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VEGETATION OF THE STRMEC FOREST REMNANT

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Abstract

The virgin forest remnant Strmec is located in the southern part of Slovenia (Kočevsko region) and expands over 15.55 ha between 850 and 940 metres above sea level. Special attention is given to phytosociological and pedological surveys. A vegetation map was also made. The virgin forest is dominated by Dinaric fir-beech forests, namely by the geographical variant of the association *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora* with the following subassociations and variants: *-festucetosum altissimae*, *-galietosum odorati*, *-typicum*, *-mercurialetosum perennis*, *-phyllitidetosum*, *-neckeretosum crispae*, *-caricetosum albae* subass. nova var. *Neckera crispa* var. nova and var. *Helleborus niger.* var. nova.

The bedrock is mainly limestone and dolomite, which prevail in the south-western part of the virgin forest remnant. The most frequent soil types are rendzina on limestone, Rendzic Leptosol and Dystri-Chromic Cambisol.

Key words: virgin forest remnant, phytosociology, pedology, *Omphalodo-Fagetum,* fir-beech forest.

Izvleček

Pragozdni ostanek Strmec se nahaja v južnem delu Slovenije, na Kočevskem, na nadmorski višini med 850 in 940 m. Njegova površina meri 15,55 ha. Znotraj pragozdnega ostanka smo naredili fitocenološke in pedološke analize, za celotno površino pragozdnega ostanka pa izdelali vegetacijsko karto. Sestoje, ki se pojavlja v pragozdnem ostanku uvrščamo v asociacijo *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora* z naslednjimi subasociacijami in variantami: *-festucetosum altissimae*, *-galietosum odorati*, *-typicum*, *-mercurialetosum perennis*, *-phyllitidetosum*, *-neckeretosum crispae*, *-caricetosum albae* subass. nova var. *Neckera crispa* var. nova in var. *Helleborus niger* var. nova.

Matično kamnino sestavlja predvsem apnenec, na jugozahodnem delu pa se na manjši površini pojavlja dolomit. Najbolj pogosti tipi tal so rjava tla in pokarbonatna rjava tla ter rendzina na apnencu.

Ključne besede: pragozdni ostanek, fitocenologija, pedologija, *Omphalodo-Fagetum*, jelovo-bukov gozd.

1. INTRODUCTION

The virgin forest remnant of Strmec is one of the 14 virgin forest remnants in Slovenia (Mlinšek et al. 1980). It is situated in the Dinaric phytogeographical region (Wraber 1969) of Slovenia (Kočevje region), more precisely on the SW part of Stojna, between 850 and 940 m above sea level (Figure 1).

The area of the virgin forest remnant Strmec is influenced by pre-Dinaric, pre-Pannonian and interferential (high karstic) climatic types (Konečnik & Zaplotnik 2001). Characteristic of the pre-Dinaric and pre-Pannonian climate type are significantly higher temperature extremes, hot summers, cold winters, and approximately equal amounts of rainfall in the summer and autumn months. The interferential climatic type, however, is characterized by hot air masses, driven by south-westerly winds. Along the mountain barrier of the Dinaric range, these winds are cooled down and thus condition abundant precipitations

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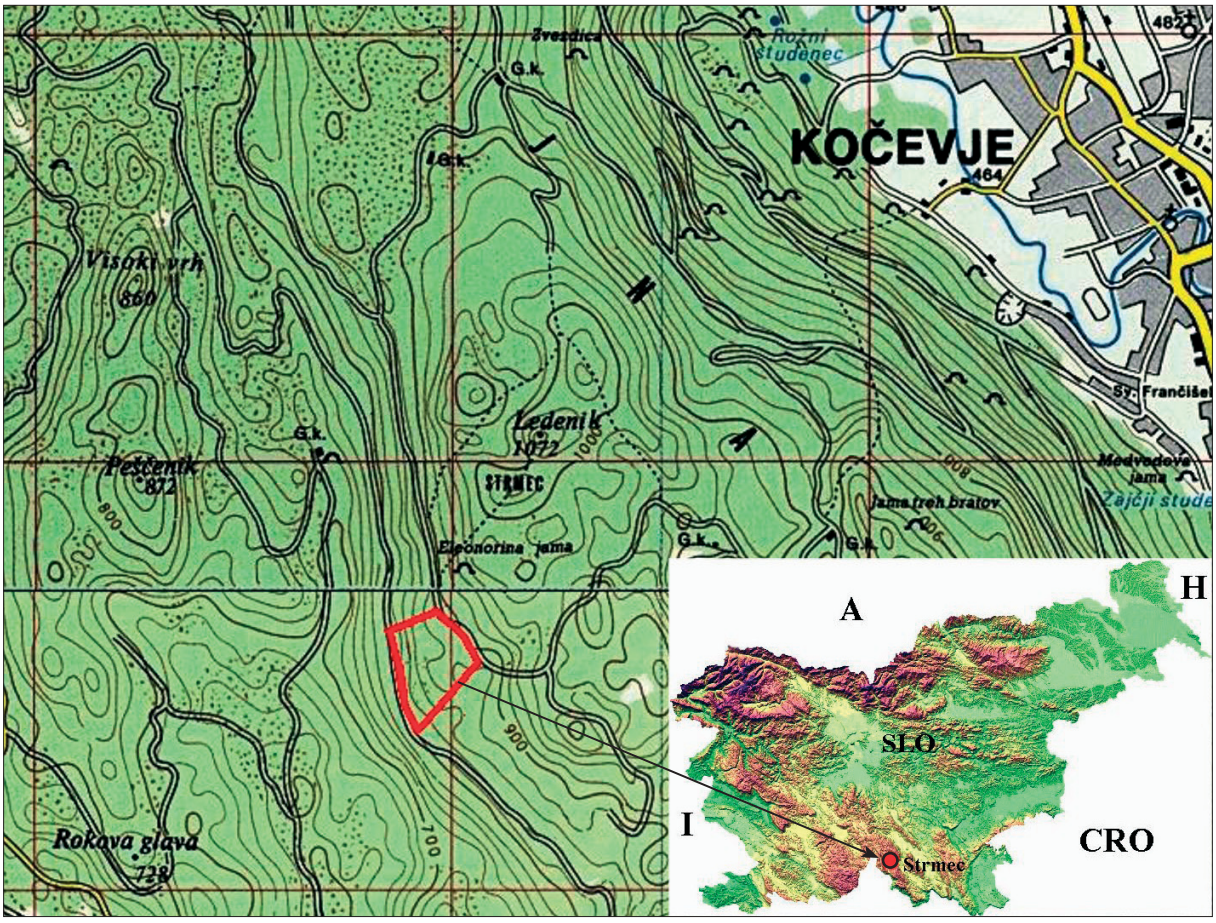


Figure 1: Location of the Strmec virgin forest remnant.

Slika 1: Lokacija pragozdnega ostanka Strmec.

in the region of the Dinaric fir-beech forests. The precipitation is greater in the autumn than in the spring period (GGN Koče 1965–74). Water from the abundant rainfalls, to a great extent, generally flows down through the porous limy base, although it also conditions the humidity level of the air, which has a decisive influence on the flourishing of fir trees.

The terrain in which the virgin forest lies is strongly undulating, since in the upper reach it is moderately inclined, in the central part gently sloping with karstic sinkholes, while in the lower reaches it is steep with rocky cliffs. It stretches along a shorter altitudinal range (a 90 m height difference); dominant is the position partially exposed to the sun (W, SW), which comes into prominence particularly in the lower, steepest part of the virgin forest.

The stands in the virgin forest are influenced by the two roads (Figure 1). The lower road was made between the 1st and 2nd world war and the upper between 1965 and 1975 (Lavrič 1999). Management of the neighbouring forests in the past, before the protective belt was established, also influenced the virgin forest.

The mean annual temperature is 8.3 °C. Extreme minimums in the vegetation period are: in May –3.9 °C, in June 0.4 °C, in July 4.5 °C, in August 2.8 °C, and in September –3.1 °C. The annual rainfall rate (10-year observation period) is 1556 mm. Rainfall is most abundant in spring (max. in June) and autumn (max. in October). The driest month is February. The number of days with precipitation (over 0.1 mm) is 155, the number of days with rainfall (over 0.2 mm) is 132, the number of days with snow (over 0.1 mm) is 37, the number of days with snow cover at 07.00 hours is 72. The relative humidity level is 81 % (GGN Koče 1990–1999).

The bedrock consists of lower to upper cretaceous grey limestone with inserted dolomited layers (Mlinšek et al. 1980).

The area of the virgin forest belonged to the estate owner count Auersperg. In the second revision of the management plan for the 2nd operating unit – Fridrihštajn from the year 1913 – for the first time there appeared in it a sub-division denoted as "Urwald" (virgin forest). Since then, that part of forest has not been managed (Konečnik & Zaplotnik 2001). At the end of the 19th century Leopold Hufnagel made an extensive management plan (Hufnagel 1892) and introduced his own model of selection forest management. That was at that time quite the opposite to clearcutting as a way of forest management, which prevailed in Central Europe. In his plans he also excluded some smaller sections from forest management and preserved them as virgin forests. The virgin forest remnant Strmec forms only part of that complex and extends over 15.55 ha. The main tree species are *Abies alba* (39 %) and *Fagus sylvatica* (48 %). Individually are admixed *Acer pseudoplatanus*, *Picea abies*, *Tillia cordata, Ulmus laevis*, *Ostrya carpinifolia, Sorbus aria, Acer platanoides* and *Acer obtusatum*. The total growing stock is high (824 m^3/ha) with a high proportion of coarse woody debris (20.1 %). The optimal development phase prevails mostly on the surface of the virgin forest remnant (Konečnik & Zaplotnik 2001).

The main goal for conserving intact nature at the end of the 19th and in the beginning of the 20th century was excluding virgin forests. After 1970 there appears conservation based on scientific research. According to Mlinšek et al. (1980), individual trees of autochtonous spruce make Strmec even more interesting.

Intensive researches into the basic ecological and structural characteristics in Slovenian virgin forest remnants started after the year 1980, but Strmec was not included in those studies (Roženbergar et al. 2003).

Despite the fact that few researches were carried out, Hočevar et al. (1995) investigated the flora; the first phytosociological researches were made by Zupančič & Puncer (1971, 1995) and Robič (2000). Konečnik and Zaplotnik (2001) conducted the most complete research into the virgin forest remnant Strmec, above all from the aspect of stand structure and regrowth.

The aim of our research, done in 2002, was to carry out a complex study of forest communities and the pedological conditions of virgin forest and also to make the vegetation map. The presented results are the continuation of our researches into Slovenian virgin forest remnants (Marinček & Marinšek 2003, 2004).

2. METHODS

The vegetation relevés were made according to the standard Central-European method (Braun-Blanquet 1964) in June, July and September 2002. The relatively small area of the virgin forest and indirect influence of two roads increase the difficulty of making quality phytosociological relevés according to the Braun-Blanquet method. In spite of that, we succeeded in making 20 relévés. The nomenclature of flowering plants follows Martinčič et al. (2007), syntaxonomy Marinček et al. (1993). The nomenclature source for mosses is according to Martinčič (2003). Detrended Canonical Analysis was made by CANOCO (ter Braak & Šmilauer 2002).

Five representative soil profiles, which were the basis for investigation of the soil conditions (Prus 2002), were made and morphologically described in July 2002. Determination of soil types was made according to the World Reference Base for Soil Resources (WRB), FAO, Unesco 1998 http://www.fao.org/docrep/W8594E/W8594E00.htm.

Laboratory analyses of soil samples were made according to ISO standards (SIST ISO 11464, SIST ISO 10390, SIST ISO 14235, SIST ISO 11261).

A vegetation map of the Strmec virgin forest remnants (Figure 3) was made according to the principles of vegetation mapping (Puncer 1984).

3. RESULTS

Floristic composition

In compliance with average ecological factors, distinctive of the Dinaric region, Central European plant species in the forest remnant of Strmec prevail. In the phytosociological sense we classify them in the order of *Fagetalia sylvaticae*: *Mercurialis perennis, Festuca altissima, Galium odoratum, Sanicula europaea, Daphne mezereum, Salvia glutinosa, Viola reichenbachiana, Acer pseudoplatanus, Mycelis muralis, Prenanthes purpurea, Senecio ovatus, Dryopteris filix-mas, Geranium robertianum, Galeobdolon flavidum, Paris quadrifolia, Euphorbia amygdaloides, Polygonatum multiflorum, Campanula trachelium, Hordelymus europaeus, Polystichum*

aculeatum, Brachypodium sylvaticum and others.

Differential species for the Illyrian beech forests – alliance *Aremonio-Fagion*: *Omphalodes verna, Aremonia agrimonoides, Cardamine enneaphyllos, Cardamine trifolia, Calamintha grandiflora, Daphne laureola, Cyclamen purpurascens, Scopolia carnolica,* and partially *Rhamnus fallax,* are relatively abundant. Their presence classifies the described fir-beech forests to alliance *Aremonio-Fagion*.

Some acidophilous species, differential species of order *Vaccinio-Piceetalia* Br.-Bl. 1939 emend. K. Lund 1967, e.g., *Goodyera repens, Luzula sylvatica, Orthilia secunda, Dryopteris expansa,* are more or less accidental, while moderate acidophilous species, e.g., *Hieracium murorum, Galium rotundifolium, Oxalis acetosella,* and *Rosa pendulina* are more abundant.

With regard to other Dinaric fir-beech virgin forests (Mlinšek et al.1980), there are relatively numerous thermophilous plants, differential species of order *Quercetalia pubescentis* s. lat., e.g., *Fraxinus ornus, Cephalanthera rubra, Ostrya carpinifolia, Euonymus verrucosa, Sorbus aria, Melittis melisophyllum, Acer obtusatum, Cornus mas.* Other thermophilous plants are mostly differential species of class *Querco-Fagetea*: *Euonymus latifolia, Ajuga reptans, Clematis vitalba, Lonicera xylosteum, Hedera helix* and *Vinca minor.*

Among the so called companion species the most frequent are: *Moehringia muscosa, Sorbus aucuparia, Asplenium trichomanes, Solidago virgaurea*, *Polypodium vulgare, Rubus idaeus, Asplenium ruta-muraria, Asplenium viride, Solanum dulcamara, Fragaria vesca, Gentiana asclepiadea* and others. *Ctenidium molluscum, Neckera crispa, Plagiochila asplenioides, Isothecium myurum, Fissidens taxifolius, Hypnum cupressiforme, Eurhynchium striatum* and *Thuidium tamariscinum* are the most frequent species among mosses (Table 3). The rest of the species composition is seen from the analytical table (Table 3).

Pedological conditions and division of subassociations into lower syntaxa

Morphological descriptions of soil for each subassociation are given separately (Tables 1 and 2).

Table 1: Analytical data of pedological samples; soil particle size distribution (texture) and chemical properties from the virgin forest remnant Strmec (Prus 2002). 1: *-festucetosum altissimae*, 2: *-galietosum odorati*, 3: *-phyllitidetosum*, 4: *mercurialetosum perennis*, 5: var. *Helleborus niger.*

Tabela 1: Analitski podatki pedoloških vzorcev; mehanska sestava in kemijske lastnosti tal v pragozdnem ostanku Strmec (Prus 2002). 1: *-festucetosum altissimae*, 2: *-galietosum odorati*, 3: *-phyllitidetosum*, 4: *mercurialetosum perennis*, 5: var. *Helleborus niger.*

			pH	P_2O_5 AL	K_2O AL	org. matter	C	CN	N total	sand	silt rude	silt fine	silt total	clay	text. class
HORIZON		DEPTH	$CaCl_2$	---- mg/100g ------			%	rat.	%	%	%	%	%	%	
1	Ah	0 – 15 cm	6.6	<2.0	5.0	19.3	11.2	19.0	0.59						
1	AC	15 – 30 cm	5.8	<2.0	6.3	9.2	5.3	23.0	0.23	12.7	17.5	42.5	60.0	27.3	MG-MI
2	Ah	0 – 12 cm	4.4	<2.0	8.9	10.2	5.9	17.4	0.34						
2	A	12 – 43 cm	5.4	<2.0	6.5	3.7	2.1	12.4	0.17	10.2	20.9	45.1	66.0	23.8	MI
2	BtC	43 – 64 cm	7.2	<2.0	9.4	4.3	2.5	13.9	0.18	4.1	17.5	45.7	63.2	32.7	MGI
3	Ah	0 – 7 cm	4.8	2.7	19.9	14.2	8.2	13.7	0.60						
3	A	7 – 32 cm	4.3	<2.0	<2.0	2.5	1.4	10.8	0.13	5.9	20.9	53.6	74.5	19.6	MI
3	BrzC	32 – 60 cm	6.1	<2.0	5.2	2.3	1.3	10.8	0.12	29.0	22.4	37.7	60.1	10.9	MI
4	Oh	0 – 12 cm	4.1	12.0	15.3	63.7	36.9	29.3	1.26						
4	AC	12 – 25 cm	6.9	<2.0	6.5	21.1	12.2	24.9	0.49						
5	Ah	0 – 12 cm	7.1	<2.0	10.9	16.5	9.6	15.5	0.62						
5	CA	12 – 32 cm	7.2	<2.0	5.9	6.6	3.8	10.6	0.36	14.5	26.6	30.3	56.9	28.6	MGI

Table 2: Results of ammono-acetate extraction from five representative pedological profiles from the virgin forest remnant Strmec (Prus 2002). 1: *-festucetosum altissimae*, 2: *-galietosum odorati*, 3: *-phyllitidetosum*, 4: *mercurialetosum perennis*, 5: var. *Helleborus niger.*

Tabela 2: Rezultati amonacetatna ekstrakcije, dobljeni iz petih reprezentativnih pedoloških profilov v pragozdnem ostanku Strmec (Prus 2002). 1: *-festucetosum altissimae*, 2: *-galietosum odorati*, 3: *-phyllitidetosum*, 4: *mercurialetosum perennis*, 5: var. *Helleborus niger.*

			Ca	Mg	K	Na	H	S	T	V	Ca	Mg	K	Na	H
HORIZON		DEPTH	---------- mmol C^+ / 100 g sample ----------							%	%	%	%	%	%
1	Ah	0 – 15 cm	44.41	0.43	0.17	0.14	14.00	45.2	59.2	76.3	75.0	0.7	0.3	0.2	23.6
1	AC	15 – 30 cm	22.20	0.23	0.13	0.10	12.55	22.7	35.3	64.3	62.9	0.7	0.4	0.3	35.6
2	Ah	0 – 12 cm	8.63	0.73	0.22	0.06	21.15	9.6	30.8	31.2	28.0	2.4	0.7	0.2	68.7
2	A	12 – 43 cm	10.67	0.62	0.14	0.05	12.55	11.5	24.1	47.7	44.3	2.6	0.6	0.2	52.1
2	BtC	43 – 64 cm	30.04	1.62	0.25	0.08	7.05	32.0	39.1	81.8	76.8	4.1	0.6	0.2	18.0
3	Ah	0 – 7 cm	13.75	1.74	0.50	0.06	23.95	16.1	40.1	40.1	34.3	4.3	1.2	0.1	59.7
3	A	7 – 32 cm	2.42	0.36	0.08	0.02	16.20	2.9	19.1	15.2	12.7	1.9	0.4	0.1	84.8
3	BrzC	32 – 60 cm	11.17	1.18	0.11	0.07	8.95	12.5	21.5	58.1	52.0	5.5	0.5	0.3	41.6
4	Oh	0 – 12 cm	28.84	3.22	0.42	0.21	39.40	32.7	72.1	45.4	40.0	4.5	0.6	0.3	54.6
4	AC	12 – 25 cm	44.29	0.91	0.13	0.15	14.35	45.5	59.9	76.0	73.9	1.5	0.2	0.3	24.0
5	Ah	0 – 12 cm	33.56	13.05	0.27	0.11	9.40	47.0	56.4	83.3	59.5	23.1	0.5	0.2	16.7
5	CA	12 – 32 cm	21.75	9.69	0.13	0.08	5.45	31.6	37.1	85.2	58.6	26.1	0.4	0.2	14.7

Stands of the association *Omphalodo-Fagetum* prevail in the whole area. On the basis of the analytical table (Table 3) we grouped those stands into seven subassociations and two variants.

Syntaxonomically we classified them to class *Querco-Fagetea* Br.-Bl. et Vlieger in Vlieger 1937, order *Fagetalia sylvaticae* Pawlovski in Pawlovski et al. 1982, alliance *Aremonio-Fagion* (Horvat 1938) Borhidi in Torok et al. 1989, suballiance *Lamio orvalae-Fagenion* Borhidi ex Marinček et al. 1993 and to association *Omphalodo-Fagetum* (Tregubov 1957) Marinček et al. 1993 var. geogr. *Calamintha grandiflora* Surina 2002 with subassociations:

- *festucetosum altissimae* Puncer et al. 1974
- *galietosum odorati* (Tregubov 1957) Puncer 1980
- *typicum* (M. Wraber 1955) Puncer 1980
- *mercurialetosum perennis* Tregubov 1957
- *phyllitidetosum* (Puncer et al. 1974) Marinček et Marinšek 2004
- *neckeretosum crispae Puncer 1980*
- *caricetosum albae* subass. nova
  - var. *Neckera crispa* var. nova
  - var. *Helleborus niger* var. nova.

Omphalodo-Fagetum var. geogr. *Calamintha grandiflora festucetosum altissimae*

Stands of the subassociation – *festucetosum altissimae* cover the largest area in Strmec. It spreads on the upper part of the virgin forest, on a moderately inclined slope. A high proportion of stoniness is characteristic for this subassociation.

Beech and fir prevail in the upper tree layer, which covers on average about 80 % of the surface. Norway spruce is admixed individually. Other tree species such as *Acer pseudoplatanus*, *Ulmus glabra,* and rarely *Sorbus aria* can be found in the lower tree and shrub layer. The latter is not well developed and is composed mainly of the young growth of tree species and shrubs *Daphne mezereum* and *Rosa pendulina*.

The herb layer covers 30 to 40 % of the surface. The species that gives the basic aspect to this subassociation, and also the main differential species, is *Festuca altissima*. Of the other two differential species, according to Puncer (1980), *Orthilia secunda* is missing and *Dicranum scoparium* appears only as an accidental species.

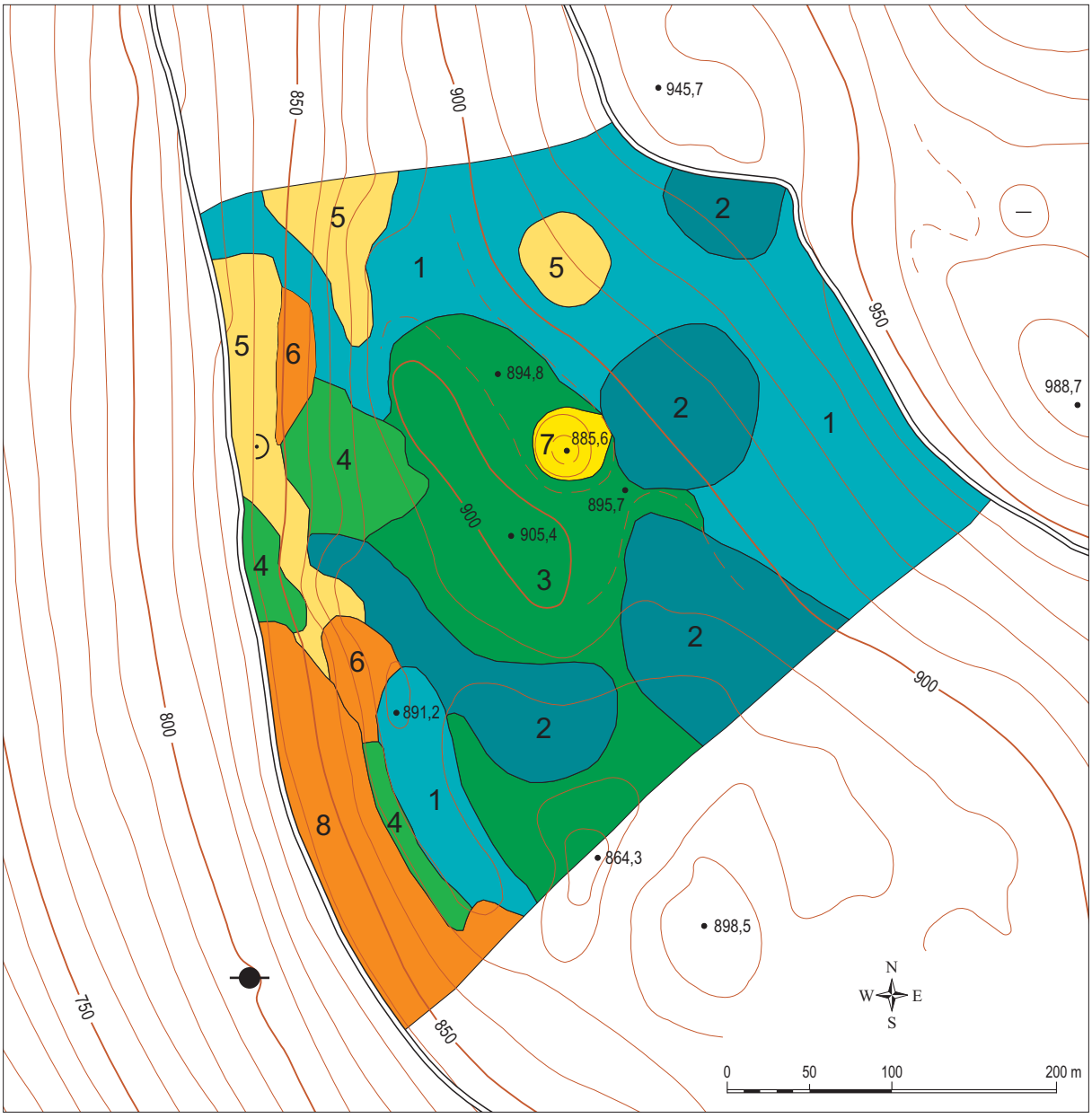


Figure 2: Vegetation map of the virgin forest remnant Strmec.
Slika 2: Vegetacijska karta pragozdnega ostanka Strmec.

Legend:

1 = *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora festucetosum altissimae*
2 = *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora galietosum odorati*
3 = *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora typicum*
4 = *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora mercurialetosum perennis*
5 = *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora neckeretosum crispae*
6 = *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* var. *Neckera crispa*
7 = *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora phyllitidetosum*
8 = *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* var. *Helleborus niger*

The main combination of species of the association *Omphalodo-Fagetum* is well presented, while *Rhamnus fallax* is missing. From order *Fagetalia sylvaticae*, the following species prevail: *Mercurialis perennis, Paris quadrifolia, Galium odoratum, Sanicula europaea, Salvia glutinosa, Viola reichenbachiana, Mycelis muralis, Geranium robertianum, Galeobdolon flavidum,* and others.

Among other species, higher cover is also reached by *Anemone nemorosa, Carex digitata, Oxalis acetosella, Asplenium trichomanes* and *Solanum dulcamara*. Mosses cover 20 to 30 % of the surface, where *Ctenidium mollluscum* prevails.

Soil profile description with commentary (Prus 2002) (Table 1 and 2, profile No. 1).
Bedrock: limestone
Soil type: rendsine, Rendzic Leptosol
Location: X = 0486092, Y = 5053126; Altitude: 925 m
Position and inclination: slope, SW, 20°

Horizons:

Ol 10–5 cm, mostly beech foliage, twigs, scarce dry grass

Of 5–0 cm, foliage and twigs, scarce roots

Oh 0–3 cm, dark reddish brown (5YR 2,5/2) organic humus horizon, very unevenly distributed. It is of a crumbly, well expressed and well subsisting structure, of scattered and crumbly consistence, dry, with dense roots and without rock fragments. Transition to the next horizon is irregular.

A 3–15 cm, dark brown (7,5 YR 3/2) silty loam, of fine subangular blocky structure with strong stability. Humus content is high, dry to fresh, with dense roots. There are 20 % sharp-edged rock fragments of 20 cm in diameter. Transition to the next horizon is gradual.

AC 15–30+ cm, dark brown to brown (7.5YR 4/4) silty clay loam to silty loam, not markedly polyhedrous. Consistence is firm. The humus content is distributed in dead roots channels and pores between the structural aggregate. Dry to fresh with dense roots. Contains 40 % rock fragments of 20 cm in diameter, share increases with depth.

Brown rendsine presents an intermediate or transitional stage in the development of rendsine to Chromic Cambisol. In this case, it is shown in

Figure 3: *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora festucetosum altissimae.*
Slika 3: *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora festucetosum altissimae.*

the poorly divisible AC horizon, which contains a lot of humus. As a matter of fact, this is characteristic of horizon A, but at the same time it contains some characteristics of the cambic horizon, e.g. heavier texture and red colour. Humus input in that horizon goes through dead root channels and pours out into the pore system.

Particularly in the dry season, humus crushes and goes down to the pores. Nutrients (phosphorus, potassium) and pH are within the usual values for that soil type. The surface horizon it is still mollic. Therefore we classify the soil to Rendzic Leptosol.

Omphalodo-Fagetum var. geogr. *Calamintha grandiflora galietosum odorati*

The site is edaphically the most favourable: moderately inclined to gentle slope and sinkholes above rocks. Medium deep Chromic Cambisol prevails on the limestone bedrock.

In the tree layer, beech prevails over silver fir, which is mostly in the lower tree layer. *Acer pseudoplatanus*, *Ulmus glabra* and *Picea abies* are admixed only individually. The shrub layer and young growth is mostly a combination of *Fagus sylvatica* and *Acer pseudoplatanus*. Other plant species in the shrub layer are: *Daphne mezereum, Sorbus aria* and *Daphne laureola*. Mesophilous species of order *Fagetalia sylvaticae* which form the majority of the herb layer, are: *Salvia glutinosa, Viola reichenbachiana, Mycelis muralis, Prenanthes purpurea, Senecio ovatus, Dryopteris filix-mas, Paris quadrifolia, Galeobdolon flavidum, Euphorbia amygdaloides, Brachypodium sylvaticum, Carex pilosa, Polygonatum multiflorum, Symphytum tuberosum, Galium odoratum, Sanicula europaea, Carex sylvatica, Cardamine bulbifera, Veronica montana,* and others.

Character species are well presented, particularly *Omphalodes verna* and *Cardamine trifolia*. Beside differential species of the subassociation (*Galium odoratum* and *Sanicula europaea*), there are also local differential species: *Cardamine bulbifera, Carex sylvatica* and *Veronica montana*; these indicate the advantageous circumstances of soil moisture. Species of alliance *Aremonio-Fagion* are abundant. Among others the highest cover value is reached by the following species: *Anemone nemorosa*, *Athyrium filix-femina* and *Oxalis acetosella*. The moss layer is not well-developed; *Ctenidium molluscum* is the most abundant.

Soil profile description with commentary (Prus 2002) (Table 1 and 2, profile No. 2)
Bedrock: limestone
Soil type: Dystri-Chromic Cambisol
Location: X = 0485979, Y = 5052939; Altitude: 890 m
Position and inclination: slope – ridge, SE, 5°

Horizons:

Ol 3–0 cm, mainly beech foliage, twigs, silver fir needles.

Ah 0–12 cm, dark brown (7.5YR 3/2) highly humic silty loam, cloddy and medium expressed; the structure is firm, medium dense and of crumbly consistence, moist, root abundance is dense, there are no rock fragments. Passage to the lower horizon is irregular.

A 12–43 cm, dark brown to brown (7.5YR 4/4), medium humic silty loam, angular blocky structure dense and crumbly consistence, moist, root abundance is dense. Rock fragments are present as individual stones. Passage to the lower horizon is gradual.

BtC 43–64+ cm, reddish brown (5YR 4/4) humic silty clay loam of angular blocky structure, which is well-formed, consistence is dense and friable, moist, root abundance is low. Consists 40 % of sharp-edged, flat rock fragments of 15 cm in diameter. Among flat stones, some of the soil pockets continue.

Ablution is in the initial phase, so that horizon E is not well-defined. However the upper part of the profile has washed out basic cations (distric character), also the difference in texture or clay share between horizon A and horizon Bt is sufficiently expressed.

Horizon Ah is moder mull. The designation Chromic Cambisol is usually used for soil with a suitable red colour. Unsaturation with basic cations in the upper two horizons is the reason for the appendix Dystri. Unfortunately WRB do not allow classification of transitional soil forms.

Omphalodo-Fagetum var. geogr. *Calamintha grandiflora typicum*

Subassociation –*typicum* appears in the central part of the virgin forest. The slope is gently inclined, stoniness is 10 to 50 %. On the limestone bedrock there is a mosaic of rendsines with different successional stages and Chromic Cambisol.

Figure 4: *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora galietosum odorati.*
Slika 4: *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora galietosum odorati.*

Figure 5: Subassociation *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora typicum.*
Slika 5: Subasociacija *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora typicum.*

The composition of the tree layer is very similar to the composition of the earlier described subassociations. Beech is prevailing over silver-fir, specially in the upper layer. *Acer pseudoplatanus* appears only sporadically. Beside young growth of the main tree species, there are also shrubs like *Daphne laureola, Daphne mezereum* and *Sorbus aria*.

The shrub layer covers from 40 to 60 %, and is mainly composed of species from the order *Fagetalia sylvaticae*: *Salvia glutinosa, Viola reichenbachiana, Mycelis muralis, Sanicula europaea, Galeobdolon flavidum, Festuca altissima, Galium odoratum, Carex sylvatica, Hordelymus europaeus,* and others.

Species from the alliance *Aremonio-Fagion*, such as *Scopolia carniolica, Lamium orvala* and *Cardamine trifolia,* are not well presented, except for *Cardamine enneaphyllos*. Among differential species of the association *Omphalodo-Fagetum, Calamintha grandiflora* and *Rhamnus falllax* are missing entirely. Among others, *Oxalis acetosella* reaches a slightly higher cover value.

The moss layer is not well developed. Most frequent taxa are *Ctenidium molluscum* and *Isothecium myurum*.

Stands of the ***Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora* –*phylitidetosum*** and **– *mercurialetosum perennis***, are not typically developed and only cover smaller areas (Figure 2). They are represented with a single relevé (Table 3).

Soil profile description of the subassociation – *phylitidetosum* with commentary (Prus 2002) (Table 1 and 2, profile No. 3)
Bedrock: limestone
Soil type: Dystri-Chromic Cambisol
Location: X =0485980,Y = 5053098, 920 mnv
Position and inclination: slope – sinkhole, S, 5°

Horizons:

Ol 2–0 cm, beech foliage, twigs, scarce fir needles, herb remnants

Ah 0–7 cm, dark brown (7.5YR 3/2) strong humic silty clay, cloddy and fine subangular blocky structure, well expressed and medium structure, loose and crumbly consistence, moist, root abundance is medium dense, without rock fragments. Passage to the lower horizon is gradual.

A 7–32 cm, yellowish brown (10YR 5/4), medium humic silty clay, tiny angular blocky structure, not well expressed and medium stability, dense and crumbly consistence, fresh to moist. There are no rock fragments, medium abundant roots. Passage to the lower horizon is diffuse.

BrzC 32–60+ cm, dark brown to brown (7,5YR 4/4) medium humic silty clay, angular blocky structure, well expressed and stable structure, moist, few roots. Contains 40–50 % rock fragments of 30 cm in diameter, starting 2 to 3 cm above the upper level of the horizon.

Beside the basic characteristics of cambic soil, this type of soil shows initial signs of rinsing. In contrast to profile 2, the removal of basic cations is more marked. Therefore, this profile has not only distric but also moderate acric characteristics (acric = highly acid). The difference in texture is atypical, i.e. there is usually a higher proportion of clay in the upper horizon. By comparison with WRB classification the same holds as for profile 2.

Soil profile description of subassociation – *mercurialetosum perennis* with commentary (Prus 2002) (Table 1 and 2, profile No. 4)
Bedrock: limestone
Soil type: Umbric-Leptosol
Location: X =0485843,Y =5052875, 890 m
Position and inclination: slope – terrace, W, 10°

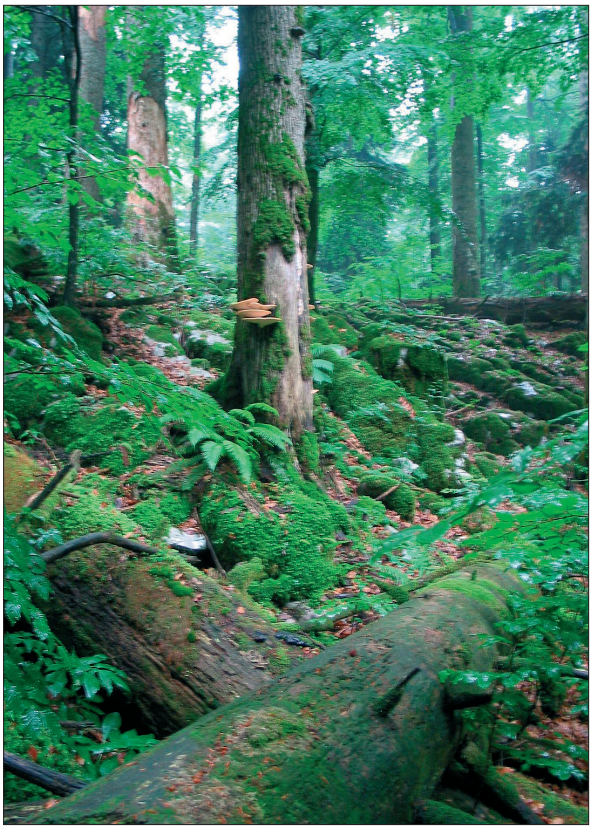
Ol 3–1 cm,beech foliage, twigs

Of 1–0 cm

Oh 0–12 cm, dark reddish brown (2,5YR 2,5/4) organic humic horizon, crumbled well expressed and subsistent structure, loose and scattered consistence. Fresh to moist with dense roots. Passage to the lower horizon is clear. Red colour, the high portion of humus and wide C/N ratio is the result of the higher proportion of rotten wood in the horizon.

AC 12–25 cm, dark reddish brown (5YR 2.5/2) very humic silty clay, crumbled well expressed and subsistent structure, loose consistence with dense roots. It contains 40 % rock fragments of 10 cm in diameter. Transition to the lower horizon is gradual.

CA 25–35+ cm, dark reddish brown (5YR 2.5/2) very humic silty clay, cloddy, well expressed and subsistent structure, loose consistence with dense roots, fresh to moist. Contains 70 % rock fragments of 10 cm in diameter.



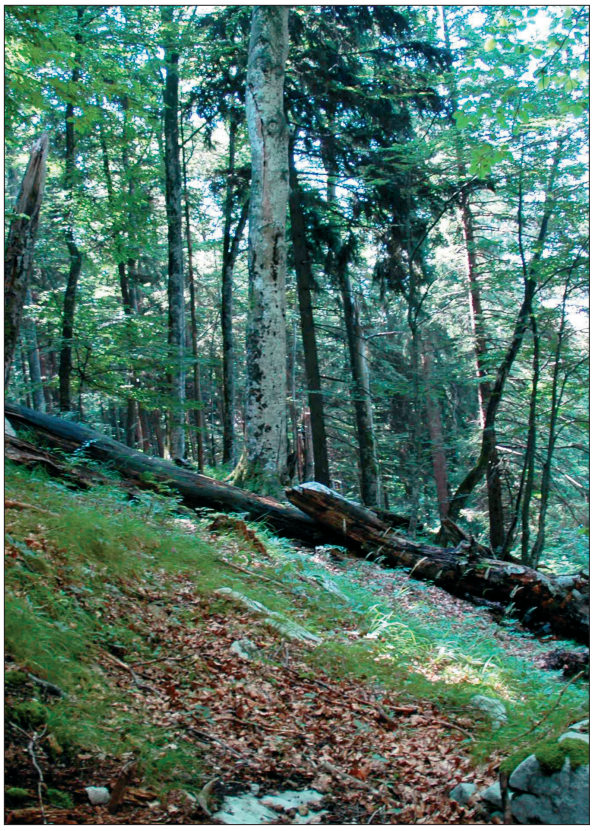


Figure 6 and 7: Subassociation *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora phylitidetosum* (left) and *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora mercurialetosum perennis.*

Sliki 6 in 7: Subasociacija *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora phylitidetosum (levo)* in *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora mercurialetosum perennis.*

Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora neckeretosum crispae

Stands of the subassociation –*necekeretosum* are very localised; they are developed on rocks of the northern, north-eastern and southern part of the virgin forest remnant (Figure 2). Stoniness in places reaches 100 %. In rock cracks there are rendsins of different development stages from protorendsine to brownised rendsine with a more or less deep stratum of moder.

Beech and silver fir are in equal portions in the tree layer. Spruce is in places admixed in higher portion. In the lower tree layer there is a higher proportion of silver fir; individually are admixed *Acer pseudoplatanus*, *Ostrya carpinifolia,* and *Ilex aquifolium*. The shrub layer is composed of a higher number of shrub and tree species: *Daphne mezereum, Rosa pendulina, Rhamnus fallax, Euonymus latifola, E. verrucosa, Acer obtusatum, Sorbus aria, Sambucus nigra, Sorbus aucuparia,* and *Clematis vitalba*.

Because of the high proportion of stoniness, the shrub layer is less developed; on average it covers 30 %. The prevailing species of alliance *Aremonio-Fagion* and order *Fagetalia sylvaticae* are: *Cardamine trifolia, Omphalodes verna, Aremonia agrimonoides, Cyclamen purpurascens, Cardamine enneaphyllos, Scopolia carniolica, Mycelis muralis, Festuca altissima, Salvia glutinosa, Sanicula europaea,* and *Carex digitata*. Species of order *Vaccinio-Piceetalia* Br.-Bl. 1939 emend. K. Lund 1967 are not well presented; those which predominate are mainly the moderate acidophilous species: *Oxalis acetosella, Rosa pendulina, Lonicera nigra,* and *Hieracium murorum*.

Distinctive acidophilous species, except *Orthilia secunda*, are totally missing. Higher cover and constancy are reached by *Asplenium trichomanes, Solanum dulcamara, Polypodium vulgare, Moehringia muscosa,* and *Solidago virgaurea*.

The distinguishing combination of subassociation –*neckeretosum* is very poor. Only *Neckera*

Slika 8: Subassociation *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora neckeretosum crispae*.

Figure 8: Subasociacija *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora neckeretosum crispae.*

crispa reaches higher cover. The absence of distinctive acidophilous species and higher cover of thermophylous shrubs indicate a transition to stands of the association *Ostryo-Fagetum* (M. Wraber ex Trinajstić 1972).

***Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* subas. nova**

Stands of the subassociation -*caricetosum albae* are developed on the western part of the virgin forest remnant (Figure 2). One part of it is placed on ledges directly above the cliff, the second, bigger part lies below on the homogeneous steep slope. On the upper part, limestone bedrock prevails, and dolomite on the lower.

Tree composition is quite heterogeneous. Silver fir, particularly in the second tree layer, prevails over beech on the upper part above the cliff, while beech prevails on the lower part. In some parts there is a high proportion of admixed spruce and thermophylous deciduous trees, e.g., *Fraxinus ornus, Ostrya carpinifolia, Sorbus aria,* and *Acer obtusatum*.

The shrub layer covers about 25 %. Beside young growth of tree species there are also shrub species: *Daphne mezereum, Daphne laureola, Rosa arvensis, Lonicera xylosteum, Hedera helix, Euonymus verrucosa, Sorbus aucuparia, Rosa pendulina,* and others. The herb layer is well developed, covering from 60 to 90% of the surface. Species of order *Fagetalia sylvaticae* prevail: *Galium odoratum, Sanicula europaea, Mercurialis perennis, Mycelis muralis, Neottia nidus-avis, Salvia glutinosa, Prenanthes purpurea* and *Lilium martagon*. Likewise species of alliance *Aremonio-Fagion: Aremonia agrimonoides, Omphalodes verna, Cardamine trifolia, Cyclamen purpurascens, Cardamine enneaphyllos* and *Helleborus niger.*

By comparison with other virgin forest remnants in the framework of the areal of subassociation *Omphalodo-Fagetum*, the presence of moderate thermophilous taxa is interesting: *Tamus communis, Calamagrostis varia, Carex alba, Digitalis grandiflora* and *Cephalanthera rubra*. Acidophilous species are, except for *Picea abies*, very rare. *Luzula sylvatica* and *Orthilia secunda* appear only as accidental species. Among others species, those having higher cover and presence are *Moehringia trinervia, Oxalis acetosellla, Asplenium trichomanes* and *Solidago virgaurea*.

Moss layer on the rocks, which is mainly composed of species such as *Neckera crispa, Ctenidium molluscum* and *Isothecium myurum,* reaches cover to 40 %.

Differential species for the subassociation – *caricetosum albae* are*: Carex alba, Fraxinus ornus,* and *Cephalanthera rubra*. They indicate a thermophilous character, which is a consequence of the position, partly exposed to the sun and the steep slope.

We divided subassociation – *caricetosum albae* into two variants:

***Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* subass. nova. var. *Neckera crispa* var. nova**

The areal of that variant is directly above the cliff (Figure 2). The bedrock is made of limestone, and rendsines of different developmental stages prevail on it. *Neckera crispa, Luzula sylvatica* and

Figure 9: Variant *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* subass. nova. var. *Neckera crispa* var. nova (n. prov.).

Slika 9: Varianta *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* subass. nova. var. *Neckera crispa* var. nova (n. prov.).

Orthilia secunda, as differential species, show similarity to the subassociation –*neckeretosum*. The variant is poor in species of alliance *Aremonio-Fagion* and also of order *Fagetalia sylvaticae*. Partly differential are species *Asplenium trichomanes, Asplenium ruta-muraria* and *Polypodium vulgare*, which indicate stoniness.

The nomenclature type of the variant is relevé No. 7 in Table 3 (*holotypus hoc loco*).

***Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* subass. nova var. *Helleborus niger* var. nova**

A variant with taxa *Helleborus niger* is spread on the lower, southern border of the virgin forest remnant (Figure 2). The slope is steep and the relief homogeneous with only indicated surface stoniness. Beech prevails over silver fir, which can be found only in the lower tree and shrub layer.

The characteristic species of the association *Omphalodo-Fagetum* are well presented. Only taxa *Rhamnus fallax* is missing. Differential species of the subassociation reach high cover, particularly *Carex alba*. Differential species of the variant are *Helleborus niger* and *Calamagrostis varia*. The presence of *Primula vulgaris* and *Vicia oroboides* is interesting because they are species with optimal thriving in the submontane region.

The moss layer is not well developed and covers only 5 % of the surface.

The nomenclature type of the subassociation and variant is relevé No. 1 in Table 3 (*holotypus hoc loco*).

Soil profile description with commentary (Prus 2002) (Table 1 and 2, profile No. 5)
Bedrock: dolomite
Soil type: rendzina, Rendzic Leptosol
Location: X = 0485817, Y = 5052817, 865 m
Position and inclination: slope – middle, W, 25°

Figure 10: Variant *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* subass. nova var. *Helleborus niger* var. nova.

Slika 10: Varianta *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* subass. nova var. *Helleborus niger* var. nova.

Horizons:

Ol 2–0 cm, beech foliage, scarce fir needles and herb remnants

A 0–12 cm, real dark greyish brown (10YR 3/2), very humic silty clay, subangular blocky structure, medium expressed, medium dense and of crumbly consistence, fresh to moist with abundant roots, without rock fragments. Passage to the lower horizon is evident.

CA 12–32+ cm, dark brown (10YR 3/3) humic silty clay loam, subangular blocky structure, medium expressed, crumbly consistence, fresh to moist with medium abundance of roots. Contains 60% sharp-edged rock fragments of 10 cm in diameter.

The chemical and physical characters of the profile are rather similar to profile No. 1. Only an amount of magnesium, on the adsorbing part of the soil, explicitly stands out. This fact confirms the determination of dolomite as a bedrock.

Numerical analyses

The Detrended Canonical Analysis (DCA) was used to present the relations between the phytosociological relevés of the forest remnant Strmec (Figure 11). The relevés of the subassociation *caricetosum albae* var. *Helleborus niger* are well distinguished from others because of dolomite bedrock. In the upper part of the diagram there are relevés of the subassociation – *galietosum odorati*, which thrive on the deepest soil. In the central part of the diagram appear relevés of the subassociations *-festucetosum altissimae* and *-typicum*. In the lower part of the diagram there are relevés of stands, which thrive on shallow soil (subassociations *caricetosum albae* var. *Neckera crispa* and *neckeretosum crispae*).

Also the presentation of *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* subass. nova and two syntaxa are presented in DCA diagram (Figure 12), where relevés of community *Omphalodo-Fagetum* var. geogr. *Cala-*

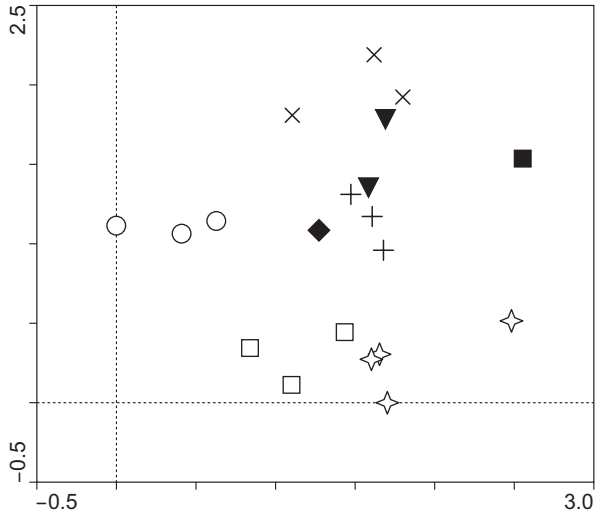


Figure 11: DCA ordination diagram of the relevés of subassociations of *Omphalodo-Fagetum* (Tregubov 1957) Marinček et al. 1993 var. geogr. *Calamintha grandiflora* Surina 2002 association from Table 3. ○: *caricetosum albae* var. *Helleborus niger*, □: *caricetosum albae* var. *Neckera crispa*, ✧: *neckeretosum crispae*, +: *festucetosum altissimae*, ◆: *mercurialetosum*, ▼: *typicum*, ×: *galietosum odorati,* ■: *phyllitidetosum.*

Slika 11: DCA ordinacijski diagram popisov subasociacij združbe *Omphalodo-Fagetum* (Tregubov 1957) Marinček et al. 1993 var. geogr. *Calamintha grandiflora* Surina 2002 iz Tabele 3. ○: *caricetosum albae* var. *Helleborus niger*, □: *caricetosum albae* var. *Neckera crispa*, ✧: *neckeretosum crispae*, +: *festucetosum altissimae*, ◆: *mercurialetosum*, ▼: *typicum*, ×: *galietosum odorati,* ■: *phyllitidetosum.*

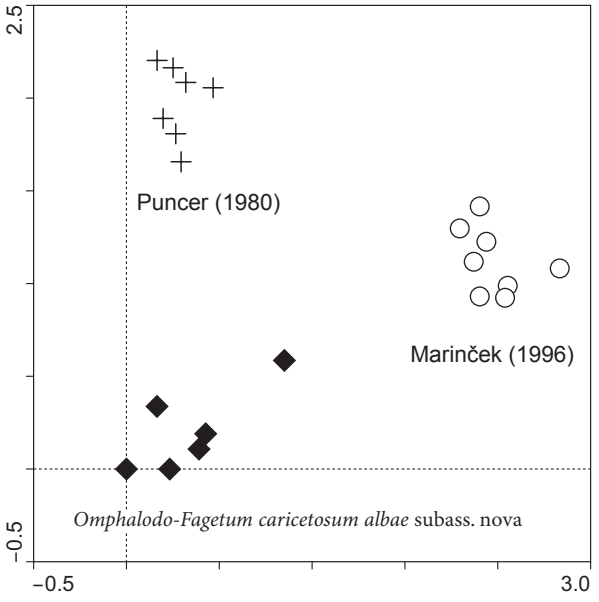


Figure 12: DCA ordination diagram of the relevés from
- *Omphalodo-Fagetum caricetosum albae* subass. nova (Table 3),
- *Ostryo-Fagetum* var. geogr. *Acer obtusatum* geogr. subvar. *Omphalodes verna* (Marinček 1996),
- *Omphalodo-Fagetum asaretosum* var. *Carex alba* (Puncer 1980).

Slika 12: DCA ordinacijski diagram popisov iz subasociacij
- *Omphalodo-Fagetum caricetosum albae subass. nova (Tabela 3),*
- *Ostryo-Fagetum var. geogr. Acer obtusatum geogr. subvar. Omphalodes verna* (Marinček 1996),
- *Omphalodo-Fagetum asaretosum* var. *Carex alba* (Puncer 1980).

mintha grandiflora caricetosum albae subass. nova are well distinguished from relevés of *Ostryo-Fagetum* M. Wraber ex Trinajstić 1972 var. geogr. *Acer obtusatum* Marinček, Puncer & Zupančič 1980 geogr. subvar. *Omphalodes verna* (Marinček 1996) and *Omphalodo-Fagetum asaretosum* var. *Carex alba* (Puncer 1980).

DISCUSSION AND CONCLUSIONS

In Dinaric silver fir-beech forests, the relief (beside exposition, altitude, etc.) is one of the most decisive factors of site condition which reflects in the floristic composition of forest communities (Puncer 1980). In the virgin forest remnant Strmec it is not so distinctive.

Development of the typical syntaxons: *-galietosum odorati, -festucetosum altissimae, -mercurialetosum, -neckeretosum* and others, which prevail in other virgin forest remnants in the Dinaric region (these are particularly Rajhenau and Pečka, which expand on a relatively bigger area (Mlinšek et al. 1980)), is made difficult because of special ecological conditions which are dependent on the prevalent exposed to the sun position, unexpressive relief and smallness of the virgin forest. Because of the small areas and partly transitional character of syntaxa in Strmec (Figure 11), making a comparison with syntaxa from the other virgin forest remnants is relatively difficult. The small number of relevés do not enable a well-grounded review of the floristic structure of individual syntaxa, nevertheless the actual situation is presented. The collected inventory material reflects only the local conditions. Comparison is partly possible by using syntaxa from the virgin forest remnant Pečka. In general it is also exposed to the

west, but its relief is more undulating (Marinček & Marinšek 2004). This results in special microclimatic conditions (Vilhar et al. 2006).

The greatest resemblance is in subassociation –*galietosum odorati*. The differential combination: *Galium odoratum* and *Sanicula europaea* is well represented. We added two local differential species: *Cardamine bulbifera* and *Veronica montana*, which indicate favourable moist conditions of the soil.

The lack of relevés is reflected to a high degree in subassociation –*festucetosum altissimae*. Among differential species of the subassociation (Puncer 1980), only *Festuca altissima* is constant and in places highly abundant. The second differential species, *Dicranum scoparium,* appears only with lower frequency.

The particularity of the site conditions is more distinctive in subassociation –*neckeretosum crispae*. Of all differential species, according to Puncer (1980): *Neckera crispa, Huperzia selago, Goodyera repens, Rhytidiadelphus loreus, Lycopodium annotinum, Vaccinium myrtillus,* only *Neckera crispa* appears with higher abundancy. *Goodyera repens* appears only as an accidental species.

The presence of some thermophylous species, such as *Euonymus verrucosa, Sorbus aria* and *Ostrya carpinifolia*, gives the subassociation a partly thermophilous character.

Accetto (1998) lowered the syntaxonomical rank of the subassociation *typicum* and treats it as variant *Omphalodo-Fagetum* var. *Asplenium trichomanes* with differential species *Asplenium trichomanes* and *Moehringia muscosa*. On the basis of the analysis we made in Strmec, for the time being we cannot accept his interpretations. Despite small floristic differences between subassociations *galietosum* and *typicum,* differences do exist in depth and stoniness of the soil (site of the subassociation *galietosum* has deeper soil and the percentage of bare rock is much more lower than in the subassociation *typicum*). Therefore we mapped sites of the subassociation *typicum* separated from the sites of the subassociation *galietosum* and according to Puncer (1980), we treat them on the rank of the subassociation *typicum*.

The most interesting feature of the virgin forest remnant of Strmec is, beside the cliff, the part between the cliff and lower road. On the steep slope, exposed to the sun and partly under the influence of dolomite, there has formed a special subassociation. We described it as *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae*. The special floristic composition dictates comparison with apparently similar associations: *Abieti-Fagetum dinaricum* (= *Omphalodo-Fagetum*) *asaretosum* var. *Carex alba* (Puncer 1980) and *Ostryo-Fagetum* M. Wraber ex Trinajstić 1972 var. geogr. *Acer obtusatum* Marinček 1996 (Figure 12).

Syntaxon *Omphalodo-Fagetum asaretosum* var. *Carex alba*, in comparison to subassociation - *caricetosum albae*, thrives on lower altitudes, according to Puncer (1980) from 500 to 700 m. Variant -*Carex alba* has a submontane character. An argument for this are the transgressive character species of submontane beech forests: *Hacquetia epipactis, Aposeris foetida, Asarum europaeum,* partly differential species of variant *Luzula pilosa,* and character and differential species of class *Querco-Fagetea* and also differential species of submontane beech forests in the wider sense: *Ligustrum vulgare, Cornus sanguinea, Berberis vulgaris, Carpinus betulus, Quercus petraea, Clematis vitalba, Acer campestre* and *Viburnum lantana*. All stated species in the mountain belt, where Strmec is located, are completely missing. Furthermore in the tree layer of variant with *Carex alba*, silver fir is prevailing over beech. Subassociation –*caricetosum albae* has a montane character. A proof for that is the complete absence of the earlier mentioned species and the presence of some montane elements: *Cardamine enneaphyllos, Cardamine bulbifera, Cardamine trifolia* and *Scopolia carniolica*.

The presence of species, like *Helleborus niger, Carex alba, Primula vulgaris* and *Vicia oroboides*, forms a link between those syntaxons, but their floristic composition is so different that they belong to two different independent subassociations of association *Omphalodo-Fagetum*.

Robič (2000) classified stands from the lower part of the virgin forest into the syntaxon *Ostryo-Fagetum* var. geogr. *Acer obtusatum*. Considering the more or less informative investigation, and low vitality of the silver fir, this is in itself understandable. The recent situation indicates a special subassociation in the frame of the Dinaric fir-beech forest.

Comparison with syntaxon *Ostryo-Fagetum* var. geogr. *Acer obtusatum* shows that subassociation *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* contains numerous species which are frequent in the Dinaric fir-beech forests (s. lat.): *Abies alba, Daphne laureola, Calamintha grandiflora, Rhamnus fallax, Cardamine trifolia, Festuca altissima, Cardamine enneaphyllos, Aremonia agrimonoides, Scopolia carniolia,* and

other species, like *Cardamine trifolia, Lonicera alpigena, Luzula sylvatica, Rosa pendulina, Orthilia secunda*, which classify forests of subassociation *-caricetosum albae* to fir-beech forests of association *Omphalodo-Fagetum*.

The exception is taxon *Omphalodes verna,* which has higher coverage in syntaxon *Ostryo-Fagetum* var. geogr. *Acer obtusatum* than in subassociation *-caricetosum albae*.

Both syntaxa are connected with the number of species characteristic for beech forests; occuring with rather high coverage values are: *Cyclamen purpurascens, Acer pseudoplatanus, Senecio ovatus, Viola reichenbachiana, Rosa arvensis, Carex digitata*. *Euphorbia amygdaloides, Polygonatum multiflorum, Lilium martagon, Mycelis muralis, Primula vulgaris, Salvia glutinosa, Sanicula europaea, Prenanthes purpurea, Lonicera xylosteum, Mercurialis perennis, Acer platanoides,* and *Euonymus latifolius.* They have features in common with some thermophilous species: *Fraxinus ornus, Sorbus aria* and *Acer obtusatum*. *Calamagrostis varia* and *Carex alba*, as moderate thermophilous species, in subassociation *-caricetosum albae* they have much higher coverage and presence. Both syntaxa are distinguished by species of order *Quercetalia pubescentis*: *Melittis melisophyllum, Convallaria majalis, Berberis vulgaris, Betonica officinalis, Carex flacca, Viburnum lantana, Ligustrum vulgare, Peucedanum oreoselinum, Vincetoxicum hirundinaria, Inula salicina, Epipactis atrorubens, Cirsium erisithales* and other species from class *Querco-Fagetea: Clematis vitalba, Acer campestre, Corylus avellana, Crataegus monogyna, Cruciata glabra, Galium laevigatum, Melampyrum nemorosum, Quercus petraea, Sorbus torminalis, Helleborus odorus, Lonicera caprifolium, Carpinus betulus, Prunus avium, Asarum europaeum, Dryopteris filix-mas, Epimedium alpinum, Pteridium aquilinum, Melica uniflora* and others.

All listed taxa appear only in stands of *Ostryo-Fagetum* var. geogr. *Acer obtusatum*. Although they both have a small number of thermophilous species, the study revealed very large differences (Figure 12) in the floristic inventory of both syntaxa that belong to different sub-alliances in the frame of alliance *Aremonio-Fagion*.

Phytosociological and pedological analyses and review of the actual conditions in the virgin forest remnant Strmec are important for understanding the ecological processes which take place in such an ecosystem. The research could be also important as a basis for further biological and forestry investigations.

4. POVZETEK

Vegetacija pragozdnega ostanka Strmec

Pragozdni ostanek Strmec, s površino 15.55 ha (Mlinšek 1980), se nahaja na južnem delu Slovenije, na Kočevskem (jugozahodni del Stojne), in spada v dinarsko fitogeografsko območje (Wraber 1969). Leži na nadmorski višini od 850 do 940 m.

Predel, kjer se nahaja pragozdni ostanek je bil dolgo v lasti veleposestnika grofa Auersperga. V drugi reviziji gospodarskega načrta za II. obratno enoto – Fridrihštajn iz leta 1913, se je v njem prvič pojavil pododdelek z zaznamkom »Urwald« (pragozd). Od takrat se s tem delčkom gozda naj ne bi gospodarilo (Konečnik & Zaplotnik 2001).

Namen naše raziskave, ki smo jo opravili leta 2002 je detajlna proučitev gozdnih združb in pedoloških razmer v pragozdnem ostanku Strmec ter izdelava vegetacijske karte. Predstavljeni rezultati raziskave so nadaljevanje niza fitocenoloških raziskav slovenskih pragozdnih ostankov (Marinček & Marinšek 2003, 2004).

Popise vegetacije smo naredili po standardni srednjeevropski züriško-montpellierskio metodi (Braun-Blanquet 1964). Nomenklaturo rastlinskih vrst navajamo po Martinčič et al. (2007), sintaksonomsko nomenklaturo po Marinček et al. (1993), nomenklaturni vir za mahove pa je Martinčič (2003). Pri analizi popisov smo si pomagali z DCA analizo (kanonična analiza z odstranjenim trendom) (ter Braak & Šmilauer 2002).

Talne razmere smo proučili na podlagi petih reprezentančnih talnih profilov, ki smo jih naredili julija 2002. V laboratorijih Centra za pedologijo in varstvo okolja so bile izvedene sledeče analize: ugotavljanje pH vrednosti, določevanje organskega ogljika, organska snovi, celokupnega dušika dostopnega kalija, dostopnega fosforja, določitev izmenjalnih, bazičnih kationov (Ca, Mg, K, Na), določitev stopnje nasičenosti z bazami ter mehanska analiza tal.

Relief terena je v zgornjem delu pragozdnega ostanka zmerno nagnjen, v srednjem položen in vrtačast, za spodnji del pa je značilen strm teren s skalnatimi stenami. Prevladuje jugozahodna ekspozicija terena. Večina matične kamnine je apnenčasta, na spodnjem delu pa je apnencu primešan še dolomit. Glavni tipi tal, ki se pojavljajo v pragozdnem ostanku so: rendzina, rjava tla in pokarbonatna rjava tla.

Gozdne sestoje, ki poraščajo pragozdni ostanek Strmec uvrščamo v geografsko varianto asociacije *Omphalodo-Fagetum* (Tregubov 1957) Marinček et al. 1993 var. geogr. *Calamintha grandiflora* Surina 2002. V okviru te asociacije smo na območju pragozda izločili naslednje že v preteklosti opisane subasociacije (Slika 2 in 12, Tabela 3):

– *festucetosum altissimae* Puncer et al. 1974
– *galietosum odorati* (Tregubov 1957) Puncer 1980
– *typicum* (M. Wraber 1955) Puncer 1980
– *mercurialetosum perennis* Tregubov 1957
– *phyllitidetosum* (Puncer et al. 1974) Marinček et Marinšek 2004
– *neckeretosum crispae* Puncer 1980

ter novo subasociacijo, z dvema variantama:

– *caricetosum albae* subass. nova
  • var. *Neckera crispa* var. nova
  • var. *Helleborus niger* var. nova.

Nomenklaturni tip subasociacije in variante *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* var. *Helleborus niger* je fitocenološki popis št. 1 v Tabeli 3 (*holotypus hoc loco*). Nomenklaturni tip variante *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* var. *Neckera crispa* je fitocenološki popis št. 7 v Tabeli 3 (*holotypus hoc loco*).

Novo subasociacijo *Omphalodo-Fagetum* var. geogr. *Calamintha grandiflora caricetosum albae* subass. nova smo utemeljili s primerjavo z združbama *Ostryo-Fagetum* M. Wraber ex Trinajstić 1972 var. geogr. *Acer obtusatum* Marinček, Puncer & Zupančič 1980 geogr. subvar. *Omphalodes verna* (Marinček 1996) in *Omphalodo-Fagetum asaretosum* var. *Carex alba* (Puncer 1980) (Slika 12).

Subasociacijo –*caricetosum albae* in njeni varianti uvrščamo v asociacijo *Omphalodo-Fagetum* (Tregubov 1957) Marinček et al. 1993 var. geogr. *Calamintha grandiflora* Surina 2002, v podzvezo *Lamio orvalae-Fagenion* Borhidi ex Marinček et al. 1992, zvezo *Aremonio-Fagion* (I. Horvat 1983) Török, Podani & Borhidi 1989, red *Fagetalia sylvaticae* Pawlovski in Pawlovski et al. 1982 in razred *Querco-Fagetea* (Br.-Bl. et Vlieger in Vlieger 1937).

Opravljene fitocenološke in pedološke analize ter izdelana vegetacijska karta pragozdnega ostanka Strmec so pomembni za razumevanje ekoloških procesov, ki potekajo v ekosistemih, kot je jelovo-bukov gozd. Raziskava je pomembna tudi kot osnova za nadaljne različne biološke in gozdarske raziskave.

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Table 3: Analytical phytosociological table of the association *Omphalodo-Fagetum* (Tregubov 1957) Marinček et al. 1993 var. geogr. *Calamintha grandiflora Surina* 2002 with subassociations and variants.

Tabela 3: Analitska tabela asociacije *Omphalodo-Fagetum* (Tregubov 1957) Marinček et al. 1993 var. geogr. *Calamintha grandiflora Surina* 2002 s subasociacijami in variantami.

Relevé number		2	1	3	4	5	7	6	8	9	10	11	12	13	14	15	16	19	17	18	20
Month		6	6	6	6	6	9	7	9	9	7	6	6	6	6	6	7	6	7	6	6
Day		20	20	20	20	20	4	23	4	4	23	18	18	18	18	18	23	18	23	18	18
Year		2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002
Relevé area (m^2)		400	400	400	400	400	400	60	400	300	400	400	400	400	400	400	400	400	400	400	400
Altitude (m)		880	875	880	875	920	860	880	865	850	870	870	855	920	920	920	890	890	930	870	865
Aspect (degrees)		270	225	270	270	270	270	270	270	270	315	225	270	225	203	248	180	225	225	135	180
Slope (degrees)		30	25	30	30	20	35	0	25	25	15	25	30	25	25	10	15	10	5	10	5
Cover tree layer (%)		90	75	90	60	60	60	70	70	60	85	90	80	80	80	80	90	70	90	90	80
Cover shrub layer (%)		20	20	25	10	30	30	10	10	30	10	5	10	5	5	10	20	60	10	10	30
Cover herb layer (%)		80	70	70	90	70	30	30	30	40	40	20	40	40	30	40	40	60	70	60	60
Cover moss layer (%)		5	5	5	20	30	40	50	30	50	70	40	10	25	20	30	30	5	5	0	2
Cover bare rock (%)		5	10	20	30	50	90	80	60	80	90	7	30	60	50	40	50	10	10	5	5
Character species of the association		***caricetosum albae***						***neckeretosum***				***phyllitidetosum***	***mercurialetosum***	***festucetosum***			***typicum***		***galietosum***		
		var. *Helleborus niger*			var. *Neckera crispa*																
Abies alba	A1	.	.	+	1	4	1	2	1	+	2	2	2	2	3	1	1	1	+	+	2
Abies alba	A2	2	+	2	3	2	2	2	2	1	1	1	3	1	1	2	1	1	1	2	1
Abies alba	B	+	.	+	.	.	+	+	.	+	.	.	.	.	+	+	+	.	+	.	.
Abies alba	C	.	.	+	+	+	+	.	+	.	+	+	+	1	.	+	.	1	+	.	+
Aremonia agrimonoides		+	+	+	+	1	+	+	+	+	+	+	+	+	+	+	1	+	+	+	+
Calamintha grandiflora		.	+	.	.	.	.	.	+	.	+	.	+	+	+	.	.	.	+	.	+
Omphalodes verna		1	1	1	+	+	.	.	1	+	+	+	+	+	1	1	1	+	2	2	1
Cardamine trifolia		+	+	+	.	.	+	.	+	+	+	1	+	+	+	2	+	+	1	2	1
Daphne laureola	B	.	+	+	+	+	+	.	.	+	+	+	+	+	+	+	+	+	+	+	+
Rhamnus fallax		.	.	.	.	.	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.

Differential species of subass. and variants																					
Carex alba	C	3	2	2	4	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fraxinus ornus	A2	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fraxinus ornus	B	1	1	1	.	2	+	.	.	.	.	.	.	.	.	.	.	+	.	.	+
Cephalanthera rubra	C	+	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Ostrya carpinifolia	A1	.	.	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Ostrya carpinifolia	A2	.	.	.	2	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.
Ostrya carpinifolia	B	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helleborus niger	C	2	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Neckera crispa	D	+	.	+	1	1	3	4	2	3	4	2	1	+	1	2	1	+	.	.	.
Goodyera repens	C	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Phyllitis scolopendrium		.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.
Mercurialis perennis		1	1	1	.	1	1	.	+	+	+	.	2	1	1	1	.	.	+	.	.
Festuca altissima		.	.	.	.	1	.	+	+	+	+	+	+	2	2	2	+	+	+	.	.
Galium odoratum		+	+	.	.	.	.	.	.	.	+	+	.	+	+	.	1	+	1	1	3
Sanicula europaea		+	+	1	.	+	+	.	+	.	+	+	+	+	+	1	+	1	1	2	2
Calamagrostis varia		2	+	2	2	1	1	.	1	1	.	.	+	.	.	.	.	.	.	.	.
Luzula sylvatica		.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orthilia secunda		.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Hieracium sylvaticum		.	+	+	.	1	+	1	.	.	.	.	+	.	.	.	.	.	.	.	.
Carex sylvatica		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	+
Cardamine bulbifera		.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	1	1
Veronica montana		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Aremonio-Fagion																					
Cyclamen purpurascens	C	+	+	+	1	+	1	+	1	1	+	.	1	+	+	+	.	.	+	.	.
Cardamine enneaphyllos		+	+	+	.	+	.	.	+	+	.	1	+	+	1	+	+	+	+	+	+
Scopolia carniolica		.	.	.	.	.	+	1	.	1	.	1	.	.	.	.	+	.	.	.	+
Lamium orvala		.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	+
Primula vulgaris		+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia oroboides		1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardamine kitaibelli		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Homogyne sylvestris		.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Fagetalia sylvaticae																					
Fagus sylvatica	A1	4	3	4	1	+	2	2	2	2	2	.	3	4	3	4	4	4	4	5	4

Relevé number		2	1	3	4	5	7	6	8	9	10	11	12	13	14	15	16	19	17	18	20
Fagus sylvatica	A2	1	+	+	+	+	.	+	1	1	+	+	+	1	2	2	+	1	+	+	+
Fagus sylvatica	B	+	1	+	1	2	+	+	.	1	+	1	+	+	.	1	+	.	1	1	3
Fagus sylvatica	C	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	1	+
Fagus sylvatica	D	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Daphne mezereum	B	+	+	+	+	+	+	+	1	+	+	+	+	+	+	+	+	+	+	+	+
Salvia glutinosa	C	1	+	+	+	+	+	.	+	+	+	.	+	+	.	+	+	+	+	+	1
Viola reichenbachiana		.	+	+	.	+	.	+	+	+	.	+	+	.	+	+	+	+	+	+	+
Acer pseudoplatanus	A1	.	.	+	.	.	.	.	.	.	+	+	.	+	+	.	.	+	.	+	.
Acer pseudoplatanus	A2	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Acer pseudoplatanus	B	+	+	+	+	.	.	+	+	+	.	1	+	+	+	1	1	1	+	1	1
Acer pseudoplatanus	C	.	.	+	.	.	.	.	.	+	+	.	+	1	+	.	+	1	.	.	+
Mycelis muralis		.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	.	+	+	+
Prenanthes purpurea		+	+	+	+	+	+	.	.	+	.	.	+	+	.	+	+	.	+	+	.
Senecio ovatus		+	.	+	.	.	+	.	.	+	.	+	.	+	.	+	.	.	+	+	+
Geranium robertianum		.	.	.	.	+	+	+	+	+	1	.	.	+	+	+	.	.	.	.	.
Dryopteris filix-mas		.	.	.	.	.	.	.	+	.	1	1	+	+	+	.	.	.	.	+	+
Acer platanoides	A1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acer platanoides	A2	+	.	.	.	+	+	.	+	+	.	+	.	+	.	.	.	.	+	+	.
Galeobdolon flavidum	C	.	.	.	.	.	.	.	.	.	+	+	.	+	+	+	+	+	+	.	+
Paris quadrifolia		.	.	+	.	.	.	.	.	.	+	+	.	+	.	+	.	.	.	+	+
Euphorbia amygdaloides		.	.	+	.	.	.	.	.	.	.	.	.	+	.	+	.	.	+	+	+
Brachypodium sylvaticum		+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	1
Ulmus glabra	A1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.
Ulmus glabra	B	.	+	.	.	.	.	+	+	.	.	.	.	+	+	+	.	.	+	+	.
Ulmus glabra	C	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.
Carex pilosa		.	+	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	4	.	.
Neottia nidus-avis		+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Polygonatum multiflorum		.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+
Rosa arvensis	B	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Actaea spicata	C	+	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.
Campanula trachelium		.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Hordelymus europaeus		.	.	+	.	1	.	.	.	.	+	.	+	.	.	+	1	.	1	.	.
Polystichum aculeatum		.	.	.	.	.	.	.	+	.	+	1	+	.	.	.	+	.	.	.	.
Sambucus nigra	B	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.

Melica nutans	C	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
Symphytum tuberosum		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Lonicera alpigena	B	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonatum verticillatum	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Lonicera nigra	B	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Arum maculatum	C	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Tilia platyphyllos		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Viola sp.		.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Epilobium montanum		.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Adoxa moschatellina		.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Euphorbia dulcis		.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunus avium		.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lilium martagon		.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Querco-Fagetea																					
Carex digitata	C	.	.	+	+	+	1	1	+	1	.	.	+	+	+	.	.	.	.	.	.
Euonymus latifolius	B	.	.	.	+	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Euonymus verrucosus		.	.	.	+	+	1	+	+	1	.	.	.	.	.	.	.	.	.	.	.
Sorbus aria	A2	.	+	.	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Sorbus aria	B	+	+	+	+	+	+	.	+	.	.	.	+	.	.	+	+	+	+	.	+
Ajuga reptans	C	+	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Anemone nemorosa		+	+	+	.	.	.	.	.	.	.	+	+	+	+	+	.	+	1	1	+
Clematis vitalba	B	.	+	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.
Lilium martagon	C	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lonicera xylosteum	B	+	+	.	.	+	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Melittis melissophyllum	C	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Athyrium filix-femina		.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	+	+
Hedera helix	B	+	.	+	+	.	+	.	+	.	.	.	+	.	.	.	.	+	.	.	.
Acer obtusatum	A2	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acer obtusatum	B	+	+	+	+	+	.	.	.	+	.	+	.	.	+	.	.	.	+	.	.
Acer obtusatum	C	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tilia platyphyllos	B	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+
Vinca minor	C	.	.	.	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Pyrus pyraster	B	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hepatica nobilis	C	.	.	1	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Ilex aquifolium	A2	.	.	.	.	.	.	.	+	.	.		.	.	.	.	.	.	.	.	.

Relevé number		2	1	3	4	5	7	6	8	9	10	11	12	13	14	15	16	19	17	18	20
Ilex aquifolium	B	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.
Tamus communis	C	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cornus mas	B	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acer campestre									+												
Circaea intermedia	C	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Taxus baccata	A2	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Ulmus minor	B	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Cephalanthera longifolia	C																	+			
Vaccinio-Piceetalia																					
Picea abies	A1	.	1	+	2	.	2	+	+	2	.	.	+	+	+	.	.	.	.	.	.
Picea abies	A2	+	1	+	.	.	+	.	.	+	.	.	.	+	+	.	.	.	.	+	.
Picea abies	B	.	.	+	.	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.
Picea abies	C	.	.	+	.	.	+	.	.	+	+	.	.	.	+	+	.	.	.	.	.
Dryopteris expansa		.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Dryopteris dilatata		.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Dryopteris carthusiana		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Galium rotundifolium		.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	+	.	.	.
Others																					
Moehringia muscosa	C	+	.	.	.	+	+	+	+	1	.	.	.	+	.	+	.	.	.	.	.
Oxalis acetosella		+	.	.	+	+	.	.	+	+	+	+	+	+	+	+	+	+	+	2	2
Sorbus aucuparia	B	+	.	.	+	+	+	.	+	.	+	.	+	.	.	.	.	.	.	.	.
Asplenium trichomanes	C	.	.	.	+	+	+	.	+	1	1	.	.	+	+	+	.	.	.	.	.
Solidago virgaurea		.	.	.	1	+	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.
Rosa pendulina	B	.	.	.	+	+	1	1	+	1	.	.	+	+	+	+	+	.	+	.	.
Polypodium vulgare	C	.	.	.	.	+	.	+	.	+	1	+	.	.	.	.	.	.	.	.	.
Rubus idaeus	B	.	.	.	.	+	.	.	.	+	+	.	.	+	.	.	.	.	+	.	.
Asplenium ruta-muraria	C	.	.	.	.	+	+	+	+	1	.	.	.	.	.	.	.	.	.	.	.
Asplenium viride		.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.
Solanum dulcamara		.	.	.	.	.	.	+	+	+	1	.	.	+	+	.	.	.	.	.	.
Cardaminopsis arenosa		.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fragaria vesca		.	.	+	.	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.
Glechoma hirsuta		.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gentiana asclepiadea		.	.	+	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	+	.

Sorbus aucuparia	A2	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sorbus aucuparia	C	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crataegus monogyna	B	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cruciata glabra	C	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala chamaebuxus		.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Piptatherum virescens		.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus sp.	B	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Saxifraga rotundifolia	C	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Solanum dulcamara	B	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Cardamine flexuosa	C	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Rubus fruticosus	B	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Euonymus europaeus	C		.	.	.	.	.	.	.	.		+	.	.	.	.	.	.	.	.	.
Moehringia trinervia		.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium erisithales		.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Digitalis grandiflora		.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fragaria sp.		.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thalictrum aquilegiifolium		.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ribes sp.	B	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium aparine	C	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veratrum album		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Pteridium aquilinum		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Mosses																					
Ctenidium molluscum	D	+	.	1	1	3	2	2	1	2	3	2	2	2	2	1	2	+	+	1	1
Hypnum cupressiforme		1	.	+	.	.	.	.	+	+	+	.	+	.	+	.	.	+	.	.	.
Isotechyum myurum		1	.	+	+	3	.	1	1	1	1	2	1	+	.	1	1	+	.	+	1
Plagiochila asplenioides		.	.	.	+	+	1	+	1	.	+	.	.	.	.	.	1	.	.	.	.
Dicranum scoparium		.	.	.	.	1	.	+	.	+	.	.	.	+	.	.	.	.	.	.	+
Fissidens taxifolius		.	.	.	.	.	1	+	1	.	.	.	.	.	+	.	.	.	.	.	.
Tortella tortuosa		.	+	.	.	+	+	+	+	.	.	.	.	+	+	.	.	.	.	.	.
Plagiomnium undulatum		.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	+	+
Thamnobryum alopecurum		.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.
Rhizomnium punctatum		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Neckera complanata		.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Plagiothecium sylvaticum		.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.

Relevé number	2	1	3	4	5	7	6	8	9	10	11	12	13	14	15	16	19	17	18	20
Chrysosplenium alternifolium	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Mnium sp.	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Cladonia sp.	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dictamnus albus	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Atrichum undulatum	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Marchantia polymorpha	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Encalypta streptocarpa	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Fissidens cristatus	·	+	·	+	·	1	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Dicranum pobysetum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Bryum capillare	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+