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OAK FOREST VEGETATION IN THE NORTHERN PART OF THE ŠTIAVNICKÉ VRCHY MTS (CENTRAL SLOVAKIA)

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Abstract
The phytosociological research of the oak forest vegetation was carried out in the northern part of the Štiavnické vrchy Mts (Central Slovakia) using the standard Zürich-Montpellier approach. The data set consisting of 41 phytosociological relevés was obtained by the authors in two vegetation seasons in 2008 and 2009. The numerical classification and the ordination methods were applied to determine the main vegetation types and to explain the structure of the vegetation-environmental data matrix, respectively. Four associations within two classes were distinguished: *Luzulo albidae-Quercetum petraeae* Hilitzer 1932, typical for shallow, mineral-poor and acidic soils, *Melico uniflorae-Quercetum petraeae* Gergely 1962 occuring on mesic stands with skeletal and deeper soils, *Poo nemoralis-Quercetum dalechampii* Šomšák et Háberová 1979 developing on moderately canopy-opened stands in the submontane belt, *Sorbo torminalis-Quercetum* Svoboda ex Blažková 1962 growing on moderately acidic substrates in drier regions. The major environmental gradients responsible for variation in forest species composition was associated with soil nutrient and soil reaction following the Ellenberg indicator values as well as the measured environmental variables (C/N-ratio and soil acidity). Special attention was given to the discussion on species composition and site ecology.
Key words: classification, phytosociology, ecology, *Quercetea robori-petraeae*, *Querco-Fagetea*, gradient analysis, the Western Carpathians.

Izvleček
Fitocenološke raziskave hrastovih gozdov v severnem delu gorovja Štiavnické vrchy (srednja Slovaška) smo naredili po Zürichško-Montpellierski metodi. Enainštirideset vegetacijskih popisov smo naredili v dveh vegetacijskih sezonah v letih 2008 in 2009. Za določitev glavnih vegetacijskih tipov in za obrazložitev strukture podatkovne matrike vegetacijskih popisov in ekoloških spremenljivk smo uporabili numerično klasifikacijo in ordinacijo. Znotraj dveh razredov smo ločili štiri asociacije: *Luzulo albidae-Quercetum petraeae* Hilitzer 1932, značilna za plitva, z minerali revna, kisla tla, *Melico uniflorae-Quercetum petraeae* Gergely 1962, ki se pojavlja na mezičnih rastiščih s skeletnimi, globljimi tlemi, *Poo nemoralis-Quercetum dalechampii* Šomšák et Háberová 1979, ki se razvije v zmerno odprtih sestojih v submontanskem pasu, *Sorbo torminalis-Quercetum* Svoboda ex Blažková 1962 pa uspeva na zmerno kislih tleh v sušnejših predelih. Glavna okoljska gradienta, ki vplivata na floristično sestavo, sta hranila v tleh in reakcija tal. Odražata se tako v Ellenbergovih indikatorskih vrednostih kot v merjenih okoljskih spremenljivkah (C/N razmerje in kislost tal). Poseben poudarek smo namenili diskusiji o vrstni sestavi in ekologiji rastišč.
Ključne besede: klasifikacija, fitosociologija, ekologija, *Quercetea robori-petraeae*, *Querco-Fagetea*, gradientna analiza, zahodni Karpati.

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INTRODUCTION

The genus *Quercus* (*Fagaceae*) represents one of the most abundant groups of trees in temperate Europe (Nixon 1993). It is considered a taxonomically complicated group with high frequency of hybridization. This process has been reflected in the difficult determination of some oak species and also in different evaluation of their taxonomic status (Gömöry et al. 2001, Franjić et al. 2006). The species composition and proportion of *Quercus* species in the tree layer of the Carpathian-Pannonian forest vegetation changes depending on the site conditions mainly soil depth and soil water availability (cf. Jakucs 1961, Ellenberg 1982, Magic 2006). Among the oak species native to this area (cf. Magic l.c.), *Q. petraea* agg. (incl. *Q. petraea* s. str., *Q. dalechampii*, *Q. polycarpa*) and *Q. cerris* are the most frequently dominating taxa.

The oak forests are important elements of the natural Carpathian-Pannonian vegetation, and they are substantial habitats of many endangered species (cf. Jakucs 1961). Except for two associations included into the order *Fagetalia*, the oak forest vegetation types have been traditionally classified in the territory of Slovakia into the orders *Quercetalia roboris* and *Quercetalia pubescenti-petraeae* (Jarolímek et al. 2008a). Acidophilous oak forests of the order *Quercetalia roboris* are commonly developed on a mineral deficient substrate with shallow soil, whereas the xero- and thermophilous oak forests of the order *Quercetalia pubescenti-petraeae* are associated on shallow to deep soils containing a high concentration of mineral nutrients, especially in areas with a drier and warmer microclimate. Oak forest vegetation has already been several times investigated in the past. Additionally to the regional phytosociological studies from various parts of Slovakia (e.g. Klika 1937, Michalko 1957, Neuhäusl & Neuhäuslová-Novotná 1964, Neuhäuslová-Novotná 1965, Šomšák & Háberová 1979, Kliment & Watzka 2000, Slezák & Kukla 2009a), there are a few papers exclusively devoted to their floristic differentiation patterns and spatial distribution (Šomšák 1963, Jurko 1965, Neuhäuslová-Novotná & Neuhäusl 1965, Miadok 1991, Chytrý 1994, Kanka 2001, Roleček 2004). Despite the fact that nowadays a part of thermophilous oak forests of the order *Quercetalia pubescenti-petraeae* has been discussed by Roleček (2005), the syntaxonomy of the oak forest vegetation types requires a comprehensive revision.

The Štiavnické vrchy Mts are volcanic mountains situated in the central part of Slovakia (Figure 1). They occupy a geographic territory in the transition zone between the Western Carpathian and the Pannonian phytogeographic region. Mountain units situated on the border of these regions belong generally to the botanicaly attractive areas. Due to the diversity of both plant species and communities, they have been recently the subject of some studies (e.g. Michálková 2007, Hrivnák et al. 2008).

A basic survey of forest communities of the study area has been partially outlined by Balkovič (2002) and Slezák & Hegedüšová (2010), although only a little information is available on the ecological patterns of the oak forests. The data on their variability and floristic composition are relatively rare. Although some individual relevés were published in papers focusing on floristical records (e.g. Slezák & Kukla 2009b), the detailed classification and description of site ecology remain still poorly known. For this reason, the aim of the current paper is to establish the main vegetation types of oak forests in the northern part of the Štiavnické vrchy Mts and to characterise their major environmental gradients.

METHODS

The vegetation study was carried out according to the principles of the standard Zürich-Montpellier approach using the modified 9-degree Braun-Blanquet scale (Barkman et al. 1964). Forty-one phytosociological relevés with dominance or co-dominance (at least 25 % cover in the tree layer) of an oak species were recorded by the authors in the northern part of the Štiavnické vrchy Mts in 2008–2009 and stored in a TURBOVEG database (Hennekens & Schaminée 2001). Numerical classification of the data set was performed by the Hierclus program from the SYN-TAX 2000 package (Podani 2001) with the Sørensen (Bray-Curtis) distance as a measure of dissimilarity and the beta-flexible linkage method ($\beta = -0.25$). Species percentage cover was logarithmically transformed. The optimal number of clusters was estimated by the 'crispness' method (Botta-Dukát et al. 2005) using the JUICE software (Tichý 2002). The same woody species recorded in different layers were merged for the purpose of the numerical classification. The moss layer was also integrated in the analysis. The diagnostic species

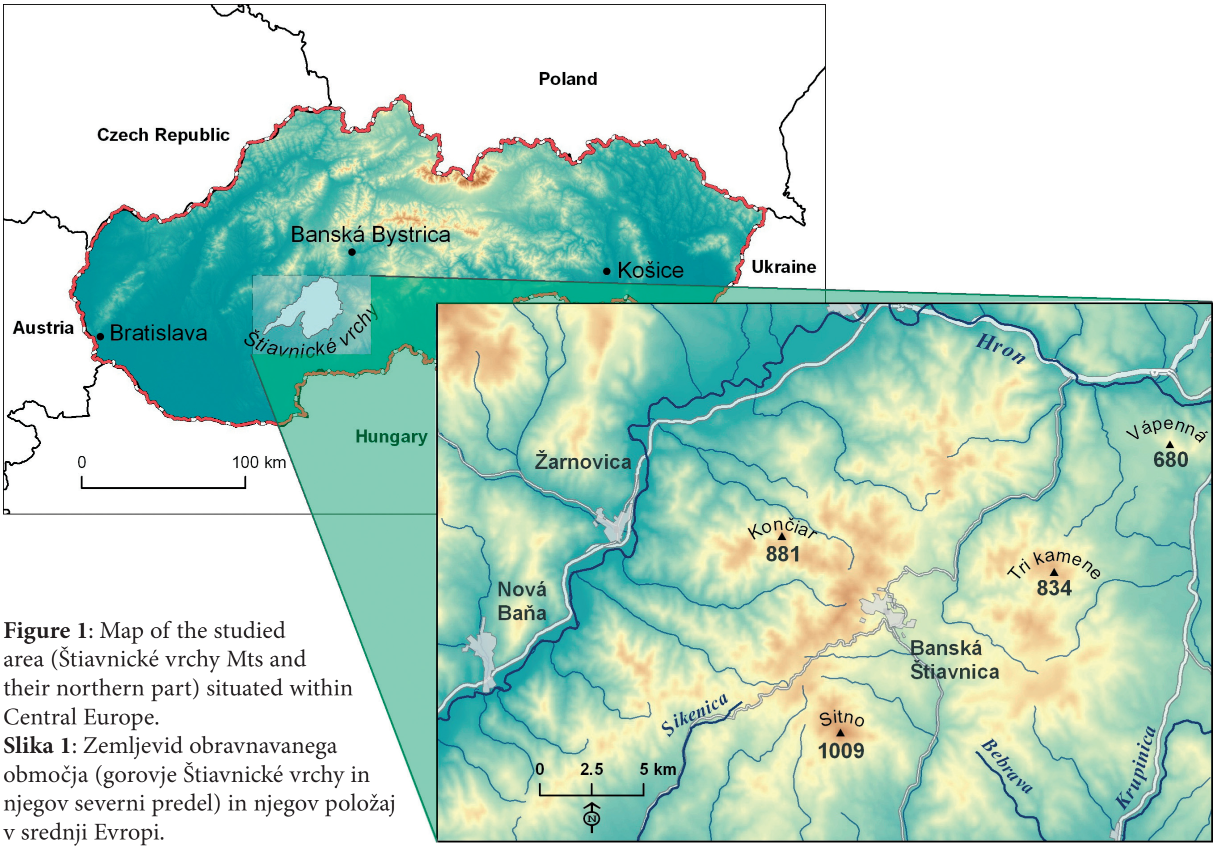

Figure 1: Map of the studied area (Štiavnické vrchy Mts and their northern part) situated within Central Europe.
Slika 1: Zemljevid obravnavanega območja (gorovje Štiavnické vrchy in njegov severni predel) in njegov položaj v srednji Evropi.

of the associations were determined on the basis of the fidelity concept (Chytrý et al. 2002) and frequency in the JUICE software. The size of all clusters was standardized to an equal size (Tichý & Chytrý 2006). The species with simultaneous values of phi coefficient > 0.30 and frequency > 30 were considered as diagnostic ones. Fisher's exact test ($P < 0.05$) was used to eliminate the fidelity value of species with a non-significant pattern of occurrence. The results of classification are summarised in Table 1, in which the assignment of species to higher vegetation units (alliances, classes) follows Moravec (1998), Moravec et al. (2000) and Jarolímek et al. (2008b). The percentage constancy (frequency) was given for each species in individual clusters and species were ranked by the decreasing value. Since the diagnostic species were obtained from an analysis of deciduous oak forests from a part of the Štiavnické vrchy Mts, they are only of a local validity. Detrended correspondence analysis (DCA) using the CANOCO for Windows package (ter Braak & Šmilauer 2002) was used to explain the structure of the vegetation-environmental data matrix and to interpret the main environmental gradients. Ellenberg indicator values for vascular plants (Ellenberg et al. 1992) and measured environmental variables for vegetation plots were plotted onto a DCA ordination diagram as supplementary variables. Geographical coordinates (longitude, latitude) and altitude were measured by the Garmin GPSmap 60 CSx (WGS 84).

Understory light conditions were recorded by the hemispherical photographs. Their processing and calculation of canopy openness (CO), i.e. the percentage of open sky seen from beneath a forest canopy (Jelaska 2004), was subsequently done using Gap Light Analyser software (Frazer et al. 1999). Soil samples were randomly taken in three places in each vegetation plot from the uppermost mineral horizon (0–5 cm depth, litter removed) and mixed to form a single sample per plot in order to reduce the soil heterogeneity. They were dried at laboratory temperature, crushed and passed through a 2 mm sieve. Soil acidity (pH) was measured with the equipment WTW Inolab pH 720 in distilled water (1:2.5 soil:water ratio) and C/N-ratio with NCS-FLASH 1112 analyser. Determination of exchangeable cations (Ca^{2+}) in the soil samples were stated after extraction in a

0.1 M $BaCl_2$-solution (Mehlich II) using an Atomic Absorption Spectrometer (AAS). In addition, soil profiles of individual vegetation types were made in September 2009 for description of morphological features and for determination of soil types. They were classified using the Slovak Soil Classification System (Sobocká 2000) in terminology of the World Reference Base for Soil Resources (ISSS-ISRIC-FAO 1998).

The nomenclature of non-vascular and vascular plants follows the checklist by Marhold & Hindák (1998), and the syntaxa names are in accordance with Jarolímek et al. (2008a).

RESULTS AND DISCUSSION

Numerical classification distinguished four main groups of relevés according to their floristic similarity (Figure 2). They represent acidophilous, mesophilous and thermophilous oak vegetation corresponding to the four associations within classes of deciduous forests *Quercetea robori-petraeae* and *Querco-Fagetea*. Their syntaxonomical position is as follows:

Class: *Quercetea robori-petraeae* Br.-Bl. et R. Tx. ex Oberd. 1957
Order: *Quercetalia roboris* R. Tx. 1931
Alliance: *Genisto germanicae-Quercion* Neuhäusl et Neuhäuslová-Novotná 1967
Association: *Luzulo albidae-Quercetum petraeae* Hilitzer 1932

Class: *Querco-Fagetea* Br.-Bl. et Vlieger in Vlieger 1937
Order: *Fagetalia* Pawłowski in Pawłowski et al. 1928
Alliance: *Carpinion betuli* Issler 1931
Association: *Melico uniflorae-Quercetum petraeae* Gergely 1962
Order: *Quercetalia pubescenti-petraeae* Klika 1933
Alliance: *Quercion confertae-cerris* Horvat 1954
Association: *Poo nemoralis-Quercetum dalechampii* Šomšák etHáberová 1979
Alliance: *Quercion petraeae* Zólyomi et Jakucs ex Jakucs 1960
Association: *Sorbo torminalis-Quercetum* Svoboda ex Blažková 1962

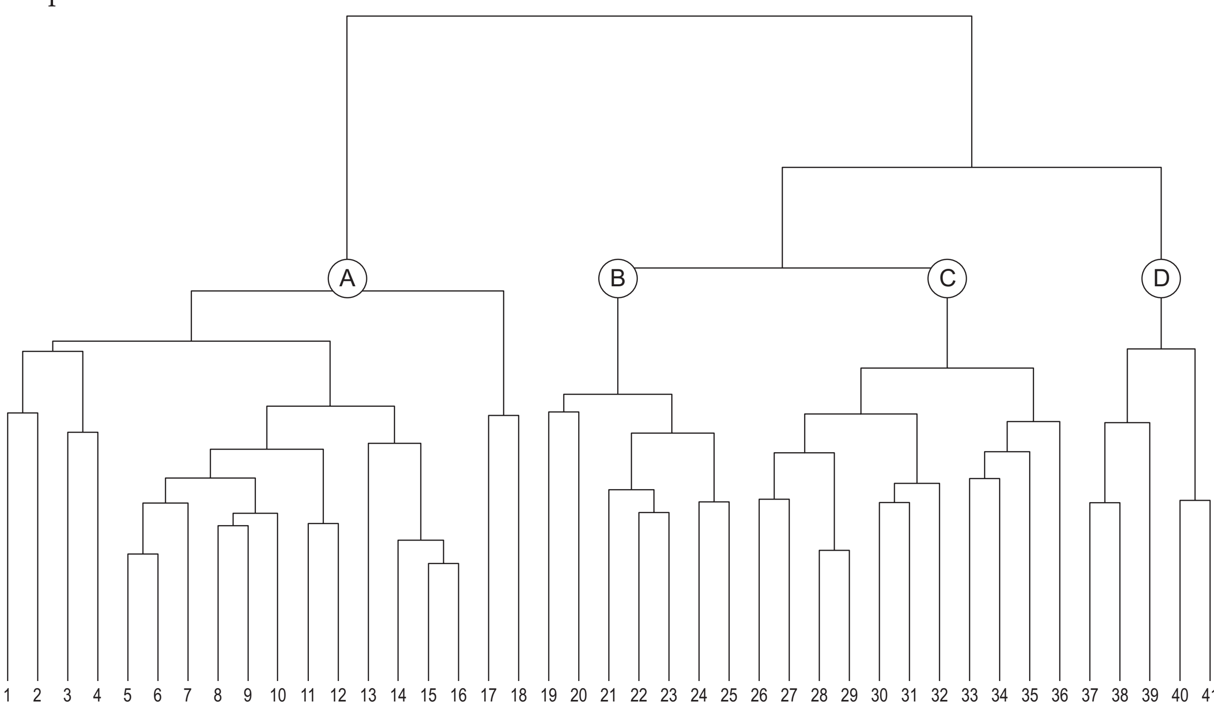

Figure 2: Dendrogram of numerical classification of oak forest vegetation in the northern part of the Štiavnické vrchy Mts (Cluster A – *Luzulo albidae-Quercetum petraeae*, B – *Melico uniflorae-Quercetum petraeae*, C – *Poo nemoralis-Quercetum dalechampii*, D – *Sorbo torminalis-Quercetum*).

Slika 2: Dendrogram numerične klasifikacije hrastovih gozdov severnega dela gorovja Štiavnické vrchy (Klaster A – *Luzulo albidae-Quercetum petraeae*, B – *Melico uniflorae-Quercetum petraeae*, C – *Poo nemoralis-Quercetum dalechampii*, D – *Sorbo torminalis-Quercetum*).

The data set of 41 relevés comprises 178 vascular plants and 34 bryophytes. The most common herb species recorded in more than 70 % of relevés were generalists of oak forest habitats such as *Poa nemoralis*, *Galium schultesii*, *Veronica chamaedrys* and a bryophyte *Hypnum cupressiforme*.

Syntaxonomy and Site ecology

Luzulo albidae-Quercetum petraeae (Cluster A, Table 1, relevés 1–18)

This community represents acidophilous oak forests preferring moderately canopy-opened stands with shallow and mineral-poor soils (distric cambisols) at altitudes of 330–670 m. Moreover, in some places, mainly on steep slopes, the organic matter can be blown away and it causes nutrient depletion of the soils. Distribution is confined to small patches, primarily at ridge parts and convex spots. The simple vertical structure and the regular occurrence of oligotrophic and oligo-mesothrophic vascular plants (e.g. *Genista pilosa*, *G. tinctoria*, *Hieracium lachenalii*, *H. sabaudum*, *Veronica officinalis*), along with local admixture of thermophilous ones (*Cardaminopsis arenosa*, *Hylotelephium maximum* and *Lembotropis nigricans*), are typical features of this community. The shrub layer is generally formed only of young trees. In most cases, the herb layer is dominated by *Luzula luzuloides*, seldom also by the narrow-leaved grass *Avenella flexuosa*. The peculiar feature of the species composition is a higher presence and coverage of mosses in comparison with the other detected oak vegetation types (Table 1). It is usually composed of common acidic-tolerant species including *Ceratodon purpureus*, *Dicranum scoparium*, *Hypnum cupressiforme*, *Polytrichum formosum* and *P. piliferum*. The proportion and the total spectrum of non-vascular plants coincide with the previous findings (Moravec 1998) as well as with a broad comparative study of European acidic woodlands (Härdtle 2004). In Slovakia, analogous communities with similar floristical structure are chiefly known from foothills of the Western Carpathians, less often from Inner-Carpathian basins (Slezák 2010).

Neuhäusl & Neuhäuslová-Novotná (1967) revised the previous classifications (e.g. Mráz 1957) and introduced a new division of association into the *Luzulo albidae-Quercetum typicum* Mráz 1957 and *Luzulo albidae-Quercetum genistetosum tinctoriae* Samek ex Neuhäusl et Neuhäuslová-Novotná 1967 subassociations. Outside Slovakia, this syntaxonomical concept is broadly accepted in adjacent countries (Moravec 1998, Willner & Grabherr 2007, Matuszkiewicz 2008).

Acidophilous oak and mixed oak deciduous forests are a typical vegetation type on acidic geological substrates in the colline and submontane belt of the sub-continental part of Europe. Their ecological singularity is emphasized through the specific site conditions, i.e. presence of skeletal soils with low nutrient supply (Neuhäusl & Neuhäuslová-Novotná 1967, Slezák & Kukla 2009a) and the litter removing (e.g. forest grazing) promoting their acidification (Šilc et al. 2008). The coverage of species-poor herb layer is markedly determined by the canopy structure. Therefore the species composition is created particularly by light-demanding species with the affinity to acidic habitats. The recent occurrence of some associations (e.g. *Vaccinio vitis-ideae-Quercetum* Oberd. 1957, *Viscario-Quercetum* Stöcker 1965) is limited due to lack of suitable sites and their change to pine or larch plantation (cf. Moravec 1998). Studies of acidophilous *Quercus petraea* agg. forests have had a long history in various European countries (Härdtle 2004), but their syntaxonomical position is not consistent. They are classified within the *Querco-Fagetea* class (e.g. Solomakha 1996, Willner & Grabherr 2007) or within the separate class *Quercetea robori-petraeae* (e.g. Jarolímek et al. 2008a).

Melico uniflorae-Quercetum petraeae (Cluster B, Table 1, relevés 19–25)

The cluster B includes broad-leaved mixed oak forests occupying gentle and south-facing slopes on deeper luvi-cambisols in the submontane belt (420–805 m a.s.l.). It represents the *Melico uniflorae-Quercetum petraeae* association, which was first described by Gergely (1962) from the Mții Trascăului Mts in Romania. The stands are characterized by co-dominance of *Quercus petraea* agg. and *Carpinus betulus* in the tree layer and the prevalence of *Melica uniflora* in the herb layer. The shrub and moss layers are poorly developed. This community with relatively low floristical variability is clearly distinct from the other clusters. It belongs to the transition type between mesophilous oak-hornbeam and xerophilous oak forests (cf. Šomšák & Háberová 1979). It is well-differentiated through the presence of numerous mesophilous and shade-tolerant species ranked into the *Carpinion betuli* alliance and *Fagetalia* order (*Dactylis polygama*, *Galium odoratum*, *Geum urbanum*, *Neottia nidus-avis*, *Pulmonaria obscura*, *Symphytum tuberosum*, *Viola collina*, *V. reichenbachiana*). The frequent abundance of *Poa nemoralis* reflects more opened sites with skeletal soils. Except for the *Hieracium sabaudum* and *Luzula luzuloides*, the acidophilous species are completely missing (Table 1). Several flora elements including *Alliaria petiolata*, *Geranium robertianum*, *Glechoma hirsuta* and *Mercurialis perennis* indicate a relatively base-rich habitat with good mineralization of humus. Although the species composition conventionally comprises the thermophilous plants (e.g. *Fragaria moschata*, *Clinopodium vulgare*, *Lathyrus niger*), this association is rather close to the *Carpinion betuli* alliance.

Mesophilous broad-leaved oak-hornbeam forests are important elements of the Western Carpathian forest vegetation (Michalko 1991). Communities that are assigned to this alliance prefer low-altitudinal areas with subcontinental climate on mesotrophic to eutrophic soils (Knollová & Chytrý 2004). The above mentioned ecological conditions are typical for some Slovak mountain units (e.g. Drienčanský kras Mts, Slovenský kras Mts, Vihorlatské vrchy Mts), where the *Melico uniflorae-Quercetum petraeae* is considered as common forest vegetation. Within the ecological range of the *Carpinion betuli* vegetation, it displays certain differences in terms of the stand structure, floristic composition and overall physiognomy (cf. Michalko 1957, Neuhäuslová-Novotná 1965, Moravec et al. 2000).

Poo nemoralis-Quercetum dalechampii (Cluster C, Table 1, relevés 26–36)

The community settles temperate slopes on distric cambisols with elevation range from 380 m to 694 m a.s.l. The partially mesophilous character of the stands is fully reflected in the species composition (Table 1). The uniformity of tree layer is expressed by the absolute dominance of *Quercus petraea* agg. Other woody species such as *Carpinus betulus* and *Quercus cerris* are only accompanying. The shrub layer with low coverage is constantly developed. Apart from *Acer campestre*, the typical shrubs are absent. Besides the dominance of medium-tall grass *Poa nemoralis* and a significant number of generalists of mesic forest habitats (*Alliaria petiolata*, *Campanula rapunculoides*, *Galium schultesii*, *Melica uniflora* and *Veronica chamaedrys*), the characteristic feature of the herb layer is the occurrence of several thermophilous species (*Astragalus glycyphyllos*, *Clinopodium vulgare*, *Fragaria moschata*). The beech forest herbs (*Dentaria bulbifera* and *Tithymalus amygdaloides*) along with *Carex muricata* agg., *Cruciata glabra* and *Dryopteris filix-mas* enrich the floristic spectrum. The participation of some acidophytes and acidic-tolerant species including *Luzula luzuloides*, *Hypnum cupressiforme* and *Hedwigia ciliata* is also constant. Consequently, the species composition, predominantly the abundant group of more nutrient-demanding species supports assignment of the *Poo nemoralis-Quercetum dalechampii* to the order *Fagetalia*. The present finding corresponds with a previous study by Kliment & Watzka (2000), where it was placed into the *Carpinion betuli* alliance. By contrast, it has been ranked into the order *Quercetalia pubescenti-petraeae* following the contemporary national checklist of vegetation units (Jarolímek et al. 2008a), and equally the original description of the association (cf. Šomšák & Háberová 1979). The missing comprehensive revision of oak forest communities and mainly the great variability of the species composition has probably led to the syntaxonomical differences as for classification at the level of higher vegetation units (alliance, order).

Accessible data about the *Quercion confertae-cerris* alliance are concentrated to warm and dry areas of Slovakia, but the alliance does also rarely occur in some relatively cooler parts of the country, too (Neuhäusl & Neuhäuslová-Novotná 1964, Neuhäuslová-Novotná & Neuhäusl 1965, Neuhäuslová-Novotná 1968, Michalko 1991, Kliment & Watzka 2000). The *Poo nemoralis-Quercetum dalechampii* represents the most mesic forest type in comparison with the other related associations of the same syntaxonomic affiliation (*Carici montanae-Quercetum petraeae* Gergely 1962, *Quercetum petraeae-cerris* Soó 1957, partially *Potentillo albae-Quercetum* Libbert 1933 and *Sorbo torminalis-Quercetum*). In addition to its typical aspect (the *Poo nemoralis-Quercetum dalechampii typicum* subassociation), Šomšák & Háberová (1979) proposed the assignment of the stands with higher cover of the grass species *Luzula luzuloides* and constant occurrence of *Platanthera bifolia*, *Steris viscaria* and a bryophyte *Polytrichum formosum* to the new subassociation *Poo nemoralis-Quercetum da-*

lechampii luzuletosum. The latter is characterized by the lower presence of some thermophilous herbs and absence of sunny-slope species (*Lactuca quercina* and *Vicia tenuifolia*). Due to the small number of relevés from the geographically limited area (Slovenský kras Mts), this classification needs to be revised. Similar oak habitats were formerly classified as the subassociation *Querco petraeae-Carpinetum* Soó et Pócs (1931) 1957 *poetosum nemoralis* (Mikyška 1939) Klika 1951 (e.g Michalko 1957, Balkovič 2002).

Sorbo torminalis-Quercetum (Cluster D, Table 1, relevés 37–41)

The thermophilous oak forests of slightly acidic substrates on distric cambisol build open to moderately closed stands on south-facing slopes in the submontane belt (390–540 m a.s.l.). *Quercus petraea* agg. and *Q. cerris* alternate as dominants of the tree layer, while *Sorbus torminalis* and *Carpinus betulus* with a lower coverage are admixed only individually. Due to favourable light conditions, the shrub layer has been usually developed, and encompasses thermophilous shrubs (*Ligustrum vulgare* and *Cornus mas*) together with saplings of *Sorbus torminalis* and *Quercus petraea* agg. The grassy physiognomy of the species-rich herb layer resulted from the dominance of *Poa nemoralis*, *Brachypodium pinnatum* and the local presence of *Festuca heterophylla* and *F. pseudodalmatica*. Except for the common dry-mesic forest species and acidic-tolerant ones (*Cardaminopsis arenosa*, *Clinopodium vulgare*, *Galium glaucum*, *Genista pilosa*, *G. tinctoria*, *Hylotelephium maximum*, *Pyrethrum corymbosum*, *Silene nutans*), the herb layer is enriched by facultative calciphyte *Campanula persicifolia* and mesophilous species such as *Dactylis polygama* and *Galium schultesii* (cf. Chytrý & Horák 1997). However, the conspicuous aspect is formed by both plants of dry grasslands and forests fringes, including *Dianthus carthusianorum*, *Origanum vulgare*, *Teucrium chamaedrys*, *Tithymalus cyparissias*, *Trifolium aplestre* and *Verbascum chaixii* subsp. *austriacum*. In the moss layer were found *Atrichum undulatum*, *Bryum capillare*, *Hypnum cupressiforme* and *Weissia controversa*.

These forests exhibit similarities to the thermophilous turkey oak forests on mineral-rich soils included in the association *Quercetum petraeae-cerris*, primarily to the *Poa nemoralis* variant containing more mesic flora elements (cf. Roleček 2005). The partial differences have been observed in the abundance of thermophilous plants; several of them are missing (e.g. *Filipendula vulgaris*, *Fragaria viridis*, *Rosa gallica*) or else manifest a lower frequency (e.g. *Lychnis coronaria*, *Vicia cassubica*) in our data set (Table 1). On the other hand, numerous plants with close relation to the sunny and drier sites have their ecological optimum in this alliance. Up to now, the Central European thermophilous oak forests of *Sorbo torminalis-Quercetum* have been known from the Bohemian Massif and Moravia region in the Czech Republic, from where they have extended to northern Austria (Chytrý 1997). In the last decade, this association has been reported from Poland as well (Kwiatkowski 2003, Bednorz 2007).

Neuhäusl & Neuhäuslová-Novotná (1964) documented an other two oak woodlands in the southern part of the Štiavnické vrchy Mts; canopy-opened oak forests with Carpathian sub-endemic tall grass *Poa pannonica* subsp. *scabra* (*Poo scabrae-Quercetum* (Magyar 1933) Neuhäusl et Neuhäuslová-Novotná 1964) and sub-xerophilous forests of sunny slopes (*Festuco heterophyllae-Quercetum* Neuhäusl et Neuhäuslová-Novotná 1964). Because of their obvious relation to arid stands in the colline belt, it was not possible to find these distinctive communities in the more humid and cooler northern part of the mountain unit.

Soil profiles description

The morphological description of soil pits provides some insights into the impact of soil physical structure on vegetation. From the individual soil profiles, there have been deduced some general characteristics for the associated oak vegetation types: 1) the forests have been developed on shallow to medium deep cambisols; 2) the content of rock fragments is very variable; 3) for the individual vegetation types, the soil texture is relatively homogeneous throughout the profile; 4) the whole soil profile is biologically active down to the parent material (see root system).

In general, the soil water (its forms, amount and tenacity) serves a central role in a number of processes occurring in soils, and therefore influences the plant community composition and its physiognomy. Its status is directly linked to the soil depth and texture (along with the location in landscape and the seasonal partitioning of rainfalls). The shallow and very skeletal soils have a lower water-holding capacity (cf. Lavelle & Spain

2003). This leads to periodic soil water-deficit mainly for elements of the tree layer. These stands are occupied by more canopy-opened forests (*Luzulo albidae-Quercetum petraeae* and *Sorbo torminalis-Quercetum*) with species having higher requirements on the light conditions and tolerance to drought. Vegetation of the alliances *Carpinion betuli* and *Quercion confertae-cerris* established on the deeper soils has a surface rich in organic matter. The favourable conditions are also reflected in the global floristic composition (higher presence of nutrient-demanding and shade-tolerant species; Table 1).

Ass.: *Luzulo albidae-Quercetum petraeae*
Bedrock (Quartzite); Soil subtype (Dystric-Cambisol); Position (relevé no. 17); Horizons:
Ool 2–1 cm, dry grasses, oak foliage and twigs
Oof 1–0 cm, mostly oak foliage together with dry grasses
Aoq 0–4 cm, dark brown (7.5YR 3/4) sandy loam, fresh moist, fine granular structure, loose consistent, many fine roots, rock fragments (30 %), clear wavy boundary to next horizon
Bv 4–20 cm, yellowish brown (10YR 5/4) silty loam, fresh moist, medium granular structure, medium firm consistent, many fine roots, rock fragments (45 %), gradual transition to next horizon
B/C 20–40 cm, yellowish brown (10YR 5/6) silty loam, fresh moist, medium granular structure, firm consistent, common fine roots, rock fragments (65 %)
C_1 40+ cm, silicate parent material

Ass.: *Melico uniflorae-Quercetum petraeae*
Bedrock (Andesites); Soil subtype (Luvi-Cambisol); Position (relevé no. 24); Horizons:
Ool 3–1 cm, oak and oak-hornbeam litter
Oof 1–0 cm
Aoq 0–2 cm, dark brown (7.5YR 3/4) silty loam, moist, fine to medium granular structure, loose consistent, many fine roots, rock fragments (0 %), clear smooth boundary to next horizon
Bv_1 2–30 cm, light brown (7.5YR 6/3) silty loam, fresh moist, fine subangular blocky structure, medium firm consistent, common fine roots, rock fragments (0 %), diffuse boundary to next horizon
Bvt 30–60 cm, light brownish grey (10YR 6/2) silty loam, fresh moist, subangular blocky structure, firm consistent, common fine roots, rock fragments (10 %), gradual transition to next horizon
B/C 60–75+ cm, light brownish grey (10YR 6/2) silty loam, fresh moist, subangular blocky structure, firm consistent, few fine roots, rock fragments (65 %)

Ass.: *Poo nemoralis-Quercetum dalechampii*
Bedrock (Andesites); Soil subtype (Dystric-Cambisol); Position (relevé no. 26); Horizons:
Ool 5–3 cm, oak litter
Oof 3–0 cm, partially decomposed oak litter and dry grasses
Aoq 0–5 cm, dark brown (7.5YR 3/4) silty loam, fresh moist, fine to medium granular structure, loose to friable consistent, many fine roots, rock fragments (10 %), clear wavy boundary to next horizon
Bv_1 5–25 cm, brown (7.5YR 5/3) silty loam, fresh moist, medium granular structure, medium firm consistent, many fine roots, rock fragments (20 %), gradual transition to next horizon
Bv_2 25–55 cm, light brown (7.5YR 6/3) silty loam, fresh moist, fine subangular blocky structure, firm consistent, common fine roots, rock fragments (40 %), gradual transition to next horizon
B/C 55–80 cm, light brownish grey (10YR 6/2) silty loam, fresh moist, subangular blocky structure, very firmly consistent, few fine roots, rock fragments (70 %)
C_1 80+ cm, silicate parent material

Ass.: *Sorbo torminalis-Quercetum*
Bedrock (Andesites); Soil subtype (Dystric-Cambisol); Position (relevé no. 37); Horizons:
Ool 4–2 cm, dry grasses, oak foliage and twigs
Oof 2–0 cm, mostly oak foliage
Aoq 0–2 cm, dark brown (7.5YR 3/4) silty loam, fresh moist, fine granular structure, loose consistent, many fine roots, rock fragments (<5 %), clear wavy boundary to next horizon
Bv 2–20 cm, greyish brown (10YR 5/2) silty loam, fresh moist, medium to coarse granular soil structure, medium firm consistent, many fine roots, rock fragments (20 %), gradual transition to next horizon
B/C 20–55 cm, greyish brown (10YR 5/2) silty loam, fresh moist, medium to coarse granular soil structure, firm consistent, common fine roots, rock fragments (70 %)
C_1 55+ cm, silicate parent material

Main environmental gradient

The vegetation-environment relationships are displayed on the DCA ordination diagram (Figure 3). The DCA analysis revealed a clear floristical and ecological separation of the individual vegetation types within the ordination space. The main gradient expresses the combination of the soil reaction and available nutrients in the soil following the Ellenberg indicator values (1. axis). This could be explained by their mutual correlation (cf. Härdtle et al. 2003, 2005, Schuster & Diekmann 2005). Along this nutrient poor-rich-gradient, the vegetation plots are ordered from forests of acidic stands to forests closely related with slightly acidic and neutral habitats. Accordingly, the right part of the scatter-plot is occupied by the relevés of the *Luzulo albidae-Quercetum petraeae*, preferring shallow and acidic soils with low nutrient content. The most mesophilous forests, having most favourable edaphic conditions (*Melico uniflorae-Quercetum petraeae*), dominate the opposite part. Moreover, light belongs to the environmental variables displaying a strong positive correlation. In this sense, the communities are arranged from more or less shaded to the canopy-opened ones. These general patterns of floristic variation were also emphasized by DCA analysis of the measured parameters (Figure 4). The first ordination axis was highly positively correlated with C/N-ratio and negatively correlated with soil reaction (pH).

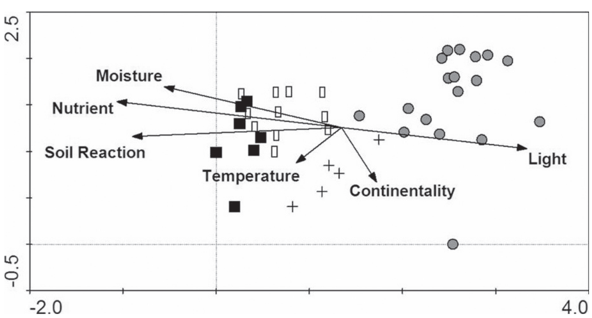

Figure 3: DCA ordination diagram of the oak forest vegetation samples with Ellenberg indicator values as supplementary variables (length of gradient 3.471; eigenvalues of the first two axes are 0.501 and 0.231; total inertia 4.234). Shaded circles – *Luzulo albidae-Quercetum petraeae*, full squares – *Melico uniflorae-Quercetum petraeae*, crosses – *Sorbo torminalis-Quercetum*, empty rectangles – *Poo nemoralis-Quercetum dalechampii*. Correlations between first two axes and environmental variables: Light (0.780 and 0.132), Continentality (0.115 and –0.231), Temperature (–0.217 and –0.237), Soil Reaction (–0.902 and –0.315), Nutrient (–0.945 and –0.158), Moisture (–0.732 and –0.022).

Slika 3: Diagram DCA ordinacije popisov hrastovih gozdov z Ellenbergovimi indikatorskimi vrednostmi kot dodatnimi spremenljivkami (dolžina gradienta 3,471; lastne vrednosti prvih dveh osi 0,501 in 0,231; variabilnost vseh ordinacijskih osi 4,234). Zasenčeni krožci – *Luzulo albidae-Quercetum petraeae*, polni kvadratki – *Melico uniflorae-Quercetum petraeae*, križci – *Sorbo torminalis-Quercetum*, prazni pravokotniki – *Poo nemoralis-Quercetum dalechampii*. Korelacija med prvima dvema osema in okoljske spremenljivke: svetloba (0,780 in 0,132), kontinentalnost (0,115 in –0,231), toplota (–0,217 in –0,237), reakcija tal (–0,902 in –0,315), hranila (–0,945 in –0,158), vlažnost (–0,732 in –0,022).

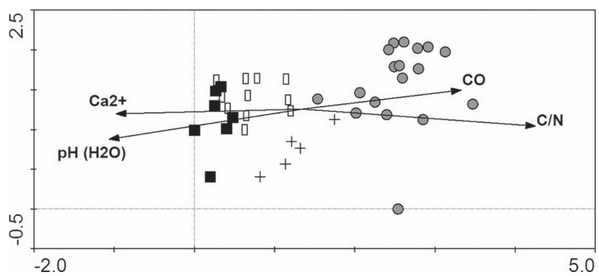

Figure 4: DCA ordination diagram of both samples and measured environmental variables: soil reaction (pH), calcium (Ca^{2+}), C/N-ratio, canopy openness (CO). Correlations between the first two axes and environmental variables: pH (–0.715 and –0.339), Ca^{2+} (–0.676 and –0.223), C/N (0.833 and 0.180), CO (0.584 and 0.253). For explanation of the symbols of vegetation types see Figure 3.

Slika 4: Diagram DCA ordinacije vzorcev in merjenih okoljskih spremenljivk: reakcija tal (pH), kalcij (Ca^{2+}), C/N razmerje, odprtost sklopa (CO). Korelacija med prvima dvema osema in okoljskimi spremenljivkami: pH (–0,715 in –0,339), Ca^{2+} (–0,676 in –0,223), C/N (0,833 in 0,180), CO (0,584 in 0,253). Za razlago simbolov vegetacijskih tipov glej Sliko 3.

The study supported the relevance of soil and light conditions as determinants affecting the species composition of deciduous forests. The water availability and the other just discussed factors have been confirmed by controlling the vegetation distribution at local and/or regional level (e.g. Kanka 2001, Härdtle et al. 2005, Wallnöfer & Hotter 2008, Slezák & Kukla 2009a), while the geographical gradient has been found significant at large-scale (cf. Knollová & Chytrý 2004).

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Table 1: Phytosociological table of the oak forest vegetation in the northern part of Štiavnické vrchy Mts.
Tabela 1: Fitocenološka tabela hrastovih gozdov v severnem delu gorovja Štiavnické vrchy.

Relevé No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	**C (%)**	19	20	21	22	23	24	25	**C (%)**	26	27	28	29	30	31	32	33	34	35	36	**C (%)**	37	38	39	40	41	**C (%)**
Cluster	A																			B								C												D					
E_3																																													
Quercus petraea agg.	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	**100**	4	.	3	4	4	3	3	**86**	4	4	5	5	4	4	4	3	4	4	4	**100**	4	3	4	b	3	**100**
Carpinus betulus	.	.	.	r	.	.	.	+	r	r	.	+	.	.	.	.	.	+	**33**	+	b	3	b	a	3	4	**100**	r	+	+	+	1	a	a	3	.	.	.	**73**	r	+	+	.	.	**60**
Fagus sylvatica	a	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	b	1	**28**	1	a	r	+	.	.	r	**71**	.	.	.	.	.	.	.	.	r	.	.	**9**	+	.	+	.	.	**40**
Pinus sylvestris	.	+	.	.	.	.	.	.	r	.	.	.	1	r	1	.	.	.	**28**	.	.	1	.	.	.	.	**14**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Sorbus aria	+	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	**17**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Quercus cerris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	4	.	+	.	.	.	**29**	b	1	+	.	.	.	.	.	.	.	.	**27**	.	.	.	4	3	**40**
Sorbus torminalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	+	.	**14**	.	.	.	.	+	.	.	.	.	.	.	**9**	1	1	.	.	.	**40**
E_2																																													
Quercus petraea agg.	.	+	.	1	+	+	+	.	.	.	+	r	1	+	+	+	+	1	**72**	r	.	.	.	.	.	.	**14**	.	.	.	.	.	.	.	.	.	+	.	**9**	.	.	1	+	+	**60**
Fagus sylvatica	a	.	.	.	.	.	+	+	.	.	+	r	.	r	+	.	.	.	**39**	.	1	.	.	.	.	r	**29**	.	.	.	.	r	1	.	1	+	.	r	**45**	.	.	1	.	+	**40**
Carpinus betulus	.	.	.	.	.	r	r	r	r	+	.	.	.	.	.	.	.	.	**28**	.	.	.	.	r	+	1	**43**	.	+	.	.	.	.	.	1	.	1	.	**27**	.	.	.	.	.	**.**
Rosa canina agg.	.	r	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	**11**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	+	.	.	**20**
Acer campestre	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	**6**	.	.	.	.	.	.	.	**.**	.	.	r	1	.	.	+	.	.	1	.	**36**	r	.	.	+	.	**40**
Sorbus torminalis	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	**6**	.	.	.	.	.	.	.	**.**	.	+	.	.	.	.	.	.	.	.	.	**9**	1	r	.	.	.	**40**
Crataegus monogyna	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	r	.	.	.	.	.	.	**14**	.	.	.	.	+	.	.	.	.	.	+	**18**	+	1	.	.	.	**40**
Crataegus laevigata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	+	.	**14**	.	r	+	.	.	.	.	.	.	r	.	**27**	.	.	r	.	.	**20**
Cornus mas	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	+	.	.	.	r	.	.	.	.	.	.	**18**	r	+	.	.	.	**40**
E_1																																													
DgS of *Luzulo albidae-Quercetum petraeae*																																													
Hieracium lachenalii	1	+	.	.	.	+	+	1	1	+	+	+	1	+	1	1	r	.	**78**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	+	.	**20**
Avenella flexuosa	1	b	.	.	+	.	1	.	.	1	1	1	3	b	m	b	3	b	**72**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Veronica officinalis	r	.	r	r	+	+	+	r	+	.	+	.	+	.	.	.	.	.	**56**	.	.	r	.	.	.	.	**14**	.	.	.	.	.	.	.	r	.	r	r	**27**	.	.	+	.	.	**20**
Ceratodon purpureus E_0	.	.	.	r	.	r	r	.	.	.	r	.	+	1	r	r	.	+	**50**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	r	.	r	**18**	.	.	.	.	.	**.**
Polytrichum formosum E_0	b	.	+	.	r	.	.	1	r	r	.	1	1	.	.	.	.	.	**44**	.	.	.	.	.	r	.	**14**	.	.	.	.	.	.	.	.	.	r	.	**9**	.	.	.	r	.	**20**
Dicranum scoparium E_0	1	r	.	.	.	.	r	.	.	.	b	a	1	.	.	.	r	b	**44**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Silene nemoralis	.	m	.	+	.	.	.	.	.	.	.	r	.	+	r	+	.	.	**33**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	m	.	.	**20**
Lembotropis nigricans	a	a	.	a	.	.	.	.	+	.	+	+	.	.	.	.	.	.	**33**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	r	.	.	**20**
Polytrichum piliferum E_0	.	.	.	.	.	+	.	.	.	.	.	.	b	r	a	.	+	+	**33**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
DgS of *Melico uniflorae-Quercetum petraeae*																																													
Viola reichenbachiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	+	+	+	.	+	r	**71**	.	.	.	.	.	+	.	.	.	r	.	**18**	.	.	.	.	.	**.**
Glechoma hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	a	a	b	+	+	**71**	1	1	+	.	.	.	.	.	.	.	.	**27**	.	.	.	.	.	**.**
Neottia nidus-avis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	r	r	+	r	r	.	**71**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Symphytum tuberosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	+	+	.	.	.	+	+	**57**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	+	.	.	.	**20**
Rubus hirtus agg.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	**6**	r	r	.	.	.	r	r	**57**	.	.	+	r	.	.	r	.	.	.	.	**27**	.	.	.	.	.	**.**
Bromus benekenii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	r	.	.	.	.	+	+	**43**	.	.	.	.	.	.	r	.	.	.	.	**9**	.	.	.	.	.	**.**
Pulmonaria obscura	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	+	.	.	.	.	r	+	**43**	.	.	.	.	.	.	+	.	.	.	.	**9**	.	.	.	.	.	**.**

Relevé No.										1	1	1	1	1	1	1	1	1	**C**	1	2	2	2	2	2	2	**C**	2	2	2	2	3	3	3	3	3	3	3	**C**	3	3	3	4	4	**C**
DgS of *Poo nemoralis-Quercetum dalechampii*																																													
Astragalus glycyphyllos	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	r	.	.	.	**14**	+	r	+	+	.	r	.	r	+	.	.	**64**	.	.	.	.	.	**.**
Paraleucobryum longifolium E$_0$	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	r	r	.	.	r	+	.	.	**36**	.	.	.	.	.	**.**
DgS of *Sorbo torminalis-Quercetum*																																													
Galium glaucum	.	.	.	r	.	.	.	.	.	.	.	.	.	.	r	r	.	.	**17**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	+	+	+	1	+	**100**
Bryum capillare E$_0$	.	.	r	.	.	r	.	.	.	.	.	.	r	.	.	.	.	.	**17**	.	.	.	.	.	r	.	**14**	.	.	.	.	r	.	.	.	.	.	.	**9**	r	+	r	.	r	**80**
Verbascum chaixii subsp. *austriacum*	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	**6**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	r	**9**	+	+	+	.	r	**80**
Trifolium alpestre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	+	**9**	1	r	+	.	+	**80**
Ligustrum vulgare E$_2$	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	+	+	.	.	.	.	.	.	**18**	1	1	.	1	+	**80**
Tithymalus cyparissias	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	r	a	+	+	.	**80**
Teucrium chamaedrys	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	1	1	+	.	.	**60**
Dianthus carthusianorum	r	.	.	.	.	.	.	.	.	r	.	.	.	.	.	+	.	.	**17**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	+	+	+	.	.	**60**
Silene nutans	r	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	**17**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	+	.	.	1	+	**60**
Weissia controversa E$_0$	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	r	r	.	+	.	**60**
Pyrethrum corymbosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	+	.	.	.	.	+	.	**29**	.	r	.	.	.	.	.	.	+	r	.	**27**	+	+	r	.	.	**60**
Lychnis coronaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	r	+	**40**
Brachypodium pinnatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	1	.	.	.	.	.	.	**14**	.	.	.	.	.	.	.	.	.	.	.	**.**	1	4	.	.	.	**40**
Anomodon viticulosus E$_0$	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	r	.	r	.	.	**40**
Origanum vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	r	r	.	.	**40**
Festuca heterophylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	+	.	.	.	.	.	.	**14**	.	.	.	.	.	.	.	.	.	.	.	**.**	a	1	.	.	.	**40**
Festuca pseudodalmatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	+	r	**40**
DgS of *Genisto germanicae-Quercion*, *Quercetea robori-petraeae*																																													
Luzula luzuloides	3	3	b	r	4	4	4	3	4	4	3	4	a	4	3	3	r	1	**100**	+	+	.	.	.	.	+	**43**	1	+	.	.	+	.	.	.	.	1	r	**45**	.	.	r	r	+	**60**
Hieracium sabaudum	+	+	1	+	+	+	+	+	+	+	1	+	+	.	+	+	.	.	**83**	r	.	r	.	.	.	r	**43**	r	.	r	r	.	.	.	.	.	.	.	**27**	+	r	+	.	.	**60**
Genista tinctoria	a	.	+	+	+	.	.	+	+	r	r	1	.	.	.	.	.	.	**50**	.	.	.	.	.	.	.	**.**	+	.	.	.	.	.	.	.	.	.	r	**18**	b	+	.	1	m	**80**
Melampyrum pratense	.	b	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	**11**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	r	.	.	.	.	**20**
DgS of *Carpinion betuli*																																													
Melica uniflora	.	.	r	.	.	.	.	.	.	+	.	+	.	r	.	.	.	.	**22**	3	4	3	4	4	3	4	**100**	+	1	1	b	1	3	a	3	+	+	1	**100**	.	r	.	a	+	**60**
Lathyrus vernus	r	.	.	.	.	.	.	.	.	r	.	+	.	.	.	.	.	.	**17**	.	r	.	r	.	.	.	**29**	.	1	.	.	1	1	.	.	r	1	.	**45**	.	.	.	+	.	**20**
Stellaria holostea	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	**11**	.	.	r	.	.	.	.	**14**	.	.	.	.	.	.	.	r	+	+	.	**27**	.	.	.	.	.	**.**
Dactylis polygama	.	.	.	.	.	r	.	.	r	.	.	.	.	.	.	.	.	.	**11**	+	.	+	+	+	r	.	**71**	r	.	.	.	.	.	.	.	.	.	.	**9**	+	+	m	+	1	**100**
Campanula rapunculoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	b	.	r	1	r	.	.	**57**	1	+	+	.	+	.	+	+	.	.	1	**64**	+	r	+	.	.	**60**
DgS of *Quercion confertae-cerris*																																													
Lathyrus niger	.	+	.	.	.	.	.	.	r	.	.	r	.	.	.	.	.	.	**17**	+	.	.	r	.	.	.	**29**	.	.	.	.	.	.	.	.	+	.	.	**9**	.	.	+	.	.	**20**
Clinopodium vulgare	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	**6**	.	.	.	.	.	+	+	**29**	+	.	.	.	+	.	.	+	+	r	.	**45**	+	1	+	.	.	**60**
DgS of *Quercion petraeae*																																													
Steris viscaria	1	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	**17**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	r	.	**9**	.	.	.	.	.	**.**
Pilosella officinarum	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	+	.	.	**17**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
DgS of *Querco-Fagetea*																																													
Poa nemoralis	b	+	+	1	+	+	+	+	r	r	.	+	.	.	r	.	.	.	**67**	1	+	+	+	r	b	a	**100**	4	4	4	4	4	1	4	b	4	3	4	**100**	3	+	+	4	4	**100**
Galium schultesii	1	+	+	.	.	+	+	.	1	+	+	+	.	r	.	+	.	.	**61**	+	.	1	.	+	+	a	**71**	1	a	a	1	1	1	1	+	1	+	1	**100**	1	r	r	+	+	**100**

Veronica chamaedrys	r	.	+	.	.	.	r	+	1	+	.	+	.	r	+	+	.	.	**56**	r	.	+	r	.	+	r	**71**	r	+	1	+	r	r	.	+	+	r	+	**91**	+	+	1	1	+	**100**
Galium odoratum	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	3	b	b	+	+	a	r	**100**	+	+	+	.	.	+	1	1	.	.	.	**55**	r	.	.	.	.	**20**
Convallaria majalis	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	.	+	.	.	.	.	.	**14**	.	.	.	.	.	.	.	.	.	+	.	**9**	.	.	.	.	.	**.**
Moehringia trinervia	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	r	+	+	.	.	.	+	**57**	.	+	.	.	1	+	+	.	.	+	r	**55**	.	.	.	.	.	**.**
Dentaria bulbifera	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	1	a	+	1	a	a	+	**100**	+	+	r	+	+	1	r	a	1	1	.	**91**	.	.	.	.	.	**.**
Dryopteris filix-mas	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	**6**	r	.	.	r	.	+	.	**43**	r	.	.	.	r	.	r	r	.	+	+	**55**	.	.	.	.	.	**.**
Mercurialis perennis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	+	a	b	1	+	.	+	**86**	.	.	.	1	+	+	r	r	.	.	1	**55**	.	.	.	.	.	**.**
Polygonatum multiflorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	r	+	.	.	.	r	**43**	.	.	.	.	r	+	.	r	.	.	.	**27**	.	.	.	.	.	**.**
Brachypodium sylvaticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	+	.	.	.	.	+	.	**29**	.	.	.	.	.	.	.	.	.	.	+	**9**	.	.	.	.	.	**.**
Pulmonaria officinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	+	+	.	.	.	.	**29**	.	.	.	.	1	+	.	+	.	.	.	**27**	.	.	.	.	.	**.**
Campanula trachelium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	+	+	.	.	.	**29**	.	.	+	+	.	.	.	1	+	.	.	**36**	r	.	.	.	.	**20**
Mycelis muralis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	+	.	.	.	.	**14**	.	.	.	.	.	.	.	r	.	.	+	**18**	.	.	.	.	.	**.**
Other species																																													
Quercus petraea agg.	1	m	+	+	1	1	m	1	1	1	1	1	+	+	+	+	m	1	**100**	+	.	1	1	.	1	+	**71**	1	.	1	1	+	1	+	1	m	1	+	**91**	m	+	+	1	1	**100**
Fagus sylvatica	1	r	r	.	r	r	+	+	1	1	+	+	+	+	+	r	1	+	**94**	1	1	+	r	+	r	+	**100**	.	.	.	.	r	+	.	m	+	+	+	**55**	1	.	+	r	+	**80**
Cardaminopsis arenosa	+	.	+	+	+	+	+	+	r	r	+	+	+	+	r	+	.	.	**83**	.	.	.	.	.	r	.	**14**	.	.	+	.	.	.	r	.	+	+	+	**45**	r	.	+	+	r	**80**
Genista pilosa	.	.	.	a	a	1	+	1	.	1	1	1	+	+	a	m	b	1	**78**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	r	.	+	.	+	**60**
Hylotelephium maximum	r	+	.	.	r	r	+	.	.	.	+	+	r	+	r	+	.	+	**67**	.	.	.	.	.	r	.	**14**	.	+	r	.	.	.	.	r	+	+	+	**55**	r	r	+	1	+	**100**
Digitalis grandiflora	.	r	a	b	r	.	.	r	.	.	+	+	.	+	+	.	.	r	**56**	r	.	.	r	.	.	r	**43**	+	.	.	.	.	.	r	r	1	+	.	**45**	.	.	.	+	.	**20**
Campanula persicifolia	r	.	r	.	.	r	.	+	+	+	r	+	.	.	.	r	.	.	**50**	.	.	+	r	.	.	+	**43**	+	+	r	+	+	r	.	+	+	+	1	**91**	+	.	.	+	+	**60**
Dalanum ladanum	.	.	m	+	.	.	r	r	.	.	.	r	r	+	.	.	.	1	**44**	.	.	.	.	.	r	r	**29**	.	.	r	r	.	.	+	r	.	.	.	**36**	r	.	1	.	.	**40**
Carpinus betulus	+	.	+	r	+	+	.	.	.	.	.	.	+	.	.	.	.	r	**39**	.	a	1	+	m	1	+	**86**	m	.	1	+	.	+	r	m	.	+	.	**64**	+	+	.	.	.	**40**
Polypodium vulgare	a	.	.	.	.	.	.	.	.	.	1	1	.	r	.	+	.	r	**33**	.	.	.	.	.	.	.	**.**	.	.	.	r	.	.	.	.	.	.	+	**18**	.	.	.	+	.	**20**
Rosa canina agg.	.	.	.	r	.	.	r	.	r	r	.	.	.	r	.	.	.	.	**28**	.	.	.	.	.	.	.	**.**	.	+	+	+	.	.	.	.	.	.	+	**36**	+	.	r	+	.	**60**
Asplenium trichomanes	r	r	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	**22**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	r	**20**
Hypericum perforatum	.	r	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	r	**22**	.	.	.	r	.	.	.	**14**	.	.	.	.	.	.	.	.	r	r	r	**27**	.	+	r	.	r	**60**
Galium album	.	+	.	m	+	+	.	.	.	.	.	.	.	.	.	.	.	.	**22**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Fallopia dumetorum	.	.	1	.	.	.	.	r	+	.	.	.	.	.	.	.	.	r	**22**	.	.	r	.	r	r	r	**57**	.	+	r	+	+	+	+	+	+	+	+	**91**	r	r	+	r	.	**80**
Cruciata glabra	+	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**17**	1	.	.	.	.	+	+	**43**	.	+	.	.	+	.	.	1	1	.	+	**45**	1	+	.	.	.	**40**
Picea abies	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	**17**	.	.	.	.	.	.	r	**14**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Fraxinus excelsior	.	.	1	.	.	.	.	r	+	.	.	.	.	.	.	.	.	.	**17**	a	+	r	m	m	.	+	**86**	+	+	.	.	.	.	.	.	.	.	.	**18**	r	r	.	r	r	**80**
Allium oleraceum	.	.	r	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	**17**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	+	**9**	.	.	.	+	.	**20**
Linaria genistifolia	.	.	.	r	.	.	.	.	.	.	+	.	.	+	.	.	.	.	**17**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Sorbus aucuparia	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	**11**	r	.	.	.	.	.	.	**14**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Silene vulgaris	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**11**	r	.	.	.	.	.	.	**14**	.	r	.	.	.	.	.	.	.	.	+	**18**	.	.	.	.	r	**20**
Cephalanthera longifolia	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	**11**	.	.	.	.	+	.	r	**29**	r	.	.	.	.	.	.	.	.	.	.	**9**	.	.	.	.	.	**.**
Tilia platyphyllos	.	.	.	.	.	.	.	.	+	r	.	.	.	.	.	.	.	.	**11**	.	.	.	.	r	+	.	**29**	r	.	.	.	.	.	.	.	.	.	+	**18**	.	.	.	.	.	**.**
Polygonatum odoratum	.	.	.	.	.	.	.	.	.	.	r	+	.	.	.	.	.	.	**11**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	+	.	**9**	.	.	.	.	.	**.**
Galeopsis tetrahit	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	r	+	.	**18**	.	.	.	.	.	**.**
Quercus cerris	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	r	+	.	r	.	.	.	**43**	+	.	.	.	.	.	.	.	.	.	.	**9**	.	.	.	.	.	**.**
Securigera varia	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	.	.	.	r	.	.	.	**14**	+	.	+	+	.	.	.	.	.	.	.	**27**	1	.	.	.	1	**40**
Hieracium murorum	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	.	.	.	.	.	+	.	**14**	.	.	.	.	.	.	.	.	.	+	.	**9**	r	.	.	.	+	**40**

Relevé No.										1	1	1	1	1	1	1	1	1	C	1	2	2	2	2	2	2	C	2	2	2	2	3	3	3	3	3	3	3	C	3	3	3	4	4	C
Lapsana communis	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	.	.	.	.	.	r	r	**29**	.	.	.	.	.	.	r	.	r	.	.	**18**	+	r	.	.	.	**40**
Galium aparine	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	1	+	+	+	+	+	.	**86**	.	r	.	.	+	1	.	1	1	r	.	**55**	r	.	.	.	.	**20**
Acer platanoides	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	+	.	+	+	.	m	1	**71**	r	+	r	r	+	+	.	r	.	.	+	**73**	.	.	.	.	.	**.**
Myosotis arvensis	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	.	.	r	+	.	.	.	**29**	.	.	.	.	.	.	.	.	.	.	r	**9**	.	.	r	.	.	**20**
Robinia pseudacacia	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	**6**	.	r	.	.	.	.	.	**14**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	+	.	**20**
Achillea nobilis	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	**6**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	+	**9**	r	.	r	.	.	**40**
Fragaria moschata	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	**6**	1	+	.	.	r	1	1	**71**	+	1	+	.	r	.	.	+	.	r	+	**64**	r	+	r	+	+	**100**
Crataegus monogyna	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	**6**	.	r	.	+	.	.	.	**29**	+	.	.	.	+	.	+	.	.	.	.	**27**	r	+	.	+	.	**60**
Alliaria petiolata	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	**6**	+	r	r	r	r	r	.	**86**	.	+	+	+	+	r	+	.	+	r	+	**82**	.	r	.	.	.	**20**
Ribes uva-crispa subsp. *grossularia*	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	**6**	r	.	.	.	.	.	.	**14**	.	.	.	r	r	r	r	.	.	.	.	**36**	.	.	.	.	r	**20**
Sorbus torminalis	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	**6**	.	.	.	r	.	.	.	**14**	r	.	.	.	.	.	.	.	.	.	.	**9**	.	.	.	r	r	**40**
Corylus avellana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	**6**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	r	+	.	.	**18**	.	.	.	.	.	**.**
Cerasus avium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	**6**	+	+	.	+	.	r	.	**57**	r	.	.	.	.	.	.	.	.	.	.	**9**	.	.	r	.	.	**20**
Acer pseudoplatanus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	**6**	r	.	.	.	.	r	.	**29**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	**.**
Pyrus communis agg.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	**6**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	r	.	.	**9**	.	1	r	.	.	**40**
Geranium robertianum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	r	+	r	.	r	r	+	**86**	.	+	+	+	+	1	+	.	r	.	+	**73**	.	.	.	.	.	**.**
Acer campestre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	+	+	+	+	+	+	**86**	+	1	+	+	.	+	+	r	.	+	.	**73**	1	+	.	+	.	**60**
Geum urbanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	r	+	+	r	+	+	**86**	.	.	.	+	+	r	+	.	.	.	r	**45**	+	r	.	.	.	**40**
Rosa sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	r	.	.	r	r	r	**57**	+	.	.	.	r	r	.	.	.	.	.	**27**	.	+	.	.	.	**20**
Tithymalus amygdaloides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	r	+	.	r	+	**57**	+	.	+	1	1	r	+	.	.	.	+	**64**	.	.	.	.	.	**.**
Viola collina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	1	1	r	r	**57**	+	r	.	r	+	+	+	.	.	.	.	**55**	.	.	.	.	.	**.**
Ulmus glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	r	.	.	.	.	r	.	**29**	r	.	.	.	.	.	.	.	.	.	.	**9**	.	.	.	.	.	**.**
Ligustrum vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	r	r	.	.	.	**29**	1	.	.	.	.	.	.	.	.	.	.	**9**	.	1	.	m	1	**60**
Impatiens parviflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	r	.	.	r	.	**29**	.	.	.	.	.	.	.	.	.	.	+	**9**	.	.	.	.	.	**.**
Melittis melissophyllum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	+	.	.	.	.	.	.	**14**	.	+	.	.	.	.	.	+	.	r	.	**27**	.	.	.	.	.	**.**
Cystopteris fragilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	+	.	.	.	.	**14**	.	.	.	.	r	.	.	.	r	+	+	**36**	.	r	.	r	+	**60**
Hedera helix	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	r	.	.	.	.	**14**	.	.	+	+	.	.	.	.	+	.	.	**27**	.	.	.	.	.	**.**
Carex muricata agg.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	+	r	r	r	.	.	.	.	.	.	r	**45**	r	.	.	+	.	**40**
Vicia hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	+	+	r	.	.	.	+	.	.	**36**	r	+	.	+	.	**60**
Glechoma hederacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	**.**	.	.	.	1	+	r	1	.	.	.	.	**36**	.	.	.	+	r	**40**
E$_0$																																													
Hypnum cupressiforme	.	+	1	a	1	+	1	b	+	r	a	+	a	+	r	a	r	a	**94**	.	.	.	.	r	r	.	**29**	.	.	1	+	.	r	.	+	b	r	a	**64**	1	r	a	1	.	**80**
Hedwigia ciliata	.	r	.	.	+	.	.	.	.	r	1	.	.	.	.	.	.	+	**28**	.	.	.	.	.	.	.	**.**	.	.	r	r	.	.	.	+	1	.	r	**45**	.	.	.	.	.	**.**
Atrichum undulatum	.	.	r	.	.	.	+	1	+	.	.	.	r	.	.	.	.	.	**28**	.	.	.	.	.	+	.	**14**	.	.	.	.	.	.	.	.	.	r	.	**9**	.	.	+	r	+	**60**
Schistidium apocarpum	.	.	.	.	.	r	.	.	.	r	+	.	r	.	.	.	.	.	**22**	.	.	.	.	.	.	.	**.**	.	.	.	r	.	r	.	.	r	.	r	**36**	.	.	r	.	.	**20**
Brachythecium velutinum	r	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	**17**	.	.	.	.	.	r	.	**14**	.	.	.	.	.	.	.	.	.	.	r	**9**	.	.	.	.	1	**20**
Plagiomnium affine	.	.	r	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	**11**	.	.	.	.	.	.	.	**.**	.	.	.	.	.	.	.	.	.	.	.	**.**	.	r	.	.	.	**20**
Brachythecium starkei	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	**6**	.	.	.	.	.	.	.	**.**	.	.	r	.	r	.	.	.	.	.	.	**18**	.	.	.	.	.	**.**
Bryum subelegans	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	**6**	.	.	.	.	.	.	.	**.**	.	.	r	.	.	.	.	.	.	r	r	**27**	.	.	.	.	.	**.**

Legend

A – *Luzulo albidae-Quercetum petraeae*, B – *Melico uniflorae-Quercetum petraeae*, C – *Poo nemoralis-Quercetum dalechampii*, D – *Sorbo torminalis-Quercetum*, DgS – Diagnostic species.

Species present only in one or two relevés:

E_3 – tree layer: *Abies alba* (18, +), *Acer campestre* (35, +; 38, +), *A. platanoides* (21, +; 22, +), *A. pseudoplatanus* (19, r), *Betula pendula* (17, r), *Cerasus avium* (18, +), *Corylus avellana* (19, r; 34, +), *Fraxinus excelsior* (19, a; 22, 1), *Larix decidua* (17, a), *Pinus nigra* (12, +), *Sorbus aucuparia* (37, +), *Tilia cordata* (1, +), *T. platyphyllos* (35, r; 36, +).

E_2 – shrub layer: *Betula pendula* (17, +), *Corylus avellana* (19, a; 25, r), *Picea abies* (1, 1; 17, +), *Pinus sylvestris* (16, r), *Pyrus communis* agg. (38, 1), *Ribes uva-crispa* subsp. *grossularia* (30, +), *Robinia pseudacacia* (40, +), *Rosa* sp. (18, r; 32, r), *Sorbus aria* (36, +; 37, +), *S. aucuparia* (37, +).

E_1 – herb layer: *Ajuga genevensis* (36, r; 38, r), *A. reptans* (24, r; 33, r), *Allium senescens* subsp. *montanum* (37, +), *Anthoxanthum odoratum* (7, r; 13, 1), *Anthriscus cerefolium* (22, r), *A. sylvestris* (20, r), *Asarum europaeum* (25, +), *Asplenium septentrionale* (2, +; 36, r), *Athyrium filix-femina* (19, r), *Betonica officinalis* (19, r), *Betula pendula* (17, r), *Calamagrostis arundinacea* (1, 1; 19, 1), *Cardamine impatiens* (4, r), *Carex pilosa* (21, b; 30, r), *Circaea lutetiana* (19, r), *Cornus mas* (37, +), *Crataegus laevigata* (24, +), *Dactylis glomerata* (12, r), *Dorycnium herbaceum* (37, r), *Epilobium montanum* (19, r), *Epipactis helleborine* (19, +), *Erysimum odoratum* (2, r), *Fragaria vesca* (31, +; 32, 1), *Galeobdolon luteum* (23, r; 30, 1), *Galium verum* (2, +), *Geranium sanguineum* (38, +), *Heracleum sphondylium* (19, +; 20, r), *Hieracium racemosum* (39, 1), *H.* sp. (1, 1; 21, r), *Hordelymus europaeus* (19, r; 20, r), *Hypericum hirsutum* (30, r; 31, r), *Jovibarba hirta* (18, +), *Juglans regia* (41, r), *Juniperus communis* (12, r), *Lamium maculatum* (30, +; 31, r), *Larix decidua* (17, r), *Laserpitium latifolium* (19, r; 35, +), *Lilium martagon* (19, r), *Luzula campestris* (7, +; 13, +), *Pimpinella saxifraga* (1, r), *Pinus sylvestris* (13, +; 17, r), *Platanthera bifolia* (20, r; 29, r), *Prunus spinosa* (20, r; 24, +), *Ranunculus auricomus* agg. (20, +), *Rhamnus catharticus* (31, r), *Acetosella vulgaris* (18, +), *Sanicula europaea* (19, +; 24, r), *Scrophularia nodosa* (19, r; 22, r), *Senecio ovatus* (19, +; 25, r), *S. germanicus* (19, r), *S.* sp. (18, r), *Sorbus aria* (18, +), *Stachys alpina* (23, r), *Urtica dioica* (36, r), *Verbascum nigrum* (34, +), *Verbena officinalis* (18, +), *Vicia cassubica* (40, 1), *V. sepium* (19, +), *Vincetoxicum hirundinaria* (11, r; 27, +), *Viola mirabilis* (19, r), *Waldsteinia geoides* (32, +).

E_0 – moss layer: *Brachythecium albicans* (13, r), *Bryum caespiticium* (31, r), *Dicranella heteromalla* (1, r; 7, r), *Dicranum montanum* (9, r), *Eurhynchium hians* (24, r), *Homalothecium sericeum* (39, 1), *Hylocomium splendens* (1, 1), *Isothecium myurum* (1, 1; 30, r), *Leucodon sciuroides* (5, +; 6, r), *Mnium stellare* (1, 1; 3, 1), *Myurella julacea* (28, r), *Plagiothecium denticulatum* (12, r), *Pleurozium schreberi* (1, 1), *Pohlia nutans* (13, +), *Polytrichum juniperinum* (1, a), *Rhytidiadelphus triquetrus* (1, +), *Tortula ruralis* (5, r), *T. subulata* (28, r).

Locations of relevés

Relevé number, locality–village, altitude (m), aspect (in letters), slope (degrees), relevé area, cover of tree layer (E_3), cover of shrub layer (E_2), cover of herb layer (E_1), cover of mosses and lichens (E_0), longitude, latitude, date (day/month/year), relevé author.

1. Kozelník (Dolinka), 490 m, NW, 40°, 400 m², E_3 70 %, E_2 10 %, E_1 85 %, E_0 30 %, 19°00'07.8"E, 48°30'00.9"N, 9. 6. 2010, M. Slezák.
2. Banská Belá, Jergištôlňa (Široký vrch Mt), 635 m, SW, 30°, 400 m², E_3 70 %, E_2 3 %, E_1 80 %, E_0 5 %, 18°54'31.9″E, 48°28'66.1″N, 17. 6. 2009, M. Slezák.
3. Hodruša Hámre, Kopanice (Havránkovo), 575 m, SW, 25°, 400 m², E_3 85 %, E_2 0 %, E_1 60 %, E_0 9 %, 18°46'20.7"E, 48°26'62.0"N, 19. 6. 2008, M. Slezák.
4. Bzenica, Chobien Mt., 330 m, SSW, 25°, 400 m², E_3 65 %, E_2 3 %, E_1 55 %, E_0 10 %, 18°45'09.6″E, 48°31'62.7"N, 29. 6. 2009, M. Slezák.
5. Bzenica, Hlinická hora Mt., 365 m, S, 15°, 400 m², E_3 65 %, E_2 2 %, E_1 70 %, E_0 9 %, 18°46'03.6"E, 48°31'32.8"N, 29. 6. 2009, M. Slezák.
6. Bzenica, 370 m, SE, 25°, 400 m², E_3 70 %, E_2 3 %, E_1 70 %, E_0 9 %, 18°45'23.3"E, 48°31'60.9"N, 29. 6. 2009, M. Slezák.
7. Lehôtka pod Brehmi, Gráfovská Mt, 545 m, S, 20°, 400 m², E_3 65 %, E_2 5 %, E_1 70 %, E_0 6 %, 18°50'71.6"E, 48°32'79.9"N, 14. 7. 2009, M. Slezák.
8. Žarnovica, Dolné Hámre, 417 m, E, 30°, 400 m², E_3 70 %, E_2 3 %, E_1 60 %, E_0 30 %, 18°44'73.2"E, 48°27'91.3"N, 22. 7. 2009, M. Slezák.
9. Žarnovica, Lukavica (Mäsiarka Mt), 531 m, SSW, 25°, 400 m², E_3 70 %, E_2 2 %, E_1 70 %, E_0 6 %, 18°45'27.6"E, 48°29'48.3"N, 27. 7. 2009, M. Slezák.
10. Žarnovica, Lukavica (Kašivár Mt), 510 m, W, 5°, 400 m², E_3 70 %, E_2 2 %, E_1 70 %, E_0 4 %, 18°45'27.0"E, 48°29'26.6"N, 27. 7. 2009, M. Slezák.
11. Sklené Teplice, Pustý hrad, 530 m, E, 35°, 400 m², E_3 65 %, E_2 6 %, E_1 60 %, E_0 25 %, 18°50'97.8"E, 48°31'97.5"N, 1. 7. 2009, M. Slezák.
12. Žarnovica, Lukavica (Bartkovci), 504 m, W, 20°, 400 m², E_3 70 %, E_2 2 %, E_1 70 %, E_0 15 %, 18°46'49.2"E, 48°28'70.3"N, 3. 8. 2009, M. Slezák.
13. Lehôtka pod Brehmi, Gráfovská Mt, 530 m, E, 20°, 400 m², E_3 65 %, E_2 3 %, E_1 60 %, E_0 30 %, 18°51'17.8"E, 48°32'75.4"N, 14. 7. 2009, M. Slezák.

14. Vyhne, Čubernovo (Klokoč Mt), 585 m, S, 30°, 400 m^2, E_3 65 %, E_2 3 %, E_1 70 %, E_0 6 %, 18°47'48.2"E, 48°29'26.8"N, 3. 8. 2009, M. Slezák.
15. Vyhne, Čubernovo (Klokoč Mt), 605 m, S, 35°, 400 m^2, E_3 65 %, E_2 4 %, E_1 70 %, E_0 10 %, 18°47'27.1"E, 48°29'42.3"N, 8. 9. 2009, M. Slezák.
16. Vyhne, Čubernovo (Klokoč Mt), 585 m, SSW, 35°, 400 m^2, E_3 70 %, E_2 3 %, E_1 70 %, E_0 9 %, 18°47'18.8"E, 48°29'40.4"N, 8. 9. 2009, M. Slezák.
17. Vyhne (Šprochová), 515 m, SSW, 30°, 400 m^2, E_3 60 %, E_2 5 %, E_1 60 %, E_0 4 %, 18°49'53.6"E, 48°29'85.7"N, 10. 6. 2008, M. Slezák.
18. Vyhne, Spálený vrch Mt, 670 m, SW, 40°, 400 m^2, E_3 60 %, E_2 5 %, E_1 30 %, E_0 30 %, 18°49'13.7"E, 48°29'58.8"N, 10. 6. 2008, M. Slezák.
19. Dobrá Niva, 805 m, SW, 20°, 400 m^2, E_3 80 %, E_2 10 %, E_1 80 %, E_0 0 %, 19°00'52.2"E, 48°28'69.4"N, 9. 6. 2008, M. Slezák.
20. Banský Studenec, 775 m, SE, 10°, 400 m^2, E_3 85 %, E_2 3 %, E_1 90 %, E_0 0 %, 18°59'67.5"E, 48°26'75.2"N, 13. 6. 2008, M. Slezák.
21. Voznica, 420 m, SW, 20°, 400 m^2, E_3 80 %, E_2 0 %, E_1 75 %, E_0 0 %, 18°43'49.0"E, 48°27'36.3"N, 16. 6. 2008, M. Slezák.
22. Voznica, 425 m, SW, 20°, 400 m^2, E_3 80 %, E_2 0 %, E_1 80 %, E_0 0 %, 18°43'55.0"E, 48°27'28.6"N, 16. 6. 2008, M. Slezák.
23. Hodruša Hámre, Kopanice (Trstené), 640 m, SW, 25°, 400 m^2, E_3 80 %, E_2 1 %, E_1 95 %, E_0 1 %, 18°47'08.4"E, 48°26'37.7"N, 19. 6. 2008, M. Slezák.
24. Šášovské Podhradie (Suť), 600 m, W, 20°, 400 m^2, E_3 80 %, E_2 5 %, E_1 90 %, E_0 4 %, 18°55'78.9"E, 48°33'97.4"N, 25. 6. 2008, M. Slezák.
25. Močiar, 670 m, SW, 15°, 400 m^2, E_3 90 %, E_2 5 %, E_1 80 %, E_0 0 %, 18°57'30.5"E, 48°31'25.7"N, 29. 7. 2008, M. Slezák.
26. Voznica (Ferencky), 380 m, SW, 25°, 400 m^2, E_3 70 %, E_2 2 %, E_1 70 %, E_0 0 %, 18°43'20.8"E, 48°27'39.0"N, 16. 6. 2008, M. Slezák.
27. Hronská Breznica, 635 m, W, 15°, 400 m^2, E_3 70 %, E_2 5 %, E_1 90 %, E_0 0 %, 19°00'84.0"E, 48°32'54.6"N, 13. 7. 2009, M. Slezák.
28. Banská Belá, Antošíkovci, 625 m, SE, 20°, 400 m^2, E_3 90 %, E_2 3 %, E_1 80 %, E_0 5 %, 18°57'18.3"E, 48°28'44.7"N, 10. 7. 2008, M. Slezák.
29. Banská Belá, Antošíkovci, 610 m, SE, 20°, 400 m^2, E_3 85 %, E_2 5 %, E_1 85 %, E_0 3 %, 18°57'20.5"E, 48°28'45.1"N, 10. 7. 2008, M. Slezák.
30. Banská Belá, Antošíkovci, 650 m, NW, 15°, 400 m^2, E_3 70 %, E_2 8 %, E_1 80 %, E_0 1 %, 18°57'31.6"E, 48°28'56.5"N, 10. 7. 2008, M. Slezák.
31. Banská Belá, Antošíkovci, 645 m, SE, 20°, 400 m^2, E_3 80 %, E_2 3 %, E_1 60 %, E_0 1 %, 18°57'34.5"E, 48°28'57.4"N, 10. 7. 2008, M. Slezák.
32. Močiar, 685 m, SSE, 20°, 400 m^2, E_3 80 %, E_2 3 %, E_1 80 %, E_0 0 %, 18°57'45.0"E, 48°31'30.1"N, 29. 7. 2008, M. Slezák.
33. Banský Studenec (Zvotle), 645 m, SW, 25°, 400 m^2, E_3 85 %, E_2 6 %, E_1 80 %, E_0 5 %, 18°57'94.0"E, 48°27'38.5"N, 8. 7. 2008, M. Slezák.
34. Banský Studenec (Zvotle), 680 m, S, 25°, 400 m^2, E_3 70 %, E_2 2 %, E_1 80 %, E_0 15 %, 18°57'98.4"E, 48°27'42.8"N, 8. 7. 2008, M. Slezák.
35. Banská Belá, Háj, 555 m, W, 25°, 400 m^2, E_3 75 %, E_2 9 %, E_1 60 %, E_0 2 %, 18°55'62.5"E, 48°29'23.4"N, 17. 6. 2009, M. Slezák.
36. Sklené Teplice, Drieňový vrch Mt, 694 m, W, 25°, 400 m^2, E_3 65 %, E_2 4 %, E_1 90 %, E_0 10 %, 18°53'01.5"E, 48°32'58.6"N, 29. 7. 2009, M. Slezák.
37. Šášovské Podhradie (Blanočný vrch Mt), 490 m, SSW, 25°, 400 m^2, E_3 70 %, E_2 12 %, E_1 85 %, E_0 5 %, 18°54'69.9"E, 48°34'61.4"N, 25. 6. 2008, M. Slezák.
38. Šášovské Podhradie (Blanočný vrch Mt), 540 m, SW, 20°, 400 m^2, E_3 50 %, E_2 12 %, E_1 80 %, E_0 4 %, 18°54'90.9"E, 48°34'63.3"N, 25. 6. 2008, M. Slezák.
39. Šášovské Podhradie, Istebné valley, 478 m, SE, 30°, 400 m^2, E_3 70 %, E_2 9 %, E_1 50 %, E_0 15 %, 18°53'87.3"E, 48°33'66.7"N, 7. 8. 2009, M. Slezák.
40. Žarnovica, Dolné Hámre, 443 m, SSE, 15°, 400 m^2, E_3 80 %, E_2 9 %, E_1 90 %, E_0 7 %, 18°44'12.7"E, 48°27'88.7"N, 22. 7. 2009, M. Slezák.
41. Žarnovica, Dolné Hámre, 390 m, SW, 20°, 400 m^2, E_3 80 %, E_2 6 %, E_1 80 %, E_0 6 %, 18°44'66.1"E, 48°27'89.7"N, 22. 7. 2009, M. Slezák.