



BOTANICAL EXPLORATION AND POTENTIAL UTILIZATION OF GRASSLANDS AT
SOUTH-TISZÁNTÚL

PH.D. THESIS

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1. Introductions and aims

Among natural values of Hungary grasslands occupy high priority place, since each grassland type has its own specific function. Their role is very important not just in agriculture but to preserve biodiversity, conservation of natural resources and also emphasized aesthetic and recreational sites. Role of grasslands become manifold, in the narrow scene it's completed with beekeeping, herb growing and rural tourism. They become a scene of more and more complex research (Barcza 2011, Nagy 2010) and even in addition of economic aspects several other scientific researches (e.g. meteorology, botany, ecophysiology and soil science) performed jointly (Czóbel et al. 2005, 2007, 2012, Balogh et al. 2007, Lelleiné Kovács 2008, 2011, Tuba et al. 2004a, 2004b). From global aspects grasslands have serious feedback for greenhouse gas flows and climate change due to their carbon absorb capacity. Increasing atmospheric CO₂ concentration - which is one of the main cause of climate change - is also greatly influenced by grasslands (Nagy et al. 1997, Nagy and Tuba 2008, Wyckoff and Bowers 2010, Nagy 2010). They provide opportunity for extensive farming and in addition they play important role in carbon storage (Soussana et al. 2007, Wohlfahrt et al. 2008, Nagy 2010), besides soil ventilation (Balogh 2009, Lelleiné Kovács 2008, Barcza et al. 2011, Czóbel et al. 2012). As an effect of inadequate grazing or drought, released carbon amount can be increased which degrade carbon content of soil. The process - as important ecosystem feature - affects toward the vulnerability of the fertility.

In addition of global focus it's important to explore the ways of grasslands usage which mainly focus of the implementation of natural or semi-natural grasslands. They are essential in the preservation of biodiversity, wildlife management and landscape value as well as in the sustaining green corridors (Kovács-Hostyánszki et al. 2012, 2013, Hopkins and Del Prado 2007, Taylor et al. 1993, Fekete and Virágh 1982). Grassland ecosystems - particularly natural or semi-natural stands - decline significantly with changes of ecological factors in global and local scales. Areas of moist and wetland habitat shrink particularly (Hong-yu et al. 2004, Kleijn and Sutherland 2003, Báldi and Faragó 2007, Tilman et al. 2002, Tschardt et al. 2005, Tamisier and Grillas 1994, Van der Nat et al. 2003, Margareta 1995, Lastrucci et al. 2010, Stoate et al. 2009, Geiger et al. 2011, Uj et al. 2013) from which several author drew attention (Kárpáti 2001, Margóczy 2001, Nagy et al. 2001, Dér et al. 2003, Várallyay 2007).

Natural conservation farming can be achieved mainly with extensive grassland methods which primary purpose are the adequate supply of high quality products along with minimal environmental impact, lower expense and effectiveness (Várallyay 2004, 2005). For conservation requirements among land use methods - beside forest management - grassland management suits the best (Birkás and Gyuricza 2004), which main reason that during extensive farming of species-rich grasslands ensuring soil coverage can be solved throughout the whole year (Barcsák and Kertész 1990, Szemán 1994). In the early 1900s, semi-natural grassland have been spread across Central Europe. However, in the recent decade both their number and extension decreased strongly which main reasons are change of cultivation, high degree of melioration and the decline of livestock. Agricultural production is dominant in substantial part of Hungary so it follows that natural conservation activity highly depend on cooperation with agricultural. Farming methods have crucial role in grassland protection or - if necessary - in the restoration (Ángyán et al. 1999, 2003, Kárpáti 2007). These areas are extremely important for proper coordination of agriculture cultivation and environmental protection (Penksza 2014). In recent years, I have been taking part in research works which were mainly focused on Tiszántúl area. My present work presents examinations of pastures, meadows and grassland fragments of Tiszántúl, attempting to be more widely involve all types of turf. My main aim was to give the most comprehensive assessment from their botanical, grassland management condition, helping coordination efforts of grassland managements and natural conservation which aims to ensure sustainability and balance.

Considering the above my aims were as follow:

-Detailed analysis and evaluation of related literature

-During floristical investigation the main aim was to explore the flora of the area broadly. Determination and listing of new species - respected to the area - which are highly relevant in the aspects of ecological and natural protection.

-During coenological work we were mainly interested in the following questions:

- What are the most typical, extensive basis vegetation types of the examined areas which are important scenes of conservation and management?
- Based on typical vegetation units how unified, stable floristically according their appearance?
- Among typical vegetation units are there any of them which require further analysis according their coenosystematic situation?

- Effects of natural conservation treatments (grazing and mowing):

Investigation of effects on conservation treatments on floristical composition, vegetation, physiognomy, functional group distribution and determination of grassland management. Using multivariate statistic methods in order to analysis in deeper context.

Composition analysis and evaluation of natural conservation of examined vegetation plots and determination of their nutritional values and diversity were also important goals.

-Taxonomical studies of problematical species:

My aim was taxonomical evaluation and comparative analysis of dominant and problematic grass populations (*Festuca*) in case of the examined area.

-Important aim was to provide information in order to determinate which treatment method suits the best to preserve biodiversity and to maintain natural conservation and economical values.

2. Materials and methods

During fieldwork of South-Tiszántúl several sample plots were visited. Sample areas were examined in two separated time period, between 1999 and 2001 and 2003-2010. In part of plots – mainly in the first time period – floristical data was collected for the areas and coenological surveying were taken in loess grasslands. In the survey period loess grassland vegetation was also assessed.

Investigated plots were the follows:

I. Plots in the western region of Körös-Maros National Park (Csongrád shire):

1. Böre-hill (west from driveway between Szentes and Hódmezővásárhely),
2. Bökényi-hill,

II. Plots at Mágor-puszta Nature Conservation Area:

3. Belső-Mágorpuszta,
4. Region of “Kék-tó” along Szeghalom,
5. Bangókert (between Vésztő and Szeghalom),

III. Loess and grass spot sin Békés shire:

6. Kétegyháza-Elek,
7. Battonya (Száráz-stream),
8. Tura grassland,
9. Medgyesegyháza.

Overall, 29 spots were separated in the first period from which 9 discussed in details in the thesis. Typical vegetation units were examined during second period highlighting the effects of conservation treatments in vegetation.

Coenological recordings were as follows:

I. Plots in the western region of Körös-Maros National Park (Csongrád shire):

1. Bökényi-pile /sheep pasture/,

II. Plots at Mágor-puszta Nature Conservation Area:

2. Waste of Mágor (Vésztő-Mágor) /sheep pasture/,
3. Pasture next to Körösladány /sheep pasture/,
4. Meadow of Némethi /meadow/,
5. Glade of Fok-köz /abandoned/,
6. Surrounding area of „Kék-tó” at Szeghalom /sheep pasture/,

III. Loess grassland of Békés shire:

7. Battonya /meadow/

IV. Moss areas of Kis-Sárrét:

8. Pasture of Sző /cattle pasture/,
9. Moss of Kisvátyon / abandoned/,
10. Moss of Kisgyant /buffalo pasture/,
11. Surrounding area of Geszt (Biharugra) /sheep pasture/.

List of species of each area was prepared in several field trips during floristical examination. Comparing with previous floristic data, new species occurrence were highlighted.

Coenological conditions surveying were taken from typical stocks in order to characterization following Blanquet (1964) method. For sample squares 2 x 2 m quadrates were applied. Coverage values for each species were given in percentage.

Different utilization of grassland effects were examined in vegetation units. For the comparison of vegetation unit typical coenological survey in similar number (5-5 survey) were taken. Dominant and problematic turf grass species were not clearly determined taxonomically hence taxonomical examination of populations performed and transect method applied too. Examination two hill (Bőre-hill, Bökényi-hill) performed in order to monitor how the vegetation units converted into each other in case of contacting quadrates (2 x 2 m). In each hill 6-6 transect were inspected and each of transects were positioned to involve association such as *Agropyro cristati* - *Kochietum prostratae*, három or *Salvia nemorosae* - *Festucetum rupicolae*.

Taxonomical investigation of *Festuca* species of loess grassland at Battonya have been taken with 50 coenological survey and with the application of 2 x 2 m quadrates.

Names of species followed the nomenclature made by Király (2009), for names of association Borhidi (2003) coenosystematic pattern was applied.

Distribution of social behavior types (SBT) (Borhidi 1993, 1995) and natural protection categories (TVK) (Simon 1988, 2000) were evaluated beside lifestyle analysis (Raunkiaer 1934, Pignatti 2005).

For nutritional value determination of frequent species in turf, Klapp-like (Klapp et al. 1953) method was applied.

Festuca subjects were analyzed morphology from Battonya. According their primal appearance they appeared as *Festuca pseudovina*, therefore for comparison *Festuca pseudovina* were collected not from the nearby area but saline grassland next to Biharugra. In case of control (*Festuca pseudovina*) and other types from Battonya, parameters of 10-10 plants were measured and averaging. In case of measurement series from each group and from *Festuca pseudovina* comparative materials 26 parameters were measured with microscopy of three-three panicles. Localized sampling based on Wilkinson and Stace (1991) as well as Csányi and Horánszky (1973). Characterization parameters of lonely apical and forth festoon of the side branch (Herczeg et al. 2012) were measured.

For multivariate statistical evaluation of coenological surveys R 3.1.2 statistical environment was applied. Classification and ordination (DCA) of data was also performed.

For coenological examination Shannon-diversity was applied (Pielou 1975). During taxonomical examination for multivariate analysis of sample squares SYN-TAX program was applied (Podani 1993, 1997). For this a hierarchical (cluster analysis) and a non-hierarchical (coordination-analysis) methods were applied. In both cases such function was applied which taken into consideration of coverage values of species (Czekanowski, Bray-Curtis).

3. Results

3.1. Floristical results

List of species was created for the examined area highlighting the protected or rare species. The following species and taxons are important to mention according their coverage values: *Bromus racemosus*, *Hypericum elegans*, *Poa humilis*, *Festuca javorkae*, *Linaria kochianiovichii*, *Polygonum arenastrum*, *Euphorbia virgata* var. *virgata* f. *angustissima*, *Verbascum x divaricatum*, *Taeniatherum caput-medusae*, *Festuca valesiaca* and *Agrostis gigantea*.

3.2. Coenological results

During coenosystematic analysis of typical grasslands three distinct characteristic vegetation group was distinguished according their soil conditions – emphasizing the importance of salt and water contents. These were as follows: saline pastures, foxtail saline meadows and loess turf.

For the analyzed region coenological examination showed three distinct vegetation units. From these loess grassland surveys were enough different to use them for comparative analysis in coenosystematic aspects. During examination successfully separated a coeno taxon according the domination of slender bluegrass (*Koeleria cristata*) in *Salvio-Festucetum rupicolae Koelerietosum cristatae* sub association.

From coenological surveys of alkaline study plots there are smaller groups in which species richness is small regardless of coenosystematic classification groups. From them artemisia regions (*Artemisio santonici-Festucetum pseudovinae*) form the most unique branch. Among surveys, quadrates – mainly classified among Artemisia wastelands - which were taken from buffalo pasture form mostly groups. These show larger matches than saline grassy plots.

Arrangement of coenological surveys of alkali foxtail meadows species somposition and dominance relationships are important. In the sampling plot where calamagrostis (*Calamagrostis epigeios*) was dominant, amount of other species were low and they also separated. Plots where no intervention treatment performed - as an abandonment area - low number of species observed also.

Coenological surveys separated according characteristic grass species. In the aspect of economically important groups - such as legumes – presented contingently and had not played important role in the separation.

According to the Simon-like natural protection categories (Simon 1988, 2000) the lack of grazing and conservation management can be determined, since species indicates degradation multiplied. Areas occupied mainly by disturbance tolerant species but in the absence of grazing and mowing, weeds became more and more important. Amount of weed was obvious in case of foxtail meadows which main reason came from lack of treatment due to abandonment of the area. During the investigation of loess grasslands meadows and pastures separated definitely since disturbance tolerant and weed species occurred lesser amount in meadows.

Based on **Borhidi-like** social behavior types (Borhidi 1993) the results were quite similar in saline grasslands, since aggressive competitors occurred just in case of *Achilleo setaceae-Festucetum pseudovinae Koeleria* subassociation. This confirmed the hypothesis that lack of natural conservation treatments (grazing and mowing) leads to grassland degradation. In case of foxtail meadow

Calamagrostis epigeiod vegetation – which presume much degraded associations – was the reason of intense anthropogenic distribution. Nature like majority of the species were generalist, competitors and natural pioneers. Their amount was significant in case of sheep and buffalo pastures. In the aspect of natural conservation grazing and mowing indicated similar results in the examined loess grasslands. Combination of them would lead to the most diverse habitat.

Investigations based on **Pignatti-like** reflects effects of conservation treatments, hence excellent indicators in the aspect of vegetation alterations. As an effect of intense grazing increment of creeping species and decline of annual lawn species observed. The more used saline wastelands and saline foxtail meadows larger coverage was not observed in case of annual and rosette species in contrast previous literary researches (Kahmen és Poschlod 2008, Catorci et al. 2011). However, there was an increment in the amount of annual perennial species which confirmed previous studies (Gatti et al. 2007). This raise negatively correlated with intensification of grasslands.

Diversity studies demonstrated that sheep pasture of *Artemisia santonicum* area (*Artemisia santonici-Festucetum pseudovinae*) were the most valuable. Buffalo grazed sample plots showed higher values than other livestock grazed plots.

Successfully differentiated a group of stems from *Festuca rupicola* species which could be assessed as separated taxon. These separated stems belong to *Festuca callieri* Margf.

3.3. New scientific results

Floristical results

Species list of the area produced, emphasizing rare or protected species.

Results of coenological investigations

Coenological investigations based on examined plots showed three, large extensive vegetation units were differentiated. Among these vegetation types loess grassland surveys separated so much that we could investigate their comparative analysis according to their coenosystematic aspects. During analysis, we have successfully separated *Salvia-Festucetum rupicolae Koelerietosum cristatae* sub association according to dominance of slim light-ryegrass (*Koeleria cristata*).

Results based on life habitat of species in vegetation units.

We have managed to show the effects of natural conservation in the way that they act as indicators in the aspect of vegetation change by Pignatti-like habitat classification. According to this creeping species came into view as an effect of extensive grazing. Occurrence of annual perennials declined with the increase of grazing pressure.

Results of nature protection investigations

As an assessment of natural conservation investigations degradation indicates species accumulated in saline turfs as a result of grazing. However grazing with sheep helped to preserve natural state of the turfs. Abandonment of alkaline foxtail meadows led to degradation of grasslands, therefore conservation treatments are essential, emphasizing the removal of biomass. Grazing with buffalo established valuable turf in both of the aspects of conservation and grassland management.

Distribution tolerant species and weeds occurred in lesser extent in loess grassland. For turf treatment mainly mowing can be suggested, however grazing can help to maintain grassland besides lesser grazing pressure.

Nutritional results

The accumulated dead biomass - due to the lack of treatment - had its negative impact for the nutritional factors in the investigated area. Nutritional values of turf became higher than to grazing – in case of alkaline wastelands - and mowing - in case of saline foxtail meadows and loess grasslands.

Results of diversity investigations

Artemisia wasteland (*Artemisia santonici-Festucetum pseudovinae*) sample plots, including sheep pastures were the most valuable. Grazing with buffalos resulted higher values than grazing with cattle. During natural protection treatments buffalo was very suitable.

Grazing with different animals not just help to preserve biodiversity in the same vegetation types but it can increase diversity. These kind of data can be resorted for habitat reconstructions.

Results of taxonomical investigations

Successfully differentiated a group of stems from *Festuca rupicola* specie which could be assessed as separated taxon. These separated stems belong to *Festuca callieri* Margf.

4. Conclusion

The main aim of this study was to characterize and evaluate general vegetation and to provide useful practical (natural conservation and management) information. Therefore, the effects of performed conservation treatments - grazing with sheep, cattle and buffalo – were also investigated. Beyond this change of vegetation of the abandonment vegetation units were also examined.

With regard of **mowing**, several studies confirmed that mowing increase diversity and species richness of abandonment areas (Bobbink et al. 1978, Bobbink és Willems 1991, Fenner and Palmer 1998, Myklesstad and Saetersdal 2004, Deák and Tóthmérész 2007, Klimek et al. 2007), consequently, stability increased. Several Hungarian authors published similar data (Penksza et al. 2007, 2008, 2010, 2013, Zimmermann et al. 2011, Szabó et al. 2011, Kiss et al. 2011, Harcsa et al., 2008). Among investigated reliefs, only saline foxtail meadows have great importance related with mowing and biomass removal, also this is the way of traditionally treatment. Present study presents abandonment and grazed results of sample plots which were not received conservation treatments. Among alkali foxtail meadows some of them featured *Calamagrostis epigeios* dominance, where sheep grazing and absence of mowing was typical. I was not preferred in neither of the aspects of biodiversity, grassland or conservation values.

Grazing with livestock in rough grass turf - tall, broad leaf plated grass - was not effective, besides significant amount of dead biomass produced as standing grass amount and as accumulated litter on the ground. Consequently, it had strong inhibitor effect on other species. For reconstructed turf, regular biomass removal - mainly by grazing or mowing - is essential (Házi et al. 2012; Kelemen et al. 2014, Török et al. 2010). During swarding often observed that dead phytomass accumulate after the first year (Deák et al. 2011), which could be several times more in amount than its typical for turf type. This could hinder colonization of target species. According loess grassland data besides mowing, grazing could provide variable habitat too.

Grazing vary significantly based on the analyzed data. Several previous study reports increased species richness effect of grazing (Fischer és Wipf 2002, Tóth et al. 2003, Pykala et al. 2005, Catorci et al. 2006, 2007a, 2007b, 2009, 2011, Gatti et al. 2007, Kampmann et al. 2007). Its beneficial effects were confirmed in several national publications (Szabó et al. 2011, Szentes et al. 2009a, 2009b, 2011a, Penksza et al. 2008) particularly emphasized enhancing effect on grasses (Jávor et al. 1999, Vandenberghe et al. 2007, Catorci et al. 2011, Penksza et al. 2007, 2009a, 2010, 2009b, Szentes et al. 2009a, 2009b). Our results correlate and confirm this in both cases of saline grasslands and loess areas. The amount of spiky species increased (Mann and Tischew 2010) which was mainly observed in case of remote loess area of pen house. Biodiversity can be achieved by sheep - in case of short grassed areas - while by cattle - in case higher grassy grounds. This was actually true in case of extensive grasslands due to making them intense or more intense implies the species number (Nagy 1993, Szemán 1999) and natural protection reduction. This study confirm this trend.

With the abandonment of mowing and grazing (Losvik 1999) the species richness decline (Smith and Ruston 1994). In their previous study they confirmed that species richness and diversity is smaller in overgrazed than in under-grazed areas. Several authors received similar type of results

in case of biomass-richness of species connection besides broad productivity gradients (Lamb 2008, Schaffers 2002, Waide et al. 1999). These studies point out that cumulative biomass can cause decline in the number of species, hence great attention should be paid during treatments.

The use of **Pignatti-like** (Pignatti 2005) lifestyle categories based on performed tests proved that application of Pignatti distribution suits better for grassland inspection than **Raunkiaer-like** (1934) because it further separates the different kind of lifestyles as functional groups.

Distribution of species frequency and Pignatti-like lifestyle categories demonstrated which featured in loess grasslands as indicator of grazing. As a result of intense grazing – in this case the sheep grazed loess grassland surveys – creeping species came to the fore, such as *Cynodon dactylon* and ordinary couch grass (*Elymus repens*). Amount of annual species also accumulated. Tendency was the same in case of Italian investigations where besides annual species creeping annual species accumulated in large number and percentage (Gatti et al. 2007, Catorci et al. 2011).

Based on data of investigation of **natural conservation** the absence of grazing accumulate the amount of degradation indication species in saline meadows, however grazing by sheep helps to maintain natural state of the grassland. Abandonment of alkali foxtail meadow plots can lead to degradation of grassland, therefore natural protection treatment is essential besides the removal of biomass from the area. Grazing with water buffalo help to establish valuable turf in the aspects of natural conservation and grassland management. Disturbance tolerant and weeds occurred in lesser extent in grazed loess grasslands. For turf treatment mainly mowing can be proposed in addition – according the present study – grazing can help maintain the turf alongside lesser pressure.

Accumulated dead biomass because of the lack of treatment had its negative effects on **nutritional values**. According to the samplings saline turfs have the lowest nutritional values. In samplings where meadow foxtail (*Alopecurus pratensis*) and ordinary couch grass (*Elymus repens*) have large coverage values, nutritional values are remarkable too. This applies especially for surveys from saline meadow foxtail plots, however if the dead biomass was not removed from it, the large amount of litter resulted its negative effects.

Based on **diversity** experiments, grazing with different animals in the same vegetation types lead different results which indicates that the this difference has its decisive role in mosaic habitat formation. This confirms that in case of reconstruction of same vegetation habitat type experiments different animals should be applied for grazing.

Overall we can declare that with restoration of hayfields and pastures - in the test areas - we can achieve favorable conditions in species composition, diversity of life forms and grassland management values. The present study confirm these assumptions in all the three examined vegetation types. Grazing has its emphasized role in saline grasslands, since diversity, life form variety and natural conservation worth preserved the best in case of sheep grazing. Our examination showed that grazing with cows and buffalos are beneficial as well beside sheep.

Besides abandonment, grazing with sheep highly improve composition of vegetation, since it became more valuable and diverse. Grazing with buffalos resulted positive changes in natural protection and grazing management aspects.

In loess grasslands – based on the observed areas – mowing had the best positive effects, since the area became more diverse, composition of species increased according grassland management categories. In addition, a more diverse, rich in species and valuable pasture can be maintained by grazing.

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6. PUBLICATIONS

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