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Botanical survey of disturbed habitats considering the directives of sustainable agriculture and preservation of biodiversity

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1. Introduction, objectives of the research work

A significant part of Hungary (approx 67%, FVM 2001) is under agricultural cultivation where the original vegetation has almost been eliminated by the continuous human presence and centuries-long agricultural activities. The once-natural habitats have gone, or are undergoing significant change. Nowadays one of the environmental problems of high importance is the decrease in biodiversity, often due to the degradation, fragmentation or disappearance of habitats. Therefore, one of the possible solutions of preservation of biodiversity is to retain and manage these habitats. The habitats that are adjacent to or surrounded by agricultural plough-lands are called semi-natural disturbed habitats and they play an important role in the maintenance of biodiversity. In such habitats incidentally botanical values can also be found and their vegetation is considered to be more or less semi-natural. At the same time they are exposed to the indirect effects of agricultural cultivation. The most important degradation factors that affect these habitats are drying, overgrazing, pollution and other unprofessional agricultural practices. Where it is possible, however, the elaboration and application of state improving treatments referring to the given habitat must be aimed for. By such a treatment from an environmental point of view these habitats gradually can regain their natural state and their flora and fauna can gradually be enriched. It is of great importance that cultivation methods and utilisation of such areas should be in harmony with environmental protection goals.

There are several preconditions for successfully preserving these precious habitats in the given state. One of the most important is to get to know the composition and structure of the plant associations of the habitat, thus we can conclude consequences on the botanical state and occasional degradation of the habitat.

The primary objective of my research work was to scope out the species structure, probable botanical values of five disturbed habitats and to collect data on the importance (for example refuge) of them in the given small region. That is to show and to scientifically sum up the flora and fauna of the researched habitats and to express their importance in preserving biodiversity. Where it was possible I collected data on the fauna of the habitats. Other aim was to establish the basics of a future monitoring survey in order to trace the changes of the botanical situation of the habitats due to climate change.

2. Antecedents of the research work

From amongst the characteristic habitats natural forests, swamps and different meadows have been driven back during the last decades or centuries. Loess and sandy plains, dry grasslands have been driven back as well. We must pay special attention to those habitats that are natural "islands" or formed by human activities and save such species and associations that possibly do not occur anywhere else. A large part of our protected areas is grasslands, where most of our endemic plant and animal species occur and live.

The ignorance of regular utilisation of natural grasslands has a disadvantageous impact on the flora, and in the incorrectly utilised grasslands those plants can propagate themselves quickly that cannot bear grazing well. In such grasslands thickets, bushes would gradually appear besides the stinging weed species.

Fragmentation and separation of semi-natural habitats, and settlement of invasive species, populations mean serious problems in the Great Plain that also disadvantageously affects the flora and fauna of the given habitats.

For the decrease of biodiversity mainly the destruction of habitats is to blame. Essential condition of preservation of biodiversity is the preservation of natural and semi-natural habitats. Each of the five habitats I examined is rich in species and important elements of the ecological network of the region. In my present work I would like to throw light upon the botanical, ecological values of these habitats and to outline the future possibilities of their longevity. In my work by the revelation of the flora and fauna of five such habitats I would like to show the importance of such habitats in the preservation of biodiversity and natural values. For fulfilling their "value preserving" tasks their biological values must be uncovered then their treatment methods determined.

3. Research methods

3.1. Geographical position, soil- and meteorological features of the habitats

The examined habitats are under the management of Tedej Joint Stock Company on the confines of Hajdúnánás-Tedej. From the west the solonchak-solonetz like soils characteristic to the saline grasslands of the Hortobágy determine the farming practices, while from the east the chernozem soils of the Hajdúság dominate (Tamás, 2003).

Soil formation rock: loess, soil type: solonchak-like meadow soil, subtype: carbonated. The thickness of the humus layer is 0.71-0.90 m, humus content is 2.01-3.00%. The thickness of the arable soil is 101-150 cm (Olvasztó, 2000).

The climate of the region is dry continental, the yearly average temperature is 9.9 ºC, the yearly average precipitation is 580 mm, from which 300-350 mm fall during the vegetation period(DE ATC MTK Agri-meteorology Observatory).

Speaking in a general way for each habitat small, but characteristic micro-relief unevenness, slight surface downflow are typical, which play a determining role in formation of the plant associations found in the examined habitats.

3.2. The habitats under examination

The **first** habitat is an approximately 10 ha **protected saline meadow**. It borders a plough-land from the north. Once this habitat was the part of the field, but decades ago because of its unfavourable soil features it was withdrawn from cultivation. Since 1992 this habitat has been under environmental protection by the Hortobágy National Park. One of the characteristics of this habitat is its mosaic-like structure and as a consequence it can be divided into six characteristic associations. In my work this habitat was taken as a control area.

The shape of the habitat is quadratic, its area is approx. 10 hectares. It is surrounded from the north by a *Robinia pseudoacacia* wood, from the west by a road, from the south by the village, and from the east by an agricultural field and a once military object, that is already out of use. According to its soil and vegetation characteristics this seminatural disturbed habitat can be classified as a saline meadow. The area is under extensive agricultural utilisation, it is cut once a year and some parts more or less regularly are grazed.

The **second** habitat is an ***Alopecurus* meadow** lying by the western side of Keleti-main canal. About two-third of the habitat is mainly covered by *Alopecurus pratensis* and *Poa*

pratensis, while about one quarter is under continuous water cover with characteristic swamp vegetation. The habitat is surrounded from the east by the Keleti- main canal, from the south by an asphalted service road, from the west by a plough-land, and from the east by an irrigation canal and a reedy area. The rectangle-shaped area is about 17 hectares. A mintaterületet egy, az aszfaltozott útról a Keleti-főcsatorna gátjára felvezető földút szeli át, amelynek következtében az aszfaltozott út – kavicsozott földút – gát háromszögben egy mély fekvésű mocsárrét jött létre.

The **third** habitat is situated opposite to the second habitat along the other (eastern) bank of Keleti- main canal. It is a **degraded *Puccinellia* grassland** with characteristic saline spots in the western side (along the dam of the canal) with a swampy association, while on the eastern and southern edges a mixed weed population can be found. Its form is rectangle-shaped and its area is about 15 hectares. According to its soil and vegetation characteristics this seminatural disturbed habitat can be classified as a saline meadow as well. It can be divided into three characteristic plant associations. Due to its role as feeding- and living space of several highly protected water bird species its third (*Caricetum elatae*) association can be valued very precious. A mintaterület legjellemzőbb és legnagyobb kiterjedésű társulása egy szolonyec szikfoknövényzet társulás.The Keleti-main canal connects the second and third habitats as a green corridor.

The **fourth** habitat is a **degraded grassland**. It has a long, oval-like shape, its area is about 12 hectares. This habitat is surrounded by plough-lands and is divided into four smaller parts by an asphalted service road and irrigation canals, therefore the habitat can be considered very fragmented. As a result of this fragmentation and the minor surface unevenness, different plant associations can be observed on the two sides of the service road. The system of the irrigation canals functions as green corridor between the habitat and the nearby grasslands.

The **fifth** habitat is a **very saline meadow** that is enclosed by the plough-land no. P8. and is one of the small vegetation spots amongst agricultural fields Despite of its small area the habitat can be divided into characteristic plant associations. Its surface is quite uneven and lies deeper than the adjacent plough-land. The habitat can be considered dry as it was not covered by water for a long time even in springtime. Its area is less than a hectare (0.9 ha), its shape is long and oval. Since an irrigation canal passes through the habitat that canal can function as a green corridor.

On the service maps of Tedej Joint Stock Company all of the mentioned five habitats are marked as "grasslands" and have less importance in their grass management system. Greater part of the first, the second, the fourth and the fifth habitats are cut, and after cutting the *Alopecurus* association of the second habitat is grazed during the summer.

For choosing these habitats for examination one of the criteria was that all of them can function as refuge for the regional characteristic plant- an animal species.

3.3. Coenological characterisation of the examined habitats, examination methods, examination points of view

For the successful grassland and pasture management phytocenology and ecology of grasslands are indispensable. The direct ecological, phytocenological evaluation methods (the TWR indicator numbers (Zólyomi and Précsényi, (1964), Zólyomi et al. (1969) and naturalness and degradation of the plant associations) give fast and reliable data. The regular long-term repetition of the examinations show the direction and character of the changes (Simon, 2004).

During the coenological survey of the habitats at first I had made a species list, then identified the associations (according to the National Biodiversity Monitoring System Vol. II. (1997) and Borhidi (2003)), I had observed the species structure of the given associations, then this list was enriched with newly found species during the coming years. In the case of the number of species I have paid special attention to the those species that belong to the Poaceae and the Asteraceae plant families. In the case of naming the species I used Simon's (2000) plant identification handbook.

The coenological survey was made by the Braun-Blanquet method (1951) as understood by Simon-Seregélyes (2002) with 2x2 m sample squares. In each association (where possible) three squares were set.

On the basis of the surveys four coenological tables and a diagram were compiled for each habitat. They contain 1) the list of plant families richest in species, 2) the environmental protection categories of the species found of the given habitat (Simon (1988, 1992, 2000)), the flora element types and their comparison to the values of the Hungarian Flora (Simon, 2000), the diagram shows the Raunkier-type life forms of the given habitat (Soó, 1964-1980, Simon 2000).

During the processing of the coverage data I counted statistical indicators such as (dispersion, variational coefficient, median). For the deeper correlations amongst the plant associations – as variables – was looked by factor analysis (Sajtos-Mitev, 2007). Grouping of the associations was made by two different cluster analyses (Hierarchical Cluster Analysis, K-Means Cluster)(Sajtos-Mitev, 2007).

4. Results and main consequences

4.1. Protected saline meadow

At present the number of species in the habitat is 81. The results of the surveys reflect primarily the spring aspect (April-May). Then several parts of the area are under slight water coverage and the habitat is rich in species. After the spring cutting the habitat dries out and revives only after the early autumn rains. According to the environmental protection values, from the association-forming species that refer to natural conditions 9, from the accompanying species 20, while from the pioneer species 7, that is total 36 species can be found in the habitat. From the species refer to degradation 45, accurately 26 weed species, 18 disturbance tolerant species and one adventive species are present. These data leads us to conclude that the area preserves its semi-natural state, but quite strong degradation effect has an influence on it.

In the habitat the ratio of the cosmopolitan species is approximately threefold of the value characteristic to the Hungarian Flora. This ratio can be explained by the fact the habitat is surrounded by plough-lands and a *Robinia pseudoacacia* wood, from where the spreading of cosmopolitan weed species is high.

In the habitat the number of hemicryptophyta species is the highest (31 species = 38.27%), followed by the therophytas (24 species = 29.63%). The number of hemitherophyta species is 14, i.e. 17.28% of the total number of species

Table 1 contains those plant families that are the richest in species in the habitat. One can see that significant part of the species belongs to the Poaceae (19 species – 23.75%) and the Asteraceae (16 species – 19.75%) families. The high per cent of the Poaceae species and their high coverage (75-80%) point out the positive renewing affect of cutting and grazing for the grass species. The other plants families contain one-two, or rather three species (for example Fabaceae) in the habitat.

Table 1

Plant family	Number of species (Pc)	Percentage
Poaceae	19	23,46
Asteraceae	16	19,75
Brassicaceae	5	6,17
Lamiaceae	5	6,17
Cyperaceae	4	4,94
Total	49	60,49

The area is very mosaic-like and in spite of its relatively small total surface it can be divided into six characteristic associations according to the dominant plant species on the characteristic soil type.

Table 2

Plant associations	Dominant species
Bolboschoeno-Phragmitetum Borhidi & Balogh 1970	*Phragmites australis*
Agrostio stoloniferae-Alopecuretum pratensis Soó 1933 corr. Borhidi 2003	*Alopecurus pratensis, Agrostis stolonifera*
Artemisio santonici-Festucetum pseudovinae Soó in Máthé 1933 corr. Borhidi 2003	*Artemisia santonicum, Festuca pseudovina*
Puccinellietum limosae Magyar ex Soó 1933	*Puccinellia distans*
Plantagini tenuiflorae - Pholiuretum pannonici Wendelbg. 1943	*Plantago tenuifolia, Pholiurus pannonicus*
Alopecuro-Arrhenatheretum (Máthé & Kovács 1960) Soó 1973	*Alopecurus pratensis, Arrhenatherum elatius*

4.2. Alopecurus meadow

In the habitat according to the surveys made in 2005 and 2006 the number of species is 112. The dominant species of the swampy association are from the Cyperaceae and Juncaceae families, while on the side of the dam of the Keleti-main canal are from the Fabaceae and Poaceae families. In the *Alopecurus* association the dominants species are the *Alopecurus pratensis* and the *Poa pratensis*.

In spite of the high percentage of species referring to degradation the habitat can be considered as semi-natural. A large part of the weed species occurs only with a few specimens mainly in the edges of the adjacent to plough-land from the west and along the woody-

shrubby verge by the dam of the canal. The number of species referring to natural conditions is lower, but their number of specimens and coverage is significant.

In the habitat the ratio of the cosmopolitan species is almost fourfold of the value characteristic to the Hungarian Flora. This ratio in this habitat can also be explained by the fact that the habitat is surrounded from one side by a plough-land, from where the spreading of cosmopolitan weed species is vigorous. Fortunately the coverage of these weed species is still low.

In the habitat as it could be waited for, the number of hemikryptophyta species is the highest (41 species = 36.6%); they are followed by the therophyta species (31 species = 27.7%). The number of hemitherophyta species is 14, i.e. 12.5% of the total number of species. In the *swampy meadow* association of course the number of those species whose wintering organs are under water is significant (11 species = 9.8%). The phanerophyta species in the woody-shrubby edge by the dam of the canal takes 5.36% of the total number of species.

Table 3 contains the five such plant families that are the richest in species in the habitat. One can see that significant part of the species here also belongs to the Poaceae and the Asteraceae families. In this habitat the ratio of the grass species is only 12.61% comparing to the 23.46% found in the case of the first habitat. The ratio of the Asteraceae species is approximately the same, the difference is only 1% in favour of the second habitat (20.72% and 19.75%). The ratio of the Fabaceae species does not reach the 13.5% ratio considered low by Haraszti (7.21%), but higher than in the first habitat (3.70%).

Table 3

Plant family	**Number of species (Pc)**	**Percentage**
Asteraceae	23	20,72
Poaceae	14	12,61
Fabaceae	8	7,21
Cyperaceae	7	6,31
Brassicaceae	5	4,50
Total	57	51,35

The habitat can be divided into the following associations:

Table 4

Plant associations	Dominant species
Másodlagos mocsárrét	*Lythrum salicaria,*
Agrostio stoloniferae-Alopecuretum pratensis Soó 1933 corr. Borhidi 2003	*Agrostis stolonifera, Alopecurus pratensis, Poa pratensis*
Butomo-Alismatetum lanceolati (Tímár 1947) Hejný 1969	*Butomus umbellatus, Alisma lanceolatum*

4.3. Degraded *Puccinellia* grassland

In the third habitat the number of species is 82 at the moment. In the habitat protected plant species does not occur, and the number of weed species reflecting to the degradation of the habitat is quite high.

The habitat can be considered as strongly degraded because a significant part of it is covered by a mixed weed vegetation, where species referring to degradation occur in high numbers and coverage. From amongst the species referring to natural conditions *Carex elata*, *Typha angustifolia* and *Phragmites australis* can be insisted upon the watery *Caricetum* association that is situated along the woody-shrubby edge by the dam of the canal. The fourth such species, *Alopecurus pratensis* does not form continuous vegetation: its coverage is insignificant. In the habitat the ratio of the cosmopolitan species is three-fold of the value characteristic to the Hungarian Flora. This ratio can also be thanked by the fact the habitat is situated by a plough-land. From the edge of this plough-land the spreading of weed species can be considered as significant.

The number of hemikryptophyta species is the highest (27 species = 33.0%). The number of therophyta species is high due to the mixing weedy vegetation on the edges, where the number of the warm-season annual weed species is high (24 species = 29.3%). The species number of the hemitherophyta species is 14, i.e. 17.1% of the total species number.

As in the above-mentioned two habitats significant part of the species belongs to the Poaceae and the Asteraceae families. The ratio of the Asteraceae species is almost the same as of the first habitat, but the ratio of the grasses is lower with about 5% (Table 5.).

Table 5

Plant family	Number of species (Pc)	Percentage
Asteraceae	15	18,29
Poaceae	15	18,29
Fabaceae	5	6,1
Lamiaceae	5	6,1
Brassicaceae	5	6,1
Boraginaceae	4	4,88
Total	49	59,76

In the habitat the following associations can be observed:

Table 6

Plant associations	Dominant species
Caricetum elatae Koch 1926	*Carex elata, Phragmites austrialis, Bolboschoenus maritimus*
Puccinellietum limosae Magyar ex Soó 1933	*Puccinellia limosa*
Carduo acanthoidis – Onopordetum acanthii Soó ex Tímár 1955	*Rumex crispus, Cirsium arvense, Carduus acanthoides, Galium aparine*

4.4. Degraded grassland

This habitat is not too rich in species. During 2005 and 2006 I found 78 species from which many are weed species.

The habitat can be considered as medium degraded since the number and coverage of weed- and disturbance tolerant species highly exceeds that of the association forming- and accompanying species. Compared to the data of the first habitat, we can establish that in this fourth habitat the number and percentage of species referring to natural conditions is lower than in the first habitat (28 species = 36.4% and 36 species = 44.4%). But differently from the second and third habitats, the number of species referring to degradation just slightly exceeds the data seen in the case of the first habitat, but expressing it in percentage the difference can be evaluated as significant (49 species = 63.6% and 45 species = 55.5%).

In the habitat the ratio of the cosmopolitan species is almost fivefold of the value characteristic to the Hungarian Flora. This ratio in this habitat can also clearly be explained by

the fact that almost one-fifth of the habitat is a weedy association, where many weed species can be found.

The number of hemikryptophyta species is outstandingly high (36 species = 46.8%). They are followed by the therophyta species (17 species = 22.1%). The number of hemitherophyta species is 10, i.e. 13.0% of the total species number.

Table 7 contains the five such plant families that are the richest in species in the habitat. Wee can see that significant part of the species here also belongs to the Poaceae and the Asteraceae families. Comparing to the first habitat we can point out that ratio of the Asteraceae species is higher with approximately 5% than in the first habitat (24.36% and 19.75%), but the ratio of the grass species is lower with more than 4 per cent (19.23% and 23.46%)

Table 7

Plant family	**Number of species (Pc)**	**Percentage**
Asteraceae	19	24,36
Poaceae	15	19,23
Fabaceae	4	5,13
Lamiaceae	4	5,13
Total	42	53,85

According to the coenological survey in the fourth habitat the following associations can be separated:

Table 8

Plant associations	Dominant species
Agrostio stoloniferae-Alopecuretum pratensis Soó 1933 corr. Borhidi 2003	*Alopecurus pratensis, Agrostis stolonifera*
Artemisio santonici-Festucetum pseudovinae Soó in Máthé 1933 corr. Borhidi 2003	*Artemisia santonicum, Festuca pseudovina*
Ruderális gyomtársulás	*Elymus repens, Xanthium strumarium, Cirsium arvense, Artemisia vulgaris*
Bolboschoenetum maritimi Eggler 1933	*Bolboschoenus maritimus*
Puccinellietum limosae Magyar ex Soó 1933	*Puccinellia limosa, Aster tripolium L. subsp. pannonicum*

4.5. Saline meadow

In the fifth habitat the number of species is 87 at present. The habitat can also be considered as degraded because of the high species number and coverage of weeds and disturbance tolerant species. The number and the coverage of species referring to natural conditions are low; they are about to withdraw.

Compared to the data of the first habitat we can state that number and percentage of species referring to natural conditions are much less and less than in the case of the first habitat (27 species = 31.0% and 36 species = 44.4%). Therefore the number and coverage of species referring to degradation is significantly higher than in the case of the first habitat (60 species = 69.0% and 45 species = 55.5%).

In the habitat the ratio of the cosmopolitan species is more than fourfold of the value characteristic to the Hungarian Flora. This ratio in this habitat can clearly be explained by the fact that the habitat is surrounded by plough-lands, from where the spreading of cosmopolitan weed species is high.

In the habitat the number of hemikryptophyta and therophyta species are outstandingly high (37 species = 42.5% and 28 species = 32.2%). The number of hemitherophyta species is also significant (13), representing 14.94% of the total species number

In this habitat also the Asteraceae and the Poaceae species are in the highest number and average (Table 9). Comparing to the data of the first habitat we can point out that in this habitat the ratio of the Asteraceae species is higher with akmost 1%, while the ratio of the Poaceae species is lower with 4%, than in the first, control habitat.

Table 9

Plant family	Number of species (Pc)	Percentage
Asteraceae	18	20,69
Poaceae	17	19,54
Fabaceae	6	6,90
Chenopodiaceae	5	5,75
Polygonaceae	5	5,75
Total	51	58,63

According to the coenological survey in the fifth habitat the following associations can be found:

Table 10

Plant associations	Dominant species
Achilleo setaceae-Festucetum pseudovinae Soó (1933) 1947 corr. Borhidi 1996	*Achillea millefolium, Festuca pseudovina*
Agrostio stoloniferae –Alopecuretum pratensis Soó 1933 corr. Borhidi 2003	*Alopecurus pratensis, Agrostis stolonifera, Elymus repens*
Puccinellietum limosae Magyar ex Soó 1933	*Puccinellia limosa*
Bolboschoeno-Phragmitetum Borhidi & Balogh 1970	*Bolboschoenus maritimus, Phragmites australis*
Ruderális gyomtársulás	*Elymus repens, Phragmites australis*

4.6. Comparison of the flora element types of the habitats

Table 11.a.

Cosmopolitan species		**In the Hungarian Flora**		**6,5%**
1st habitat	**2nd habitat**	**3rd habitat**	**4th habitat**	**5th habitat**
20,99%	**24,11%**	**19,75%**	**28,95%**	**26,75%**
3,2x	**3,7x**	**3x**	**4,4x**	**4,1x**

Table 11.b.

Eurasian species		**In the Hungarian Flora**		**22,5%**
1st habitat	**2nd habitat**	**3rd habitat**	**4th habitat**	**5th habitat**
43,21%	**46,43%**	**51,85%**	**43,42%**	**50%**
1,9x	**2x**	**2,3x**	**1,9x**	**2,2x**

Table 11.c.

European species		**In the Hungarian Flora**		**20,4%**
1st habitat	**2nd habitat**	**3rd habitat**	**4th habitat**	**5th habitat**
16,05%	**15,18%**	**12,35%**	**11,84%**	**9,3%**
0,8x	**0,7x**	**0,6x**	**0,6x**	**0,4x**

4.7. Comparison of the life form types of the habitats

Table 12.a.

Hemicryptophyta life form type				
1st habitat	**2nd habitat**	**3rd habitat**	**4th habitat**	**5th habitat**
Number of hemicryptophyta species in the given habitat				
31	**41**	**27**	**6**	**37**
Percentage of the hemicryptophyta species from the total number of species				
38,27%	**36,61%**	**32,97%**	**46,75%**	**42,53%**
Total number of species (100%)				
81	**112**	**82**	**78**	**87**

Table 12.b.

Therophyta life form type				
1st habitat	**2nd habitat**	**3rd habitat**	**4th habitat**	**5th habitat**
Number of therophyta species in the given habitat				
24	**31**	**24**	**17**	**28**
Percentage of the therophyta species from the total number of species				
29,63%	**27,68%**	**29,27%**	**22,08%**	**32,18%**
Total number of species (100%)				
81	**112**	**82**	**78**	**87**

Table 12.c.

Hemitherophyta life form type				
1st habitat	**2nd habitat**	**3rd habitat**	**4th habitat**	**5th habitat**
Number of hemitherophyta species in the given habitat				
14	**14**	**14**	**10**	**13**
Percentage of the hemitherophyta species from the total number of species				
17,28%	**12,5%**	**17,07%**	**12,98%**	**14,94%**
Total number of species (100%)				
81	**112**	**82**	**78**	**87**

4.8. Statistical analysis of the coverage, number of species, Shannon value and evenness of the habitats

On the basis of the comprehensive table of estimated total coverage, number of species, Shannon-value and evenness I counted mathematical average, statistical dispersion and variational coefficient (Table 13.a.-d.). Expressing the variational coefficient in per cent in the economic practice the variability can be qualified as the follows:

0-10% – homogenity
10-20% – medium variability
20-30% – strong variability
Above 30% extreme variability characterizes the statistical universe (Szűcs, 2002).

In our case the above-mentioned factors describe the variability well.

Table 13.a.

	Habitat	Average	Dispersion	Variational coefficient
Coverage (%)	I.	55,28	13,23	23,9%
	II.	62,86	24,64	39,2%
	III.	80,00	4,47	5,6%
	IV.	56,33	22,00	39,0%
	V.	59,67	12,88	21,6%

The average of the coverage is the highest in the case of the third habitat, here the variational coefficient shows homogeneity as well. The higher coverage values of the two examined associations of the third habitat were caused by the longer (several-month long) water coverage in this part of the habitat. The moisture content of the soil remains high even after the termination of the water coverage due to the habitat's deeper lying. In the summer only the surface of the soil becomes drier. This promotes the higher coverage.

Figure 1

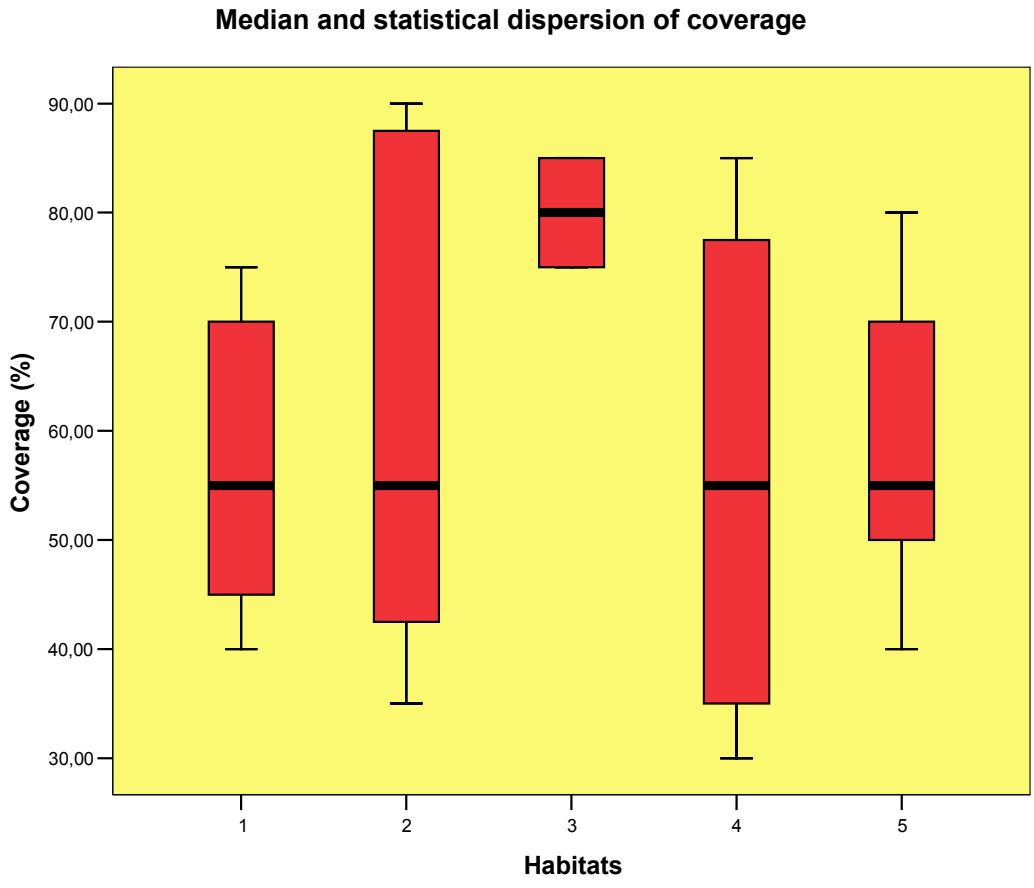


Figure 1 shows that the median is the highest in the third habitat, while in the case of the other four habitats is almost the same.The biggest dispersion can be observed in the case of the second and the fourth habitats.

Table 13.b

	Habitat	Average	Dispersion	Variational coefficient
Number of species	I.	14,61	6,13	41,9%
	II.	21,86	16,55	75,7%
	III.	12,50	7,87	62,9%
	IV.	12,73	8,15	64,0%
	V.	10,27	4,30	41,9%

With respect to the number of species in case of all the five habitats extreme fluctuation characterizes the statistical universe Its main reason is that the habitats contain several and quite different plant associations, where the species structure and characteristics of the habitat are significantly different.

Figure 2

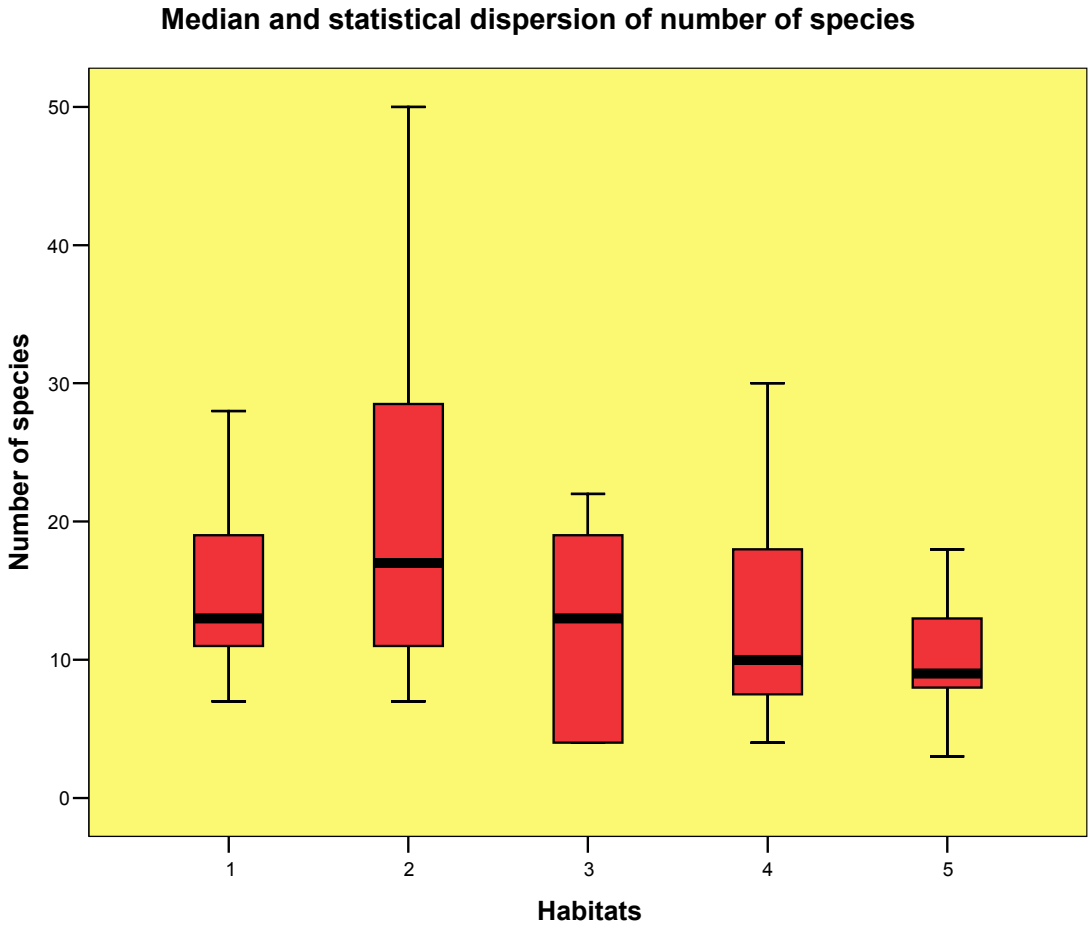


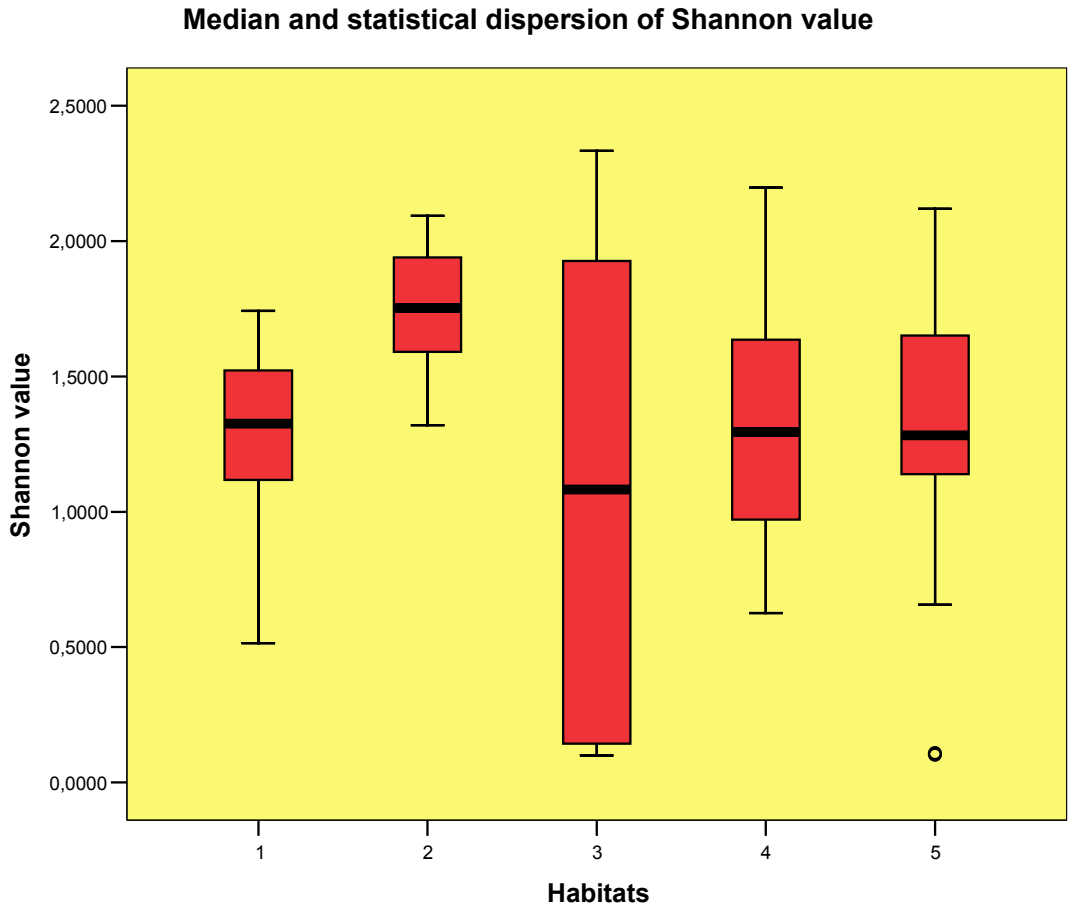
Figure 2 shows the median, interquartal extent and the 5-95 per cent extent of the number of species of each habitat. It is obvious that the median is the highest in the case of the second habitat, where statistical dispersion is the biggest too.

Table 13.c

	Habitat	Average	Dispersion	Variational coefficient
Shannon-value	I.	1,27	0,33	26,1%
	II.	1,75	0,28	16,2%
	III.	1,11	1,01	91,3%
	IV.	1,31	0,47	36,1%
	V.	1,25	0,59	46,6%

The average is the higher and the dispersion is the smaller in the case of the second habitat. The variational coefficient indicates medium variability. But in the case of the second habitat we must take into consideration that the species do not have the same value. It means that in case of the presence of more disturbance tolerant- and weed species the value of species diversity is even higher but the environmental protection value of the habitat can decrease.

Figure 3



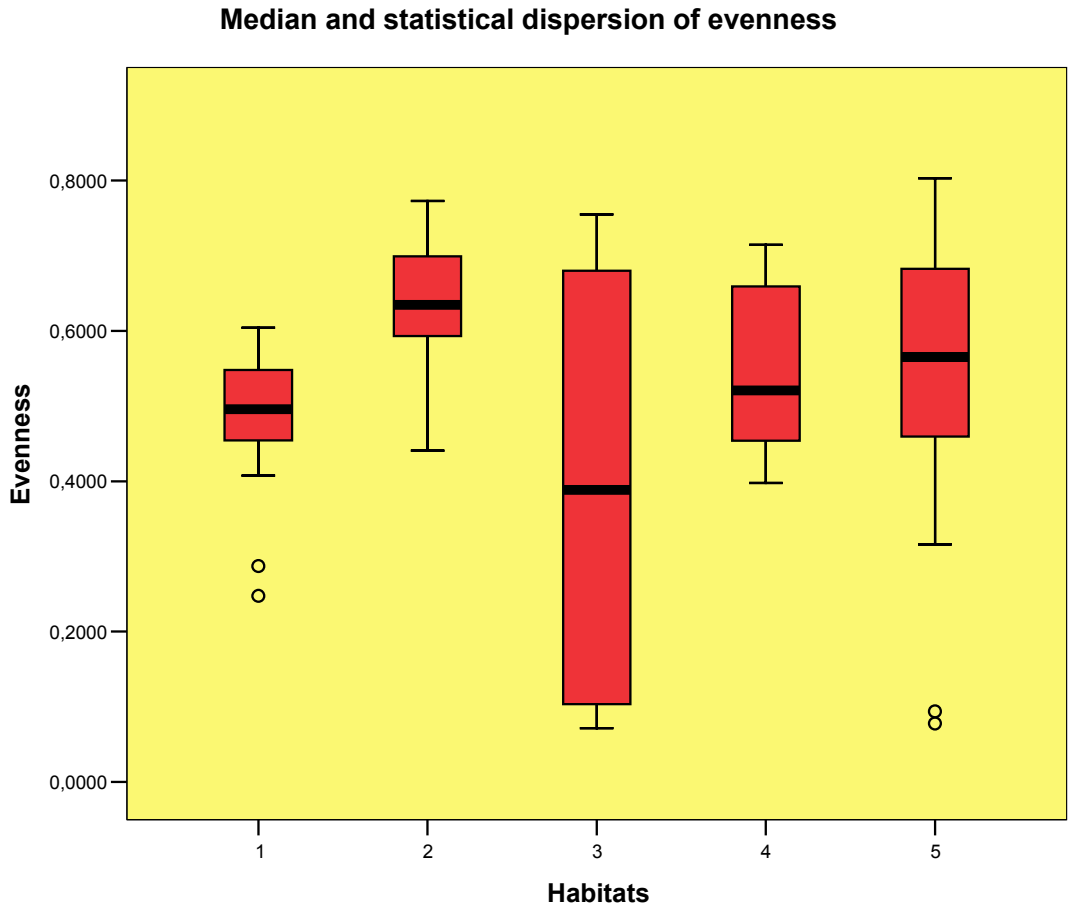
Median of the Shannon values is the lowest in the case of the third habitat, but the statistical dispersion is the highest. In the fourth and the fifth habitat no big difference can be seen according to the median.

13.d. táblázat

	Habitat	Average	Dispersion	Variational coefficient
Evenness	I.	0,48	0,10	19,6%
	II.	0,63	0,11	17,6%
	III.	0,40	0,32	79,4%
	IV.	0,56	0,11	20,1%
	V.	0,53	0,23	42,8%

The average of the evenness – that here shows how evenly distributes the coverage of the given habitat among its forming plant associations – is the lower in the case of the third habitat, the statistical dispersion is the highest and the variational coefficient shown extreme fluctuations. The highest average can be observed in the case of the second habitat, the variational coefficient indicates medium variability.

Figure 4



The median of the evenness is the smallest in the case of the third habitat, and the statistical dispersion is the highest here as well.

4.9. Grouping of associations by cluster analysis according to the coverage data of their plant families

For the more simple and more analysable factor resolution I have made factor rotation. From amongst the offered procedures I have applied the Varimax method, because the Varimax rotation is more stabile and separates the factors better than the other procedures. This helps in the analyses of the factors (Sajtos-Mitev, 2007). The rotated factor weight matrix can be seen in Table 14. The factor weight shows the correlation between the original variable and the given factor, whose value can change between -1 and 1 (Sajtos-Mitev, 2007). With this the belonging to the factors can be obtained (Table 14).

Table 14

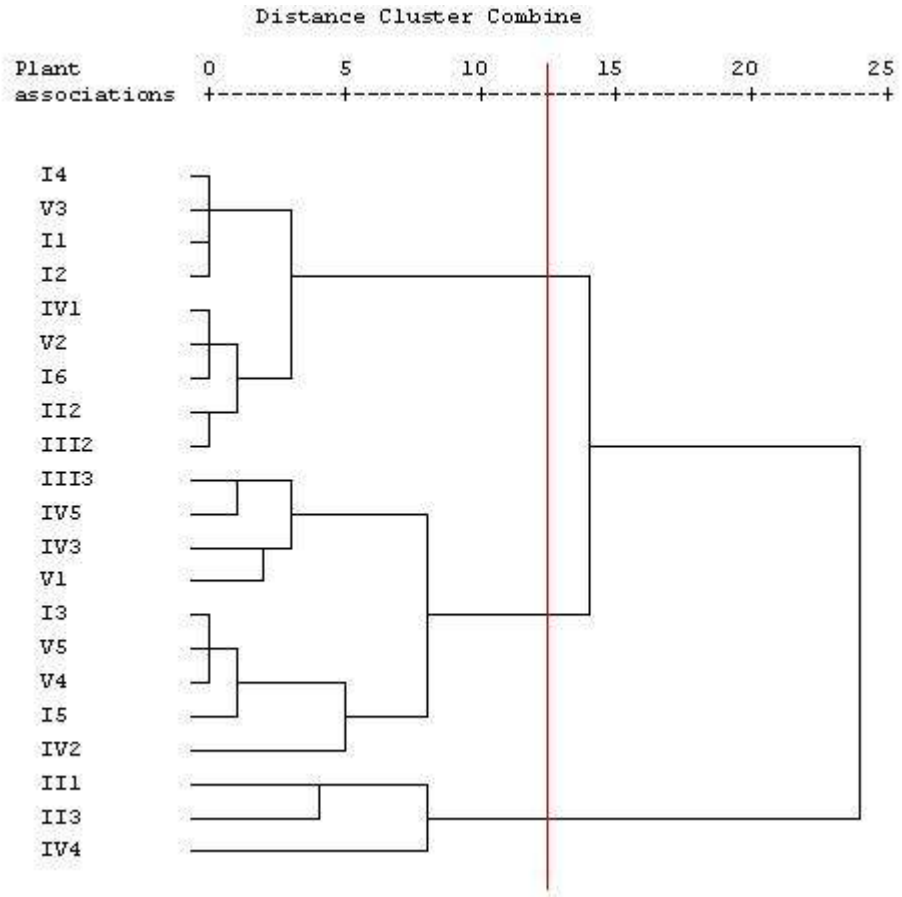
Plant associations	Factors		
	I.	II.	III.
V-2	.950	.310	-.012
II-2	.946	.318	.032
III-2	.946	.323	-.010
IV-1	.942	.333	-.014
V-5	.942	.318	.068
I-2	.941	.334	.021
I-6	.939	.337	-.011
I-1	.938	.341	.035
I-4	.933	.356	-.014
V-4	.931	.343	.082
I-3	.923	.382	-.020
V-3	.921	.387	-.012
I-5	.896	.285	-.040
V-1	.762	.639	-.033
IV-2	.372	.923	-.025
III-3	.489	.866	-.037
IV-5	.578	.814	-.017
IV-3	.667	.728	-.036
II-1	-.033	-.047	.912
II-3	-.008	-.075	.838
IV-4	.053	.055	.686

Rotated factor weight matrix

The associations of the I. factor: I-1, I-2, I-3, I-4, I-5, I-6, II-2, III-2, IV-1, V-1, V-2, V-3, V-4, V-5. Name of this factor is „**associations dominated by Poaceae species**”. The associations of the II. factor: III-3, IV-2, IV-3, IV-5. This factor has the name of „**weed- and weedy associations dominated by Asteraceae and Poaceae species**”. The name of the III. factor, where the II-1, II-3, IV-4 associations belong to, is ”**no Poaceae dominated, tipical watery associations**”.

I have also made the agglomerative classification used in quantitative ecology. Like in factor analyses the starting point was the coverage values of the plant families of the plant associations. The main point of the method is to close up the two most similar variables and hereinafter they are handled as one (Turcsányi (edit.) 1995). Continuing the procedure all the variables are to be closed up. In every step of the closing up the connecting value is to be given. The results can be demonstrated well in a dendrogram (Figure 5). As regard the plant associations during the first several steps the I-1, I-2, I-4, V-3; the I-6, IV-1, V-2; the II-2, III-2; and the I-3 V-4, V-5 associations have been closed up. Further on these and the other still not connected variables turned to be the newer connectable variables.

Figure 5



Dendogram of the associations

Interpretation of the dendrogram can be made from the opposite way –from the right to the left – as well. Separating the plant associations on the basis of their differences, for the most part the associations II-1, II-3 and IV-4 separated from the others. These three associations are the watery associations also classified into the III. factor by the ordination, whose coverage and species- and family structure characteristically differ from the other

associations. Founding smaller differences the other 18 assiciations can be divided into two other parts, into 9-9 associations. Then the analysis can continue with more and more dividings.

The dendogram on Figure 5 was made by the Hierarchical Cluster Analysis of the SPSS Program. Name of the method is Nearest Neighbor, the used distance function was the square Euclidean distance. The dendogram is suitable for deciding the number of clusters to be formed. Between the tenth and fifteenth connecting points the twenty-one examined plant associations divide into three clusters.

Using an other cluster method, the K-Means Cluster algorithm of SPSS, I have formed three clusters. Contrary the Hierarchical Cluster Analysis here the program marked out three cluster central points. Each association was classified by the help of a distance function into the cluster having the closer central point. The classification can be seen in Table 15.

Table 15

Plant associations	Cluster
I3	1
I5	1
III3	1
IV2	1
IV3	1
IV5	1
V1	1
V4	1
V5	1
II1	2
II3	2
IV4	2
I1	3
I2	3
I4	3
I6	3
II2	3
III2	3
IV1	3
V2	3
V3	3

Grouping of the associations into clusters

Comparing Tables 14 and 15 we can see that this algorithm has classified the same associations into one cluster as the hierarchical method after the tenth connecting point.

Since both cluster analyses put the same associations into the same cluster, so one can state that the associations in each cluster are different from the associations of the other ones according to the coverage data of the plant families.

4.10. Possible changes in plant structure of the examined habitats, recommendable treatments from an environmental point of view

The most important expectable changes in the habitats are the worsening of the water balance, drying of the habitats and the spreading of invasive and other weed species that can have decisive impact to the plant structure.

From amongst the disadvantageous factors reflecting the present state of the habitats primarily the effects of **climate change** must be mentioned. The milder winters, the warmer summers and the in parallel observable precipitation deficiency decisively contribute to the expected transformation – drying out – of the habitats.

Because of the climate change more and more warm-season annual plant species appear in the whole region. For example in the adjacent sugar-beet, wheat and maize fields year by year the velvetleaf (*Abutilon theophrasti*) and rough cockleburr (*Xanthium strumarium*) infections are of growing significance. The presence of these weed species can be observed at the edges of the habitats, but in the habitats they can not settle thanks to the cutting done at the end of May or at the beginning of June. A cleaning cutting at the end of the summer would hinder the ripening of their seeds, so this application is justifiable in hindrance of degradation of the habitats. In the spreading of the invasive weed species the location of these natural or semi-natural habitats is of great role. They are surrounded by or adjacent to agricultural lands, from where fertilizers and other chemicals can infiltrate and this nutrient enrichment can also promote the spreading of weeds as well.

In my opinion in order to hinder shrubbing or afforestation in the second habitat, stalk cutting, cutting out or pulling out with roots of the *Eleagnus angustifolia* seedlings are recommendable.

Besides the climate change the **agricultural activities** in the neighbouring fields may also have effects to the habitat.

For maintenance of valuable grasslands, proper and regular utilisation is of basic importance. If it does not happen in this way the characteristics of the vegetation of the given grassland may gradually change, probably in an unfavourable way. Even in the case of unutilised grasslands, regular and rational grassland management is essential in order to avoid becoming weedy.

In summary we can state that the examined habitats the hierarchy and look of the associations reflect the habitats with similar characteristics of the Hortobágy. Although due to the agricultural activities the degradation of the associations can be considered significant. From the presence of character species and the number of endemic and protected species we can conclude that these habitats can fulfil a role of both refuge and buffer zone.

5. Results

I have stated that ***all these five habitats*** – that exist like small "islands" amongst the big agricultural plough-lands - ***are important elements of the ecological network***.

I have shown that besides the already protected first habitat (protected saline meadow) from the point of view of protected animals ***the second and the third habitats must be emphasised.*** These yet not protected habitats provide living space of such protected bird species as white stork, spoonbill, common heron, bittern and oriole as well as frog and snake species. The woody-bushy edges by the dams of Keleti – main canal give shelter for roe deer, rabbits, hedgehogs and cuckoos and the main canal itself functions as green corridor. In the other habitats irrigation canals can be found as well, which can be considered as green corridors too. Besides they can ease the isolation affects of the agricultural lands.

I have determined the following ***main environmental protection priorities*** that can be used for the examined habitats:

1. richness in species
2. richness of higher taxonomical units (families, genera)
3. endangered situation

I have shown that the ecological network must never be interpreted from the point of view of one emphasised species or population, but ***all living creatures living in natural conditions must be taken into consideration***. It means that maintenance and help of the dynamics of natural processes must be the main ordering principles.

I have pointed out that ***protection of*** natural and semi-natural ***habitats out of protected areas*** is of high importance. I have emphasised that ***it would be better to protect certain habitats rather*** than certain species since it better helps preserving biodiversity.

I have stated that a ***decrease of the isolation effect of agricultural surfaces*** with the establishment of the network of green corridors is very important even in the case of the given habitats.

I have pointed out how important it is ***to moderate*** or discontinue ***the effects of outer influences*** playing role in the degradation of the habitats.

I have pointed out that in the case of all habitats the ratio of hemicryptophyta species is the highest (32-46%), followed by the therophyta species (22-32%) that indicate the drying out of the habitats.

I have stated that in case of all five habitats the Eurasian flora elements are almost twice (43-52%) of the value characteristic to the Hungarian flora (22.5%). The ratio of the cosmopolitan species is quite high as well (20-29%) comparing to the value of the Hungarian flora (6.5%). This can be explained by the growing number of the warm-season annual weed species. But the percentage of the European elements is lower (9-16%) than of the Hungarian flora (20,4%).

As a result of the statistical analyses I have pointed out that number of species in case of all the five habitats extreme fluctuation characterizes the statistical universe.

As regards the average of the coverage it is the highest in case of the third habitat (degraded *Puccinellia* grassland), and the variational coefficient shows homogenity as well.

In examining the Shannon-value the average is the highest in case of the second habitat (*Alopecurus* meadow), and the statistical dispersion is the smallest. The variational coefficient shows medium variability.

The median of evenness is the lower in case of the third habitat (degraded *Puccinellia* meadow) and the statistical is the highest here as well**.**

I have done the Hierarchical and the K-Means Cluster Analyses for the 21 plant associations of the five habitats. Both cluster analyses put the same associations into the same cluster, so one can state that the associations in each cluster are different from the associations of the other ones according to the coverage data of the plant families.

6. Practical usefulness of the results

I have laid the fundamentals of a monitoring examination. I would like to survey these habitats regularly in order to see the changes in their species list, extent of their associations, etc. This takes a stand on the fact that for preserving biodiversity protection and rehabilitation of natural and semi-natural habitats situated out of the protected areas are necessary. I tried to emphasise that it would be better to protect rather certain habitats than certain species since it better helps to preserve biodiversity.

As a result of the regular and recurring examination experts may have get a more exact picture on the effects of climate change on semi-natural, disturbed habitats.

In summary, one of the most important preconditions for successful protection of the original state of habitats valuable from environmental protection point of view is to get to know the composition and structure of the plant associations of the given habitat. Thus we can conclude consequences on the botanical state, occasional degradation of the habitat or on the possible threatening factors.

7. Publications

Scientific studies in Hungarian: 1

TANYI,P -NYAKAS,A - K.SZABÓ, ZS - PECHMANN,I: Egy természetközeli, szikes rét botanikai állapotfelmérése, DE ATC Agrártudományi Közlemények, 2006/19. p.38. – 44.

Scientific studies in foreign languages: 3

TANYI,P – NYAKAS,A – K.SZABÓ,ZS: Botanical survey of a seminatural disturbed habitat. Natural Resources and Sustainable Agriculture, International Scientific Session, Oradea-Debrecen, University of Oradea Publishing House, 2005, p.339-345

TANYI,P - NYAKAS,A - K.SZABÓ ZS: A seminatural disturbed habitat and its threatening factors. Sustainable Agriculture Across Borders in Europe, Conference Proceedings, p. 267-270, Debrecen, 6 May, 2005

K.SZABÓ, ZS. – PAPP, M. - NYAKAS, A. - **TANYI, P**: Habitat dependant morphological variability of two *Poa* species. Natural Resources and Sustainable Agriculture, International Scientific Session, Oradea-Debrecen, University of Oradea Publishing House, 2005, p.163-172

Conferences in foreign languages (read by lectors): 4

PECHMANN,I.-TAMAS,J-**TANYI,P-**TOTH,T**:** (2003): Evaluation of agroecological buffer zones by hyperspectral and GIS methods in East-Hungary. (Előadás és összefoglaló). BES Annual Meeting 2003. 09.09.-09.11. Manchester Metropolitan University.

TANYI, P., PECHMANN I., NYAKAS A. (2003): Biodiversity studies in a semi-natural, disturbed habitat. (Poszter és összefoglaló) BES Annual Meeting 2003. 09.09.-09.11. Manchester Metropolitan University

TANYI,P - PECHMANN,I: Biodiversity studies in semi-natural disturbed habitats (Előadás és poszter), Faculty of Environmental Protection, Natural Resources and Sustainable Development Conference , summaries p.175, Oradea, 8-9 May, 2003

TANYI P. - K. SZABO, ZSUZSANNA: Comparison of seminatural disturbed habitats on the basis of their ecological features and threatening factors. 41st Croatian & 1st International Symposium on Agriculture in Opatija. (poszter és összefoglaló), 2006. 02.13.-17. Proceedings p. 499.

Conferences in Hungarian (read by lectors): 2

TANYI,P: Egy ecsetpázsitos rét botanikai állapotfelmérése. IV. Erdei Ferenc Konferencia, Kecskemét, 2007. augusztus 27.-28. (poszter és összefoglaló – accepted for publication)

TANYI,P: Egy fragmentált gyep botanikai állapotfelmérése. XLIX. Georgikon Napok, Keszthely 2007. szeptember 20.-21. (poszter és összefoglaló - accepted for publication).

Conferences in Hungarian (not read by lectors): 5

PECHMANN I., Tamás J., Katona Zs., Burai P., **Tanyi P.** (2003): Hiperspektrális technológiák alkalmazása a vegetáció-térképezésben. (Előadás). „A környezetállapot értékelés korszerű módszerei" tudományos konferencia, Gyöngyösoroszi

TANYI,P – NYAKAS,A – K. SZABÓ, ZS: Egy természetközeli bolygatott élőhely botanikai állapotfelmérése (poszter és összefoglaló), I. Magyar Tájökológiai Konferencia, Szirák, 2004. szeptember 17.-19. Összefoglaló: p.70

K. SZABÓ, ZS. – PAPP, M. - NYAKAS, A. - **TANYI, P**: Poa formák homoki élőhely nedvesség grádiense mentén (poszter és összefoglaló). I. Magyar Tájökológiai Konferencia, Szirák, 2004. szeptember 17.-19. Összefoglaló: p.71

TANYI,P: Egy hajdúsági rét botanikai állapotfelmérése. Aktuális Flóra- és Vegetációkutatás a Kárpát-medencében VII., 2006. 02.24.-26. (poszter és összefoglaló), KITAIBELIA, XI. évf. 1. szám, p. 82.

TANYI,P – K. SZABÓ, ZS - NYAKAS,A: Kultúrtájba ékelt természetközeli vegetációfoltok botanikai állapotfelmérése (poszter és összefoglaló). II. Magyar Tájökológiai Konferencia, Debrecen, 2006. április 7.-9. Összefoglaló: p.71

Other publications: 1

TANYI P.: „Lépegető kövek" a hálózatban. Cikk. Magyar Mezőgazdaság, 2006. május 24. 14.-15. p.