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10 **The occurrence of *Spiraea crenata* L. and other rare steppe plants in Pannonian**
11 **graveyards**

12

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29 Running title: **The occurrence of rare *Spiraea crenata* in graveyards**

31 **Abstract:** *Spiraea crenata* was categorised as a species extinct from Hungary at the end of
32 the 20th century. This steppe-relic species was rediscovered in 2000 in a rural graveyard
33 (Pusztamonostor). As a result of our recent survey of 294 Pannonian graveyards, we found
34 further 12 localities of *S. crenata*. We also found 27 populations of further protected plant
35 species, mainly with pontic, pontic-pannonian, Eurasian or continental distribution. We found
36 that the total scrub cover of graveyards with *S. crenata* was significantly higher than
37 graveyards without this species; this is obviously related to the fact that the individuals of *S.*
38 *crenata* were found mostly in edges of the graveyards, where they could survive mowing
39 among high and dense scrubs or small trees. Other factors (geographic position, altitude
40 above sea level, area of graveyards, proportion of grasslands, and proportion of territory
41 covered by graves) were not related to the presence of the species. The total number of other
42 protected species was significantly higher in graveyards with *S. crenata*. Most of the sites
43 with *S. crenata* functioned as graveyards during the 2nd Military Survey of the Austrian
44 Empire (1806–1869; 10 out of 13 sites), and the 3rd Military Survey (1869–1887; 12 of 13
45 sites). The long usage history of these graveyards suggests that the *S. crenata* individuals –
46 along with other remarkable species – might be remnants of the original steppe vegetation
47 rather than the result of plantations for ornamental purposes. Our results highlight the role of
48 graveyards in the preservation of steppe flora, one of the most endangered component of the
49 European flora.

50

51 **Key words:** Cemetery; flora of Central Europe; Pannonian Ecoregion; Red List species; relic
52 species; steppe species

53

54 **Introduction**

55 *Spiraea crenata* L. (scalloped spirea, syn.: *S. crenifolia* C. A. Meyer, *S. sawranica* Bess.) is a
56 medium height (0.5–1 m), deciduous shrub. It is mainly distributed throughout the western
57 and central Eurasian steppe zone; its native range extends from Southeast Europe to the
58 Caucasus and Altai Mountains (Kurtto et al. 2004, Fig. 1.). The area of *S. crenata*, however, is
59 discontinuous especially on the western part; the westernmost locations of the plant are in
60 Spain, where a distinct endemic taxon [subsp. *parvifolia* (Pau) Romo] was described
61 (Gamarra & González 1997). Based on the map of Kurtto et al. (2004), the westernmost
62 known sites of *Spiraea crenata* subsp. *crenata* were the former (extinct) Hungarian
63 occurrences (Fig. 1.).

64 Localities in Central and Southeastern Europe are very few—the species is known only in
65 Romania (Sârbu et al. 2013), Slovakia (Holub 1999), Ukraine (Dobrochaeva 1954), Bulgaria
66 (Vladimirov 2014), Kosovo (Josifović 1972), and Hungary (Bartha et al. 2004). The plant was
67 found in a few locations in the southeastern parts of its area: in Iran (Schönbeck-Temesy
68 1969) and Turkey (Davis et al. 1965). The species was considered extinct in Bulgaria (Peev &
69 Vladimirov 2011), but a new site was found in 2012 (Vladimirov et al. 2014). The species is
70 protected by law in Hungary (Király 2007) and in Slovakia (Eliáš et al. 2015).

71 *Spiraea crenata* was categorised as extinct in Hungary (Németh 1989, Bartha 1989, 1996,
72 1999, Bartha & Nagy 2004, Kurtto 2009). Based on historical data (Kitaibel in Gombocz
73 1945, Janka 1866, Vrabélyi 1868, Kerner 1869), *S. crenata* was obviously a native element of
74 the Pannonian flora, but nowadays it is practically absent from preserved natural steppe
75 habitats in Hungary. In 2000, Udvardy (2004) found one specimen in the graveyard of the
76 village Pusztamonostor. Three years later, two more polycormons were found in the same
77 location (Bartha et al. 2004), together with several rare and valuable steppe species

78 (*Amygdalus nana* L., *Vinca herbacea* Waldst. & Kit. and *Allium rotundum* L.). These
79 individuals were considered the last three polycormons of a nearly extinct species in Hungary.
80 The Pannonian Plain, located in Central Europe in the arc of the Carpathians with Hungary in
81 its centre, is the westernmost part of the Eurasian steppe zone (Bohn et al. 2003). Although
82 today it is characterised by agricultural lands with large areas of arable fields, there is
83 paleontological evidence of a significant steppe biota during the Holocene (Magyari et al.
84 2010, Németh et al. 2016). Furthermore, a meta-analysis of the phylogeographic patterns of
85 steppe plants and animals in Central-Eastern Europe found evidence of long-term survival of
86 steppe organisms with specific lineages developed locally (Kajtoch et al. 2016). Therefore,
87 despite the profound transformation of steppe flora and fauna in the Pannonian Plain (Molnár
88 et al. 2012), the remaining steppe biota includes unique lineages and deserves high
89 conservation attention and botanical research activity.

90 Graveyards can be refuges for different kinds of organisms worldwide (Barrett & Barrett
91 2001, Laske 1994). They can play significant role in conserving plant species, even for
92 centuries (McBarron et al. 1988). Burial places are appropriate for tallgrass prairie remnants
93 in North America (Could 1941), and they can be suitable for orchids in Eurasia (Löki et al.
94 2015, Molnár V. et al. 2017). These territories are mostly undisturbed, sacred areas where the
95 land is exempted from the vast majority of land transformation activities. Although their
96 importance is now recognized, our knowledge about the conservation values of graveyards is
97 incomplete. The importance of graveyards in conserving steppe plants and animal species is
98 getting more important due to drastic changes of the natural landscapes worldwide (Barrett &
99 Barrett 2001).

100 On 5 May 2015, during a botanical survey of Pannonian graveyards, two of the authors of this
101 paper found a specimen of *Spiraea crenata* in the graveyard of Tiszaszentimre-Újszentgyörgy
102 (Eastern Hungary). Since this was the second modern recording of the species in a Hungarian

103 graveyard, we performed a systematic search of the species in graveyards within its former
104 distribution area in the Pannonian Ecoregion and some neighbouring areas. Two hypotheses
105 were formulated. 1. Ancient graveyards established at the time when the species was more
106 widespread can serve as refuges for *Spiraea crenata*. 2. Graveyards with *S. crenata* harbour
107 higher number of valuable plant species than burial grounds without *S. crenata*.

108

109 **Material and methods**

110 We evaluated 294 graveyards between June 2015 and May 2016 (See supplementary data
111 Table S1). We focused our research on lowland areas in the Pannonian Ecoregion, especially
112 in the regions where previous historical occurrences of *Spiraea crenata* were reported. In
113 Slovakia, we surveyed four graveyards around the single previously known location [Svätušie
114 (formerly Plešany), Trebišov District] (Holub 1999). In Romania, we investigated the
115 graveyard at Tureni (approximately 1 km away from known natural occurrence of the
116 species), and four other graveyards near the Hungarian border. We devoted most of our
117 attention to Hungary, where we surveyed 3–64 (mean±SD=31.7±23.5) graveyards in the
118 counties studied. We made a detailed survey in each graveyard to detect all vascular plant
119 species of conservation interest with a special focus on *Spiraea crenata*. All plant species
120 protected by Hungarian law were documented by counting or estimating the number of
121 individuals. The geo-coordinates and the altitude of these graveyards were determined by a
122 Garmin E-Trex Legend GPS handheld device using the WGS84 format. The nomenclature of
123 plants follows Király (2009); authors of plant names are listed in Table 2.

124 Since historical maps proved to be useful to detect long-term land cover changes (Skaloš et al.
125 2011), we checked the status of graveyards with *Spiraea crenata* by using the digitized map
126 sheets of the 2nd and 3rd Military Survey of the Austrian Empire (made between 1806–1869,
127 and 1869–1887, respectively) (Web1, Web2).

128 To examine which variables can predict the occurrence of *Spiraea crenata*, we measured the
129 total area of graveyards, area covered by graves, area of scrubby habitats (including forests on
130 the abandoned parts), and area of grasslands, using Google Earth Pro software. We
131 statistically compared the characteristics (latitude, longitude, altitude, total area, area covered
132 by graves, area of scrubby habitats and area of grasslands) of graveyards with and without *S.*
133 *crenata* using Kruskal-Wallis tests (since none of these variables were normally distributed).

134

135 **Results**

136 We confirmed the previous known occurrence of *Spiraea crenata* in the graveyard of
137 Pusztamonostor. The species was found in 12 additional graveyards (Table 1). Newly found
138 sites are in four counties [Hajdú-Bihar (2), Jász-Nagykun Szolnok (5), Pest (1) and Szabolcs-
139 Szatmár-Bereg (4)] in central and eastern Hungary (Fig. 2). 1–4 polycormons were found in
140 each graveyard, totalling 24 individuals. (Table 1).

141 Individuals of *Spiraea crenata* were typically found at the edge of graveyards (Fig. 3A, D, E),
142 often under trees (Fig. 3A) or among other shrubs e.g. lilac (*Syringa vulgaris* L., Fig. 3B) or
143 blackthorn (*Prunus spinosa* L., Fig. 3D). The shrub flowered more richly in sunny, open
144 habitats (Fig 3C). However, some individuals in open habitats (like in Jászfényszaru and
145 Tetétlen) were damaged by mowing. Some individuals (in Dabas, Hajdúszoboszló, Nyírmada
146 and Jászfényszaru) formed large (several m² in area) polycormons.

147 Geographic location, altitude, area of the graveyards, together with lists of protected plant
148 species found in each one, are given in supplementary data (Table S1). At least one more
149 protected plant species occurred in 69% of graveyards that hosted *Spiraea crenata*. We found
150 at least one more protected species in 112 (38%) graveyards (Fig. 4). In total, 28 protected
151 plant species were found (Table 2). Substantial differences could be observed in frequency,
152 abundance and distribution pattern of protected plant species. Each species was found in 1–

153 56 graveyards (mean \pm SD = 7 \pm 11.5). The number of protected plant species detected in
154 only one graveyard was 12. The highest number of protected species in a given graveyard was
155 7, but in 75 graveyards (25 %) only one taxon occurred. Graveyards that were habitats for 5
156 or more protected plants were extremely rare (4 – 1.3 %) (Fig. 5).

157 We recorded a range of 1–50,000 individuals of protected species in graveyards. In the case of
158 *Lathyrus lacteus* only a single individual was found; in the case of 8 plant species, more than
159 1,000 individuals were found. Graveyards harboured more species with Pontic-Pannonian,
160 Pontic, or Pontic-Mediterranean distribution (altogether 11 species) than continental (4
161 species), and Eurasian and Pannonian (2–2 species) plants (Table 2, Fig 6). Based on the
162 number of recorded individuals of protected plants, and the monetary value declared by
163 Hungarian law, the total conservation value of the individuals found in graveyards is
164 approximately 1,540,000 Euros.

165 Graveyards where *Spiraea crenata* was present had significantly higher scrub cover (Kruskal-
166 Wallis rank-sum test, $\chi^2 = 6.39$, P = 0.011, Fig. 7A), but graveyards with and without *S.*
167 *crenata* did not differ in area ($\chi^2 = 1.31$, P = 0.25), in area covered by graves ($\chi^2 = 0.57$, P =
168 0.45) or in grassland cover ($\chi^2 = 1.69$, P = 0.19). Furthermore, there was no significant
169 difference in the location of graveyards with and without *S. crenata* (latitude: $\chi^2 = 0.95$, P =
170 0.33; longitude: $\chi^2 = 0.11$, P = 0.74; altitude: $\chi^2 = 0.13$, P = 0.71).

171 The number of other protected species in graveyards with *Spiraea crenata* was significantly
172 higher than in graveyards without the species (Fig. 7B; Kruskal-Wallis rank-sum test, $\chi^2 =$
173 8.29, P = 0.004).

174 **Discussion**

175 Valuable populations of rare and protected plant species were recorded in graveyards of the
176 Pannonian Ecoregion, including a dozen previously unknown locations of the rare steppe
177 shrub species, *Spiraea crenata*. These unexpected occurrences of the shrub in this kind of

178 anthropogenically influenced habitat may raise the question of autochthony. The two most
179 likely explanations for recent occurrences of the species are: i) human introduction by
180 intentional planting for ornamental purposes or ii) survival of a few plants of former
181 spontaneous populations. Though the prior use of the shrub as an ornamental species cannot
182 be ruled out, we consider some factors which strengthen the proposition that at least some
183 individuals represent last remnants of the original steppe vegetation.

184 First, we found several other valuable (mainly Pontic-Pannonian) species in the surveyed
185 graveyards, including some species of quite small size or with short blooming periods (e.g.
186 *Taraxacum serotinum* (Waldst. et Kit.) Poir, *Thlaspi jankae* A. Kern., *Sternbergia*
187 *colchiciflora* Waldst. & Kit.); the planting by rural people of these 'inconspicuous' species for
188 ornamental purposes is highly improbable.

189 Second, graveyards containing *Spiraea crenata* hosted significantly more other protected
190 plants than graveyards without the shrub. The survival of these species with a habitat
191 preference similar to *S. crenata* can be a parallel survival together with the latter species.

192 Third, 10 and 12 (77% and 92%, respectively) of graveyards harbouring *Spiraea crenata* have
193 been continuously used as burial places at least since the 19th century, as recorded during the
194 2nd and 3rd Military Surveys of the Austrian Empire, respectively (Table 3). We believe that
195 the chance for survival of the original vegetation is higher in long-established graveyards. The
196 land use was less intensive in the 18th–19th centuries than today (Molnár et al. 2012), and in
197 this period several *S. crenata* populations were known in Hungary. Graveyards, established
198 before the 19th century have been continuously free of agricultural use; thus these graveyards
199 could preserve elements of the original vegetation. In comparison, graveyards without
200 *Spiraea crenata* used as burial places during the 2nd and 3rd Military Surveys constitute a
201 smaller subset (60% and 75%) in our survey.

202 Fourth, traditional sustainable land use in Hungarian graveyards lasting for centuries can be
203 outlined based on the comprehensive ethnographic work of Balassa (1989). Even in the near
204 past, Hungarians used to separate graveyards into three parts with different utilisation. The
205 first part was unused (reserve) areas. The biggest part was the actual burial ground that slowly
206 transformed into the third part, where older graves were present and the land was more natural
207 than recently used parts of the graveyard; the trees and bushes were suppressed, and the grass-
208 covered graves got flatter. Only some old gravestones remind us that this part was used as a
209 graveyard long ago. These parts traditionally were often used for grazing and mowing; and
210 local residents considered them part of the natural landscape. A natural cycle of usage of these
211 three parts continuously provided territories in traditionally managed graveyards that could
212 serve as habitats for native flora and fauna.

213 Fifth, ornamental plant cult in Hungarian rural communities appeared only at the end of the
214 19th and the beginning of the 20th centuries (Rapaics 1932). Before that time, planting
215 ornamental plants in graveyards was not practised (Balassa 1989). Calvinist graveyards were
216 especially puritan (without any planted ornamental plants) before the Second World War
217 (Balassa 1989) and Calvinism was widespread in the Hungarian part of the Pannonian Plain.

218 Additionally, occurrences of *Spiraea crenata* in graveyards are also documented in the centre
219 of its distribution area. A population of *S. crenata* [together with other characteristic steppe
220 plant species, like: *Aster oleifolius* (Lam.) Wagenitz, *Oxytropis pilosa* (L.) DC., *Phlomis*
221 *pungens* Willd, *Phlomis tuberosa* L., *Pseudolysimachion incanum* (L.) Holub, *Salvia nutans*
222 L., *Stipa lessingiana* Trin. & Rupr, *Taraxacum serotinum* (Waldst. et Kit.) Poir.] was
223 recorded in the graveyard of Tatarskaya Kargala (Russia, Orenburg region, 51.95277° N,
224 55.17916° G. Sramkó, unpublished observation) (Supplementary data Fig. S1.). Steppe
225 habitats are generally threatened by agricultural use, notably ploughing. Some patches of dry
226 grassland vegetation – especially in the western region of the steppe zone – remain in small,

227 fragmented habitat spots like kurgans (Moysienko & Sudnik-Wójcikowska 2009, Deák et al.
228 2016a, 2016b), earthworks, and roadside verges (Zólyomi 1969), which are equally unsuitable
229 for agricultural use as arable fields. Graveyards as refuges of steppe vegetation patches have
230 not been in the focus of researchers' attention, but our data demonstrate that old graveyards
231 harbour a number of steppe plant species. Graveyards (just as kurgans) are more stable habitats
232 than e.g. roadside verges and field margins thus they have a very important conservational role. Our
233 results reported here and elsewhere (Löki et al. 2015, Molnár V. et al. 2017, Molnár V. et al.
234 submitted) also suggest that graveyards – similarly to other urban or semi-urban habitats (cf.
235 Araújo 2003, Smith et al. 2006, Kantsa et al. 2013) – may harbour and preserve valuable
236 endangered organisms.

237 Finally, steppe habitats and biota are amongst the most threatened ones within Europe (Török
238 et al. 2016) as anthropogenic influence started to adversely impact them during the prehistoric
239 era (Molnár et al. 2012, Németh et al. 2016). During this long period, the westernmost part of
240 the steppes has been greatly reduced, both in size and in species diversity. The
241 phylogeographic patterns of the surviving species, however, tell about a long evolutionary
242 history of these species in the Central-Eastern European region (Kajtoch et al. 2016).
243 Therefore, preservation of our natural steppe heritage also preserves these unique
244 westernmost lineages that now thrive in semi-natural, anthropogenic habitats in an extremely
245 anthropogenic landscape. The long-term survival of these relicts is highly dependent on a
246 traditional or well-planned management of these semi-natural, anthropogenic habitats.

247

248 **Implications for management**

249 Finding further populations of *Spiraea crenata* in Pannonian graveyards is probable.
250 Thematic research should be focused on old, neglected (seemingly 'messy') rural graveyards
251 where the area is substantially covered by scrubs. Local authorities (nature conservation

252 agencies, council or church) maintaining the graveyards and nature conservation agencies
253 should be informed to secure the survival of *S. crenata* individuals in the case of newly found
254 populations. Every management activity (especially electric mowing and shrub control),
255 should be applied with caution in the habitats of *S. crenata*.

256

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268

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396 **Tables**

397

398 Table 1. Data of occurrences of *Spiraea crenata* in surveyed graveyards.

399

Settlement	Geographic position	Alt. (m)	No. of <i>Spiraea crenata</i> individuals	Other plant species of conservational interest
Abádszalók	47.47092° N, 20.59575° E	88	2	<i>Amygdalus nana</i>
Dabas	47.18994° N, 19.30294° E	100	2	<i>Amygdalus nana</i> , <i>Festuca wagneri</i>
Hajdúszoboszló	47.45000° N, 21.37256° E	87	1	<i>Cephalanthera damasonium</i> , <i>Amygdalus nana</i>
Jászfényszaru	47.55906° N, 19.72718° E	111	2	<i>Amygdalus nana</i>
Nagykálló	47.87751° N, 21.82915° E	120	2	–
Nyírbéltek	47.69334° N, 22.11251° E	158	1	–
Nyírmada	48.06919° N, 22.20518° E	139	1	<i>Ranunculus illyricus</i>
Pusztamonostor	47.55563° N, 19.80304° E	141	2	<i>Amygdalus nana</i> , <i>Vinca herbacea</i>
Tetőtlen	47.32134° N, 21.30986° E	87	2	–
Tiszaörs	47.50378° N, 20.81923° E	92	4	<i>Ranunculus illyricus</i> , <i>Iris pumila</i>
Tiszaszentimre	47.48273° N, 20.72721° E	90	1	<i>Amygdalus nana</i> , <i>Ranunculus illyricus</i>
Tiszaszentimre-Újszentgyörgy	47.44973° N, 20.71298° E	95	1	<i>Amygdalus nana</i> , <i>Iris pumila</i>
Újfehértó	47.80446° N, 21.65626° E	125	3	–

400

401

402 Table 2. Legally protected plant taxa found in the graveyards evaluated (distribution types
 403 provided after Horváth et al. 1995).
 404

Species	Distribution	Number of graveyards	Total number of specimens
<i>Amygdalus nana</i> L.	Pontic	56	510
<i>Ranunculus illyricus</i> L.	Pontic-Mediterranean	27	42,200
<i>Linaria biebersteinii</i> Besser	Eurasian	17	1050
<i>Ornithogalum brevistylum</i> Wolfner	Mediterranean	15	52,000
<i>Spiraea crenata</i> L.	Continental	13	22
<i>Aster sedifolius</i> L.	Continental	8	8,700
<i>Phlomis tuberosa</i> L.	Eurasian	8	1330
<i>Thlaspi jankae</i> A. Kern.	Pannonian	8	980
<i>Vinca herbacea</i> Waldst. & Kit.	Pontic-Pannonian	7	660
<i>Clematis integrifolia</i> L.	Continental	5	1800
<i>Iris pumila</i> L.	Pontic-Pannonian	4	30
<i>Festuca wagneri</i> Degen, Thaisz et Flatt	Pannonian	3	300
<i>Taraxacum serotinum</i> (Waldst. & Kit.) Poir.	Pontic-Pannonian	3	75
<i>Iris arenaria</i> Waldst. & Kit.	Pontic-Pannonian	2	180
<i>Potentilla patula</i> Waldst. & Kit.	Pontic-Pannonian	2	160
<i>Sternbergia colchiciflora</i> Waldst. & Kit.	East-submediterranean	1	7,500
<i>Peucedanum officinale</i> L.	Central European	1	5,000
<i>Achillea ochroleuca</i> Ehrh.	Pontic-Pannonian	1	100
<i>Cephalanthera damasonium</i> (Mill.) Druce	Central European	1	100
<i>Pseudolysimachion incanum</i> (L.) Holub	Continental	1	100
<i>Pulsatilla pratensis</i> (L.) Mill.	Central European	1	100
<i>Stipa borysthena</i> Klokov	Pontic-Pannonian	1	100
<i>Centaurea arenaria</i> M. Bieb. ex Willd	Pontic-Pannonian	1	50
<i>Scilla vindobonensis</i> Speta	Central European	1	50
<i>Ornithogalum refractum</i> Kit. in Willd.	Balkan	1	15
<i>Achillea chritmifolia</i> Waldst. & Kit.	Pannonian-Balkan	1	10
<i>Iris aphylla</i> L.	Pontic-Pannonian	1	7
<i>Lathyrus lacteus</i> (M.Bieb.) Wissjul.	European	1	1

405

406 Table 3. Land use data for graveyards harbouring *Spiraea crenata* during 2nd and 3rd Military
 407 Survey of Austrian Empire (19th century).

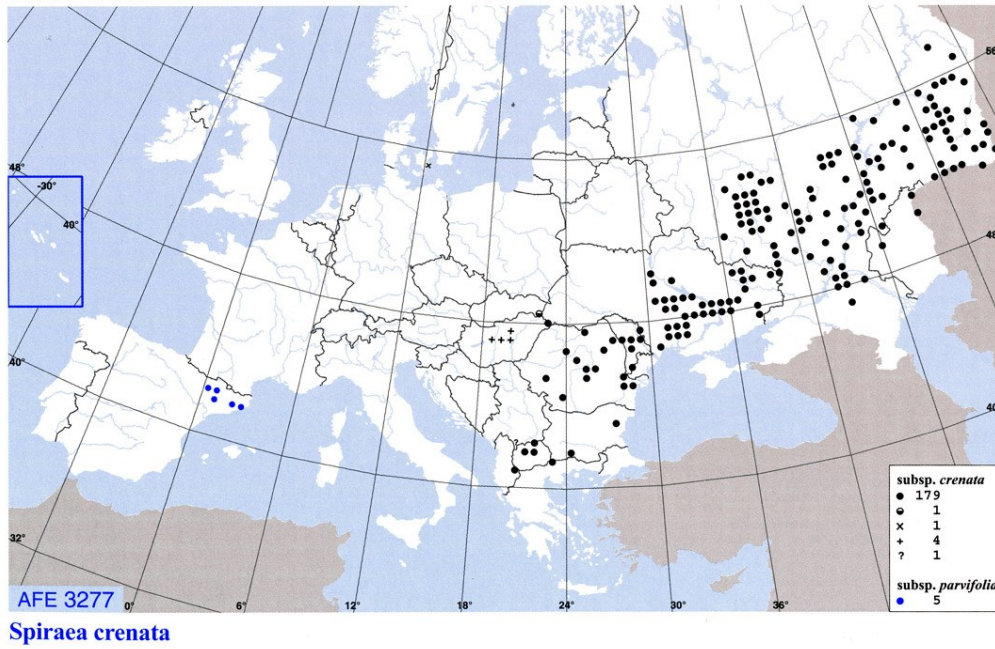
408

Settlement	2nd Military Survey (1806–1869)	3rd Military Survey (1869–1887)
Abádszalók	graveyard	graveyard
Dabas	graveyard	graveyard
Hajdúszoboszló	graveyard	graveyard
Jászfényszaru	graveyard	graveyard
Nagykálló	graveyard	graveyard
Nyírbéltek	graveyard	graveyard
Nyírmada	graveyard	graveyard
Pusztamonostor	ploughed	graveyard
Tetétlen	graveyard	graveyard
Tiszaörs	graveyard	graveyard
Tiszaszentimre	graveyard	graveyard
Tiszaszentimre-Újszentgyörgy	orchard	orchard
Újfehértó	ploughed	grassland

409

410 **Figures**

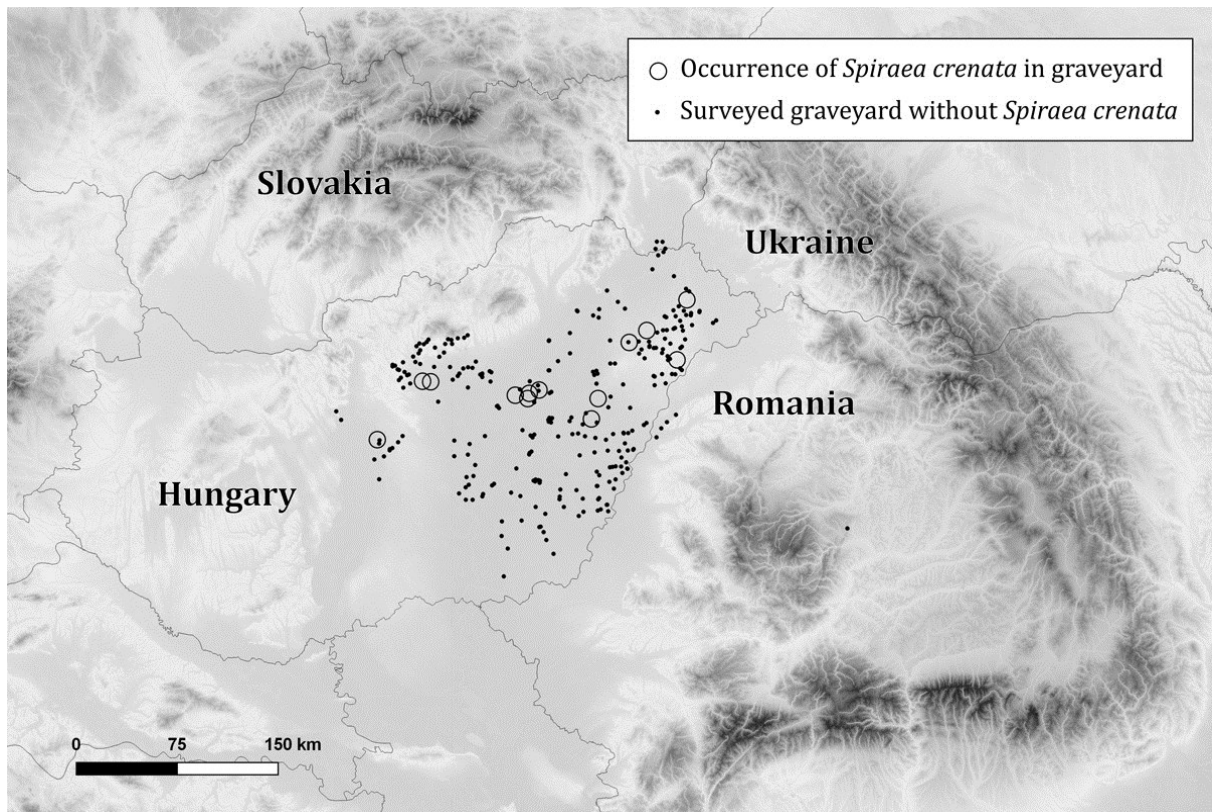
411



412

413 Fig. 1. Distribution of *Spiraea crenata* in Europe as presented in Atlas Florae Europaea
414 (reproduced with the kind permission of the Committee for Mapping the Flora of Europe &
415 Societas Biologica Fennica Vanamo, Helsinki).

416

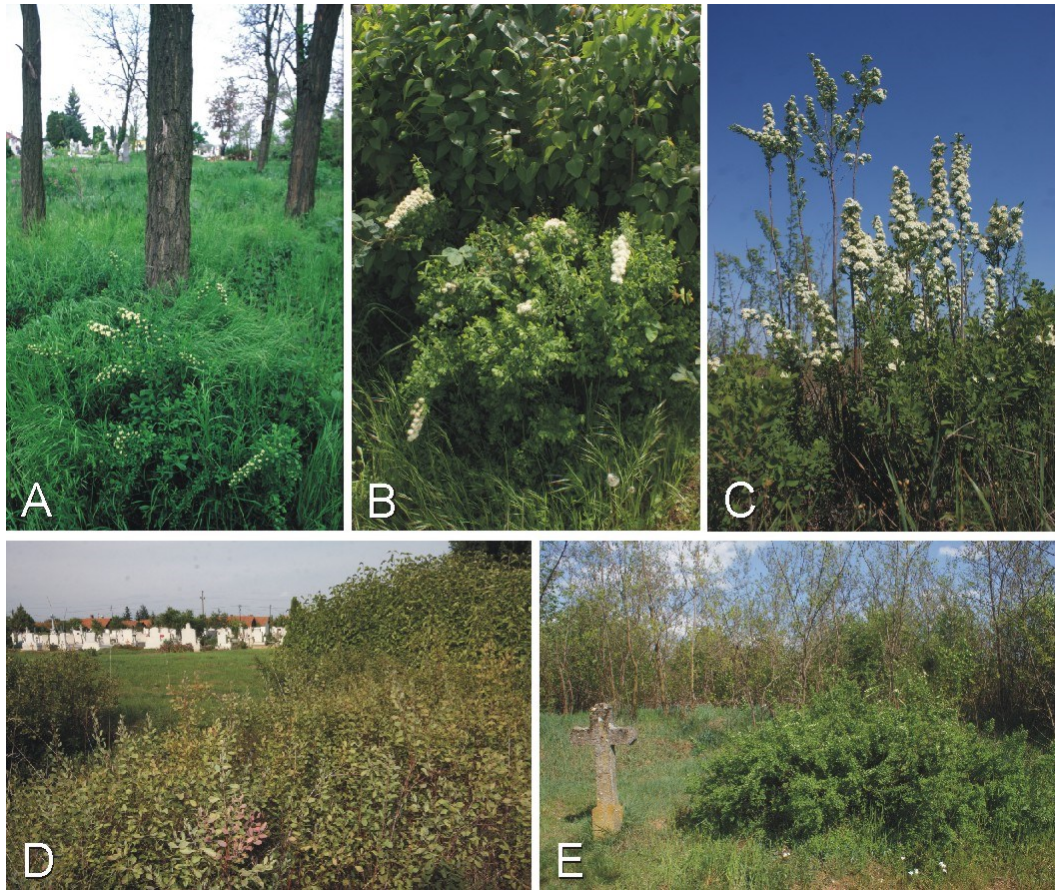


417

418 Fig. 2. Distribution of graveyards surveyed and occurrences of *Spiraea crenata* in the

419 Pannonian Ecoregion

420



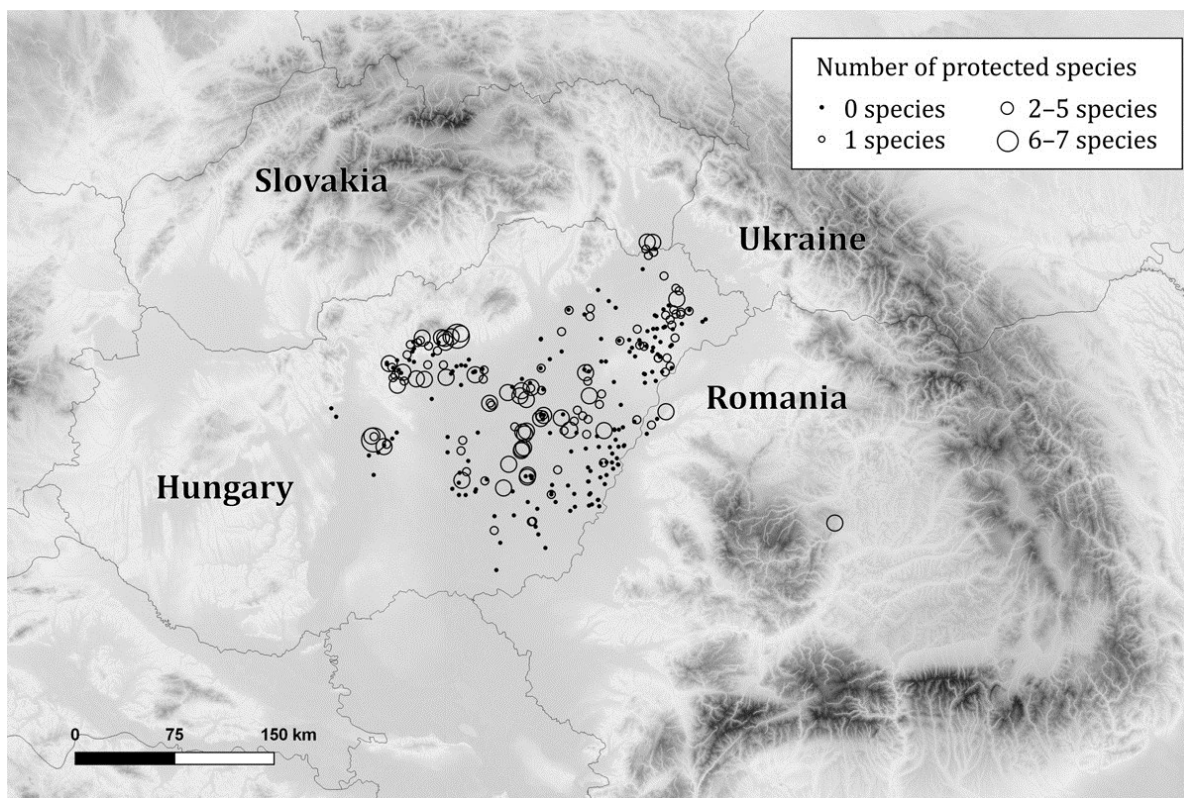
421

422 Fig. 3. Habitats of *Spiraea crenata* in Hungarian graveyards. A: Pusztamonostor, 2004; B:

423 Tiszaszentimre-Újszentgyörgy, 2015; C: Nagykálló, 2016, D: Jászfényszaru, 2015, E:

424 Nyírmada, 2016. Photographs: A – C, E. by A Molnár V.; D by V. Lőki.

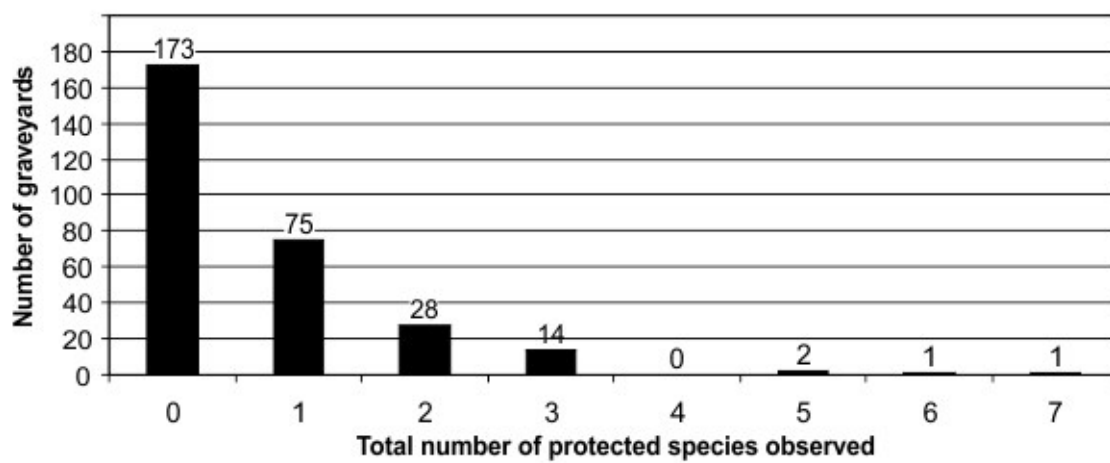
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426

427 Fig. 4. Number of other protected plant species in graveyards of the surveyed area.

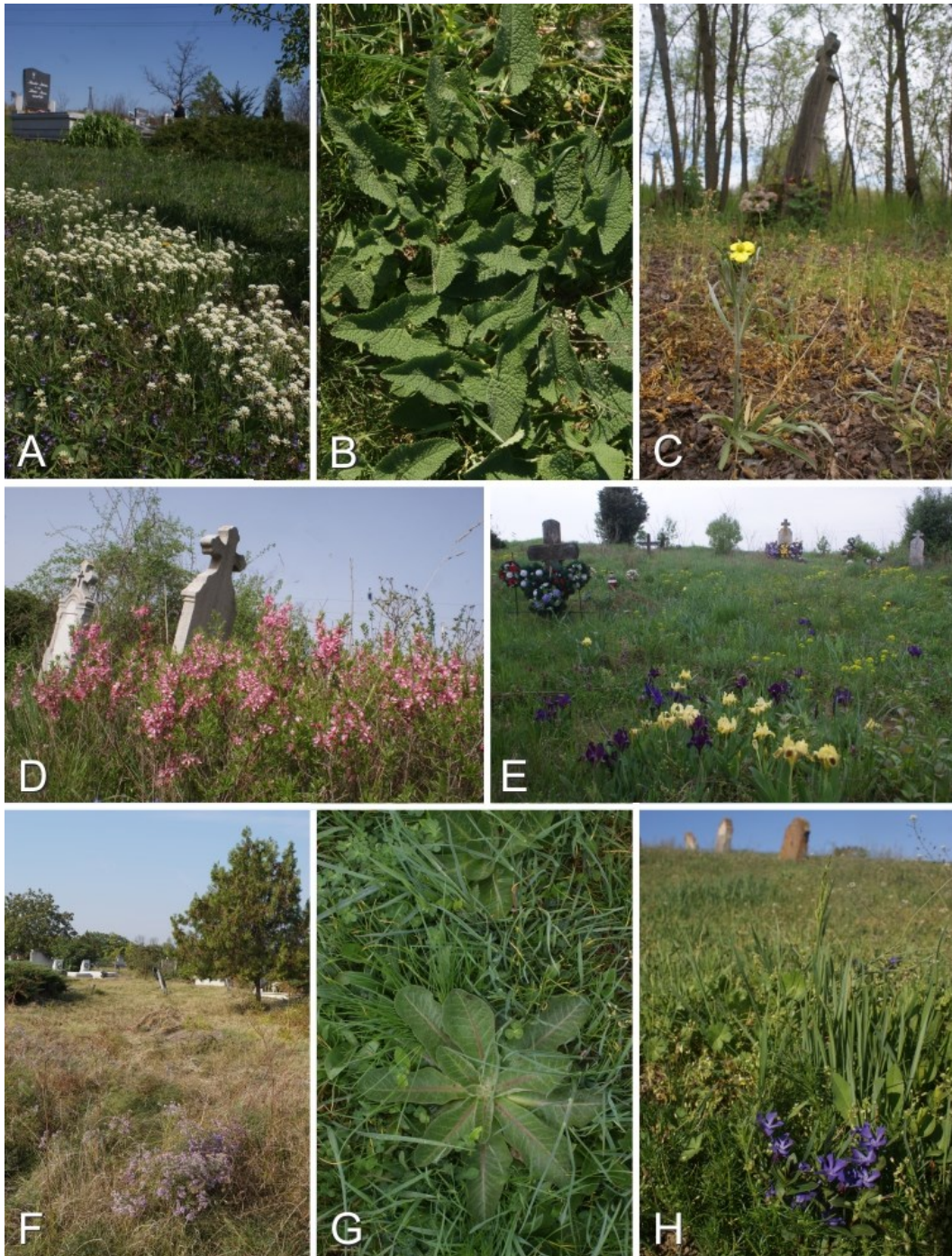
428



429

430 Fig. 5. Distribution of number of protected plant species in the 294 graveyards surveyed.

431



432

433 Fig. 6. Examples of legally protected vascular plant species found in Hungarian graveyards

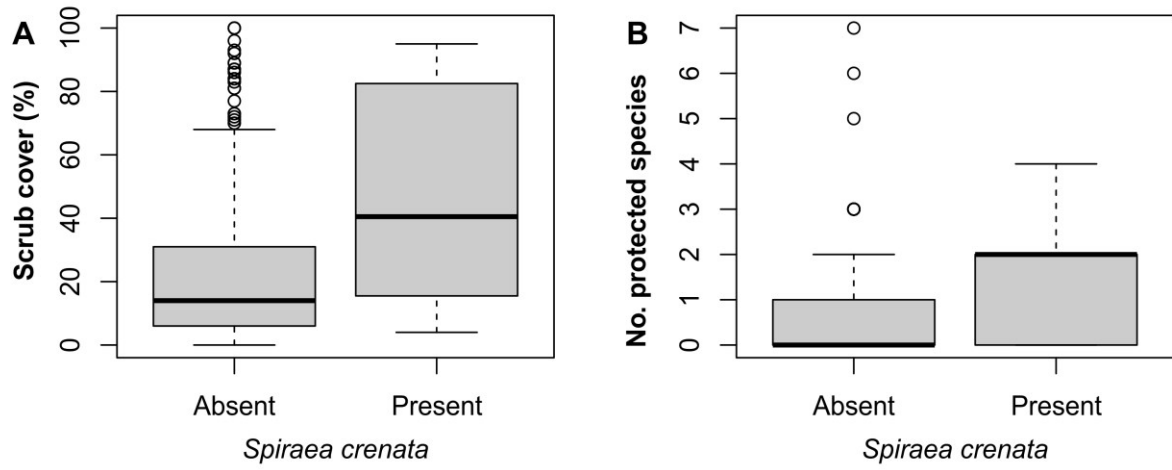
434 [with settlement names in square brackets]. A: *Thlaspi jankae* [Abasár]; B: basal leaves of

435 *Phlomis tuberosa* [Domoszló]; C: *Ranunculus illyricus* [Nyírderzs]; D: *Amygdalus nana*

436 [*Jászfényszaru*]; E: *Iris pumila* [Tiszaszentimre-Újszentgyörgy]; F: *Aster sedifolius* and

437 *Peucedanum officinale* [Berettyóújfalu]; G: Spring leaf rosette of *Taraxacum serotinum*

438 [*Dány*]; H: *Vinca herbacea* [Aszód] – Photographs: by A Molnár V.



439

440 Fig. 7. Comparison of scrub cover (A) and number of other protected vascular plant species

441 (B) in graveyards with and without *Spiraea crenata*.

442

443

444 **Supplementary data**



445

446 Fig. S1. Refuge of steppe vegetation (including *Spiraea crenata*) in a graveyard near Tatarskaya Kargala (Orenburg region, Russia, 2016).
 447 Photographed by G. Sramkó.

448

449 Table S1. Geographic location, altitude, area, protected species, proportion of scrub of the 294 graveyards studied. Localities are listed
 450 alphabetically, first by country, then by settlement. Occurrences of *Spiraea crenata* are highlighted with boldface. A dash “–” indicates that no
 451 protected species were recorded. Country abbreviations: Hu – Hungary, Ro – Romania, Sk – Slovakia.
 452

Country	Settlement	Latitude, longitude	Altitude (m)	Area (ha)	Protected species	Percentage of scrub
Hu	Abádszalók	47.47092° N, 20.59575° E	88	5.37	<i>Amygdalus nana</i> (15), <i>Spiraea crenata</i> (2)	80

Hu	Abasár	47.79360° N, 20.00336° E	167	1.89	<i>Potentilla patula</i> (150), <i>Clematis integrifolia</i> (900), <i>Thlaspi jankae</i> (300), <i>Phlomis tuberosa</i> (80), <i>Ornithogalum brevistylum</i> (1)	2
Hu	Abony	47.18435° N, 20.02418° E	90	5.53	-	29
Hu	Apc	47.79623° N, 19.69782° E	166	1.56	-	6
Hu	Aszód	47.65681° N, 19.46926° E	153	3.73	<i>Vinca herbacea</i> (77), <i>Amygdalus nana</i> (9)	12
Hu	Átány	47.62208° N, 20.35571° E	94	0.98	-	3
Hu	Átány	47.61563° N, 20.37128° E	93	1.67	<i>Amygdalus nana</i> (2)	2
Hu	Atkár	47.71258° N, 19.88407° E	121	1.6	-	9
Hu	Bag	47.63319° N, 19.49409° E	139	2.39	<i>Ranunculus illyricus</i> (800)	0
Hu	Bakonszeg	47.18961° N, 21.44648° E	97	2.68	-	56
Hu	Baktalórántháza	48.00348° N, 22.07863° E	129	2.35	-	23
Hu	Baktalórántháza	47.96671° N, 22.09953° E	147	0.27	<i>Ranunculus illyricus</i> (10)	22
Hu	Balkány	47.78120° N, 21.85470° E	135	NA	-	NA
Hu	Balkány	47.77462° N, 21.85307° E	229	3.39	<i>Ranunculus illyricus</i> (40)	60
Hu	Balkány-Nádaspuszta	47.70318° N, 21.80843° E	147	NA	-	NA
Hu	Balmazújváros	47.60677° N, 21.36717° E	118	NA	-	NA
Hu	Balmazújváros	47.61861° N, 21.32507° E	83	11.77	-	11
Hu	Balmazújváros	47.62479° N, 21.35667° E	80	1.08	<i>Linaria biebersteinii</i> (10)	NA
Hu	Balmazújváros	47.59882° N, 21.33708° E	80	1.14	<i>Amygdalus nana</i> (1), <i>Linaria biebersteinii</i> (150)	11
Hu	Báránd	47.28700° N, 21.22869° E	86	3.5	<i>Amygdalus nana</i> (3)	10
Hu	Bélmegyer	46.86935° N, 21.17007° E	82	1.86	-	24
Hu	Berettyóújfalu	47.22590° N, 21.51348° E	91	5.06	<i>Aster sedifolius</i> (5000), <i>Peucedanum officinale</i> (5000)	5
Hu	Besenyőd	47.96016° N,	132	0.9	-	9

		22.01125° E				
Hu	Biharkeresztes	47.13109° N, 21.70576° E	100	1.08	-	31
Hu	Biharkeresztes	47.12600° N, 21.70115° E	100	3.15	-	10
Hu	Biharnagybajom	47.21175° N, 21.24998° E	100	2.73	-	16
Hu	Biharugra	46.97857° N, 21.59967° E	104	1.71	-	9
Hu	Biri	47.80767° N, 21.84941° E	125	NA	-	NA
Hu	Boconád	47.64316° N, 20.19427° E	100	2.01	-	6
Hu	Bököny	47.73279° N, 21.75681° E	138	1.49	-	3
Hu	Bucsa	47.21031° N, 20.99867° E	90	7.67	-	9
Hu	Cibakháza	46.95921° N, 20.20352° E	85	4.16	<i>Amygdalus nana</i> (3)	6
Hu	Cigánd	48.25889° N, 21.88132° E	96	2.09	-	0
Hu	Csabacsúd	46.83126° N, 20.64365° E	85	3.71	-	32
Hu	Csanádapáca	46.55048° N, 20.88766° E	92	3.58	-	5
Hu	Csány	47.64932° N, 19.83547° E	114	3.21	<i>Thlaspi jankae</i> (3)	7
Hu	Csépa	46.80778° N, 20.13223° E	84	3.22	-	9
Hu	Csorvás	46.63597° N, 20.83390° E	91	1.31	<i>Ornithogalum brevistylum</i> (100)	77
Hu	Csorvás	46.63341° N, 20.82182° E	91	6.97	<i>Sternbergia colchiciflora</i> (1500)	19
Hu	Dabas	47.18651° N, 19.32385° E	108	2.17	<i>Iris arenaria</i> (30)	100
Hu	Dabas	47.18994° N, 19.30294° E	100	2.17	<i>Amygdalus nana</i> (15), <i>Spiraea crenata</i> (2), <i>Festuca wagneri</i> (100)	93
Hu	Dabas Dél	47.16569° N, 19.31962° E	101	NA	<i>Vinca herbacea</i> (500), <i>Iris pumila</i> (5), <i>Iris arenaria</i> (150), <i>Stipa borysthénica</i> (100), <i>Festuca wagneri</i> (100), <i>Achillea ochroleuca</i> (100)	NA
Hu	Dánszentmiklós	47.21316° N, 19.53995° E	137	1.51	-	7
Hu	Dány	47.51844° N, 19.54668° E	135	2.14	<i>Vinca herbacea</i> (42), <i>Taraxacum serotinum</i> (20)	3

Hu	Darvas	47.10939° N, 21.33949° E	99	2.34	-		87
Hu	Debrecen	47.53893° N, 21.60716° E	118	2.21	-		NA
Hu	Doboz	46.73088° N, 21.23572° E	79	5.5	-		7
Hu	Domony	47.65227° N, 19.44597° E	134	NA	-		NA
Hu	Domoszló	47.83231° N, 20.11679° E	187	2.03	-	<i>Clematis integrifolia</i> (500), <i>Ranunculus illyricus</i> (5), <i>Thlaspi jankae</i> (300), <i>Phlomis tuberosa</i> (150), <i>Achillea chritimifolia</i> (1), <i>Lathyrus lacteus</i> (1)	2
Hu	Ebes	47.46178° N, 21.48953° E	93	1.9	-	<i>Amygdalus nana</i> (1)	18
Hu	Egyek	47.62753° N, 20.90880° E	89	3.68	-		8
Hu	Egyek	47.62738° N, 20.91515° E	92	NA	-	<i>Phlomis tuberosa</i> (1)	NA
Hu	Érd	47.36933° N, 18.91752° E	141	7.86	-		14
Hu	Erk	47.60725° N, 20.07164° E	93	1.28	-		14
Hu	Érpatak	47.80870° N, 21.75285° E	127	2.31	-		3
Hu	Fábiánsebestyén	46.66985° N, 20.47035° E	82	2.16	-		4
Hu	Földeák	46.31662° N, 20.48808° E	79	3.74	-		13
Hu	Földes	47.29853° N, 21.36041° E	106	3.21	-	<i>Amygdalus nana</i> (6)	14
Hu	Furta	47.12041° N, 21.46332° E	88	5.12	-		61
Hu	Fülöp	47.60425° N, 22.06545° E	148	1.24	-		6
Hu	Fülöp-Bánháza	47.60279° N, 22.09595° E	146	0.77	-	<i>Amygdalus nana</i> (1)	39
Hu	Fülöpösdaróc	47.94035° N, 22.47995° E	111	0.7	-		10
Hu	Füzesgyarmat	47.09070° N, 21.20006° E	95	3.23	-		2
Hu	Gáborján	47.23201° N, 21.65454° E	95	1.79	-		10
Hu	Galgahévíz	47.61711° N, 19.55877° E	127	1.41	-		0
Hu	Gemzse	48.13464° N,	118	NA	-	<i>Ranunculus illyricus</i> (10000)	NA

		22.19891° E				
Hu	Gemzse	48.13754° N, 22.19682° E	119	1.58	<i>Ranunculus illyricus</i> (10000)	0
Hu	Gerendás	46.60113° N, 20.86177° E	106	1.22	-	16
Hu	Gerla	46.70435° N, 21.19161° E	91	1.35	-	33
Hu	Geszteréd	47.75848° N, 21.77925° E	142	3.01	-	5
Hu	Gyomaendrőd	46.92940° N, 20.82665° E	87	0.8	-	5
Hu	Gyomaendrőd	46.93267° N, 20.81346° E	80	3.24	-	NA
Hu	Gyomaendrőd	46.92986° N, 20.76775° E	82	3.14	-	45
Hu	Gyomaendrőd	46.91611° N, 20.82449° E	86	6.17	-	1
Hu	Gyomaendrőd	46.92441° N, 20.78260° E	81	7.25	<i>Linaria biebersteinii</i> (30), <i>Aster sedifolius</i> (8)	29
Hu	Gyomaendrőd	46.93674° N, 20.78649° E	81	2.83	<i>Aster sedifolius</i> (50), <i>Ornithogalum brevistylum</i> (100)	86
Hu	Gyöngyös	47.79300° N, 19.93896° E	187	9.72	-	14
Hu	Gyöngyöshalász	47.73935° N, 19.92774° E	129	1.56	<i>Thlaspi jankae</i> (6)	9
Hu	Gyöngyöspata	47.82081° N, 19.78262° E	222	1.42	<i>Clematis integrifolia</i> (25), <i>Phlomis tuberosa</i> (1), <i>Vinca herbacea</i> (1)	13
Hu	Győrtelek	47.92477° N, 22.45000° E	112	1.12	-	31
Hu	Hajdúbajos	47.39167° N, 21.67306° E	106	3.1	-	1
Hu	Hajdúböszörmény	47.67054° N, 21.48724° E	131	20.83	-	26
Hu	Hajdúböszörmény	47.67054° N, 21.53047° E	133	3.76	-	81
Hu	Hajdúdorog	47.81525° N, 21.48500° E	105	6.59	-	2
Hu	Hajdúszoboszló	47.45000° N, 21.37256° E	87	22.6	<i>Cephalanthera damasonium</i> (100), <i>Amygdalus nana</i> (1), <i>Spiraea crenata</i> (1)	23
Hu	Hajdúszovát	47.39494° N, 21.46893° E	98	5.91	<i>Amygdalus nana</i> (1)	45
Hu	Hatvan	47.66802° N, 19.70427° E	121	7.11	-	23

Hu	Hatvan	47.68010° N, 19.65996° E	118	2.26	-		15
Hu	Hencida	47.24709° N, 21.69289° E	94	3.47	-		6
Hu	Heréd	47.71393° N, 19.63902° E	121	2.08	<i>Ranunculus illyricus</i> (40)		27
Hu	Heves	47.60134° N, 20.26743° E	97	0.74	-		68
Hu	Heves	47.60749° N, 20.28622° E	98	4.39	-		7
Hu	Heves	47.60443° N, 20.28546° E		NA	-		NA
Hu	Heves	47.58544° N, 20.28625° E	92	4.28	<i>Amygdalus nana</i> (5), <i>Vinca herbacea</i> (3)		27
Hu	Hevesvezekény	47.55711° N, 20.36380° E	89	1.33	<i>Amygdalus nana</i> (2)		27
Hu	Hévízgyörk	47.62976° N, 19.50638° E	135	1.99	-		0
Hu	Iklad	47.66254° N, 19.44657° E	152	2.1	-		1
Hu	Ilk	48.12118° N, 22.22674° E	119	3.71	<i>Ranunculus illyricus</i> (2700)		27
Hu	Jármi	47.97213° N, 22.24169° E	140	2.08	<i>Ranunculus illyricus</i> (1000)		5
Hu	Jászapáti	47.51967° N, 20.15216° E	92	10.76	-		40
Hu	Jászárokszállás	47.64866° N, 19.98439° E	98	9.19	<i>Aster sedifolius</i> (1)		7
Hu	Jászberény	47.42996° N, 19.87311° E	108	NA	-		NA
Hu	Jászdózsa	47.56882° N, 20.00949° E	91	2.3	<i>Ornithogalum brevistylum</i> (100), <i>Clematis integrifolia</i> (60)		19
Hu	Jászfényszaru	47.55906° N, 19.72718° E	111	3.01	<i>Amygdalus nana</i> (20), <i>Spiraea crenata</i> (2)		41
Hu	Kaba	47.35770° N, 21.25885° E	81	8.65	<i>Amygdalus nana</i> (4)		11
Hu	Kállósemjén	47.86463° N, 21.92652° E	134	4.26	-		4
Hu	Kántorjánosi	47.93794° N, 22.14151° E	147	12.08	<i>Ranunculus illyricus</i> (3500)		81
Hu	Karcag	47.32663° N, 20.94112° E	84	1.53	-		15
Hu	Karcag	47.32811° N,	87	6.94	-		13

		20.91610° E				
Hu	Karcag	47.29893° N, 20.93140° E	85	NA	-	NA
Hu	Karcag	47.32586° N, 20.93700° E	84	4.64	<i>Amygdalus nana</i> (1)	5
Hu	Karcag	47.32383° N, 20.93829° E	83	3.1	<i>Amygdalus nana</i> (4), <i>Aster sedifolius</i> (3500)	15
Hu	Karcag	47.30395° N, 20.90992° E	84	12.71	<i>Amygdalus nana</i> (5), <i>Linaria biebersteinii</i> (150), <i>Ornithogalum brevistylum</i> (1000)	3
Hu	Karcag	47.31602° N, 20.90592° E	84	3.3	<i>Ornithogalum brevistylum</i> (1)	35
Hu	Kartal	47.67808° N, 19.54377° E	161	2.47	-	7
Hu	Kenderes	47.25042° N, 20.66354° E	87	7.44	<i>Linaria biebersteinii</i> (10)	5
Hu	Kétsoprony	46.71803° N, 20.87785° E	85	1.36	-	0
Hu	Kisléta	47.82639° N, 21.99915° E	145	4.32	-	6
Hu	Kisnána	47.84796° N, 20.14938° E	168	2.27	<i>Clematis integrifolia</i> (300), <i>Thlaspi jankae</i> (8), <i>Phlomis tuberosa</i> (13)	33
Hu	Kisrozvagy	48.34557° N, 21.93563° E	101	0.83	<i>Amygdalus nana</i> (1)	4
Hu	Kistújszállás	47.20436° N, 20.75772° E	86	NA	<i>Amygdalus nana</i> (1), <i>Linaria biebersteinii</i> (200)	NA
Hu	Kistújszállás	47.22229° N, 20.77448° E	82	6.3	<i>Amygdalus nana</i> (1), <i>Ornithogalum brevistylum</i> (50)	37
Hu	Kistújszállás	47.21651° N, 20.73982° E	84	6.64	<i>Amygdalus nana</i> (1), <i>Linaria biebersteinii</i> (10), <i>Aster sedifolius</i> (100)	55
Hu	Kisvárda	48.21589° N, 22.08360° E	108	5.4	<i>Ranunculus illyricus</i> (1500)	27
Hu	Komádi	47.01467° N, 21.48329° E	98	8.59	-	4
Hu	Komádi	47.01729° N, 21.50782° E	89	3.01	<i>Amygdalus nana</i> (1)	8
Hu	Kondoros	46.76226° N, 20.78731° E	74	8.24	-	36
Hu	Körmösdpuszta	47.07698° N, 21.59124° E	95	1.15	-	36
Hu	Körösladány	46.97117° N, 21.07143° E	91	5.93	<i>Amygdalus nana</i> (2)	28
Hu	Körösnagyharsány	47.00493° N, 21.64906° E	94	1.17	-	15

Hu	Körösnyárharsány	47.00674° N, 21.64541° E	95	1.36	-	30
Hu	Köröstarcsa	46.87331° N, 21.01859° E	87	6.91	-	3
Hu	Körösetetlen	47.08523° N, 20.02389° E	87	0.49	-	29
Hu	Körösújfalú	46.96397° N, 21.38376° E	90	1.01	-	16
Hu	Körösszakál	47.01934° N, 21.58851° E	92	1.71	-	4
Hu	Körösszegapáti	47.04642° N, 21.63538° E	97	1.83	-	3
Hu	Kötegyán	46.73441° N, 21.46720° E	89	0.83	-	59
Hu	Kunadacs	46.93833° N, 19.32025° E	99	1.99	-	8
Hu	Kunmadaras	47.42618° N, 20.77374° E	94	4.03	<i>Amygdalus nana</i> (1), <i>Ornithogalum brevistylum</i> (100)	24
Hu	Kunpeszér	47.06451° N, 19.27521° E	96	0.57	-	12
Hu	Kunszentmárton	46.82940° N, 20.28726° E	82	6.7	-	26
Hu	Kunszentmárton	46.84420° N, 20.29399° E	83	8.1	-	2
Hu	Lácacséke	48.36593° N, 21.98559° E	110	0.51	<i>Ranunculus illyricus</i> (20)	35
Hu	Levelek	47.96572° N, 21.99614° E	129	1.38	-	6
Hu	Lőrinci	47.73463° N, 19.69067° E	123	5.12	-	30
Hu	Magyarbánhegyes	46.46181° N, 20.95498° E	101	3.51	-	16
Hu	Magyarhomorog	47.02083° N, 21.53700° E	89	2.86	-	5
Hu	Máriapócs	47.88017° N, 22.01675° E	137	1.69	-	10
Hu	Markaz	47.82908° N, 20.05698° E	214	1.78	<i>Ranunculus illyricus</i> (1000), <i>Thlaspi jankae</i> (150)	3
Hu	Mátrafüred	47.82323° N, 19.96579° E	314	0.95	<i>Potentilla patula</i> (10), <i>Thlaspi jankae</i> (60)	84
Hu	Méhkerék	46.77561° N, 21.45384° E	97	0.84	-	73
Hu	Méhkerék	46.77620° N,	87	2.79	-	21

		21.45830° E				
Hu	Mezőberény	46.81163° N, 21.01139° E	73	6.4	-	20
Hu	Mezőberény	46.82805° N, 21.01322° E	87	3.61	-	18
Hu	Mezőberény	46.81131° N, 21.01105° E	83	6.13	<i>Linaria biebersteinii</i> (100)	9
Hu	Mezőcsát	47.81228° N, 20.91115° E	93	NA	-	NA
Hu	Mezőcsát	47.81330° N, 20.91063° E	93	NA	-	NA
Hu	Mezőcsát	47.81624° N, 20.91300° E	93	5.47	-	9
Hu	Mezőgyán	46.87849° N, 21.52041° E	95	1.38	-	14
Hu	Mezőpeterd	47.16664° N, 21.62362° E	98	2.2	-	6
Hu	Mezősas	47.11864° N, 21.56845° E	89	1.58	-	7
Hu	Mezőtúr	47.00740° N, 20.60618° E	86	15.93	<i>Amygdalus nana</i> (2), <i>Linaria biebersteinii</i> (1)	12
Hu	Murony	46.76198° N, 21.05189° E	82	0.94	-	3
Hu	Nagyhegyes	47.54379° N, 21.35763° E	92	2.14	<i>Amygdalus nana</i> (1)	14
Hu	Nagyiván	47.49169° N, 20.93437° E	89	1.71	-	2
Hu	Nagyiván	47.48466° N, 20.91857° E	86	1.39	<i>Iris pumila</i> (5)	44
Hu	Nagykálló	47.87751° N, 21.82915° E	120	7.73	<i>Spiraea crenata</i> (2)	4
Hu	Nagymágocs	46.57617° N, 20.46776° E	80	3.94	<i>Ornithogalum brevistylum</i> (350)	47
Hu	Nagyrábé	47.20152° N, 21.34709° E	102	3.36	<i>Amygdalus nana</i> (4)	19
Hu	Nagyréde	47.77025° N, 19.84318° E	151	1.68	<i>Ornithogalum brevistylum</i> (15)	9
Hu	Nagyrév	46.95240° N, 20.13874° E	84	6.07	-	73
Hu	Nagyszénás	46.67489° N, 20.65519° E	89	4.29	-	0
Hu	Nyírábrány	47.54586° N, 22.00524° E	134	3.47	-	16

Hu	Nyiracsád	47.60387° N, 21.97202° E	140	NA	-	NA
Hu	Nyírbéltek	47.69334° N, 22.11251° E	158	4.7	<i>Spiraea crenata</i> (2)	44
Hu	Nyírbogát	47.79521° N, 22.04984° E	156	1.51	-	43
Hu	Nyírcsászári	47.87683° N, 22.16730° E	153	1.6	-	21
Hu	Nyílderzs	47.90336° N, 22.15760° E	139	0.6	<i>Ranunculus illyricus</i> (100)	100
Hu	Nyírgelse	47.76016° N, 21.98023° E	151	NA	-	NA
Hu	Nyírgyulaj	47.88797° N, 22.07938° E	143	0.82	-	39
Hu	Nyírgyulaj	47.89315° N, 22.09168° E	148	0.94	-	96
Hu	Nyírgyulaj	47.89300° N, 22.09373° E	157	2.18	-	32
Hu	Nyírlugos	47.69938° N, 22.04611° E	162	NA	-	NA
Hu	Nyírlugos	47.69213° N, 22.02851° E	166	NA	<i>Amygdalus nana</i> (1)	NA
Hu	Nyírlugos ótemető	47.69257° N, 22.02889° E	157	1.87	<i>Ranunculus illyricus</i> (1)	15
Hu	Nyírlugos-Cserhágó	47.71668° N, 22.02352° E	172	NA	-	NA
Hu	Nyírmada	48.06919° N, 22.20518° E	139	2.9	<i>Ranunculus illyricus</i> (1500), <i>Spiraea crenata</i> (1)	95
Hu	Nyírmártonfalva	47.59210° N, 21.89311° E	141	2.35	-	0
Hu	Nyírmártonfalva	47.58861° N, 21.90208° E	159	NA	-	NA
Hu	Nyírmeggyes	47.91123° N, 22.25328° E	139	3.04	-	49
Hu	Nyírmihálydi	47.73652° N, 21.97216° E	156	NA	-	NA
Hu	Nyírtelek	48.01377° N, 21.62413° E	119	0.97	-	71
Hu	Nyírtelek	48.05621° N, 21.55792° E	106	0.78	-	31
Hu	Nyírvasvári	47.82175° N, 22.18846° E	148	2.18	<i>Ranunculus illyricus</i> (20)	1
Hu	Okány	46.89575° N,	84	2.43	-	11

		21.36082° E				
Hu	Okány	46.89571° N, 21.36577° E	94	7.54	-	19
Hu	Ópályi	47.99956° N, 22.32436° E	117	NA	-	NA
Hu	Ópályi	47.99233° N, 22.32211° E	117	2	<i>Ranunculus illyricus</i> (2000)	7
Hu	Öcsöd	46.90948° N, 20.39669° E	82	1.88	-	39
Hu	Öcsöd	46.89940° N, 20.37845° E	80	7.49	<i>Amygdalus nana</i> (1)	56
Hu	Őr	47.97409° N, 22.19788° E	155	0.86	<i>Ranunculus illyricus</i> (200)	24
Hu	Örkény	47.13015° N, 19.42016° E	121	2.38	-	5
Hu	Örkény	47.13701° N, 19.44393° E	128	1.98	<i>Centaurea arenaira</i> (50)	89
Hu	Örkény	47.12237° N, 19.41878° E	120	1.56	<i>Vinca herbacea</i> (25) <i>Festuca wagneri</i> (100)	15
Hu	Pálosvörösmart	47.81808° N, 19.99688° E	269	0.44	<i>Ranunculus illyricus</i> (500), <i>Thlaspi jankae</i> (150)	2
Hu	Papos	47.98597° N, 22.24476° E	147	NA	<i>Ranunculus illyricus</i> (200)	NA
Hu	Penészlek	47.62927° N, 22.15742° E	157	0.4	-	0
Hu	Penészlek	47.64021° N, 22.14212° E	165	1.32	<i>Amygdalus nana</i> (1)	2
Hu	Petőfibánya	47.75396° N, 19.70518° E	140	1.9	-	2
Hu	Piricse	47.76783° N, 22.14365° E	151	2.86	-	70
Hu	Piricse	47.77649° N, 22.15827° E	151	1.22	-	11
Hu	Pocsaj	47.28307° N, 21.80164° E	140	1	-	24
Hu	Pocsaj	47.29591° N, 21.82596° E	146	4.34	<i>Amygdalus nana</i> (1)	65
Hu	Pócspetri	47.87923° N, 21.98094° E	134	2.73	-	4
Hu	Polgár	47.86149° N, 21.10859° E	92	6.33	<i>Amygdalus nana</i> (1)	5
Hu	Pusztamonostor	47.55563° N, 19.80304° E	141	3.36	<i>Amygdalus nana</i> (2), <i>Spiraea crenata</i> (2), <i>Vinca herbacea</i> (10)	40

Hu	Pusztavacs	47.17398° N, 19.49757° E	129	1.27	-		87
Hu	Püspökladány	47.33055° N, 21.12257° E	86	3.91	-		100
Hu	Püspökladány	47.30757° N, 21.10581° E	88	12.37	<i>Amygdalus nana</i> (5), <i>Linaria biebersteinii</i> (10)		30
Hu	Rakamaz	48.12680° N, 21.45617° E	98	3.09	-		8
Hu	Rohod	48.02859° N, 22.12823° E	133	2.03	-		7
Hu	Rózsaszentmárton	47.79163° N, 19.73917° E	188	1.93	<i>Phlomis tuberosa</i> (40)		41
Hu	Sarkad	46.73906° N, 21.36984° E	83	8.7	-		6
Hu	Sarkad	46.74650° N, 21.39757° E	94	2.81	-		6
Hu	Sarkadkeresztúr	46.81059° N, 21.37324° E	91	2.1	-		18
Hu	Sarkadkeresztúr	46.81851° N, 21.38284° E	88	1.08	-		48
Hu	Sárrétudvari	47.22935° N, 21.18563° E	93	1.46	<i>Amygdalus nana</i> (3), <i>Linaria biebersteinii</i> (10)		21
Hu	Szakoly	47.76878° N, 21.91483° E	143	NA	-		NA
Hu	Szakoly	47.76771° N, 21.89420° E	137	1.15	<i>Amygdalus nana</i> (1)		63
Hu	Szarvas	46.85340° N, 20.55691° E	84	13.19	<i>Amygdalus nana</i> (6), <i>Linaria biebersteinii</i> (5)		3
Hu	Székkutas	46.49562° N, 20.52553° E	84	1.58	-		6
Hu	Szelevény	46.80750° N, 20.19586° E	82	2.45	-		6
Hu	Szentpéterszeg	47.23400° N, 21.61064° E	99	2.03	-		14
Hu	Szentpéterszeg	47.22966° N, 21.61281° E	92	4.54	-		89
Hu	Szerep	47.22528° N, 21.13195° E	89	1.85	<i>Amygdalus nana</i> (5)		12
Hu	Szolnok	47.16273° N, 20.16798° E	85	25.45	<i>Amygdalus nana</i> (3)		13
Hu	Szücsi	47.80537° N, 19.76580° E	204	1.78	<i>Phlomis tuberosa</i> (45)		2
Hu	Tarhos	46.81490° N,	83	1.73	-		32

		21.22920° E				
Hu	Tarnabod	47.68244° N, 20.22623° E	106	0.79	-	14
Hu	Tarnaméra	47.64695° N, 20.15313° E	100	1.59	-	21
Hu	Tarnaörs	47.59205° N, 20.05664° E	93	1.61	-	1
Hu	Tatárszentgyörgy	47.08404° N, 19.36511° E	108	4.87	-	2
Hu	Tetétlen	47.32134° N, 21.30986° E	87	1.3	<i>Spiraea crenata</i> (2)	21
Hu	Tiszacsege	47.68541° N, 20.99707° E	90	3.02	-	3
Hu	Tiszaderzs	47.50745° N, 20.63960° E	90	4.12	-	17
Hu	Tiszadob	48.00199° N, 21.17395° E	94	4.18	-	72
Hu	Tiszadob	47.99760° N, 21.18001° E	87	0.77	<i>Amygdalus nana</i> (1)	17
Hu	Tiszaigar	47.53313° N, 20.80894° E	82	0.97	-	24
Hu	Tiszainoka	46.90346° N, 20.15990° E	82	0.93	<i>Linaria biebersteinii</i> (100), <i>Ornithogalum brevistylum</i> (3)	2
Hu	Tiszakürt	46.88710° N, 20.13081° E	81	5.25	-	13
Hu	Tiszalök	48.01053° N, 21.38267° E	99	7.16	<i>Amygdalus nana</i> (3)	51
Hu	Tiszaörs	47.49874° N, 20.81562° E	98	2.08	<i>Amygdalus nana</i> (1)	7
Hu	Tiszaörs	47.50378° N, 20.81923° E	92	NA	<i>Spiraea crenata</i> (4) <i>Ranunculus illyricus</i> (1000), <i>Iris pumila</i> (1)	NA
Hu	Tiszapüspöki	47.21281° N, 20.31143° E	83	2.1	-	21
Hu	Tiszaroff	47.40385° N, 20.42954° E	84	3.68	<i>Amygdalus nana</i> (25)	54
Hu	Tiszaroff	47.38979° N, 20.44349° E	86	2.26	<i>Amygdalus nana</i> (15)	48
Hu	Tiszaroff	47.40192° N, 20.42419° E	85	NA	<i>Amygdalus nana</i> (300), <i>Linaria biebersteinii</i> (100), <i>Ornithogalum brevistylum</i> (100)	NA
Hu	Tiszaszentimre	47.48273° N, 20.72721° E	90	1.51	<i>Amygdalus nana</i> (1), <i>Spiraea crenata</i> (1), <i>Ranunculus illyricus</i> (20)	9
Hu	Tiszaszentimre- Újszentgyörgy	47.44973° N, 20.71298° E	95	0.71	<i>Amygdalus nana</i> (1), <i>Spiraea crenata</i> (1) <i>Iris pumila</i> (20)	10

Hu	Tiszaszőlős	47.55878° N, 20.73202° E	89	1.58	-		13
Hu	Tiszaug	46.84809° N, 20.06866° E	81	1.48	-		7
Hu	Tiszavasvári	47.97129° N, 21.32639° E	115	2.54	-		83
Hu	Tiszavasvári	47.95802° N, 21.37808° E	105	6.53	<i>Amygdalus nana</i> (3)		6
Hu	Told	47.12140° N, 21.65107° E	97	0.65	-		12
Hu	Tószeg	47.09505° N, 20.15172° E	84	5.55	<i>Aster sedifolius</i> (15)		4
Hu	Tököl	47.31529° N, 18.96345° E	98	NA	-		NA
Hu	Tura	47.59694° N, 19.58255° E	143	1.51	-		5
Hu	Tura	47.60121° N, 19.59883° E	125	4.55	<i>Ornithogalum refractum</i> (15)		29
Hu	Túrkeve	47.10603° N, 20.73129° E	88	3.65	<i>Linaria biebersteinii</i> (100), <i>Ornithogalum brevistylum</i> (50000)		5
Hu	Túrkeve	47.09638° N, 20.72610° E	89	4.4	<i>Linaria biebersteinii</i> (50), <i>Aster sedifolius</i> (10), <i>Ornithogalum brevistylum</i> (10)		6
Hu	Túrkeve	47.11483° N, 20.74759° E	90	7.68	<i>Amygdalus nana</i> (1), <i>Linaria biebersteinii</i> (30), <i>Ornithogalum brevistylum</i> (100)		36
Hu	Újfehértó	47.80446° N, 21.65626° E	125	5.94	-		8
Hu	Újfehértó	47.80266° N, 21.66431° E	134	5.76	<i>Spiraea crenata</i> (1)		85
Hu	Újiráz	46.98684° N, 21.36042° E	87	0.6	-		7
Hu	Újszentmargita	47.73446° N, 21.10957° E	111	1.8	-		92
Hu	Vácszentlászló	47.58147° N, 19.52449° E	167	1.9	<i>Amygdalus nana</i> (1)		0
Hu	Vaja	48.00082° N, 22.17617° E	139	4.83	<i>Ranunculus illyricus</i> (30)		37
Hu	Valkó	47.56631° N, 19.50530° E	182	2.18	<i>Taraxacum serotinum</i> (40)		22
Hu	Vámospércs	47.53393° N, 21.90221° E	129	4.37	-		20
Hu	Vezseny	47.02923° N, 20.22021° E	83	2.9	-		84
Hu	Zagyvaszántó	47.77913° N,	132	1.09	<i>Ranunculus illyricus</i> (25)		13

		19.66997° E					
Hu	Zaránk	47.63933° N, 20.10839° E	98	1.32	-		43
Hu	Zsadány	46.92223° N, 21.47793° E	90	3.34	-		21
Hu	Zsadány- Fancsikapuszta	46.93752° N, 21.53637° E	89	NA	-		NA
Hu	Zsámbok	47.54485° N, 19.61113° E	131	2.61	<i>Taraxacum serotinum</i> (15)		10
Ro	Roșiori	47.26206° N, 21.96448° E	124	3.14	<i>Amygdalus nana</i> (10)		25
Ro	Săcueni	47.34752° N, 22.10247° E	123	5.12	<i>Pulsatilla montana</i> (100), <i>Scilla vindobonensis</i> (50)		15
Ro	Satu Nou	47.20507° N, 21.91998° E	106	0.97	-		35
Ro	Tureni	46.62485° N, 23.70954° E	512	NA	<i>Iris aphylla</i> (7), <i>Phlomis tuberosa</i> (1000)		NA
Ro	Tuta	47.30128° N, 22.01790° E	108	3.23	-		24
Sk	Kráľovský Chlmec	48.42885° N, 21.97650° E	104	2.75	<i>Ranunculus illyricus</i> (5000), <i>Veronica incana</i> (100), <i>Amygdalus nana</i> (1)		14
Sk	Pribeník	48.38710° N, 22.00240° E	118	1.27	-		13
Sk	Svätuše	48.43018° N, 21.92376° E	111	1.41	<i>Ranunculus illyricus</i> (1000), <i>Amygdalus nana</i> (5)		15
Sk	Veľký Horeš	48.38537° N, 21.91085° E	106	1.26	<i>Amygdalus nana</i> (1)		13

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