Tuexenia 42: 275–296. Göttingen 2022.
doi: 10.14471/2022.42.009, available online at www.tuexenia.de

Habitat preference of the endangered species *Crambe tataria* (*Brassicaceae*) from Romania

Habitatpräferenzen der gefährdeten Art *Crambe tataria* (*Brassicaceae*) aus Rumänien

Simona Dumitrița Chirilă[1, *], Irina Gabriela Cara[2, 3] & Iuliana Motrescu[3, 4]

[1]*Department of Biology, Alexandru Ioan Cuza University of Iasi, Blvd. Carol I 20A, 700505 Iasi, Romania;*
[2]*Department of Pedotechnics, Ion Ionescu de la Brad University of Agricultural Sciences and Veterinary Medicine, 3 Sadoveanu Alley, 700490, Iasi, Romania;*
[3]*Research Institute for Agriculture and Environment, Ion Ionescu de la Brad University of Agricultural Sciences and Veterinary Medicine, 3 Sadoveanu Alley, 700490, Iasi, Romania;*
[4]*Department of Sciences, Ion Ionescu de la Brad University of Agricultural Sciences and Veterinary Medicine, 3 Sadoveanu Alley, 700490, Iasi, Romania*
**Corresponding autor, e-mail: simonachirilasc@yahoo.com*

Abstract

Crambe tataria is a protected species, thermophilic relict in Europe and steppe postglacial relict in Romania. In the past three decades, the size of *C. tataria* populations has been significantly reduced, and the geographical distribution of these populations is fragmented. Despite its status, there is insufficient data on the environmental conditions of this priority species. This study aimed to identify the main plant communities with *C. tataria* and the relationships between their floristic composition and environmental variables. The floristic composition based on 211 phytocoenological relevés from the Romanian Grasslands Database (164 relevés; EU-RO-008) and personal data (47 relevés). The vegetation groups were identified using hierarchical agglomerative clustering methods. Detrended correspondence analysis (DCA) and canonical correlation analysis (CCA) evaluated the relationship between floristic composition and environmental variables. Climatic variables were represented by the environmental variables. The analysis of the floristic composition was performed based on the presence/absence matrix. The vegetation analysis indicated that *C. tataria* grows and persists in a limited number of plant communities, with a preference for the *Arrhenatherion elatioris*, *Festucion valesiacae*, *Stipion lessingianae*, *Cirsio-Brachypodion pinnati*, *Danthonio-Brachypodion* and *Prunion fruticosae*. The most important variable that influences the floristic composition is the elevation. The analyzed populations prefer alkaline soils rich in nitrogen, phosphorus, and potassium. Arsenic and lead were also present in high concentrations. Investigations have shown that in addition to the *Festuco-Brometea* the phytocoenoses of *C. tataria* identified belong to the *Molinio-Arrhenatheretea*, and *Rhamno-Prunetea* classes. The areas occupied by xerophilic meadows of the *Festuco-Brometea* are in different stages of degradation due to overgrazing, particularly in north-eastern Romania.

Keywords: *Crambe tataria* populations, elevation, environmental conditions, floristic composition, habitat preference

Erweitere deutsche Zusammenfassung am Ende des Artikels

Manuscript received 15 October 2021, accepted 30 September 2022
Published online 12 December 2022
Co-ordinating Editor: Christian Berg

1. Introduction

Europe is home to a unique diversity of ecologically and economically important plants. Thus, the flora of Europe is one of the best known and studied in the world but is strongly influenced over time due to direct and indirect extinctions caused by human interventions (SILVA et al. 2008). The European flora (excluding Turkey) includes over 12,500 species of vascular plants (RADFORD & ODÉ 2009). According to the criteria in the International Union for Conservation of Nature's Red List (IUCN), of the 4700 vascular endemic plants in Europe, about 1917 taxa (species and subspecies) are considered endangered (BACHMAN et al. 2016). As a result of the accelerated pace of industrialization and development in the last 250–300 years, along with the destruction of habitat, pollution, and invasive species (OOSTERMEIJER 2003), Europe's flora has been classified as one of the most endangered (SILVA et al. 2008).

Study object of this research is *Crambe tataria* (*Brassicaceae*). This species is distributed in Central and Eastern Europe and Western Siberia (MÂNZU et al. 2020). At the global level, *C. tataria* is not threatened (SÂRBU et al. 2007). In Europe, according to the criteria set out in the International Union for Conservation of Nature's Red List of Threatened Species, the species' status is of least concern (LC) due to its wide distribution in Central, Eastern, and South-Eastern Europe (KELL 2011). In Romania, this species is considered vulnerable and rare (OLTEAN et al. 1994). The western limit of its geographical distribution crosses Central Europe (Hungary) and southeastern Central Europe (Romania), where most localities with C. tataria have been identified.

Crambe tataria occurs in various of habitats, including dry grasslands, roadsides, farmland, and abandoned orchards (HORVÁTH 2005, CHIRILĂ 2022). It was also observed at the edge and inside pine forests (*Pynus sylvestris* L.). In Romania, the species is widespread in the North-East, South and Central regions, on sunny hills and slopes with moderately accentuated, southwestern and northeastern slopes. *Crambe tataria* has been reported at elevations between 77 m (ANIȚEI 2000) and 644 m (CHIRILĂ 2022). In the analyzed habitats, the amount of precipitation varied from 478 mm to 731 mm. The soils of *C. tatarica* habitats are rich in nutrients and have an alkaline pH. High concentrations of lead and silicon have also been identified (CHIRILĂ 2022). *Crambe tataria* is currently in decline due to habitat degradation and fragmentation. Of the 168 populations of *C. tataria* reported in Romania, approximately 60–70% have not been identified in the last three decades (CHIRILĂ 2021). Population decline is caused both indirectly (pollution, invasive species, and climate change) and directly (overgrazing, land-use change, mechanized mowing, flower picking during vegetation, etc.) by human activities (HORVÁTH 2005, CHIRILĂ 2021, 2022).

Crambe tataria is mainly threatened by overgrazing (HORVÁTH 2005). This factor destroys the species' leaves, inflorescences, and fruits (CHIRILĂ 2022). The species was one of the most important basic vegetables during famines, consumed by many peoples. Bread was made from the roots (RAPAICS 1938), the leaves were eaten as a salad or vegetable, or in various sauces (KALISTA 2017). The shoots were eaten as a substitute for *Asparagus officinalis* L., and the leaves as a substitute for *Spinacia oleracea* L. (PÂRVU 2005).

Research on the habitat preference of *C. tataria* is essential to explain the probabilities of its survival in current habitat conditions and its ability to occupy new favourable habitats. Also, this research is necessary for developing endangered species conservation strategies. Research on plant species, rare or declining, is insufficient, with most of the existing ones focusing on genetic structure. In contrast, only a few studies focus on population characteristics and reproduction ability. Moreover, land-use change can have significant consequences for small populations, prone to population declines and extinction due to demographic variation. Therefore, rare plant species limited to small and isolated populations may be more likely to become extinct (FISCHER & MATTHIES 1998). This study was designed to investigate the habitat preferences of *C. tataria* species in Romania because scientific data on the appropriate habitat for this species are insufficient.

2. Study area

The study area is represented by three historical regions in Romania: Muntenia, Moldova, and Transylvania (Fig. 1). The climate is temperate continental, with mean annual precipitation from 478 mm to 731 mm and mean annual temperature from 7 °C to 11 °C. The dominant soil types are chernozem and phaeozem (Digital Soil Map Of The World, http://www.fao.org/geonetwork/srv/en/metadata.show%3Fid=14116, accessed 2021-09-12).

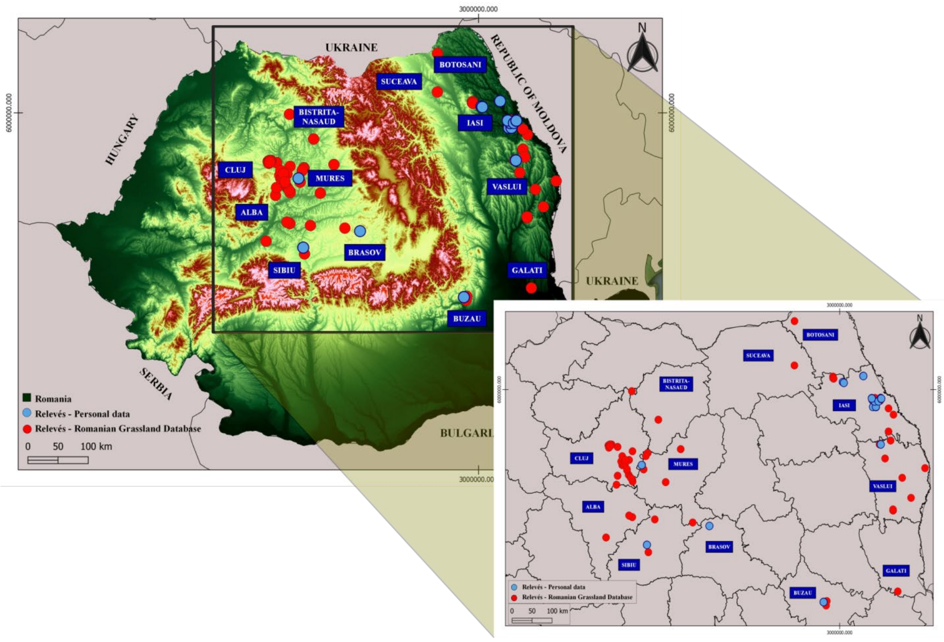

Fig. 1. Area of the study.

Abb. 1. Das Untersuchungsgebiet.

3. Material and methods

3.1 Study species

Crambe tataria (Fig. 2) is a grassland species with a discontinuous distribution, from the Pannonian Plain to the steppes north of the Black Sea (MÂNZU et al. 2020). It is a pontic hemicryptophyte, green-bluish, with a height ranging from 25 to 150 cm (SÂRBU et al. 2013). The root is fleshy and sweet, blackish-brown on the outside and white on the inside, and up to 120 cm long (NYÁRÁDY 1955).

Fig. 2. *Crambe tataria* Sebeók. **a)** In the flowering stage, **b)** the fruiting stage and c) the maturity stage (Photos: S. D. Chirilă, a) and b) May 2020, c) September 2020).

Abb. **2**. *Crambe tataria* Sebeók. **a)** In der Blütephase, **b)** der Fruchtphase und **c)** der Reifephase (Fotos: S. D. Chirilă, a) and b) Mai 2020, c) September 2020).

3.2 Vegetation sampling and classification

For syntaxonomic assignment of the vegetation, 213 relevés (including 604 taxa) were used. Most relevés (164) were obtained from the Romanian Grassland Database (RGD; VASSILEV et al. 2018), and 47 relevés were made between May and July 2020 in some localities in Romania. The size of the own 47 relevés in the field was 100 m^2, and the relevé sizes (164 relevés) obtained from the Romanian Grassland Database varied from 10 m^2 to 200 m^2. For the analysis of the species composition, the presence-absence matrix was created from the transformation of the database records. The taxonomy and nomenclature of vascular plants were checked following the EURO+MED (2022). For further data preparation and analysis, all relevés were imported into JUICE 7.0 (TICHÝ 2002). Then, before the numerical classification, we standardized our relevé dataset (DENGLER et al. 2012, JANSSEN et al. 2016, MUCINA et al. 2016, WILLNER et al. 2019): (i) taxonomy and nomenclature were unified; (ii) taxa identified only at the genus level were eliminated; (iii) lichens and bryophytes were excluded from the analysis as they were only recorded in some relevés. The final dataset included 211 relevés and 572 species.

Vegetation classification was performed by hierarchical agglomerative clustering, using the flexible β algorithm (β = -0.25) and the Bray-Curtis distance. Subsequently, the dendrogram was created using the GINKGO program of the VegAna package (BOUXIN 2005). The optimal number of clusters was identified using the corrected Rand index (RAND 1971) and the mean silhouette index (ROUSSEEUW 1987). For each cluster, diagnostic species were identified based on the IndVal (DUFRÊNE & LEGENDRE 1997) and validated by a permutation test (DE CÁCERES & LEGENDRE 2009) using GINKGO software (BOUXIN 2005). Habitat type was classified using the classification expert system for EUNIS habitats (CHYTRÝ et al. 2020). Moreover, the habitat codes in the expert system correspond to those used in the European Red List of Habitats (JANSSEN et al. 2016). The nomenclature of plant associations follows COLDEA et al. (2012) and CHIFU et al. (2014). The mean values for each analysis are presented.

3.3 Analysis of soil samples

In this study, 47 soil samples were analyzed. Determination of total concentrations of chemical elements: arsenic (As), and lead (Pb), was realized according to the standard SR EN 15309:2007 “Characterization of waste and soil; Determination of elemental composition by X-ray fluorescence’’. The determination of the chemical composition of these chemical elements was performed by X-ray fluorescence spectrometry (XRF). The spectrometric determination of mobile phosphorus (P) and potassium (K) in the ammonium acetate solution was performed according to the Egner-Riehm-Domingo method. The total nitrogen (N) in the soil was performed by the Kjeldahl method (LĂCĂTUȘU 2016, LUNGU & RIZEA 2017). The soil pH was determined according to SR ISO10390:2015 “Soil quality – Determination of pH" For the 164 relevés from the RGD database, the values regarding As, Pb (PANAGOS et al. 2012), N, P, K, and soil pH (BALLABIO et al. 2019) were extracted from the European Soil Database & soil properties (ESDAC; https://esdac.jrc.ec.europa.eu/resource-type/european-soil-database-soil-properties, accessed 2022-03-12).

3.4 Environmental variables

The environmental variables used in multivariate analyses were represented by abiotic variables (elevation, slope, aspect, and precipitation of driest quarter). Precipitation of the driest quarter was extracted from the WorldClim database (FICK & HIJMANS 2017).

3.5 Other statistical analyses

The relationships between the floristic composition and the environmental variables were analyzed using CANOCO version 5 (TER BRAAK & ŠMILAUER 2012). Detrended correspondence analysis (DCA) was applied to detect floristic gradients. To quantify the "strength" of the effect of each environmental variable studied on the floristic composition, we applied canonical correspondence analysis (CCA). The significance of the variables was assessed using the Monte Carlo permutation test (999 permutations). To determine the collinearity between our variability (floristic composition and environmental variables), the variable inflation factor (VIF) was used in CANOCO. Variables with VIF value > 5 are considered multicolinary and have been excluded from the model (Table 1). The map with the relevés distribution was made in the QGIS version 3.18.3 (https://qgis.org).

Table 1. VIF (variation inflation factor) analysis between environmental variables.
Tabelle 1. VIF-Analyse zwischen Umgebungsvariablen.

Variables	VIF
Precipitation of driest quarter (Bio 17)	3.635
Elevation	4.045
Aspect	1.045
Slope	1.314

4. Results

4.1 Habitat types

Crambe tataria has been identified in three main habitat types: mesic and xeric scrub and *Robinia* groves, dry grasslands, meadows and mesic pastures. Mean vegetation cover was 80%, and mean moss cover was 5%. Vegetation was classified into three vegetation classes, five orders, six alliances, and 19 associations.

Class: *Molinio-Arrhenatheretea* R. Tx. 1937
  Order: *Arrhenatheretalia* R. Tx. 1931
    All.: *Arrhenatherion elatioris* Koch 1926
      Ass.: *Arrhenatheretum elatioris* Br.-Bl. ex Scherrer 1926

Class: *Festuco-Brometea* Br.-Bl. et Tx. ex Klika et Hadač 1944
  Order: *Festucetalia valesiacae* Br.-Bl. et R. Tx. ex Br.-Bl. 1949
    All.: *Festucion valesiacae* Klika 1931
      Ass.: *Elytrigietum hispidi* (Dihoru 1970) Popescu et Sanda 1988
      Ass.: *Medicagini minimae-Festucetum valesiacae* Wagner 1941

Ass.: *Botriochloetum* (*Andropogonetum*) *ischaemi* (Kristiansen 1937) Pop 1977
Ass.: *Salvio nutanti-nemorosae-Festucetum rupicolae* (*Salvio nutantis-Paeonietum tenuifoliae*) Zólyomi 1958
Ass.: *Festuco rupicolae-Caricetum humilis* Soó. (1930) 1947
Ass.: *Koelerietum macranthae* (Răvăruț et al. 1956) Popescu et Sanda 1988
Ass.: *Stipetum capillatae* (Hueck 1931) Krausch 1961
Ass.: *Agropyro pectinati-Stipetum capillatae* (Burduja et al 1956) Chifu et al. 1998
Ass.: *Taraxaco serotinae-Festucetum valesiacae* (Burduja et al. 1956) Sârbu et al. 1999
Ass: *Thymo pannonici-Chrysopogonetum grylli* (Bârcă 1973) Doniţă et al. 1992
All.: *Stipion lessingianae* Soó 1947
Ass.: *Galio octonarii-Stipetum tirsae* (Ciocârlan 1969). Popescu et Sanda 1992
Ass.: *Stipetum pulcherrimae* Soó 1942
Ass.: *Artemisietum pontico-sericeae* Soó (1927) 1942
Ass.: *Jurineo arachnoideae-Stipetum lessingianae* (Dobrescu 1974) Chifu, Mânzu et Zamfirescu 2006
Order: *Brachypodietalia pinnati* Korneck 1974
All.: *Cirsio-Brachypodion pinnati* Hadac & Klika in Klika & Hadac 1944
Ass.: *Carici humilis-Brachypodietum pinnati* Soó ex Pop et al. 2001
Ass.: *Festuco rupicolae-Brachypodietum pinnati* (Soó 1927)
Order: *Brachypodio-Chrysopogonetalia* (Horvatič 1958) Boşcaiu 1972
All.: *Danthonio-Brachypodion* Boşcaiu 1972
Ass.: *Danthonio alpinae-Stipetum stenophyllae* Ghişa 1941
Class: *Rhamno-Prunetea* Rivas Goday et Borja Carbonell ex Tüxen 1962
Order: *Prunetalia spinosae* R. Tüxen 1952
All.: *Prunion fruticosae* Dziubałtowski 1926
Ass.: *Prunetum tenellae* Soó 1951

Crambe tataria is a meso-xerophilous-mesophilic species with specific characteristics of steppe and forest-steppe grasslands, which grows on deep soils such as phaeozem and luvic chernozem. *Crambe tataria* sites are characterized by open vegetation located on the southern (180°), south-southwestern (203°), and southwestern (225°) slopes. The species was also observed on eastern (90°) and northern (360°) slopes. *Crambe tataria* was observed on slopes between 4° and 20°, followed by slopes with slopes of 21° to 60°. The mean annual precipitation was 585 mm, and the mean annual temperature was 9 ℃. The type of grassland management is represented by the following categories: non-grazed grasslands, mowed grasslands, and grazed grasslands. The mean richness of plant species per 10 m^2 varies between 7 to 117 species, with a mean of 48 species per m^2. The vegetation cover was from 42% to 90%. The cover of bryophytes was mostly low, between 1% and 50%. Shrubs and semi-shrubs were rare. Perennials predominate in the plant communities. In terms of humidity, the meso-xerophyte group dominates.

The *Festuco-Brometea* class corresponds to the dry grassland habitat type. These grasslands are xerophilous and xero-mesophilic and occur on weakly alkaline soils rich in phosphorus, arsenic, and lead. Most grasslands are grazed, with higher mean annual temperatures but lower mean annual precipitation than mesic and xeric scrub and *Robinia* groves habitat and meadows and mesic pastures habitat. The *Molinio-Arrhenatheretea* class corresponds to the type of habitat meadows and mesic pastures. These meadows are mesophilic, and poor in species. Unlike other habitat types, these meadows are non-grazed and characterized by the highest nitrogen, potassium, and calcium concentrations. The mean annual precipitation was higher than in the dry grassland's habitat. The *Rhamno-Prunetea* class corresponded to mesic habitat type, xeric scrub, and *Robinia* groves. These communities were characterized by mean annual precipitation, higher elevation, and slopes but with a lower vegetation cover than the other two habitats. Among the three habitat types in which the species *C. tataria* was identified, we found that dry grasslands are the optimum habitat of the species. This is indicated by the occurrence of the species in most plots in dry grasslands (*n* = 197, 97.5%). In the mesic and xeric scrub and *Robinia* groves habitat (*n* = 4, 1.9%) and the meadows and mesic pastures (*n* = 1, 0.4%), *C. tataria* was recorded in a small number of plots.

4.2 Cluster analysis

The results of the cluster analysis are presented in the dendrogram and the synoptic table (Supplement E1). The dendrogram resulting from the application of the agglomerative hierarchical clustering algorithm was cut into nine partitions with ten clusters. Based on the corrected rand index (0.994) and silhouette index (0.136), vegetation was classified into five groups (Fig. 3). These five groups reflect the syntaxonomic classification described in the literature (CHIFU et al. 2014), depending on their diagnostic species. Group A includes the communities of the grass steppes of the *Stipion lessingianae*. Group B represents narrow-leaved dry grasslands and short-grass steppes (the alliance *Festucion valesiacae*). Group C includes the subcontinental broad-leaved semi-dry grasslands and tall-grass steppes of the *Cirsio-Brachypodion pinnati* and *Danthonio-Brachypodion*. Group D includes the lowland to submontane mesic meadows communities of the *Arrhenatherion elatioris* and group E communities of the *Prunion fruticosae*.

The *Stipion lessingianae* alliance (Cluster A, 42% of the total plots) includes plots of the communities distributed in the south and centre of Romania, at elevations from 300 m to 610 m. In the analyzed communities, the steppe and Mediterranean species are dominant. In general, *Stipa lessingiana*, *S. pulcherrima* and *S. tirsa* predominate. Steppe species are also present, such as *Adonis vernalis*, *Knautia arvensis*, *Festuca valesiaca*, *Salvia nemorosa*, *S. nutans* and *Stachys recta*. These communities are used for grazing. Soils are

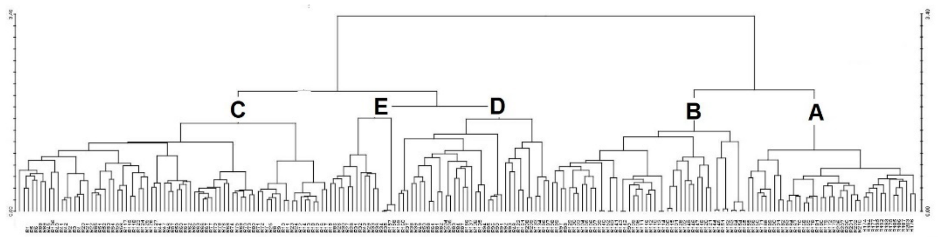

Fig. 3. Dendrogram of relevés with *Crambe tataria* in Romania. Cluster A – *Stipion lessingianae*; Cluster B – *Festucion valesiacae*; Cluster C – *Cirsio-Brachypodion pinnati* and *Danthonio-Brachypodion*; Cluster D – *Arrhenatherion elatioris*; Cluster E – *Prunion fruticosae*.

Abb. 3. Dendrogramm von Vegetationsaufnahmen mit *Crambe tataria* in Rumänien. In der englischen Abbildungsunterschrift werden die Cluster den Syntaxa zugeordnet.

characterized by neutral pH, with a very high potassium and nitrogen concentration and a medium concentration of phosphorus. The arsenic concentration was within normal limits, and the lead concentration exceeded the alert threshold values (Table 2). The alliance includes three associations:

The *Stipetum pulcherrimae* was identified in Mureș, Cluj, and Brașov counties, on steep slopes of 42° (10°–60°), with a north-southern aspect and at elevations from 300 m to 610 m (mean 415 m). The mean annual temperature was 8.3 °C (6.9–8.9 °C), and the mean annual precipitation was 598 mm (300–610 mm). On plots of 10 m^2, the vegetation coverage was 90% with 52 species per 10 m^2; on plots of 20 m^2, the vegetation coverage was 80% with 45 species per 20 m^2. Cover of moss layer was 14%. The soils are neutral, with a very high concentration of potassium and nitrogen, a medium concentration and phosphorus, and values within normal limits of lead and arsenic (Table 2).

The *Jurineo arachnoideae-Stipetum lessingianae* is distributed in the Cluj, Mureș, Iași, Alba, and Botoșani counties, with at elevations from 82–500 m (mean 296 m). The mean annual precipitation was 579 mm (545–641 mm), and the mean annual temperature was 9 °C (7.7–10.2 °C). The slopes were steep (4.4°–55°, mean 20°), with southwestern and eastern aspects. Vegetation coverage was 85% with 47 species per 10 m^2, and on plots of 20 m^2, there was a vegetation coverage of 70% with 45 species per 20 m^2. The genetic type of soil is calcium chernozem. The soils are neutral, with a very high potassium and nitrogen concentration and a medium concentration of phosphorus. Exceedances of normal arsenic values and the lead alert threshold exceedances have been identified (Table 2).

The *Galio octonarii-Stipetum tirsae* was reported in Buzău county, at elevations of 350 m, on small, north-eastern exposed slopes of 5°. Vegetation coverage was 90%, and the richness of vascular plant species was 42 species per 10 m^2. The mean annual temperature was 9.5 °C, and the mean annual precipitation was 563 mm. This association was characterized by neutral soils, with a very high concentration of potassium and nitrogen, a low concentration of phosphorus, and normal values of arsenic and lead. Compared to other associations, it was characterized by the lowest values for phosphorus, arsenic, and lead (Table 2).

The *Festucion valesiacae* alliance (Cluster B) is distributed in the North-East, Central and South-East regions of Romania, on flat to moderately sloping terrain, with north-eastern and south-western aspects. The dominant species are *Jurinea arachnoidea*, *Phlomis herba-venti*, *Astragalus onobrychis*, *Agropyron cristatum*, *Festuca valesiaca*, *Centaurea orientalis*, *Taraxacum serotinum*, *Artemisia austriaca* etc. These grasslands are generally used as pastures. The alliance is characterized by neutral soils, with normal values of arsenic and lead, rich in potassium, nitrogen, and phosphorus (Table 2).

Within the alliance, the *Medicagini minimae-Festucetum valesiacae* is distributed in Iași, Vaslui, and Brașov counties, where the soils are characterized by alkaline pH. The association is distributed at elevations from 82 m to 410 m (mean 137 m), where the mean annual precipitation is 568 mm (545–610 mm), and the mean annual temperature is 9.4 °C (8.5–9.6 °C). *Festuca valesiaca* phytocoenoses grow on sunny coasts, with south-eastern aspects and mostly steep slopes (2°–30°, mean 15.6°). The vegetation coverage was 93% with 51 species per 10 m^2, and on plots of 20 m^2, the vegetation coverage was 99% with 97 species per 20 m^2. The genetic type of soil characteristic of the analyzed area is gleic luvisol. Soils are rich in potassium, with a medium concentration of phosphorus and nitrogen, and have normal arsenic and lead values (Table 2).

The *Botriochloetum* (*Andropogonetum*) *ischaemi* was identified in Iași and Vaslui counties, at elevations from 120 m to 439 m (mean 290 m), on steep, north-eastern exosed slopes of 30°–40° (mean 33°). The mean annual temperature was 8.9 °C (8.2–9.4 °C), and the mean annual precipitation was 536 mm. The vegetation cover was 70%, and the richness of the plant species was 66 species per 10 m^2. Soils are moderately acidic, with a medium phosphorus concentration and a high concentration of potassium and nitrogen. Arsenic and lead had normal concentrations (Table 2).

The *Salvio nutanti-nemorosae-Festucetum rupicolae* is distributed in Mureș County, on moderately steep slopes (from 5.3° to 27.8°) and with north-western aspects. The mean elevation was 450 m, the mean annual precipitation was 629 mm (601–731 mm), and the mean annual temperature was 8.1 °C. The vegetation cover was 94%, and the richness of the vascular plant species was 80 species per 25 m^2. The soils are neutral, with a very high concentration of potassium, a medium concentration of phosphorus, and a high concentration of nitrogen. Lead and arsenic are in normal concentrations (Table 2).

The *Festuco rupicolae-Caricetum humilis* has been identified in some grasslands in Alba, Cluj, and Mureș counties, at elevations from 300 m to 535 m (mean: 397 m), on mostly steep slopes of (from 4° to 45°, mean 26°), with north-eastern and south-western aspects. The mean annual temperature was 8.5 °C, and the mean annual precipitation was 617 mm. The plots had the following characteristics: The vegetation cover was 90% with 45 species per 25 m^2; on plots of 16 m^2, the vegetation coverage was 80% with 47 species per 16 m^2; and on plots of 10 m^2, the vegetation cover was 80% with 32 species per 10 m^2. Cover of moss layer was 2.8% on 25 m^2 and 2.5% on 16 m^2. Soils are moderately acidic, with very high potassium and nitrogen concentrations and low phosphorus concentrations. Lead and arsenic were in normal concentrations (Table 2).

The *Koelerietum macranthae* was reported in Iași County, at elevations of 180 m, on 5° slopes, with north-eastern aspects. The vegetation cover was 100%, and the richness of the vascular plant species was 62 species per 10 m^2. The mean annual temperature was 9.6 °C, and the mean annual precipitation was 567 mm. Cover of the lichen layer was 62%, and the soils are neutral, rich in potassium and nitrogen concentrations, and poor phosphorus concentrations. Normal values for arsenic and lead were recorded (Table 2). The lowest potassium concentration was recorded in this association compared to the other associations.

The *Stipetum capillatae* was identified in some grasslands in Iași and Vaslui counties, where the mean annual precipitation was 564 mm, and the mean annual temperature was 9.5 °C. This association was characterized by elevations of 130 m, with 17° slopes. The richness of vascular plant species was 49 species per 10 m^2. The soils are neutral, with high phosphorus, nitrogen, and potassium concentrations and normal values of arsenic and lead (Table 2).

The *Taraxaco serotinae-Festucetum valesiacae* has been identified in Bistrița-Năsăud, Iași, and Vaslui counties, at elevations from 77 m to 483 m (mean 174 m). The annual precipitation was from 516 mm to 623 mm (mean: 558 mm), and the annual temperature was from 7.6 °C to 10.2 °C (mean: 9.3 °C). The genetic type of soil characteristic of the analyzed area is calcium chernozem. These plant communities occur on partly steep slopes from 3.6° to 35° (mean 12.6°), with south-western and north-eastern aspects. Cover of the moss layer was 6%, and total vegetation cover was 90%, with 64 species on 10 m^2. The soils are weakly alkaline, with a high potassium, nitrogen, and phosphorusconcentration. Lead values were recorded above the alert threshold allowed by law in Romania (Order no. 756 of November 3, 1997; http://legislatie.just.ro/Public/DetaliiDocument/13572, accessed 2021-08-12). Concentrations of arsenic recorded values above the normal limit (Table 2).

The *Thymo pannonici-Chrysopogonetum grylli* was identified in Buzău county, at elevations from 141 m to 337 m (mean: 271 m). The area's relief is represented by hills with sunny slopes (west-southwest) with moderate slopes (10.2°). The mean annual temperature in the area was 9.55 °C, and the mean annual precipitation was 561 mm. The characteristic soil genetic type is luvic phaeozem. Three plots were included in this association, with a mean of 51 species per 10 m^2. The overall vegetation cover was 95%. The pH of the soil was weakly alkaline and rich in nitrogen and phosphorus. Lead recorded values above the alert threshold, and arsenic recorded values above the normal limit allowed by Romanian law (Order no. 756 of November 3, 1997). This association was characterized by the highest values of arsenic, lead, phosphorus, and potassium (Table 2).

The *Agropyro pectinati-Stipetum capillatae* was identified in the counties of Iași and Vaslui, on steep slopes (mean: 32.5°) with an eastern aspect. Phytocoenoses dominated by *Stipa capillata* occur at low elevations, from 140 to 200 m, with a mean annual temperature of 9.8 °C (9.4–10.2 °C) and mean annual precipitation of 566 mm (560–572 mm). The mean vegetation cover was 95%, and the richness of vascular plant species was 41.5 per 10 m^2. Soils are weakly alkaline, rich in potassium and nitrogen, and poor in phosphorus. Lead and arsenic were in normal concentrations (Table 2).

The *Cirsio-Brachypodion pinnati* and *Danthonio-Brachypodion* alliances (Cluster C) were distributed in Romania's North-West, Central and South-East regions, on moderately to steeply sloping terrain. *Danthonio-Brachypodion* includes xeric grasslands. Most species are Balkanian and sub-Mediterranean. Coenoses developed in slightly humid conditions (500–600 mm per year). Dominant are *Stipa tirsa*, *Danthonia alpina* and *Agrostis capillaris*. The *Cirsio-Brachypodion pinnati* alliance includes Central European species. *Carex humilis*, *Brachypodium pinnatum*, *Trifolium alpestre*, and *Polygala major* are dominant species. Soils are moderately acidic, rich in potassium and nitrogen, and poor in phosphorus. Lead exhibited values above the alert threshold. This alliance showed the lowest value for soil pH compared to the other alliances (Table 2).

The *Carici humilis-Brachypodietum pinnati* is poor in species and was identified in the Alba, Cluj, Sibiu, and Buzău counties, on moderate to steep slopes (5°–30°) with sunny and shady aspects. On the 10 m^2 plots, the vegetation coverage was 94%, and the richness of vascular plant species was 32 species, and on the 20 m^2 plots, the vegetation coverage was 90%, with only nine species. The elevation ranged from 245 m to 430 m (mean: 343 m). The mean annual precipitation was 594 mm, and the mean annual temperature was 9 °C. Soils are neutral, rich in potassium and nitrogen, and low in phosphorus. Lead exceeded the normal value allowed by law. Arsenic was in normal concentrations (Table 2).

The *Festuco rupicolae-Brachypodietum pinnati* was identified in Mureș County, at high elevation (395 m). The mean annual precipitation was 612 mm, and the mean annual temperature was 8.5. The analyzed association was observed on the slopes with northeast aspects, on steep slopes from 5.3° to 27.8° (mean: 16°). The genetic type of soil characteristic of the area is the luvic phaeozem. The vegetation cover was 100%, and the richness of the vascular plant species was 97 species per 10 m^2. Soils are moderately acidic and rich in potassium, phosphorus, and nitrogen. Arsenic has exceeded the normal value allowed by Order no. 756 of November 3, 1997, in Romania. Lead was high above the alert threshold (Table 2).

The *Danthonio alpinae-Stipetum stenophyllae* was identified in Cluj County, at high elevation (545 m), on flat slopes (5°) with southwest and east aspect. The vegetation cover was 100%, and the richness of the vascular plant species was 58 species per 10 m^2. The lowest values for the mean annual temperature were recorded. The annual precipitation is 597 mm. The soils are moderately acidic, the lowest value compared to the other associations. Arsenic was in normal concentrations, and lead has exceeded its normal value. Soils were also rich in potassium and nitrogen and poor in phosphorus (Table 2).

The *Arrhenatherion elatioris* alliance (Cluster D) is characteristic for mesophilic grasslands. The mesic meadows are used as hayfields. The characteristic species are *Arrhenatherum elatius*, *Taraxacum officinale*, *Lotus corniculatus*, *Falcaria vulgaris*, *Leucanthemum vulgare*, *Inula helenium*, *Lathyrus tuberosus*, and *Digitalis grandiflora*. This alliance was characterized by the highest soil pH values, lead, arsenic, phosphorus, and potassium. Thus, the soils are weakly alkaline, rich in phosphorus, nitrogen, and potassium, and have a normal arsenic concentration in the soil. Lead recorded values above the alert threshold (Table 2).

The *Arrhenatheretum elatioris* is poor in number of species (29 species) and was identified in Sibiu County, at moderate elevation (328 m), on low slopes (12°) with a northern aspect. The mean annual temperature was 8.53 °C, and the mean annual precipitation was 616 mm. The genetic type of soil is gleic luvisol. The overall vegetation cover was 100%.

The *Elytrigietum hispidi* was identified in Sibiu on slightly steep slopes from 12.8° to 20.8° (mean: 15°) with north-eastern aspects and at elevations from 485 m to 644 m (mean 587 m). The mean annual precipitation was 616 mm, and the mean annual temperature was 8.6 °C. The characteristic genetic type of soil is the gleic luvisol. The soils are weakly alkaline, with a high concentration of phosphorus and potassium, low nitrogen concentration and values above the normal limit allowed by Romanian law, and exceeding the value of the alert threshold for lead (Table 2). The highest pH and lead values were recorded in this association.

The *Prunion fruticosae* alliance (Cluster E) is distributed in the North-West and Central regions of Romania, in steppe areas. Phytocoenoses of *Prunus tenella* are xerophilous. The characteristic species are *Prunus tenella*, *Phragmites australis*, *Rosa gallica*, and *Vinca herbacea*. Soils are moderately acidic, rich in potassium and nitrogen, and low in phosphorus. Lead and arsenic were in normal concentrations. This alliance recorded the lowest values for arsenic, lead, potassium, and phosphorus (Table 2).

The *Prunetum tenellae* is poor in species and includes woody and grassy species, xerophilous-xeromesophilic, and located in the steppe areas of Cluj and Mureș. These communities occur at elevations of 473 m, on steep slopes (43°), with a south-western aspect. The general vegetation cover was 70%, and the mean richness was 32 per 10 m^2. The coverage of the moss layer was 1%. The mean annual temperature was 8.6 °C, and the mean annual precipitation was the highest of all communities analyzed (628 mm). The characteristic species of the association is *Prunus tenella*.

The *Artemisietum pontico-sericeae* occurs in Cluj County, at elevations from 310 m to 540 m (mean: 508 m). With a mean of 17 species per 10 m^2 the community is species-poor. The mean annual temperature was 8.7 °C, and the mean annual precipitation was 590 mm. The relief is represented by hills with north-south aspects, with steep slopes from 15°–60° (mean: 29°). Soils are moderately acidic, rich in potassium and nitrogen, and have a normal concentration of lead and arsenic and a medium concentration of phosphorus (Table 2).

Table 2. Measured values for the analyzed chemical parameters. Values are means ± standard deviations (SD). BIO17 = the precipitation of driest quarter, BIO12 = the mean annual precipitation, BIO1 = the mean annual temperature, ELV - elevation. Aspect: S - south, SSW- south-southwest, WSW- west-southwest, SE- southeast, SW- southwest, NNE- north-northeast, NE- northeast.

Tabelle 2. Messwerte für die analysierten chemischen Parameter. Werte sind Mittelwerte ± Standardabweichungen (SD).

	pH	Pb	As	P	K	N	BIO1	BIO12	BIO17	ELV	Aspect	Slope
Cluster A - alliance *Stipion lessingianae*	**6.9±0.4**	**27±25**	**4±2.6**	**26±16.2**	**313±25.3**	**2±0.7**	**8.9±0.5**	**580±17.7**	**79.5±2.5**	**354±116.8**	**SW**	**22±13.5**
Ass. *Stipetum pulcherrimae*	6.9±0.3	18.8±1.6	3.2±0.5	26.3±6.6	337.4±45.7	2.6±0.3	8.3±0.5	598±10.2	80.8±1.9	414.8±82.9	SSW	41.8±13.5
Ass. *Jurineo arachnoideae-Stipetum lessingianae*	7.06±0.5	51.9±38.4	7.02±4.8	34.9±22.2	294.2±5	1.7±1.1	9.08±0.6	579.8±25.3	80.7±3.1	299.5±150.7	S	20.06±13.6
Ass. *Galio octonarii-Stipetum tirsae*	6,8	10,4	1,2	17,1	308,1	1,7	9,5	563	77	350	WSW	5
Cluster B - alliance *Festucion valesiacae*	**6.9±0.4**	**29.09±9.7**	**3.9±1.3**	**33±16.9**	**302.5±62.6**	**1.6±0.5**	**9.1±0.2**	**573.3±28.5**	**82.8±7.5**	**225.5±75.1**	**SE**	**18.8±9.7**
Ass. *Medicagini minimae-Festucetum valesiacae*	7.02±0.4	22.8±22.3	3.2±3	32.9±20.6	288±33.4	1.6±0.6	9.4±0.3	567.6±17.1	81.4±1.9	137.4±109.3	SE	15.6±10.1
Ass. *Botriochloetum (Andropogonetum) ischaemi*	6.5±0.8	13.5±2.9	2.1±0.4	26.8±6.6	260.3±70.1	1.7±0.3	8.8±0.5	527.7±36	80.4±7.8	289.5±128.8	S	32.8±4.8
Ass. *Salvio nutanti-nemorosae-Festucetum*	6.8±0.5	19±2.5	2.6±0.7	28.6±8	319.6±62.7	2.8±0.1	8.1±0.1	628.8±57.1	88.4±14.3	450±23.2	SW	17.2±11.3
Ass. *Festuco rupicolae-Caricetum humilis*	6.7±0.6	20±2.4	3.2±0.6	25.7±6.8	306.9±59.2	2.5±0.3	8.5±0.5	616.9±50.4	85.5±12.4	397.4±93	S	26.07±14.3
Ass. *Koelerietum macranthae*	6,9	12,4	2,7	22,5	215,7	1,3	9,6	567	87	180	NNE	5,2
Ass. *Stipetum capillatae*	7.4±0.5	13.05±1.1	2.6±0.6	33.1±8.3	354.6±187.2	1.3±0.04	9.5±0.1	563.5±6.3	83±7.07	130±70.7	NNE	17.3±17.9
Ass. *Taraxaco serotinae-Festucetum valesiacae*	7.09±0.5	57.3±43.1	7.01±4.8	48.2±35.5	313.4±44.6	1.2±1	9.2±0.5	561.8±24.8	80.5±5.2	184.2±105	SE	12.9±8.6
Ass. *Thymo pannonici-Chrysopogonetum grylli*	7.1±0.2	90.3±10.5	10.6±0.5	50.9±48.1	312.3±39.5	0.4±0.1	9,5	561	77	271.3±112.8	NNE	10.2±0.4
Ass. *Agropyro pectinati-Stipetum capillatae*	7.2±0.1	13.5±2.9	1.8±0.2	30±2.08	351.7±67.4	2.4±1.7	9.8±0.5	566±8.4	82±4.2	170±42.4	SE	32.5±10.6

	pH	Pb	As	P	K	N	BIO1	BIO12	BIO17	ELV	Aspect	Slope
Cluster C - alliances *Cirsio-Brachypodion pinnati* and *Danthonio-Brachypodion*	**6.3±0.2**	**42.7±27.4**	**4.8±2.5**	**31.7±18.9**	**285±27.8**	**2.4±0.6**	**8.3±0.2**	**599±8.4**	**83.6±3.1**	**427.4±59.08**	**SE**	**14.4±9.4**
Ass. *Carici humilis-Brachypodietum*	6.4±0.3	28.4±11.7	2.7±1.2	26.4±6.1	302.8±51.1	2.7±0.8	9.06±0.6	587.8±14.03	81.4±5.6	342.8±81.7	SE	22.1±9.1
Ass. *Festuco rupicolae-Brachypodietum pinnati*	6.6±0.4	78±69.8	7.2±6.1	43±41.4	323.3±26.6	1.5±1	8.5±0.03	612.2±2.8	82	394.5±46.05	SE	16.2±9.7
Ass. *Danthonio alpinae-Stipetum stenophyllae*	6±0.05	21.9±0.7	4.6±0.3	25.9±9.3	229±5.8	3.1±0.09	7.6±0.04	597	87.5±0.7	545±49.5	SE	5
Cluster D - alliance *Arrhenatherion elatioris*	**7.7±0.05**	**95±4.3**	**6.6±3.2**	**59.7±42.7**	**295,6±22.4**	**0.43±0.1**	**8.7±0.07**	**616**	**80**	**457.6±88.7**	**NE**	**13.6±4.6**
Communities of *Arrhenatheretum elatioris*	7,7	94	6	50,4	320	0,46	8,5	616	80	328	NE	11,8
Communities of *Elytrigietum hispidi*	7.8±0.05	95±4.3	7.3±3.2	69.09±42.7	271.3±22.4	0.4±0.1	8.6±0.07	616	80	587.3±88.7	SE	15.4±4.6
Cluster E - alliance *Prunion fruticosae*	**6.5**±0.1	**19.05±4.5**	**3.6±1.1**	**25**±2.1	**258**±7.1	**2.3±0.24**	**8.6±0.3**	**609±11.55**	**79±2**	**498±48**	**S**	**36±6.9**
Communities of *Artemisietum pontico-sericeae*	6.6±0.1	19.7±0.6	4.5±0.1	30.1±2.1	266.2±7.1	2,1	8.7±0.2	590.3±9.3	78	508.1±66.7	S	29.3±11.4
Communities of *Prunetum tenellae*	6,4	18.4±8.5	2.8±2.1	19,9	250,7	2.6±0.24	8.6±0.4	627.5±13.8	80±2	487.5±29	S	43±2.4

4.3 The relationship between floristic composition and environmental variables

In the detrended correspondence analysis (DCA), the position of the 211 relevés can be observed according to the gradients of the similar floristic composition along the axes of the ordinogram (Fig. 3, Table 3). The first axis is the most important and explained the most significant variation in plant species data and the relationship between floristic composition and environmental variables. Along the first axis, the length of the floristic similarity gradients was 0.4305. This indicates a unimodal pattern of variation in floristic composition. In this context, the canonical analysis of the correspondences was applied to observe the effect of the variables on the floristic composition.

In the DCA analysis, dry grasslands, meadows, and mesic pastures were separated so that these three types of meadows are mesic and xeric scrub and *Robinia* groves (Fig. 4). Mesic and xeric scrub and *Robinia* groves were positively correlated with slope. Meadows and mesic pastures were positively correlated with elevation, and dry grasslands were positively correlated with aspect and the precipitation of driest quarter (BIO17).

Table 3. Summary of the DCA analysis

Tabelle 3. Zusammenfassung der DCA-Analyse

	Axis 1	Axis 2	Axis 3	Axis 4
Eigenvalues	0.4305	0.2519	0.2244	0.1928
Explained variation (cumulative)	4.12	6.54	8.69	10.53
Gradient length	3.4	2.57	3.91	3.76
Pseudo-canonical correlation (suppl.)	0.8574	0.4917	0.3377	0.3407

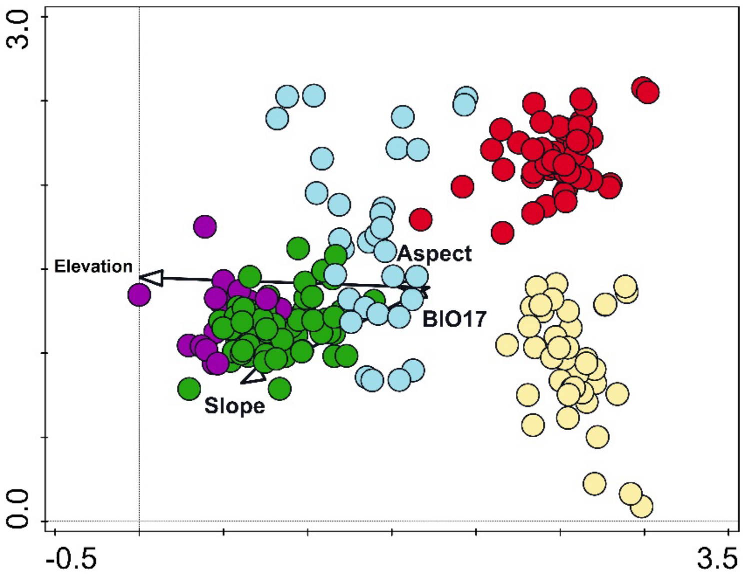

Fig. 4. DCA ordination diagrams of the 211 vegetation plots. Red = cluster A, yellow = cluster B, blue = cluster C, purple = cluster D, green = cluster E.

Abb. 4. DCA-Ordnungsdiagramme der 211 Aufnahmeflächen. Rot = cluster A, gelb = cluster B, blau = cluster C, violett = cluster D, grün = cluster E.

Table 4. Results of the CCA ordination of the effect of abiotic variables on the floristic composition of communities with *Crambe tataria*, BIO17 = the precipitation of driest quarter.

Tabelle 4. Ergebnisse einer CCA-Ordination mit den Effektstärken abiotischer Variablen auf die floristische Zusammensetzung von Lebensgemeinschaften mit *Crambe tataria*. In der englischen Abbildungsunterschrift werden die Variablen zugeordnet.

Variables	Explains (%)	Contribution (%)	pseudo-F	*p*-value	*p*-value (adj.)
Elevation	2.9	31.5	6.3	0.0001	0.0007
Slope (°)	1.5	16.4	3.3	0.0001	0.0007
BIO17	1.2	12.5	2.5	0.0001	0.0007
Aspect	0.8	8.3	1.7	0.0001	0.0007

From the four axes of the detrended correspondence analysis axis DCA1 was the most important, representing the largest variation in data on floristic composition. Following the application of the canonical correspondence analysis (CCA), the quantification of the "strength" of the effect of each environmental variable studied on the floristic composition of *C. tataria* communities can be observed (Table 4). In this sense, the CCA analysis showed the most important variable that explains the variation of the floristic composition was the elevation. This variable explained 2.9% (31.5% contribution) of the variation of the floristic composition, compared to the other three environmental variables used in ecological modelling. The second significant variable was the slope which explained 1.5% of the variation of the floristic composition. The precipitation of driest quarter explained 1.2%, and the aspect explained 0.8% of the variation of the floristic composition.

5. Discussion

5.1 General aspects

Crambe tataria is listed in Annex I to the BERN CONVENTION (1998), Annexes IIb and IVb to Council Directive 92/43 EEC (EUROPEAN COMMISSION 1992), and Annex IIIb to Government Emergency Ordinance no. 57 of June 20, 2007. The species is also included in Annex I of the International Treaty on Plant Genetic Resources for Food and Agriculture (FAO 2001). In the IUCN European Red List, the species is listed as "Least Concern" (BILZ et al. 2011). The main threats to the species are as follows (KELL 2011): overgrazing, land-use change, mechanized mowing, flower picking during vegetation, pollution, fires, use of chemical fertilizers in agriculture, invasive species, and climate change. The geographical units that provide the most favourable environmental conditions for the development of *C. tataria* are the Moldavian Plateau and the Transylvanian Depression. Favourable environmental conditions can also ensure the Romanian Plain and the Curvature Subcarpathians (CHIRILĂ 2022).

According to the European Red List of Habitats (JANSSEN et al. 2016, CHYTRÝ et al. 2020), *C. tataria* occurrences correspond to the following habitat types: R Grasslands and lands dominated by forbs, mosses, or lichens: R1 Dry grasslands: R1A Semi-dry perennial calcareous grassland (E1.2a); and R1B Continental dry steppe (E1.2b); R2 Mesic grasslands: R22 Low and medium altitude hay meadow (E2.2).

In this study, habitat requirements for *C. tataria* in Romania were investigated. Dry grasslands, meadows and mesic pastures and mesic and xeric scrub and *Robinia* groves turned out to be the habitats of the species in Romania. Of these habitats, the results obtained confirmed that dry grasslands are a favourable habitat for *C. tataria*. This is supported both by the very large number of *C. tataria* sampling areas and by the high values of the number of individuals per plot, population density, plant height, number of leaves per plant, inflorescence circumference, the proportion of flowering individuals, compared to mesophilic meadows (CHIRILĂ 2022). Associations of the Festuco-Brometea class, in which *C. tataria* was identified, have been reported in other studies (SOÓ 1942, BĂDĂRĂU 2001, KERESZTY & GALÁNTAI 2001, OROIANET et al. 2007, ZAMFIRESCU et al. 2008, KELL 2011, OROIANET et al. 2017, MÂNZU et al. 2020). In the *Festuco-Brometea* communities, species richness was highest. Most of the analyzed associations presented a good ecological status.

The floristic composition is varied and rich, consisting of numerous species characteristic of the *Festucion valesiacae* and *Stipion lessingiana* alliances. In the floristic composition, the species that belong to the *Cirsio-Brachypodion pinnati* and *Danthonio-Brachypodion* alliances are present. The plant species that frequently occur in the plots with *C. tataria* are *Stipa lessingiana*, *Festuca valesiaca*, *Rapistrum perenne*, *Adonis vernalis*, *Salvia nutans*, *S. nemorosa*, and *Filipendula vulgaris*. The areas occupied by these formations are in various states of degradation, especially in north-eastern Romania, due to overgrazing. In grasslands dominated by *Stipa lessingiana* and *Festuca valesiaca*, *Crambe tataria* is common. The species' survival in such grasslands is due to the decrease of the anthropogenic impact, the sufficiently extensive habitat, and a large number of flowering individuals (CHIRILĂ 2022). Also, species' survival is due to the increase in the distance between the nearest locality and the plot, the main nutrients (N, P, K), and the decrease in the vegetation height (CHIRILĂ 2021, 2022). In contrast, in grasslands with *Chrysopogon gryllus*, *Brachypodium pinnatum*, and *Calamagrostis epigejos*, *Crambe tataria* occurs in low density (CHIRILĂ 2021) due to competition (HORVÁTH 2005). To germinate, *C. tataria* needs poor micro-habitats on loess without vegetation that completely covers the soil (HORVÁTH 2005).

In the mesic and xeric scrub and *Robinia* groves, *C. tataria* was present in 1.9% of the total number of plots. In these grasslands, many individuals of *C. tataria* occur around the bushes of *Prunus tenella*, *P. spinosa,* and *Crataegus monogyna*. This habitat limits the spread of the species in grasslands (HORVÁTH 2005). The grasslands are non-grazed and the floristic composition is poor in species. Common species are *Prunus tenella*, *Crambe tataria*, *Teucrium chamaedrys*, *Securigera varia*, and *Crataegus monogyna*. Meadows and mesic pastures were rare, so *Crambe tataria* was rarely found in these habitats. The floristic composition is very poor in species. *C. tataria* was only present in 0.4% of the total number of sample areas. The mean annual precipitation and elevation in mesophilic meadows were higher than in other habitat types.

5.2 The relationship between floristic composition and environmental variables

The *Festucion valesiacae* communities that appear on the southern aspect (S, SW) are closely correlated with the precipitation of the driest quarter. The community is also rich in vascular plant species but poor in bryophyte species. This may be due to drought and light competition from tall, dense plants (DENGLER et al. 2012). The communities of *Prunion fruticosae*, *Cirsio-Brachypodion pinnati*, and *Arrhenatherion elatioris* are correlated with the elevation and the precipitation of the driest quarter. In this context, the *Prunion fruticosae* community distributed over high elevation areas (from 473 m to 531 m) has a high mean annual precipitation (628 mm). Moreover, the precipitation of the driest quarter is higher than the other two communities. Thus, the communities of *Cirsio-Brachypodion pinnati* and

Arrhenatherion elatioris are found at lower elevations and mean annual precipitation. The precipitation of the driest quarter showed values similar to or lower than the *Prunion fruticosae* community. The communities of *Stipion lessingianae* and *Cirsio-Brachypodion pinnati* are correlated with aspect. While *Stipion lessingianae* communities occur on shady (NE) and sunny (SSW, SW) slopes, *Cirsio-Brachypodion pinnati* communities appear on sunny (SSW) slopes.

The first DCA axis was positively correlated with slope, the precipitation of driest quarter (BIO17) and aspect, and negatively with elevation. In this context, we can suggest that the main cause of the floristic differences in the grasslands is the mean annual precipitation. This has led to the separation between xerophilous communities, rich in species, with slightly sloping slopes (12°), and mesophilic communities, poor in species, with steep slopes (23°). An increase in calcium concentration, vegetation cover, and decreased vascular plant richness along the first axis separated the mesophilic communities of *Arrhenatherion elatioris* from the xerophilous communities of *Stipion lessingianae* and *Festucion valesiacae*.

In our study, the grasslands showed a compositional difference caused by the increase in elevation. The elevation is one of the main factors of changes in floristic composition (GUO et al. 2013, MARDARI et al. 2019). Due to the decrease in temperature, the floristic composition and the performance of the plants respond very much to the increase in elevation (KÖRNER 2007). Thus, it is expected that in the next century, temperature changes that occur at high elevations (hundreds of meters) are equal to global temperature increases of about 3 °C (DE LONG et al. 2015). Moreover, the use of altitudinal gradients has become a valuable tool for studying how factors such as nutrient availability, floristic composition, soil characteristics, and species interactions of upper and underground ecosystem components change with climate factors (DE LONG et al. 2015). The slope aspect significantly affects the influence of the floristic composition in the semi-arid grasslands. This influences temperature, evapotranspiration, and wind speed (YANG et al. 2020). Previous studies (NADAL-ROMERO et al. 2014, XUE et al. 2018) showed that plants on the south-western slopes are more likely to resist drought and radiation. Due to stronger solar radiation and higher evaporation, these slopes retain less moisture (XUE et al. 2018). The slope is one of the most important variables influencing the floristic composition. Our finding that elevation and slope influence the floristic composition is consistent with the results of previous studies in grassland (BENNIE et al. 2006).

6. Conservation implications

Grasslands, which represent a significant part of the ecosystem, are mainly in poor condition due to overgrazing (SUTTIE et al. 2005). These grasslands must be preserved as they are essential for the global food supply. Moreover, grasslands are significant carbon deposits (O'MARA 2012). Practices that could help reduce greenhouse gas emissions are (O'MARA 2012): reducing grazing intensity; improving grassland productivity through practices such as fertilization and irrigation; nutrient and fire management; and introducing new grasses with deep roots, which increase carbon in the soil (TILMAN et al. 2006). Diversified grassland management could increase species diversity (VALKÓ et al. 2012). Some management actions could improve species conservation and naturalness in dry grasslands (SENGL et al. 2016): restoration of buffer zones at the edge of grasslands and introduction of management adapted to the growth of competitive grasses.

This study indicated that dry grasslands rich in species are the optimal habitat of *Crambe tataria* species in Romania compared to mesophilic grasslands (CHIRILĂ 2022), where the species recorded lower values on population characteristics (plant height, leaf size, proportion of flowering individuals, inflorescence circumference, number of leaves/plants). One of the causes of the decline of the population of *C. tataria* is overgrazing (KERESZTY & GALÁNTAI 2001, HORVÁTH 2005, CHIRILĂ 2022).

According to BĂDĂRĂU et al. (1999), *C. tataria* was much more widespread in Transylvania, so current populations have regressed due to anthropogenic impact. In this context, species conservation strategies should be based on proper habitat management: rotational grazing, control or elimination of shrub species, and elimination of invasive species. Conservation measures for the species in question should include restoring habitats and maintaining the actual population size.

Erweiterte deutsche Zusammenfassung

Einleitung – *Crambe tataria* gilt aufgrund von Überweidung der Standorte und der Umwandlung von Grasland in Ackerland als gefährdete Art. In Rumänien besiedelt *C. tataria* Trockenwiesen, Obstplantagen und verlassene Gärten sowie landwirtschaftliche Flächen. Ziel der Studie war es, die Lebensraumpräferenzen von *C. tataria* in Rumänien zu identifizieren.

Untersuchungsgebiet – Das Untersuchungsgebiet wird durch drei historische Regionen in Rumänien repräsentiert: Muntenien, Moldawien und Siebenbürgen. Das Klima ist gemäßigt kontinental, mit einem mittleren Jahresniederschlag von 478 bis 731 mm und einer mittleren Jahrestemperatur mit Werten von 7 bis 10 °C. Die dominierenden Bodentypen sind Chernozem, Phaeozem und Luvisol (Digital Soil Map Of The World, http://www.fao.org/geonetwork/srv/en/metadata.show%3Fid=14116, accessed 2021-09-12).

Methoden – Die floristische Zusammensetzung der Habitate wurde auf Basis von 211 phytozönologischen Aufnahmen aus der Rumänischen Grasland-Datenbank (EU-RO-008; 164 Probeflächen) und eigenen Daten (47 Probeflächen) analysiert. Die Größe der eigenen Aufnahmen (47 Probeflächen) betrug 100 m^2, die Größe der Aufnahmen aus der rumänischen Grünlanddatenbank (164 Probeflächen) 10 bis 200 m^2. Für die 47 gesammelten Bodenproben (eigene Daten) wurden der Boden-pH-Wert sowie Stickstoff-, Phosphor-, Kalium-, Blei- und Arsenkonzentrationen gemessen. Für die 164 Aufnahmen aus der RGD-Datenbank wurden die Werte zu As, Pb (PANAGOS et al. 2012), N, P, K und Boden-pH (BALLABIO et al. 2019) aus der European Soil Database (ESDAC) extrahiert. Zur Analyse des Klimaeinflusses auf die Populationen wurde der Niederschlag des trockensten Quartals aus der WorldClim-Datenbank entnommen (FICK & HIJMANS 2017). Die Vegetationsklassifizierung erfolgte durch hierarchisches agglomeratives Clustering unter Verwendung des flexiblen β-Algorithmus ($\beta = -0{,}25$) und der Bray-Curtis-Distanz. Zusammenhänge zwischen Artenzusammensetzung und Umweltvariablen wurden mit DCA und CCA analysiert. Die Analyse der floristischen Zusammensetzung erfolgte anhand einer Präsenz/AbsenzMatrix. Um die Kollinearität zwischen unserer Variabilität (floristische Zusammensetzung und Umgebungsvariablen) zu bestimmen, wurde in CANOCO der variable Inflationsfaktor (VIF) verwendet. Die Karte mit der Verteilung der Plots wurde in der QGIS version 3.18.3 (https://qgis.org) erstellt.

Ergebnisse – Die Vegetation mit *Crambe tatarica* wurde in fünf Gruppen eingeteilt. Diese spiegeln die in der Literatur beschriebene Syntaxonomie wider (COLDEA et al. 2012, CHIFU et al. 2014): Gruppe A – *Stipion lessingianae*; Gruppe B – *Festucion valesiacae*; Gruppe C – *Cirsio-Brachypodion pinnati* und *Danthonio-Brachypodion*; Gruppe D – *Arrhenatherion elatioris*; Gruppe E – *Prunion fruticosae*. Die erste Achse der Vegetation nach einer DCA war am stärksten mit der Höhenstufe korreliert.

Diskussion – *Crambe tataria* wächst in einer relativ begrenzten Anzahl von Pflanzengesellschaften. Unsere Ergebnisse bestätigen das gehäufte Vorkommen von *C. tataria*-Populationen in xerophilen Graslandgesellschaften. Gemäß der Europäischen Roten Liste der Lebensräume – EUNIS (JANSSEN et al. 2016, CHYTRÝ et al. 2020) entspricht *C. tataria* den folgenden Lebensraumtypen: R Grünland und Stauden-, Moos- oder Flechten-dominierte Flächen: R1 Trockenrasen: R1A Semi - mehrjähriges Trockengrünland (E1.2a); und R1B Kontinentale Trockensteppe (E1.2b); R2 Mesophiles Grasland: R22 Mähwiesen in niedriger und mittlerer Höhe (E2.2). Einer der häufigsten Lebensräume der untersuchten Arten sind die xerophilen Wiesen der *Festuco-Brometea*. Die von dieser Formation~~-~~besetzten Flächen befinden sich aufgrund von Überweidung in unterschiedlichen Stadien der Degradation, insbesondere im Nordosten Rumäniens. Den stärksten Einfluss auf die floristische Zusammensetzung der Pflanzengesellschaften mit *C. tataria* hat die Höhenlage.

Schlussfolgerung – Diese Studie zeigt~~e~~, dass die Höhenlage der wichtigste Faktor ist, welcher ~~der~~ die floristische Zusammensetzung von *Crambe tataria*-Phytozönosen beeinflusst. Ihre analysierten Populationen bevorzugen alkalische Böden, die reich an Stickstoff, Phosphor und Kalium sind. Auch Arsen und Blei waren in hohen Konzentrationen vorhanden. Der bevorzugte Lebensraum der Art ist xerophiles Grasland.

Acknowledgements

We wish to thank RGD members Kiril Vassilev, Eszter Ruprecht and Constantin Mardari for their contributions.

Authors contributions

S.D. Chirilă contributed to manuscript conceptualization, methodology (vegetation sampling and classification, environmental variables and other statistical analyses), data collection (took soil samples and identified plant species in the field) software use during data analysis, data curation, writing (original draft preparation; visualization, investigation, supervision, validation, writing), reviewing and editing of the manuscript. **I.G. Cara** contributed to methodology (soil analysis), software (soil analysis), data curation (soil analysis), editing of the manuscript (soil analysis), visualization, supervision and validation. **I. Motrescu** contributed to methodology (soil analysis), VIF analysis, software (soil analysis), data curation (soil analysis), editing of the manuscript (soil analysis), visualization, supervision and validation.

ORCID iDs

Irina Gabriela Cara https://orcid.org/0000-0002-3614-954X
Simona Dumitrița Chirilă https://orcid.org/0000-0003-3397-1834
Iuliana Motrescu https://orcid.org/0000-0001-6161-8822

Supplements

Additional supporting information may be found in the online version of this article.

Zusätzliche unterstützende Information ist in der Online-Version dieses Artikels zu finden.

Supplement E1. Synoptic table with the percentage frequencies of plant species in the communities with *Crambe tataria* from Romania.

Anhang E1. Übersichtstabelle mit den prozentualen Häufigkeiten von Pflanzenarten in den Gesellschaften mit *Crambe tataria* aus Rumänien.

References

ANIȚEI, L.G. (2000): Flora si vegetatia Bazinului Bahlui (jud. Iasi) (Flora and vegetation of the Bahlui Basin Iași County) [in Romanian]. – PhD Thesis, Iasi.

BACHMAN, S., FERNANDEZ, E.P., HARGREAVES, S., LUGHADHA, E.N., RIVERS, R. & WILLIAMS, E. (2016): Extinction risk and threats to plants. – In: RBG KEW: The State of the World's Plants Report – 2016: 58–63. Kew, Royal Botanic Gardens.

BALLABIO, C., LUGATO, E., FERNÁNDEZ-UGALDE, O., ORGIAZZI, A., JONES, A., BORRELLI, P., MONTANARELLA, L. & PANAGOS, P. (2019): Mapping LUCAS topsoil chemical properties at European scale using Gaussian process regression. – Geoderma 355: 113912.

BĂDĂRĂU, A.S. (2001): Biogeographic research on steppe species of *Astragalus* L. from the Transylvanian Depression (II). – Studia Universitatis Babeş- Bolyai, Geographia series, Vol. XLVI, 1: 51–67.

BĂDĂRĂU**,** A.S., COLDEA, G., GROZA, G.,GUDASZ, C. (1999): The biogeography of an endemic element from the Transylvanian Plain, *Astragalus exscapus* ssp. *transsylvanicus*. – Studia Univ. Babes-Bolyai Geogr. 44: 45–59.

BENNIE, J., HILL, M.O., BAXTER, R. & HUNTLEY, B. (2006): Influence of slope and aspect on long-term vegetation change in British chalk grasslands. – J. Ecol. 94: 355–368.

BERN CONVENTION (1998): Convention on the conservation of European wildlife and natural habitats. – URL: https://rm.coe.int/1680746347 [accessed 2021-01-02].

BILZ, M., KELL, S.P., MAXTED, N. & LANSDOWN, R.V. (2011): European Red List of Vascular Plants. – Luxembourg: Publications Office of the European Union: 145 pp.

BOUXIN, G. (2005): Ginkgo, a multivariate analysis package. – J. Veg. Sci. 16: 355–359.

CHIFU, T., IRIMIA, I. & ZAMFIRESCU, O. (2014): *Festuco-Brometea*. – In: CHIFU, T. (Ed.). Diversitatea fitosociologică a vegetației României. Vol. II. Vegetația erbacee antropizată. Tom 1. Vegetația pajiștilor (*Festuco-Brometea*. In: CHIFU T. (Ed.). The phytosociological diversity of Romania's vegetation. Volume II. Anthropogenic herbaceous vegetation. Part 1. Meadow vegetation) [in Romanian]: 113–397. Institutul European, Iași.

CHIRILĂ, S.D. (2021): Ecological and chorological studies of the species *Crambe tataria* Sebeók from Romania. – Rom. J. Biol. - Plant Biol. 66: 39–54.

CHIRILĂ, S.D. (2022): Analysis of the characteristics of some populations of *Crambe tataria* Sebeók from Romania. – Acta Oecol. 114: 103810.

CHYTRÝ, M., TICHÝ, L., HENNEKENS, S.M. ... SCHAMINÉE J.H.J. (2020): EUNIS Habitat Classification: expert system, characteristic species combinations and distribution maps of European habitats. – Appl. Veg. Sci. 23: 648–675.

COLDEA, G., OPREA, A., SÂRBU, I., SÂRBU, C. & ȘTEFAN, N. (2012): The vegetable associations of Romania. – Cluj University Press Publishing House, Cluj-Napoca: 482 pp.

DE CÁCERES, M. & LEGENDRE, P. (2009): Associations between species and groups of sites: indices and statistical inference. – Ecology 90: 3566–3574.

DE LONG, J.R., KARDOL, P., SUNDQVIST, M.K., VEEN, G.F. & WARDLE, D.A. (2015): Plant growth response to direct and indirect temperature effects varies by vegetation type and elevation in a subarctic Tundra. – Oikos 124: 772–783.

DENGLER, J., BECKER, T., RUPRECHT, E. ... UĞURLU, E. (2012): *Festuco-Brometea* communities of the Transylvanian Plateau (Romania) – a preliminary overview on syntaxonomy, ecology, and biodiversity. – Tuexenia 32: 319–359.

DUFRÊNE, M. & LEGENDRE, P. (1997): Species assemblages and indicator species: the need for a flexible assymmetrical approach. – Ecol Monogr. 67: 345–366.

EUROPEAN COMMISSION (1992): Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. – URL: http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.html [accessed 2019-01-22].

EURO+MED (2022): Euro+Med PlantBase – the information resource for Euro-Mediterranean plant diversity. – URL: http://ww2.bgbm.org/EuroPlusMed [accessed 2022].

FAO (FOOD AND AGRICULTURE ORGANIZATION) (2001): International Treaty on Plant Genetic Resources for Food and Agriculture. – Food and Agriculture Organization of the United Nations, Rome, Italy: 68 pp. – URL: https://www.fao.org/3/i0510e/i0510e.pdf [accessed 2022-03-12].

FICK, S.E. & HIJMANS, R.J. (2017): Worldclim 2: New 1-km spatial resolution climate surfaces for global land areas. – Int. J. Climatol. 37: 14.
FISCHER, M. & MATTHIES, D. (1998): Effects of population size on performance in the rare plant *Gentianella germanica*. – J. Ecol. 86: 195–204.
GUO, Q., KELT, D. A., SUN, Z., LIU, H., HU, L., REN, H. & WEN, J. (2013): Global variation in elevational diversity patterns. – Sci. Rep. 3: 3007.
HORVÁTH, A. (Ed.) (2005): Tátorján (*Crambe tataria*) (Tartarian breadplant - *Crambe tataria*) [in Hungarian]. – KvVM Természetvédelmi Hivatal: 23 pp.
JANSSEN, J.A.M., RODWELL, J.S., CRIADO, G. … XYSTRAKIS, F. (2016): Red List of European Habitats: Part 2. Terrestrial and freshwater habitats. – Publications Office of the European Union, Luxembourg: 38 pp.
KALISTA, M. (2017): Underutilized medicinal species of *Crambe* L. of the flora of Ukraine. – Agrobiodiversity for improving nutrition, health and life quality 1: 216–220.
KELL, S.P. (2011): *Crambe tataria*. The IUCN Red List of Threatened Species 2011. – URL: https://www.iucnredlist.org/species/162122/5544350 [accessed 2021-02-23].
KERESZTY, Z. & GALÁNTAI, M. (2001): A *Crambe tataria* Sebeôk és rádi állományának ex-situ konzervációja (Ex-situ conservation of the population of *Crambe tataria* Sebeôk in Rád. Hungary) [in Hungarian, with English summaries]. – Botanikai Közlemenyek: 88(1–2): 2–10.
KÖRNER, C. (2007): The use of 'altitude' in ecological research. – Trends Ecol. Evol. 22: 569–574.
LĂCĂTUȘU, R. (2016): Agrochimie (Agrochemistry) [in Romanian]. – Terra Nostra, Iași: 440 pp.
LUNGU, M. & RIZEA, N. (2017): Chimia globală a solului. Procese, determinări, interpretări (Global soil chemistry. Processes, determinations, interpretations) [in Romanian]. – Terra Nostra, Iași:474 pp.
MARDARI, C., BÎRSAN, C., ȘTEFANACHE, C., ȘCHIOPU, R., GRIGORAȘ, V., BALAEȘ, T., DĂNILA, D. & TĂNASE, C. (2019): Population structure and habitat characteristics of *Arnica montana* L. in the NE Carpathians (Romania). – Tuexenia 39: 401–421.
MÂNZU, C.C., IRIMIA, I., CÎȘLARIU, A.G. & CHINAN, V.-C. (2020): Chorological data for some rare plant species from ROSCI0222 „Sărăturile Jijia Inferioară-Prut"and ROSPA0042 „Eleșteele Jijiei și Miletinului"(Iași County). – Acta Horti Bot. Bucur. 46: 35–54.
MUCINA, L., BÜLTMANN, H., DIERßEN, K. ... TICHÝ, L. (2016): Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen and algal communities. – Appl. Veg. Sci. 19: 3–264.
NADAL-ROMERO, E., PETRLIC, K., VERACHTERT, E., BOCHET, E. & POESEN, J. (2014): Effects of slope angle and aspect on plant cover and species richness in a humid Mediterranean badland. – Earth Surf. Process Landf. 39: 1705–1716.
NYÁRÁDY, E.I. (1955): *Crambe* L. – In: SĂVULESCU T. (Ed.): Flora Republicii Populare Romîne, Vol. III (Flora of the Romanian People's Republic, Vol. III) [in Romanian]. – Academia Republicii Populare Romîne, București: 662 p.
OLTEAN, M., NEGREAN, G., POPESCU, A., ROMAN, N., DIHORU, G., SANDA, V. & MIHĂILESCU, S. (1994): Lista roșie a plantelor superioare din România (Red list of superior plants in Romania). –In: OLTEAN, M. (Ed.): Studii, sinteze, documentaţii de ecologie 1 (Studies, syntheses, ecology documentation 1) [in Romanian]. – Academia Română, Institutul de Biologie, București: 52 pp.
O'MARA, F.P. (2012): The role of grasslands in food security and climate change. – Ann. Bot. 110: 1263–1270.
OOSTERMEIJER, J.G.B. (2003): Threats to rare plant persistence. – In: BRIGHAM C.A., SCHWARTZ, M.W. (Eds.): Population Viability in Plants: 17–58. Springer-Verlag, Berlin.
OROIAN, S., HIRIȚIU, M. & CURTICĂPEAN, M. (2007): The xero-mezophylic and xerophylic grasslands of *Festuco-Brometea* class in the Sighișoara-Târnava mare potential Natura 2000 Site (Transylvania, Romania). – Transylv. Rev. Syst. Ecol. Res. 4: 83–126.
OROIAN, S., SĂMĂRGHIȚAN, M. & TĂNASE, C. (2017). Plants species of community interest identified in the flora of the Transylvanian plain (Mureş county). – Studia Universitatis „Vasile Goldiş", Life Sciences Series 27(3): 1–210.
PANAGOS, P., VAN LIEDEKERKE, M., JONES, A. & MONTANARELLA, L. (2012): European Soil Data Centre: Response to European policy support and public data requirements. – Land Use Policy 29: 329–338.
PÂRVU, C. (2005): Enciclopedia plantelor, plante din Flora României (Encyclopedia of plants, plants from the Flora of Romania) [in Romanian]. – Tehnică București 4: 648–649.

RADFORD, E.A. & ODÉ, B. (Eds.) (2009): Conserving Important Plant Areas: investing in the Green Gold of South East Europe. – Plantlife International, Salisbury: 141 pp.

RAND, W.M. (1971): Objective criteria for the evaluation of clustering methods. – J. Am. Stat. Assoc. 66 (336): 846–850.

RAPAICS, R. (1938): A tátorján (Tartarian breadplant – *Crambe tataria*) [in Hungarian]. –A természet (Budapest) 34: 253–256.

ROUSSEEUW, P.J. (1987): Silhouettes: a Graphical Aid to the Interpretation and Validation of Cluster Analysis. – Comput. Appl. Math. 20: 53–65.

SÂRBU, A., OPREA, A. & SÂRBU, I. (2007): Plants from the habitat directive – Annex IIb, presents in Romania. – Bul. Grădinii Bot. Iași 14: 23–27.

SÂRBU, I., ȘTEFAN, N. & OPREA, A. (2013): Plante vasculare din România – Determinator ilustrat de teren (Vascular plants from Romania – Illustrated field determinant) [in Romanian]. – Victor B Victor, București: 1320 pp.

SENGL, P., MAGNES, M., WAGNER, V., ERDŐS, L. & BERG, C. (2016): Only large and highly-connected semi-dry grasslands achieve plant conservation targets in an agricultural matrix. – Tuexenia 36: 167–190.

SILVA, J.P., TOLAND, J., JONES, W., ELDRIDGE, J., THORPE, E., CAMPBELL, M. & O'HARA, E. (2008): LIFE and endangered plants: Europe's threatened flora. – Office for Official Publications of the European Communities, Luxembourg: 49 pp.

SOÓ, R. (1942): Az erdélyi medence endemikus és reliktum növényfajai (Endemic and relict plant species of the Transylvanian basin) [in Hungarian]. – Acta Bot. Hung. 5: 141–183.

SUTTIE, J.M., REYNOLDS, S.G. & BATELLO, C. (Eds.) (2005): Grasslands of the World (Vol. 34). – Food & Agriculture Org.

TER BRAAK, C.J.F. & ŠMILAUER, P. (2012): Canoco reference manual and user's guide: software for ordination (version 5.0). Microcomputer Power – Ithaca, New York.

TICHÝ, L. (2002): JUICE, software for vegetation classification. – J. Veg. Sci. 13: 451–453.

TILMAN, D., HILL, J. & LEHMAN, C. (2006): Carbon-negative biofuels from low-input high-diversity grassland biomass. – Science 314: 1598–1600.

VALKÓ, O., TÖRÖK, P., MATUS, G. & TÓTHMÉRÉSZ, B. (2012): Is regular mowing the most appropriate and cost-effective management maintaining diversity and biomass of target forbs in mountain hay meadows? – Flora 207: 303–309.

VASSILEV, K., RUPRECHT, E., ALEXIU, V. ... DENGLER, J. (2018): The Romanian Grassland Database (RGD): historical background, current status and future perspectives. – Phytocoenologia 48: 91–100.

WILLNER, W., ROLEČEK, J., KOROLYUK, A. ... YAMALOV, S. (2019): Formalized classification of the semi-dry grasslands of central and eastern Europe. – Preslia 91: 25–49.

XUE, R., YANG, Q., MIAO, F., WANG, X. & SHEN, Y. (2018): Slope aspect influences plant biomass, soil properties and microbial composition in alpine meadow on the Qinghai-Tibetan plateau. – J. Soil Sci. Plant Nutr. 18: 1–12.

YANG, J., EL-KASSABY, Y.A. & GUAN, W. (2020): The effect of slope aspect on vegetation attributes in a mountainous dry valley, Southwest China. – Sci. Rep. 10: 16465.

ZAMFIRESCU, Ș.R., ZAMFIRESCU, O., POPESCU, I.E., ION, C. & STRUGARIU, A. (2008): Vipera de stepă (*Vipera ursinii moldavica*) şi habitatele sale din Moldova (România) (Moldavian meadow viper (*Vipera ursinii moldavica*) and its habitats in Moldova – Romania) [in Romanian]. – Universitatea „Alexandru Ioan Cuza" – Iași 6: 29 pp.

Supplement E1. Synoptic table with the percentage frequencies of plant species in the communities with *Crambe tataria* from Romania. Alliances (groups) are: A – *Stipion lessingianae*, B – *Festucion valesiacae*, C – *Cirsio-Brachypodion pinnati* and *Danthonio-Brachypodion*, D – *Arrhenatherion elatioris*, E – *Prunion fruticosae*.

Anhang E1. Übersichtstabelle der prozentualen Häufigkeiten von Pflanzenarten in den Gesellschaften mit *Crambe tataria* aus Rumänien. Verbände (Gruppen) sind: A – *Stipion lessingianae*, B – *Festucion valesiacae*, C – *Cirsio-Brachypodion pinnati* und *Danthonio-Brachypodion*, D – *Arrhenatherion elatioris*, E – *Prunion fruticosae*.

Group (cluster)	A	B	C	D	E
No. of relevés	40	46	73	36	16
Acer tataricum	·	·	·	3	·
Achillea collina	·	22	19	50	6
Achillea millefolium	·	7	23	22	·
Achillea nobilis	8	·	·	·	·
Achillea ochroleuca	·	·	·	8	·
Achillea pannonica	10	7	·	8	13
Achillea setacea	78	61	4	19	·
Adonis vernalis	88	·	55	28	6
Adonis volgensis	·	2	·	·	·
Aegilops cylindrica	5	·	·	·	·
Aegonychon purpurocaeruleum	·	·	1	·	·
Agrimonia eupatoria	20	20	10	17	·
Agropyron cristatum	15	65	·	·	·
Agrostis capillaris	·	·	·	8	·
Agrostis stolonifera	·	·	·	8	·
Ajuga chamaepitys	·	13	1	3	·
Ajuga genevensis	·	9	1	3	·
Ajuga laxmannii	20	43	47	19	·
Allium albidum subsp. albidum	·	2	26	·	·
Allium denudatum	·	·	5	6	·
Allium flavescens subsp. flavescens	·	2	·	·	·
Allium flavum	·	11	3	3	·
Allium flavum subsp. tauricum	·	2	·	·	·
Allium rotundum	·	4	1	·	·
Allium scorodoprasum	·	·	·	3	·
Alopecurus pratensis	3	·	·	·	·
Althaea cannabina	·	4	·	·	·
Alyssum alyssoides	·	11	12	8	6
Alyssum turkestanicum	·	17	·	·	·
Anchusa ochroleuca	·	28	·	·	·
Anchusa officinalis	·	11	·	·	·
Androsace elongata	·	2	·	·	·
Anemone sylvestris	·	2	·	3	6
Anisantha tectorum	·	4	·	·	·
Anthericum ramosum	·	20	4	25	·
Anthoxanthum odoratum	8	·	·	11	·
Anthyllis vulneraria	·	2	1	14	·
Arabis hirsuta	·	·	3	8	·
Arctium lappa	·	2	·	·	·
Arenaria serpyllifolia	·	26	4	11	·
Aristolochia clematitis	8	·	·	·	·
Arrhenatherum elatius	5	9	1	19	·
Artemisia absinthium	·	15	3	·	·
Artemisia austriaca	8	43	·	·	·
Artemisia campestris	·	·	8	14	69
Artemisia pontica	·	·	26	·	75
Artemisia vulgaris	·	·	·	3	·
Asparagus officinalis	50	54	47	14	31
Asparagus tenuifolius	·	2	·	·	·
Asperula cynanchica	5	46	49	61	·
Asperula tenella	·	2	·	·	·
Asperula tinctoria	·	2	11	3	·
Aster amellus	·	4	3	31	·
Astragalus asper	·	·	4	14	·
Astragalus austriacus	3	11	4	19	·
Astragalus dasyanthus	·	9	15	11	·
Astragalus exscapus	·	·	16	·	·
Astragalus exscapus subsp. pubiflorus	·	2	·	·	·
Astragalus glycyphyllos	·	·	·	6	·
Astragalus monspessulanus	·	·	75	3	56
Astragalus onobrychis	·	65	1	·	·
Astragalus ponticus	·	2	·	·	·
Astragalus vesicarius	·	·	1	6	·
Asyneuma canescens	5	2	·	3	·
Atriplex patula	3	·	·	·	·
Avenula pubescens	·	·	·	14	·
Ballota nigra	·	4	·	·	·
Bassia prostrata	·	9	·	·	·
Bellevalia speciosa	·	2	·	·	·
Berteroa incana	·	9	·	·	·
Bothriochloa ischaemum	3	48	49	17	25
Brachypodium pinnatum	3	9	14	47	6
Brassica elongata	20	·	38	11	56
Brassica nigra	3	·	·	·	·
Briza media	3	·	·	17	·
Bromopsis erecta	·	7	·	3	·
Bromopsis inermis	3	28	15	8	6
Bromus arvensis	·	·	1	6	·
Bromus hordeaceus	·	11	·	·	·
Bromus japonicus	·	2	·	·	·
Bromus squarrosus	·	2	·	·	·
Buglossoides arvensis	·	9	3	·	·
Bupleurum affine	·	2	·	·	·
Bupleurum falcatum	8	7	12	39	13
Calamagrostis epigejos	5	9	·	11	25
Camelina microcarpa	5	9	·	6	·
Campanula bononiensis	·	4	1	3	·
Campanula glomerata	·	·	·	25	·
Campanula persicifolia	·	·	·	6	·
Campanula sibirica	·	59	49	33	19
Capsella bursa-pastoris	·	·	1	·	·
Carduus acanthoides	3	13	5	6	·
Carduus crispus	·	2	1	·	·
Carduus hamulosus	5	39	47	28	·
Carduus nutans	·	4	·	·	·
Carex caryophyllea	·	4	·	·	·
Carex distans	20	·	·	·	·
Carex filiformis	·	15	7	11	·
Carex humilis	8	4	89	47	25
Carex liparocarpos	·	2	·	·	·
Carex michelii	·	17	1	6	·
Carex montana	·	·	·	6	·
Carex praecox	·	13	·	·	·
Carex supina	·	2	·	·	·
Carthamus lanatus	·	2	·	·	·
Carum carvi	·	·	·	6	·
Caucalis platycarpos	·	·	11	·	·
Centaurea atropurpurea	·	·	·	6	·
Centaurea diffusa	·	2	·	·	·
Centaurea jacea	·	2	·	·	·
Centaurea jacea subsp. angustifolia	·	·	·	6	·
Centaurea neiceffii	5	·	·	·	·
Centaurea orientalis	78	78	·	·	·
Centaurea phrygia subsp. indurata	·	·	·	6	·
Centaurea phrygia subsp. phrygia	·	·	·	3	·
Centaurea pugioniformis	·	·	·	3	·
Centaurea scabiosa	·	15	10	33	·
Centaurea scabiosa subsp. spinulosa	·	9	15	25	·
Centaurea scabiosa subsp. adpressa	·	4	·	·	·
Centaurea solstitialis	·	17	·	·	·
Centaurea stoebe	·	7	·	19	·
Centaurea stoebe subsp. australis	35	48	25	19	·
Centaurium erythraea	·	2	·	·	·
Cephalaria radiata	·	·	3	3	·
Cephalaria transsylvanica	·	2	·	·	·
Cephalaria uralensis	·	·	62	·	50
Cerastium fontanum subsp. vulgare	·	·	·	6	·
Ceratocarpus arenarius	·	11	·	·	·
Ceratocephala falcata	·	2	·	·	·
Ceratocephala orthoceras	·	4	·	·	·
Cerinthe minor	20	43	·	8	·
Chondrilla juncea	·	2	·	·	·
Chrysopogon gryllus	8	7	·	·	·
Cichorium intybus	3	11	·	11	·
Cirsium arvense	3	·	·	8	·
Cirsium pannonicum	·	·	·	11	·
Cirsium serrulatum	·	2	·	·	·
Cirsium vulgare	8	·	·	·	·
Cleistogenes serotina	·	17	14	11	·
Clematis integrifolia	23	30	1	6	·
Clematis recta	·	2	·	11	·
Clinopodium acinos	·	26	3	3	·
Clinopodium vulgare	5	·	1	14	·
Colchicum bulbocodium subsp. versicolor	·	7	·	·	·
Convolvulus arvensis	75	11	40	28	6
Cornus mas	·	·	·	6	·
Cornus sanguinea	5	·	·	8	·
Cota tinctoria	·	20	·	3	·
Crambe tataria	**100**	**100**	**100**	**100**	**100**
Crataegus monogyna	13	7	11	42	·
Crepis foetida	5	11	·	·	·
Crepis setosa	·	11	·	3	·
Crepis tectorum	·	2	·	·	·
Crocus reticulatus	·	2	·	·	·
Cruciata glabra	·	·	1	14	·
Crupina vulgaris	·	·	1	·	·
Cuscuta campestris	·	2	·	·	·
Cuscuta epithymum	·	·	4	·	·
Cyanus triumfettii subsp. axillaris	·	·	·	6	·
Cyanus triumfettii subsp. strictus	·	·	·	8	·
Cyanus triumfettii	·	·	·	6	·
Cynoglossum officinale	3	·	5	·	·
Cynoglottis barrelieri	3	7	18	6	·
Cytisus albus	·	·	29	33	25
Cytisus austriacus	78	54	·	11	·
Cytisus ratisbonensis	·	·	3	·	·
Dactylis glomerata	83	13	1	39	·
Danthonia alpina	·	·	·	8	·
Daucus carota	·	22	3	8	·
Dianthus capitatus	68	28	·	·	·
Dianthus carthusianorum	·	2	14	47	·
Dianthus membranaceus	·	41	·	11	·
Dictamnus albus	·	·	47	28	·
Digitalis grandiflora	·	·	·	6	·
Diplotaxis muralis	·	·	1	·	·
Dorycnium pentaphyllum subsp. herbaceum	8	41	63	44	44
Draba nemorosa	·	2	·	·	·
Draba verna	·	2	·	·	·
Echinops sphaerocephalus	·	·	8	11	·
Echium italicum	·	4	·	·	·
Echium vulgare	·	22	14	11	·
Elaeagnus angustifolia	·	·	1	·	·
Elymus hispidus subsp. hispidus	·	7	·	3	·
Elymus uralensis subsp. viridiglumis	·	·	1	0	·
Elytrigia intermedia	13	57	52	44	19
Elytrigia repens	13	20	7	8	·
Erigeron acris	·	11	·	3	·
Erigeron annuus	3	2	·	8	·
Eryngium campestre	30	33	63	31	25
Eryngium maritimum	·	·	·	·	·
Eryngium planum	3	·	10	6	·
Erysimum cuspidatum	·	2	·	·	·
Erysimum diffusum	·	37	·	·	·
Erysimum hieraciifolium	·	4	·	6	·
Erysimum odoratum	8	11	4	17	·
Euphorbia agraria	·	7	·	·	·
Euphorbia angulata	·	·	·	6	·
Euphorbia cyparissias	·	20	59	44	50
Euphorbia esula	·	9	1	3	·
Euphorbia esula subsp. tommasiniana	·	2	14	19	19
Euphorbia falcata	·	·	·	3	·
Euphorbia illirica	·	2	1	8	·
Euphorbia nicaeensis	48	30	·	·	·
Euphorbia nicaeensis subsp. glareosa	·	17	·	·	·
Euphorbia salicifolia	·	·	·	3	·
Euphorbia seguieriana subsp. niciciana	·	·	36	3	·
Falcaria vulgaris	45	54	47	50	6
Fallopia convolvulus	·	·	1	·	·
Ferulago campestris	·	11	·	·	·
Ferulago sylvatica	·	·	1	6	·
Festuca rupicola subsp. rupicola	·	·	1	6	·
Festuca stricta subsp. sulcata	·	2	77	36	6
Festuca valesiaca	90	85	7	25	·
Festuca valesiaca subsp. parviflora	·	·	1	3	·
Filipendula vulgaris	63	57	51	50	13
Fragaria vesca	·	·	5	14	·
Fragaria viridis	55	24	41	28	·
Frangula alnus	·	·	1	·	·
Fraxinus excelsior	·	·	5	·	·
Gagea pratensis	·	2	·	·	·
Gagea pusilla	·	2	·	·	·
Galatella linosyris	·	7	60	25	31
Galatella villosa	3	22	·	·	·
Galium album	·	·	1	3	·
Galium boreale	·	·	4	6	·
Galium glaucum	·	20	79	36	38
Galium humifusum	·	15	·	·	·
Galium moldavicum	·	4	·	·	·
Galium mollugo	·	7	·	·	·
Galium octonarium	35	46	·	·	·
Galium rubioides	·	·	1	6	·
Galium verum	78	54	15	50	·
Genista tinctoria	·	4	25	17	6
Gentiana cruciata	·	·	·	3	·
Geranium pratense	·	·	·	3	·
Geranium sanguineum	·	·	·	31	·
Goniolimon tataricum	·	·	·	·	6
Haplophyllum suaveolens	·	2	·	·	·
Helianthemum canum	·	·	1	·	·
Helianthemum nummularium subsp. obscurum	·	·	1	·	·
Helichrysum arenarium	·	17	·	·	·
Helictochloa pratensis	·	·	1	·	·
Heracleum sphondylium	·	·	·	8	·
Herniaria glabra	·	2	·	·	·
Herniaria incana	·	26	·	·	·
Hesperis tristis	·	·	·	8	·
Hieracium umbellatum	·	·	·	3	·
Hieracium villosum	·	2	·	·	·
Hieracium virosum	3	15	·	·	·
Hierochloe repens	·	9	·	3	·
Holcus lanatus	3	·	·	3	·
Hordeum murinum	10	·	·	·	·
Hyacinthella leucophaea	·	7	·	·	·
Hyoscyamus niger	·	2		·	·
Hypericum elegans	5	4	5	14	·
Hypericum perfoliatum	·	·	·	11	·
Hypericum perforatum	·	28	10	6	·
Hypochaeris maculata	·	·	1	11	·
Hypochaeris radicata	·	·	·	3	·
Inula britannica	·	2	·	14	·
Inula ensifolia	·	24	62	31	31
Inula germanica	35	46	11	14	·
Inula helenium	·	·	·	11	·
Inula hirta	58	20	8	28	·
Inula oculus-christi	·	11	·	·	·
Inula salicina	·	9	1	3	6
Iris aphylla	40	30	25	36	19
Iris graminea	18	11	·	3	·
Iris pontica	·	·	4	6	·
Iris pumila	·	·	36	·	·
Iris sintenisii subsp. brandzae	10	13	·	·	·
Iris variegata	·	·	1	6	·
Jacobaea erucifolia	3	11	·	·	·
Jacobaea vulgaris	·	30	27	14	·
Jurinea arachnoidea	3	87	·	·	·
Jurinea ledebourii	·	·	18	6	25
Jurinea mollis	20	·	7	11	·
Jurinea transylvanica	·	·	58	17	13
Klasea lycopifolia	·	·	·	3	·
Klasea radiata	·	17	34	28	25
Knautia arvensis	73	54	4	47	·
Koeleria glauca	·	·	5	·	·
Koeleria macrantha	60	74	37	39	6
Koeleria splendens	·	·	5	·	·
Lactuca serriola	·	2	4	·	·
Lappula squarrosa	·	11	7	6	·
Laserpitium latifolium	·	·	·	6	·
Lathyrus pallescens	·	2	4	6	·
Lathyrus pannonicus	·	·	10	8	6
Lathyrus pannonicus subsp. collinus	3	15	·	·	·
Lathyrus pratensis	·	·	·	11	·
Lathyrus tuberosus	3	15	·	3	·
Lembotropis nigricans	·	·	1	11	25
Leontodon biscutellifolius	·	4	32	6	·
Leontodon hispidus	·	·	3	14	·
Leonurus cardiaca subsp. villosus	3	4	·	·	·
Leopoldia comosa	70	52	21	17	·
Leopoldia tenuiflora	·	·	51	14	31
Lepidium campestre	·	4	1	6	·
Lepidium draba	3	11	·	·	·
Leucanthemum vulgare	·	7	1	31	·
Ligustrum vulgare	·	·	14	11	·
Linaria angustissima	·	·	5	·	38
Linaria genistifolia	5	7	·	17	·
Linaria vulgaris	·	4	·	6	·
Linum austriacum	15	35	4	17	·
Linum catharticum	·	·	1	3	·
Linum flavum	5	33	3	14	6
Linum hirsutum	·	52	14	·	25
Linum nervosum	·	·	16	31	·
Linum perenne	·	11	·	·	·
Linum tenuifolium	·	9	11	·	6
Lithospermum officinale	18	·	1	·	·
Lolium perenne	·	2	·	·	·
Lotus corniculatus	3	28	·	19	·
Malabaila graveolens	10	33	·	·	·
Malva sylvestris	15	·	·	3	·
Malva thuringiaca	3	26	·	8	·
Marrubium peregrinum	68	65	·	3	·
Marrubium pestalozzae	·	·	·	6	·
Marrubium vulgare	5	4	4	·	·
Medicago falcata	35	85	66	50	38
Medicago lupulina	·	17	·	8	·
Medicago minima	·	7	·	·	·
Medicago monspeliaca	·	2	·	·	·
Melampyrum arvense	73	50	23	8	31
Melampyrum bihariense	·	·	·	3	·
Melampyrum cristatum	·	4	·	3	·
Melampyrum nemorosum	·	·	·	3	·
Melica ciliata	·	37	15	·	·
Melica picta	·	·	1	·	·
Melica transsilvanica	·	·	5	·	·
Melilotus officinalis	·	17	4	8	31
Mercurialis ovata	8	2	·	11	·
Minuartia setacea	·	2	·	·	·
Muscari neglectum	·	·	1	·	·
Muscari racemosum	·	11	·	·	·
Myosotis arvensis	·	·	·	3	·
Nepeta nuda	5	9	5	36	·
Nepeta ucranica	·	·	19	11	25
Neslia paniculata	·	·	3	·	·
Nigella arvensis	·	4	3	3	·
Noccaea kovatsii	·	·	1	·	·
Noccaea perfoliata	·	4	1	·	·
Nonea pulla	35	54	36	36	·
Onobrychis arenaria	·	2	12	17	·
Onobrychis viciifolia	53	70	34	42	·
Ononis spinosa subsp. hircina	·	9	·	3	·
Onosma arenarium	·	2	·	·	·
Onosma pseudarenaria	·	·	1	·	·
Origanum vulgare	·	·	·	11	·
Orlaya daucoides	·	·	1	·	·
Ornithogalum collinum	·	·	·	3	·
Ornithogalum gussonei	·	4	·	·	·
Ornithogalum pyramidale	·	·	3	·	·
Ornithogalum umbellatum	3	·	·	3	·
Orobanche alba	13	·	14	3	·
Orobanche caryophyllacea	·	2	·	·	·
Orobanche elatior	·	·	·	3	·
Orobanche lutea	·	2	·	3	·
Orobanche teucrii	·	·	·	3	·
Oxytropis pilosa	·	26	30	11	38
Paeonia tenuifolia	·	·	·	22	·
Pedicularis comosa subsp. campestris	·	·	·	8	·
Petrorhagia prolifera	·	7	·	·	·
Peucedanum alsaticum	·	2	·	·	·
Peucedanum cervaria	·	·	7	8	·
Peucedanum officinale	·	·	·	6	·
Peucedanum oreoselinum	·	·	·	6	·
Peucedanum ruthenicum	·	·	42	·	·
Peucedanum tauricum	·	·	3	11	·
Phelipanche purpurea	·	·	·	·	13
Phleum montanum	10	·	21	25	6
Phleum phleoides	90	15	5	36	·
Phlomis herba-venti subsp. pungens	3	83	·	·	·
Phlomis tuberosa	30	43	4	19	·
Phragmites australis	38	17	10	11	69
Picris hieracioides	8	15	5	6	·
Pilosella bauhini	·	11	7	6	·
Pilosella echioides	·	17	·	·	·
Pilosella officinarum	·	7	3	8	·
Pimpinella saxifraga	3	4	4	25	·
Pinus nigra	·	·	1	·	·
Plantago argentea	·	·	55	22	50
Plantago cornuti	5	·	·	·	·
Plantago lanceolata	35	37	3	50	·
Plantago media	35	61	36	36	·
Poa angustifolia	20	7	8	19	·
Poa bulbosa	·	2	·	·	·
Poa compressa	·	2	·	·	·
Poa pratensis	30	4	·	6	·
Podospermum canum	·	9	1	·	·
Podospermum purpureum	·	·	·	·	6
Polycnemum arvense	·	2	·	·	·
Polygala comosa	·	9	·	·	·
Polygala major	23	4	15	31	6
Polygala vulgaris	·	7	1	·	·
Polygonatum hirtum	·	2	·	·	·
Pontechium maculatum	33	57	19	25	·
Potentilla alba	·	·	·	3	·
Potentilla argentea	55	35	·	14	·
Potentilla cinerea	·	11	49	19	13
Potentilla erecta	3	·	·	19	·
Potentilla heptaphylla	·	·	·	3	·
Potentilla incana	3	39	10	6	25
Potentilla inclinata	·	4	·	·	·
Potentilla pedata	·	·	·	6	·
Potentilla recta	·	41	5	6	·
Primula veris	3	2	·	25	·
Prunella grandiflora	·	13	·	14	·
Prunella laciniata	·	·	·	3	·
Prunella vulgaris	·	9	·	6	·
Prunus fruticosa	·	·	·	6	·
Prunus spinosa	25	7	11	31	·
Prunus tenella	3	7	42	22	50
Psephellus marschallianus	·	7	·	·	·
Psephellus trinervius	·	·	21	25	44
Pulmonaria mollis	·	·	·	6	·
Pulmonaria montana	·	9	1	·	·
Pulsatilla montana	·	11	23	3	19
Pulsatilla patens	·	·	·	3	·
Pulsatilla pratensis	·	7	·	·	·
Pulsatilla vulgaris subsp. grandis	·	4	·	·	·
Pyrus communis subsp. pyraster	·	2	1	14	13
Quercus robur	·	·	·	3	·
Ranunculus acris	·	11	·	·	·
Ranunculus illyricus	·	11	·	·	·
Ranunculus polyanthemos subsp. polyanthemos	23	2	1	14	·
Rapistrum perenne	18	20	1	6	·
Reseda inodora	·	4	·	·	·
Reseda lutea	25	57	5	·	·
Rhamnus catharticus	3	·	·	11	·
Rhamnus saxatilis subsp. tinctorius	·	·	1	·	·
Rhinanthus angustifolius	·	·	1	3	·
Rhinanthus minor	·	2	·	8	·
Rhinanthus rumelicus	·	11	·	3	·
Rindera umbellata	·	2	·	·	·
Robinia pseudacacia	·	·	3	11	·
Rosa canina	10	·	·	11	·
Rosa gallica	3	9	19	14	·
Rostraria cristata	·	·	1	·	·
Rumex acetosa	3	·	·	·	·
Rumex crispus	3	·	·	·	·
Rumex tuberosus	·	11	·	·	·
Salix alba	·	·	·	3	·
Salvia aethiopis	·	9	·	·	·
Salvia austriaca	43	54	34	25	·
Salvia nemorosa	95	85	37	22	31
Salvia nutans	13	2	63	47	38
Salvia pratensis	38	22	16	42	6
Salvia transsylvanica	·	·	40	22	·
Salvia verticillata	8	39	11	25	·
Salvia x betonicifolia	·	·	1	·	·
Sanguisorba minor	·	·	·	6	·
Scabiosa ochroleuca	8	52	4	42	·
Schedonorus pratensis	60	9	·	8	·
Scleranthus annuus	·	11	·	·	·
Scleranthus polycarpos	·	2	·	·	·
Scorzonera hispanica	5	·	56	14	6
Scorzonera humilis	·	·	·	3	·
Scorzonera parviflora	·	·	·	3	·
Securigera varia	25	57	26	44	·
Sedum maximum	·	·	·	6	·
Senecio leucanthemifolius subsp. vernalis	·	4	·	·	·
Serratula tinctoria	·	·	·	8	·
Seseli annuum	·	·	·	11	·
Seseli gracile	·	·	·	8	·
Seseli osseum	·	·	7	3	·
Seseli pallasii	·	·	25	17	6
Seseli peucedanoides	·	·	·	6	·
Sesleria caerulea	·	·	1	·	·
Sideritis montana	·	15	1	8	6
Silene bupleuroides	·	·	·	·	6
Silene chlorantha	·	4	·	·	·
Silene densiflora	·	15	·	8	·
Silene donetzica	·	4	·	·	·
Silene nemoralis	·	·	·	3	·
Silene otites	·	43	3	3	·
Silene vulgaris	·	7	·	6	·
Sinapis arvensis	·	·	·	3	·
Sisymbrium loeselii	·	9	·	·	·
Sisymbrium polymorphum	·	9	·	·	·
Solidago virgaurea	·	·	·	3	·
Sonchus arvensis	·	·	·	3	6
Stachys annua	·	9	·	3	·
Stachys germanica	·	2	·	3	·
Stachys officinalis	5	22	·	8	·
Stachys recta	95	65	78	72	31
Stellaria graminea	5	4	·	·	·
Stipa capillata	·	28	14	11	·
Stipa lessingiana	80	26	38	8	63
Stipa pennata	10	15	·	3	·
Stipa pulcherrima	·	28	79	19	6
Stipa tirsa	8	24	7	28	·
Tanacetum corymbosum	8	2	1	17	·
Tanacetum vulgare	·	7	·	·	·
Taraxacum erythrospermum	·	2	·	·	·
Taraxacum officinale	·	2	4	3	·
Taraxacum serotinum	18	35	·	·	·
Teucrium chamaedrys	95	72	88	75	25
Teucrium montanum	·	·	44	·	25
Teucrium polium	8	37	·	11	·
Thalictrum aquilegiifolium	·	·	·	6	·
Thalictrum flavum	·	·	·	3	·
Thalictrum minus	78	65	47	28	·
Thesium dollineri	·	4	·	·	·
Thesium linophyllon	·	·	22	44	·
Thesium linophyllon subsp. montanum	·	·	3	·	·
Thesium ramosum	·	·	7	·	·
Thymelaea passerina	·	·	1	3	·
Thymus odoratissimus	·	2	·	8	·
Thymus pulegioides	8	·	·	14	·
Thymus pulegioides subsp. pannonicus	10	65	29	33	·
Thymus serpyllum L. subsp. serpyllum	·	9	51	28	50
Tragopogon dubius	·	28	37	14	·
Tragopogon dubius subsp. major	·	·	·	·	25
Tragopogon pratensis	·	11	·	6	·
Tragopogon pratensis subsp. orientalis	·	11	7	19	·
Tragus racemosus	·	2	·	·	·
Trichophorum alpinum	·	7	·	·	·
Trifolium alpestre	28	33	7	19	·
Trifolium arvense	·	15	·	·	·
Trifolium medium	·	4	·	3	·
Trifolium montanum	55	48	16	50	·
Trifolium ochroleucon	·	7	·	·	·
Trifolium pannonicum	·	·	·	3	·
Trifolium pratense	·	9	·	11	·
Trifolium repens	·	7	·	3	·
Trifolium rubens	·	·	3	6	·
Trinia glauca	·	4	4	·	·
Trinia kitaibelii	·	39	4	·	·
Trinia multicaulis	·	7	·	·	·
Tripleurospermum inodorum	·	2	·	·	·
Urtica dioica	·	·	·	·	·
Valeriana officinalis	·	2	·	3	·
Valerianella dentata	·	4	·	·	·
Veratrum nigrum	·	2	·	3	·
Verbascum blattaria	3	9	·	·	·
Verbascum chaixii subsp. austriacum	·	·	3	8	·
Verbascum lychnitis	5	9	1	3	·
Verbascum nigrum	3	2	·	·	·
Verbascum phlomoides	5	·	4	6	·
Verbascum phoeniceum	·	9	22	14	6
Verbascum speciosum	·	4	·	·	·
Veronica arvensis	·	4	·	8	·
Veronica austriaca	73	48	11	19	·
Veronica austriaca subsp. teucrium	·	2	19	8	·
Veronica chamaedrys	3	·	·	19	·
Veronica incana	·	4	·	·	·
Veronica officinalis	·	·	7	·	·
Veronica orchidea	·	2	44	22	6
Veronica prostrata	·	7	8	·	·
Veronica spicata	·	7	3	6	·
Veronica spuria	·	·	·	3	·
Vicia cracca	70	39	1	8	·
Vicia hirsuta	·	·	1	·	·
Vicia sativa subsp. nigra	·	·	·	8	·
Vicia sepium	·	·	·	6	·
Vicia villosa	8	·	12	3	·
Vinca herbacea	30	28	55	14	·
Vinca minor	·	·	·	6	·
Vincetoxicum hirundinaria	23	11	8	19	·
Viola ambigua	·	·	25	14	·
Viola arvensis	·	11	·	·	·
Viola collina	·	·	·	3	·
Viola hirta	3	7	29	28	·
Viola suavis	·	·	3	·	·
Viola tricolor	·	·	·	3	·
Xeranthemum annuum	·	17	·	·	·
Xeranthemum cylindraceum	·	4	·	·	·
Xeranthemum inapertum	·	2	·	·	·