Verges as fragments of loess grasslands near Kondoros

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Loess vegetations of the Carpathian Basin have been ploughed for a thousand years. Therefore, in Hungary, it is also important to find out the composition of loess vegetation. Therefore, loess steppes of verges of the Transdanubia have nearly disappeared.

The extent of the loess bedrock and its vegetation were significant in the Pannonian area, but nowadays (Zólyomi, 1936, 1958; Zólyomi et al., 1997), they have been left in only fragments, mainly because of intensive agricultural activities and expansion of agricultural areas (Rákóczi and Barczi, 2014; Barczi et al., 2004a, b; Penksza et al., 2011; Deák et al., 2016a; Valkó et al., 2018). Therefore, the patches are very important, extending mainly over the central plain of the Pannonian area, but also spreading up to the foothills (Bíró et al., 2018; Penksza et al., 1994, 1996). Thus, several researchers have investigated these remnant vegetation patches in the central Carpathian Basin, Szerényi and Kalapos (2000), Csontos and Tamás (2007), Csontos et al., (2022). However, most of the studies were made in the Great Hungarian Plain, where the role of the Cumanian mounds was also significant from among the remnants. These patches of loess remnants are considered as hot spots for vegetation (Deák et al., 2016b, 2022; Dembicz et al., 2018, 2020). In addition, verges alongsideagricultural areas and roads, where the vegetation has been reduced, are also very important as relics of the former vegetation (Csathó, 2008, 2011; Szentes et al., 2022; Bajor et al., 2016).

The significance of these remnants has already drawn attention to the importance of conserving the unplowed land strips, earthen fortifications and earthworks and to the necessity of urgent action by Zólyomi (1958) in the last century in order to conserve vegetation of grasslands through the conservation, management such as grazing and mowing (Házi et al., 2011, 2012, 2022; Valkó et al., 2018; Herczeg, 2005; Herczeg et al., 2005). Kiss (1968) found a complex loess grassland at Tatársánc in the southern part of the east of the river Tisza. In spite of the research, these grasslands have disappeared without their values being known, and due to the missing management, invasive species can colonize and spread easily (Deák et al., 2015, 2017; Csontos et al., 2022).

Habitat loess and fragmentation are often coupled with additional effects such as agricultural activities (e.g., lawn breaking up, use of chemicals, water management) that lead to the degradation of the habitat (Deák et al., 2016a, b; Pándi et al., 2014; Szentes et al., 2007, 2009; Szabó et al., 2010, 2011; Horváth and Komarek, 2016).

However, the work of Deák et al. (2021a, b) reveals that kurgans have still a significant role in the conservation of species, which of traditional management can help to improve (Csathó, 2005, 2009; Kuussaari et al., 2009; Bagaria et al., 2015; Deák et al., 2017; Joanne et al., 2004; Yezzi et al., 2021).

Ecological behaviour and dynamics of species of habitats can also help to sustain the habitats because existence of ecologically variable species can form habitats, and to maintain their functional diversity, but degradation of habitat is possible too (Tóth, 1998, 1999, 2004; Tóth et al., 2019; Sudnik-Wójcikowska et al., 2011).

Csathó (2005, 2009, 2011) categorized verges based on their bordering objects and their origin. We can identify three types of verges: I. interspaced verges, II. border verges and III. periodic verges. Interspaced verges are between two objects (e.g., road-railway, canal-dirt road). Border verges are situated next to roads, railways, canals so on and so forth. Periodic verges are grass verges that are in direct contact with agricultural fields from both sides. He shows the impact on the quality of the grassland that is affected by activities in contact with the verges. He describes that the vegetation of the border verges has usually better condition than the vegetation of the periodic verges, which is damaged by leaching fertilizer. Furthermore, he categorizes the grasslands into two groups based on their origin. According to his opinion, it could be significant for their conservation value. Primary verges preserve traces of original loess vegetation.

Besides the vegetation of the Cumanian mounds, there were several research about ages and structure of their soils (Barczi et al., 2004a, b, 2012; Penksza et al., 2011). Soil and botanical studies help to understand the history of vegetation, too. Knowledge of the current condition and development of vegetation, which is related to soil processes, can provide much help. A detailed botanical survey was carried out on the area of the Csípő mound in the Hortobágy area (Barczi et al., 2004a, b) and Csípő mound (Vona and Penksza, 2004). Verges and remnants of loess grassland are also important for their economic utilization, Kiss and Penksza (2018) and Kiss et al. (2008, 2011) have investigated this and provided data for changes of vegetation of grazed grasslands (Török et al., 2016, 2018). Nagy and Penksza (2006, 2007), Nagy et al. (2007) carried out mapping of habitats.

The aims of this study were to date the age of the sample verges and explore types of verges. Is there a correlation between the types, location, expanse and vegetation types of the verges? Which of the

coenologically important species of the genus *Festuca* occur in the verges and patches of loess grassland?

In the study of the vegetation of the verges, grasses are characteristic of the verges, as many of them are dominant, among them the taxonomically was problematic for identification, and that was the genus *Festuca*, which includes dominant and characteristic species on loess associations (Szentes et al., 2022). Therefore, taxonomic analysis of the species of this genus was also carried out. During this study, taxa with a transitional sclerenchyma form were also found in the area, which could be observed in species with a bundle sclerenchyma [54,55]. The Festuca javorkae, which was related to Festuca rupicola, could also be problematic, although this species was clarified (Penksza, 2000a, b, 2009, 2019, 2020; Penksza et al., 2019, 2020; Markgraf-Dannenberg, 1980) and its species differentiation was shown using molecular studies by Bauer et al. (2003) and Galli et al. (2006).

In this work, the main question was: is there a probability of developing original loess species and vegetation on the grassland remnants, verges? Based on these, the detailed questions and objectives: Is there a correlation between the different ages of the verges (documented based on maps) and the patches of remnant vegetation that have developed on them, and whether the older ones are more valuable? Is there a correlation between the types, location, expanse and vegetation types of the verges?

Our surveys were carried out in central lowland area of the Carpathian Basin, in Békés county, beside Kondoros. According to the landscape geography classification, the settlement is part of the Békés Plain. Overall, 41 blocks of verges were separated and surveyed in the area. A section extended until it was interrupted by a perpendicular dirt road or until it was ploughed away. Based on the supplemented list of species in the verges paths and the recorded species in the coenological surveys, the degree of degradation of each quadrat was given using the nature conservation value categories (TVK), according to Simon (2000).

Coenological surveys on the plots of verges were carried out in 2×2 m quadrats, of which were surveyed in each plot along 50 m transects, marked at every 10 m from the centre of the verges towards the two ends. Quadrats were made according to the method of Braun-Blanquet (1964), but coverage was given in percentage. The loess species according to category of 5.3 of the Horváth et al. (1995) database because loess species belong to constant species, and within this category they are diagnostic species of loess grasslands. Species names are given according to the nomenclature of Király (2009) and Engloner et al. (2001).

According to the first military survey map (http1) the area of Kondoros was a contiguous grassland in the first half of the 19th century. The distribution of the five most and five least loess species of the verges according to their TVK values. It can be seen easily that the number of loess species represents the natural condition and degradation of the vegetation: the verges with more loess species indicate better natural conditions. Nevertheless, due to intensive anthropogenic effects on nature (based on examined military survey maps and current agricultural activities), it also shows that even in the most valuable verges according to these criteria, the number of weed species are significant, and even among the natural condition indicative species including unique species, specially protected species, protected species, constant species, accompanying species, pioneers; and the disturbance-tolerant species are dominant.

Based on the coenological data, there were two types of verges, which were the interspaced verge and the border verge, but within these there was a wide one, which was wider than 5 m, and a narrow one, which was narrower than 5 m. These coenological data were used to generate the classification analysis. In the results, these data were well distinguished. Data of 14 quadrats of interspaced verges could be characterized clearly, although data of 2 quadrats of interspaced verges can be found in this clade, but their features similar to wide border verge, clade II. Species from clade III were the most uniform. The number of species was highest in the type I, the interspaced verge (between 80 and 95), compared to surveys of the wide border verge (between 60 and 70) and the narrow verge (between 40 and 45). Based on the diversity assessment from the survey, data of the interspaced verge showed the highest diversity value. The least diverse was the data of the type of the narrow verge with the highest number of species in this verge type. Festuca rupicola is a dominant grassland species on the loess grasslands (Salvio nemorosae-Festucetum rupicolae) and it is the namesake species of the association. Another verge with good natural condition is, which is situated along the railway line. This verge is 120 years old; it must be secondary in origin. In contrast, it has the best values for numerous indicators of all the studied verges. It is one of the widest verges, it is an interspaced verge that does not contact the farmland and so is not affected by negative impacts.

***Keywords**:* South Transdanubia; loess verges; natural condition; Festuca rupicola

REFERENCE

Bagaria, G.-Helm, A.-Rod`a, F.-Pino, J. (2015): Assessing coexisting plant extinction debt and colonization credit in a grassland-forest change gradient. Oecologia 179: 823-834.

Bajor, Z.-Zimmermann, Z.-Szabó, G.-Fehér, Zs.-Járdi, I.-Lampert, R.-Kerény-Nagy, V.-Penksza, P.-L Szabó, Zs.-Székely, Zs.-Wichmann, B.-Penksza, K. (2016): Effect of conservation management practices on sand grassland vegetation in Budapest, Hungary. Applied Ecology and Environmental Research 14 (3): 233-247.

Barczi A.-Penksza K.-Joó K. (2004a): Alföldi kunhalmok talaj-növény összefüggés-vizsgálata. Agrokémia Talajt. 53: 3-16.

Barczi, A.-Penksza, K.-Joó, K. (2004b): Reseach of soil-plant connections on Kurgans in Hungary. Ekológia (Bratislava) 23: 15-22.

Barczi A.-Joó K.-Penksza K.-Pető Á. (2012): Egykori és mai tájfejlődés vizsgálata kunhalmok talajtani és botanikai vizsgálatai segítségével a Csípő-halom példáján. In: Farsang A.-Mucsi L.-Keveyné Bárány I. (szerk.): Táj- Érték, lépték, változás. GeoLitera pp. 171-180.

Bauer L.-Galli Z.-Penksza K.-Engloner A.-Szerdahelyi T.-Kiss E.-Heszky L. (2003): Morfológiai és molekuláris taxonómiai vizsgálatok kárpát-medencei *Festuca* fajokon. In Kárpát-Medencei Biológiai Szimpózium, Budapest III: 33-37.

Biró, M.-Bölöni, J.-Molnár, Z. (2018): Use of long-term data to evaluate loss and endangerment status of Natura 2000 habitats and effects of protected areas. Conserv. Biol. 3: 660-671.

Braun-Blanquet, J. (1964): Pflanzensoziologie; Wien: New York, NY, USA, pp. 2-865.

Csathó A. I. (2005): A mezsgyék természetvédelmi jelentősége az Alföld löszvidékein. Tájökológiai Lapok 3: 363-364.

Csathó A. I. (2008): Mezsgyék kutatása a Körös-Maros Nemzeti Park Igazgatóság működési területén. In Kutatási Jelentés; KMNPI: Szarvas, Hungary

Csathó A. I. (2009): Előzetes javaslatok a mezsgyék mintavételezéséhez. In Magyar Ökológus Kongresszus, Előadások és poszterek összefoglalói; Szeged, MÖK, Hungary, 8: 41.

Csathó A. I. (2011): Az elsődleges és másodlagos mezsgyék növényzetének összehasonlító vizsgálata a battonyai Gránic és Csárda-dűlő példáján. Tájökológiai Lapok 9: 345-356.

Csontos P.-Tamás J. (2007): Fás mezsgyék növényzetének vizsgálata a Balaton-felvidéken. Acta Agron. Ovariensis 49: 3-13.

Csontos, P.-Tamás, J.-Kovács, Zs.-Schellenberger, J.-Penksza, K.-Szili-Kovács, T.-Kalapos, T. (2022): Vegetation dynamics in a loess grassland: plant traits indicate stability based on species presence, but directional change when cover is considered. Plant-Basel 11: 6 Paper: 763.

Deák, B.-Valkó, O.-Török, P.-Kelemen, A.-Miglécz, T.-Szabó, S.-Szabó, G.-Tóthmérész, B. (2015): Micro-topographic heterogeneity increases plant diversity in old stages of restored grasslands. Basic Appl. Ecol. 16: 291-299. https://doi.org/10.1016/j.baae.2015.02.008

Deák, B.-Tóthmérész, B.-Valkó, O.-Sudnik-Wójcikowska, B.-Bragina, T. M.-Moysiyenko, I.-Bragina, T. M.-Apostolova, I.-Dembicz, I.-Bykov, N. I.-et al. (2016a): Cultural monuments and nature conservation: The role of kurgans in maintaining steppe vegetation. Biodivers. Conserv. 25: 2473-2490.

Deák, B.-Valkó, O.-Török, P.-Tóthmérész, B. (2016b): Factors threatening grassland specialist plants. A multi-proxy study on the vegetation of isolated grasslands. Biol. Conserv. 204: 255-262.

Deák, B.-Tölgyesi, C.-Kelemen, A.-Bátori, Z.-Gallé, R.-Bragina, T. M.-Abil, Y. A.-Valkó, O. (2017): The effects of micro-habitats and grazing intensity on the vegetation of burial mounds in the kazakh steppes. Plant Ecol. Divers. 10: 509-520.

Deák, B.-Bede, Á.-Rádai, Z.-Tóthmérész, B.-Török, P.-Torma, A.-Lőrinczi, G.-Nagy, A.-Mizser, S.-Kelemen, A.-Valkó, O. (2021a): Different extinction debts among plants and arthropods after loss of grassland amount and connectivity. Biol. Conserv. 264, 109372

Deák, B.-Rádai, Z.-Bátori, Z.-Kelemen, A.-Lukács, K.-Kiss, R.-Mák, E. I.-Valkó, O. (2021b): Ancient burial mounds provide safe havens for grassland specialist plants in transformed landscapes. A trait-based analysis. Front. Ecol. Evol. 9., 619812

Deák, B.-Valkó, O.-Nagy, D. D.-Török, P.-Torma, A.-Lőrinczi, G.-Kelemen, A.-Nagy, A.-Bede, A.-Mizser, S.-et al. (2022): Habitat islands outside nature reserves. Threatened biodiversity hotspots of grassland specialist plant and arthropod species. Biol. Conserv. 241, 108254 https://doi.org/10.1016/j.biocon.2019.108254

Dembicz, I.-Szczeparska, L.-Moysiyenko, I. I.-Wódkiewicz, M. (2018): High genetic diversity in fragmented Iris pumila L. populations in Ukrainian steppe enclaves. Basic Appl. Ecol. 28: 37-47. https://doi.org/10.1016/j.baae.2018.02.009

Dembicz, I.-Moysiyenko, I. I.-Kozub, L.-Dengler, J.-Zakharova, M.-Sudnik-Wójcikowska, B. (2020): Steppe islands in a sea of fields: Where island biogeography meets the reality of a severely transformed landscape. J. Veg. Sci. 21, e12930, 10.1111/jvs.12930

Engloner A.-Penksza K.-Szerdahelyi T. (2001): A hajtásos növények ismerete. Egyetemi és Főiskolai tankönyv. Nemzeti Tankönyvkiadó, pp. 268.

Galli, Z.-Penksza, K.-Kiss, E.-Sági, L.-Heszky, L. E. (2006): Low variability of Internal Transcribed Spacer rDNA and trnL (UAA) intron sequences of several taxa in the Festuca ovina aggregate (Poaceae)

Házi, J.-Bartha, S.-Szentes, Sz.-Penksza, K. (2011): Seminatural grassland management by mowing of Calamagrostis epigejos in Hungary. Plant Biosystem 145(3): 699-707.

Házi, J.-Penksza, K.-Bartha, S.-Hufnagel, L.-Tóth, A.-Gyuricza, Cs.-Szentes, Sz. (2012): Cut mowing and grazing Effects with grey cattle on plant species composition in case of Pannon wet grasslands. Applied Ecology and Environmental Research 10(3): 223-231.

Házi, J.-Penksza, K.-Barczi, A.-Szentes, S.-Pápay, G. (2022): Effects of Long-Term Mowing on Biomass Composition in Pannonian Dry Grasslands. AGRONOMY 12: 5 p. 1107

Herczeg E. (2005): Botanikai vizsgálatok kunhalmok Dél-tiszántúli löszgyepein. Kanitzia 13: 45-54.

Herczeg E.-Pottyondy Á.-Penksza K. (2005): Cönológiai vizsgálatok eltérő gazdálkodású dél-tiszántúli löszgyepekben. Tájökológiai Lapok 3: 259-265.

Horváth J.-Komarek L. (2016): A világ mezőgazdaságának fejlődési tendenciái. SZTE-MGK, Hódmezővásárhely. 270 p

Horváth F.-Dobolyi Z. K.-Morschhauser T.-Lőkös L.-Karas L.-Szerdahelyi T. (1995): FLÓRA adatbázis 1.2. Taxonlista és attribútum-állomány. In FLÓRA Munkacsoport; MTA-ÖBKI; MTM Növénytára: Vácrátót, Hungary

Joanne Clavel, J.-Julliard, R.-Devictor, V. (2004): Worldwide decline of specialist species: Toward a global functional homogenization? Front. Ecol. Env. 9: 222-228.

Király G. (ed.) (2009): Új Magyar Füvészkönyv. Magyarország Hajtásos Növényei. Határozókulcsok; Aggteleki Nemzeti Park Igazgatóság: Jósvafő, Hungary, pp. 3-456.

Kiss I. (1968): Ősgyep-maradvány az orosházi Nagytatársáncon. Acta Acad. Paedagog. Szeged. 2: 39-61.

Kiss T.-Penksza K. (2018): A legeltetés hosszú távú hatása kiskunsági füves pusztákon. Természetvédelmi Közlemények 24: 104-113.

Kiss T.-Penksza K.-Tasi J.-Szentes S. (2008): Juh- és marhalegelő cönológia és gyepgazdálkodási vizsgálata kiskunsági területeken. Gyepgazdálkodási Közlemények 6: 39-45.

Kiss, T.-Lévai, P.-Ferencz, Á.-Szentes, Sz.-Hufnagel, L.-Nagy, A.-Balogh, Á.-Pintér, O.-Saláta, D.-Házi, J.-Tóth, A.-Wichmann, B.-Penksza, K. (2011): Change of composition and diversity of species and grassland management between different grazing intensity. In Pannonian dry and wet grasslands. Appl. Ecol. Environ. Res. 9: 197-230.

Kuussaari, M.-Bommarco, R.-Risto, K.-Heikkinen, R.-Helm, A.-Krauss, J.-Lindborg, R.-Öckinger, E.-Pärtel, M.-Pino, J.-et al. (2009): Extinction debt: A challenge for biodiversity conservation. Trends Ecol. Evol. 24: 564-571.

Markgraf-Dannenberg, I. (1980): 'Festuca L.'. In Flora Europaea; Tutin, T. G.-Heywood, V. H.-Burges, N. A.-Moore, D. M.-Valentine, D. H.-Walters, S. M.-Webb, D. A. (Eds.) Cambridge University Press: Cambridge, UK, Volume 5, pp. 125-153.

Nagy A.-Penksza K. (2006): Élőhely-értékelési lehetőségek dél-tiszántúli és veresegyházi területeken természetességi mutatók alapján. Tájökológiai Lapok 4: 115-125.

Nagy A.-Penksza K. A (2007): Vésztő-Mágor Természetvédelmi Terület élőhelytérképe, és környezetgazdálkodási-természetvédelmi értékelési lehetősége. Tájökológiai Lapok 5: 103-116.

Nagy A.-Penksza, K.-Laborczi A.-Kiss T. (2007): Habitat mapping of Vésztő-Mágorpuszta (South-East Hungary) protected natural area. Lucr. Ştiinţifice 9: 125-132.

Pándi, I.-Penksza, K.-Botta-Dukát, Z.-Kröel-Dulay, Gy. (2014): People move but cultivated plants stay: abandoned farmsteads support the persistence and spread of alien plants. Biodiversity and Conservation 23(5): 1289-1302.

Penksza, K. (2000a): Die Koerrektur der histologischen Beschreibung von Festuca javorkae von Májovszky im Jahre 1962, und Angaben zum Vorkommnis der Art in Ungarn. Ber. Inst. Landsch.-Pflanz. Univ. Hohenh. 10: 49-54.

Penksza K. (2000b): A Festuca javorkae Májovský és a Festuca wagneri Degen, Thaisz et Flatt jellemzése és a Festuca ovina-csoport határozókulcsa. Kitaibelia 5: 275-278.

Penksza K. (2009): Poa – Perje. In: Király G. (szerk.): Új magyar füvészkönyv. pp. 510-511.

Penksza K. (2019): Kiegészítések a hazai Festuca taxonok ismeretéhez I. (A Festuca psammophila series Festuca vaginata alakkörei). Botanikai Közlemények 106(1): 65-70.

Penksza K.-Morschhauser T.-Horváth F.-Asztalos J. (1994): A Kétágú-hegy vegetációtérképe. Bot. Közlem. 81: 157-164.

Penksza K.-Káder F.-Benyovszky B. M. (1996): Vegetációtanulmány a Balatonalmádi (Vörösberény) melletti Megye-hegyröl. Bot. Közlem. 83: 77-90.

Penksza K.-Tasi J.-Szentes Sz. (2007): Eltérő hasznosítású Dunántúli középhegységi gyepek takarmányértékeinek változása. Gyepgazdálkodási Közlemények 5: 1-8.

Penksza, K.-Loksa, G.-Barczi, A.-Joó, K.-Malatinszky, Á. (2011): Effects of extrazonal and climatic conditions on the vegetation of kurgans. A pilot study from the Hortobágy (Csípő-halom). In Kurgan studies: An Environmental and Archaeological Multiproxy Study of Burial Mounds in the Eurasian Steppe Zone; Pető, Á.-Barczi, A. (Eds.); BAR International Series: Oxford, UK, pp. 347-350.

Penksza, K.-Szabó, G.-Zimmermann, Z.-Lisztes-Szabó, Z.-Pápay, G.-Járdi, I.-Fűrész, A.-S-Falusi, E. (2019): The taxonomic problems of the Festuca vaginata agg. and their coenosystematic aspects. Georg. Agric. 23: 63-76.

Penksza, K.-Csík, A.-Filep, A. F.-Saláta, D.-Pápay, G.-Kovács, L.-Varga, K.-Pauk, J.-Lantos, C.-Lisztes-Szabó, Z. (2020): Possibilities of Speciation in the Central Sandy Steppe, Woody Steppe Area of the Carpathian Basin through the Example of Festuca Taxa. Forests 11, 1325-1327.

Rákóczi, A.-Barczi, A. (2014): Protected landscape elements in the European Union, the influence of EC decree 73/2009 on the condition of Hungarian mounds. Tájökológiai Lapok 12: 95-105.

Simon T. (2000): A Magyarországi Edényes Flóra Határozója; Tankönyvkiadó: Budapest

Sudnik-Wójcikowska, B.-Moysiyenko, I. I.-Zachwatowicz, M.-Jabłońska, E. (2011): The value and need for protection of kurgan flora in the anthropogenic landscape of steppe zone in Ukraine. Plant Biosyst 145: 638-653.

Szabó G.-Zimmermann Z.-Szentes Sz.-Sutyinszki Zs.-Penksza K. (2010): Természetvédelmi és gyepgazdálkodási vizsgálatok a Dinnyési, Fertő gyepeiben. Gyepgazdálkodási Közlemények, 8: 31-38.

Szabó G.-Zimmermann Z.-Bartha S.-Szentes Sz.-Sutyinszki Zs.-Penksza K. (2011): Botanikai, természetvédelmi és gyepgazdálkodási vizsgálatok Balaton-felvidéki szarvasmarha-legelőkön. Tájökológiai Lapok 9(2): 431-440.

Szentes, Sz.-Kenéz, Á.-Saláta, D.-Szabó, M.-Penksza, K. (2007): Comparative researches and evaluations on grassland manegament and nature conservation in natural grasslands of the Transdanubian mountain range. Cereal Research Communications 35: 1161-1164.

Szentes Sz.-Wichmann B.-Házi J.-Tasi J.-Penksza K. (2009): Vegetáció és gyep produkció havi változása badacsonytördemici szürkemarha legelőkön és kaszálón. Tájökológiai Lapok 7(2): 319-328.

Szentes, Sz.-Sutyinszki, Zs.-Kiss, T.-Fűrész, A.-Saláta, D.-Harkányiné Székely, Zs.-Penksza, K. (2022): Verges as Fragments of Loess Grasslands in the Carpathian Basin and Their Festuca Species. Diversity, 14, 510. https://doi.org/10.3390/d14070510

Szerényi J.-Kalapos, T. (2000): Löszpusztai vegetáció maradványai az Érd-százhalombattai Sánc-hegyen. In Proceedings of the Lippay János. Vas Károly Tudományos Ülésszak, Szt. István Egyetem, Budapest, Hungary, 6-7 November 2000.

Török, P.-Valkó, O.-Deák, B.-Kelemen, A.-Tóth, E.-Tóthmérész, B. (2016): Managing for composition or species diversity? Pastoral and year-round grazing systems in alkali grasslands. Agric. Ecosyst. Environ. 234: 23-30.

Török, P.-Penksza, K.-Tóth, E.-Kelemen, A.-Sonkoly, J.-Tóthmérész, B. (2018): Vegetation type and grazing intensity jointly shape grazing on grassland biodiversity. Ecol. Evol. 8: 10326-10335.

Tóth A. (1998): Veszélyeztetett löszgyep reliktum foltok a nagykunsági halmokon. Kitaibelia 3: 329-330.

Tóth A. (szerk.) (1999): Kunhalmok. Alföldkutatásért Alapítvány Kiadványa, Kisújszállás

Tóth A. (2004): A kunhalom-kérdésről. In A kunhalmokról más szemmel; Tóth A. (Ed.); Alföldkutatásért Alapítvány: Kisújszállás-Debrecen, Hungary, pp. 7-12.

Tóth, C. A.-Deák, B.-Nyilas, I.-Bertalan, L.-Valkó, O.-Novák, T. (2019): Iron age burial mounds as refugia for steppe specialist plants and invertebrates. Case study from the Zsolca mounds (NE Hungary). Hacquetia 18: 195-206. https://doi.org/10.2478/hacq-2019-0009

Valkó, O.-Tóth, K.-Kelemen, A.-Miglécz, T.-Sonkoly, J.-Tóthmérész, B.-Török, P.-Deák, B. (2018): Cultural heritage and biodiversity conservation. Plant introduction and practical restoration on ancient burial mounds. Nat. Conserv. 24: 65-80. https://doi.org/10.3897/ natureconservation.24.20019

Vona M.-Penksza K. (2004): A szentesi Kántor-halom vegetációjának változása és ennek összefüggése a talaj vízháztartásával. Tájökológiai Lapok 2: 341-348.

Yezzi, A.-Nebbia, A.-Zalba, S. (2021): Fragmentation of Coastal Grasslands by Plantations and Spontaneous Spread of Invasive Pines in the Southern Pampa. Diversity 13: 637. https://doi.org/10.3390/d13120637

Zólyomi, B. (1936): Übersicht der Felsenvegetation in der Pannonischen Florenprovinz und dem Nordwestlich Angrenzenden Gebiete. Ann. Hist.-Nat. Mus. Nat. Hung. 32: 136-174.

Zólyomi B. (1958): Fitocönológiai analízis az alföldi löszhátak eredeti növénytakarójának maradványain. A II. Biol. Vándorgy. ea-inak ism. Szeged, V. 19.-21.

Zólyomi, B.-Kéri, M.-Horváth, F. (1997): Spatial and temporal changes in the frequency of climatic year types in the Carpathian Basin. Coenoses 12: 33-41.

http1://maps.arcanum.com/hu/map/firstsurvey-lower-austria/?bbox=1859421.4186977376%2C6117715.954432676%2C1962534.9698544405%2C6155399.409377268&map-list=1&layers=151 (accessed on: 02.05.2022.)