UNIVERSITY OF WEST HUNGARY

THESES OF DOCTORAL (PHD) DISSERTATION

# COMPARATIVE ANALYSIS OF SEMI-DRY GRASSLANDS IN PANNONHALMA-HILLS

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## INTRODUCTION AND AIMS

Grassland associations are habitats which integrated to the landscape of Europe.

Inside of this group the dry,- semi-dry grasslands has a big importance because of its high biodiversity and variation. Therefore, coenological data processing of these habitats have already been in the center of nature conservation importance (ILLYÉS et al. 2009). These habitats have higher value in the Carpathian-basin region, because the dry grasslands which are found in Hungarian forest-steppes regions are represented as a chain link between East-European zonal steppe vegetation and West-European edafic steppe meadows.

Investigation, data processing and classification help to highlight the vegetation difference between landscapes, connection, direction of the flora and the system of association groups. Coenological examination is an important and current exercise that is bear record to the frequently changing Central-European phytosociological judgement. The data processing dissension of some association groups is also conspicuous in Hungary. The main reason of it, is coming from the local and regional scale researches which were typical earlier. (BAUER 2012).

In the last decades there was a notable improvement in the research of association relation of semi-dry grasslands. ILLYÉS et al. (2007) were separated 5 semi-dry grassland types which are based on coenological surveys from different parts of Hungary. Therefore, the categories of the old system (BORHIDI 2003) was also reevaluated. BAUER (2012) was analyzed and estimated the dry and semi-dry grasslands of Bakony region by more than 1500 coenological surveys. His study (BAUER l.c.) does not contains the region of Pannonhalma Hills "because of the lack of semi-natural open grasslands".- This statement is only true for proper definition of dry grasslands.

Distribution of grasslands on Pannonhalma Hills is not significant on the whole, for that reason I have taken into my research all of the semi-natural grassland stands which are found in the microregion area. I have investigated the area from 2004 to 2012 and took sufficient number of coenological surveys about the different type of grasslands.

Aim of my researches:

- Reveal and describe the origin, evolution and organization of grassland stands in the region,
- Classification of grassland communities, describe the separated groups, introduce the dominant hierarchy of it,
- Phytocoenological evaluation of dry- and semi-dry grasslands on Pannonhalma Hills, and the comparison with different associations,
- Investigate the main character of grasslands on Pannonhalma Hills and compare in regional scale and country scale,
- Research the internal and external dynamic processions of grasslands which determine the direction of succession,
- Evaluation of grassland stands in the view of nature conservation,
- Surveying the occurrence and stands of protected or rare plants species in the treeless habitats of research area.

## MATERIALS AND METHODS

### Introduction of study area

Pannonhalma Hills (often called Sokoró or Sokoró Hills) is situated in north-west part of Hungary. It is located in the northern region of Transdanubia and mostly contains low hills. There are three separated dump comb which are situated in southeast-northwest direction and bordered by Kisalföld region.

It was evolved by young geological and geomorphological procession. It is moderately or strongly proportioned (DÖVÉNYI 2010). The three outstanding hills at higher altitudes are covered by loess or lessivated brown forest soils. The different climatic effects prevail together in the area (oceanic, Mediterranean, continental), oceanic climatic effect is the strongest, and less expressed is continental climate. The effect of Kisalföld and Bakony mountain is also perceptible which highlight the transitional situation of the area.

In the viewpoint of phytogeography it belongs to Bakonyicum floristic region in the Vesprimense subregion. Because of the high proportion of broadleave plant species, Pannonhalma Hills original vegetation is separated from Kisalföld region, at the same time the absence of the mountain rocky plant species separates it from Bakony region. Long-ago the area was continuously covered by forest, today the landscape has totally changed. Due to transformation of natural woody plant communities, mostly *Robinia pseudoacacia* and *Quercus cerris*-plantations can found in the area. Semi-natural forests are only represented by fragments of Querco-Carpinetum or Quercetum petraeae and Quercetum pubescentis After the cutting of forests beginning in the roman age, distribution of vineyards are increase. Appearing and reorganization of secondary dry- and semi-dry grasslands were observable in the place of abandoned vineyards.

### Methodology of coenological survey

Aim of my study was the examination of natural and semi-natural treeless plant communities in the area of Pannonhalma Hills. In the interest of it all the grasslands which can rate in habitat categories was sample unit of my work.

In 2004 there were field surveys for mark out the sample areas. In that time I identified the ecologically different type of grassland habitats (open closed sand grasslands, semi-natural semi-dry grasslands with good species composition and with bad regeneration potential, just as forest steppe meadows and forest edges). I also made a note about the environment, species composition and nature conservation importance of these habitats. For the data assessment, evaluation and comparison I have used the Braun-Blanquet terminology which is the most accepted in Central-Europe. With this methodology 148 semi-dry grassland coenological relevées were made in the sample quadrates between 2004 and 2012. In these study 130 relevées were evaluated.

### Methodology of data processing

For the evaluation of coenological surveys and comparison with another habitat groups multiple statistical analysis were used with aid of the Syntax program. For connection analysis between surveys and for group separation hierarchical classification was used. Classification were made with beta-flexibile method (beta=-0,25). Ruzicka-index was used for quantitve analysis which was resulted spherical groups in the multi-dimension range. For measuring the distance between survey subjects ordination were made with principal

coordination analysis. From different parameters the Jaccard-distance index was represented the most significant classification, group difference and relation.
Box-plot analysis were made for background variables with the aid of R programme.

## RESULTS AND DISCUSSION

### Evolution of the grasslands on Pannonhalma Hills

The expansion of treeless habitats has changed during the time periods. Until second century B.D. we suppose that the hills were covered by forest vegetation. In that time period the romans started to plant grape cultivation on the hills with eastern exposure around the towns. After that, hills were covered by vineyards from 900 A.D. until the medieval times (1600 A.D.) About 400 years ago the fallow which is now replaced with black locust could be covered by dry shrublands with the following species: *Quercus pubescens, Cerasus fruticosa, Rosa spinosissima, Ligustrum vulgare, Prunus spinosa.* From the beginning of 18$^{th}$ century until the arriving of phyloxera disease the proportion of vineyards was quiet high and the area of grasslands was low. Therefore, decreasing of refuge areas and disappearing of xerotherm oak species is happened. During the period of phyloxera disease the area of vineyards decreased dominantly under few decades. In the middle of 20$^{th}$ century, land parceling was resulted the disappearing further of refuge areas. These effects had high influence in the decreasing under critical limit of important species which has taken a part in the succession dynamics for a long time. Therefore the chance of these forest steppe elements to alive become lower and lower. In the same time, new adventive alien species occurred (next to black locust) in the area, which has played important role in the secunder succession of vineyard fallows.

### The classification of examined grassland stands

The coenological relevées which were made in different type of semi-dry grasslands, in different treeless vegetation units (weed growth fallows and hay fields, invasive species dominant types) and in transitional stands were separated with hierarchical classification. The semi-natural *Bromus erectus* grasslands with good competition skills were separated into two groups. The another big group is represented together by the stands which are rich in dicotyledonous species, *Brachypodium pinnatum* grasslands and the stands which are in early regeneration or early degradation phase.

According to further classification results inside the three type (homogenious *Bromus erectus* grassland, species rich *Bromus erectus* grassland, semi-dry grassland with rich dicotyledonous species) a drier xerotherm and a mesic type was separated. The reason of separation is based on the differences of species composition (proportion of mesic, xeromesic, xerophil elements) and the different exposure of grasslands. The grasslands where dicotyledonous species was dominant, and *Brachypodium* grasslands, did not separated significantly because of the similar abiotic factors and lower sample number.

### Description of separated vegetation units

Semi-natural, secondary grasslands mainly classified in the group of semi-dry (Brometalia erecti) grasslands.

1. *Bromus erectus* grasslands

The types which are dominated by *Bromus erectus* are conspicuous. Number of coenological relevées also represents it (92% of the samples are in this group). It was separated to two groups and four subgroups by the classification. I came to the conclusion that climatic factors, relief and site conditions together has favorable effect for the grass processing of this species.

According to domination *Carex flacca* and *Festuca pseudovina* have the highest constant value. The accessoric elements are coming from Festuco-Brometea group (*Thymus glabrecens, Achillea collina*) and also association neutral xeromesic species such as *Hieracium umbellatum, Coronilla varia.*

- Homogenous *Bromus erectus* grassland

The stand dynamics of these grasslands is not so variable and the species diversity is very low. *Bromus erectus* is growing strongly, between it the grasslands frequently become open. The species diversity is the lowest of this grassland type (the average species number is 14). These grasslands are evolved because of the abiotic factors (microclimate) and are resistant agianst the propagules which is coming from outside. Differenctial species in this groups: *Plantago media, Poa pratensis, Vitis vinifera.*

- Species rich *Bromus erectus* grasslands

This is the most prevalent semi-dry grassland type. It can occur in different site conditions, but mostly appears in middle angle slopes with north-eastern exposure. Usually occurs in old parceling vineyards which is boarder with variable vegetation such as verge or forest edges. In this group, *Linum catharticum* has differential value against the other groups.

2. *Brachypodium pinnatum* grasslands

*Brachypodium pinnatum* grasslands does not play important role in the system of semi-dry grasslands. Its stands only occurs in steep slopes with northern exposure. Species richness is in the middle (average species number in a quadrate is 18,1). Constant element is the *Centaurea scabiosa* agg. in it. Forest species (*Clematis vitalba, Silene nutans*) and forest edge species *(Campanula glomerata, Peucedanum alsaticum*) abundance value were higher which allude to the cool microclimate.

3. Semi-dry grassland with rich dycotiledon species

These grasslands are situated between the *Bromus, Brachypodium* type grasslands and the grasslands which are in degradation phase. In coenologycal view these types are not significantly different from others. The reason of separation from other semi-dry grasslands is because its physiognomy, higher species diversity, domination of species and nature conservation value difference. In coenological sense these are also Brometalia erecti-grasslands but the dcotyledonous species play important role in this type.
Evolution can be in two ways: 1. aboriginal type of grasslands which has never been disturbed; 2. Grazed or burnt grasslands which become rich in dicotyledon species.
Differential species are: *Lembotropis nigricans, Chamaecytisus austricus, Salvia pratensis* and *Inula ensifolia*.

**Phytocoenological judgement and flora connections**

The appearance of semi-dry grasslands are also special in the situations where normally *Brachypodium pinnatum* has primary role but in these grasslands *Bromus erectus* take the leader positions in associations. The grasslands only in small areas graduate into semi-dry grasslands which are covered with narrow leaved grass species (for example: in some part of Tényő-Nagyhegy). These grasslands neither do not touch the minimum ecological preference in warm slopes.

The Pannonhalma Hills is located in the connection zone of two different association groups (Bromion erecti, Cirsio-Brachypodion). It is appreciable because of the mixing

character and differential species in the associations. The examined stands are not the same than Bromion erecti group. The Pannonhalma Hills species pool is close to Sanguisorbo minoris - Brometum erecti associations which contains less continental species and also similar to Polygalo majoris – Brachypodietum pinnati which appears in northeast limit of forest steppe zone. Correspondence between the species contents of Euphorbio pannonicae – Brachypodietum pinnati is lower.

I compared my relevées with anothers works (see ILLYÉS et al. 2009, BAUER ined.) originated from the association which stand the closest to my study area. According to the ordination results there are differences between my surveys and Sanguisorbo minoris – Brometum erecti association results. In species composition and dominant species, my surveys are also different from Polygalo majoris – Brachypodietum pinnati association. There are more submediterrean, subatlantic dominant species in these surveys but the constant and subconstant species are quiet similar (*Polygala major, Dorycnium germanicum, Inula ensifolia*) to stands of Pannonhalma Hills. The geology and habitat types of Mezőföld is similar to my study area, therefore we suppose Euphorbio pannonicae – Brachypodietum pinnati association in the sample area but there are only a few *Brachypodium pinnatum* grasslands and most of the differential species are missing (like *Euphorbia glareosa, Carex michelii*).

We can conclude for the phytogeographical connections only from a few plant species because of the habitat transformation. Only some continental species appears in northward direction from Móri-árok which is situated between Bakony and Vértes mountains. There are only a few flora elements coming from the warm southern slopes of Dunántúli-Középhegység. Cause the degradation of the area the decreasing of semi-natural habitats also perceptible. The sensible typical loess species does not occur in Pannonhalma Hills, or it appears only in small isolated grasslands *(Inula germanica, Phlomis tuberosa*). In sandy grasslands which are located in northeastern part of the hills, the influence of Kisalföld is perceptible (*Carex liparicarpos, Oxytropis pilosa*). The repeating succession line, pressure of invasive species, site degradation has serious effect on the grasslands species compounds.

**Nature conservation situation and evaluation**

The semi-dry grasslands between forest edge and settlements are outside of Pannonhalma landscape protection area. Grasslands of the Józan valley's and of Tokaj next to Győrújbarát are very rich in orchids and this area become protected after the occurrence of *Ophrys apifera*. The ancient grasslands of Tényő's Nagyhegy and Nyúl's Pillis-tető are in the same state of protection.

On the territories of species-rich semi-dy grasslands has no nature conservation management or experiment. Grazing or haying are completely lacking because of the lack of animal keeping in these grasslands. That is why the area is only influenced by spontaneous succession procession. After nature conservation evaluation it would be possible to work out grassland management programmes for the most important stands. Present study highlight to the location of these valuable grasslands, the dynamic of it and the distribution data of protected species. The study also represents the landscape history and the grasslands history of the area.

In the area of Pannonhalma Hills according to herbarium, publication data and my research data, 63 protected plants species were detected. In grasslands 38 taxon (9 of it is new occurrence), in forests 25 taxon distribution data were recorded.

**THESES**

- The mosaic of vegetation, articulation of relief has not got so positive effect on grassland regeneration. The main reason is the disappearing of important semi-dry grassland species from refuge areas and the presence of invasive species (*Solidago gigantea, Robinia pseudoacacia*) which has high influence on grassland structures.

- In the southeast slope of Tényő's Nagyhegy grasslands, the structure and composition of assocations were influenced by the dry and warm microclimate. These effects are favorable for *Bromus erectus* stands and restrict the spread of invasive species.

- In the sample area of Győrújbarát and Józan-valley the succession process is faster because of northern exposure and relief articulation. In the scrubbing procession meso-hygrophil shrubs and *Robinia pseudacacia* take a part. The grasslands species can not resist to the spreading of these shrubs.

- The evaluation of semi-dry grasslands surveys with statistical methods resulted the separation of these grasslands into 4 types.

- The most typical grass species is *Bromus erectus,* which is dominant in semi-natural grassland fragments and in vineyard fallows.

- Inside the group of Brometum erecti grasslands a homogenous Brometum erecti stands was separated (the abundance of Bromus is higher than 60%, poor in species diversity, dynamics is not important). The Brometum erecti stands which has high species diversity (appears in different site conditions, rich flowering capacity) also separated from other grassland types.

- The most frequent subconstant element of Brometum erecti stands are *Coronilla varia* and *Festuca rupicola*. The *Carex flacca* is typical species of semi-dry grasslands. *Hieracium umbellatum, Linum catharticum* has high constant value also.

- The *Brachypodium pinnatum* grasslands are conspicuously underling position. It occurs scattered in small areas and only in northern exposure. Constant element is the *Centaurea scabiosa* agg., and the *Inula ensifolia* is subconstant.

- In the grasslands which are rich in dicotyledonous species the function of grass species is underling. It can be ancient originated grasslands which was not disturb for hundred years or grasslands which are influenced by some exterior effect that is why are rich in dycotiledons.

- According to species composition and dominance hierarchy these grasslands are belonging to the continental centred Cirsio – Brachypodion association group. The grasslands where *Bromus erectus* is dominant has special appearance because of the presence of pontic and continental elements.

- In the course of classification I came to the conclusion that the grasslands of Pannonhalma Hills are close to Polygalo majoris – Brachypodietum and Sanguisorbo

majoris – Brometum associations. The lack of typical loess species was resulted that these grasslands are far from Euphorbio pannonico – Brachypodietum grasslands.

- Researches resulted the occurrence of 8 protected and 1 strictly protected plant species which are new data in this area. Especially important the discover of *Ophrys apifera.* The present number of protected plant species increase to 63. The following species has important stands: *Linum hirsutum, Ophrys apifera, Orchis purpurea, Orchis militaris.* Grid maps were made about distribution of some taxa in the area of grasslands.

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