Vysokej, 1000 m (Vartíková Rig. práca, Msc., depon. in PrF UK Bratislava, 1975) (6985c-7085a). – ”Vlčkovie grúň”, 48°54′18,5″ N, 19°13′18,68″ E (Pavlišin 2014 BIOM) (7081c). – Liptovská Osada, Zvolen Mt. (Lengyel 1931 BP 274759) (7081c). – Salatín Mt., N slope (Bělohlávková & Fišerová Folia Geobot. Phytotax. 24/1: 18, tab. 4, 1989) (7082a). – Salatín Mt., 48°58′42,31″ N, 19°21′41,69″ E (Šibík 2015 BIOM) (7082a). – Pánska hoľa Mt., 48°55′17,72″ N, 19°24′33,49″ E (Kliment 2013 BIOM) (7082c). – ”Magurka”, 48°56′14,77″ N, 19°25′59,41″ E (Vyšinský 2014 BIOM) (7082d). – Chabenec Mt., cca 1800 m (Scheffer 1931 SLO) (7082d). – Chabenec Mt., cca 50 m W, 1900 m (7082d). – slope below Chabenec Mt., 1775 m (both Pekarovič Dipl. práca, Msc., depon. in VŠLD Zvolen: 23a, 30b, 1975) (7082d). – Siná Mt., W slope (7083a). – Siná Mt., SE slope (both Fajmonová Biológia 33/7: 558, tab. 2, 1978) (7083a). – Siná Mt., E slope, 1480 m (Fajmonová Preslia 58/1: 44, tab. 1, 1986) (7083a). – Žiarska hoľa Mt., 48°55′18,44″ N, 19°32′25,34″ E (both Jánošík 2014 BIOM) (7083c). – Dereše Mt., S slope, 1580 m (Šoltésová, Acta Fac. Rer. Natur. 167)
2014 BIOM) (7086d). – Stredná hoľa Mt., 48°54'2,23'' N, 20°7'6,45'' E (Jánošík 2014 BIOM) (7086d).
– „Škutová”, 48°54'11,1'' N, 20°9'33,21'' E (Dukpala 2014 BIOM) (7086d). – from Veľký Brunov lodge up to the top of Kráľova hoľa Mt. (Vartíková 1975 SLO) (7086d-7186b).
– „Škutová”, 48°54'11,1'' N, 20°9'33,21'' E (Dukpala 2014 BIOM) (7086d).
– Nová hoľa Mt., Donovaly (Bačkor 2017 BIOM) (7086d).
– Veľká Sútecká dolina valley, 48°53'56,29'' N, 19°12'7,33'' E (Pirchala 2014 BIOM) (7086d-7186b).
– Stredná hoľa Mt., 48°54'2,23'' N, 20°7'6,45'' E (Jánošík 2014 BIOM) (7086d).
 – „Škutová”, 48°54'11,1'' N, 20°9'33,21'' E (Dukpala 2014 BIOM) (7086d).
– from Veľký Brunov lodge up to the top of Kráľova hoľa Mt. (Vartíková 1975 SLO) (7086d-7186b).
– „Škutová”, 48°54'11,1'' N, 20°9'33,21'' E (Dukpala 2014 BIOM) (7086d).
– Nová hoľa Mt., Donovaly (Bačkor 2017 BIOM) (7086d).
– Veľká Sútecká dolina valley, 48°53'56,29'' N, 19°12'7,33'' E (Pirchala 2014 BIOM) (7086d-7186b).
– Stredná hoľa Mt., 48°54'2,23'' N, 20°7'6,45'' E (Jánošík 2014 BIOM) (7086d).
1911 BP 165567; Dostál 1926 PRC) (6784c). – site Zelenô, slope to the 1st Roháčske pleso tarn, 1635 m (6784c). – site Zelenô, NW slope, 1710 m, 1955 m (Komárková Dipl. práca, Msc., depon. in PrF UK Bratislava: tab. 32, 1964) (6784c). – Smutná dolina valley, couloir below Ostrý Roháč Mt., 1725 m, 49°12′2,3″ N, 19°44′52,8″ E (Ballová Bull. Slov. Bot. Spoločn. 38/1: 94, 2016) (6784c). – Rákoň Mt. – Predná Zábrať Mt. (Školek 2002 BIOM) (6784d). – Smutná dolina valley, avalanche couloir on SW slope of Rákoň Mt., 1540 m (Komárková Dipl. práca, depon. in PrF UK Bratislava: tab. 32, 1964) (6784d). – Smutná dolina valley, below Ostrý Roháč Mt. (Školek 2002 BIOM; Sedláková 2017 BIOM) (6784d). – Smutná dolina valley, slope below Jamnícke sedlo saddle, 1605 m (Komárková Dipl. práca, depon. in PrF UK Bratislava: tab. 32, 1964) (6784d). – near Jamnické pleso tarn (Školek 1976 BIOM) (6784d). – Račkova dolina valley, end, 49°12′2,62″ N, 19°48′12,20″ E (Duchoň 2015 BIOM) (6874d). – Ostrý Roháč Mt., 1600 m (Pax 1905 BP 165596) (6784d-6884b). – Kresanica Mt., 49°13′55,11″ N, 19°54′41,29″ E (Duchoň 2013 BIOM) (6785c). – Tomanova dolina valley, N slope of Poľská Tomanová Mt., cca 1790 m (Šedláčková 1958 BRNU 610181) (6785c). – below Tomanové pleso tarn, 49°13′6,33″ N, 19°54′44,28″ E (Kicková 2015 BIOM) (6785c). – Rozpadlý hrebeň ridge [Rozpadlý Grúň] (Radwanska-Paryska 1946 TNP 2431) (6785d). – Zadná Tichá dolina valley, „Tarišková“, 49°13′38,22″ N, 19°58′56,02″ E (Duchoň 2015 BIOM) (6785d). – Jalovecká dolina valley, below Baníkov Mt., 1200 – 1250 m (Dostál Věda přír. 12: 154, 1931) (6884a). – Parichvost valley, 49°11′46,34″ N, 19°42′18,55″ E (Sedláková 2015 BIOM) (6884a). – Pachoľa Mt. (Sedláková 2018 BIOM) (6884a). – Baníkov Mt. (Školek 1976 BIOM) (6884a). – Smutná dolina valley, below the ridge of Nohavica Mt., 1870 m (Komárková Dipl. práca, depon. in PrF UK Bratislava: tab. 32, 1964) (6884a). – Račkove plesá tarns (Školek 1976) (6884b). – Račková dolina valley, SW slope of Ježová Mt., 1570 m (both Horák Acta scient. 1971/5) (6884b). – Račkova dolina valley, Kotlová Mt. (Školek 1976 BIOM) (6884b). – Bystrá dolina valley, below the ridge of Holý vrch Mt., 1230 m (Domin Carpatica 2b: 7, 1940) (6884c). – Bystrá dolina valley, 49°10′34,11″ N, 19°50′39,52″ E (Duchoň 2015 BIOM) (6884a). – Bystrá dolina valley, Kotonová Mt. (Školek 1976 BIOM) (6885a). – couloir below the ridge Bystrá Mt. – Kotlová Mt., 1760 m (Dúbravcová Dipl. práca, Msc., depon. in PrF UK Bratislava, 1974) (6885a). – Kamenníštá dolina valley, 49°10′14,6″ N, 19°53′6,37″ E (Vyšinský 1975) (6784c). – Tichá dolina valley, Suchý žľab couloir, 1300 m (Štolte Dépr. práca, Msc., depon. in PrF UK Bratislava, 1969) (6885a). – Krížna dolina valley, 49°10′46,3″ N, 19°57′42,6″ E (Duchon 2014 BIOM) (6885b). – Malé Krížne Mt., 1520 m, 1550 m (6885b). – Všiváky Mt., 1555 m, 1565 m (6885b). – Kudrová dolina valley, left side, 1600 m (6885b). – above locality called Kvasničné, 1570 m, 1580 m (all Vidličková Biológia 44/1: 64, tab. 1, 1989) (6885b). – Bystrá dolina valley, bottom (Školek 1976 BIOM) (6885c). 23b. Vysoké Tatry Mts.: Široká dolina valley (Šoltész 2002 BIOM) (6786d). – Žabia Bielovodská dolina valley (Šeffer & Šefferová Biológia 44/1: 47, tab. 1, 1989) (6885b). – Bystrá dolina valley, bottom (Školek 1976 BIOM) (6885c). 23b. Vysoké Tatry Mts.: Široká dolina valley (Šoltész 2002 BIOM) (6786d). – Žabia Bielovodská dolina valley (Šeffer & Šefferová Biológia 44/1: 47, tab. 1, 1989) (6885b). – Bystrá dolina valley, bottom (Školek 1976 BIOM) (6885c). 23b. Vysoké Tatry Mts.: Široká dolina valley (Šoltész 2002 BIOM) (6786d). – Žabia Bielovodská dolina valley (Šeffer & Šefferová Biológia 44/1: 47, tab. 1, 1989) (6885b). – Bystrá dolina valley, bottom (Školek 1976 BIOM) (6885c). 23b. Vysoké Tatry Mts.: Široká dolina valley (Šoltész 2002 BIOM) (6786d). – Žabia Bielovodská dolina valley (Šeffer & Šefferová Biológia 44/1: 47, tab. 1, 1989) (6885b). – Bystrá dolina valley, bottom (Školek 1976 BIOM) (6885c). 23b. Vysoké Tatry Mts.: Široká dolina valley (Šoltész 2002 BIOM) (6786d). – Žabia Bielovodská dolina valley (Šeffer & Šefferová Biológia 44/1: 47, tab. 1, 1989) (6885b). – Bystrá dolina valley, bottom (Školek 1976 BIOM) (6885c). 23b. Vysoké Tatry Mts.: Široká dolina valley (Šoltész 2002 BIOM) (6786d). – Žabia Bielovodská dolina valley (Šeffer & Šefferová Biológia 44/1: 47, tab. 1, 1989) (6885b). – Bystrá dolina valley, bottom (Školek 1976 BIOM) (6885c).
near Nižné Wahlenbergovo pleso tarn, 49°9'38,35" N, 20°1'28,66" E (6886a). – above Nižné Wahlenbergovo pleso tarn, 49°9'33,34" N, 20°1'38,67" E (all Školek 2000) (6886a). – Furkotská dolina valley, ŠtrbskéSolisko Mt., scree below rocky wall, cca 2080 m (Dúbravcová 1991 SLO) (6886a). – Mlynická dolina valley, above Capi pleso tarn (Hodoval 1970 BRA) (6886a). – Mlynická dolina valley, below Capi pleso tarn, 49°9'58,36" N, 20°2'36,65" E (Šoltés 2000 BIOM) (6886a).

– Mlynická dolina valley, Kozie plesá tarns, 49°10'0,3" N, 20°2'29,02" E (Celerová 2014 BIOM) (6886a). – Mlynická dolina valley, below Nižné Kozie pleso tarn, 49°9'34,35" N, 20°2'30,64" E (Šoltés 1999 BIOM, 2001 BIOM) (6886a). – Mlynická dolina valley, from vodopád Skok waterfall to Nižné Kozie pleso tarn, cca 1700 – 1920 m (not. Koprivý 2014) (6886a). – Mlynická dolina valley, below Satan Mt. (Šeffer et Šefferová Biológia 44/1: 47, tab. 1, 1989) (6886a). – Mlynická dolina valley, above vodopád Skok waterfall (Weber 1925 BRA, Dostál 1936 PR 36236) (6886a). – Mengusovská dolina valley, below Žabie pleso tarn, 49°10'18,34" N, 20°3'13,66" E (Šoltés 2002 BIOM) (6886a). – Mengusovská dolina valley, near Žabie pleso tarn outflow (6886a). – Mengusovská dolina valley, below Žabie pleso tarn, 49°9'38,36" N, 20°4'38,64" E (Šoltés 2002 BIOM) (6886a). – below Nižné Bielovodské Žabie pleso tarn, Rysy Mt. (Filarszky & Kümmerle 1909 BP 165492, 539777) (6886b). – Bialčanská [Žabia Bielovodská] dolina valley, below Žabia kopa Mt. (Šoltés 2002 BIOM) (6886b). – between Popradske pleso tarn and Žabie plesá tarns (Galisová 1956 SLO) (6886a). – Popradske pleso tarn (Klein s. dat. BRA; Švestka 1924 BRNU 038624; Ptačovský 1929 SAV) (6886a). – Popradske pleso tarn, 49°9'10,12" N, 20°4'41,12" E (Šoltés 2001 BIOM) (6886a). – between Popradske pleso tarn and Rysy Mt., cca 1700 m (Tuzson 1906 BP 539779) (6886a-b). – above Ťažké pleso tarn, 49°11'24,37" N, 20°6'27,94" E (Šibík 2015 BIOM) (6886b). – Česká [Ťažká] dolina valley, between tarns (Šoltés 2002) (6886b). – above Ťažké pleso tarn, 49°11'10,97" N, 20°6'15,11" E (Šedláková 2015 BIOM) (6886b). – Štiavnica dolina valley (Šoltés 2002 BIOM) (6886b). – Kačacia dolina valley (6886b). – Kačacia dolina valley, near tarn (both Šoltés 2000 BIOM) (6886b). – Kačacia dolina valley, above Kačacie pliesko tarn (Šeffer & Šefferová Biológia 44/1: 47, tab. 1, 1989)
Litvorová dolina valley (Šoltés 2000 BIOM) (6886b). – Zadná Javorová dolina valley (6886b). – Rumanová dolinka valley (both Šoltés 2002 BIOM) (6886b). – Zlomisková dolina valley, Dračia dolinka valley, cca 1850 m (6886b). – Dračia dolinka valley, cca 2000 m (6886b). – Zlomisková dolina valley, cca 1700 m (all Krajina 1928 PRC) (6886b). – Zlomisková dolina valley, 49°9'51,06'' N, 20°6'14,10'' E (Celerová 2015 BIOM) (6886b). – Zlomisková dolina valley, below Zlomisková veža Mt. (Šoltés 2001 BIOM) (6886b). – Zlomisková dolina valley, below Tupá Mt. (Šoltés 2002 BIOM) (6886b). – „Zlomisková roveň“ (Šoltés 2001 BIOM) (6886b). – Zlomisková dolina valley, near Ľadový potok brook (Šeffer & Šefferová Biológia 44/1: 47, tab. 1, 1989) (6886b). – Zlomisková dolina valley, Ľadové pleso tarn (Futák 1943 SLO) (6886b). – Tupá Mt., S slope, cca 2000 – 2100 m (Dostál, 1935 PRC) (6886b). – Velická dolina valley, below Guľatý kopec Mt. (Šeffer & Šefferová Biológia 44/1: 47, tab. 1, 1989; Šoltés 2000 BIOM) (6886b). – above Dlhé pleso tarn, 49°10'9,07'' N, 20°8'14,21'' E (Sedláková 2015 BIOM) (6886b). – above Velické pleso tarn, 1750 m (not. Michalčik 2016) (6886b). – Velická dolina valley, herbaceous meadow in upper part (Sillinger 1925 PR 123473) (6886b). – Velická dolina valley, 1750 m (not. Maršalek 2015 BIOM) (6886b). – Važecká dolina valley (Thaisz 1912 BP 165531) (6886c). – Važecká dolina valley, „Zadný Handel“ (Školek 2001 BIOM) (6886c). – Važecká dolina valley, mouth of Suchá voda valley (Školek 2001 BIOM) (6886c). – Ostrá Mt., 49°8'36,18'' N, 20°1'13,21'' E (Lipták 2015 BIOM) (6886c). – Furkotská dolina valley, near tourist signpost „Škutnastá polana“, next to Furkotský potok brook, cca 1770 m (not. Koprivý 2014) (6886c). – „Škutnastá polana“, 49°8'24,71'' N, 20°1'58,28'' E (Maršálek 2015 BIOM) (6886c). – between tourist signpost „Škutnastá polana“ and Chata pod Soliskom chalet, cca 1800 m, 49°8'42,9'' N, 20°1'13,78'' E (not. Koprivý 2014) (6886c). – below Predné Solisko Mt., 49°8'55,68'' N, 20°9'55,68'' E (Celerová 2014 BIOM; Škibík 2015 BIOM) (6886c). – Veľká Studená dolina valley, 1600 m (Margittai 1915 BP 483923) (6886c). – Patria Mt., 49°8'45,09'' N, 20°4'6,47'' E (Maršálek 2015 BIOM) (6886c). – above
Štrbské pleso tarn, cca 1700 m (Širjaev 1925 BRNU 058933) (6886c). – Trigan Mt., 49°8'44,62'' N, 20°4'8,42'' E (Maršalek 2015 BIOM) (6886c). – crossroads towards Popradské pleso tarn, 49°7'0,03'' N, 20°4'51,81'' E (Figura 2015 BIOM) (6886c). – towards Popradské pleso tarn (Domin 1919 PRC) (6886c). – Nové Štrbské pleso tarn (Gombocz 1929 BP 165528) (6886c). – Štôlska dolina valley, 49°8'50,47'' N, 20°6'35,59'' E (Šibík 2014 BIOM) (6886d). – Štôlska dolina valley, slope of Túpá Mt. (6886d). – bottom of Batizovská dolina valley (both Šoltés 2001 BIOM) (6886d). – ridge between Velická dolina valley and Batizovská dolina valley, 1520 m (Manica Záver. správa Zvolen: 81, 1973) (6886d). – below Mačacia veža Mt., cca 2350 m (Kümmerle 1928 BP 165530) (6887a). – Slavkovská dolinka valley (Lengyel 1930 BP 274756; Paclová 1954 TNP 10077) (6887a). – below Slavkovský štít Mt. (6887a). – mountainside of Slavkovský štít Mt., 1650 m (Šoltésová Acta Fac. Rer. Natur. Univ. Comen. Bot. 23: tab. 3, 1974) (6887a). – Veľká Studená dolina valley (Štehlo 1876 BP 165495; Nyárády 1906 BP 462062; Lengyel 1913 BP 274769) (6887a). – Javorový štít Mt. – Prostredný hrebeň ridge (Šoltés 2001 BIOM) (6887a). – Veľká Studená dolina valley, below Žltá stena (Šoltés 2002 BIOM; Sedláková 2013 BIOM). (6887a). – Malá Studená dolina valley, above Chata kpt. Nálepku [= Zamkovského chata] chalet (Soják 1955 PR 562904) (6887a). – Studená dolina valley (Kržišč 1859 BP 165529; Greschik 1886 SLO; Winkler 1899 BP 165599; Brym 1923 PRC; Švestka 1925 BRNM; Tetmayer 1961 BP 366947) (6887a). – Hrebienok, below ski-lift, 1294 m (Podroužková Medvecká Bull. Slov. Bot. Spoločn. 33/1: 113 2011) (6887a). – towards Skalnaté pleso tarn, cca 1 km from Štart, 1155 m (Šoltés Dipl. práca, depon. in PrF UK Bratislava, 1969) (6887b). – Tatranská Lomnica settlement (s. coll. 1925 PRC) (6887b). 23c. Belianske Tatry Mts.: Kýčera Mt., 49°16'21,29'' N, 20°9'48,45'' E (Lipták 2015 BIOM) (6786b). – below Koň Mt., 49°15'32,44'' N, 20°9'35,87'' E (Maršalek 2015 BIOM) (6786b). – Holica Mt., 49°14'43,70'' N, 20°7'9,54'' E (Maršalek 2015 BIOM) (6786d). – „Genšia šija”, 49°14'26,05'' N, 20°7'43,99'' E (Lipták 2015 BIOM) (6786d). – Podšpády settlement, ridge of Havran Mt., 1030 m (Šomšák Biol. Práce 32/4: 79, tab. 7, 1986) (6787a). – Javorinka Mt., near Podšpády settlement (Domin & Krajina 1925 PRC) (6787a). – near Biela brook, 900 – 950 m (Vašák 1967 PR 292192) (6787a). – valley between Muráň Mt. and Nový vrch Mt., cca 1100 m (Domin Věda přír. 3: 98, 1922) (6787a).
49°15'11,65'' N, 20°10'49,91'' E (Sedláková 2014 BIOM) (6787a). – Haaven Mt., N slope, cca 1600 – 2150 m (Klástersky & Mésiček 1959 PR 292180) (6787a). – below the saddle between Nový vrch Mt. and Haaven Mt. (Domin Věda přír. 3: 166-167, 1922; Domin Tatranská květěna: 15, 1928) (6787a). – Tristárska dolina valley, 1600 – 1650 m (Mikoláš 2009 W) (6787a). – Belgášovská Javorinka Mt., 1150 – 1210 m (6787b). – Belgášovská Javorinka Mt., towards Tokárska dolina valley, opposite to Solnisko, 1200 – 1100 m (both Domin Carpatica 2b: 13, 1940) (6787b). – Tokářeň (Simonkai 1890 BP 165562) (6787b). – below Tokářeň, 970 m (Šomšák Biol. Práce 32/4: 53, tab. 4, 1986) (6787b).

– Čuba Mt. [= Kýčera Mt.], NW slope, cca 1100 m (Domin & Krajina 1925 PRC) (6787a). – below the saddle between Nový vrch Mt. and Ždiarska Vidlá Mt., 1485 – 1495 m, 1665 – 1710 m (Domin Rozpr. 2. Tř. čes. Akad. 34/19: 9, 1925) (6787c). – Ždiarska vidla Mt., 1950 – 2000 m (Mikoláš 2006 W) (6787c). – Predne Koperšady valley [= Predné Medodoly] and Zadné Koperšady valley [= Zadné Medodoly] (Krajina Věda přír. 6: 137, 1925) (6787c). – Monkova dolina valley, „Široký úplaz”, cca 1500 m (not. Dudáš 2014) (6787c). – Malý Čosek Mt., 49°15’56,35” N, 20°14’13,77” E (Lipták 2015 BIOM) (6787c). – Javorinská dolina valley, 1550 m (Domin Věda přír. 3: 94, 1922) (6787c). – Kopa Mt., grasslands near upper limit of spruce forest (Domin Věda přír. 3: 51, 1922) (6787c). – Faixova lúka meadow, on N slope of the spot height 1605, cca 1550 m (Müller 1946 BRNU 335844) (6787d). – site Červená hlina, spruce forest, cca 1270 m (Futák 1961 SAV) (6787d). – Dolina Siedmich prameňov valley (Hazslinszky s. dat. BP 165526; Filarszky 1900 BP 165558; Pacllová & Rybárska 1969 SLO) (6787d). – Faixová skala Mt., above 1450 m (Domin Rozpr. 2. Tř. čes. Akad. 34/19: 9, 1925) (6787d). – Faixova lúka meadow, on N slope of the spot height 1605, cca 1550 m (Müller 1946 BRNU 335844) (6787d). – site Červená hlina, spruce forest, cca 1270 m (Futák 1961 SAV) (6787d). – Suchá dolina valley, 1130 m, 1150 m (Šoltsésova Acta Fac. Ren. Natur. Univ. Comen. Bot. 23: tab. 3, 1974) (6787d). – Faixová skala Mt., above 1450 m (Domin Rozpr. 2. Tř. čes. Akad. 34/19: 9, 1925) (6787d). – Faixova lúka meadow, on N slope of the spot height 1605, cca 1550 m (Müller 1946 BRNU 335844) (6787d). – site Červená hlina, spruce forest, cca 1270 m (Futák 1961 SAV) (6787d). – Dolina Siedmich prameňov valley (Hazslinszky s. dat. BP 165526; Filarszky 1900 BP 165558; Pacllová & Rybárska 1969 SLO) (6787d). – Tatranská Kotlina settlement (Greschik 1891 BRA; Jávorka 1955 BP 234598) (6787d). – Tatranská Kotlina settlement, towards the cave (Galisová 1956 SLO) (6787d). – Suchá dolina valley near Tatranská Kotlina settlement (Futák 1953 SLO) (6787d). 24. Pienniny Mts.: mountainside of Holica Mt., above Dunajec river (6588d). – below Vápeník rock (both Benčatová Cievnaté rastliny Pienin: 12, 2001) (6687d). 25. Turčianska kotlina basin: humid meadows 2 km NW from the Blatnica village, 48°56’53,49” N, 18°55’53,02” E (lit. Bernátová 1976 BIOM) (7079d). 26a. Liptovská kotlina basin: between Kokavský most bridge and Hrdovo settlement, cca 855 m (Vrlíková 1975 SLO) (6885c). 26b. Spišské kotlín basin: Nižné Hágy settlement, 900 m (not. Michalko 1970) (6886d). – Štrba village (Černý 1924 BRA) (6986a). – Spišská Teplica village (Oklozilová 1956 TNP 1435) (6987c). 28. Západné Beskydy Mts.: below Piško Mt., above „Tajch”, 49°31’47,43” N, 19°18’15,6” E (Pavlíšin 2013 BIOM) (6481d). – Babia hora Mt., near Bystrá brook, cca 995 m, 980 m (Migrupa 1974 SLO) (6482b-6483a-c). – Babia hora Mt., in lower mountain degree (6482b-6483a-c). – Babia hora Mt., in subalpine zone (Migrupa Dipl. práca, Msc., depon in. PrF UK Bratislava 1977) (6483a). – Veľká Rača massif., ridge near ski-lift (Magic Spr. z výsk. a invent. prác. na 13. TOPe: 8, 9, 1978) (6579d). – Veľká Rača Mt.,
49°25'30,84'' N, 18°59'12,64'' E (Vnuk 2014 BIOM; Rizman 2015 BIOM) (6579d). – Rycierova hora Mt., 49°24'53,71'' N, 19°5'31,62'' E (Rizman 2015 BIOM) (6580d). – Veľká Rača massif, near the spot height Bednárová (1093 m) (6580d). – Veľká Rača massif, spot height Bugaj (1139 m) (both Magic Spr. z výsk. a invent. prác. na 13. TOPe: 8, 9, 1978) (6680a). – NR Javorinka, 49°18'53,99'' N, 19°8'27,49'' E (Pietorová 2010 BIOM) (6680d). – Lokca village, 49°22'32,93'' N, 19°22'50,05'' E (Rizman 2015 BIOM) (6682a). – Kubínska hoľa Mt., valley W from the cottage (Michalko 1954 SAV) (6781b). – Hrčova Kečka Mt., 49°14'42,38'' N, 19°10'46,42'' E (Vyšinský 2015 BIOM) (6781c).

29. Spišské vrchy Mts.: Tatranská Javorina settlement, SE part of Chovancov vrch Mt., 960 m (Šomšák Biol. Práce 32/4:p. 103, tab. 9, 1986) (6786b). – SW from Repisko Mt., 950 m (6787a). – below Príslop Mt. (6787a). – Ždiar village, Belá brook, S from the spot height 1086, 830 m (all Šomšák Biol. Práce 32/4: 79, tab. 7, 1986) (6787b). – Pálenica Mt., near Belanské kúpele spa (Klášterský 1925 PR 292190) (6787d). – Pálenica Mt., 900 m (Šomšák Biol. Práce 32/4: 53, tab. 4, 1986) (6787d). – Ihla Mt. (Vraný 1885, 1887, BRA; Simonkai 1908 BP 165561) (6889b). – Jankovec Mt. (Greschik 1915 SLO) (6889d).

30b. Čergov Mts.: Livovská Huta, spot height 1127,2, NE slope (Kliment Ochrana prírody 16: 110, 1998) (6791d). – between Majdan settlement and spot height Priehyba (822m) (6792d). – Drienica, 1,2 km SW from Lysá Mt., near the stream, 780 m (both Sofron Zbor. Východoslov. Múz., ser. AB, prír. vedy XVI: 66, 1975) (6892b). Carpaticum orientale.

31. Bukovské vrchy Mts.: abandoned village Ruské, NR Pľaša (Dostál Zborn. Východoslov. Múz. 20: 248, 1979) (68100c). – below the ridge of Pľaša Mt. (Dostál Zborn. Východoslov. Múz. 27: 34, 35, 1986) (68100c). – Pľaša Mt., 1070 – 1125 m (Hadač, Terray et al. Kvet. Bukov. vrchov: 127, 1991) (68100c). – spot height 1112 between Pľaša Mt. and Ďurkovec Mt. (Soják Preslia 31/3: 308, 1959; Soják 1962 PR 561265; Hadač, Terray et al. Kvet. Bukov. vrchov: 127, 1991) (68100c). – ridge between Pľaša Mt. and Ďurkovec Mt. (Hadač, Terray et al. Kvet. Bukov. vrchov: 127, 1991) (68100c-d). – meadow on Kýčera Mt., spot height 855 (Soják 1957 PR 561264; Soják Preslia 31/3: 308, 1959) (69101a). – near cabin below Kýčera Mt. (Hadač, Terray et al. Kvet. Bukov. Vrchov: 127, 1991) (69101a).

General data (not mapped)

15. Slovenské rudohorie Mts.: very rare species of Volovské vrchy Mts. (Mráz & Mikoláš Bull. Slov. Bot. Spoločn. 18: 166, 1996). 21b. Krivánska Malá Fatra Mts.: Krivánska Malá Fatra Mts. (Bělohlávková & Fišerová Folia Geobot. Phytotax. 24/1:p. 6, tab. 1, 1989). 21c. Veľká Fatra Mts.: Veľká Fatra Mts. (Bělohlávková & Fišerová Folia Geobot. Phytotax. 24/1: 6, tab. 1, 1989). 22. Nízke Tatry Mts.: Nízke Tatry Mts. (Bělohlávková & Fišerová Folia Geobot. Phytotax. 24/1: 6, tab. 1, 1989). 23. Tatry Mts.: Tatry Mts. (Borbás 1878 BP 731294; Faustusi 1888 PRC; Studnička 1888 PR; Hazslinszky s. dato BP 165560, 165572). 23b. Vysoké Tatry Mts.: Vysoké Tatry Mts. (Greschik 1884 SLO; Ginzery 1904 BRA; Greschik 1910 SLO; s. coll. s. dato BRA). 23c. Belianske Tatry Mts.: Belianske Tatry Mts. (Bělohlávková & Fišerová Folia Geobot. Phytotax. 24/1: 6, tab. 1, 1989). – Belianske Tatry Mts., in 2050 m (Domin Naše Tatry II: 131, 1931). – spruce forest in the valley, cca 1000 m (Domin Tatranská květěna: 11, 1928). 24. Pieniny Mts.: Pieniny Mts. (Domin 1920 PRC). 28. Západné Beskydy Mts.: in fir-beech forest in flysch parts of Orava region (Vološčuk Acta Botanica Slovaca 4: 112, 1978). 29. Spišské vrchy Mts.: in subalpine forests of Levočsko – Lúbovnianske vrchy Mts. (Greschik 1894 SLO). – on glades in subalpine forests of Levočsko – Lúbovnianske vrchy Mts. (Greschik 1889 SLO).
Plant material for cytometric analyses:

1. Central Slovakia, Stolické vrchy Mts., Stolica Mt., 48°46'40" N, 20°12'48" E, 5 July 2014, leg. Koprivý, KO 32196-32198 (3 accessions); 2. Central Slovakia, Stolické vrchy Mts., Kohút Mt., 48°44'33,6" N, 20°11'21,9" E, 21 July 2014, leg. Koprivý, KO 32202-32204 (3 accessions); 3. Central Slovakia, Stolické vrchy Mts., Malý Kohút Mt., 48°43'23,88" N, 20°10'40,87" E, 23 May 2015, leg. Koprivý, KO 32199-32201 (3 accessions); 4. Central Slovakia, Stolické vrchy Mts., Trsteník Mt., 48°51'31,7" N, 20°14'23,7" E, 24 May 2015, leg. Koprivý, KO 32193-32195 (3 accessions); 5. Central Slovakia, Slovenský raj Mts., Ondrejisko Mt., 48°51'9,8" N, 20°15'16,8" E, 24 May 2015, leg. Koprivý, KO 32190-32192 (3 accessions).

Seed material from natural populations:

1. Central Slovakia, Stolické vrchy Mts., Stolica Mt., 48°46'33,2" N, 20°12'14,74" E, 6 August 2015, leg. Koprivý (5 accessions); 2. Central Slovakia, Nízke Tatry Mts., Trangoška, 48°55'33,61" N, 19°37'12,15" E, 21 August 2015, leg. Koprivý (7 accessions); 3. Central Slovakia, Stolické vrchy Mts., Kohút Mt., 48°44'33,6" N, 20°11'21,9" E, 23 August 2015, leg. Koprivý (7 accessions).