Polish Botanical Journal 49(2): 181–202, 2004

SYNTAXONOMICAL REVISION OF PLANT COMMUNITIES WITH *CAREX FIRMA* AND *DRYAS OCTOPETALA* (ALLIANCE *CARICION FIRMAE*) IN THE WESTERN CARPATHIANS

JOZEF ŠIBÍK, ANTON PETRÍK & JÁN KLIMENT

Abstract: A syntaxonomical revision of plant communities with dominants *Carex firma* and *Dryas octopetala* in the Western Carpathians is presented, including a comparison with related plant communities from the Alps. The syntaxonomical position of the studied communities has been re-evaluated, and a new classification concept is offered. Communities from the subalpine belt of the Krivánska Malá Fatra, Chočské vrchy and Nízke Tatry Mts are classified within the association *Dryado octopetalae-Caricetum firmae* Sillinger 1933, and two new subassociations *primuletosum auriculae* and *saxifragetosum aizoidis* are described. The plant communities from the subalpine and alpine belts of the Západné Tatry and Belianske Tatry Mts are different. We classify them within the association *Arenario tenellae-Caricetum firmae* (Br.-Bl. 1930) *nom. nov*., with two subassociations recognized: *typicum* and *salicetosum reticulatae*. Phytocoenological relevés obtained in recent years confirm the well-pronounced separation of the association *Androsaceo lacteae-Festucetum versicoloris* Sillinger 1933. According to our revision, phytocoenoses in the montane belt or on inversion sites of the Veľká Fatra, Muránska planina and Slovenský raj Mts, including some communities of the subalpine belt of the Tatras, cannot be classified in the alliance *Caricion firmae* Gams 1936, but belong to the alliances *Seslerio-Asterion alpini* Hadač *ex* Hadač *et al*. 1969, *Potentillion caulescentis* Br.-Bl. *in* Br.-Bl. & Jenny 1926 *emend.* Sutter 1969 and *Cystopteridion* Richard 1972.

Key words: *Caricion firmae*, alpine vegetation, syntaxonomy, numerical classification, Alps, Western Carpathians, Slovakia

Jozef Šibík, Institute of Botany, Slovak Academy of Sciences, Dúbravská cesta 14, SK-845 23 Bratislava, Slovak Republic; e-mail: jozef.sibik@savba.sk
Anton Petrík, Botanical Garden of Comenius University, Botanická 3, SK-841 04 Bratislava, Slovak Republic
Ján Kliment, Botanical Garden of Comenius University, SK-038 15 Blatnica, Slovak Republic; e-mail: kliment@rec.uniba.sk

INTRODUCTION

In the Western Carpathians, the distribution center of communities with dominance of *Carex firma* and *Dryas octopetala* occurs in the subalpine and alpine belts. These communities occur especially on north-facing steep slopes and in rocky grooves, but can be found also on inversion sites or on steep south-facing rocky walls. Initial syntaxonomical studies of these communities appeared in the 1920s. Using the criterion of the dominance of one of the determinant species, Szafer *et al.* (1923) described associations *Caricetum firmae* and *Dryadetum* from the Polish side of the West Tatras. Pawłowski and Stecki (1927) and Klika (1932) considered stands with dominance of *Dryas octopetala* to be only a facies or stage of the association *Caricetum firmae* (*Firmetum*). Based on the marked similarity of floristic composition between stands of these two dominant species in the Western Carpathians, Sillinger (1933) treated them as facies of the association *Dryadeto-Firmetum*. In comparing the vegetation of the Central Alps and the Tatra Mts, Braun-Blanquet (1930) used the name *Caricetum firmae tatricum* to designate phytocoenoses from the Tatras. Pawłowski (1935) employed the geographical epithet *Caricetum firmae carpaticum* to delimit and distinguish West Carpathian stands from those of the Alps. Hadač *et al.* (1969) distinguished two units in the Belianske Tatry Mts, namely *Caricetum firmae carpaticum* and *Dryadetum octopetalae tatricum*. Two names proposed by Hadač (cf. Mucina & Maglocký 1985), *Saxifrago caesiae-Caricetum firmae* and *Festuco*

versicoloris-Dryadetum octopetalae, reversed the original physiognomical classification.

In recent decades, detailed field research on communities with dominance of *Carex firma* and *Dryas octopetala* has been carried out in the central part of the Western Carpathians and their foothills. These studies, followed by numerical classification, have brought new insights for the syntaxonomical classification of these communities, which we present in this paper.

Material and methods

The syntaxonomical revision presented here included 413 phytocoenological relevés of plant communities with the dominance and higher abundance of *Carex firma* and *Dryas octopetala*, from the central part of the Western Carpathians and their foothills. Since these communities with *Carex firma* have been often merged with the association *Caricetum firmae* Rübel 1911 from the Alps (cf. Grabherr & Mucina 1993: 406), we also included 21 relevés of this association originating from the Alps. In this study, only differences between the Alpine and West Carpathian communities are highlighted, so the Alpine association and its diagnostic taxa are not evaluated in more detail. All relevés used in this study were collected in accordance with the principles of the Zürich-Montpelliér school (Braun-Blanquet 1964), but applying different scales of abundance and dominance used by various authors: the five- or seven-degree scale of Braun-Blanquet, the 10-degree or a combined 11-degree scale of Hadač and Domin (cf. Sillinger 1933; Hadač *et al.* 1969), and a modified 9-degree scale (Barkman *et al.* 1964).

To obtain data comparable for numerical classification, all relevés were transformed to a nine-degree ordinal scale (van den Maarel 1979). Taxa determined only at the level of genus were excluded, and some taxa were classified within higher or more broadly defined taxa: *Anthoxanthum odoratum* agg. (*A. alpinum*, *A. odoratum*), *Carex sempervirens* (subsp. *tatrorum*, subsp. *silicicola*), *Cardaminopsis arenosa* agg. (*C. borbasii*), *Empetrum hermaphroditum* (*E. nigrum*), *Gentianella lutescens* (subsp. *tatrae*), *Helianthemum grandiflorum* (subsp. *grandiflorum*, subsp. *glabrum*, subsp. *obscurum*), *Jovibarba globifera* (subsp. *glabrescens*), *Leucanthemum vulgare* agg. (*L. margaritae*), *Lotus corniculatus* (var. *alpicola* Beck), *Luzula luzuloides* (subsp. *luzuloides*, subsp. *rubella*), *Pimpinella major* (subsp. *rhodochlamys*), *Solidago virgaurea* (subsp. *minuta*), *Swertia perennis* (subsp. *alpestris*), *Pulsatilla slavica* (*P. subslavica*), *Schistidium apocarpum* (*S. atrofuscum*, *S. strictum*) and *Thymus pulcherrimus* (subsp. *pulcherrimus*, subsp. *sudeticus*). Numerical classification employed the NCLAS program from the SYN-TAX 5 package (Podani 1993). The β-flexible method (β = -0.25) with Jaccard's, Ružička's and Wishart's similarity coefficients was used. The hypotheses obtained were evaluated by comparison and through analysis of phytocoenological tables.

To determine the content of the alliance *Caricion firmae* and the syntaxonomical position of other communities with the dominance of *Carex firma* and *Dryas octopetala*, our phytocoenological relevés were also compared with closely related plant communities of the alliance *Seslerio-Asterion alpini* (*Elyno-Seslerietea*) and classes *Asplenietea trichomanis*, *Juncetea trifidi* and *Carici rupestris-Kobresietea* from the Western Carpathians, and to a lesser extent also from the Eastern and Southern Carpathians and the Alps.

The synoptic table (Table 1) shows the combined results of several partial syntheses, which could not be presented as a single dendrogram due to the high number of relevés. The caption of each column contains the number of relevés used for the synthesis and the average number of species in a given community. The frequency as a percentage (99 = 100%) and mean value of abundance (upper index) are given for each taxon. They were calculated with FYTOPACK (Jarolímek & Schlosser 1997). If only four or fewer relevés were available (column Ds), only the presence of taxa in a given community is indicated, in italics. Individual columns also contain abbreviated references (for unpublished data only author names are given), the number of relevés, and their position on the level of orographic units according to the map for the *Database of Fauna of Slovakia* (scale 1:500,000). Diagnostically important taxa of individual plant communities are marked in bold.

The nomenclature of taxa generally follows Marhold and Hindák (1998); names of taxa occurring only in the Alps follow Ehrendorfer (1973). Subspecies (given without the species epithet) appearing in Table 1 in individual relevés (holotype) or repeating in the text are asterisked (*). Names of syntaxa are according to Mucina and Maglocký (1985); the names of diagnostic taxa of higher rank follow recent synthetic studies from the Tatra Mts (Hadač *et al.* 1969; Unar *et al.* 1985), Slovakia (Valachovič *et al.* 1995; Dúbravcová 1996), the Eastern Alps (Grabherr & Mucina 1993) and Romanian Carpathians (Coldea *et al.* 1997). The names of newly distinguished and described syntaxa include authors' citations.

In the descriptions of communities, the following abbreviations are used: Art. = article of *International*

Code of Phytosociological Nomenclature (Weber *et al.* 2000); Ass. = association; const. = constant companion taxon (frequency higher than 60%); dif. = differential taxon; dom. = dominating taxon; r. = relevé.

Description of plant communities

Elyno-Seslerietea Br.-Bl. 1948

Seslerietalia coeruleae Br.-Bl. *in* Br.-Bl. & Jenny 1926

Caricion firmae Gams 1936

Arenario tenellae-Caricetum firmae **(**Br.-Bl. 1930) *nom. nov. hoc loco*

Table 1, column B

Basionym: *Caricetum firmae tatricum* Br.-Bl. 1930 (Art. 34).

Synonyms: *Firmetum* Pawłowski & Stecki 1927 p.p. maj. (Art. 31), *Firmetum* (= *Caricetum firmae*) *carpaticum* Pawłowski 1935 p.p. maj. (Art. 34), *Caricetum firmae* Šmarda 1956 (Art. 31), *Dryadetum octopetalae tatricum* Hadač *et al.* 1969 (Art. 34), *Caricetum firmae* Domin 1936 (Art. 2b, 31), *Saxifrago caesiae-Caricetum firmae* (Szafer *et al.* 1923) Hadač in Mucina & Maglocký 1985 p.p. maj. (Art. 2b), *Festuco versicoloris-Dryadetum* (Szafer *et al.* 1923) Hadač in Mucina & Maglocký 1985 p.p. min. (Art. 2b), *Carex firma*-ass. Domin 1923 (nom. nud.), *Dryadeto-Caricetum firmae* Domin 1925a (nom. nud.), *Caricetum firmae* Domin 1925b (nom. nud.), *Dryadetum* Domin 1925b (nom. nud.), *Caricetum firmae* (= *Firmetum*) Domin 1928 (nom. nud.), *Caricetum firmae tatrense* Domin 1930, 1931 (nom. nud.), *Caricetum firmae tatricum* Klika 1932 (nom. nud.). – Non: *Caricetum firmae* Rübel 1911, *Caricetum firmae* Szafer *et al.* 1923, *Dryadetum* Szafer *et al.* 1923.

Diagnostic taxa: *Carex firma* (dom., const.), *Dryas octopetala* (dom., const.), *Androsace chamaejasmae* (dif.), *Arenaria tenella* (dif.), *Cerastium eriophorum* (dif.), *Chamorchis alpina* (dif.), *Lloydia serotina* (dif.), *Minuartia gerardii* (dif.), *M. sedoides* (dif.), *Pedicularis oederi* (dif.), *Rhodax alpestris* (dif.), *Silene acaulis* (dif.), *Alectoria ochroleuca* (dif.), *Dactylina madreporifirmis* (dif.), *Thamnolia vermicularis* (dif.), *Vulpicida tubulosus* (dif.), *Bistorta vivipara* (const.), *Crepis jacquinii* (const.), *Festuca versicolor* (const.), *Galium anisophyllon* (const.), *Ranunculus alpestris* (const.), *Saxifraga caesia* (const.), *Ditrichum flexicaule* (const.), *Tortella tortuosa* (const.).

Nomenclatural type: Braun-Blanquet 1930: 25.

Two-layered dwarf shrub-herbaceous plant community, usually open. Along with tuft-rosette-forming hemicryptophytes, cushion-forming and tufted chamaephytes, small dwarf shrubs with dense branches are also present. Among them, *Dryas octopetala* together with the dominant sedge, *Carex firma*, determine the physiognomy of this community. Several other herb species are represented in the community as well (*Silene acaulis*, *Arenaria tenella*, *Saxifraga caesia*, *Minuartia gerardii*, *Androsace chamaejasme*, *Pedicularis oederi*, *Ranunculus breyninus*, *R. alpestris*, *Minuartia sedoides*, etc.). The layer of mosses and lichens (E_0) is enriched by species like *Vulpicida tubulosus* and *Dactylina madreporiformis*, contributing to the color variation of the community. Most plants reach height of 3–10 cm; only flowering stems or stems of some grasses overreach them to 10–25 cm in height. On sites exposed to extremely strong winds, a conspicuous belt-and-terrace structure of the vegetation can be observed. Narrow vegetation belts are situated on the steep front of a terrace, which retains exposed gravel material.

The optimum of chionophobic sub-hygrophilous plant communities of the association *Arenario tenellae-Caricetum firmae* occurs in the alpine and subalpine belts (alt. 1550–2150 m) in limestone-dolomite parts of the Tatra Mts. They inhabit very shallow to shallow, strongly humic, neutral to slightly basic, skeletal soils, in the winter covered with snow only briefly or without any snow. Due to the humid and cold climate, processes of plant material decomposition and formation of fine humic earth are very slow. Plant communities of this association mostly inhabit moderate to steep, NW–NE-facing windy slopes. More rarely they occur on sites oriented in other directions: in these cases they inhabit steep rocky walls with a minute fine earth layer deposited in fissures and on exposed terraces. On slopes with a sufficiently thick layer of detritus exposed to harsh high-mountain climate with strong winds, formation of festooned soils typical for this community is observed (cf. Šmarda 1956: 27).

Table 1. Comparison of the Western Carpathian plant communities of the alliance *Caricion firmae* (B–Ds) with association *Caricetum firmae* Rübel 1911 (A) and other plant communities with higher abundance of species *Carex firma* and *Dryas octopetala* (E–H) from the West Carpathians (a brief synoptic table).

A – *Caricetum firmae*, B – *Arenario tenellae-Caricetum firmae*, B1 – *A-C. typicum*, B2 – *A-C. salicetosum reticulatae*, C – *Dryado octopetalae-Caricetum firmae*, C1 – *D-C. primuletosum auriculae*, C2 – *D-C. saxifragetosum aizoidis*, D – *Androsaceo lacteae-Festucetum versicoloris* (Ds – Sillinger 1933: 229–230), E – *Dryado octopetalae-Salicetum reticulatae* (?*Festucion versicoloris*), F – *Drabo tomentosae-Artemisietum petrosae* (*Potentillion caulescentis*), G – *Potentillion caulescentis*/*Seslerio-Asterion alpini*, H – *Cystopteridion*/*Seslerio-Asterion alpini*

Community		A	B1	B2	B	C1	C2	C	D	Ds	E	F	G	H
Number of relevés		21	90	92	182	52	36	88	9	4	38	11	45	40
Average species number		25	36	42	39	33	35	34	27	?	61	22	35	37
Differential taxa of the associations of alliance *Caricion firmae*														
cf, fv	*Silene acaulis*	57^{2}	68^{3}	78^{3}	**73^{3}**	.	.	.	.	.	99^{6}	27^{3}	13^{3}	.
cf, fv	*Pedicularis oederi*	?	46^{2}	83^{2}	**64^{2}**	17^{3}	.	10^{3}	11^{2}	.	99^{3}	9^{2}	11^{3}	.
cf	*Androsace chamaejasme*	?	63^{2}	58^{2}	**60^{2}**	10^{3}	.	6^{3}	.	.	74^{3}	9^{2}	18^{3}	.
cf, pt	*Arenaria tenella*	.	82^{3}	39^{2}	**60^{2}**	.	.	.	.	.	8^{2}	91^{2}	7^{2}	.
cf	*Rhodax alpestris*	90^{3}	80^{3}	38^{3}	**59^{3}**	13^{2}	.	8^{2}	.	*1*	66^{3}	18^{3}	11^{4}	3^{1}
oe, cf	*Minuartia sedoides*	10^{1}	41^{2}	66^{3}	**54^{2}**	.	.	.	.	.	97^{4}	9^{2}	.	.
	Thamnolia vermicularis (E_0)	38^{2}	49^{2}	58^{2}	**53^{2}**	6^{2}	.	3^{2}	.	.	45^{2}	.	2^{2}	.
cf	*Vulpicida tubulosus* (E_0)	10^{1}	48^{2}	45^{3}	**46^{3}**	.	.	.	.	.	29^{2}	.	.	.
cf	*Minuartia gerardii*	71^{2}	40^{2}	43^{2}	**42^{2}**	.	.	.	.	.	95^{3}	9^{2}	9^{2}	.
cf	*Chamorchis alpina*	38^{2}	43^{2}	25^{2}	**34^{2}**	.	.	.	.	.	24^{2}	.	2^{2}	.
fv, oe	*Lloydia serotina*	.	20^{2}	38^{2}	**29^{2}**	.	.	.	.	.	74^{3}	.	.	.
	Alectoria ochroleuca (E_0)	.	16^{2}	34^{3}	**25^{2}**	4^{3}	.	2^{3}	.	.	5^{3}	.	2^{2}	.
fv, oe	*Cerastium eriophorum*	.	19^{2}	29^{2}	**24^{2}**	.	.	.	.	.	89^{3}	9^{1}	2^{2}	.
	Dactylina madreporiformis (E_0)	.	33^{3}	12^{3}	**23^{3}**	.	.	.	.	.	8^{2}	.	.	.
Sc, Pc	*Dianthus nitidus*	.	.	10^{2}	5^{2}	77^{2}	89^{3}	**82^{2}**	56^{2}	.	.	.	11^{2}	18^{2}
cy	*Tofieldia calyculata*	.	1^{3}	24^{2}	13^{2}	73^{3}	83^{3}	**77^{3}**	11^{2}	*2*	11^{2}	.	36^{2}	90^{3}
	Pinguicula alpina	5^{1}	20^{2}	48^{2}	34^{2}	73^{2}	61^{2}	**68^{2}**	.	*2*	34^{2}	.	31^{2}	63^{2}
	Hypnum cupressiforme (E_0)	.	13^{2}	10^{2}	12^{2}	40^{3}	42^{3}	**41^{3}**	11^{3}	.	18^{2}	.	24^{3}	8^{2}
pc	*Androsace lactea*	.	7^{2}	15^{2}	11^{2}	58^{2}	31^{2}	47^{2}	**99^{3}**	***4***	.	73^{2}	33^{3}	48^{2}
	Poa alpina	5^{1}	14^{2}	23^{2}	19^{2}	2^{2}	8^{1}	5^{2}	**78^{2}**	***2***	74^{2}	18^{2}	20^{2}	13^{3}
fv	*Saxifraga moschata*	.	6^{2}	8^{2}	7^{2}	4^{2}	3^{3}	3^{2}	**78^{2}**	**.**	66^{3}	.	.	.
(cy)	*Viola biflora*	.	2^{2}	4^{2}	3^{2}	8^{2}	33^{2}	18^{2}	**56^{3}**	***4***	21^{3}	9^{1}	22^{2}	60^{2}
cy	*Cortusa matthioli*	.	.	.	.	8^{2}	11^{2}	9^{2}	**56^{2}**	***3***	3^{2}	.	7^{2}	48^{2}
aa	*Cystopteris montana*	.	.	.	.	.	.	.	**33^{2}**	**.**	.	.	.	5^{2}
Differential taxa of the subassociations														
Sc, pc	*Trisetum alpestre*	.	**86^{3}**	32^{2}	58^{3}	25^{2}	8^{2}	18^{2}	.	.	.	99^{3}	71^{2}	65^{2}
Sc	*Euphrasia salisburgensis*	38^{2}	**71^{2}**	21^{2}	46^{2}	8^{2}	11^{2}	9^{2}	11^{2}	.	5^{2}	.	67^{2}	15^{2}
Sc	*Ranunculus breyninus*	.	**70^{3}**	12^{2}	41^{2}	2^{1}	3^{2}	2^{2}	.	*2*	55^{3}	27^{2}	31^{2}	5^{2}

pc	*Leontopodium alpinum*	24^{2}	**42^{3}**	9^{2}	25^{2}	.	.	.	.	.	.	27^{2}	27^{2}	5^{2}
	Squamarina gypsacea (E_0)	5^{1}	**34^{2}**	2^{2}	18^{2}	.	.	.	.	.	.	45^{3}	9^{2}	.
st, oe	*Oxytropis carpatica*	.	**31^{3}**	4^{3}	18^{3}	.	.	.	.	.	18^{2}	18^{3}	.	.
Sc, pc	*Aster alpinus*	24^{2}	**24^{3}**	.	12^{3}	2^{5}	.	1^{5}	.	.	.	.	9^{3}	.
ac	*Salix reticulata*	19^{2}	12^{2}	**80^{3}**	47^{3}	6^{6}	36^{5}	18^{5}	11^{6}	.	99^{6}	.	7^{2}	.
ES	*Selaginella selaginoides*	29^{2}	14^{2}	**53^{2}**	34^{2}	67^{2}	81^{3}	73^{2}	33^{3}	*4*	84^{2}	.	42^{3}	58^{2}
	Campylium stellatum (E_0)	.	12^{2}	**51^{2}**	32^{2}	40^{2}	44^{3}	42^{3}	.	.	45^{3}	.	11^{2}	18^{3}
	Hypnum bambergeri (E_0)	.	16^{2}	**49^{3}**	32^{3}	31^{5}	19^{5}	26^{5}	.	.	83	.	.	.
	Soldanella carpatica	.	3^{1}	**47^{2}**	25^{2}	62^{2}	89^{3}	73^{3}	89^{3}	*2*	95^{3}	.	44^{3}	63^{3}
cy	*Swertia perennis*	.	2^{2}	**46^{2}**	24^{2}	56^{3}	61^{2}	58^{2}	89^{3}	*4*	87^{3}	.	16^{2}	38^{3}
	Viola alpina	.	1^{2}	**33^{3}**	17^{3}	13^{3}	.	8^{3}	.	.	.	.	7^{2}	.
ac	*Salix retusa*	29^{2}	.	**22^{2}**	11^{2}	.	.	.	.	.	37^{5}	.	.	.
	Orthothecium rufescens (E_0)	5^{1}	9^{2}	**46^{3}**	27^{2}	**40^{3}**	11^{3}	28^{3}	.	.	18^{2}	.	9^{2}	88^{3}
pc	*Primula *hungarica*	.	58^{3}	34^{2}	46^{2}	**79^{2}**	.	47^{2}	11^{2}	*2*	.	55^{3}	73^{3}	65^{3}
Sc, pc	*Gentiana clusii*	81^{2}	19^{2}	22^{2}	20^{2}	**77^{2}**	28^{2}	57^{2}	11^{2}	*3*	.	.	78^{2}	45^{2}
pc	*Campanula cochleariifolia*	19^{2}	63^{3}	47^{2}	55^{3}	**56^{2}**	14^{2}	39^{2}	11^{2}	*3*	.	99^{2}	78^{3}	85^{3}
	Racomitrium lanuginosum (E_0)	.	8^{2}	17^{3}	13^{3}	**48^{3}**	17^{3}	35^{3}	.	.	16^{5}	.	.	.
Sc, pc	*Sesleria albicans*	99^{3}	20^{3}	5^{3}	13^{3}	**38^{2}**	.	23^{2}	.	*2*	.	9^{2}	49^{5}	95^{5}
cy	*Asplenium viride*	.	2^{2}	18^{2}	10^{2}	**31^{2}**	.	18^{2}	11^{2}	*3*	3^{1}	.	44^{2}	78^{2}
	Entodon concinnus (E_0)	.	22^{2}	28^{2}	25^{2}	**31^{2}**	.	18^{2}	.	.	39^{2}	18^{2}	20^{2}	.
	Cololejeunea calcarea (E_0)	.	2^{2}	1^{2}	2^{2}	**29^{2}**	.	17^{2}	.	.	.	.	.	.
	Mnium thomsonii (E_0)	.	9^{2}	27^{2}	18^{2}	**27^{2}**	.	16^{2}	.	.	71^{3}	.	4^{2}	3^{2}
	Hymenostylium recurvirostrum(E_0)	.	3^{2}	4^{5}	4^{3}	**23^{2}**	.	14^{2}	.	.	.	.	4^{2}	40^{3}
	Didymodon giganteus (E_0)	.	9^{2}	22^{3}	15^{3}	**21^{5}**	.	13^{5}	.	.	13^{3}	.	2^{2}	13^{3}
	Saxifraga aizoides	.	43^{2}	64^{2}	54^{2}	8^{2}	**78^{3}**	36^{3}	44^{3}	*1*	61^{2}	.	7^{2}	.
	Salix alpina	.	32^{2}	55^{2}	44^{2}	21^{3}	**78^{5}**	44^{5}	67^{5}	.	16^{3}	18^{2}	22^{5}	.
ES, Tr	*Biscutella laevigata*	24^{2}	28^{2}	34^{2}	31^{2}	17^{2}	**75^{3}**	41^{3}	.	.	26^{2}	.	13^{2}	15^{2}
	Huperzia selago	.	1^{2}	8^{2}	4^{2}	6^{2}	**67^{2}**	31^{2}	22^{2}	.	16^{2}	.	7^{2}	8^{1}
	Parnassia palustris	5^{1}	10^{2}	10^{2}	10^{2}	12^{2}	**56^{2}**	30^{2}	22^{2}	*1*	32^{2}	.	24^{2}	.
cf, ac	*Pyrola carpatica*	.	1^{3}	8^{2}	4^{2}	6^{2}	**47^{3}**	23^{3}	.	.	76^{3}	.	.	.
	Vaccinium myrtillus	.	.	.	.	6^{2}	**47^{2}**	23^{2}	44^{5}	.	5^{2}	.	13^{3}	3^{1}
	Dicranum scoparium (E_0)	.	1^{1}	5^{2}	3^{2}	13^{2}	**42^{5}**	25^{3}	11^{5}	.	29^{5}	.	2^{3}	28^{2}
ES	*Scabiosa lucida*	.	16^{2}	4^{2}	10^{2}	.	**36^{2}**	15^{2}	11^{3}	*1*	8^{2}	.	49^{3}	18^{2}
JT	*Festuca supina*	.	2^{2}	3^{2}	3^{2}	.	**31^{5}**	13^{5}	.	.	39^{3}	.	2^{2}	.
	Pogonatum urnigerum (E_0)	.	.	.	.	.	**19^{5}**	8^{5}	.	.	.	.	.	.
Caricion firmae														
pc	*Carex firma*	99^{7}	98^{6}	99^{7}	99^{7}	99^{7}	99^{7}	99^{7}	33^{3}	*2*	71^{5}	99^{5}	78^{6}	85^{6}
	Dryas octopetala	99^{3}	57^{5}	90^{5}	74^{5}	83^{5}	99^{7}	90^{6}	67^{5}	.	89^{5}	27^{2}	42^{5}	20^{6}

(cont.)

Table 1. *Continued.*

Community		A	B1	B2	B	C1	C2	C	D	Ds	E	F	G	H
ac, cy	*Ranunculus alpestris*	?	53^{2}	93^{2}	74^{2}	99^{3}	97^{3}	99^{3}	89^{3}	*4*	79^{2}	55^{2}	38^{3}	53^{3}
fv	*Bistorta vivipara*	81^{2}	66^{2}	78^{2}	72^{2}	50^{2}	94^{3}	68^{3}	33^{3}	*3*	99^{4}	36^{2}	27^{2}	.
fv	*Bartsia alpina*	57^{2}	23^{2}	51^{2}	37^{2}	79^{2}	97^{3}	**86^{3}**	56^{4}	*4*	68^{2}	.	33^{2}	18^{3}
pc	*Saxifraga caesia*	95^{3}	69^{3}	65^{3}	67^{2}	77^{3}	39^{3}	61^{3}	.	.	5^{1}	55^{3}	27^{3}	.
	Pedicularis rosea	29^{2}	.	.	.	.	.	.	.	.	.	.	.	.
	Arenaria ciliata	29^{2}	.	.	.	.	.	.	.	.	.	.	.	.
	Sesleria sphaerocephala	29^{3}	.	.	.	.	.	.	.	.	.	.	.	.
	Gentiana terglouensis	29^{2}	.	.	.	.	.	.	.	.	.	.	.	.
	Phyteuma sieberi	10^{2}	.	.	.	.	.	.	.	.	.	.	.	.
Seslerio-Asterion alpini														
Pc	*Dianthus *praecox*	.	6^{2}	.	3^{2}	.	6^{2}	2^{2}	22^{2}	*2*	.	.	29^{2}	.
	Hieracium villosum	.	8^{2}	.	4^{2}	.	3^{2}	1^{2}	.	.	.	.	31^{2}	.
	Rhodax rupifragus	.	.	2^{3}	1^{3}	2^{2}	.	1^{2}	.	.	.	.	.	.
	Festuca tatrae	.	1^{2}	.	1^{2}	.	.	.	.	.	.	.	29^{2}	35^{2}
	Leontodon incanus	.	1^{3}	.	1^{3}	.	.	.	.	.	.	.	4^{3}	13^{2}
	*Allium *montanum*	.	2^{1}	.	1^{1}	.	.	.	.	.	.	.	2^{2}	.
	Gentianella fatrae	.	.	.	.	8^{2}	.	5^{2}	.	.	.	.	16^{2}	8^{2}
	Pulsatilla slavica	.	.	.	.	4^{2}	.	2^{2}	.	.	.	.	9^{2}	3^{2}
	Acinos alpinus	.	.	.	.	2^{3}	.	1^{3}	.	.	.	.	4^{2}	.
	Veronica fruticans	.	.	.	.	.	.	.	.	*2*	.	.	11^{2}	.
	Arctostaphyllos uva-ursi	.	.	.	.	.	.	.	.	*1*	.	.	2^{8}	.
	Saussurea discolor	.	.	.	.	.	.	.	.	.	.	.	11^{5}	10^{2}
	Allium ochroleucum	.	.	.	.	.	.	.	.	.	.	.	9^{2}	8^{2}
Seslerietalia coerulae, Elyno-Seslerietea														
Sc, cy	*Bellidiastrum michelii*	38^{2}	23^{2}	43^{3}	34^{2}	52^{2}	56^{3}	53^{3}	11^{3}	*3*	21^{3}	.	58^{3}	93^{5}
	Galium anisophyllon	5^{1}	76^{2}	48^{2}	62^{2}	60^{2}	64^{2}	61^{2}	56^{2}	.	95^{2}	18^{2}	64^{2}	55^{2}
	Phyteuma orbiculare	.	37^{2}	25^{2}	31^{2}	52^{2}	56^{2}	53^{2}	33^{3}	*3*	61^{2}	.	67^{2}	90^{2}
st	*Sesleria tatrae*	.	22^{2}	47^{2}	35^{2}	13^{3}	28^{3}	19^{3}	78^{3}	.	74^{2}	9^{2}	33^{5}	3^{1}
Sc	*Thymus pulcherrimus*	.	11^{2}	9^{2}	10^{2}	.	17^{2}	7^{2}	11^{2}	*2*	.	.	60^{3}	28^{3}
	Helianthemum grandiflorum	.	18^{2}	11^{2}	14^{2}	.	11^{2}	5^{2}	11^{3}	.	3^{2}	.	31^{2}	.
	Gentiana verna	48^{2}	3^{2}	3^{2}	3^{2}	2^{2}	22^{2}	10^{2}	.	.	3^{2}	.	24^{3}	.
Sc	*Anthyllis *alpestris*	90^{3}	21^{2}	12^{2}	16^{2}	8^{2}	39^{3}	20^{3}	.	.	.	.	20^{2}	.
Sc, pc	*Veronica aphylla*	5^{1}	2^{2}	14^{2}	8^{2}	.	11^{1}	5^{1}	.	.	.	.	22^{3}	.
Sc, fv	*Potentilla crantzii*	.	.	2^{2}	1^{2}	.	14^{2}	6^{2}	.	.	5^{2}	.	2^{2}	.
st	*Linum extraaxillare*	.	2^{1}	2^{2}	2^{1}	.	.	.	.	.	5^{2}	.	.	.
	Thesium alpinum	.	.	1^{2}	1^{2}	.	.	.	.	.	.	.	11^{2}	18^{2}
Sc	*Polygala *brachyptera*	.	12^{2}	.	6^{2}	.	.	.	.	.	.	.	31^{2}	40^{2}

	Gymnadenia conopsea	.	2^{2}	.	1^{2}	.	.	.	.	.	.	.	2^{1}	5^{1}
st	*Astragalus frigidus*	.	1^{2}	1^{2}	1^{2}	.	.	.	11^{3}	.	18^{3}	.	.	.
sa	*Oxytropis *tatrae*	.	1^{5}	1^{2}	1^{3}	.	.	.	.	.	.	.	.	.
st	*Astragalus australis*	10^{2}	7^{2}	.	3^{2}	.	.	.	.	.	8^{2}	.	.	.
st, cf	*Ranunculus thora*	10^{1}	4^{1}	4^{2}	4^{2}	.	.	.	.	.	32^{3}	.	2^{2}	.
st	*Tephroseris capitata*	.	1^{1}	.	1^{1}	.	.	.	.	.	8^{1}	.	.	.
st	*Astragalus norvegicus*	.	.	1^{2}	1^{2}	.	.	.	.	.	5^{2}	.	.	.
st	*Bupleurum ranunculoides*	.	13^{2}	2^{2}	8^{2}	.	.	.	.	.	.	.	4^{2}	.
	Carduus glaucinus	.	3^{2}	.	2^{2}	.	.	.	.	.	.	.	7^{3}	.
	Traunsteinera globosa	.	1^{2}	.	1^{2}	.	.	.	.	.	.	.	.	.
st	*Astragalus alpinus*	.	.	.	.	.	.	.	.	.	5^{3}	.	.	.
Sc	*Globularia cordifolia*	24^{2}	.	.	.	.	.	.	.	.	.	.	4^{2}	3^{1}
Sc	*Carex ericetorum*	24^{2}	.	.	.	.	.	.	.	.	.	.	.	8^{3}
Sc	*Festuca pumila*	90^{3}	.	.	.	.	.	.	.	.	.	.	.	.
Sc	*Carex mucronata*	38^{5}	.	.	.	.	.	.	.	.	.	.	.	.
Sc	*Achillea clavennae*	24^{2}	.	.	.	.	.	.	.	.	.	.	.	.
Sc	*Pedicularis rostrato-capitata*	10^{2}	.	.	.	.	.	.	.	.	.	.	.	.
Sc	*Oxytropis campestris*	5^{2}	.	.	.	.	.	.	.	.	.	.	.	.
Carici rupestris-Kobresietea														
	Carex rupestris	67^{2}	11^{6}	.	5^{6}	2^{6}	.	1^{6}	.	.	.	.	2^{7}	.
	Carex capillaris	.	7^{2}	1^{2}	4^{2}	2^{2}	.	1^{2}	.	.	13^{3}	.	.	.
	Elyna myosuroides	48^{2}	.	.	.	.	.	.	.	.	.	.	.	.
	Kobresia simpliciuscula	.	19^{3}	10^{5}	14^{5}	.	.	.	.	.	.	27^{3}	.	.
Sc	*Oxytropis halleri*	.	4^{2}	1^{2}	3^{2}	.	.	.	.	.	24^{2}	.	.	.
fv	*Comastoma tenellum*	.	11^{2}	10^{2}	10^{2}	.	.	.	.	.	24^{2}	.	.	.
	Gentiana nivalis	.	4^{2}	2^{2}	3^{2}	.	.	.	.	.	5^{2}	.	.	.
Festucion versicoloris														
	Festuca versicolor	.	99^{5}	99^{5}	99^{5}	96^{3}	92^{5}	94^{5}	99^{6}	*4*	97^{5}	99^{5}	62^{5}	13^{5}
	Pedicularis verticillata	.	43^{2}	25^{2}	34^{2}	48^{2}	81^{2}	61^{2}	89^{2}	.	47^{2}	9^{2}	47^{3}	23^{2}
cf	*Hedysarum hedysaroides*	5^{1}	7^{3}	22^{2}	14^{2}	.	8^{3}	3^{3}	11^{3}	.	66^{5}	.	.	.
oe, an	*Saxifraga oppositifolia*	.	8^{3}	8^{2}	8^{2}	.	.	.	.	.	8^{2}	9^{2}	.	.
oe	*Ligusticum mutellinoides*	.	3^{2}	12^{2}	8^{2}	.	.	.	.	.	87^{3}	.	.	.
	Carex fuliginosa	.	10^{2}	15^{2}	13^{2}	.	.	.	.	.	82^{3}	.	.	.
oe	*Antennaria carpatica*	.	1^{2}	4^{2}	3^{2}	.	.	.	.	.	29^{3}	.	.	.
	Saussurea alpina	.	3^{2}	1^{2}	2^{2}	.	.	.	.	.	26^{2}	.	.	.
	*Luzula *mutabilis*	.	.	1^{2}	1^{2}	.	.	.	.	.	32^{2}	.	.	.
	Dianthus glacialis	.	.	2^{2}	1^{2}	.	.	.	.	.	24^{2}	.	.	.
	Agrostis alpina	43^{2}	2^{3}	.	1^{3}	.	.	.	.	.	.	.	.	.

(cont.)

Table 1. *Continued.*

Community		A	B1	B2	B	C1	C2	C	D	Ds	E	F	G	H
Loiseleurio-Vaccinion														
	Vaccinium vitis-idaea	.	4^{1}	17^{2}	11^{2}	42^{2}	89^{5}	**61^{3}**	67^{5}	*1*	45^{3}	.	24^{3}	8^{2}
	Empetrum hermaphroditum	.	1^{3}	1^{2}	1^{3}	17^{2}	25^{2}	20^{2}	33^{5}	.	.	.	2^{3}	.
	Vaccinium gaultherioides	5^{1}	2^{3}	2^{2}	2^{2}	.	.	.	.	.	5^{2}	.	.	.
st	*Euphrasia tatrae*	.	1^{2}	.	1^{2}	.	.	.	.	.	3^{2}	.	.	.
	Salix kitaibeliana	.	.	1^{2}	1^{2}	.	.	.	.	.	3^{2}	.	.	.
Caricetalia curvulae, Juncetea trifidi														
	Cetraria islandica (E_0)	71^{2}	39^{2}	72^{3}	55^{2}	40^{2}	36^{3}	39^{3}	.	.	89^{2}	.	24^{2}	10^{2}
	Sanionia uncinata (E_0)	.	4^{2}	13^{2}	9^{2}	15^{3}	31^{3}	22^{3}	11^{3}	.	71^{3}	.	.	.
	Polytrichum alpinum (E_0)	.	.	7^{2}	3^{2}	.	8^{3}	3^{3}	22^{5}	.	39^{5}	.	.	.
	Carex atrata	.	1^{3}	10^{2}	5^{2}	.	14^{2}	6^{2}	.	.	68^{3}	.	.	.
	Campanula tatrae	.	16^{2}	14^{2}	15^{2}	.	.	.	.	.	61^{2}	.	20^{3}	.
ns	*Luzula sudetica*	.	1^{2}	1^{2}	1^{2}	.	.	.	.	.	61^{2}	.	.	.
	Campanula alpina	.	3^{2}	9^{2}	6^{2}	.	.	.	.	.	55^{3}	.	.	.
	Primula minima	.	4^{2}	22^{2}	13^{2}	.	.	.	.	.	53^{3}	.	9^{2}	.
	Oreochloa disticha	.	1^{3}	3^{3}	2^{3}	.	.	.	.	.	21^{3}	.	.	.
	Cetraria cucullata (E_0)	.	7^{2}	9^{3}	8^{2}	.	.	.	.	.	3^{2}	.	.	.
	Cetraria nivalis (E_0)	19^{1}	10^{2}	11^{2}	10^{2}	.	.	.	.	.	3^{3}	.	.	.
	Cladonia arbuscula (E_0)	.	3^{2}	2^{2}	3^{2}	.	.	.	.	.	3^{2}	.	.	.
	Cladonia gracilis (E_0)	.	7^{2}	12^{2}	9^{2}	.	.	.	.	.	3^{2}	.	.	.
jt	*Juncus trifidus*	.	.	1^{2}	1^{2}	.	.	.	.	.	26^{3}	.	.	.
	Pulsatilla scherfelii	.	.	1^{2}	1^{2}	.	.	.	.	.	3^{2}	.	.	.
	Gentiana frigida	.	.	.	.	.	.	.	.	.	11^{2}	.	.	.
	Avenula versicolor	.	.	.	.	.	.	.	.	.	8^{2}	.	.	.
jt	*Hieracium alpinum*	.	.	.	.	.	.	.	.	.	5^{3}	.	.	.
jt	*Senecio *carpathicus*	.	.	.	.	.	.	.	.	.	3^{3}	.	.	.
Arabidion coeruleae														
	Sedum atratum	48^{2}	7^{2}	.	3^{2}	.	.	.	.	.	.	9^{1}	.	.
pt	*Saxifraga wahlenbergii*	.	1^{2}	38^{2}	20^{2}	12^{2}	19^{2}	15^{2}	56^{2}	.	82^{2}	.	.	13^{2}
	Myosotis alpestris	.	3^{2}	14^{2}	9^{2}	8^{2}	6^{2}	7^{2}	22^{2}	.	89^{2}	.	.	.
pt	*Pritzelago alpina*	.	7^{2}	22^{2}	14^{2}	2^{2}	.	1^{2}	11^{2}	.	29^{2}	.	.	.
	Leontodon pseudotaraxaci	.	4^{2}	16^{2}	10^{2}	.	6^{3}	2^{3}	.	.	26^{3}	.	2^{1}	.
	Veronica alpina	.	1^{1}	.	1^{1}	.	.	.	.	.	3^{2}	.	7^{2}	.
an	*Saxifraga androsacea*	.	.	.	.	4^{2}	.	2^{2}	.	.	29^{2}	.	.	.
st	*Cardaminopsis halleri*	.	.	.	.	.	.	.	.	.	47^{2}	.	.	.

	Tofieldia pusilla	.	.	.	.	.	.	.	.	.	11^{3}	.	.	.
	Carex atrofusca	.	.	.	.	.	.	.	.	.	8^{2}	.	.	.
	Arctous alpina	.	.	.	.	.	.	.	.	.	5^{5}	.	.	.
Salicetalia herbaceae, Salicetea herbaceae														
	Luzula alpinopilosa	.	.	.	.	.	.	.	.	.	21^{2}	.	.	.
fp, an	*Doronicum stiriacum*	.	.	.	.	.	.	.	.	.	8^{5}	.	.	.
fp	*Festuca picturata*	.	.	.	.	.	.	.	.	.	3^{3}	.	.	.
Potentillion caulescentis														
cf	*Crepis jacquinii*	76^{2}	83^{3}	65^{3}	74^{3}	88^{3}	53^{3}	74^{3}	11^{2}	*2*	13^{3}	82^{2}	62^{3}	93^{5}
cf	*Draba aizoides*	43^{2}	34^{2}	30^{2}	32^{2}	15^{2}	.	9^{2}	11^{2}	.	11^{2}	55^{2}	36^{2}	.
sa	*Minuartia langii*	.	4^{2}	.	2^{2}	2^{2}	3^{2}	2^{2}	.	*1*	.	.	44^{2}	.
	Kernera saxatilis	10^{1}	11^{2}	.	5^{2}	4^{1}	.	2^{1}	.	.	.	.	38^{2}	10^{3}
sa	*Gypsophila repens*	14^{1}	18^{3}	1^{2}	9^{3}	4^{3}	.	2^{3}	.	.	.	.	13^{2}	.
	Draba tomentosa	.	12^{2}	9^{2}	10^{2}	.	.	.	.	.	.	36^{2}	.	.
	Artemisia eriantha	.	10^{2}	1^{2}	5^{2}	.	.	.	.	.	.	36^{2}	.	.
	Petrocallis pyrenaica	.	.	.	.	.	.	.	.	.	.	99^{2}	.	.
Cystopteridion														
	Cystopteris fragilis	.	2^{2}	1^{2}	2^{2}	10^{2}	.	6^{2}	22^{2}	*2*	3^{1}	.	18^{2}	45^{2}
	Neckera crispa (E_0)	.	4^{2}	.	2^{2}	10^{2}	.	6^{2}	.	.	.	.	9^{3}	53^{3}
	Valeriana tripteris	.	.	.	.	.	.	.	11^{2}	*1*	.	.	.	28^{2}
	Carex brachystachys	.	.	.	.	.	.	.	.	.	.	.	7^{2}	35^{2}
Gp	*Gymnocarpium robertianum*	.	.	.	.	.	.	.	.	.	.	.	2^{2}	20^{2}
Potentilletalia caulescentis, Asplenietea trichomanis														
AT	*Tortella tortuosa* (E_0)	48^{2}	88^{3}	96^{5}	92^{5}	65^{5}	72^{5}	68^{5}	22^{5}	.	66^{3}	91^{3}	67^{3}	90^{5}
Pc	*Ditrichum flexicaule* (E_0)	10^{1}	78^{3}	66^{3}	72^{3}	63^{3}	67^{3}	65^{3}	22^{5}	.	61^{3}	72^{3}	49^{3}	85^{5}
Pc, Sc	*Saxifraga paniculata*	14^{1}	42^{2}	48^{2}	45^{2}	33^{2}	50^{2}	40^{2}	44^{2}	*4*	71^{5}	.	60^{3}	38^{2}
Pc	*Fissidens cristatus* (E_0)	5^{1}	6^{2}	8^{3}	7^{2}	27^{2}	3^{3}	17^{2}	.	.	.	9^{2}	9^{2}	58^{2}
Pc	*Asplenium ruta-muraria*	.	4^{2}	.	2^{2}	.	.	.	.	.	.	.	18^{2}	5^{2}
Pc	*Hieracium bupleuroides*	.	.	.	.	.	.	.	.	.	.	.	4^{3}	3^{2}
Thlaspietea rotundifolii														
pt	*Cerastium *glandulosum*	.	6^{2}	8^{2}	7^{2}	.	.	.	.	.	18^{3}	9^{2}	4^{2}	.
pt	*Delphinium oxysepalum*	.	.	1^{1}	1^{1}	.	.	.	33^{2}	.	3^{2}	.	.	.
aa, cy	*Arabis alpina*	.	.	2^{2}	1^{2}	.	.	.	22^{2}	.	.	.	.	3^{2}
an	*Saxifraga hieraciifolia*	.	.	2^{2}	1^{2}	.	.	.	.	.	34^{2}	.	.	.
pt, ac	*Papaver tatricum*	.	.	1^{2}	1^{2}	.	.	.	.	.	.	.	.	.
an	*Saxifraga bryoides*	.	.	.	.	.	.	.	.	.	3^{2}	.	.	.

(cont.)

Table 1. *Continued.*

Community		A	B1	B2	B	C1	C2	C	D	Ds	E	F	G	H
Other taxa														
	Picea abies	.	3^{1}	3^{1}	3^{1}	29^{2}	33^{2}	31^{2}	11^{1}	.	8^{1}	.	7^{2}	75^{2}
	Pinus mugo	.	6^{1}	15^{2}	10^{1}	42^{2}	25^{3}	35^{2}	11^{1}	.	8^{2}	.	7^{2}	5^{2}
	Cardaminopsis arenosa agg.	.	7^{2}	15^{2}	11^{2}	21^{2}	28^{1}	24^{2}	.	.	16^{2}	9^{1}	22^{2}	15^{2}
	Gentianella lutescens	.	44^{2}	22^{2}	33^{2}	29^{2}	36^{1}	32^{2}	.	.	.	.	44^{2}	20^{2}
tf	*Rhodiola rosea*	.	32^{2}	14^{2}	23^{2}	.	11^{2}	5^{2}	44^{2}	.	5^{2}	27^{2}	2^{1}	.
	Homogyne alpina	5^{1}	.	1^{2}	1^{2}	.	14^{2}	6^{2}	11^{5}	.	16^{3}	.	11^{2}	.
	Anemone narcissiflora	.	.	2^{2}	1^{2}	.	14^{2}	6^{2}	.	.	11^{2}	.	4^{2}	.
	Carex sempervirens	.	17^{2}	9^{2}	13^{2}	6^{2}	28^{3}	15^{3}	.	.	53^{2}	.	36^{5}	.
	Ranunculus pseudomontanus	.	1^{2}	5^{2}	3^{2}	2^{1}	6^{2}	3^{1}	22^{2}	.	.	.	29^{2}	.
	Coeloglossum viride	.	2^{1}	3^{2}	3^{1}	2^{1}	.	1^{1}	.	.	37^{2}	.	4^{2}	.
	Bistorta major	.	1^{2}	1^{2}	1^{2}	.	.	.	11^{7}	.	29^{2}	.	.	.
	Larix decidua	.	1^{2}	1^{1}	1^{2}	4^{2}	.	2^{2}	.	.	.	.	7^{2}	25^{2}
	Jovibarba globifera	.	1^{2}	.	1^{2}	2^{2}	3^{2}	2^{2}	.	.	.	.	13^{2}	3^{2}
	Botrychium lunaria	.	2^{2}	1^{2}	2^{2}	.	.	.	.	.	5^{2}	.	.	.
	Salix silesiaca	.	.	.	.	10^{2}	3^{2}	7^{2}	.	.	.	.	9^{3}	73^{2}
	Hieracium bifidum	.	.	.	.	6^{3}	3^{1}	5^{2}	.	.	.	.	16^{2}	23^{2}
	Luzula sylvatica	.	.	.	.	.	6^{2}	2^{2}	33^{3}	.	.	.	.	3^{1}
	Luzula luzuloides	.	.	.	.	.	3^{2}	1^{2}	22^{3}	*1*	3^{2}	.	4^{1}	.
	Potentilla aurea	.	.	1^{2}	1^{2}	.	3^{2}	1^{2}	11^{2}	.	5^{2}	.	11^{2}	.
	Carex ornithopoda	5^{1}	1^{1}	.	1^{1}	2^{2}	.	1^{2}	.	*2*	.	.	11^{3}	5^{3}
	Pseudorchis albida	.	6^{2}	9^{2}	7^{2}	2^{1}	8^{2}	5^{2}	11^{2}	.	8^{2}	.	.	.
	Pimpinella major	.	.	.	.	2^{2}	.	1^{2}	11^{3}	.	.	.	4^{2}	3^{2}
	Clematis alpina	.	.	.	.	2^{2}	.	1^{2}	.	*1*	.	.	2^{2}	8^{2}
	Hieracium caesium	.	.	2^{1}	1^{1}	.	3^{2}	1^{2}	.	.	.	.	4^{2}	.
	Ligusticum mutellina	.	.	1^{2}	1^{2}	.	8^{2}	3^{2}	.	.	5^{3}	.	7^{2}	.
	Saxifraga ×patens	.	1^{1}	.	1^{1}	.	6^{1}	2^{1}	.	.	.	.	.	.
	Sorbus aucuparia	.	2^{1}	1^{1}	2^{1}	19^{2}	6^{2}	14^{2}	11^{1}	.	.	.	2^{2}	20^{1}
	Thymus alpestris	.	8^{2}	2^{2}	5^{2}	.	3^{2}	1^{2}	.	.	16^{2}	.	11^{2}	.
	Juncus triglumis	.	.	1^{2}	1^{2}	.	.	.	.	.	3^{2}	.	.	.
	Aconitum firmum	.	.	.	.	.	3^{2}	1^{2}	22^{2}	.	5^{2}	.	.	.
	Lotus corniculatus	5^{1}	.	.	.	.	3^{5}	1^{5}	.	.	.	.	22^{2}	.
	Campanula serrata	.	.	.	.	.	.	.	11^{2}	.	.	.	7^{2}	5^{1}
	Primula elatior	.	.	.	.	.	.	.	33^{2}	.	3^{1}	.	4^{2}	.
	*Achillea *alpestris*	.	.	.	.	.	.	.	11^{2}	.	3^{2}	.	2^{2}	.
	Saxifraga mutata	.	.	.	.	4^{2}	.	2^{2}	.	.	.	.	.	.
	Solidago virgaurea	.	.	.	.	.	.	.	.	.	3^{1}	.	2^{2}	3^{3}
	Pinus sylvestris	.	.	.	.	.	.	.	.	.	.	.	2^{1}	23^{4}

Calamagrostis varia	.	.	.	.	.	.	.	.	.	.	.	4^{3}	30^{3}
Melampyrum sylvaticum	.	.	.	.	.	.	.	.	.	.	.	7^{2}	20^{2}
Arabis pumila	24^{2}	.	.	.	.	.	.	.	.	.	.	.	.
Campanula scheuchzeri	19^{2}	.	.	.	.	.	.	.	.	.	.	.	.
Valeriana saxatilis	14^{2}	.	.	.	.	.	.	.	.	.	.	.	.
Gentianella campestris	14^{1}	.	.	.	.	.	.	.	.	.	.	.	.
Soldanella minima	10^{2}	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla nitida	10^{2}	.	.	.	.	.	.	.	.	.	.	.	.
Polygala alpestris	10^{1}	.	.	.	.	.	.	.	.	.	.	.	.
Soldanella alpina	10^{1}	.	.	.	.	.	.	.	.	.	.	.	.
*Thymus *polytrichus*	10^{1}	.	.	.	.	.	.	.	.	.	.	.	.
Daphne arbuscula	.	.	.	.	.	.	.	.	.	.	.	11^{5}	.
Acer pseudoplatanus	.	.	.	.	.	.	.	.	.	.	.	.	25^{1}
Genista pilosa	.	.	.	.	.	.	.	.	.	.	.	.	18^{2}
Galium austriacum	.	.	.	.	.	.	.	.	.	.	.	.	15^{2}
Carex humilis	.	.	.	.	.	.	.	.	.	.	.	.	10^{5}
Bryophytes & Lichens (E_0)													
Cladonia pyxidata	38^{2}	2^{2}	13^{2}	8^{2}	2^{2}	3^{3}	2^{3}	.	.	.	.	4^{3}	3^{2}
Schistidium apocarpum	.	26^{2}	12^{2}	19^{2}	8^{2}	6^{3}	7^{2}	11^{5}	.	3^{2}	73^{3}	27^{2}	23^{2}
Hylocomium splendens	.	4^{5}	33^{2}	19^{3}	50^{3}	89^{5}	$\mathbf{66^{5}}$	56^{5}	.	89^{6}	.	9^{3}	53^{3}
Rhytidiadelphus triquetrus	.	6^{3}	27^{2}	16^{2}	27^{2}	36^{3}	31^{3}	11^{3}	.	92^{3}	.	13^{2}	20^{3}
Rhytidium rugosum	.	40^{2}	40^{2}	40^{2}	33^{3}	22^{3}	28^{3}	22^{5}	.	45^{3}	.	33^{3}	8^{2}
Distichium capillaceum	.	23^{2}	50^{2}	37^{2}	27^{2}	8^{2}	19^{2}	11^{5}	.	50^{3}	.	22^{3}	58^{2}
Ctenidium molluscum	.	30^{2}	57^{2}	43^{2}	50^{3}	56^{3}	52^{3}	.	.	13^{2}	18^{2}	31^{3}	88^{5}
Campylium chrysophyllum	5^{1}	4^{2}	12^{2}	8^{2}	4^{2}	11^{3}	7^{3}	.	.	21^{3}	9^{2}	4^{2}	8^{3}
Bryum elegans	5^{1}	.	8^{2}	4^{2}	13^{2}	.	8^{2}	.	.	3^{3}	45^{2}	2^{2}	18^{2}
Hypnum vaucheri	.	11^{2}	3^{2}	7^{2}	6^{3}	11^{5}	8^{3}	.	.	.	45^{2}	2^{2}	5^{2}
Fulgensia bracteata	.	18^{2}	2^{2}	10^{2}	2^{2}	.	1^{2}	.	.	.	55^{2}	2^{2}	3^{2}
Plagiochila porelloides	.	3^{2}	18^{2}	11^{2}	10^{2}	.	6^{2}	.	.	53^{2}	.	7^{2}	30^{2}
Distichium inclinatum	.	4^{2}	5^{2}	5^{2}	10^{2}	.	6^{2}	.	.	5^{2}	.	13^{2}	23^{2}
Thuidium philibertii	.	2^{1}	1^{2}	2^{1}	6^{2}	.	3^{2}	.	.	24^{2}	.	2^{2}	3^{2}
Pleurozium schreberi	.	2^{2}	9^{2}	5^{2}	6^{2}	19^{3}	11^{3}	.	.	24^{3}	.	4^{2}	.
Homalothecium philippeanum	.	13^{2}	1^{2}	7^{2}	2^{2}	3^{3}	2^{3}	.	.	3^{2}	.	29^{3}	.
Encalypta alpina	.	24^{2}	29^{3}	27^{3}	4^{2}	.	2^{2}	.	.	5^{2}	.	11^{3}	.
Ctenidium procerrimum	.	40^{3}	25^{2}	32^{3}	4^{3}	.	2^{3}	.	.	3^{2}	.	7^{2}	.
Myurella julacea	5^{1}	14^{2}	14^{2}	14^{2}	6^{2}	.	3^{2}	.	.	8^{2}	9^{2}	.	.
Megaspora verrucosa	.	21^{2}	20^{3}	20^{2}	2^{2}	.	1^{2}	.	.	3^{2}	27^{2}	.	.
Ptilidium ciliare	.	1^{1}	3^{2}	2^{2}	2^{3}	6^{3}	3^{3}	.	.	47^{2}	.	.	.
Encalypta streptocarpa	.	8^{2}	4^{2}	6^{2}	6^{2}	.	3^{2}	.	.	.	36^{2}	9^{2}	10^{2}

(cont.)

Table 1. *Continued.*

Community	A	B1	B2	B	C1	C2	C	D	Ds	E	F	G	H
Solorina bispora	.	17^2	18^2	18^2	4^2	3^2	3^2	.	.	.	18^2	.	3^2
Lecanora epibryon	.	12^2	16^2	14^2	2^2	.	1^2	.	.	.	27^2	.	.
Psora decipiens	19^2	7^2	1^2	4^2	.	.	.	.	.	.	18^2	2^2	.
Solorina saccata	14^1	1^2	10^2	5^2	.	.	.	.	.	.	.	4^2	15^2
Campylium halleri	.	1^2	9^2	5^2	15^2	.	9^2	.	.	.	.	4^2	30^2
Barbula crocea	.	1^3	1^2	1^3	27^2	.	16^2	.	.	.	.	2^2	58^3
Racomitrium canescens	.	1^2	2^2	2^2	8^5	.	5^5	.	.	21^2	.	2^2	.
Pohlia cruda	.	2^2	8^2	5^2	2^2	.	1^2	.	.	50^2	.	.	.
Dicranum spadiceum	.	1^2	11^2	6^2	4^2	.	2^2	.	.	47^3	.	.	.
Dicranum fuscescens	.	1^1	.	1^1	.	.	.	.	.	21^3	.	2^2	3^5
Cirriphyllum cirrosum	.	6^2	25^2	15^2	.	.	.	.	.	16^2	.	.	.
Plagiopus oederiana	.	.	3^3	2^3	6^2	.	3^2	.	.	5^2	.	2^5	35^3
Meesia uliginosa	.	.	15^2	8^2	8^2	.	5^2	.	.	24^2	.	.	15^2
Blepharostoma trichophyllum	.	.	12^2	6^2	10^2	.	6^2	.	.	47^2	.	.	8^2
Tritomaria quinquedentata	.	.	1^2	1^2	6^2	.	3^2	.	.	34^2	.	.	15^2
Timmia austriaca	.	.	2^2	1^2	.	.	.	11^2	.	37^2	.	.	13^2
Scapania cuspiduligera	.	.	2^2	1^2	.	.	.	.	.	21^2	.	.	.
Philonotis tomentella	.	.	1^2	1^2	.	.	.	.	.	26^3	.	.	.
Xanthoria elegans	.	2^2	.	1^2	.	.	.	.	.	.	82^3	.	.
Lophozia bantriensis	.	.	1^2	1^2	.	.	.	.	.	.	.	4^2	28^2
Isopterygiopsis pulchella	.	.	.	.	.	.	.	.	.	26^2	.	.	.
Polytrichum formosum	.	.	.	.	.	.	.	.	.	21^5	.	.	.
Number of the accesoric taxa E_1	12	6	8	13	2	7	8	8	0	6	0	40	31
Number of the accesoric taxa E_0	5	80	82	124	35	23	55	3	0	57	4	32	37

EXPLANATIONS

aa – *Arabidion alpinae*, ac – *Arabidion coerulae*, an – *Androsacion alpinae*, AT – *Asplenietea trichomanis*, cf – *Caricion firmae*, cy – *Cystopteridion*, ES – *Elyno-Seslerietea*, fv – *Festucion versicoloris*, fp – *Festucion pictae*, Gp – *Galio-Parietalia officinalis*, JT – *Juncetea trifidi*, jt – *Juncion trifidi*, ns – *Nardion strictae*, oe – *Oxytropido-Elynion*, Pc – *Potentilletalia caulescentis*, pc – *Potentillion caulescentis*, pt – *Papaverion tatrici*, sa – *Seslerio-Asterion alpini*, Sc – *Seslerietalia coerulae*, st – *Seslerion tatrae*, tf – *Trisetion fusci*, Tr – *Thlaspietalia rotundifolii*, (cy) – taxon with lower relation to the relevant syntaxon and with coenological optimum also in other syntaxon; ? – taxa recorded in the association *Caricetum firmae* Rübel 1911 by other authors (cf. Grabherr *et al*. 1993: 407)

SOURCES

A: *Caricetum firmae*: 21 – Braun-Blanquet & Jenny 1926, Table 7, r. 1–21, Alps;

B1: *Arenario tenellae-Caricetum firmae typicum*: 1 – Braun-Blanquet 1930: 25, Belianske Tatry Mts (*Caricetum firmae tatricum*); 7 – Dúbravcová *et al.* 1980 (Msc.), Table 1, r. 12–18, Západné Tatry Mts (*Dryadeto-Caricetum firmae*); 5 – Hadač *et al.* 1969: 63–64, r. 136, 214, 218, 231, 240, Belianske Tatry Mts (*Dryadetum octopetalae tatricum*); 3 – Hadač *et al.* 1969: 58–59, r. 24, 153, 154, Belianske Tatry Mts (*Caricetum firmae carpaticum*); 2 – Pawłowski 1935, Table 2, r. 3, 7, Belianske Tatry Mts (*Caricetum firmae carpaticum*); 2 – Šmarda *et al.* 1971, Table 2, r. 1, 3, Belianske Tatry Mts (*Caricetum firmae*); 67 – Petrík ined., Belianske Tatry Mts (65), Vysoké Tatry Mts (2); 3 – Valachovič ined., Belianske Tatry Mts;

B2: *A.-C. salicetosum reticulatae*: 11 – Dúbravcová *et al.* 1980 (Msc.), Table 1, r. 1–11, Západné Tatry Mts (*Dryadeto-Caricetum firmae*); 2 – Hadač *et al.* 1969: 58–59, r. 149, 150, Belianske Tatry Mts (*Caricetum firmae carpaticum*); 10 – Pawłowski & Stecki 1927, Table 2, r. 7–9, 13–17, West Tatras, Table 2., r. 21, 22, Belianske Tatry Mts (*Firmetum*); 5 – Pawłowski 1935, Table 2, r. 1, 2, 4, 6, 8, West Tatras (*Caricetum firmae carpaticum*); 4 – Šmarda *et al.* 1971, Table 2, r. 2, 4 – 6, Belianske Tatry Mts (*Caricetum firmae*); 10 – Unar *et al.* 1984, Table 15, r. 1–10, Západné Tatry Mts (*Caricetum firmae carpaticum*); 48 – Petrík ined., Belianske Tatry Mts (29), Vysoké Tatry Mts (1), Západné Tatry Mts (18); 2 – Valachovič ined., Belianske Tatry Mts;

C1: *Dryado octopetalae-Caricetum firmae primuletosum auriculae*: 2 – Bělohlávková & Fišerová 1976, Table 1, r. 1, 5, Krivánska Malá Fatra Mts (*Dryadeto-Firmetum*); 1 – Pawłowski 1935, Table 2, r. 5, Chočské vrchy Mts (*Caricetum firmae carpaticum*); 5 – Sillinger 1933: 223, r. 1–5, Nízke Tatry Mts (*Dryadeto-Firmetum*); 1 – Bernátová ined., Chočské vrchy Mts; 2 – Mucina ined., Nízke Tatry Mts (1), Chočské vrchy Mts (1); 22 – Petrík ined., Krivánska Malá Fatra Mts (10), Nízke Tatry Mts (9), Chočské vrchy Mts (3); 6 – Šibík 2003, Table 3, r. 28–33, Krivánska Malá Fatra Mts; 8 – Švandová-Ursíniová 1966, Table 1, r. 1–8, Chočské vrchy Mts; 5 – Valachovič ined., Nízke Tatry Mts (4), Chočské vrchy Mts (1);

C2: *D.-C. saxifragetosum aizoidis*: 8 – Bělohlávková & Fišerová 1976, Table 1, r. 2–4, 6–10, Krivánska Malá Fatra Mts (*Dryado-Firmetum*); 1 – Bernátová ined., Krivánska Malá Fatra Mts; 27 – Šibík 2003, Table 3, r. 1–27, Krivánska Malá Fatra Mts;

D: *Androsaceo lacteae-Festucetum versicoloris*: 4 – Bělohlávková 1980, Table 8, r. 12–15, Krivánska Malá Fatra Mts; 2 – Milová & Urbanová 1989: 295, Krivánska Malá Fatra Mts; 1 – Švandová-Ursíniová 1966, Table 1, r. 9, Chočské vrchy Mts; 1 – Bernátová ined., Chočské vrchy Mts; 1 – Mucina ined., Chočské vrchy Mts;

Ds: ass. *Festuca versicolor-Androsace lactea*: 4 – Sillinger 1933: 229–230, Nízke Tatry Mts;

E: *Dryado octopetalae-Salicetum reticulatae*: 1 – Bernátová ined., Belianske Tatry Mts; 37 – Petrík ined., Belianske Tatry Mts;

F: *Drabo tomentosae-Artemisietum petrosae*: 10 – Marhold & Valachovič 1990, Table 2, r. 1–10, Belianske Tatry Mts; Šmarda 1971, Table 1, r. 103, Belianske Tatry Mts (ass. *Artemisia petrosa-Draba tomentosa*);

G: *Potentillion caulescentis/Seslerio-Asterion alpini*: 8 – Pawłowski & Stecki 1927, Table 2, r. 5, 6, 10, 11, 18–20, 23, West Tatras (*Firmetum*); 5 – Szafer *et al.* 1923, Table 13, r. 1–5, West Tatras (*Caricetum firmae*); 2 – Szafer *et al.* 1923, Table 12, r. 1–2, West Tatras (*Dryadetum*); 3 – Valachovič & Jarolímek 1994, Table 1, r. 29–31, Muránska planina Mts (comm. with *Carex firma*); 13 – Bernátová ined., Západné Tatry Mts (1), Veľká Fatra Mts (12); 13 – Petrík ined., Chočské vrchy Mts (4), Krivánska Malá Fatra Mts (1), Muránska planina Mts (2), Nízke Tatry Mts (3), Veľká Fatra Mts (2), Západné Tatry Mts (1); 1 – Šibík 2003, Table 3, r. 34, Krivánska Malá Fatra Mts;

H: *Cystopteridion/Seslerio-Asterion alpini*: 7 – Šimeková & Pitoniak 1976, Table 1, r. 1–4 (*Caricetum firmae*), Table 2, r. 1–3 (comm. *Sesleria varia-Dryas octopetala*), Slovenský raj Mts; 17 – Bernátová ined., Krivánska Malá Fatra Mts (1), Lúčanská Malá Fatra Mts (1), Veľká Fatra Mts (15); 16 – Petrík ined., Muránska planina Mts (9), Slovenský raj Mts (6), Veľká Fatra Mts (1).

The association *Arenario tenellae-Caricetum firmae* occurs on limestone and dolomite bedrock, on moderate to steep slopes with a rather thick layer of detritus, but also on steep rocky slopes. The occurrence of species of individual higher syntaxa indicates that the association shows close syngenetic relationships to communities of the alliance *Potentillion caulescentis* (in the alpine belt) and *Seslerio-Asterion alpini* (in the subalpine belt). On sites with a deeper soil profile which diminishes the influence of basic bedrock, the occurrence of species of the alliances *Arabidion coerulae*, *Festucion versicoloris* and *Juncion trifidi* increases, depending on moisture and slope orientation. This phenomenon evidences the process of succession, which eventually may lead to the formation of those communities.

Arenario tenellae-Caricetum firmae typicum Petrík *subass. nov. hoc loco*

Table 1, column B1

DIFFERENTIAL SPECIES: *Aster alpinus*, *Euphrasia salisburgensis*, *Leontopodium alpinum*, *Oxytropis carpatica*, *Ranunculus breyninus*, *Trisetum alpestre*, *Squamarina gypsacea*.

NOMENCLATURAL TYPE: identical with the type of the association name.

Plant communities of this subassociation are open, show average abundance of about 55–70%, and inhabit various sites on limestone and dolomite in the alpine and sometimes the subalpine belt of the Tatra Mts. Usually they occur on moderate to steep, mostly north-facing slopes with geests of various depths, but often can be found also on steep to abrupt rock walls situated on peaks and edges of various orientations. The layer of detritus is 15–30 cm (sometimes even 40–50) cm deep, and contains only a small amount of fine earth, retaining only a small amount of water. These communities therefore appear to be more xerophilous.

Plant communities of the typical subassociation occur mainly in the Belianske Tatry Mts. In the Západné Tatry Mts, these communities usually occur on rather steep and dry rocky sites.

Based on differences in ecological conditions, two variants can be distinguished: the typical one, and a variant with *Kobresia simpliciuscula*. The typical variant comprises communities on stabilized dolomite scree slopes. The communities on rocky sites are positively differentiated by *Gentiana clusii*, *Bellidiastrum michelii* and *Anthyllis vulneraria* subsp. *alpestris*. The variant with *Kobresia simpliciuscula* is concentrated on limestone of high-mountain ridges. Unlike the typical variant, it is differentiated by *Oxytropis carpatica* and *Dactylina madreporiformis*. Based on the constant presence of those differential taxa and overall floristic similarities (except for a higher proportion of *Lloydia serotina* and *Carex fuliginosa*), communities with *Carex rupestris* codominant to dominant can also be assigned to this variant.

Arenario tenellae-Caricetum firmae salicetosum reticulatae Petrík *subass. nov. hoc loco*

Table 1, column B2

DIFFERENTIAL TAXA: *Salix reticulata*, *S. retusa*, *Selaginella selaginoides*, *Soldanella carpatica*, *Swertia perennis* subsp. *alpestris*, *Viola alpina*, *Campylium stellatum*, *Hypnum bambergeri*, *Orthothecium rufescens*.

NOMENCLATURAL TYPE: Petrík ined., holotypus

LOCALITY: Belianske Tatry Mts, Zadné Jatky Mt., northern slope, alt. 1920 m, aspect: N, slope: 35°, relevé area: 20 m^2, cover total: 90%, E_1: 80%, E_0: 30%, 3. 8. 1995

E_1: *Carex firma* 3, *Dryas octopetala* 3, *Silene acaulis* 2b, *Saxifraga paniculata* 2a, *Bistorta vivipara* 1, *Festuca versicolor* 1, *Minuartia gerardii* 1, *Pedicularis oederi* 1, *Salix reticulata* 1, *Saxifraga aizoides* 1, *Swertia *alpestris* 1, *Androsace chamaejasme* +, *Bartsia alpina* +, *Campanula alpina* +, *Carex fuliginosa* +, *Cerastium eriophorum* +, *Crepis jacquinii* +, *Dichodon cerastoides* +, *Draba aizoides* +, *Galium anisophyllon* +, *Hedysarum hedysaroides* +, *Huperzia selago* +, *Ligusticum mutellinoides* +, *Lloydia serotina* +, *Minuartia sedoides* +, *Myosotis alpestris* +, *Phyteuma orbiculare* +, *Pinguicula alpina* +, *Pyrola carpatica* +, *Ranunculus alpestris* +, *Rhodax alpestris* +, *Salix retusa* +, *Saxifraga wahlenbergii* +, *Selaginella selaginoides* +, *Soldanella carpatica* +, *Vaccinium vitis-idaea* +, *Chamorchis alpina* r.

E_0: *Dicranum spadiceum* 2a, *Ditrichum flexicaule* 2a, *Hylocomium splendens* 2a, *Tortella tortuosa* 2a, *Campylium stellatum* +, *Cirriphyllum cirrosum* +, *Cte-*

nidium molluscum +, *Distichium capillaceum* +, *Encalypta alpina* +, *Hypnum bambergeri* +, *Orthothecium rufescens* +, *Pleurozium schreberi* +, *Polytrichum* sp. +, *Rhytidium rugosum* +, *Schistidium apocarpum* +, *Cetraria islandica* +, *Cladonia *pocillum* +.

Within the association *Arenario tenellae-Caricetum firmae,* stands of *A.-C. salicetosum reticulatae* are slightly more hygrophilous. They occur on moderate to steep, mostly north-facing, wind-exposed slopes in the subalpine and alpine belts. They occupy rather deep soils, usually with well-developed but often discontinuous layers of black fine humic earth 5–15 cm thick. The soils exhibit high retention of water; this determines the occurrence of hygrophilous and humicolous species, which are the differential species of the association. In comparison with the typical subassociation, these communities have a higher proportion and abundance of mosses.

Based on differences in ecological conditions, three variants can be distinguished within this subassociation: with *Cerastium eriophorum*, with *Viola alpina*, and with *Dianthus nitidus*.

Plant communities of the variant with *Cerastium eriophorum* occur mostly in the alpine belt of the Belianske Tatry Mts. They are positively differentiated by the species *Kobresia simpliciuscula*, *Comastoma tenella*, *Primula minima*, and by higher constancy of *Arenaria tenella*, *Minuartia gerardii*, *Rhodax alpestris* and some other taxa as well.

The variant with *Viola alpina* comprises communities occurring in the subalpine to alpine belts of the Červené vrchy Mts in the Západné Tatry Mts. It is positively differentiated by *Viola alpina* and characterized by higher constancy of *Bellidiastrum michelii* and *Pedicularis verticillata*. In contrast to the previous variant, the variant with *Viola alpina* is positively differentiated also by *Bartsia alpina*, *Sesleria tatrae* and *Selaginella selaginoides*.

Plant communities treated within the variant with *Dianthus nitidus* occur on Sivý vrch Mt. in the Západné Tatry Mts. These communities occupy a marginal position in the association *Arenario tenellae-Caricetum firmae*. The occurrence of *Dianthus nitidus* and the overall floristic composition indicate that they are transitional towards the association *Dryado octopetalae-Caricetum firmae*, and thus are interesting phytogeographically. Kliment *et al.* (2004) observed a similar phenomenon supporting the intermediate position of vegetation on Sivý vrch Mt. between the Chočské vrchy Mts and limestone parts of the Západné Tatry Mts (cf. Futák 1976: 109–110), in the associations *Diantho nitidi-Caricetum tatrorum* (Sillinger 1933) Kliment *et al.* 2004, and *Trifolio kotulae-Caricetum tatrorum* Kliment *et al.* 2004.

Dryado octopetalae-Caricetum firmae Sillinger 1933

Table 1, column C

ORIGINAL FORM OF THE NAME: *Dryadeto-Firmetum* Sillinger 1933

SYNONYMS: *Caricetum firmae* Klika 1932 p.p. maj. (Art. 31), *Firmetum* (= *Caricetum firmae*) *carpaticum* Pawłowski 1935 p.p. min. (Art. 34), *Saxifrago caesiae-Caricetum firmae* (Szafer *et al.* 1923) Hadač in Mucina & Maglocký 1985 p.p. min. (Art. 2b), *Festuco versicoloris-Dryadetum* (Szafer *et al.* 1923) Hadač in Mucina & Maglocký 1985 p.p. maj. (Art. 2b), *Caricetum firmae chočense* Klika 1932 (nom. nud.). – NON: *Caricetum firmae* Szafer *et al.* 1923, *Dryadetum* Szafer *et al.* 1923, *Firmetum* Klika 1926, *Firmetum* Pawłowski & Stecki 1927, *Dryadetum octopetalae tatricum* Hadač *et al.* 1969.

DIAGNOSTIC TAXA: *Carex firma* (dom., const.), *Dryas octopetala* (dom., const.), *Bartsia alpina* (dif.[1]), *Dianthus nitidus* (dif.), *Pinguicula alpina* (dif.), *Selaginella selaginoides* (dif.[1]), *Soldanella carpatica* (dif.[1]), *Tofieldia calyculata* (dif.), *Vaccinium vitis-idaea* (dif.[1]), *Hylocomium splendens* (dif.[1]), *Hypnum cupressiforme* (dif.), *Bistorta vivipara* (const.), *Crepis jacquinii* (const.), *Festuca versicolor* (const.), *Galium anisophyllon* (const.), *Pedicularis verticillata* (const.), *Ranunculus alpestris* (const.), *Saxifraga caesia* (const.), *Ditrichum flexicaule* (const.), *Tortella tortuosa* (const.).

[1] Differential taxa against the association *Arenario tenellae-Caricetum firmae.*

NOMENCLATURAL TYPE: Sillinger 1933: 223, rel. 2, lectotypus hoc loco.

This is a two-layered, moderately species-rich plant community (average 34 taxa per relevé) with dominance of hemicryptophytes and

chamaephytes. Generally speaking, the cushion-forming dwarf shrub *Dryas octopetala* and tufted sedge *Carex firma* are prominent, giving *Dryado octopetalae-Caricetum firmae* its distinctive stamp. Differences in the abundance of these two species do not basically change the floristic composition of the phytocoenoses. The height of the stands ranges from 5 to 15 cm (tufts, leaves) and from 15 to 30 cm (stems, stalks), with *Festuca versicolor* being a subdominant species. Numerous conspicuously flowering species (*Bartsia alpina*, *Bistorta vivipara*, *Crepis jacquinii*, *Dianthus nitidus*, *Galium anisophyllon*, *Pedicularis verticillata*, *Pinquicula alpina*, *Ranunculus alpestris*, *Saxifraga caesia*, *Selaginella selaginoides*, *Soldanella carpatica*, *Tofieldia calyculata*) and dwarf shrubs (*Vaccinium vitis-idaea*) are constant elements of these stands. The layer of mosses and lichens is well-developed; the most common species are *Tortella tortuosa*, *Ditrichum flexicaule* and *Hylocomium splendens*.

The association *Dryado-Caricetum firmae* is a chionophobic and sub-hygrophilous plant community inhabiting shallow soils developed on calcareous and dolomite bedrock (lithosol) in the supramontane and subalpine belts (alt. 1300–1750 m). It occurs mainly on sites with extreme climatic conditions, such as ridges and edges exposed to strong winds, where the snow layer is thin and of brief duration. It occupies moderate to steep (20–80°), mostly north-facing slopes, rocky walls and rocky crevices with cold and humid climate. Rarely it occurs also on sites oriented in other directions (SW, W); in these cases it is restricted to rocky walls and stabilized screes, and forms a type transitional towards rock fissure communities. The soils inhabited by these communities are black, strongly humic, neutral to slightly basic protorendzinas (= Rendzi-Lithic Leptosols), with many bedrock fragments; due to the extreme climatic conditions on mountain edges, raw litter accumulates among tufts of *Carex firma* (Sillinger 1933: 226; Bělohlávková & Fišerová 1976: 138–139).

This is an autochthonous community growing on limestone and dolomite bedrock, inhabiting steep, often shady rocky slopes and cliffs. The frequent occurrence of species of the class *Asplenietea trichomanis* (Table 1) indicates its close relationship to rock fissure communities. When it inhabits windy slopes subject to erosion, with rather deep skeletal soils developed, succession processes may lead to the formation of the association *Seslerio tatrae-Festucetum versicoloris*. On lee and often rather concave sites with thick soils developed, species of the genus *Sesleria* (*S. albicans, S. tatrae*) and *Carex sempervirens* subsp. *tatrorum* are common; the community is gradually replaced by phytocoenoses of the association *Diantho nitidi-Caricetum tatrorum*. On less exposed sites with typically humid climate enforced by a north orientation and a thick layer of accumulated litter, the association *Dryado-Caricetum firmae* is transformed into shrub communities of the alliance *Loiseleurio-Vaccinion*.

Two subassociations are distinguished here, based on differences in the ecology and floristic composition of the stands:

Dryado octopetalae-Caricetum firmae primuletosum auriculae *subass. nov. hoc loco*

Table 1, column C1

DIFFERENTIAL TAXA: *Primula auricula* subsp. *hungarica*, *Asplenium viride*, *Campanula cochleariifolia*, *Gentiana clusii*, *Sesleria albicans*, *Cololejeunea calcarea*, *Didymodon giganteus*, *Entodon concinnus*, *Hymenostylium recurvirostrum*, *Mnium thomsonii*, *Orthothecium rufescens*, *Racomitrium lanuginosum.*

NOMENCLATURAL TYPE: identical with the type of the association name.

Stands of the subassociations *D.-C. primuletosum auriculae* occur mainly on steep, north-facing rocky sites, small narrow terraces and rocky crevices, but can be found also on windy rocky ledges and slopes. Several taxa of the class *Asplenietea trichomanes* indicate relationships to rock communities. As already noted by Sillinger (1933: 224), two ecological variants can be distinguished, with more or less identical floristic composition. On mainly north-facing rocky terraces and shady rocky crevices, stands with a well-developed moss layer occur. Compact tufts of *Carex firma* and mats of *Dryas octopetala*, together with mosses, play

an important role in retaining moisture on the site. On very exposed sites, such as windy slopes and mountain edges, the layer of mosses is less developed, and more xerophilous species like *Racomitrium lanuginosum* also occur at higher frequency. This subassociation is documented from the Krivánska Malá Fatra, Chočské vrchy and Nízke Tatry Mts.

Dryado octopetalae-Caricetum firmae saxifragetosum aizoidis *subass. nov. hoc loco*

Table 1, column C2

DIFFERENTIAL SPECIES: *Saxifraga aizoides*, *Biscutella laevigata*, *Festuca supina*, *Huperzia selago*, *Parnassia palustris*, *Pyrola carpatica*, *Salix alpina*, *Scabiosa lucida*, *Vaccinium myrtillus*, *Dicranum scoparium*, *Pogonatum urnigerum*.

NOMENCLATURAL TYPE: Šibík & Dúbravcová ined., holotypus

LOCALITY: Krivánska Malá Fatra Mts, Veľký Kriváň Mt., near the hiking trail giving from ground elevation 'Hrana Veľkého Kriváňa' to height, alt. 1679 m, aspect: NNW, slope: 20°, relevé area: 25 m^2, cover total: 95%, E_1: 95%, E_0: 30%, 49°11′20,9″; 19°01′47,0″, 1. 8. 2002

E_1: *Carex firma* 4, *Dryas octopetala* 3, *Festuca versicolor* 2a, *Tofieldia calyculata* 2a, *Bartsia alpina* 1, *Biscutella laevigata* 1, *Bistorta vivipara* 1, *Pinguicula alpina* 1, *Ranunculus alpestris* 1, *Saxifraga aizoides* 1, *Selaginella selaginoides* 1, *Vaccinium vitis-idaea* 1, *Anemone narcissiflora* +, *Anthyllis *alpestris* +, *Bellidiastrum michelii* +, *Campanula cochleariifolia* +, *Dianthus nitidus* +, *Empetrum hermaphroditum* +, *Galium anisophyllon* +, *Gentiana verna* +, *Gentianella *tatrae* +, *Helianthemum grandiflorum* +, *Huperzia selago* +, *Parnassia palustris* +, *Pedicularis verticillata* +, *Phyteuma orbiculare* +, *Salix alpina* +, *Saxifraga paniculata* +, *Scabiosa lucida* +, *Soldanella carpatica* +, *Vaccinium myrtillus* +, *Veronica aphylla* +, *Viola biflora* +.

E_0: *Hylocomium splendens* 2a, *Tortella tortuosa* 2a, *Bryum* sp. 1, *Campylium stellatum* 1, *Ditrichum flexicaule* 1, *Hypnum cupressiforme* 1, *Orthothecium rufescens* 1, *Rhytidium rugosum* 1, *Sanionia uncinata* 1, *Ctenidium molluscum* +, *Hypnum bambergeri* +, *H. vaucheri* +, *Rhizomnium punctatum* +, *Rhytidiadelphus triquetrus* +, *Cetraria islandica* +, *Icmadophila ericetorum* +.

In comparison with the previous subassociation, *D.-C. saxifragetosum aizoidis* are more hygrophilous and much more closed, due to the presence of compact tufts of *Carex firma* and mats of *Dryas octopetala*. On sites with extremely exposed slopes, typical garland soils can be observed.

The subassociation is developed on north- (rarely west)-facing sites on mountain edges with very foggy climate. So far it has been documented by phytocoenological relevés only from the Krivánska Malá Fatra Mts, where it occurs extensively on north and northwest slopes of Veľký Kriváň Mt., Malý Kriváň Mt. and Chleb Mt.

In the past, communities of this subassociation probably covered smaller areas. After destruction of the subalpine shrubs during the Walachian colonization in the 16th and 17th centuries (cf. Janík 1971: 69; Plesník 1955: 30) they spread from enclaves among *Pinus mugo* stands and from steep slopes.

On sites with a thicker accumulated layer of undecomposed humus, the occurrence of acidophilous species (e.g., *Empetrum hermaphroditum*) and bryophytes (*Sphagnum* spp.) increases; succession processes may further lead to the formation of *Pinus mugo* stands. These processes are very slow, however, because stands of the subassociation *D.-C. saxifragetosum aizoidis* represent a blocked successional stage with a fixed and closed species composition.

The strongly hygrophilous character of the stands indicates some transition to the association *Androsaceo lacteae-Festucetum versicoloris*.

At present, communities of the association *D.-C. saxifragetosum aizoidis* are endangered by planting of *Pinus mugo* (cf. Bernátová *et al.* 1998: 50, 51), as compact tufts of *Carex firma* are often destroyed, and alien species introduced. Near hiking trails there is also a risk of trampling.

Androsaceo lacteae-Festucetum versicoloris Sillinger 1933

Table 1, columns D, Ds

ORIGINAL FORM OF THE NAME: Ass. *Festuca versicolor-Androsace lactea* Sillinger 1933

DIAGNOSTIC TAXA: *Festuca versicolor* (dom., const.), *Androsace lactea* (dif.), *Cortusa matthioli* (dif.), *Cystopteris montana* (dif.), *Poa alpina* (dif.), *Saxifraga moschata* (dif.), *Viola biflora* (dif.), *Bartsia alpina*

(const.), *Dryas octopetala* (const.), *Galium anisophyllon* (const.), *Pedicularis verticillata* (const.), *Ranunculus alpestris* (const.), *Salix alpina* (const.), *Saxifraga paniculata* (const.), *Sesleria tatrae* (const.), *Soldanella carpatica* (const.), *Swertia perennis* subsp. *alpestris* (const.), *Vaccinium vitis-idaea* (const.)

NOMENCLATURAL TYPE: Milová & Urbanová 1989: 295, rel. 1, neotypus hoc loco

This is a two-layer community, not very rich in species (at average 27 taxa per relevé), determined by compact tufts of the dominant species and mosses. The occurrence of several hygrophilous species (*Androsace lactea*, *Cortusa matthioli*, *Ranunculus alpestris*, *Saxifraga moschata*, *Swertia* **alpestris*, *Viola biflora*) indicates the high moisture of these stands. The communities are developed in the highest parts of mountains on steep rocky slopes, and on lee terraces in relatively protected areas in the supramontane to subalpine belt (alt. 1450–1650 m). They inhabit shallow black skeletal soils on limestone and dolomite bedrock (protorendzinas) with high content of humus. Very wet and shady, mostly north-facing sites are occupied. In the winter, snow lies longer, especially on less steep terraces or on lee sites free of strong winds.

It is an autochthonous and stable community growing on shady rocks, developed from some rock fissure communities with *Festuca versicolor* as the dominant species. Its floristic composition resembles very wet stands of the association *Dryado octopetalae-Caricetum firmae* (Sillinger 1933: 229). Higher chionophility together with high constancy of *Ranunculus alpestris* and *Saxifraga wahlenbergii* point to its intermediate position towards communities of the alliance *Arabidion coerulae*.

The community is documented by phytocoenological relevés or a synoptic table from the highest parts of the Krivánska Malá Fatra, Chočské vrchy and Nízke Tatry Mts; Sillinger (1933: 232) reported it also from the Lúčanská Malá Fatra Mts (Kľak Mt.), and from the Veľká Fatra Mts. Judging by its floristic composition, a relevé of the association *Festucetum versicoloris* Domin 1925 from the supramountane belt of the Krivánska Malá Fatra (Bělohlávková & Fišerová 1978: 108) can be also assigned to this subassociation.

DISCUSSION AND CONCLUSION

In phytocoenological studies, *Carex firma* has been treated mostly as a diagnostic taxon of the alliances *Caricion firmae* (char.) and *Potentillion caulescentis* (dif.). West Carpathian populations of this species occupy steep calcareous and dolomite slopes and rocky walls in the montane and alpine belts; more rarely they grow also on inversion sites in the Muránska planina, Slovenský raj, Malá Fatra, Veľká Fatra, Chočské vrchy, Nízke Tatry, Západné Tatry and Belianske Tatry Mts, including calcareous foothills of the Polish Tatra Mts. In most of those mountain ranges (except for the Veľká Fatra Mts), *Carex firma* often co-occurs with *Dryas octopetala*, which also has its coenological optimum in the alliance *Caricion firmae*. The abundance ratio of these two species in plant communities varies, ranging from almost equal abundance to the strong dominance of one of them.

Significant differences in the abundance of *Carex firma* and *Dryas octopetala*, altering the physiognomy of the respective stands, led Szafer *et al.* (1923: 43–46, Tabs 12, 13) to distinguish two separate associations: *Caricetum firmae* and *Dryadetum*. Similarly, Hadač *et al.* (1969: 59–64) reported two associations from the Dolina Siedmich prameňov valley in the Belianske Tatry Mts: *Caricetum firmae carpaticum* (Br.-Bl.) Pawł. 1956 and *Dryadetum octopetalae tatricum*. Hadač (in Mucina & Maglocký 1985: 187) followed the concept of Szafer *et al.* (1923), and published the names *Saxifrago caesiae-Caricetum firmae* and *Festuco versicoloris-Dryadetum*, replacing illegitimate names (the names *Caricetum firmae* and *Dryadetum octopetalae* were already published by Rübel 1911: 94, 95, 176). Plant communities with *Dryas octopetala* have been included in the association *Caricetum firmae* (*Firmetum*) by other authors also, either as facies (Pawłowski & Stecki 1927: 91) or as a stage (Klika 1932: 150). Sillinger (1933: 221) was the first to show that dominance change does not bring alterations in the overall composition of the community, and stressed this by describing a new association, *Dryadeto-Firmetum*.

The plant communities of the alpine and subalpine belts in the central Western Carpathians are treated variously by different authors. Pawłowski and Stecki (1927: 90) noted the variability of floristic composition, and distinguished two altitudinal elements (variants?): an alpine one with *Viola alpina*, *Minuartia sedoides*, *Salix retusa* and *Ligusticum mutellinoides*: and a subalpine one with *Gentiana clusii*, *Leontopodium alpinum*, *Tofieldia calyculata*, and a higher proportion of *Campanula cochleariifolia*. Klika (1932: 152) used two names to differentiate the subalpine communities of the Krivánska Malá Fatra Mts from the alpine communities of the Tatra Mts, but without presenting relevés: *Firmetum chočense* and *Caricetum firmae tatricum*, respectively. Sillinger (1933: 224) also emphasized the higher species diversity of phytocoenoses in the Tatras. As there were only negative differences between the communities from the Nízke Tatry Mts and those from the Tatra Mts, he considered the former to be only a type of the association *Caricetum firmae* (*Dryadeto-Firmetum*) *tatricum* from the Tatras, somewhat poorer in floristic composition. In line with this, several other authors included both alpine and subalpine communities under the single name *Caricetum firmae* (*Firmetum*) *carpaticum* (Pawłowski 1935: 132; Hadač *et al.* 1969: 55; Unar *et al.* 1985: 32).

Grabherr *et al.* (1993: 406) merged West Carpathian subalpine and alpine phytocoenoses with *Carex firma* with those of the Alpine association *Caricetum firmae* Rübel 1911. However, Vierhapper (1930: 146) and Pawłowski (1935: 132) had already pointed to differences in their floristic composition, and this was also noted, although indirectly, by Braun-Blanquet (1930: 25) when he described the association *Caricetum firmae tatricum*.

Somewhat deviating plant communities from the montane belt of the Veľká Fatra Mts, from cold inversion sites of the Krivánska Malá Fatra and Slovenský raj Mts with dominating *Carex firma*, have often been assigned to the association *Caricetum firmae* or the alliance *Caricion firmae* (Klika 1932: 155–156; Šimeková & Pitoniak 1976: Table 2; Bernátová *et al.* 1982: 142–143).

These conflicting treatments and the confusion surrounding classification of plant communities with dominating *Carex firma* and *Dryas octopetala* stimulated us to make the syntaxonomical revision presented here. Along with already published phytocoenological relevés, numerous unpublished data from the area of Slovakia were used. The results of this revision can be summarized as follows:

1. Our results do not support division of the plant communities with *Carex firma* and *Dryas octopetala* growing on limestone-dolomite bedrock into two associations on the basis of their physiognomy (as reported by Szafer *et al.* 1923; Hadač *et al.* 1969; Hadač in Mucina & Maglocký 1985). Our revision supports the concept proposed by Sillinger (1933: 221), that is, it shows that differences in the abundance of the two species do not significantly alter the floristic composition of the respective phytocoenoses. Nevertheless, the dwarf phytocoenoses with prevalence of *Dryas octopetala* and *Salix reticulata* occurring in the alpine belt of the Belianske Tatry Mts (Table 1, column E), first analyzed by Domin (1929: 9–10) under the name *Dryadeto-Salicetum reticulatae,* were found to represent a separate, well-defined plant community, different from phytocoenoses of the alliance *Caricion firmae* despite their sharing of several species. These communities will be analyzed in detail elsewhere (Petrík *et al.* in prep.).

2. In accord with Klika (1932: 152), we found significant differences in floristic composition between the subalpine communities of the Krivánska Malá Fatra, Chočské vrchy and Nízke Tatry Mts, and those of the alpine to subalpine belts of the Západné and Belianske Tatry Mts (Table 1, columns B, C). These two groups of phytocoenoses are treated here as two different associations. Stands from the subalpine belts can be attributed to the association *Dryado octopetalae-Caricetum firmae* Sillinger 1933. Phytocoenoses from the Tatra Mts were already clearly defined and delimited by Braun-Blanquet (1930: 25). For their designation, we therefore use the name *Arenario tenellae-Caricetum firmae* (Br.-Bl. 1930) *nom. nov*. (basionym: *Caricetum firmae tatricum* Br.-Bl. 1930).

3. The treatment of West Carpathian phytocoenoses with *Carex firma* as identical with the

Alpine association *Caricetum firmae* Rübel 1911 (Grabherr *et al.* 1993: 406) was found to be erroneous. Besides the numerous phytogeographically important species occurring in only one of these two mountain ranges (Alps: *Achillea clavenae*, *Arabis pumila*, *Campanula scheuchzeri*, *Carex mucronata*, *Festuca pumila*, *Gentiana terglouensis*, *Pedicularis rosea*, *P. rostrato-capitata*, *Sesleria sphaerocephala*, *Soldanella alpina*, *S. minima,* etc.; Western Carpathians: *Arenaria tenella*, *Campanula tatrae*, *Cerastium arvense* subsp. *glandulosum*, *Festuca versicolor* subsp. *versicolor*, *Leontodon pseudotaraxaci*, *Oxytropis carpatica*, *Primula auricula* subsp. *hungarica*, *Pyrola carpatica*, *Saxifraga wahlenbergii*, *Sesleria tatrae*, *Soldanella carpatica*, *Thymus pulcherrimus*, etc.), there were also differences in the floristic composition of the respective stands; in particular, several common species are lacking in the poorer Alpine stands (Table 1, columns A–C).

4. According to our results, plant communities with dominance of *Carex firma* occurring on limestone-dolomite peaks of the Veľká Fatra, Lúčanská Malá Fatra and Muránska planina Mts, and from inversion sites of the Krivánska Malá Fatra and Slovenský raj Mts (Table 1, columns G, H), usually classified in the alliance *Caricion firmae*, in fact belong to rock fissure communities of the alliances *Potentillion caulescentis* and *Cystopteridion* (*Leontopodio alpini-Campanuletum cochleariifoliae*, *Bellidiastro michelii-Campanuletum cochleariifoliae*) or to phytocoenoses of the association *Bellidiastro michelii-Seslerietum calcariae* (alliance *Seslerio-Asterion alpini*) advanced in succession. Also, stands from the montane to subalpine belts of the Polish West Tatras (Szafer *et al*. 1923; Pawłowski & Stecki 1927) are much more similar to the communities of these alliances. The question of their final classification will be addressed in another paper (Šibík & Kliment in prep.).

ACKNOWLEDGEMENTS. The authors are grateful to Viera Banásová, Zuzana Dúbravcová, Ivan Jarolímek, František. Krahulec, Ján Ripka and Milan Valachovič for their valuable comments and suggestions on this paper, as well as for providing publications difficult to access. Specimens of some taxonomically difficult species were determined or revised by Jan Kirschner (*Gentianella*), Eduard Králik (*Euphrasia*, *Myosotis*), Martin A. Lysák (*Sesleria*), Pavol Mártonfi (*Thymus*) and Patrick Mráz (*Hieracium*). For determination of moss specimens we are grateful to Katarina Mišíková, Katarina Kresáňová, Barbora Lučeničová and Zdeněk Pilous; lichens were kindly identified by Anna Guttová and Eva Lisická. We thank Zuzana Dúbravcová and Ivana Krajčiová-Šibíková, the co-authors of several phytocoenological relevés included in this revision, as well as Radmila Bělohlávková, Dana Bernátová, Ladislav Mucina, Jana Uhlířová and Milan Valachovič for providing their unpublished phytocoenological relevés, and the anonymous reviewer for valuable suggestions on the manuscript. We are indebted to Viera Banásová, Ivan Jarolímek and especially to Judita Lihová for reviewing the English. This work was supported by the VEGA grant agency (grant nos 1/7452/20, 1/9149/02 and 1/0045/03).

REFERENCES

BARKMAN J. J., DOING H. & SEGAL S. 1964. Kritische Bemerkungen und Vorschläge zur quantitativen Vegetationsanalyse. *Acta Bot. Neerl.* **13**: 394–419.

BĚLOHLÁVKOVÁ R. 1980. Rostlinná společenstva alpínského stupně Kriváňské Malé Fatry. Ph.D. Thesis, Faculty of Natural Sciences, Charles University, Prague.

BĚLOHLÁVKOVÁ R. & FIŠEROVÁ D. 1976. *Pyrola carpatica* – eine neue Art in Gebirge Krivánska Malá Fatra. *Preslia* **48**: 137–142 (in Czech with German summary).

BĚLOHLÁVKOVÁ D. & FIŠEROVÁ D. 1978. New localities of some vascular plants in Slovakia. *Zprávy Československ. Bot. Společn. Československ. Akad. Ved* **13**: 107–112 (in Czech with English summary).

BERNÁTOVÁ D., ŠKOVIROVÁ K. & KLIMENT J. 1982. Flora and extrasilvatic phytocoenoses of the State nature reservation Čierny Kameň in the mountains Veľká Fatra. *Ochr. Prír.* (*Bratislava*) **3**: 137–152 (in Slovak with English summary).

BERNÁTOVÁ D., UHLÍŘOVÁ J. & TOPERCER J. 1998. Some new information on subalpine vegetation of the Krivánska Fatra Mts, and management recommendations. In: M. KORŇAN (ed.), *Výskum a ochrana Krivánskej Fatry*, pp. 49–51. Správa Národného parku Malá Fatra, Varín (in Slovak with English summary).

BRAUN-BLANQUET J. 1930. Zentralalpen und Tatra, eine pflanzensoziologische Paralelle. *Veröff. Geobot. Inst. Rübel Zürich* **6**: 81–123.

BRAUN-BLANQUET J. 1964. Pflanzensoziologie. Grundzüge der Vegetationskunde. 3. Aufl. Springer Verlag, Wien.

BRAUN-BLANQUET J. & JENNY J. 1926. Vegetationsentwicklung

und Bodenbildung in der alpinen Stufe der Zentralalpen. *Denkschr. Schweiz. Naturforsch. Ges.* **63**: 183–349.

COLDEA G., SANDA V., POPESCU A. & ŞTEFAN N. 1997. Les associations végétales de Roumanie. 1. Les associations herbacées naturelles. Presses Universitaires de Cluj, Cluj-Napoca.

DOMIN K. 1925a. Které rostliny stoupají až na nejvyšší vrcholek Bielských Tater? *Věda Přír.* **6**: 258–259.

DOMIN K. 1925b. The flora of the kettle-like mountain-valley between Žďárská Vidla and Havran in the Tatras of Biela. *Spisy Přír. Fak. Karlovy Univ.* **45**: 1–30 (in Czech with English summary).

DOMIN K. 1928. The relations of the Tatra mountain vegetation to the edaphic factors of the habitat. *Acta Bot. Bohem.* **6–7**: 133–163.

DOMIN K. 1929. Contribution to the knowledge of the vegetation and flora of the Mt. Malý Havran in the Tatras of Biela. *Spisy Přír. Fak. Karlovy Univ.* **101**: 3–18 (in Czech with English summary).

DOMIN K. 1930. Zur Soziologie der chionophytischen Pflanzenassoziationen des Tatragebirges. *Veröff. Geobot. Inst. Rübel Zürich* **6**: 167–190.

DOMIN K. 1931. Květena našich Tater, její společenstva a vztahy k podnebí a půdě. Československá akciová tiskárna, Praha.

DOMIN K. 1936. Schedae ad Floram Čechoslovenicam exsiccatam. Centuria IV. *Acta Bot. Bohem.* **11**: 3–50.

DÚBRAVCOVÁ Z. 1996. Spoločenstvá triedy *Juncetea trifidi* v Západných Karpatoch. Ph.D. Thesis, Faculty of Natural Sciences, Comenius University, Bratislava.

DÚBRAVCOVÁ Z. & HAJDÚK J. 1986. Ein Beitrag zur erforschung der Vegetation der subalpinen Stufe des Berges Sivý vrch im westlichen Tatragebirge. *Zborn. Slov. Nár. Múz., Prír. Vedy* **32**: 33–54 (in Slovak with German summary).

EHRENDORFER E. (ed.) 1973. Liste der Gefässpflanzen Mitteleuropas. Gustav Fischer Verlag, Stuttgart.

FUTÁK J. 1976. Phytogeographical division of the Tatra national park and its relation to the neighbouring regions. *Zborník prác o Tatranskom národnom parku* **17**(1975): 109–131 (in Slovak with English summary).

GRABHERR G. & MUCINA L. (eds) 1993. Die Pflanzengesellschaften Österreichs. 2. Natürliche waldfreie Vegetation. Gustav Fischer Verlag, Jena.

GRABHERR G., GREIMLER J. & MUCINA L. 1993. *Seslerietea albicantis*. In: G. GRABHERR & L. MUCINA (eds), *Die Pflanzengesellschaften Österreichs*. **2**: 402–446. Gustav Fischer Verlag, Jena.

HADAČ E., BŘEZINA P., JEŽEK V., KUBIČKA J., HADAČOVÁ V., VONDRÁČEK M. *et al.* 1969. Die Pflanzengesellschaften des Tales "Dolina Siedmich prameňov" in der Belaer Tatra. *Vegetácia ČSSR*, *Ser. B* **2**: 1–343.

JANÍK M. 1971. Pastva na holiach krivánskej Malej Fatry a jej negatívny vplyv na krajinu. *životné prostredie* **5**: 69–75.

JAROLÍMEK I. & SCHLOSSER G. 1997. FYTOPACK – a system of programs to process phytocoenological tables. *Biologia* (*Bratislava*) **52**: 53–59.

KLIKA J. 1926. Quelques remarques géobotaniques sur le Velká Fatra en Slovaquie. *Sborník Přírodovědské Společnosti v Moravské Ostravě* **3**(1924–1925): 38–85 (in Czech with French summary).

KLIKA J. 1932. Der *Seslerion coerulae*-Verband in den Westkarpathen. *Beih. Bot. Centralbl.* **49B**: 133–175.

KLIMENT J., BERNÁTOVÁ D., JAROLÍMEK I. & UHLÍŘOVÁ J. 2004. Floristic composition and syntaxonomy of the communities with *Carex sempervirens* subsp. *tatrorum* in the West Carpathians. *Biologia* (*Bratislava*) **59** (in press).

MAAREL VAN DEN E. 1979. Transformation of cover-abundance values in phytosociology and its effect on community similarity. *Vegetatio* **39**: 97–114.

MARHOLD K. & HINDÁK F. (eds) 1998. Checklist of non-vascular and vascular plants of Slovakia. Veda, Bratislava.

MARHOLD K. & VALACHOVIČ M. 1990. Distribution and ecology of *Petrocallis pyrenaica* (L.) R. Br. in Belanské Tatry Mts. *Biológia* (*Bratislava*) 45: 433–439 (in Slovak with English summary).

MILOVÁ M. & URBANOVÁ V. 1989. Non-forest plant associations of the State nature reserve Prípor. *Ochr. Prír.* (*Bratislava*) **10**: 289–309 (in Slovak with English summary).

MUCINA L. & MAGLOCKÝ Š. (eds) 1985. A list of vegetation units of Slovakia. *Docum. Phytosociol. N. S.* (*Camerino*) **9**: 175–220.

PAWŁOWSKI B. 1935. Über die Klimaxassoziation in der alpinen Stufe der Tatra. *Bull. Int. Acad. Polon. Sci. Lett., Cl. Sci. Math. Nat., Ser. B, Sci. Nat*. (**1**)(1935)**:** 115–146.

PAWŁOWSKI B. & STECKI K. 1927. Die Pflanzenassoziationen des Tatra-Gebirges. IV. Teil: Die Pflanzenassoziationen des Miętusia-Tales und des Hauptmassivs der Czerwone Wierchy. *Bull. Int. Acad. Polon. Sci. Lett., Cl. Sci. Math. Nat., Ser. B, Sci. Nat.,* Suppl. **2**: 79–121.

PODANI J. 1993. SYN-TAX-pc. Computer Programs for Multivariate Data Analysis in Ecology and Systematics. Ver. 5,0. Scientia Publ., Budapest.

PLESNÍK P. 1955. Vplyv pasenia na lesy Krivánskej Malej Fatry. *Les* **2**(1–2): 29–37.

RÜBEL E. 1911. Pflanzengeographische Monographie des Berninagebietes. *Bot. Jahrb. Syst.* **47**: 1–646.

SILLINGER P. 1933. Monografická studie o vegetaci Nízkých Tater. Orbis, Praha.

SZAFER W., PAWŁOWSKI B. & KULCZYŃSKI S. 1923. Die Pflanzenassoziationen des Tatra-Gebirges. I. Teil: Die Pflanzenassoziationen des Chochołowska-Tales. *Bull.*

Int. Acad. Polon. Sci. Lett., Cl. Sci. Math. Nat., Ser. B, Sci. Nath. Suppl. (**1**)(1923): 1–66.

ŠIBÍK J. 2003. Nelesné spoločenstvá subalpínskeho stupňa Kriváskej Malej Fatry. M.Sc. Thesis, Faculty of Natural Sciences, Comenius University, Bratislava.

ŠIMEKOVÁ J. & PITONIAK P. 1976**.** Relic locality of the eight-petaled dryad (*Dryas octopetala L.*) near the Vernár in the natural area of the Slovenský raj Mts. *Biológia* (*Bratislava*) **31**: 783–793 (in Slovak with English summary).

ŠMARDA J. 1956. The vegetable cover of erosively denuded and tundra-like soils in the Tatra Mts. *Biol. Práce Slov. Akad. Vied* **2**(8): 5–50 (in Czech with English summary).

ŠMARDA J., LAZEBNÍČEK J., MATOUŠOVÁ L., NETOPIL R., PACLOVÁ L. & PIKULA J. 1971. To the ecology of plant communities of the Valley Dolina Sedmi pramenů in Belanské Tatry. *Práce a štúdie Československej ochrany prírody pri SÚPSOP v Bratislave*), *Ser. 3* **4**: 5–204 (in Czech with English summary).

ŠVANDOVÁ-URSÍNIOVÁ Ľ. 1966. Skalné spoločenstvá a spoločenstvá plytkých vápencových pôd Chočského pohoria. M.Sc. Thesis, Faculty of Natural Sciences, Comenius University, Bratislava**.**

UNAR J., UNAROVÁ M. & ŠMARDA J. 1984. Vegetation of the Tomanova dolina valley and žľab spod Diery glen in the Západné Tatry Mts. 1. Phytocoenological tables. *Folia Fac. Sci. Nat. Univ. Purkynianae Brun., Ser. Biol.* **25**(10): 5–101 (in Czech with English summary).

UNAR J., UNAROVÁ M. & ŠMARDA J. 1985. Vegetation of the Tomanova dolina valley and žľab spod Diery glen in the Západné Tatry Mts. 2. Description of natural conditions and plant communities. *Folia Fac. Sci. Nat. Univ. Purkynianae Brun., Biol.* **26**(14): 5–78 (in Czech with English summary).

VALACHOVIČ M. & JAROLÍMEK I. 1994. Plant communities with *Daphne arbuscula* Čelak. in Muránska planina Plain. *Bull. Slov. Bot. Spoločn.* 16: 75–82 (in Slovak with English summary).

VALACHOVIČ M., OŤAHEĽOVÁ H., STANOVÁ V. & MAGLOCKÝ Š. 1995. Rastlinné spoločenstvá Slovenska. 1. Pionierska vegetácia. Veda, Bratislava.

VIERHAPPER F. 1930. Vergleichende Studien über die Pflanzenassoziationen der Nordkarpathen und Ostalpen. *Veröff. Geobot. Inst. Rübel Zürich* **6**: 134–166.

WEBER H. E., MORAVEC J. & THEURILLAT J. P. 2000. International Code of Phytosociological Nomenclature. Ed. 3. *J. Veget. Sci.* **11**: 739–768.

Received 2 February 2004