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Plant communities of the alliance *Calamagrostion arundinaceae* in the Krivánska Malá Fatra Mts

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Abstract: The aim of this paper is to refer the results of phytosociogical research of the plant communities within the alliance *Calamagrostion arundinaceae* in the Krivánska Malá Fatra Mts. For the first time, the phytosociogical relevés of the associations *Digitali ambiguae-Calamagrostietum arundinaceae* and *Allio victorialis-Calamagrostietum villosae* are published from the studied area. The short synmorphological, synecological and synchorological characteristics are given, respecting the regional traits. The literary review is discussed, as well.

Keywords: *Mulgedio-Aconitetea*, phytosociology, subalpine belt, tall-grass communities, Western Carpathians.

Introduction

Plant communities dominated by *Calamagrostis arundinacea* or *Calamagrostis villosa* represent the characteristic vegetation type of the subalpine meadows in the Krivánska Malá Fatra Mts and hence it is surprising, that so far only one phytosociological relevé dominated by *Calamagrostis arundinacea* was published from this region and none dominated by *Calamagrostis villosa*. Therefore we would like to contribute to current state of knowledge of these communities, to provide the information about their occurrence and to continue in comparable studies (cf. ŠIBÍK et al. 2004, KRAJČIOVÁ-ŠIBÍKOVÁ et al. 2005, ŠIBÍKOVÁ et al. 2007, 2008a, b, c, d) regarding the flora and vegetation of the Krivánska Malá Fatra Mts.

Material and methods

The survey is based on the analysis of phytosociological data obtained during the field research in the Krivánska Malá Fatra Mts, mostly in 2003 – 2005 (cf. ŠIBÍKOVÁ 2006), and also excerpted from Slovak National Vegetation Database (http://ibot.sav.sk/cdf; see ŠIBÍKOVÁ et al. 2009). The data set of 209 relevés was analysed and the local diagnostic taxa were determined using the results of numerical classification and ordination. The presented results have been part of the diploma thesis by ŠIBÍKOVÁ (2006).

All relevés were gained following standard procedures of the Zürich-Montpellier School (BRAUN-BLANQUET 1964, WESTHOFF & VAN DEN MAAREL 1978) using the modified 9-degree Braun-Blanquet's sampling scale (BARKMAN et al. 1964) and stored in a TURBOVEG database (HENNEKENS & SCHAMINÉE 2001). Older relevés by Bělohlávková (BĚLOHLÁVKOVÁ 1980) used 7-degree Old Braun-Blanquet's sampling scale (BRAUN-BLANQUET 1964).

Numerical classification was performed using the program PC-ORD (MCCUNE & MEFFORD 1999). The Group average method with Euclidian distance similarity coefficient was used. To decrease the difference between close values of higher absolute cover (cf. LEPŠ & ŠMILAUER 2000, HERBEN & MÜNZBERGOVÁ 2003), data were transformed by square root transformation. Tables were generated in JUICE 6.4, the software for analysis and classification of ecological data (TICHÝ 2002) and finally arranged in the programme Microsoft Word. The unpublished relevés by older authors (mainly Bělohlávková) are not presented in final tables. In the tables (columns) with few relevés (< 5) the frequency (F) was replaced by the values of presence (*P*) of individual taxa. Diagnostic groups of species have local applicability, since they reflect the results of the analysis of data gained only from the area of the Krivánska Malá Fatra Mts (cf. ŠIBÍKOVÁ 2006, ŠIBÍKOVÁ et al. 2008d). Within them, the diagnostic species (fidelity value ≥ 0,30), constant species (frequency ≥ 60 %) and dominant species (cover > 50 %) were determined, corresponding the results of numerical analysis of tall-grass and tall-forb plant communities of the Krivánska Malá Fatra Mts (cf. ŠIBÍKOVÁ 2006, ŠIBÍKOVÁ et al. 2008d). Diagnostic species for individual communities of the Krivánska Malá Fatra Mts are discussed and compared with the results of the syntaxonomical revision of tall-grass vegetation from the area of Western Carpathians (KLIMENT et al. 2007a).

The values of pH were measured according to HRAŠKO et al. (1962). The geological bedrock was identified on the basis of Regional Geological Maps of the Slovak Republic (HAŠKO & POLÁK 1980).

The nomenclature of the taxa generally follows the Checklist by MARHOLD & HINDÁK (1998). The subspecies (given without the species name) are marked with asterisks (*). The names of syntaxa follow the outline of KLIMENT et al. (2007b). Abbreviations are used in the text as follows: agg. = aggregate taxon, cf. = compare, D = dominant species, I = diagnostic species, C = constant species, sp. div. = various species, r. = relevé. Abbreviations of the syntaxa names used in tables are: **aa** *Adenostylion alliariae*, **ca** *Calamagrostion arundinaceae*, **cr** *Calamagrostion variae*, **cv** *Calamagrostion villosae*, **de**

Delphinenion elati, **fc** *Festucion carpaticae*, **pm** *Pinion mugo*, **po** *Petasition officinalis*, **sa** *Astero alpini-Seslerion calcariae*, **ss** *Salicion silesiacae*, **st** *Seslerion tatrae*, **tf** *Trisetion fusci*, **Cv** *Calamagrostietalia villosae*, **Pc** *Potentilletalia caulescentis*, **ES** *Elyno-Seslerietea*, **LV** *Loiseleurio-Vaccinietea*, **MC** *Montio-Cardaminetea*, **MU** *Mulgedio-Aconitetea*, **NS** *Nardetea strictae*. Abbreviations of the authors′ names of relevés: ZD = Zuzana Dúbravcová, IJ = Ivan Jarolímek, JK = Ján Kliment, IŠ = Ivana Krajčiová-Šibíková, JŠ = Jozef Šibík.

Short literary overview

The ***Digitali ambiguae-Calamagrostietum arundinaceae*** has been documented from the Krivánska Malá Fatra Mts by a single relevé made by Kliment (1997, ined.). The association was for the first time described by SILLINGER (1933) from the Nízke Tatry Mts as subxerophilous phytocoenoses occupying straggly, rather small stands on non-calcareous bedrock. In the study about vegetation of the Poloniny Mts, KUČEROVÁ & JENÍK (1963) recorded its occurrence on the crest of Mt. Riaba skala. They characterised it as moderately subthermophilous community, the stands of which occupy the borders of rock crests edges, terraced overhangs and enclaves in glens or slopes. KLIMENT (1995) pointed out the fact, that many authors had incorrectly included into this association also the secondary stands of pastures and clearings dominated by *Calamagrostis arundinacea* and with prospective occurrence of name-giving taxon *Digitalis grandiflora*. KLIMENT et al. (2004a) in their study about plant communities of the *Calamagrostion arundinaceae* in the Bukovské vrchy Mts refer to its close relations particularly to the natural (primary) non-forest stands in higher altitudes of montane belt, on south slopes under the peak of Mt. Riaba skala. Similar proceedings concerning smaller geographical areas were published from the Muránska planina Mts (KLIMENT 2004a) and the Nízke Tatry Mts (KLIMENT 2004b). The corresponding phytocoenoses were described by KLIMENT (1998), using the name *Senecioni fuchsii-Calamagrostietum arundinaceae* (Sillinger 1933) Hadač in Mucina et Maglocký 1985. In comparable vegetation type, BERNÁTOVÁ (1986) recorded the occurrence of rare species *Erysimum hungaricum* in the Veľká Fatra Mts. Based on the results of larger syntaxonomical revision of plant communities dominated by *Calamagrostis arundinacea* in Slovakia (KLIMENT & JAROLÍMEK 2003), the authors emphasized the inclusion of latter stands into the association *Digitali ambiguae-Calamagrostietum arundinaceae*.

The ***Helianthemo grandiflorae-Calamagrostietum arundinaceae*** was described by HADAČ et al. (1969) from Dolina Siedmich prameňov Valley in the Belianske Tatry Mts. ŠMARDA et al. (1971) recorded the community from the same area under the name *Calamagrostietum arundinaceae mughicolum* Šmarda 1958 and assumed that it had arose on southern to south-eastern slopes in the dwarf pine belt after disposing the dwarf pine stands. Within the syntaxonomical revision of plant communities dominated by *Calamagrostis arundinacea* KLIMENT & JAROLÍMEK (2003) briefly refer the association

Helianthemo grandiflorae-Calamagrostietum arundinaceae as well. ŠIBÍK et al. (2004) adduced in their article a phytosociological relevé of this community to document the altitude maximum of the occurrence of *Asarum europaeum* in Slovakia. It is the first published relevé supporting the occurrence of the association not only from the area of the Krivánska Malá Fatra Mts, but also the first outside the Belianske Tatry Mts.

The name of the ***Potentillo aurei-Calamagrostietum arundinaceae*** was validly published by KLIMENT (1993) with the description coming out from the study of subalpine meadows of the Veľká Fatra Mts and Mt. Zvolen. It was characterised as enclave-forming, with deep, wet, humid and densely rooted soils on marly limestone. He considered it as a secondary plant community, natural spread after deforesting of higher altitudes of the mountain. BĚLOHLÁVKOVÁ (1980) in her study about the Krivánska Malá Fatra Mts described these phytocoenoses under the invalid name (according to the article 1 of the International Code of Phytosociological Nomenclature, WEBER et al. 2000) *Doronico austriaci-Calamagrostietum arundinaceae* Jeník et Kubíková ex Bělohlávková 1980. On the basis of numerical analyses of plant communities of the *Mulgedio-Aconitetea* and occurrence of diagnostic species, we consider these phytocoenoses as the part of the *Potentillo aurei-Calamagrostietum arundinaceae*, which was not so far recorded outside the area of the Veľká Fatra Mts.

The ***Allio victorialis-Calamagrostietum villosae*** was validly described by KLIMENT (1997) from the Veľká Fatra Mts, from the stands with marly limestone bedrock. The author pointed out the fact that the phytocoenoses considerably differ in floristic composition and their ecology from other communities of the *Calamagrostion villosae*. Later, taking into account the results of extensive syntaxonomic revision of West Carpathian vegetation (KLIMENT et al. 2004b), the association was included into the alliance *Calamagrostion arundinaceae*, where it encroaches a marginal position towards the communities of the *Calamagrostion villosae*. BĚLOHLÁVKOVÁ (1980) described similar phytocoenoses from the Krivánska Malá Fatra Mts under invalid name (according to the article 1 of the International Code of Phytosociological Nomenclature, WEBER et al. 2000) *Pleurozio schreberi-Calamagrostietum villosae* Jeník et Kubíková ex Bělohlávková 1980. Considering the numerical comparison (cf. ŠIBÍKOVÁ 2006), these phytocoenoses were included into the *Allio victorialis-Calamagrostietum villosae*. ŠIBÍK (2003) in his diploma thesis confirmed the occurrence of this association in the Krivánska Malá Fatra Mts, as well. He also presented one phytosociological relevé, which he ordered into the *Vaccinio myrtilli-Calamagrostietum villosae* Sillinger 1933. Despite the absence of characteristic taxa *Allium victorialis*, this relevé should be also included into the *Allio victorialis-Calamagrostietum villosae*. The association *Vaccinio myrtilli-Calamagrostietum villosae* does not occur in the Krivánska Malá Fatra Mts. This community is strictly bound to the granite parts of the Nízke, Západné and Vysoké Tatry Mts (cf. KLIMENT et al. 2007a).

Results and discussion

The numerical analysis

The dendrogram of numerical analysis of the phytocoenoses of the class *Mulgedio-Aconitetea*, including the alliance *Calamagrostion arundinaceae*, is presented in the study ŠIBÍKOVÁ (2006) and ŠIBÍKOVÁ et al. (2008d). In this contribution, we present the results of numerical analysis of the communities dominated by *Calamagrostis arundinacea*. The Group average method with Euclidean distance similarity coefficient was used. It most clearly shows the differences between particular groups (Fig. 1).

On the highest level of dissimilarity, the only relevé from the association *Digitali ambiguae-Calamagrostietum arundinaceae* (Fig. 1, cluster C) is aggregated with the rest of the relevés. As the next, the cluster A, which comprises the phytocoenoses of the association *Helianthemo grandiflorae-Calamagrostietum arundinaceae*, was formed. Relevé Nr. 2 (in the text) is aggregated on high level of dissimilarity with other relevés of cluster A (Fig. 1, the most left relevé marked by asterisk – *) and represents an intermediate relevé between associations *Helianthemo-Calamagrostietum arundinaceae* and *Potentillo aurei-Calamagrostietum arundinaceae*. The latter association is represented by the cluster B and when other coefficients of similarity were used, the transitory relevé was aggregated to this association, as well. The occurrence of the latter is presented from the Krivánska Malá Fatra Mts for the first time.

The characteristics of the tall-grass plant communities from the Krivánska Malá Fatra Mts

***Mulgedio-Aconitetea* Hadač et Klika in Klika 1948**

Tall-herb communities in the montane to alpine belt

***Calamagrostietalia villosae* Pawłowski et al. 1928**

Tall-grass communities of mesophilous high mountain meadows in the subalpine and alpine belt

***Calamagrostion arundinaceae* (Luquet 1926) Jeník 1961**

Tall-grass species-rich communities on drier and warmer slopes in the supramontane and subalpine belt

1. *Digitali ambiguae-Calamagrostietum arundinaceae* Sillinger 1933

Dominant species: *Calamagrostis arundinacea*

Species-rich, tall-grass plant community. Its typical aspect is given by the occurrence of many species with apparent flowers, such as *Aconitum variegatum*, *Campanula elliptica*, *Cyanus mollis*, or *Solidago *minuta*. The proximity of forests often causes the occurrence of some forest species, e.g. *Fragaria vesca*, *Galium schultesii*, *Melica nutans*, *Origanum vulgare* or *Rubus idaeus* (cf. KLIMENT 2004b). The main herb layer is except the dominant *Calamagrostis arundinacea* composed mostly by name-giving *Digitalis grandiflora* and by (sub)species *Carex *tatrorum*, *Cirsium erisithales*, *Festuca*

tatrae, *Geranium sylvaticum* and *Hypericum maculatum*. The lower herb layer is usually underdeveloped; the cryptogam layer is missing in presented relevé.

The presented relevé from the Krivánska Malá Fatra Mts differs from typical West Carpathian phytocoenoses by absence of some differential species adduced by KLIMENT et al. 2004b; e.g. *Adenostyles alliariae*, *Campanula rapunculoides*, *Epilobium montanum*, *Melampyrum sylvaticum*, *Pulmonaria obscura*, *Sorbus *glabrata* and *Urtica dioica* or constant species, such as *Gentiana asclepiadea*, *Luzula *rubella* and *Poa nemoralis*.

The phytocoenoses occur mainly on the footslopes of scree-cones below the cirques or side slopes of avalanche paths on steep, rocky slopes, where moderately deep, skeletal, densely rooted soils (KLIMENT 1998) developed. The stands are usually protected by the thick snow cover in winter – up to 140 cm (KLIMENT 1995). The presented relevé was recorded in the canopy gap in dwarf pine stands, on south-eastern steep (45°) rocky crest with rocks and stone steps.

This association is supported from the area of the Krivánska Malá Fatra Mts by only one phytosociological relevé recorded by Kliment (see below). On the basis of floristic composition and ecological characteristics, the relevé was assigned to the subassociation *Digitali ambiguae-Calamagrostietum arundinaceae luzuletosum sylvaticae* Kliment et Jarolímek 2003.

Relevé 1

Locality: the Krivánska Malá Fatra Mts, between Mt. Suchý and Mt. Ťavie chrbty, southern slopes near the saddle below Suchý Mt, ellipsoid canopy gap (ca 15 × 20 m) in dwarf pine stands, convex rocky crest with rocks and stone steps; elevation: 1 390 m a s. l.; aspect: SE, inclination: 45°, bedrock: limestone, area: 24 m^2, total cover: 90 %, cover E_1: 90 %, cover E_0: 0 %; 21. 8. 1997; JK.

E_1: *Calamagrostis arundinacea*[2] 4, *Carex *tatrorum* 2b, *Carlina acaulis* 2a, *Clinopodium vulgare* 2a, *Cyanus mollis* 2a, *Digitalis grandiflora*[2] 2a, *Festuca tatrae* 2a, *Fragaria vesca*[2] 2a, *Knautia arvensis* 2a, *Pimpinella *rhodochlamys* 2a, *Ranunculus nemorosus* 2a, *Achillea *alpestris* 1, *Aconitum variegatum* 1, *Bupleurum longifolium* 1, *Campanula elliptica* 1, *C. serrata* 1, *Cirsium erisithales*[2] 1, *Galium anisophyllon* 1, *Geranium sylvaticum*[2] 1, *Laserpitium latifolium* 1, *Leucanthemum margaritae* 1, *Phleum hirsutum* 1, *Phyteuma orbiculare* 1, *Rubus saxatilis* 1, *Scabiosa lucida* 1, *Silene vulgaris* 1, *Ajuga reptans* +, *Alchemilla crinita* +, *Arabis sagittata* +, *Asarum europaeum* +, *Briza media* +, *Cardaminopsis borbasii* +, *Carex flacca* +, *Dactylis *slovenica* +, *Dryopteris filix-mas*[1] +, *Festuca carpatica* +, *Galium schultesii*[1] +, *Heracleum sphondylium* +, *Hieracium bifidum* +, *H. lachenalii* +, *Hypericum maculatum*[2] +, *Jovibarba *hirta* +, *Knautia maxima*[2] +, *Lathyrus vernus* +, *Lilium martagon* +, *Linum catharticum* +, *Lotus corniculatus* +, *Melica nutans*[1] +, *Origanum vulgare* +, *Poa chaixii* +, *Polygonatum verticillatum* +, *Polystichum lonchitis* +, *Potentilla aurea* +, *Primula elatior* +, *Roegneria canina* +, *Rubus idaeus*[1] +, *Senecio hercynicus*[1] +, *Sesleria albicans* +, *Solidago *minuta* +, *Stachys alpina* +, *Thymus alpestris* +, *Tragopogon orientalis* +, *Trifolium * kotulae* +, *Trisetum alpestre* +, *Veronica chamaedrys* +, *Vicia oreophila* +, *Carduus personata* r, *Crepis mollis* r, *Cystopteris fragilis* r, *Hypericum hirsutum* r, *Prunella grandiflora* r, *Tithymalus amygdaloides* r.

[1] species defined by KLIMENT et al. (2007a) as differential
[2] species defined by KLIMENT et al. (2007a) as constant

2. *Helianthemo grandiflorae-Calamagrostietum arundinaceae* Hadač et al. 1969 (Tab. 1)

Diagnostic group of species
Diagnostic species: *Allium *montanum*[2], *Asarum europaeum*, *Dianthus carthusianorum*, *Fragaria vesca*, *Rubus saxatilis*
Constant species: *Achillea *alpestris*[3], *Calamagrostis arundinacea*, *Campanula elliptica*[3], *C. serrata*, *Cardaminopsis arenosa* agg., *Carlina acaulis*[3], *Cirsium erisithales*[3], *Crepis mollis*[3], *Epilobium alpestre*, *Festuca carpatica*[2], *Geranium sylvaticum*[3], *Heracleum sphondylium*, *Knautia arvensis* agg., *Linum extraaxillare*[3], *Luzula *rubella*[3], *Potentilla crantzii*[1], *Sesleria tatrae*[2], *Trisetum flavescens*[2]
Dominant species: *Calamagrostis arundinacea*[3]

[1] species defined by KLIMENT et al. (2007a) as characteristic
[2] species defined by KLIMENT et al. (2007a) as differential
[3] species defined by KLIMENT et al. (2007a) as constant

Tall-grass plant community that is typical of its species richness and diversity of vascular plants. The characteristic aspect is formed by vigorous tufts of dominant *Calamagrostis arundinacea*, together with many prominent-flowering species typical for tall-forb communities, such as *Achillea *alpestris*, *Allium *montanum*, *Digitalis grandiflora* and other species (e.g. *Cirsium erisithales*, *Geranium sylvaticum*, *Linum extraaxillare*, *Heracleum sphondylium*, *Knautia arvensis* agg. and *Rubus saxatilis*). The floristic composition of the main herb layer consists of several grasses, principally *Festuca carpatica*, *Sesleria tatrae* and *Trisetum flavescens*. The lower herb layer is occupied by the characteristic *Potentilla crantzii* and also by other constantly present species, such as *Campanula serrata*, *Carlina acaulis* or *Fragaria vesca*. Due to the thick cover of grass litter, the layer of cryptogams was strongly underdeveloped and does not exceed the cover of 2 %. The soil was densely rooted.

The relevés from the Kriváńska Malá Fatra Mts differ from the typical West Carpathian phytocoenoses from the Belianske Tatry Mts by absence of characteristic species *Bupleurum ranunculoides*, differential taxa *Festuca *versicolor*, *Rhinanthus pulcher*, *Tephroseris capitata*, constant species *Primula elatior* and *Pyrethrum clusii*; some other species occur with lower frequency (cf. KLIMENT et al. 2007a).

The optimal biotope of the community was defined by HADAČ (1956) from upper parts of avalanche paths and steep, sunny canopy gaps in dwarf pine shrubs. Presented relevés were widespread on moderately convex crests on steep (35 – 45°), S-SE facing, mostly leeward slopes closely below the ridge.

In the area of the Kriváńska Malá Fatra Mts, the stands of the association can be found on the slopes just below the peak of Mt. Pekelník and below Mt. Južné Steny, on the slope above the end of Šútovská dolina Valley in a narrow range of altitude (1 585 – 1 600 m a. s. l.).

The following relevé with dominant *Calamagrostis arundinacea* presents the intermediate phytocoenose towards the *Potentillo aurei-Calamagrostietum arundinaceae* Kliment 1993. This is supported by the results of numerical classification (cf. ŠIBÍKOVÁ 2006, ŠIBÍKOVÁ et al. 2008d), where this relevé (Fig. 1, the most left relevé marked by *) is aggregated on higher level of dissimilarity with the relevés of the *Helianthemo grandiflorae-Calamagrostietum arundinaceae*; and while other coefficients being used it linked the relevés of *Potentillo aurei-Calamagrostietum arundinaceae*.

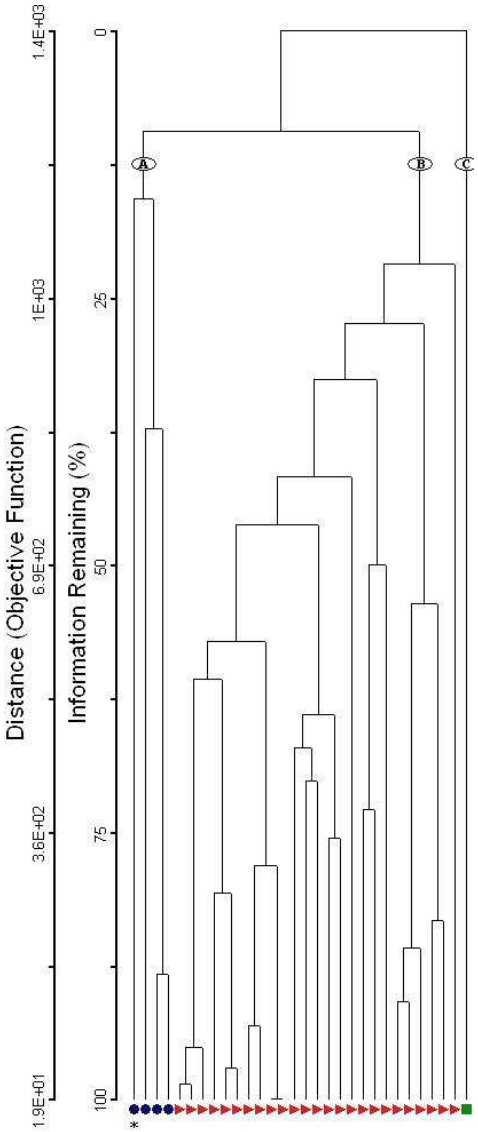

Fig. 1. Dendrogram of the numerical classification of the plant communities dominated by *Calamagrostis arundinacea* in the Krivánska Malá Fatra Mts. Used parameters: Group average method, Euclidean distance, Square root transformation.

A – *Helianthemo grandiflorae-Calamagrostietum arundinaceae*
B – *Potentillo aurei-Calamagrostietum arundinaceae*
C – *Digitali ambiguae-Calamagrostietum arundinaceae*

Relevé 2

Locality: Krivánska Malá Fatra Mts, Mt. Južné Steny, crest on the slope above the saddle, which separates the massif of Mt. Južné Steny and quartzite Mt. Úplaz above the end of Šútovská dolina Valley, steep slope with thick cover of grass litter on soil surface; elevation: 1 483 m a s. l.; co-ordinates: 49°11'23.4" N; 19°03'39.9" E; aspect: S, inclination: 35°, bedrock: marl limestone; pH (H_2O): 4.88; pH (KCl): 4.42; area: 24 m^2, total cover: 95 %, cover E_1: 95 %, cover E_0: 0 %, 3. 8. 2005; IŠ & JŠ.

E_1: *Calamagrostis arundinacea* 4, *Sesleria tatrae* 3, *Festuca *versicolor* 2b, *Allium victorialis* 2a, *Achillea *alpestris* 1, *Allium *montanum* 1, *Avenella flexuosa* 1, *Galium anisophyllon* 1, *Linum extraaxillare* 1, *Luzula *rubella* 1, *Ranunculus breyninus* 1, *Vicia oreophila* 1, *Agrostis capillaris* +, *Antennaria dioica* +, *Arabis hirsuta* +, *Botrychium lunaria* r, *Campanula serrata* +, *Carex *tatrorum* +, *Carlina acaulis* +, *Cirsium erisithales* +, *Heracleum sphondylium* +, *Knautia arvensis* agg. +, *Leucanthemum margaritae* +, *Libanotis pyrenaica* +, *Lilium martagon* +, *Phleum hirsutum* +, *Phyteuma orbiculare* +, *Soldanella carpatica* +, *Solidago *minuta* +, *Thymus alpestris* +, *Tragopogon orientalis* +, *Vaccinium myrtillus* +.

3. *Potentillo aurei-Calamagrostietum arundinaceae* Kliment 1993

Diagnostic group of species

Diagnostic species: *Avenella flexuosa*[1], *Avenula planiculmis*[1], *Calamagrostis arundinacea*, *Phyteuma spicatum*

Constant species: *Achillea *alpestris* [2], *Campanula serrata*[2], *Geranium sylvaticum*, *Heracleum sphondylium*, *Hypericum maculatum*[2], *Luzula *rubella* [2], *Vaccinium myrtillus*[2]

Dominant species: *Calamagrostis arundinacea*[2]

[1] species defined by KLIMENT et al. (2007a) as differential against the communities of the alliance dominated by *Calamagrostis arundinacea*.
[2] species defined by KLIMENT et al. (2007a) as constant

Tall-grass plant community with several well-developed herb sub-layers. The physiognomy of the phytocoenoses is determined by dominant species *Calamagrostis arundinacea*, which along with several apparently flowering species, typical for tall-forb communities (*Achillea *alpestris*, *Gentiana asclepiadea*, *Geranium sylvaticum*, *Hypericum maculatum*, *Lilium martagon*, *Phyteuma spicatum*, *Veratrum *lobelianum*) forms the upper herb sub-layer. The typical floristic composition is characterised also by lower grasses, particularly diagnostic species *Avenella flexuosa* and *Avenula planiculmis* and constant taxon *Luzula *rubella*. The lower herb sub-layer is mostly comprised of *Campanula serrata*, *Carlina acaulis* and *Vaccinium myrtillus*. Due to the high species cover and thick layer of grass litter on the soil surface, the cryptogam layer is strongly underdeveloped and often missing. The average number of vascular plants in the relevés is 26.

The association was described by KLIMENT (1993) from the main ridge of the Veľká Fatra Mts. The relevés from the Krivánska Malá Fatra Mts differ from typical phytocoenoses by the absence of constant species *Cruciata glabra* and *Pyrethrum clusii*, several other species show lower frequency (*Agrostis capillaris*, *Crepis mollis*, *Phleum hirsutum*, *Pimpinella *rhodochlamys*, *Potentilla aurea* and

Ranunculus nemorosus). *Homogyne alpina* was defined by KLIMENT et al. (2007a) as a differential species against the communities of the alliance dominated by *Calamagrostis arundinacea*. In our case, it does not meet the conditions to be the diagnostic species of the association.

The phytocoenoses of the association in the Krivánska Malá Fatra Mts are confined to moderately convex crests and side slopes of glens of predominantly S-W aspect. The altitude ranges between 1 300 and 1 600 m a. s. l. The stands are open, sunny and always protected against the strong winds. In winter, they are protected by the thick snow cover, which due to morphology of the terrain accumulates, but in spring melts down quicker than from the stands of other tall-grass communities (BĚLOHLÁVKOVÁ 1980). The average inclination of the slopes is 34° (25 – 40°). The phytocoenoses were originally confined probably to relatively small areas in canopy gaps of scarce upper part of the forests, around and above the timberline with the possibility of expanding e.g. into the avalanche paths. They could gradually widespread after the deforestation to the accessible and from the ecological point of view suitable stands in the subalpine belt (BĚLOHLÁVKOVÁ 1980).

The most abundant occurrence in the Krivánska Malá Fatra Mts recorded BĚLOHLÁVKOVÁ (1980) in the part of the ridge between Mt. Koniarky and Mt. Malý Kriváň and from Mt. Hromové over Mt. Poludňový Grúň up to Mt. Stoh. She recorded also less abundant stands from the southern slopes of Mt. Pekelník, from Mt. Kravarské and from the southern slopes of the ridge between Mt. Suchý and Mt. Malý Kriváň.

4. *Allio victorialis-Calamagrostietum villosae* Kliment 1997 (Tab. 2)

Diagnostic group of species
Diagnostic species: *Allium victorialis*[1], *Calamagrostis villosa*[2], *Ligusticum mutellina*[2], *Solidago *minuta*
Constant species: *Avenella flexuosa*[3], *Geranium sylvaticum*, *Homogyne alpina*[3], *Luzula *rubella*[3], *Vaccinium myrtillus*[3], *Veratrum *lobelianum*
Dominant species: *Avenella flexuosa*, *Calamagrostis villosa*, *Vaccinium myrtillus*

[1] species defined by KLIMENT et al. (2007a) as characteristic
[2] species defined by KLIMENT et al. (2007a) as differential
[3] species defined by KLIMENT et al. (2007a) as constant

Closed tall-grass plant community dominated by *Calamagrostis villosa*. Several conspicuous flowering tall-forbs (e.g. *Allium victorialis*, *Gentiana asclepiadea*, *Geranium sylvaticum*, *Hypericum maculatum* or *Campanula serrata*) often revive the outwardly monodominating phytocoenoses with average height of 50 – 90 cm. The middle herb layer is built mostly by *Luzula *rubella* and *Avenella flexuosa*. In the ground layer *Vaccinium myrtillus*, *Soldanella carpatica*, *Potentilla aurea* and *Homogyne alpina* occur frequently. The cryptogam layer is usually due to thick cover of grass litter on the soil surface strongly underdeveloped, more often missing.

The relevés from the Krivánska Malá Fatra Mts differ from typical West Carpathian phytocoenoses by lower frequency of the species *Campanula serrata*, *Deschampsia cespitosa* and *Hypericum maculatum*, which were defined by KLIMENT et al. (2007a) as constant taxa of the association.

The phytocoenoses are usually situated on leeward, S-SE (-N) facing, moderately concave slopes with average inclination of 28° (5 – 45°). The suitable biotopes are also shallow terrain depressions or canopy gaps in the dwarf pine shrubs. The stands are protected by thick snow cover in winter. The association was described by KLIMENT (1997) from subalpine meadows on marly limestone of the Veľká Fatra Mts. The occurrence of this vegetation is in the Krivánska Malá Fatra Mts predominantly confined to the marly limestone, but they might be found also on calcareous type of geological substrate. The soil is deep, densely rooted with a thick layer of grass litter on the surface. Its acid reaction causes species-poorer floristic composition of the phytocoenoses in comparison with other tall-herb or tall-grass communities. On the other hand, they are one of the most species-rich from those, found on acid soils. Extremely species-poor relevés with absence of several diagnostic taxa of the association were excluded from original table (cf. ŠIBÍKOVÁ 2006). They are situated after frequency value (Tab. 2) to show the variability of the stands dominated by *Calamagrostis villosa*.

The phytocoenoses of the *Allio victorialis-Calamagrostietum villosae* were in area of the Krivánska Malá Fatra Mts recorded on eastern slope of Mt. Malý Kriváň, in the glens and on the slopes between Mt. Veľký Kriváň and Mt. Pekelník, in the glens between Mt. Chleb and Mt. Hromové, in the saddle behind Mt. Hromové; and below Mt. Steny against the saddle between the main ridge and Mt. Úplaz, in the range of altitude 1 350 – 1 650 m a. s. l. The species-poorer type, supposedly still within the variability of the community is the relevé recorded from northern slope of Mt. Pekelník near the tourist path from Snilovské sedlo Saddle to Mt. Chrapáky, and the relevé recorded from south-eastern slopes of Mt. Koniarky.

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Tab. 1. ***Helianthemo grandiflorae-Calamagrostietum arundinaceae*** **Hadač et al. 1969**

Relevé number			123	
Number of species			444 129	*P*
Diagnostic group of species				
ca	*Calamagrostis arundinacea*	D	444	*3*
	Fragaria vesca	I	+++	*3*
ca	*Dianthus carthusianorum*	I	+++	*3*
	Rubus saxatilis	I	1++	*3*
ES	*Allium *montanum*	I	+11	*3*
	Asarum europaeum	I	111	*3*
Cv	*Achillea *alpestris*	C	+++	*3*
Cv	*Campanula elliptica*	C	+++	*3*
Cv	*Campanula serrata*	C	+++	*3*
	*Cardaminopsis *borbasii*	C	+r+	*3*
	Carlina acaulis	C	+++	*3*
Cv	*Cirsium erisithales*	C	+1+	*3*
Cv	*Crepis mollis*	C	+++	*3*
de	*Epilobium alpestre*	C	+++	*3*
fc	*Festuca carpatica*	C	1a1	*3*
MU	*Geranium sylvaticum*	C	b++	*3*
	Heracleum sphondylium	C	11+	*3*
	Knautia arvensis	C	++1	*3*
Cv	*Linum extraaxillare*	C	111	*3*
Cv	*Luzula *rubella*	C	ab1	*3*
CK	*Potentilla crantzii*	C	+++	*3*
st	*Sesleria tatrae*	C	+11	*3*
	Trisetum flavescens	C	+1+	*3*
Calamagrostion arundinaceae				
	Vicia oreophila		.+1	*2*
	Hieracium prenanthoides		.r.	*1*
Calamagrostietalia villosae				
	*Pimpinella *rhodochlamys*		a.+	*2*
	Phleum hirsutum		.++	*2*
cv	*Calamagrostis villosa*		1..	*1*
	Cyanus mollis		.a.	*1*
	Anemone narcissiflora		..+	*1*
	Crepis conyzifolia		..+	*1*
Mulgedio-Aconitetea				
	Gentiana asclepiadea		+.+	*2*
de	*Delphinium elatum*		1..	*1*
	*Aconitum *moravicum*		+..	*1*
	Thalictrum aquilegiifolium		+..	*1*
Elyno-Seslerietea				
	Carduus glaucinus		.++	*2*
	Phyteuma orbiculare		.++	*2*
	Helianthemum grandiflorum		1..	*1*
	Galium anisophyllon		..+	*1*
Other species				
	Vicia cracca		1.1	*2*
	Myosotis sylvatica		++.	*2*
	Galium album		.ab	*2*
	Digitalis grandiflora		.aa	*2*
	Anthoxanthum alpinum		.1+	*2*

Tab. 1. – cont.

	Relevé number	123	
	Number of species	444 129	*P*
	Carex flacca	.1+	*2*
	Arabis hirsuta	.++	*2*
	Leucanthemum margaritae	.++	*2*
	Senecio hercynicus	.rr	*2*
	Polygonatum verticillatum	a..	*1*
	Symphytum tuberosum	1..	*1*
	Bartsia alpina	+..	*1*
	Avenella flexuosa	+..	*1*
	Galeobdolon luteum	+..	*1*
	Geum rivale	+..	*1*
	Paris quadrifolia	+..	*1*
	Stachys alpina	+..	*1*
	Viola biflora	+..	*1*
	Poa nemoralis	.a.	*1*
	Mercurialis perennis	.+.	*1*
	Thymus alpestris	.+.	*1*
	Tragopogon orientalis	.+.	*1*
	Vicia sepium	.+.	*1*
	Alchemilla sp.	..+	*1*
	Bistorta major	..+	*1*
	Botrychium lunaria	..r	*1*
	Clinopodium vulgare	..+	*1*
	Hippocrepis comosa	..+	*1*
	Hypericum maculatum	..+	*1*
	*Leontodon *hispidus*	..+	*1*
Pc	*Saxifraga paniculata*	..+	*1*
	Thymus ×pseudocarpaticus	..+	*1*

Localities of the phytocoenological relevés

1. Krivánska Malá Fatra Mts (KMF), Mt. Pekelník, convex crest below the rocky slopes on the ridge, below steep slope directly under the top; elevation: 1 585 m a. s. l.; co-ordinates: 49°11'26.9" N; 19°01'11.6" E; aspect: S, slope: 35°, geology: lime stone, area: 18 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 1 %, mosses and lichens were not determined; 23. 7. 2003; JK & JŠ.

2. KMF, Mt. Pekelník, slightly convex crest below the touristic path on the ridge, below the steep slope directly under the top; elevation: 1 600 m a. s. l.; co-ordinates: 49°11'26.6" N; 19°01'07.8" E; aspect: SE, slope: 45°, geology: lim estone, area: 24 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 1 %, mosses and lichens were not determined; 23. 7. 2003; JK & JŠ (see also Šibík et al. 2004, p. 66).

3. KMF, Mt. Pekelník, slightly convex crest below the rocky slopes on the ridge, directly below the top; elevation: 1 590 m a. s. l.; co-ordinates: 49°11'26.9" N; 19°01'09.5" E; aspect: S, slope: 35°, geology: limestone, area: 24 m^2, total cover: 98 %, cover E_1: 98 %, cover E_0: 2 %, mosses and lichens were not determined; 23. 7. 2003; JK & JŠ.

Tab. 2. *Allio victorialis-Calamagrostietum villosae* Kliment 1997 (r. 1 – 9, 13 – 19) and community with *Calamagrostis villosa* (r. 10 – 12)

			0000000001111111		111	
Relevé number			**1234567893456789**		**012**	
Number of species			**2322122221122333**	**F**	**000**	***P***
			6086790678441541	**%**	**898**	
Diagnostic group of species						
cv	*Calamagrostis villosa*	I	4545555555555554	100	555	*3*
Cv	*Luzula *rubella*	C	a1a111a+11+1a+11	100	.1.	*1*
	Ligusticum mutellina	I	111+.++11++11+11	94	...	*0*
	Avenella flexuosa	C	a34aa1111a1.a+.b	88	111	*3*
LV	*Vaccinium myrtillus*	C	11+.+++.1+++11.3	81	+..	*1*
Cv	*Solidago *minuta*	I	.+r.+++++r+1.++1	81	..+	*1*
MU	*Geranium sylvaticum*	C	+a1a.1..++.1++a+	75	...	*0*
	Homogyne alpina	C	a1+....++111a111	75	aa.	*2*
ca	*Allium victorialis*	I	.aabbaa1a..b3.+.	69	...	*0*
MU	*Veratrum *lobelianum*	C	.+1+....r+++++++	69	...	*0*
Calamagrostion arundinaceae						
	Calamagrostis arundinacea		1...1a++1.....	38	...	*0*
	Vicia oreophila		.....+++.....	19	...	*0*
	Hieracium prenanthoides		+.....+.....	13	...	*0*
Calamagrostietalia villosae						
	Campanula serrata		+++1++++++++.+++	94	.+.	*1*
	*Achillea *alpestris*		.+++++++...+..+.	56	...	*0*
	Cirsium erisithales		.+..1.++.....+.	31	...	*0*
	Phleum hirsutum		.++.+.....	19	...	*0*
	Linum extraaxillare		.......++.....+.	19	...	*0*
	Crepis conyzifolia		......++.....	13	...	*0*
	Astrantia major		.......r.....+.	13	...	*0*
	Crepis mollis		.......r.....+.	13	...	*0*
	*Pimpinella *rhodochlamys*		...r.....	6	...	*0*
Mulgedio-Aconitetea						
MU	*Acetosa arifolia*		b.+..+.+++.+.+1.	56	+..	*1*
MU	*Gentiana asclepiadea*		+.1+.....+++..+.	44	..+	*1*
MU	*Poa chaixii*		+.....+.+..	19	...	*0*
fc	*Festuca carpatica*		...+.....+1.	19	...	*0*
MU	*Aconitum *moravicum*		.....1.....1.+	19	...	*0*
aa	*Doronicum austriacum*		1.....a..	13	...	*0*
aa	*Ranunculus platanifolius*		...+.....+.....	13	...	*0*
tf	*Rhodiola rosea*		...+.....1	13	...	*0*
aa	*Athyrium distentifolium*		+.....	6	1..	*1*
po	*Valeriana sambucifolia*		.....+.....	6	...	*0*
MU	*Thalictrum aquilegiifolium*		.....+..	6	...	*0*
aa	*Silene dioica*		.....+..	6	...	*0*
MU	*Primula elatior*		.....+.	6	...	*0*
MU	*Senecio subalpinus*		.....+	6	...	*0*
Other species						
	Polygonatum verticillatum		++1b111+a+....+.	69	...	*0*
	Soldanella carpatica		.+...++.+r++++++	69	...	*0*
	Bistorta major		+++b....++a+11..	63	+..	*1*
	Hypericum maculatum		b.+a..++...+.+1+	56	.+.	*1*
	Deschampsia cespitosa		+.1+..+....11+aa	56	...	*0*
	Senecio hercynicus		a+1+.....r+1+.	50	...	*0*
NS	*Potentilla aurea*		++.....+..+++++	50	...	*0*

Tab. 2. – cont.

		0000000001111111	F	111	
	Relevé number	**1234567893456789**	**%**	**012**	
	Viola biflora	.r++.+.....+.+++	50	r..	*1*
st	*Sesleria tatrae*	.1+++1.....++.a	50	...	*0*
	Heracleum sphondylium	.+.1.+++...+..+.	44	...	*0*
	Luzula sylvatica	........++11.+++	44	.++	*2*
	Rubus idaeus	31.......++..11.	38	.1.	*1*
	Alchemilla sp.	..rr...+...+.+1.	38	...	*0*
LV	*Vaccinium vitis-idaea*	.++..+..+......a	31	...	*0*
ES	*Galium anisophyllon*	.r+..+.........+	25	...	*0*
	Lilium martagon	....rr.rr.......	25	...	*0*
sa	*Sesleria albicans*	......++1.....+.	25	...	*0*
	Sorbus aucuparia	.....r.......r.+	19	...	*0*
	Trisetum flavescens	1....+..........	13	...	*0*
	Picea abies	.+......r.......	13	...	*0*
ES	*Ranunculus breyninus*	.r...r..........	13	...	*0*
	Cruciata glabra	...+...+........	13	...	*0*
	*Festuca *versicolor*	....+a..........	13	...	*0*
cf	*Salix alpina*	........1......a	13	...	*0*
pm	*Pinus mugo*	............+1..	13	...	*0*
	Agrostis capillaris	1...............	6	.+.	*1*
	Bryophytes (E_0)				
	Plagiothecium sp.	............3..+	13	...	*0*
	Brachythecium sp.	............1..+	13	...	*0*
	Pleurozium schreberi	............1..4	13	...	*0*
	Polytrichum sp.	............+..+	13	...	*0*
	Hylocomium splendens	.............1.3	13	...	*0*

Taxa occuring in a single relevé:

E_1: *Bartsia alpina* + (5); *Campanula cochlearifolia* + (8); *Carex ovalis* + (12); *Carlina acaulis* r (9); *Cortusa matthioli* + (17); *Crepis paludosa* + (18); *Epilobium montanum* r (3); *Galeopsis speciosa* + (1); *Galium album* s. l. + (7); *Knautia arvensis* agg. + (2); *Knautia kitaibelii* + (18); *Leontodon *hispidus* r (5); *Maianthemum bifolium* 1 (12); *Nardus stricta* + (12); *Phyteuma spicatum* r (3); *Pilosella aurantiaca* + (1); *Potentilla crantzii* + (3); *Ranunculus pseudomontanus* r (2); *Ranunculus nemorosus* + (9); *Rhinanthus pulcher* + (17); *Rosa pendulina* + (17); *Salix silesiaca* + (19); *Swertia *alpestris* r (17); *Thalictrum minus* + (9); *Thymus *pulcherrimus* + (2); *Valeriana tripteris* + (19); *Vicia cracca* + (4); *Vicia sepium* + (4).

E_0: *Amblystegium compactum* + (6); *Bryum* sp. + (6); *Dicranum* sp. + (19); *Mnium* sp. + (18); *Rhytidiadelphus* sp. 3 (16).

Localities of the phytocoenological relevés

1. Krivánska Malá Fatra Mts (KMF), Mt. Malý Kriváň, the eastern slope above the end of the Studenec Valley, below the rock formation „Sviňa“, across quartzite crest, mild crest in avalanche glen, above the avalanche outcrops; elevation: 1 456 m a. s. l.; co-ordinates: 49°11’11.6” N; 19°00’12.0” E; aspect: E, slope: 30°, geology: lime stone; pH (H_2O): 4.43; pH (KCl): 4.19; area: 24 m^2, total cover: 100 %, E_1: 100 %, E_0: 0 %; 28. 7. 2005; IŠ & JŠ.

2. KMF, Mt. Veľký Kriváň, near the glen dividing the massif of Mt. Veľký Kriváň and of Mt. Pekelník, the enclave in secondary dwarf pine stands; elevation: 1 572 m a. s. l.; co-ordinates: 49°11’25.1” N; 19°01’32.0” E; aspect: SW, slope: 30 °, geology: limestone; pH (H_2O): 4.52; pH (KCl): 4.40; area: 20 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 2. 8. 2005; IŠ & JŠ.

3. KMF, Mt. Pekelník, near rocky complex between Mt. Veľký Kriváň and Mt. Pekelník, edge of the glen on southern slope below quartzite scree near the ground elevation „Hrana Veľkého Kriváňa“; elevation: 1 545 m a. s. l.; co-ordinates: 49°11’24 .7” N; 19°01’28.3” E; aspect: SSE, slope: 30°,

geology: limestone, area: 24 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 22. 7. 2003; JK & JŠ.

4. KMF, Mt. Pekelník, southern slope between Mt. Veľký Kriváň and Mt. Pekelník, mild crest near rocky complex on one side and glen on other side; elevation: 1 535 m a. s. l.; co-ordinates: 49°11'24.3" N; 19°01'27.9" E; aspect: SSE, slope: 3 5°, geology: limestone, area: 24 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 22. 7. 2003; JK & JŠ.

5. KMF, Mt. Južné Steny, crest below the top, across the saddle between Mt. Úplaz and Mt. Steny, slightly sheltered part of the crest; elevation: 1 496 m a. s. l.; co-ordinates: 49°11'24.7" N; 19°03'40.2" E; aspect: S, slope: 25°, geology: marl limestone; pH (H_2O): 4.60; pH (KCl): 4.18; area: 24 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 3. 8. 2005; IŠ & JŠ.

6. KMF, Mt. Steny, crest below the top, slope above the marly outcrops; elevation: 1 512 m a. s. l.; co-ordinates: 49°11'25.8" N; 19°03'40.8" E; aspect: SE, slope: 20°, geology: marl limestone; pH (H_2O): 4.45; pH (KCl): 4.26; area: 24 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 1 %; 3. 8. 2005; IŠ & JŠ.

7. KMF, Mt. Južné Steny, western edge of massive outcrops; flat, more or less even crest, on the soil surface was approximately 8 cm deep layer of leafmould; elevation: 1 560 m a. s. l.; co-ordinates: 49°11'30.8" N; 19°03'41.0" E; aspect: S, slope: 25°, geology: marl limestone, area: 24 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 20. 8. 2002; JK.

8. KMF, Mt. Južné Steny, the upper edge of marly outcrops, westwards, reed grass stand on mild southern slope, approximately 15 m in diameter; elevation: 1 600 m a. s. l.; 49°11'32.3" N; 19°03'41.4" E; aspect: SSE, slope: 10 – 15°, geology: marl limestone, area: 25 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 20. 8. 2002; JK.

9. KMF, Mt. Južné Steny, eastern edge of the marly outcrops, belt of *Calamagrostis villosa* growth along the edge of the outcrops; elevation: 1 580 m a. s. l.; co-ordinates: 49°11'32.6" N; 19°03'42.8" E; aspect: SEE, slope: 25 – 30°, geology: marl limestone, area: 24 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 20. 8. 2002; JK.

10. KMF, Mt. Veľký Kriváň, next to the touristic path (yellow mark) from Snilovské sedlo Saddle to Mt. Chrapáky, mild, nothern slope; elevation: 1 478 m a. s. l.; co-ordinates: 49°11'40.3" N; 19°01'37.5" E; aspect: S, slope: 25°, geology: lime stone, area: 25 m^2, total cover: 90 %, cover E_1: 90 %, cover E_0: 0 %; 23. 7. 2003; IJ & IŠ.

11. KMF, Mt. Koniarky, little avalanche glen on western slopes; elevation: 1 434 m a. s. l.; co-ordinates: 49°11'45.8" N; 19°00'16.9" E; aspect: SE , slope: 25°, geology: coloured keuper shale, area: 40 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 1. 8. 2002; IJ.

12. KMF, Mt. Koniarky, southeastern slope above the touristic path from Bublen Saddle to Koniarky Saddle, above the Studenec Valley; species *Carex ovalis*, *Luzula sylvatica*, *Nardus stricta* and *Solidago *minuta* were not present in relevé, but close to it and in the same vegetation type; elevation: 1 500 m a. s. l.; co-ordinates: 49°11'35 .0" N; 19°00'36.1" E; aspect: SE, slope: 20°, geology: coloured keuper shale, area: 25 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 31. 7. 2002; IJ, ZD & JŠ (see also ŠIBÍK 2003, p. 73).

13. KMF, Mt. Malý Kriváň, slope below the touristic path on the ridge in direction to rock formation „Sviňa", around 20 m above the touristic path; elevation: 1 616 m a. s. l.; co-ordinates: 49°11'09.3" N; 18°59'57.4" E; aspect: SEE, slope: 2 5°, geology: limestone, area: 25 m^2, total cover: 100 %, cover E_1: 95 %, cover E_0: 0 %; 31. 7. 2002; IJ & ZD.

14. KMF, Mt. Malý Kriváň, flat crest below first little saddle below rock formation „Sviňa"; elevation: 1 549 m a. s. l.; co-ordinates: 49°11'13.3" N; 19°0 0'04.6" E; aspect: SEE, slope: 20°, geology: marl limestone, area: 25 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 1. 8. 2002; IJ.

15. KMF, Mt. Hromové, on the right side of the touristic path from Sedlo za Hromovým Saddle to Mt. Chleb, dense litter on soil surface; elevation: 1 548 m a. s. l.; co-ordinates: 49°11'25.8" N; 19°03'28.0" E; aspect: NNW, slope: 5°, geology: marl limestone, pH (H_2O): 4.38; pH (KCl): 4.15; area: 24 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 0 %; 3. 8. 2005; IŠ & JŠ.

16. KMF, below Hromové sedlo Saddle, in direction to Vrátna dolina Valley, small crest between two avalanche glens, species *Hypericum maculatum* and *Salix silesiaca* were present close to the relevé, together with secondary dwarf pine stands; elevation: 1 500 m a. s. l.; co-ordinates: 49°11'24.4" N; 19°03'13.1" E; aspect: NNW, slope: 2 0°, geology: marl limestone, area: 32 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 70 %; 30. 7. 2002; IJ, ZD & JŠ (see also ŠIBÍK 2003, p. 67).

17. KMF, Mt. Malý Kriváň, in direction to Priehyb Saddle, avalanche glen within dwarf pine stands; elevation: 1 503 m a. s. l.; co-ordinates: 49°11'00 .0" N; 18°59'15.0" E; aspect: J, slope: 35°, geology: limestone, area: 25 m^2, total cover: 90 %, cover E_1: 90 %, cover E_0: 5 %; 24. 7. 2003; IJ & IŠ.

18. KMF, Mt. Južné Steny, the southern top, undulating crest on the southern slopes below the top; elevation: 1 600 m a. s. l.; co-ordinates: 49°11'29 .8" N; 19°03'38.9" E; aspect: NE, slope: 10°, geology: marl limestone, area: 25 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 1 %; 22. 8. 2001; JK.

19. KMF, Mt. Hromové, the beginning of the glen declining from Hromové sedlo Saddle to Vrátna dolina Valley, in direction to the edge of Chlebské kotle Kettle, mildly steep slope below the crowberry stand within blueberry stands; elevation: 1 545 m a. s. l.; co-ordinates: 49°11'21.7" N; 19°03'11.1" E; aspect: NNE, slope: 30°, geology: marl limestone, area: 24 m^2, total cover: 100 %, cover E_1: 100 %, cover E_0: 80 %; 30. 7. 2002; IJ, ZD & JŠ (see also Šibík 2003, p. 65).

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