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Development of glade vegetation after secondary spruce forest cutting in Spiš part of Slovenské rudohorie Mts.

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ABSTRACT: The paper describes the development of two stages in glade community of an association *Rubo idaei-Calamagrostietum arundinaceae* FAJMONOVÁ 1986 in Spiš part of Slovenské rudohorie Mts.

KEYWORDS: secondary spruce forests, glade phytocoenoses, development stages

Introduction

In Spiš part of Slovenské rudohorie Mts., glade vegetation usually developed after secondary spruce forests had been cut. These were planted 200-300 years ago on the sites of *Circaeo alpini-Abietetum* ŠOMŠÁK 1982, *Abieti-Fagetum* KLIKA 1936, *Luzulo albidae-Abietetum* OBERD. 1957 associations. Due to its natural regeneration, spruce tree has been gradually creating continuos secondary forests. This continuity has been supported by artificial regeneration by the way of large-area as well as small-area cutting. Sustain regeneration of secondary spruce forests on the same site caused the uniform character of herb layer. Domination of oligo- and semioligotrophic plants as *Avenella flexuosa, Vaccinium myrtillus, Luzula campestris*, *Solidago virgaurea, Maianthemum bifolium, Oxalis acetosella* etc. seems to be a typical feature here. These spruce forests are classified, nowadays, within association *Avenello-culti-Piceetum* HADAČ et SOFRON 1980 nom. nud. Cambisols, Cambic Podzols and Stagni-Cambisols (according ANONYMUS 2000) are dominant soil types in our stands.

Large-area as well as small-area clear-cutting forest regeneration determines the glade phytocoenose development (association *Rubo idaei-Calamagrostietum arundinaceae* FAJMONOVÁ 1986). Several syngenetic stages of this association were described after glade-phytocoenose study had been realized in Spiš part of Slovenské rudohorie Mts. (HALUŠKOVÁ 1998). Stage with *Rubus idaeus* as well as *Calamagrostis arundinacea* stage seems to be of the greatest importance. They are classified as variants from the syntaxonomical point of view (HALUŠKOVÁ 1998). Their genesis is topic what this paper is focused on. Because massive spruce forest dying, glade phytocoenoses are widespread in our study area (for localisation see Fig. 1). They cover approximately 3000 ha within cadastral area of Švedlár Village and Nálepkovo Village. The problem of forest dying in Spiš part of Slovenské rudohorie Mts. is solved in whole scale of its reasons in work of ŠOMŠÁK et al. (1997).

Presented paper is aimed to explain different genesis of two glade-phytocoenose stages of an association *Rubo idaei-Calamagrostietum arundinaceae* FAJMONOVÁ 1986. It deals with *Rubus idaeus* and *Calamagrostis arundinacea* stages.

Methods

Phytocoenose analysing proved the development of glade vegetation after secondary spruce forests. Well closed (80-100 years old) spruce stands as well as thinned stands, that emerged due to sanitation cutting of widely dying spruce individuals, were analysed for their floristic composition (ANTONI 1997). Achieved results were compared with phytocoenoses that developed after one-shot clear cutting in the same conditions in Spiš part of Slovenské rudohorie Mts. Most of material comes from communal forests of Nálepkovo Village where Department of Soil Science of Faculty of Natural Sciences Comenius University in Bratislava

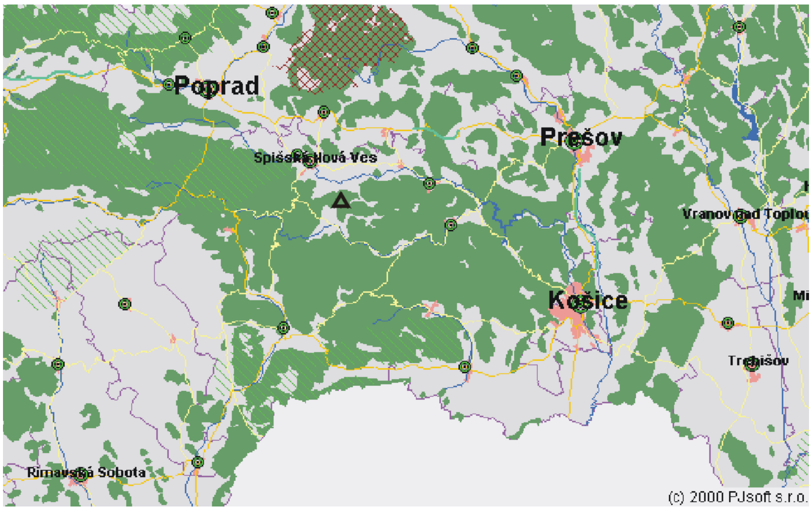


Figure 1: Localisation of study area (∆) in Slovakia

has grant assignment. It is focused on soil and vegetation biodiversity changes under effect of massive Norway spruce dying. Due to comparison, some material was obtained from Forest District of state forests in Stará Voda Village and communal forests in Švedlár Village. All the phytocoenological relevés were sampled according to zürich-montpellier geobotanical school in Braun-Blanquet scale. Nomenclature of vascular plants is according to DOSTÁL et ČERVENKA (1991, 1992). Soils are described and characterized by JURÁNI (1997) and DLAPA et al. (1997).

Results

1. Development of glade phytocoenoses

Glade phytocoenoses develop as a consequence of artificial forest regeneration as well as salvage cutting. The blanks after massive secondary forest dying are dominant in our study area. Sanitation cutting of damaged stands is realized by continuous cutting of dead individuals or individuals of lower vitality according to intensity of spruce dying. One-shot clear cutting of damaged forest or its parts is another method. Area removal of dead forest is, in generally, equal to planned clear-cutting forest regeneration. Two different approaches to liquidation of old parent stands (cutting of individual, continuously dying trees or one-shot area cutting) have, however, different effect on realization of glade plants. This could be reflected within two developing stages.

1.1. Development of glade phytocoenoses after continuous cutting of damaged trees

This way of tree processing means continuous decreasing of stand density and thus the decreasing of total cover of tree canopy as well. Higher solar input into the underbrush evokes abrupt expansion of *Rubus idaeus* population. Its abundance should increase from 5-10 % under well-closed canopy to 60-70 % in 2-3 years. However, it is relatively low (40-70 cm). Herb layer is fully insolated after parent stand was totally cut. Already in the second year after blank has emerged, the population of *Rubus idaeus* largely increases its abundance until the whole area is covered. It is also accompanied with vitality multiplying. There is a considerable increase in its height and leaf percentage. Nearly total obscuration of soil surface and space deficiency determines low vitality of heliophilous grasses, *Calamagrostis arundinacea* including (Tab. Nr. 1., Relevé Nr. 16-20). Tree individuals begin to realise after 5-6 years as soon as this aspect is relatively stable. We especially mean planted as well as natural seeded trees as *Sorbus aucuparia, Salix caprea, Betula pendula*, *Sambucus racemosa* and somewhere *Frangula alnus* (Stagni-Cambisols). These trees gradually repress *Rubus idaeus* with intensity always depending on intensity of forest regeneration.

Total floristic composition of this stage is, in generally, equal to parent phytocoenoses of secondary spruce forests. It is especially true for species number. However, some synanthropic and apophytic species (JURKO 1990) as

Hypericum maculatum, Agrostis tenuis, Potentilla erecta, Campanula patula, Poa pratensis, Calamagrostis epigeios, Galeopsis pubescens, Taraxacum officinale etc. emerge.

Sometimes, especially if *Abies alba* is frequent enough in parent stand, stage with *Senecio fuchsii* foregoes *Rubus idaeus* stage.

1.2. Development of glade phytocoenoses after one-shot cutting of forest

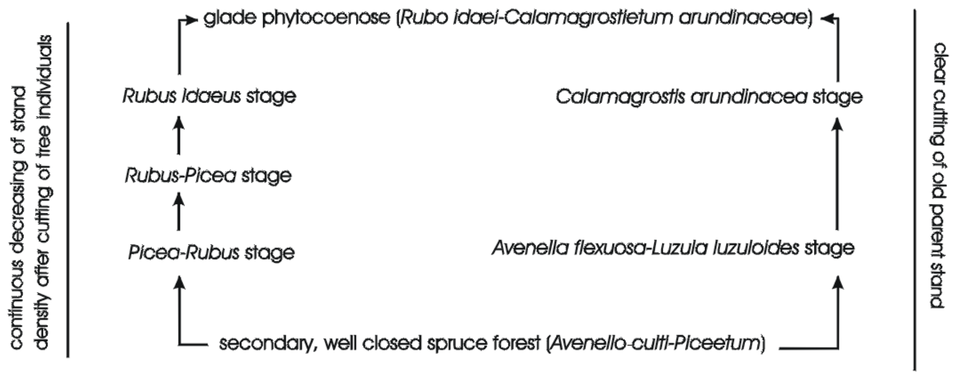
This chapter deals with blanks that emerged after one-shot forest cutting. Abrupt insolation of herb layer under previously well-closed canopy evokes development of grasses - *Calamagrostis arundinacea* that is accompanied by *Avenella flexuosa* and *Luzula luzuloides* especially. *Rubus idaeus* is of low vitality within dense vegetation and huge expansion of *Calamagrostis arundinacea* inhibits its growth. Therefore, *Rubus idaeus* takes only second-rate place in species domination. Total phytocoenological composition of *Calamagrostis arundinacea* stage is presented in Tab. Nr. 1. (Relevé Nr. 21-25).

Calamagrostis arundinacea stage covers also calamity blanks, especially those after one-shot clear cutting in large areas of dead spruce forests. These calamity blanks dominate in our study area. Communal forests of Village of Nálepkovo can serve as a typical example. From 3 200 ha, there are nowadays approximately 800 ha of damaged forests. Under conditions described above, it was found out stage developing as follows:

Parent stand → *Avenella flexuosa* and *Luzula luzuloides* stage (2-3 years after clear cutting) → *Calamagrostis arundinacea* stage (3-4 years after clear cutting) → association *Rubo idaei-Calamagrostietum arundinaceae* (5-9 years after clear cutting) → stage of regenerated forest

2. Schematic pattern of glade vegetation stage developing

Based on mentioned above, we can summarise following idea of glade vegetation stage developing in secondary-progressive succession on blanks that emerged after artificial forest regeneration and calamity disintegration.



3. Glade phytocoenoses and forest regeneration

Glades after massive spruce dying are regularly regenerated by voluntary planting (artificial regeneration). We have to mention also supporting role of natural seeding and young natural reproduction that are widely used in reforestation. In any case, glades are the objects that considerably prolong regeneration time. They are also objects that require high financial investment to take care of plantations (repeated grass cutting around the seedlings and wildlings) during initial years (1-5 years). Based on average data documentation of Head Office of communal forests of Nálepkovo, treatment costs calculated per one-hectare range between 6000-8000 Sk per year. It costs from 24 000 to 32 000 Sk per 4 year period when treatment into planted forests is allowed.

Artificial forest regeneration already respects, nowadays, the natural tree species composition. It means that *Fagus sylvatica* and *Abies alba* are preferred in reforestation. Spruce tree, based on experiences with its preliminary dying in this territory (ŠOMŠÁK et al. 1995), is admixed only in target woody composition and its natural seed regeneration is preferred. In few last years, late spring frosts have repeated in Hnilec River watershed. They were of such intensity that one-year old beech and fir seedlings totally failed. It was recognized that frost affected treated cultures mostly. We mean especially seedlings with cut grasses (*Calamagrostis arundinacea*) or raspberry (*Rubus idaeus*) in their surrounding. On the other hand, seedling failing was minimum within non-treated cultures. Together with forest management of Nálepkovo communal forests, our opinion is that it is necessary to move treatment of cultures (grass cutting) to the second half of vegetation period (August, September). Cut stems and stalks regenerate so that they can protect seedlings against spring-frosts but not with such intensity to flatten seedlings, together with snow, toward the soil surface. This application is testing on pilot experimental plots in communal forests of Nálepkovo Village (ANTONI 1997).

Summary

This contribution is focused on two stages of glade phytocoenose *Rubo idaei-Calamagrostietum arundinaceae* Fajmonová 1986. It deals with *Rubus idaeus* and *Calamagrostis arundinacea* stage. The first stage (*Rubus idaeus*) develops after continuous decreasing of stand density of secondary spruce forest (association *Avenello-culti-Piceetum* HADAČ ET SOFRON 1980 nom. nud.). Its occurrence is a consequence of continuous dying of damaged spruce forests. Contrary, *Calamagrostis arundinacea* stage develops after one-shot clear cutting at artificial forest regeneration or after massive dying of spruce forest in Hnilec River watershed (Spiš part of Slovenské rudohorie Mts.). We also discuss removing of seedling treatment time (beech and fir) from end of spring (May, June) to the second half of vegetation period (August, September). Cut stems and stalks will have time enough to regenerate so that they could protect seedlings against spring-frosts. However, they will not regenerate with such intensity to flatten, together with snow, seedlings toward the soil surface.

Tab. 1: Phytocoenological composition of well closed secondary spruce forests and their glade developing stages with *Rubus idaeus* and *Calamagrostis arundinacea* in Spiš part of Slovenské rudohorie Mts.

	Well closed spruce forest (*Avenello-culti-Piceetum*)											Continuous decreas in stand density						Glade phytocoenoses											
																		continuous cutting						one-shot clear cutting					
E_3 cover (%)	80	85	80	75	80	75	80	75	75	80		35	40	40	40	35		0	0	0	0	0		0	0	0	0	0	
E_2 cover (%)	5	7	1	5	10	15	7	15	30	1		1	5	5	10	15		10	1	5	1	5		1	1	3	0	1	
E_1 cover (%)	85	80	75	90	85	80	75	85	75	75		85	80	75	85	95		95	100	100	95	100		95	95	100	95	95	
E_0 cover (%)	35	60	50	65	60	40	20	25	20	40		20	25	25	35	35		10	15	10	30	10		5	5	10	5	10	
Relevé Nr.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**C**	**11**	**12**	**13**	**14**	**15**	**C**	**16**	**17**	**18**	**19**	**20**	**C**	**21**	**22**	**23**	**24**	**25**	**C**
E_3																													
Picea abies	5	5	4	4	4	4	4	4	4	4	V	3	3	3	3	3	V	.	.	.	.	.	.	.	.	.	.	.	.
Abies alba	.	.	r	.	.	r	r	.	r	+	III	+	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.
Pinus sylvestris	.	.	.	r	r	.	.	.	.	.	II	.	r	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.
Betula pendula	.	.	.	.	.	.	r	.	.	r	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sorbus aucuparia	.	.	.	.	r	.	.	.	r	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E_2																													
Picea abies	1.2	1.2	+	+	1.2	1.1	1.1	2.1	2.2	+	V	+	1.1	.	1.1	1.1	IV	+	+	1.1	.	.	III	.	.	.	.	r	I
Frangula alnus	.	+	+	1.1	+	1.1	.	.	1.1	.	III	.	.	1.1	.	1.1	II	r	.	.	.	.	I	.	.	.	.	r	I
Sorbus aucuparia	.	.	.	.	+	+	r	.	1.1	+	III	.	r	r	1.1	1.1	IV	1.1	+	.	+	1.1	IV	+	+	1.1	.	r	IV
Abies alba	r	+	+	.	.	+	r	.	+	r	IV	.	.	.	r	.	I	.	.	.	.	.	.	.	.	.	.	.	.
E_1																													
Diff.																													
Rubus idaeus	1.1	1.2	+.2	+.2	1.1	1.2	1.2	2.2	1.2	1.2	V	4.5	3.3	3.4	4.4	4.3	V	5.5	5.5	5.5	5.5	5.5	V	1.3	3.3	2.2	1.2	1.2	V
Calamagrostis arundinacea	+.2	1.2	+.2	1.2	2.2	1.2	+.2	2.2	1.2	2.2	V	1.2	+.2	+.2	+.2	2.2	V	1.2	.	.	r	.	II	5.5	5.5	5.5	5.5	5.5	V
Oxalis acetosella	2.2	2.1	1.1	2.1	2.1	2.1	2.2	1.1	1.1	1.1	V	2.3	3.3	2.2	1.1	1.1	V	2.2	3.3	3.3	1.2	+.2	V	2.1	2.1	+.2	.	1.1	IV
Maianthemum bifolium	2.2	2.2	1.1	1.1	2.1	2.1	2.2	1.1	2.1	2.1	V	2.2	2.1	2.1	1.1	1.1	V	2.1	+	1.2	+	1.2	V	2.2	2.2	+.2	+	+	V
Luzula luzuloides	1.2	2.2	1.2	+.2	1.2	+.2	1.2	1.2	2.2	+.2	V	1.2	1.2	1.2	+.2	1.2	V	1.2	2.2	1.2	.	1.2	IV	2.2	2.2	2.2	+.2	+.2	V
Avenella flexuosa	2.2	2.2	3.2	3.2	2.3	2.2	2.3	2.2	2.2	1.2	V	2.2	3.2	2.2	1.2	2.2	V	2.2	2.2	1.2	.	.	III	1.2	.	+.2	1.2	+.2	IV
Vaccinium myrtillus	1.2	2.2	+.2	2.2	1.2	+.2	+.2	1.2	+.2	+.2	V	1.2	2.3	1.3	1.2	+.2	V	1.2	1.2	+.2	.	.	III	1.2	2.2	.	+.2	2.2	IV
Picea abies	1.1	2.1	1.1	2.1	1.1	1.1	2.1	1.1	1.1	1.1	V	1.1	2.1	2.2	1.1	1.1	V	1.1	.	2.1	+	3.1	IV	1.1	.	+	.	+	III
Sorbus aucuparia	+	1.1	1.1	1.1	r	1.1	+	.	+	+	V	+	+	2.1	1.1	1.1	V	1.1	.	1.1	.	.	II	+	+	+	.	r	IV

Tab. 1 - continued

Dryopteris austriaca	1.2	+.2	+.2	1.2	1.2	1.2	.	.	+.2	+.2	IV	+.2	1.2	1.2	+.2	+.2	V	+.2	.	.	+.2	.	II	.	+.2	.	+.2	.	II
Athyrium filix-femina	1.2	+.2	.	+.2	+.2	.	+.2	1.2	1.2	.	IV	+.2	+.2	+.2	+.2	+.2	V	1.2	.	+.2	.	.	II	.	.	1.2	.	r	II
Rubus fruticosus agg.	+.2	.	.	r	r	.	.	r	+.2	.	III	1.2	1.2	1.2	+.2	+.2	V	1.2	+.2	2.2	.	.	III	r	+.2	+.2	.	.	III
Mycelis muralis	1.1	1.1	+	r	+	.	.	+	.	+	IV	r	1.1	.	+	+	IV	+	.	1.2	+	.	III	.	.	.	.	r	I
Senecio fuchsii	+	1.1	r	1.1	.	+	.	1.1	+	r	IV	1.1	.	1.1	1.1	+.2	IV	+	.	1.1	2.2	.	III	.	.	.	r	r	II
Frangula alnus	+	r	.	r	r	1.1	.	.	+	+	IV	.	r	1.1	1.1	1.1	IV	1.1	+	.	.	.	II	.	.	.	.	+	I
Chamerion angustifolium	+	.	.	r	.	r	.	r	r	.	III	1.1	.	.	1.1	+	III	1.1	3.2	.	.	+	III	+	+	r	.	+	IV
Solidago virgaurea	r	r	.	r	r	r	.	.	r	.	III	r	r	r	r	.	IV	1.1	+.2	.	.	.	II	.	+.2	.	1.1	r	III
Abies alba	+	.	1.1	1.2	+	.	+	+	.	r	IV	.	.	.	+	.	I	.	.	.	.	.	.	r	.	.	.	.	.
Fragaria vesca	+.2	.	.	+.2	.	+.2	+.2	.	+	.	III	+.2	.	2.2	r	.	III	+.2	.	2.2	.	.	II	.	.	.	.	.	.
Urtica dioica	r	.	.	.	.	r	.	.	r	.	II	+.2	.	.	+.2	+.2	III	+	.	.	+	+	III	r	.	+	.	.	II
Hieracium murorum	+	r	r	.	.	+	.	.	+	.	III	.	.	r	+	+	III	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium montanum	r	.	.	.	.	r	.	.	.	r	II	r	1.1	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.
Sambucus racemosa	+	.	.	r	.	.	.	.	r	.	II	.	.	.	r	+	II	r	1.1	.	.	.	II	.	.	1.1	+	.	II
Galeopsis tetrahit	.	.	r	.	.	r	r	.	r	.	II	+	r	.	+	.	III	+	.	.	.	.	I	.	.	.	.	r	I
Rubus hirtus	.	.	.	+.2	.	.	.	+.2	+.2	.	II	.	1.2	1.2	.	+.2	III	.	.	.	.	.	.	.	.	.	.	.	.
Geranium robertianum	+	.	.	r	.	+	.	.	.	+	II	r	.	.	+	.	II	.	.	1.2	+	.	II	.	.	.	.	r	I
Vaccinium vitis-idaea	.	.	.	.	+.2	.	.	.	+.2	.	II	r	.	r	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.
Gentiana asclepiadea	.	.	.	.	.	.	.	+.2	+.2	+.2	II	.	.	.	+.2	+.2	II	r	.	.	.	.	I	.	.	+.2	.	r	II
Veronica officinalis	r	.	+.2	.	.	r	.	.	r	.	II	+	.	.	.	r	II	r	.	.	.	.	I	.	.	r	.	.	I
Polygonatum verticillatum	.	.	.	.	.	.	.	.	.	+.2	I	+	.	r	.	.	II	.	.	r	.	.	I	.	.	.	1.1	.	I
Pinus sylvestris	.	.	.	.	r	.	.	.	+	.	II	.	.	.	+	.	I	r	.	.	.	.	I	.	.	.	.	r	I
Hypericum maculatum	.	.	.	.	.	.	.	.	.	.	.	.	+.2	.	r	1.2	III	r	+.2	+.2	1.1	1.2	V	.	.	r	r	.	II
Agrostis tenuis	.	.	.	.	.	.	.	.	.	.	.	+.2	.	.	+.2	+.2	III	+.2	.	1.2	.	.	II	.	.	+.2	.	+.2	II
Potentilla erecta	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	1.2	II	r	.	.	.	r	II	.	.	.	.	+.2	I
Prenanthes purpurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I	.	.	.	.	.	.	r	.	.	.	r	II
Scrophularia nodosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	r	II	.	.	.	1.1	.	I	.	.	1.2	.	.	I
Salix caprea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	II	.	.	+	.	r	II
Campanula patula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+	.	.	II	.	.	.	.	r	I
Dryopteris filix-mas	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3.2	.	1.2	1.2	III	.	.	2.3	.	.	I
Glechoma hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+.2	.	.	+	II	.	.	+	.	.	I
Poa pratensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.2	+.2	+.2	III	.	.	.	.	.	.

Tab. 1 - continued

Other species:

E_2: *Populus tremula* 16(r)

E_1: *Vicia sylvatica* 3 (+.2), *Asarum europaeum* 8 (+.2), *Moehringia trinervia* 9 (+), *Myosotis sylvatica* 9 (+), *Stellaria nemorum* 11 (r), 25 (r), *Cruciata glabra* 12 (+.2), *Populus tremula* 12 (r), *Corylus avellana* 16 (r), *Tussilago farfara* 13 (r), *Veronica chamaedrys* 14 (r), *Luzula pilosa* 16 (1.2), *Digitalis grandiflora* 16 (+), *Deschampsia caespitosa* 16 (+.2), *Hypochaeris radicata* 16 (r), *Poa annua* 16 (+.2), *Taraxacum officinale* 16 (r), *Vicia cracca* 16 (r), *Galeopsis pubescens* 17 (2.2), *Calamagrostis epigeios* 18 (+.2), *Galium mollugo* 18 (+.2), 25 (r), *Glechoma hederacea* 5 (+), 10 (+), *Viola reichenbachiana* 5 (+), *Linaria vulgar*is 25 (+).

Relevé localization (refers to Tab. 1.)

1. Nálepkovo, Záhajnica, subcompartment 523 a, altitude 590 m a. s. l., NW, slope 5-8°, relevé area 20 x 20 m, 13.8.2000
2. Nálepkovo, valley of Tichá Voda Creek, subcompartment 516 b, altitude 530 m a. s. l., NW, slope 9-13° relevé area 20 x 20 m, 18.8.2000
3. Nálepkovo, "nad Pílou", compartment 536, altitude 660 m a. s. l., N, slope 25-30°, relevé area 20 x 20 m, 18.8.2000
4. Nálepkovo, Surovec, subcompartment 220 a, altitude 790 m a. s. l., NE, slope 20-25°, relevé area 20 x 20 m, 18.8.2000
5. Nálepkovo, Surovec, compartment 219, altitude 850 m a. s. l., NE, slope 15-20°, relevé area 20 x 20 m, 18.8.2000
6. Nálepkovo, Biely potok Creek, compartment 560, altitude 780 m a. s. l., N, slope 20°, relevé area 20 x 20 m, 14.8.2000
7. Nálepkovo, Biely potok Creek, subcompartment 547 a, altitude 880 m a. s. l., NE, slope 25°, relevé area 20 x 20 m, 14.8.2000
8. Nálepkovo, Záhajnica, compartment 299, altitude 625 m a. s. l., SE, slope 20-25°, relevé area 20 x 20 m, 16.8.2000
9. Stará Voda, "Chajzerka", compartment 561, altitude 900 m a. s. l., SW, slope 20°, relevé area 20 x 20 m, 17.8.2000
10. Henclová, Predný jarok, compartment 477, altitude 730 m a. s. l., N, slope 10°, relevé area 20 x 20 m, 17.8.2000
11. Nálepkovo, Záhajnica, lower part of compartment 523, altitude 580 m a. s. l., N, slope 3-5°, relevé area 20 x 20 m, 8.9.2000
12. Nálepkovo, Biely potok Creek, compartment 554, altitude 700 m a. s. l., NE, slope 25°, relevé area 15 x 40 m, 8.9.2000
13. Nálepkovo, Záhajnica, Chajzerka, compartment 521, altitude 650 m a. s. l., N, slope 20°, relevé area 10 x 40 m, 9.9.2000
14. Stará Voda, Nad poľanou, compartment 492, altitude 890 m a. s. l., NW, slope 35°, relevé area 20 x 20 m, 9.9.2000
15. Henclová, Zadný jarok, subcompartment 513 a, altitude 800 m a. s. l., slope 25°, relevé area 15 x 40 m, 10.9.2000
16. Nálepkovo, Záhajnica, subcompartment 528 b, altitude 625 m a. s. l., NW, slope 15°, relevé area 20 x 20 m, 10.9.2000
17. Švedlár, Mlynský vrch Hill, over the railway, altitude 565 m a. s. l., N, slope 30°, relevé area 20 x 20 m, 26.7.1997 (ex HALUŠKOVÁ 1998)

18. Švedlár, Stredná dolina Valley, altitude 650 m a. s. l., S, slope 7°, relevé area 20 x 20 m, 23. 7. 1997 (ex HALUŠKOVÁ 1998)
19. Stará Voda, “Streikezská lúka”, altitude 900 m a. s. l., W, slope 7°, relevé area 20 x 20 m, 24.7.1997 (ex HALUŠKOVÁ 1998)
20. Stará Voda, “Genier”, altitude 800 m a. s. l., W, slope 15°, relevé area 20 x 20 m, 24.7.1997 (ex HALUŠKOVÁ 1998)
21. Nálepkovo, Záhajnica, altitude 820 m a. s. l., N, slope 25°, relevé area 20 x 20 m, 9.6.1997 (ex HALUŠKOVÁ 1998)
22. as 21.
23. Stará Voda, “Genier”, altitude 950 m a. s. l., W, slope 15°, relevé area 20 x 20 m, 24.7.1997 (ex HALUŠKOVÁ 1998)
24. Nálepkovo, Biely potok Creek, altitude 700 m a. s. l., E, slope 35°, relevé area 20 x 20 m, 21.8.1996 (ex HALUŠKOVÁ 1998)
25. Švedlár, Mlynský vrch Hill, altitude 565 m a. s. l., N, slope 20°, relevé area 20 x 20 m, 26.7.1997 (ex HALUŠKOVÁ 1998)

Remark: relevés Nr. 1-10 are sampled in 70-100 year old stands with tree etage cover ranging between 75-80 %. They are located according to colored forest map 1: 10 000 (1993).

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