PHYTOSOCIOLOGICAL ASSESSMENT OF SITE OF COMMUNITY IMPORTANCE HORNÁDSKE VÁPENCE

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Abstract

The Site of Community importance Hornádske vápence, which consists of six separate localities, was not explored phytosociologically enough. In 2010 I was carrying out the research of vegetation there. The most phytosociological relevés capture xerothermophilous communities of class Festuco-Brometea which are widely distributed on skeletal soils on south-oriented rocky slopes in area. Thermophile fringes of alliance Geranion sanguinei create mosaic with them. The pioneer vegetation on south-oriented slopes is represented by vegetation of alliance Alysso alyssoidis-Sedion albi. Vegetation of alliance Cystopteridion is found on the slopes with northern exposure on shaded rocks. Pine forests are often situated in contact with xerothermophilous communities. Larger area is occupied by alliance Cytiso ruthenici-Pinion which represents sub-xerothermophilous pine forests. Relict calcicolous pine forests of alliance Pulsatillo slavicae-Pinion are preserved in fragments on the edges of cliffs. However, there are also pine monocultures.

Key words: *Site of Community importance, vegetation, phytosociology, Hornádske vápence*

1 Introduction

The system of limestone rocky cliffs and steep slopes, extending in Spiš basin along the river Hornád from Markušovce to cadaster of Olcnava, includes six separate localities. As a complex, they create The Site of Community importance Hornádske vápence (SKUEV0286). It is 27, 21 ha in area (Fig. 1).

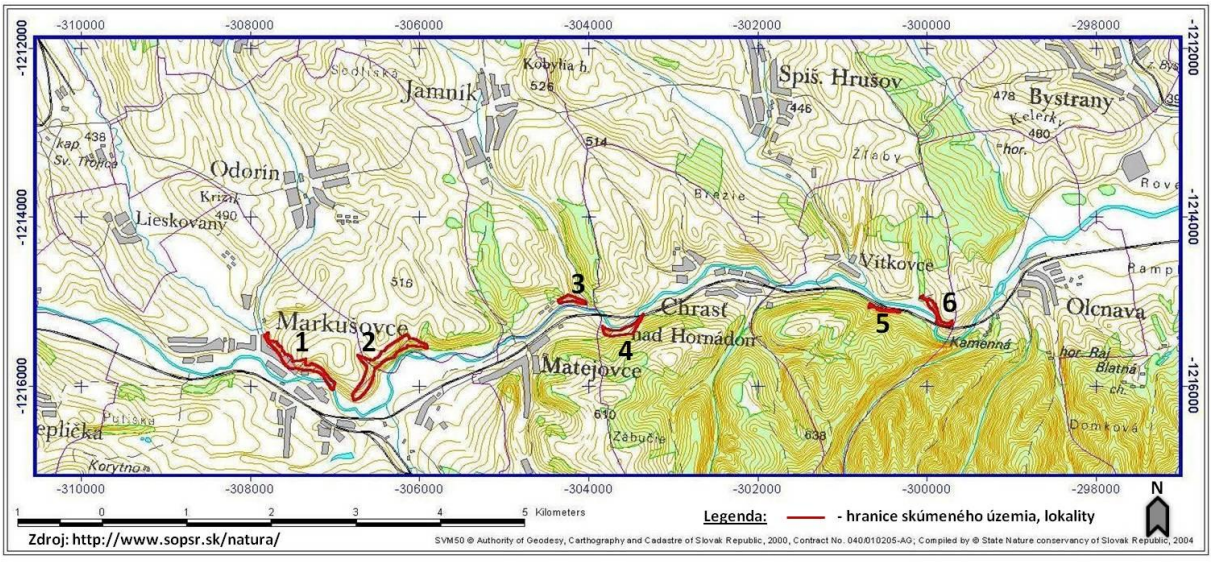

Fig. 1 Map of The Site of Community importance Hornádske vápence

Altitude of the area is in the range 403 to 505 m.a.s.l. Geological conditions consist of limestone, sandstone and conglomerate.

Tab. 1 Table of localities on researched area

Number of locality	Exposure	Description of locality	Coordinates
1	S – SW	Natural monument Markušovská transgresia paleogénu (6,97 ha)	Lat: 48° 54' 49" N Lon: 20° 38' 00" E
2	S – SE	National natural monument Markušovské steny (13,44 ha)	Lat: 48° 54' 55" N Lon: 20° 38' 55" E
3	S	On the east border is brook Jamníček, area cca 1,5 ha	Lat: 48° 55' 21" N. Lon: 20° 40' 42" E
4	N – NW	Šikľavá skala (cca 2 ha), northern edge of the karst plateau Galmus	Lat: 48° 55' 11" N Lon: 20° 41' 06" E
5	N	On the border of the Special Protection Area Volovské vrchy, area cca 1,5 ha	Lat: 48° 55' 25" N Lon: 20° 43' 42" E
6	S - SW	Hora (cca 2 ha), on the border of Galmus	Lat: 48° 55' 24" N Lon: 20° 44' 12" E

Ján Šmarda (1961) with his collective were carrying out phytogeographical research of xerothermophilous flora and analysis of meadow and peat communities of region Spiš during four years (1955 – 1958). He mentioned localities in researched area concretely as: Markušovce, rocks on the left bank of river Hornád, southeast of the village, cca 440 m and slopes near the village Vítkovce, cca 420 m. Since then, any research of vegetation has not been realized there.

Xerothermophilous vegetation of Spišská basin occurs on relict sites which were important refuges from which vegetation spread and penetrated on suitable habitats during the warmer interglacial and postglacial periods. Migration of xerothermic elements from Košice basin upriver Hornád enriched vegetation by new species. Finally, in historical period, we can monitor intensive penetration of xerothermophilous plant species in deforested land, especially along the roads and communication (Šmarda, 1961).

The aim of research was to find out phytosociological characteristics of localities on various types of habitats in the Site of Community importance Hornádske vápence.

2 Material and Methods

Phytosociological research was conducted during the growing season in 2010. Research was carried out by methods of Zurich-Montpellier school (Braun-Blanquet, 1964) using the new Braun-Blanqet 9-membered ordinal cover abundance scale (Van der Maarel, 1978). Xerothermophilous communities of class *Festuco-Brometea* were examined as well as forest and pioneer plant communities. Bryophytes and lichens were not determined. Relevés were stored in a database program Turboveg (Hennekens, 2001) and then exported to the software Juice (Tichý, 2002) for analysis. Identification of communities is based on the confrontation of the collected data from the field with the formal definitions of given syntaxons and their characteristics in the available literature. Habitat conditions were taken into account as well. Electronic expert system for identification syntaxons (Janišová, 2007) was used for relevés capturing class *Festuco-Brometea.* Nomenclature of vascular plants is listed according to Checklist of non-vascular and vascular plants of Slovakia (Marhold et al., 1998). The nomenclature of plant communities is governed by Jarolímek (2008). Principal components analysis (PCA analysis) in software Canoco was used for analysis of species variability.

3 Results and discussion

The following syntaxons were recorded in the area. We captured either representative communities or communities that are close to these vegetation units by their species composition and habitat conditions.
(Abbreviations: **C:** class, **A:** alliance, As: association)

C: FB *Festuco-Brometea* Br.-Bl. et Tüxen ex Soó 1947
A: FBB *Bromo pannonici-Festucion pallentis* Zólyomi 1936 corr. 1966 (relevés n. 15, 17, 21, 23, 29) (locality 2, 3, 6)

These five relevés were identified only at the level of alliance. It is community with dominated diagnostic taxon *Festuca pallens.* Physiognomy of this vegetation, the presence of succulent species (*Sedum* sp., *Jovibarba globifera* subsp. *hirta*) and lower total cover (70-80 %) indicated the transition from pioneer communities of the class *Sedo-Scleranthetea.* Relevés contain critical endangered taxon *Iris aphylla* subsp. *hungarica* which is an object of protection in the area.

A: FBE *Cirsio-Brachypodion pinnati* Hadač et Klika ex Klika 1951 (relevés n. 1, 6, 7, 14, 16, 24, 32)
As: FBE01 *Scabioso ochroleucae-Brachypodietum pinnati* Klika 1933 (relevés n. 1, 24) (locality 1, 3)

It is the association with the dominance of *Brachypodium pinnatum* and accompanying grasses *Bromus erectus* and *Festuca rupicola.* The high herb layer is created by *Anthericum ramosum, Scabiosa ochroleuca, Securigera varia* etc. The low herb layer is formed mainly by *Teucrium chamaedrys.*
As: FBE02 *Polygalo majoris-Brachypodietum pinnati* Wagner 1941 (relevés n. 6, 7, 14, 16, 32) (locality 1, 2, 6)

Association creates a mosaic with thermophile fringes of alliance *Geranion sanguinei* with the dominant taxon *Geranium sanguineum.* Association *Polygalo majoris-Brachypodietum pinnati* acquired transitional character to the community of thermophile fringes of alliance *Geranion sanguinei.*

A: FBA *Festucion valesiacae* Klika 1931
As: FBA02 *Alysso heterophylli-Festucetum valesiacae* (Dostál 1933) Kliment in Kliment et al. 2000 (relevés n. 25, 26, 27) (locality 3)

These three relevés incline to this association according to the character of habitat conditions and species composition, although this syntaxon is typical for dry and warm areas of the southern part of eastern and central Slovakia. *Festuca valesiaca* as a diagnostic taxon had a high cover. *Koeleria pyramidata* occurred as an accompanying diagnostic graminoid. *Phleum phleoides* as an atypical grass for this community was also found. The others diagnostic species were *Acinos arvensis, Potentilla argentea, Trifolium arvense, Echium vulgare* etc. Others species with higher abundance were *Trifolium campestre, Hylotelephium maximum, Pseudolysimachion spicatum* that together with *Phleum phleoides* are also typical for xerothermophilous community of andesite volcanic substrates *Potentillo arenaria-Festucetum pseudodalmaticae* or for others acidic communities.
As: FBA03 *Festuco rupicolae-Caricetum humilis* Klika 1939 nom. mut. propos. (relevés č. 2, 4, 5, 8, 22) (locality 1, 3)

These relevés present the vegetation of class *Festuco-Brometea* which is resembling by its character to the association *Festuco rupicolae-Caricetum humilis*, but *Carex humilis* absents in relevés. This association represents more mesophilic and heterogeneous type of vegetation compared with other syntaxons of alliance *Festucion valesiacae*.

C: *Trifolio-Geranietea sanguinei* Th. Müller 1962 (*Trifolio-Geranietea*)
A: *Geranion sanguinei* Tx. in Th. Müller 1962 (relevés n. 11, 12, 30) (locality 1, 6)

These ecotonal communities occupied extremely exposed slopes in contact with pine forests. Dominant taxon is *Geranion sanguineum.* Other characteristic species are *Inula hirta, I. ensifolia, Trifolium alpestre, Brachypodium pinnatum, Tithymalus cyparissias, Anthericum ramosum, Vincetoxicum hirundinaria* etc. Relevés again contained pontic-pannonian species *Iris aphylla* subsp. *hungarica.*
As: *Geranio-Trifolietum alpestris* Th. Müller 1962 (relevé n. 11)

C: *Asplenietea trichomanis* (Br.-Bl. in Meier & Br.-Bl. 1934) Oberdorfer 1977
A: *Cystopteridion* Richard 1972 (relevés n. 37, 38, 45) (locality 4, 5)

Communities occupy shaded and wet carbonate rocks on north-oriented localities. The characteristic taxons are *Campanula carpatica, Moehrengia muscosa, Asplenium viride* etc. Differential taxons are *Mycelis muralis, Gymnocarpium robertianum* etc. *Cystopteris fragilis* as a characteristic species absented in relevés, but outside of sample plots it had relatively low abundance in the crevices of rocks where was extended separately almost without other vegetation.

C: *Sedo-Scleranthetea* Br.-Bl. 1955
A: *Alysso alyssoidis-Sedion albi* Oberd. et Th. Müller in Th. Müller 1961 (relevés n. 3, 9, 13, 19, 33, 34) (locality 1, 2, 3, 6)

This alliance represents pioneer vegetation on sun-exposed slopes of south-oriented localities.
As: *Jovibarbo-Sedetum albi* Valachovič et Maglocký 1995 (relevés č. 3, 19, 33, 34) (locality 1, 3, 6)
As: *Allio montani-Sedetum sexangulare* Klika 1928 § (relevé n. 9) (locality 1)

Diagnostic taxon *Sedum sexangulare* had a higher cover unlike the absence of *Sedum album* which is diagnostic for the association *Jovibarbo-Sedetum albi.*

C: *Querco-Fagetea* Br.-Bl. et Vlieger in Vlieger 1937
A: *Tilio-Acerion* Klika 1955 (relevés n. 40, 43) (locality 4, 5)

Forest, azonal, edaphically conditioned communities are preserved in fragments in the yardangs which are formed by strengthened rocky debris. The tree layer is created by *Tilia platyphyllos, Acer pseudoplatanus.* The shrub layer is formed by *Lonicera nigra, L. xylosteum, Euonymus verrucosus, Corylus avellana.* In the herb layer, there are typical species for more humid and more shaded habitats: *Corthusa matthioli, Merculiaris perennis, Aconitum moldavicum, Maianthemum bifolium* etc. Relevés do not contain the typical taxon for debris *Lunaria rediviva,* even though this taxon is found on some places of these north-oriented slopes.

C: *Pulsatillo-Pinetea sylvestris* Oberd. 1992
A: *Cytiso ruthenici-Pinion* Krausch 1962 (relevés n. 18, 28, 35, 41, 44)

This widespread alliance in the area represents sub-xerothermophilous pine forests. It is expanded in Hornádska basin. Sun-exposed slopes on calcareous flysch, melaphyre or limestone in basins are typical for this community. Vegetation of this community consists of *Pinus sylvestris* in the tree layer. *Brachypodium pinnatum* dominates in the herb layer. Other characteristic taxons are *Anthericum ramosum, Aster amelloides, Colymbada scabiosa, Galium schultesii, Lembotropis nigricans, Melica nutans* etc.

C: *Erico-Pinetea* Horvat 1959

A: *Pulsatillo slavicae-Pinion* Fajmonová 1978 (relevés n. 10, 31)

As: *Carici humilis-Pinetum* (Klika 1949) Fajmonová et Šimeková 1972 (relevés n. 10, 31) (locality 1, 6)

Relict pine forests are presented in the area as small fragments at the edges of cliffs in the middle of connected forests on extreme forms of relief. Tree layer is often created only by bizarre sinuous trees *(Pinus sylvetris)* freestanding on exposed slopes and rocky formations. Relevés were classified on the basis of higher cover of *Inula ensifolia* according to Uhlířová (1992) as subassociation *Carici humilis-Pinetum typicum* Uhlířová 1985, specifically thermovariant with *Inula ensifolia. Aster amelloides, Inula ensifolia, Stachys recta, Geranium sanguineum, Asperula cynanchica* are mentioned as differential species of community. Others recorded species are *Festuca pallens, Cotoneaster integerrimus, Pulsatilla slavica, P. subslavica* etc. *Larix decidua* absents. Relict pine forests are situated on north-oriented slopes as well (locality 4 and 5), but it was not possible to record them by relevés because of their inaccessibility. In some places it is difficult to distinguish the original pine forests and pine monoculture. For example Futák (1960) mentioned the fact about Podhradská basin: "It is interesting that pine (*Pinus sylvestris)* does not form extensive forests on rocks. I found only one exemplar which could be considered as original." The National Forest Centre Zvolen states that "relict pine forests on limestone often compete with other types of forests and sometimes they are preserved just as a few trees at the edges of the cliffs."

105 representative taxons from 41 relevés of pioneer, forest and grassland vegetation of class *Festuco-Brometea* enter to PCA analysis (Principal components analysis) (Fig. 2) in software Canoco (Ter Braak, 2002).

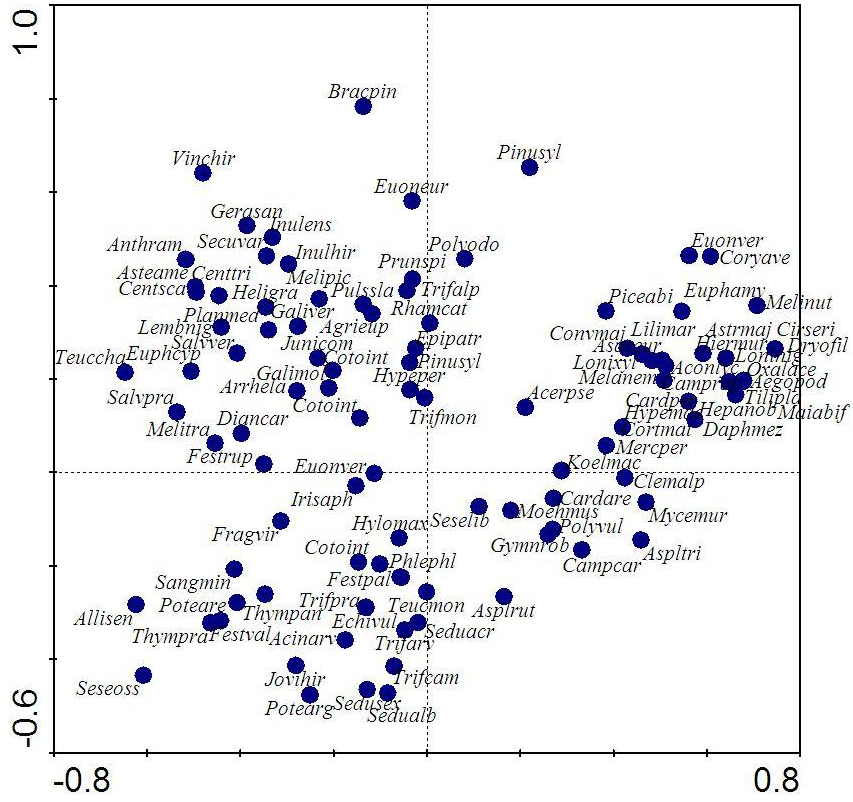

Fig. 2 PCA analysis of recorded species

The output PCA graph shows taxons occupying certain position on graph axes according to their correlative ecological similarity. Using PCA analysis, the gradient of slope exposure or gradient of temperature can be interpreted along the first ordination axis. Taxons occupying

the shaded and colder habitats on north-oriented slopes are situated on the right part of the graph. They are diagnostic and characteristic taxons of pioneer and forest communities on north-oriented slopes *(Cystopteridion, Tilio-Acerion).* They are for example: *Cardaminopsis arenosa, Campanula carpatica, Cirsium erisithales, Aconitum moldavicum, Cortusa matthioli, Tithymalus amygdaloides, Campanula rapunculoides, Gymnocarpium robertianum, Polypodium vulgare, Mercurialis perennis, Dryopteris filix-mas, Lonicera nigra* etc. The left half of the graph is occupied by thermophilic species of xerothermophilous communities on south-oriented slopes. There are mainly thermophilic graminoids, succulent species and others xerothermophilous species. Gradient of vegetal connection or successional gradient spreads along the second ordination axis. The lower half of the graph contains species typical for the pioneer communities *(Alysso alyssoidis-Sedion albi, Cystopteridion)* and even communities of class *Festuco-Brometea* with the less connected vegetation *(Bromo pannonici-Festucion pallentis).* On the other hand, the upper part of graph involves the forest species and also species which create connected grassland vegetation. This successional gradient is also indicated by taxons *Brachypodium pinnatum* and *Sedum album* which are at the opposite ends of the gradient along the second ordination axis. *Brachypodium pinnatum* formed grassland vegetation and undergrowth in forest communities with high total cover. *Sedum album*, by contrast, was typical for pioneer communities with low total cover. The amount and availability of nutrients correlates with second axis as well.

Relevés capture communities which change dynamically and are at various stages of succession. So in some cases it was difficult to identify the syntaxons. The high variability of communities was also documented by PCA analysis of species. Therefore, some relevés do not represent the syntaxon exactly, but they are close to the syntaxon by species composition, habitat, chorological and ecological characteristics. It is evidenced by the fact that the electronic expert system of grassland vegetation of Slovakia classified accurately only 2 relevés from 23 and others were classified according to the coefficients of similarity, formal definitions of syntaxons and others characteristics. For this reason we could classify several relevés at the level of alliance, but some of the representative relevés were classified at the level of association. Janišová (2007) argues that most of vegetation in the field can´t be clearly assigned to the association. No classified relevés represent nondescript types of vegetation in which species with wide ecological amplitude dominate. Even though these relevés can be classified using indexes of similarity and Twinspan procedures in software Juice (Tichý, 2002).

4 Conclusion

The research capture syntaxons representing grassland vegetation of class *Festuco-Brometea* from alliances *Bromo pannonici-Festucion pallentis, Cirsio-Brachypodion pinnati* and *Festucion valesiacae,* then pioneer vegetation of alliances *Cystopteridion* and *Alysso alyssoidis-Sedion albi* and at the end forest vegetation of alliances *Tilio-Acerion, Cytiso ruthenici-Pinion* and *Pulsatillo slavicae-Pinion.* Vegetation of termophile fringes was formed by alliance *Geranion sanguinei*. Variability of identified communities indicates their real state and it is interesting for the further research especially in terms of dynamics. Communities that change dynamically are at various stages of transition and succession. It often disturbs their positive status and complicates their inclusion in the classification of vegetation units. This research may be the basis for processing the care programme about The Site of Community importance and for management to improve and maintain status of natural habitats in the area.

5 References

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