

NEW LOCALITY OF *LEPIDIUM CARTILAGINEUM* IN THE HORTOBÁGY REGION (EAST HUNGARY)

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Abstract: A new locality of the halophyte *Lepidium cartilagineum* (J. C. Mayer) Thell. (*Brassicaceae*) was recorded at the eastern margin of the Hortobágy region, at Nagyhegyes. Despite the fact that the species is not rare in saline steppes in Hungary, it occurs exclusively on solonchak soils. The soil of the one previously documented location at Hortobágy region is not typical solonetz, with transitional solonchak characteristics. The locality found at 'Sirály-rét' (Elep, Nagyhegyes) is in a typical alkaline grassland, where the species grows in *Puccinellietum limosae* and transitional *Camphorosmetum annuae* communities. This contribution also includes 14 phytocoenological relevés taken at the locality and a comparison of the two, so far documented locations in the region. The author takes the position that this occurrence is to be regarded as native, mostly based on the habitat specifications (such as developed berm formations), vegetation structure and species composition. The continuity of the grassland patch is also proved by available historical maps and aerial photographs.

Keywords: Brassicaceae, distribution, flora mapping, alkalic vegetation, habitat preference

INTRODUCTION

Halophytic and sub-halophytic habitats are among the most characteristic and hence unique vegetation types of the Pannonian Basin (Fekete and Varga 2006, Molnár 2008, Fekete *et al.* 2011). Generations of naturalists and pedologists have studied the saline landscapes in the Pannonian Basin, which presently cover nearly 400000 hectares in Hungary (Molnár and Borhidi 2003, Tóth and Szendrei 2006). The soil – plant relationship is extraordinarily significant and based on the microrelief conditions clear vegetation units (alliances and associations) can be described (Bodrogekőzy 1965, Tóth 2011, Borhidi *et al.* 2012). Recently, the species composition of alkalic grasslands has also been studied on a larger

geographical scale in a South-East European context (Eliáš *et al.* 2013, Stevanović *et al.* 2016). The distribution of typical halophytes is mainly determined by the soil type. In accordance with the main alkalic soil types (solonetz and solonchak) the vegetation and the distribution of the diagnostic species of the vegetation units show significant differentiation. Rapaics (1930) was the first who described this phenomenon – calling it the ‘Újszász–Szeged dividing line’ –, presenting distribution maps for 11 alkalic plants. Recent floristic surveys have also proved the existence of this border line, interpreted mostly as a transition zone. The present expansion of maritime and continental salt-tolerant plants is also noteworthy in Central Europe (e.g. *Limonium gmelini* (Hohla *et al.* 2015, Kocián 2016), *Colchlearia danica* (Fekete *et al.* 2018), *Spergularia* species (Schmidt *et al.* 2018, Kúr *et al.* 2018), *Plantago coronopus* (Schmidt *et al.* 2016)). This process is man-derived through transport and the development of new constructed landscape elements such as highways.

The case of *Lepidium cartilagineum* (J. C. Mayer) Thell. is slightly different. It is a characteristic species of sand based solonchak alkalic vegetation and a surprisingly new location was found in a natural habitat in the Hortobágy (Novák and Matus 2000). In this paper the author presents the second occurrence of this species in the region, found at Nagyhegyes (East Hungary).

Lepidium cartilagineum belongs to the *Lepidium* genus, *Lepidieae* DC tribe of the *Brassicaceae* family (Al-Shehbaz *et al.* 2006). It is regarded as a Eurasian halophyte species ranging from Western Siberia to the Pannonian Basin (Meusel 1965). As far as we know, the westernmost occurrence is at Neusiedler See (or Lake Fertő) in Burgenland, Austria (Csapody 1965, Fischer and Fally 2006). The species now only occurs on the Austrian side of the lake (Király and Takács 2020). The eastern range of the species is still data deficient, although several current sources have proved its occurrences in Ukraine (Ilyinska 2014), Turkey (Bona 2012, 2014), Russia (German 2008, 2012, Dorofeyev 2018), Pakistan (Khan and Qaiser 2006) and even in China (Kefu *et al.* 2002). The taxonomic separation of the western populations of its area is not evident, the taxon here is described as “*L. crassifolium*” by Waldstein and Kitaibel (1799) from Fejér County (“*Crescit in locis salsis siccis sterilissimis Comitatus Albensis solo instar lapidis duro in quo praeter novam Camphorosmas speciem fere nullum aliud vegetabile*

crescit.”). This name is treated now mostly as a synonym of *L. cartilagineum* or mentioned only as a subspecies rank in *L. cartilagineum* subsp. *crassifolium* (Waldst. & Kit.) Thell. (Marhold in EURO+MED 2011). Some authors regard the species as a Pannonic (sub)endemic species (Soó 1964, Novák and Matus 2000).

The distribution of the species in the Carpathian Basin is well-known (Bartha *et al.* 2015). It is known in all microregions on lowlands where solonchak alkalic soils are present. In the *Eupannonicum* flora region it occurs in the Kiskunság, on the Solti- and Csepel Plain and on the Lower Tisza Plain. The Mezőföld landscape unit belongs to the *Colocense* flora region, where the species also occurs. Occurrences are also documented from the *Crisicum* flora region, especially from its western margin (e.g. Tápió region, Hatvan Plain and Jászság). East of the Tisza river, where the solonetz soil becomes predominant in alkalic steppes, it had no confirmed occurrence before a single population in Hortobágy was discovered by Novák and Matus (2000). One additional report is known close to Debrecen (Lesku and Molnár 2007), but this stand of *L. cartilagineum* was not yet confirmed according to the last years' inventories (Lesku *pers. comm.*). Nowadays *L. cartilagineum* occurs in 124 flora-mapping grids according to the online version of the *Atlas Flora Hungariae* (<http://floraatlasz.uni-sopron.hu/>, accessed 20.10.2020).

The objective of this study is to present the newly discovered locality of *L. cartilagineum* in the Hortobágy region, with special attention on its habitat preference.

MATERIALS AND METHODS

For describing the habitat conditions of the newly discovered locality, 14 phytosociological relevés were taken, using the Central-European Phytosociological School method (Braun-Blanquet 1932). I sampled only such vegetation patches where *L. cartilagineum* covers at least 15% of the relevé size (which was 1 square meter). I presented percentage of cover data for the vascular plant species. Nomenclature of flowering plants is according to Király (2009). Nomenclature of plant syntaxa follows Borhidi *et al.* (2012). Geo-coordinates of the locality and the relevés were determined using a Spectra MobileMapper GPS device and converted to WGS-84 projection. The distribution map (*Figure 1*) was prepared in the

ArcGIS 10.1 software environment. The grid numbering of the location follows the codes of the Central European Flora-mapping Project (Niklfeld 1971, Király 2003). The voucher specimen is deposited in the Herbarium Carpato-Pannonicum collection of the Hungarian Natural History Museum, Budapest (ID number: HNHM-TRA 00127570).

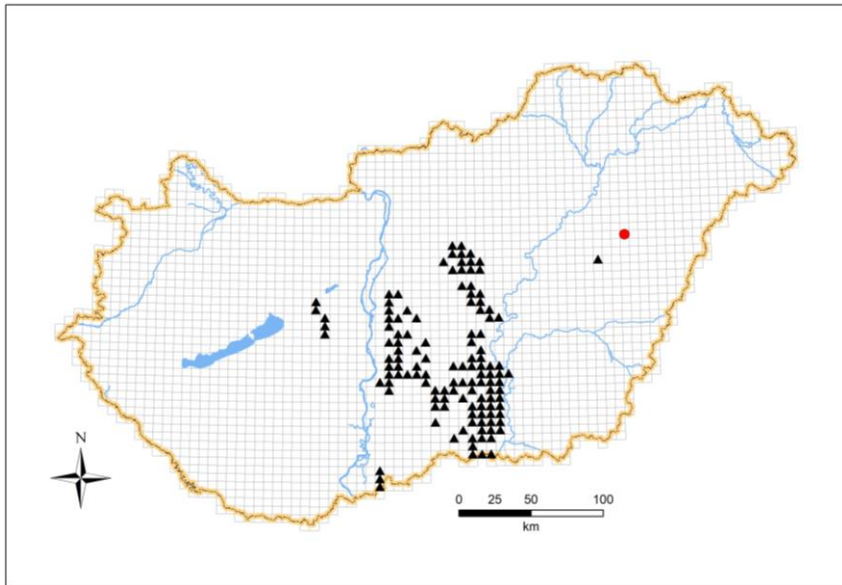


Figure 1. Present distribution of *Lepidium cartilagineum* in Hungary (red dot is the new locality presented in this paper).

RESULTS AND DISCUSSION

Discovery of the new locality of *Lepidium cartilagineum* in the Hortobágy region

On 21st May 2018 in the framework of the Land Use / Cover Area frame statistical Survey (LUCAS, Sutcliffe *et al.* 2019) I visited a location in Nagyhegyes municipality (reference of the LUCAS point is 51702776). A strong population of *L. cartilagineum* in a late flowering state was detected on a saline steppe at the LUCAS sampling point and in its surroundings. The site was revisited on 26th of May 2018 in order to (i) estimate the population size (incl. individual number and cover of the patches with *L. cartilagineum*) and (ii) record phytosociological relevés with the species studied.

The location is situated in ‘Sirály-rét’ at Nagyhegyes municipality in the border strip of two landscape units, the Hortobágy and the Hajdúság (centroid coordinates: N47,511870° and E21,314040°; altitude: 89 metres a.s.l.; CEU grid code: 8493/4). The broader toponym of the place is Elep (or Elep-puszta). The landscape pattern is rather mosaic here, both natural (e.g. alkaline grasslands, wetlands, scattered forests) and anthropogenic habitats occur (e.g. arable fields, abandoned livestock barns and farmsteads, forest plantations, fishponds and linear objects such as canals and asphalt roads). The line of the Keleti-főcsatorna (‘Main Eastern Canal’) is a remarkable landscape element here, lying approx. 600 metres eastwards from the locality. Nagyhegyes municipality (Hajdú-Bihar County) is situated approx. 3.5 kilometres north-east from the site. I found an estimated 5500 individuals occurring in a rather restricted, circa one-hectare large area.

Habitat characterisation of the locality

The Hortobágy (Middle Tisza region on the Great Hungarian Plain) is the largest coherent occurrence of an alkali habitat type in Europe, covering an area of ca. 2300 km² (Sümegei *et al.* 2013). Its geographical features, paleoecology, land-use history and diverse flora and vegetation and ethnobotany have been studied by several authors (e.g. Rapaics 1916, Soó 1934, Bodrogekőzy 1965, Szujkó-Lacza *et al.* 1982, Molnár 2009, 2013, Novák 2010, Sümegei *et al.* 2013). The continuous cover grasslands (‘steppes’) disintegrates at the eastern edge of the Hortobágy towards to Hajdúság and a mosaic landscape feature becomes predominant.

The habitat of *L. cartilagineum* is situated in an alkaline grassland, traditionally managed by sheep grazing. The extent of the grassland has fluctuated according to the available historical maps and aerial photographs (Figure 2). Nowadays it covers approx. 200 hectares. The grassland patch can be divided into two parts, differing in land-use history, microtopology and, consequently, vegetation. The western part of the grassland was formerly used for rice production, and the former irrigation dykes are still recognisable from terrain and aerial photos. In the communist era, in the 1950’s, rice cultivation was forcibly developed especially in the Hortobágy region, where numerous irrigation channels and fishponds were created (Penyige 1962, Hajdú 2006). At that time, the farmsteads around Elep functioned as labour camps. The surface here is very

flat, and is poor in microforms due to former rice cultivation, which was abandoned in the 1980's. The most frequent plant associations here are the *Achillea* alkalic steppes (*Achilleo setaceae-Festucetum pseudovinae* Soó (1933) 1947 corr. Borhidi 1996) and degraded loess grasslands (*Cynodonti-Poëtum angustifoliae* Rapaics ex Soó 1957). In gentle depressions alkali wet meadows (mainly *Agrostio stoloniferae-Alopecuretum pratensis* Soó 1933 association) also occur. The eastern part of the grassland forms a narrow border zone where typical salt berm formations ('padkás szik', according to Tóth *et al.* 2015) are significant. *L. cartilagineum* occurs only in this part of the grassland, where typical alkaline vegetation zonation is developed. Suitable habitats with salt berms ('szik padka') and blind-szik ('vakszik') for eu-halopytes cover maximum one hectare.

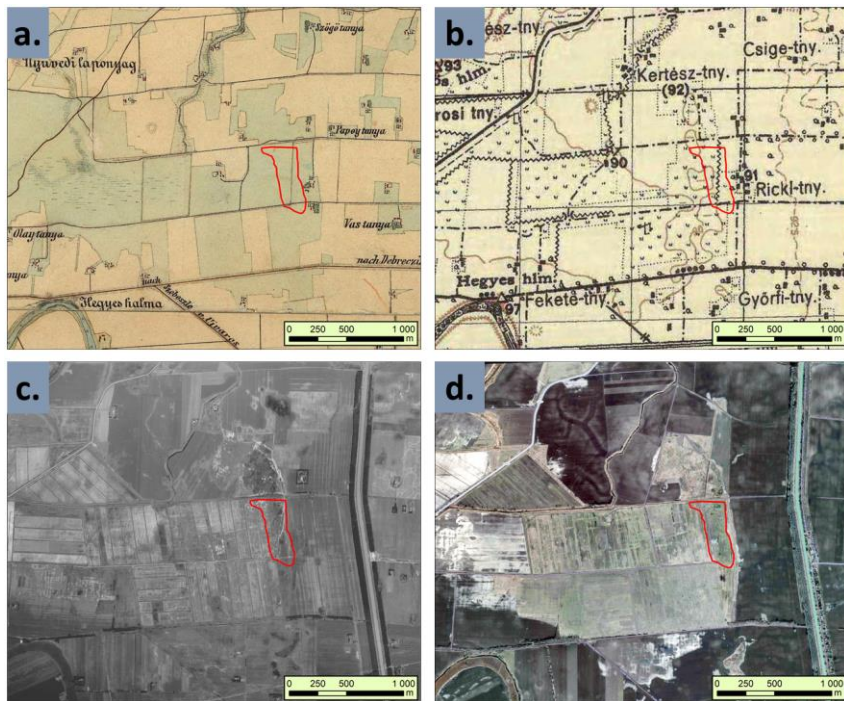


Figure 2. Location of *Lepidium cartilagineum* at Nagyhegyes (Elep) in the past 150 years on historical maps [a) Second military survey of the Habsburg Empire (1860); b) military survey of Hungary (1941), and on satellite images: c) national aerial photograph (1965) and d) Bing Satellite Image (accessed 20.10.2020)]. Red polygons represent the present habitat of the species.

L. cartilagineum occupies the gentle berm slopes and the flat depression areas where the high salt content is exposed on the surface. In mid-May the berms are dominantly covered by the late blossoming *L. cartilagineum* (Figure 3). The species is characteristic in natural berms, but also occasionally occurs on wheel tracks.

The species composition of the locality belongs to the *Puccinellion limosae* Soó 1933 alliance, resp. *Puccinellietum limosae* Magyar ex Soó 1933 plant association, which is typical on solonetz soils (Borhidi *et al.* 2012). The analytical table of the habitat is shown in Table 1. The cover of the herb layer varies between 47 and 82% (avr.: 60.4%; \pm 9.42). The height of the herb layer is between 2 and 20 centimetres; the cryptogamic layer was not developed at the period of sampling. Altogether 12 vascular species occur in the 14 relevés, the species number per plot is between 2 and 8 (4.64 ± 1.74). Due to extreme abiotic conditions the species poorness of alkalic habitats is typical and is regarded as a natural phenomenon.



Figure 3. Habitat of *Lepidium cartilagineum* at Nagyhegyes (21st May 2018) (photo of A. Schmotzer).

A higher species number is only presumed when anthropogenic disturbance is characteristic (esp. in the case of the *Hordeetum hystricis* Wendelbg. 1943 community). All species occurring in the relevés are typical in alkalic habitats. The dominant species – beside *L. cartilagineum* (frequency: V) – are *Puccinellia limosa* (V), *Camphorosma annua* (IV) and *Limonium gmelini* (III) (Figure 4). These four dominant species form the majority of the plant cover of the habitat (min: 93.8%; max: 100%; avr. 99.3%; ± 1.6). Beside these species only *Artemisia santonicum* can reach 1% cover, in only one relevé (nr. 3). The typical fescue grass of alkalic steppes, *Festuca pseudovina* is missing from the relevés, but is dominant on the loessy ridges. *Bromus hordeaceus* and *Polygonum aviculare* agg. have a weedy character, but both species are typical in alkalic habitats.

Table 1. Floristic composition of the patches with *Lepidium cartilagineum*.

Nr. of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Fr.
Coverage (%)	47	51	53	64	52	71	56	81	63	53	65	55	68	65	
Species number	6	4	4	6	5	5	8	7	3	4	2	4	5	2	
<i>Lepidium cartilagineum</i>	35	45	45	25	22	40	20	30	30	15	50	30	30	30	V (14)
<i>Puccinellia limosa</i>	8	3	4	6	20	15	25	45	30	30	15	12	25	35	V (14)
<i>Camphorosma annua</i>	2	0.3	0.5	12	8	15	3	0.3	-	0.1	-	10	5	-	IV (11)
<i>Limonium gmelini</i>	1	3	3	20	2	1	5	6	3	8	-	3	8	-	III (12)
<i>Artemisia santonicum</i>	0.5	-	-	0.5	-	-	3	-	-	-	-	-	-	-	I (3)
<i>Juncus gerardii</i>	-	-	-	0.1	-	0.1	0.5	-	-	-	-	-	-	-	I (3)
<i>Aster tripolium</i>	-	-	-	-	-	-	-	0.1	-	-	-	-	0.5	-	I (2)
<i>Spergularia cf. salina</i>	-	-	-	-	0.3	-	-	0.5	-	-	-	-	-	-	I (2)

Accompanying, accidental species with coverage percentage (%) and number of the relevé (in brackets): *Bromus hordeaceus* 0.1 (7), *Cerastium dubium* 0.1 (1), *Polygonum aviculare* agg. 0.1 (8), *Trifolium angulatum* 0.1 (7).

Relevés recorded by: András Schmotzer, Date: 26.05.2018., Location: Hungary, Hajdú-Bihar County, Nagyhegyes – toponym: ‘Sirály-rét’ (Elep). Position (centroid): 47.5121° N and 21.3136° E. Altitude: 89 m. Exposition: -. Declination: flat. Plot size: 1 m².

Comparison of the presently known localities of *Lepidium cartilagineum* in the Hortobágy region

The occurrence of the species in the Hortobágy region is unexpected. Novák and Matus (2000) found the first population in the region, at Ágota-puszta (Nádudvar). The location is situated in

the southern part of the Hortobágy. They gave a precise description of the locality, including phytosociological relevés and pedological data. They presented 14 relevés, but *L. cartilagineum* occurred only in 7 samples. A comparison of the two known localities of *L. cartilagineum* in the Hortobágy region is summarized in Table 2.

At both sites *L. cartilagineum* occurs in a natural habitat (salt berm formations, mostly in *Puccinellia* swards), but in the vicinity secondary habitats also occur (abandoned arable land at Ágota-puszta or former rice fields at Nagyhegyes). The extent of both suitable habitats is rather small, although in Ágota-puszta the alkalic vegetation mosaic is relatively larger, in relation to the landscape level. The size of the population at Nagyhegyes is much larger (36-times) than in Ágota-puszta, exceeding 5000 individuals. The species pool of the habitat shows a slight difference between the locations. In Ágota-puszta, *Festuca pseudovina* and typical alkalic forbs (e.g. *Artemisia santonicum*, *Podospermum canum*) have a larger cover and frequency value than at Nagyhegyes. Most other features compared show minor differences between the localities (e.g. species number, vegetation cover).



Figure 4. Quadrat photo of *Puccinellia* sward with dense cover of *L. cartilagineum* (photo of A. Schmotzer).

Table 2. Comparison by selected features of the two known localities of *Lepidium cartilagineum* in the Hortobágy region.

Feature	Location: Ágota-puszta (Novák and Matus 2000)	Location: Sirály-rét, Elep	Comments	
Extent of the grassland	over 500 hectares ^{1*}	approx. 120 hectares	^{1*} the locality is part of the grassland core area of Hortobágy	
Cover of patches with <i>L. cartilagineum</i>	437 m ²	980 m ²	-	
Population number	approx. 150 individuals ^{2*}	approx. 5500 individuals	^{2*} incl. sterile plants	
Vegetation type	alkalic steppe with remarkable salt berm formations	alkalic steppe with remarkable salt berm formations	-	
‘Top-3’ covering forbs beside <i>L. cartilagineum</i>	<i>Puccinellia limosa</i> / <i>Camphorosma annua</i> / <i>Limonium gmelini</i>	<i>Puccinellia limosa</i> / <i>Artemisia santonicum</i> / <i>Festuca pseudovina</i>	-	
Cover	minimal /average /maximal	50 / 60-90 / 100% ^{3*}	46 / 60 / 81%	^{3*} estimation
	mean ± SD	79.071 ± 11.507	60.286 ± 9.417	t-test, N=14, P = <0.001 (significant)
Species number	minimal - maximal and total	3-7, 9	2-8, 12	-
	mean ± SD	4.79±1.72	4.64±1.74	t-test, N=14, P = 0,828 (not significant)

CONCLUSIONS

The main issue concerning the nativeness of *L. cartilagineum* populations in the Hortobágy region is still uncertain. The distance of the two known occurrences is 22 kilometres, so they are regarded as separate populations. Compared with other expanding halophytes, *L. cartilagineum* in the Hortobágy region shows a strong affinity to natural habitats, mostly to *Puccinellia* swards with developed microforms of the surface. This association forms a vegetation zone with the adjacent alkaline pioneer stands of *Camphorosmaetum annuae* Rapaics ex Soó 1933 and the wet *Plantagini tenuiflorae-Pholiuretum pannonicum* Wendelbg. 1933 communities. Their transition belts can move depending on the rainfall for the current year (Zalatnai and Körmöczy 2004, Lukács and Radócz 2012). The separation of Pannonian alkaligrass meadows (*Puccinellion limosae* Soó 1933) is based on the main soil types according to the traditional classification (Borhidi *et al.* 2012). The *Puccinellia* swards on solonchak soils are treated under the *Puccinellenion peisonis* (Wendelbg. 1943 corr. Soó 1947) Borhidi 2003) suballiance, represented by the stands at Lake Fertő and on the Danube-Tisza interfluvium. One of the main characteristic species of this group is *L. cartilagineum*, forming a typical alkaline association called *Lepidio crassifolii-Puccinellietum limosae* Soó (1947) 1957. The corresponding suballiance of this group on solonchak soil is *Puccinellenion limosae* (Varga & V. Sipos ex Borhidi 2003), which is widespread in the *Crisicum* flora region. Nevertheless, it must be added that apart from *L. cartilagineum* no differential species is known in relation to the two above-mentioned suballiances. Bodrogekőzy (1966, 1980) characterised a *Puccinellietum* sward from Fehér-tó, Orosháza (southern Tisza valley) as *Lepidio-Puccinellietum limosae crasicum* without the presence of *L. cartilagineum*. He indicated that *Lepidium perfoliatum* behaves as a vicariant species on solonchak soil at this locality. In the Hortobágy region and in alkaline places in *Crisicum*, *L. perfoliatum* is a rather common species, sometimes also occurring in ruderal non-halophytic places. But neither in the relevés of Matus and Novák (2000) nor at Nagyhegyes has this species been shown to play an important role in the species composition of the habitat. The native status of the species at Nagyhegyes is also confirmed by pedological data. The alkalization process in the

Hortobágy is much older, dating back to the Late Pleistocene, than it was stated in several papers (Sümegei *et al.* 2013). At Nagyhegyes, in the Hajdúság landscape unit, light-coloured paleosol (alkalic soil) was detected (Szöör *et al.* 1992), which also indicates the primary origin of the alkalic grasslands there. The construction of the 'Eastern Main Canal' between 1951 and 1956 could also have caused a change in soil and vegetation conditions, including rapid alkalization (Nagy 2012), but the historical maps and aerial photo sets proved a continuous presence of the alkalic grassland here. No other evidence is available concerning the possible impact of this canal on the present state of the studied grassland (Figure 2). Novák and Matus (2000) also described some theories supporting the adventive origin of the species in the Hortobágy region, e.g. adventive occurrence far from the Pannonian Basin at Mannheim (Germany) existed or the proximity of a main road between Szolnok and Debrecen. It should be noted that the above-mentioned historical salt and post road is situated 500-800 metres southwards from the Nagyhegyes location. The deficiency of floristic data for the eastern margin of the Hortobágy is also remarkable, making it difficult to formulate a conclusion concerning the origin of the species. It is also noteworthy that the so far known locations of *L. cartilagineum* grows on the landscape margins of the Hortobágy, some authors considered these stands belonging to Hajdúság landscape units (Endes 2019). At present there seem to be more factors – esp. site characteristic, naturalness, and spatial continuity of the grassland – that suggest that the occurrences of *L. cartilagineum* should be original. Although *L. cartilagineum* is neither a rare species in Hungary (not listed as a plant under nature protection) nor mentioned in the red list categorisation (Király 2007), the occurrences in the Hortobágy and Hajdúság regions should deserve special attention in the future.

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