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ECOLOGICAL AND COENOTIC FEATURES OF *Thesium ebracteatum* Hayne AND ITS DISTRIBUTION IN UKRAINE

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Abstract

Shevchyk V.L., Goncharenko I.V., Solomakha I.V., Dvirna T.S., Solomakha V.A.: Ecological and coenotic features of *Thesium ebracteatum* Hayne and its distribution in Ukraine. Ekológia (Bratislava), Vol. 42, No. 2, p. 142–158, 2023.

Ecological analysis of the existing phytocoenological relevés was carried out, including the new localities of *Thesium ebracteatum* Hayne in the Middle Dnipro region. To study the coenotic features, the ratio of diagnostic species of different classes of vegetation in the communities was found. In the western part of the area, including the territory of Ukraine, this species grows in psamophytic communities, the basis of which is species of the *Trifolio-Geranietea sanguinei* class. In the eastern part of the area, including the territory of the Russian Federation, the species grows in steppe communities with a predominance of species of the *Festuco-Brometea* class. The analysis of ecological features of the species using the method of phytoindication showed the two clusters with the biggest differences by the acidity indicator. In the central part of Ukraine and in Europe, this species grows on soils with a higher acidity. On the contrary, in the eastern part of the area (territory of the Russian Federation), it mostly occurs on carbonate-enriched soils with low acidity. The growth of *T. ebracteatum* on more acidic soils in the western areas should be explained by a more humid climate.

Key words: Berne Convention, Middle Dnieper region, species protection, *Thesium ebracteatum,* Ukraine.

Introduction

Thesium ebracteatum Hayne (Santalaceae) is a perennial rhizomatous, facultative, semi-parasite herbaceous plant (Dostálek, Münzbergová, 2010). In relation to thermal regime, this species is submicrotherm–submesotherm; in relation to continental climate regime, it is subcontinental; in relation to climate, it is subarid–subhumid; in relation to cryoregime, it is cryophyte–hemicryophyte; according to the salt regime - the type of poor and rich soils; according to the moisture regime, there are species from slightly alternating-humid to strongly alternating-humid soils; according to the regime of light, there are species of open spaces and sparse forests (Tsyganov, 1983). It grows in moist, marshy, or peaty meadows, but also tolerates drainage well (Mazáč, 2007) on the xerothermic grasslands (Krechowski et al., 2015) and also on glades of mixed and broad-leaved forests, meadow-steppe slopes, among shrubs on rich and medium-rich soils (Solomakha, 2017).

T. ebracteatum is distributed in the Central and Eastern Europe, with some populations extending into Russia beyond the Ural mountains (Bilz, 2011; Tzvelev, 1996; Uotila, 2011; *Thesium ebracteatum* Hayne (1800). Plants of the World Online) (Fig. 1). The stronghold of the species is in Poland, where it has a geographic range of 130,900 km² (Bilz, 2011; Dostálek et al., 2014). In the Central Europe (the Czech Republic, Austria, and Germany), the populations of this species are sparse, with only a few remaining in each country and the localities' number is continuously decreasing (Hendrych, 1969; Dostálek et al., 2014).

In Ukraine, it grows in the lowland part in zones of coniferous and deciduous forests and in the forest-steppe zone (Bilz, 2011).

Such a situation with the distribution of *T. ebracteatum* is caused by a number of reasons. The abandonment of pastoral systems has been considered as the main threat as this leads to vegetation succession and competition. Pollution due to the use of fertilizers, eutrophication, and acidification cause the habitat quality to degrade. Inadequate forestry management and changes in hydraulic conditions such as drainage or flooding of

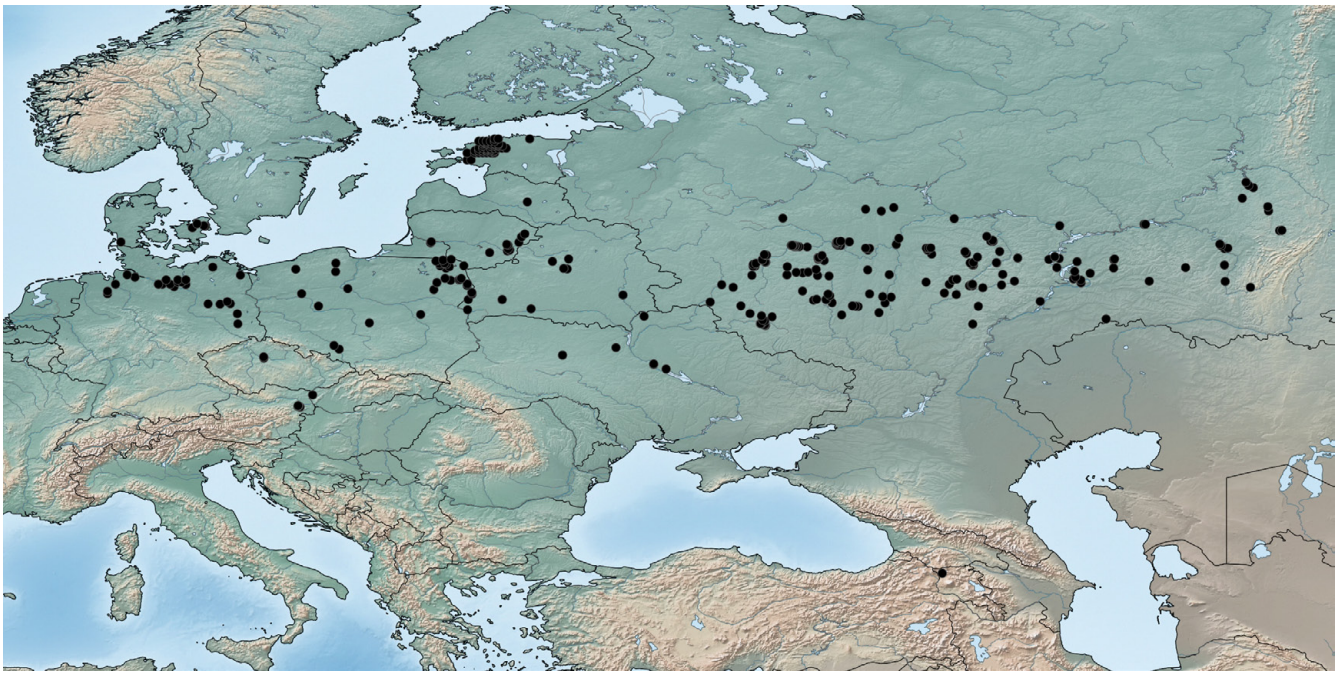

Fig. 1. The map of distribution of *Thesium ebracteatum* in Europe (according GBIF.org, 2022)

wetlands affect the species. Sand and gravel extraction has been noted as a local threat (Bilz, 2011).

Therefore, monitoring research and conservation of this species is of high interest in Europe (NATURA, 2000; Bilz, 2011; Dostálek et al., 2014).

The necessity of protection of this species was defined for the first time by the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention as amended in 1998, Part A, Annex I). It is also listed in Annex II of the Council Directive 92/43/EEC/1992.

It is one of the most endangered plant species in Europe, and it has most recently been assessed for The IUCN Red List of Threatened Species in 2011 (Bilz, 2011). *T. ebracteatum* is listed as the species of least concern in Europe (Bilz, 2011). This species is listed on Annex II of the Habitats Directive and under Appendix I of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). It is categorized as critically endangered in the Czech Republic (Holub, Procházka, 2000; Čeřovský, 1999; Dvořák, 2010), Germany (Ludwig, Schnittler, 1996; Bundesamt für Naturschutz, 2010), and Latvia (*T. ebracteatum* Hayne, 2023). In Denmark, it is categorized as regionally extinct (NERI, 2007). In Slovakia, the species is officially listed as extinct (Čeřovský, 1999). The species is listed as vulnerable in Lithuania (Rašomavičius, 2021) and Estonia (The new Estonian Red List of Threatened Species, 2001–2002). *T. ebracteatum* is also protected in Romania (Dihoru, Negrean, 2009), Poland (Załuski et al., 2009; Zarzycki, Szeląg, 2006), and in the Republic of Belarus (Kachanovskii, 2015). In Russia, the species is regionally rare, and it is protected in the Vladimir, Kaliningrad, Nizhny Novgorod, Pskov regions and in the Republic of Udmurtia (Red Data Book of the Nizhny Novgorod Region, 2005; Bilz, 2011). It is not included in the Red Data Books of Ukraine, but it is protected in the Kaniv Nature Reserve.

The focus on this species as an object of protection has stimulated an intensified and diverse study of it. Thus, molecular genetic studies have shown a high molecular dispersion between individuals of different populations and an average in the populations themselves, as well as a direct dependence of the value of intrapopulation genetic diversity on the size of the population (Dostálek et al., 2014). The distribution of the phytopathogenic fungus *Puccinia passerinii* Schroet was studied on *T. ebracteatum* (*Sucharzewska* et al., 2016). Mostly, pregenerative shoots affected by the fungus were noted, on which premature death of leaves occurred. It is quite likely that this phytopathy can reduce the overall productivity of the phytomass of this species and affect the reproductive potential of its populations.

T. ebracteatum is found in extensively used grassland, wet *Molinia* meadows, and skirts of dry forests. However, its most characteristic habitats as listed in the Habitats Directive are (Commission of the European Communities, 1992):

- 4030 European dry heaths
- 6120 xeric sand calcareous grasslands
- 6210 semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)
- 6280 Nordic alvar and precambrian calcareous flatrocks
- 6530 Fennoscandian wooded meadows
- 91I0 Euro-Siberian steppic woods with *Quercus* spp.

In Ukraine, this species is a component of the plant communities *Corynephorion canescentis alliance, C. canescentis* ordo, *C. canescentis* class and *Koelerion glauca alliance, Festuco-Astragaletalia arenarii* ordo, *F. vaginatae* class (Vinichenko, 2006).

Ten-year monitoring of individual populations in Germany has shown large changes in the number of shoots in the populations in individual years (NLWKN, 2011). Long-term observations of 27 local populations of *T. ebracteatum* revealed the fact

of disappearance of some populations in central Poland. As a result of a synthetic assessment of the status of *T. ebracteatum* populations in each of the settlements, it is concluded that 43% of the localities are in a threatened state of existence, 40% of the localities are not in a suitable state of existence, and 17% of the localities are in a suitable state of existence (Pawlikowski, 2012).

The aim of this publication is to show the peculiarities of the species localities according to relevés in the Middle Dnieper region, to carry out a comparative phytocenotic analysis of the habitats in different parts of its area, to study the ecotopical features based on phytoindication assessment of *T. ebracteatum* communities, and to make an evaluation of the potential and possibilities of the population's conservation in the Middle Dnieper region.

Material and methods

Study area

The research area is represented by a land bounded from the southwest and south by the water area of the Kaniv Reservoir and a line passing along the southern outskirts of the Kyilovo, Holovuriv, Stare, Soshnykiv, and Divychky settlements. According to the physical–geographical zoning of Ukraine, the studied territory belongs to Protsiv-Lipliav district, the North-Dnieper terrace-lowland region, the Left Bank-Dnieper region, the forest-steppe zone, and the East European plain (Tolstoukhov, 2006). By the geostructure, it is adapted to the eastern stepped slope of the crystalline basement, descending to the Dnieper-Donetsk basin, covered to a depth of 1000 m by post-Proterozoic sedimentary layers. From a geomorphological point of view, these are areas whose formation was determined by continental Pleistocene glaciation processes and alluvial and eolian processes in the post-glacial period (Pazynych, 2007). The entire territory is covered with ancient and modern alluvial sand sediments, quite often reshaped and redeposited by the wind, and in places of depression, it is complicated by modern deposits of organic origin (mud, sapropel, peat). A rather important factor in the modern stage of landscape genesis was also the anthropogenic influence on these territories, namely, flooding due to creation of the water area of the Kaniv reservoir (1974–1976). In this regard, currently, the soil cover within the height range of 88–95 m above sea level is represented by hydromorphic variants (glaciated, clayey, meadow-swamp, peat-swamp). On higher surfaces (highest points 126 m above sea level east of Kyilovo), depending on the intensity of the edaphogenesis processes, podzolic soils of different degrees of formation prevail (from weakly formed sandy to sod-low podzolic and sod-medium podzolic soils).

The territory is characterized by the following climate indicators: the sum of active temperatures above 10 °C – 2600–2800 °C; the annual amount of precipitation does not exceed 550 mm; the average monthly temperature in January is 6 °C; the average monthly temperature in July is +19 °C; and the absolute maximum and minimum temperatures (in Kyiv) are +39 and −33 °C, respectively (Veklych, 2005).

Vegetation is represented by meadow-swamp, forest-shrub-swamp, and forest communities. Wet and swampy meadows and swamps, and thickets of riparian and aquatic vegetation are common on lower terrain. Among them, the largest areas are occupied by communities of associations of *Caricetum gracilis* Almquist, 1929, *C. acutiformis* Sauer 1937 and *Phragmitetum communis* (Game 1927) Schmale 1939. Also, hygrophilous and eutrophic communities of *Filipendulion ulmariae* Segal ex Westhoff et Den Held 1969 unions are predominant. Occasionally, on elevations, communities of meadows with an acutely variable regime of moisture supply are found (*Agrostion vinealis*; Sipaylova et al., 1985). Significant areas are occupied by alder forests and secondary shrub thickets instead of meadow vegetation (classes *Alnetea glutinosae* Br.-Bl. et Tx. ex Westhoff et al., 1946, *Franguletea* Doing ex Westhoff inWesthoff et Den Held 1969). On the pine terrace, significant areas are occupied by forests of *Quercetea pubescentis* Doing-Kraft ex Scamoni et Passarge 1959, *Pyrolo-Pinetea sylvestris* Korneck 1974, and *Vaccinio-Piceetea* Br.-Bl. in Br.-Bl., Siss.et Vlieger 1939. The most highly elevated and dry forestless areas are occupied by communities of the class *Koelerio-Corynephoretea canescentis* Klika in Klika et Novak 1941.

Data and methods

We analyzed the distribution of *Thesium ebracteatum* on the territory of Ukraine from 1921 to 2022. The distribution of the species was critically analyzed according to the herbarium specimens of the National Herbarium of Ukraine, M. G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine (*KW*), databases: UkrBin: Ukrainian Biodiversity Information Network (https://ukrbin.com) and iNaturalist – social network of naturalists, citizen scientists and biologists, built on the concept of mapping and sharing biodiversity observations around the world (https://www.inaturalist.org), and literature data (Kotov, 1952; Shol, 2016; Zvyahintseva 2017; Shevchyk, 2019).

A distribution map was compiled using SimpleMappr (https://www.simplemappr.net/).

We conducted observations of individual small local populations on the territory tract of the Zmiini Islands of the Kaniv Nature Reserve during 1998–2022 and that are the object of the Emerald network "Divychky." The materials for this study were relevés in the areas with the growth of *T. ebracteatum* (Appendixes 1, 2). Relevés from other regions, taken from the literary sources, were also used for comparison (Dembicz et al., 2013; Jasik, Dite, 2017; Jakushenko 2017; Zolotareva et al., 2019).

In our research, we used phytocoenological relevés (relevés) and we laid 17 accounting plots. Relevés were carried out on standard plots with herbaceous vegetation with an area of 2×2 m. The following scale was used to assess the projective coverage of species: + – projective coverage of a species less than 1%, 1 – projective coverage from 1 to 5%, 2 – from 6 to 15%, 3 – from 16 to 25%, 4 – from 26 to 50%, 5 – more than 50% (Myrkyn et al., 2001).

Taxonomic names are given according to the The Plant List given in Appendix 3, http://www.theplantlist.org/.

For the shoots density of the studied species, we laid 15 plots measuring 0.3×0.3 m. The height of the shoots was measured using a measuring ruler with an accuracy of 1 cm.

For the formal communities classification, we used a hierarchical cluster analysis of relevés with *T. ebracteatum* using the Bray–Curtis distance (Bray, Curtis, 1957) and the flexible beta clustering algorithm (Dufrêne, Legendre, 1997; Tichý et al., 2010). Calculations in the R environment were performed (R Core Team, 2020). To determine the floristic features of the

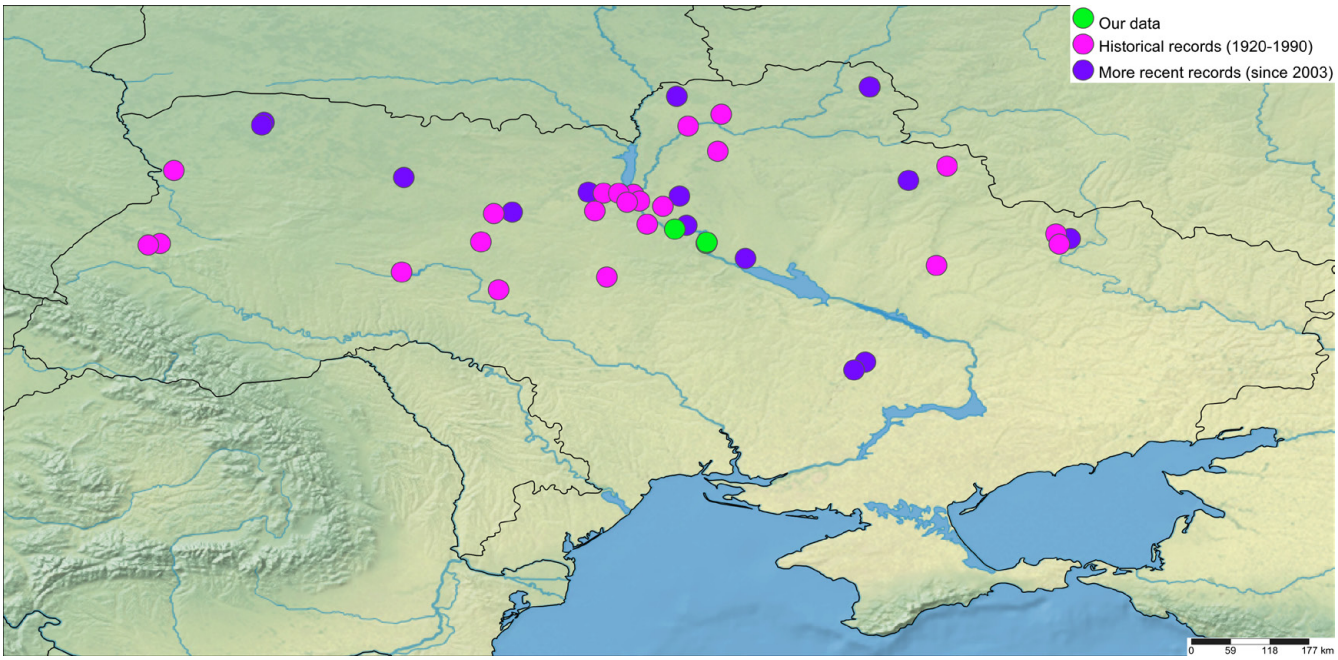

Fig. 2. The map of distribution of *Thesium ebracteatum* in Ukraine.png

communities with *T. ebracteatum*, different species with a predominant occurrence in the relevés clusters were selected.

To determine the coenotic features of the communities with *T. ebracteatum*, we calculated the proportions of diagnostic species of different vegetation classes in phytocenones, which were selected according to the results of the cluster analysis. Classification of species relative to Braun-Blanquet's classes follows the EuroVegChecklist (Mucina et al., 2016).

For the ecological assessment of localities in the studied communities with *T. ebracteatum*, we used the phytoindication method (Didukh, Plyuta, 1994). Ecological scales of six factors were used for phytoindicational calculations: Hd (soil moisture), Rc (soil acidity), Lc (general light regime), Nt (content of nitrogen compounds), Tm (climate), Kn (continentality) (Didukh, 2011). The calculation of scores for each relevé (see Appendix 4) was made on the basis of weighted average by species cover. The assessment of differences in the average values of ecological indicators was carried out using the variance analysis in the R environment.

Results and discussion

Total number of localities known from Ukraine is 50, including 12 for the Middle Dnieper region (within Kyiv and Cherkasy regions) (Fig. 2). Obviously, most of these populations have already been lost (including the unconfirmed locality of 1921: the outskirts of Poltava, the Tryba tract near the village of Mykilske, 1921, Illichevskyi, *KW;* Fig. 2 – historical records). The data given in the article relate to existing localities, some of which were discovered by us for the first time (Shevchyk, 2019). The elimination (disappearance) of the shoots of this species was noted by us in the areas where a dense layer of woody plants was formed. In the summer of 2021, as a result of route and floristic surveys of the territory of the object of the Emerald Network of Ukraine

Table 1. Differentiating two clusters of relevés with occurrence of *Thesium ebracteatum* (see dendrogram in Fig. 3). Numbers in the table are constancies of species expressed in percentages.

Cluster	A	B
Common species		
Thesium ebracteatum	100	100
Galium verum	76	92
Veronica spicata	71	92
Calamagrostis epigejos	62	50
Differentiating species of cluster A		
Peucedanum oreoselinum	71	–
Hieracium umbellatum	57	–
Festuca beckeri	62	–
Euphorbia cyparissias	48	–
Psephellus sumensis	38	–
Sempervivum ruthenicum	38	–
Verbascum lychnitis	38	–
Carex ericetorum	33	–
Dianthus borbasii	33	–
Koeleria glauca	33	–
Stipa borysthenica	33	–
Differentiating species of cluster B		
Filipendula vulgaris	–	92
Galium tinctorium	–	92
Stipa pennata	–	92
Hypericum elegans	–	75
Adonis vernalis	–	67
Helictotrichon desertorum	–	67
Onosma simplicissima	–	67
Campanula wolgensis	–	58
Dracocephalum ruyschiana	–	58
Artemisia sericea	–	50

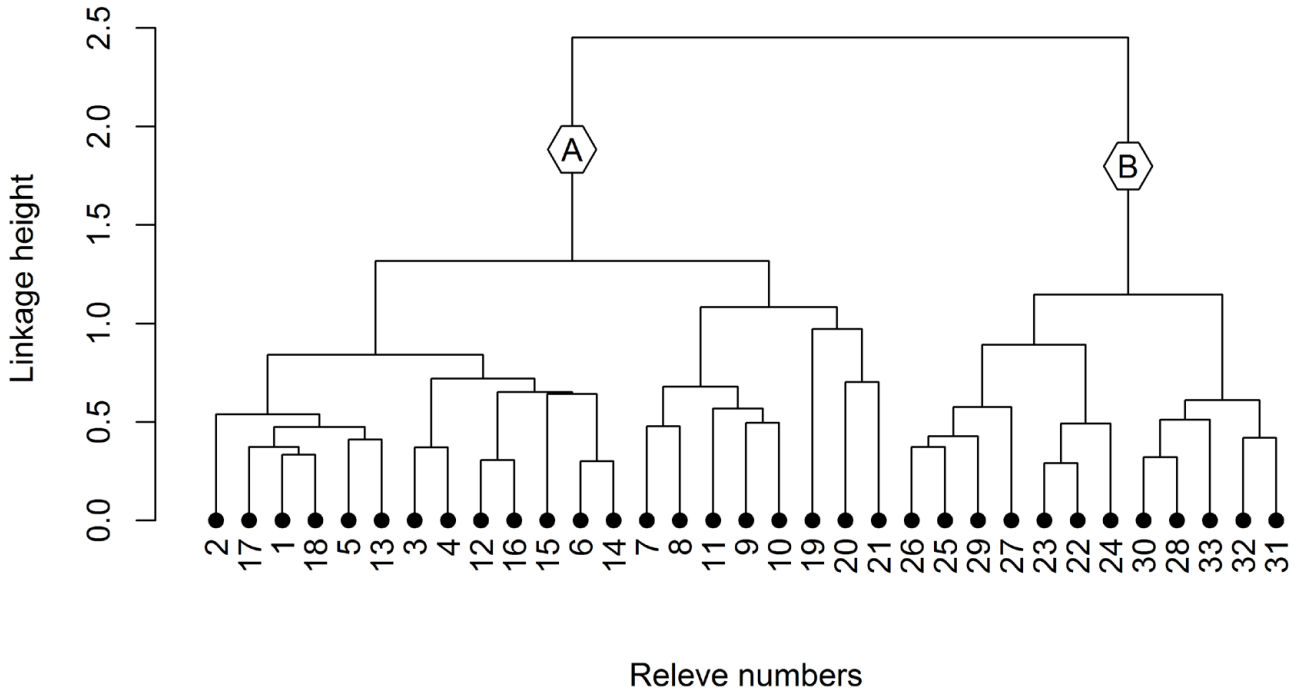

Fig. 3. The dendrogram of the cluster analysis of relevés in which *Thesium ebracteatum* occurs.

UA0000337 Divychky, two more local populations located close to each other were discovered (coordinates: 50.038672N, 31.114504E; 50.037639N, 31.112900E).

General characteristics of Thesium ebracteatum and population data

All the localities of *T. ebracteatum* discovered by us in the Middle Dnieper region are confined to the high-level sand terrace (pine terrace) of the Dnieper River with psammophilous herbaceous vegetation (Appendix 1). Local populations with an area of 5–6 to 1000 m^2 were noted. Within these areas, compact groups of shoots were most often found, and single shoots were less. As a result, changes in the number of shoots of the species were detected, even before their complete disappearance in some areas.

In relevés, the projective coverage of *T. ebracteatum* ranges from 1% to 20%. The most typical populations are with 3–5% projective coverage. The highest density of shoots is observed in well-lit areas with a thin cover of grasses. In these conditions, the shoots formed are 10–20 cm in height. In coenoses with a well-formed layer of shrubs or tall grasses, only its single shoots, which are 15–30 cm high, are registered. At the end of the flowering period (end of June–July), shoots are often affected by fungal phytopathies.

Formal classification of the Thesium ebracteatum communities

The dendrogram of the cluster analysis of relevés in which *T. ebracteatum* occurs is shown in Fig. 3. Relevé clusters are marked with the letters A and B. The main floristic differences of the communities with *T. ebracteatum* are listed in Table 1.

Cluster A combined relevés from Central Ukraine, Poland, and Slovakia, that is, the western part of the area. Cluster B combined relevés from the territory of Russia, in particular, the Sverdlovsk Region and the Republic of Bashkortostan. In the western and eastern parts of the area, *T. ebracteatum* grows in communities of different floristic composition and ecologic conditions.

The most typical dominants in cluster A are the densely turfy cereals (*Festuca beckeri* (Hack.) Trautv., *Koeleria glauca* (Spreng.) DC) and the short-rhizome and loose-turf sedges (*Carex michelii* Host, *C. ericetorum* Poll., *C. praecox* Schreb., *C. montana* L.). In some relevés, a sparse cover of mosses (*Dicranum polysetum* Sw., *Pleurozium schreberi* (Brid.) Mitt., *Brachitecium* sp., *Plagiomnium* sp.) is present. In general, most species of cluster A are indicators of low-nutrient psamophytic dry habitats.

The species composition of cluster B is quite different. Steppe species predominate here, such as *Adonis vernalis* L., *Centaurea ruthenica* Lam., *Inula hirta* L., *Artemisia seriacea* (Besser) Weber ex Stechm, *Spiraea crenata* L., *Chamaecytisus ruthenicus* (Fisch. ex Wol.) Klásk., *Stipa pennata* L., and others. Thus, in cluster A, *Thesium ebracteatum* grows as part of psammophyte communities, while in the eastern part of distribution area, this species grows in steppe communities, as indicated by the species combination of cluster B.

The ratio of diagnostic species of different classes of vegetation in the floristic composition of communities in the western and eastern parts of the distribution range of *T. ebracteatum* is shown in Fig. 4. The main part of the species composition of communities in the western part of the range (cluster A) is the species *Trifolio-Geranietea sanguinei* T. Müller 1962 and in the

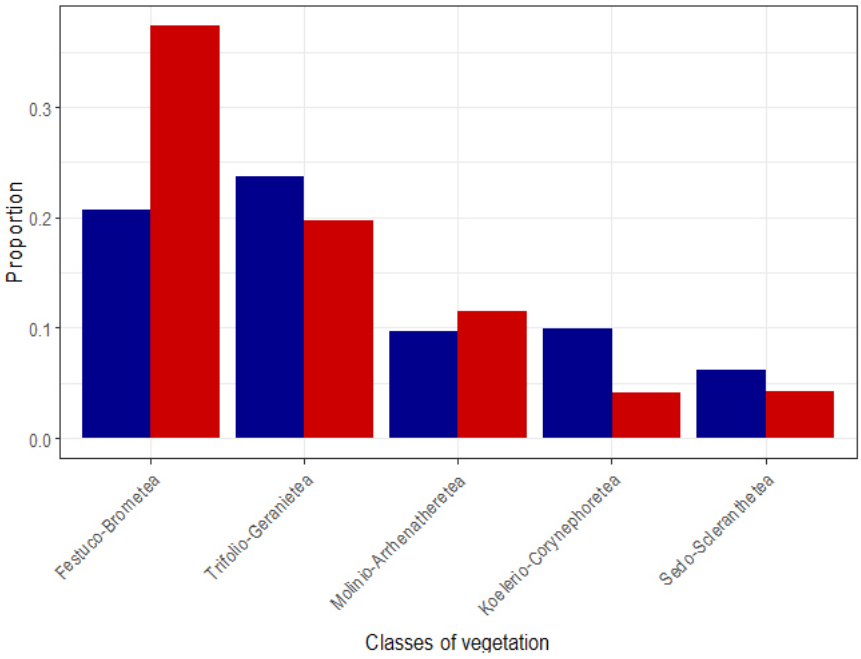

Fig. 4. Comparison of the shares of species of different classes of vegetation in the relevés of two clusters of relevés with occurrence of *Thesium ebracteatum* (see dendrogram on Fig. 2). The blue columns correspond to cluster A, and the red columns correspond to cluster B.

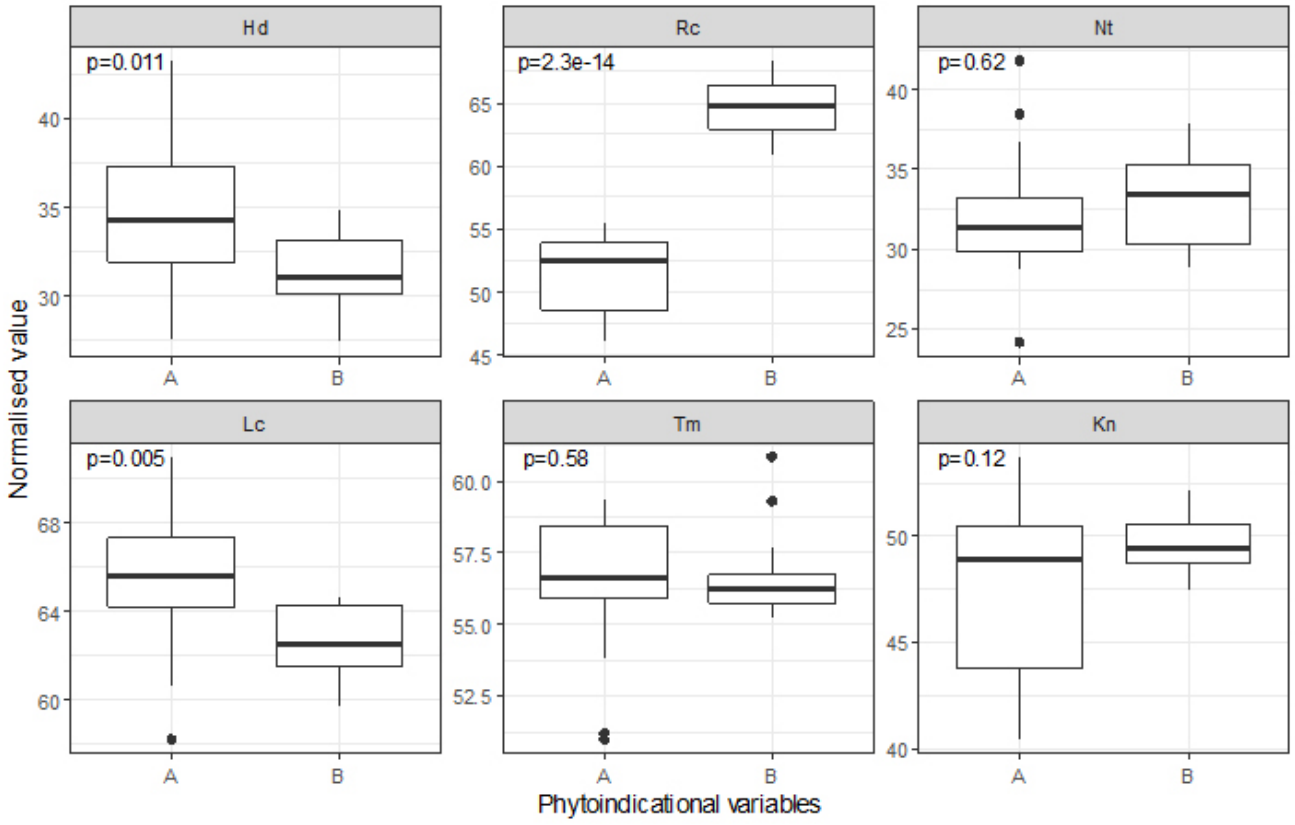

Fig. 5. Comparison of phytoindicational variables in the relevés with *Thesium ebracteatum* belonging to two clusters A and B, identified by cluster analysis (see Dendrogram on Fig. 2).

eastern part of the range (cluster B) is the species *Festuco-Brometea* Br.-Bl. et Tx. ex Soó 1947.

Phytoindicational assessment of Thesium ebracteatum communities

Fig. 5 presents a comparison of phytoindicational indicators for the two clusters ***A*** and B.

Significant differences in average values are observed for three indicators - Hd, Rc, and Lc. However, the biggest differences are found in the acidity indicator. In the central part of Ukraine, as well as in Central Europe, *T. ebracteatum* grows on soils with a higher acidity due to more humid climate. On the contrary, in the eastern part of the area, it mostly occurs as part of steppe communities on carbonate-enriched soils.

Such differences in the coenology of this species are caused by the peculiarities of coenogenesis in different parts of the area. In our opinion, the beginning of the settlement of *T. ebracteatum* in the Middle Dnieper region is most likely to be associated with the time of the dominance of forestless spaces on the plateau, namely, with the time of the Würm glaciation of Eastern Europe.

According to the results of research, in sharply continental conditions and with a climate much drier than the current climate, at that time, the plateau was dominated by poor desert-steppe vegetation, marked by the fossil remains of representatives of the *Seriphidium* section of the genus *Artemisia* L. and *Ephedra distachya* L. (Rosly, 1986; Bezusko, 1999). The settlement of *Thesium ebracteatum* on the sandy pine terrace could have taken place at the end of the swarm, after a decrease in the level of the Dnieper flow, which occurred as a result of the breakthrough of valley waters in the south through the outcrops of crystalline rocks (Krokos, 1932; Lepikash, 1934). Later, after the formation of powerful chernozems on the Loess Plateaus and the subsequent humidification of the climate, which was marked by a sharp increase (in 3–5 times) in the pollen of broad-leaved tree species about 10,000 years ago (Smirnova, Turubanova, 2003; Nosova, 2009), mesophytization and eutrophication of the meadow-steppe vegetation occurred on the plateau. This probably caused the elimination of most Central and Eastern European meadow-steppe coenopopulations of this light-loving, oligo-mesotrophic, and, to a certain extent, coenophobic species. Total plowing of chernozems completed this process already in historical time. Meadow-steppe cenopopulations of the Urals have survived due to a much larger gradient of continentality in this region. Thus, *T. ebracteatum* in the western part of its range can be considered a relict of the Würmian period with high probability.

Anthropogenic influence and conservation potential of Thesium ebracteatum in the Middle Dnieper region

There are no cases of significant anthropogenic influence in the areas with the growth of *T. ebracteatum* studied by us. In this connection, it is impossible to detect the dependence of the state of the population of this species on the influence of the anthropogenic factor. Considering the demanding nature of the species for lighting conditions and its rather limited distribution in forest coenoses and dense shrub thickets, it is possible to predict the general deterioration of the condition of its populations in the course of overgrowth of open areas of dry sandy meadows and meadow steppes with tree vegetation. Aboriginal species such as *Acer tataricum* L., *Populus tremula* L., *Pinus sylvestris* L., and *Quercus robur* L. are the most likely species of trees and shrubs that can recover in the areas with *Thesium ebracteatum* growth, under the conditions of our region. There is also high probability of the distribution of certain alien species of trees and shrubs, in particular, *Acer negundo* L. and *Amorpha fruticosa* L. To reliably ensure the survival of the population of this rare species in the conditions of phytocenoses of dry sandy meadows in the Zmiini Islands tract of the Kaniv Nature Reserve, it is necessary to constantly monitor the processes of demutation of forest vegetation. In the case of the threat of overgrowth of these areas with tree vegetation, it is advisable to remove trees and shrubs in these areas.

Conclusion

Thus, 50 localities of *Thesium ebracteatum* are currently known for the territory of Ukraine, including 12 for the Middle Dnieper region (within Kyiv and Cherkasy regions). Within the territory of the Middle Dnieper region, this species is limited to areas of the pine terrace and grows in open areas in herbaceous phytocenoses of the *Trifolio-Geranietea* class. On the other hand, in the eastern part of the area, this species is found mainly in communities of the *Festuco-Brometea* class. According to our observations, the highest density of shoots and projective coverage is observed in well-lit areas with a thin cover of grasses, which is dominated by cereals and sedges. In the conditions of such phytocenoses, shoots of height 10–20 cm are formed. In places with a pronounced closing of the shrub or tall grasses, only its single shoots are observed, which have a height of 15–30 cm. The main threat to the existence of *Thesium ebracteatum* populations in the Middle Dnieper region is the overgrowth of open areas with shrub and forest vegetation.

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Appendix 1. Relevés with occurrence of *Thesium ebracteatum*.

Relevé numbers	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Cluster designations (see Fig .3)	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Cover of herbaceous layer	**35**	**65**	**65**	**70**	**25**	**5**	**30**	**45**	**65**	**20**	**50**	**35**	**45**	**45**	**70**	**30**	**70**	**30**	**85**	**100**	**95**	**90**	**100**	**90**	**80**	**80**	**90**	**70**	**70**	**40**	**70**	**45**	**60**
Achillea millefolium				+	+	+			1			+		+		+		+		2	1	+	+				1				1		1
Achillea nobilis																							+										
Adonis vernalis																						+		+	1	2	1		+	1			1
Agrostis capillaris																				3			1										
Agrostis gigantea																						+											
Agrostis vinealis	1								+	+																							
Ajuga reptans																			1														
Alchemilla sp.																						+											
Allium oleraceum																						+	1										
Allium rubens																															1	1	+
Allium scorodoprasum																					1												
Allium strictum																												1		1		+	
Alopecurus pratensis																					1												
Alyssum tortuosum																						+											
Androsace septentrionalis																												1		1			
Anemone patens																								+				3		1	1	1	
Anemone pratensis	1				+													+															
Anemone sylvestris																									1	1		1	1				1
Antennaria dioica																						+	+	+									
Anthericum ramosum									2		+																						
Arabidopsis thaliana																	+																
Arenaria serpyllifolia																												1		1		1	
Artemisia absinthium																						+											
Artemisia armeniaca																							+	+							1		1
Artemisia campestris						1																											
Artemisia commutata																												1		2			1
Artemisia latifolia																								+									
Artemisia macrantha																									3								
Artemisia sericea																								+	2	1		1	2				1
Aster alpinus																												+	3	2	1	5	+
Aster amellus																								+									
Astragalus austriacus																															1	1	+
Astragalus danicus																						+	+	+									
Astragalus onobrychis																																	+
Betula pendula																			1			+											
Brachypodium pinnatum																						+	+	+	4	2							
Brachytecium sp.																				3													
Briza media																					1												
Bromus inermis															+	3										1	1				+		1
Bunias orientalis																							+	+									
Calamagrostis arundinacea																			2														
Calamagrostis epigejos	+		+		+			+	+	+	+	+	+			+	+	+			1			+	1	3	2		+	1			
Calluna vulgaris																			1														
Camelina microcarpa																														1			

Appendix 1. Continued

Relevé numbers	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Cluster designations (see Fig .3)	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Cover of herbaceous layer	**35**	**65**	**65**	**70**	**25**	**5**	**30**	**45**	**65**	**20**	**50**	**35**	**45**	**45**	**70**	**30**	**70**	**30**	**85**	**100**	**95**	**90**	**100**	**90**	**80**	**80**	**90**	**70**	**70**	**40**	**70**	**45**	**60**
Campanula bononiensis																									1	1	1						
Campanula sibirica																						+	+							1	1	1	1
Campanula wolgensis																							+		1	2		1	+	1	1		
Caragana frutex																						+											
Carex caryophyllea							+															+	+				1		1		4	3	1
Carex ericetorum	+				+					2		1				+	4	1															
Carex hirta							+	+			1																						
Carex michelii	1						1	1		1	1																						
Carex montana																			3														
Carex pediformis																										1		1		1		1	
Carex praecox			1	+		1	1		+	1				+																		1	
Carex sp.																									1								
Carex tomentosa																						+	+										
Centaurea borysthenica	1												1																				
Centaurea ruthenica																									3	1			1				1
Centaurea scabiosa																						+	+	+									
Chondrilla juncea						+							1		+			+															
Clausia aprica																												+		1			
Clinopodium acinos																						+											
Clinopodium vulgare																			2														
Convallaria majalis			+	+										+					2														
Cotoneaster melanocarpus																										1		1		1			
Crepis tectorum																														1			
Cytisus ruthenicus			1		+	+						1	1	+	1	1						+	+	+	3	1	1	1	+	1	+		
Danthonia decumbens																				1													
Daphne cneorum											+							+															
Dianthus acicularis																												+		2			
Dianthus borbasii	1	+			+			+					+				+	+															
Dianthus chinensis																										1					1	+	
Dianthus deltoides																						+	+										
Dicranum polysetum																			1														
Digitalis grandiflora																						+		+									
Draba nemorosa																														1		1	
Draba sibirica																						+	+								1	1	
Dracocephalum ruyschiana																						+	+	+	1	1	1		1				
Dracocephalum thymiflorum																														1	1	1	
Echinops ritro																										1		3	1	3	+		1
Elymus lolioides																									3				1		1		
Elymus reflexiaristatus																												1		1			
Elymus repens																						+	+				1						
Erigeron acris podolicus																						+	+										
Erigeron canadensis																															1		
Erysimum marschallianum																										1				1			+
Euonymus verrucosus			+	+																													

Appendix 1. Continued

Relevé numbers	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Cluster designations (see Fig .3)	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Cover of herbaceous layer	**35**	**65**	**65**	**70**	**25**	**5**	**30**	**45**	**65**	**20**	**50**	**35**	**45**	**45**	**70**	**30**	**70**	**30**	**85**	**100**	**95**	**90**	**100**	**90**	**80**	**80**	**90**	**70**	**70**	**40**	**70**	**45**	**60**
Euphorbia caesia																							+	+									+
Euphorbia cyparissias	+	+	+		+	+							3	1	+		1	+															
Euphorbia korshinskyi																										1		+	+			+	
Euphorbia microcarpa																						+	+										
Euphorbia seguieriana																														2			+
Euphorbia virgata																						+	+	+									
Euphrasia pectinata																												+		1	1		
Festuca beckeri	2	2	2	1	3	3		+		+		2	1	+			2	2															
Festuca ovina																			1														
Festuca pratensis																							+							+			
Festuca pseudovina																						+	+	+									
Festuca rubra																				4	1	+	1										
Festuca valesiaca																												4		1	4	1	+
Filipendula ulmaria																					1												
Filipendula ulmaria picbaueri																						+	+	+									
Filipendula vulgaris																						1	2	1	1	3	3		1	1	1	1	1
Fragaria moschata																					1												
Fragaria vesca																			2			+	+										
Fragaria viridis																						2	+	2	1	2	3	1		1	1		1
Galatella angustissima																												1			+	+	
Galium album																							+			2							
Galium boreale																				1	1	+	+	+	3	1	1	2	1	1	3	1	1
Galium octonarium																																	+
Galium tinctorium																						+	+	+	1	1	1	1	1	2		1	1
Galium verum	1	2	+			1		+	2	+		+	2	2	+	+	+	+		1	1	+	+	+	1		1	1	1	1	1	1	+
Genista tinctoria						+					+						+						+	+			1	1	1	1			1
Gentiana cruciata																						+	+	+		2						+	
Geranium pratense																						+											
Geranium pseudosibiricum																								+		1							
Geranium sanguineum											+								2				+				4						
Geranium sylvaticum																									1								
Gnaphalium sylvaticum																			1														
Gypsophila altissima																												1	1	2	1		1
Helictotrichon desertorum																						+			1	1		+	5	2		1	3
Helictotrichon hookeri																						+	+	1						2			1
Hieracium umbellatum	+			+		+	+		+		1		+		1	+	+	+	1				+										
Hieracium virosum																												3		1			1
Hierochloe odorata	+					+								+										+									
Holosteum umbellatum																					1												
Hypericum elegans																							+	+	1		1	1		1	+	1	1
Hypericum perforatum			+												+			+					+			1							
Hypochaeris maculata																		+				+	+	+									1
Inula hirta																						+	+	+	1	1	1		+			+	1
Inula salicina																					1												

Appendix 1. Continued

Relevé numbers	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Cluster designations (see Fig .3)	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Cover of herbaceous layer	**35**	**65**	**65**	**70**	**25**	**5**	**30**	**45**	**65**	**20**	**50**	**35**	**45**	**45**	**70**	**30**	**70**	**30**	**85**	**100**	**95**	**90**	**100**	**90**	**80**	**80**	**90**	**70**	**70**	**40**	**70**	**45**	**60**
Jacobaea vulgaris																						+	+						+				+
Jasione montana																	+																
Klasea radiata gmelinii																													1				
Knautia arvensis																							+				1						
Koeleria glauca	1	2	+	+	+												+	+															
Koeleria pyramidata																			1									1			1	1	
Laserpitium prutenicum																			2														
Lathyrus pisiformis																							+	+	1		1						
Lathyrus pratensis																						+	+										
Leucanthemum vulgare																						+	+	+		1							
Linaria genistifolia					+	+							+																				
Linaria vulgaris					+							1	1			+		+					+	+			1						
Lotus corniculatus																				1													
Luzula multiflora	1								+		+							+															
Medicago falcata																						+											
Medicago lupulina																							+										
Melampyrum cristatum																						+		+				+					
Melampyrum laciniatum					+												+	+															
Molinia caerulea																			3		1												
Myosotis alpestris																						+	+	+	1								
Nepeta nuda																									1								
Nonea rossica																						+	+										
Odontites vulgaris																	+																
Onobrychis arenaria																						+		+				+	1				
Onosma simplicissima																						+				1		1	2	3	+	1	1
Origanum vulgare																						+	+	+	1	2	2			1			
Oxytropis kungurensis																															3		
Oxytropis pilosa																												1					+
Persicaria alpina																							+	+	1	1							
Peucedanum oreoselinum	1		+	+		+	1	1		+	3	1	1	+	1	+	1	2															
Phelipanche lanuginosa																												1					
Phleum phleoides																						+	+	+	1			1		1		1	
Phleum pratense																					1												
Phlomoides tuberosa																							+	+	1	1	1						
Phragmites australis									+	+	1				1					1													
Picea abies																			1														
Pilosella cymosa																						+											
Pilosella echioides																												1			1		+
Pilosella officinalis																			1														
Pilosella officinarum								2	+									+															
Pilosella vaillantii																														1			
Pimpinella saxifraga																						+	+			1				1	1		
Pinus sylvestris																												+					
Plagiomnium sp.																				1													

Appendix 1. Continued

Relevé numbers	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Cluster designations (see Fig .3)	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Cover of herbaceous layer	**35**	**65**	**65**	**70**	**25**	**5**	**30**	**45**	**65**	**20**	**50**	**35**	**45**	**45**	**70**	**30**	**70**	**30**	**85**	**100**	**95**	**90**	**100**	**90**	**80**	**80**	**90**	**70**	**70**	**40**	**70**	**45**	**60**
Plantago lanceolata																					1												
Plantago media																							+	+					1		+	1	
Plantago urvillei																										1							
Pleurozium shreberii																			2														
Poa angustifolia	1		+			1																+	1		1	2	2				1		
Poa pratensis																								+									
Podospermum purpureum																							+		1	1		+				+	+
Polygala comosa																							+					1		1			+
Polygala sibirica																						+								1		+	
Polygonatum odoratum												+		+					1					+		2		3	+	3			+
Potentilla argentea																						+	+								1		
Potentilla humifusa																						+	+					1		1	1	1	+
Potentilla inclinata	1	1			+	+																											
Potentilla thuringiaca																						+		+									
Primula veris macrocalyx																						+	+	+									
Prunella vulgaris																						+	+										
Prunus fruticosa																									3	3	3						1
Psephellus sibiricus																												3		3	1	3	1
Psephellus sumensis	1				1	1	1						+		+		+	+															
Pteridium aquilinum							4	+																									
Pulmonaria mollis																								+									
Pyrethrum corymbosum																						+	+	+									
Ranunculus acris																					1												
Ranunculus polyanthemos																						+	+	+									
Rosa acicularis																								+									
Rosa majalis																									1	1			+				
Rosa sp.																			1														
Rubus caesius											+																						
Rubus saxatilis								+	+										1							3			+				
Rumex acetosa																				1													
Rumex acetosella	+														+			+					+										
Rumex thyrsiflorus																							+										
Salvia dumetorum																											1					1	1
Sanguisorba officinalis																						+	+	+		2		1	+				
Sedum maximum	+	+															+	+															
Sedum telephium																										1		+					
Sempervivum ruthenicum	2	3	+	+	+										2	2	+																
Serratula coronata																								+									
Seseli libanotis																							+	+			1			1			
Silene klokovii																												1		1		1	+
Silene viscaria																					1												
Solidago virga-aurea																			1			+	+										
Solidago virgaurea	2		+	1			1		1		1							+															
Sorbus aucuparia																			1														

Appendix 1. Continued

Relevé numbers	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Cluster designations (see Fig .3)	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Cover of herbaceous layer	**35**	**65**	**65**	**70**	**25**	**5**	**30**	**45**	**65**	**20**	**50**	**35**	**45**	**45**	**70**	**30**	**70**	**30**	**85**	**100**	**95**	**90**	**100**	**90**	**80**	**80**	**90**	**70**	**70**	**40**	**70**	**45**	**60**
Spiraea crenata																									2	5	5		+	+			
Stachys officinalis																						+	+										
Stellaria graminea																					1		+								1		
Stipa borysthenica	+	1				+							+	+			1	+															
Stipa capillata																																	3
Stipa dasyphylla																								1									
Stipa pennata																						2	4	2	1		1	+	3	1	1	+	+
Stipa pulcherrima																								+	1	1			1	1			3
Taraxacum erythrospermum																															1	1	
Taraxacum officinale																																	+
Taraxacum sp.																														+			
Tephroseris integrifolia																								+									
Teucrium chamaedrys										1	1																						
Thalictrum minus																						+	+	+	1	1	1		1		1		1
Thalictrum simplex																							+	+									
Thesium ebracteatum	1	+	1	+	+	1	+	+	3	1	1	1	2	2	2	3	1	+	1	1	1	+	+	+	1	+	1	1	1	1	1	1	+
Thymus bashkiriensis																												+		1		1	
Thymus pulegioides																					1												
Thymus talijevii																																	+
Thymus tschernjajevii																	+																
Trifolium lupinaster																						+	+	+		1		1	1				
Trifolium medium																								+									
Trifolium montanum																						1	2		1	1			1		1		
Trifolium pratense																						+	+										
Trifolium repens									+																								
Turritis glabra																	+							+									
Vaccinium vitis-idaea																			1														
Verbascum lychnitis	1				+	+						1	1	+			+	+															
Verbascum nigrum																										1							
Veronica austriaca teucrium																						+	+	+			1						
Veronica chamaedrys	+		+						+	+		+								2			+										
Veronica officinalis	+																+		1														
Veronica spicata	1	1	+		+	+	+	+	+			+		+		+	+	+	2	1		+	+	+	1	1		1	1	1	1	1	+
Veronica verna				+													+	+															
Vicia cassubica																			1														
Vicia cracca																							+										
Vicia pisiformis																									1								
Vicia tenuifolia																								+	1	1	1						
Vincetoxicum hirundinaria	+	+										1							1							1		1	+	2		+	1
Viola rupestris																			1			+	+								1	1	+
Viola tricolor matutina		+				+																											

Appendix 2. Location and other metadata of relevés with occurrence *of Thesium ebracteatum*.

The legend to the relevés:

- Relevé 1. 16.06.2006. Shevchyk V.L. Zmiini Islands, Kaniv Nature Reserve. (49.582714N 31.547589E). The upper part of the turfed dune.
- Relevé 2. 16.06.2006. Shevchyk V.L. Zmiini Islands, Kaniv Nature Reserve. (49.853831N 31.546484E). The upper part of the turfed dune (hump with *Carex*).
- Relevés 3–6. 14.05.2009. Shevchyk V.L. Zmiini Islands, Kaniv Nature Reserve (49.853831N 31.546484E). The upper part of the turfed dune (hump with *Carex*).
- Relevés 7–8. 27.06.2018. Shevchyk V.L. Zmiini Islands, Kaniv Nature Reserve (49.839986N 31.540139E). The lower part of the sandy slope of the southern exposure, on the northern edge of the birch grove.
- Relevés 9–11. 27.06.2018. Shevchyk V.L. Zmiini Islands, Kaniv Nature Reserve (49.839847N 31.542006E). A low-lying flat area on the coast of the bay with thickets of reeds.
- Relevés 12–16. 05.06.2018. Shevchyk V.L. Zmiini Islands, Kaniv Nature Reserve (49.855123N 31.546920E). Slopes of turfed sand dune with Formica cinerea colonies.
- Relevé 17. 26.05.2021. Shevchyk V.L., Solomakha I.V., Solomakha V.A. The object of the Emerald Network «Divychky» (50.038672N 31.114504E). A section of the slope of a dune that has long been covered with grass, the density of *Thesium ebracteatum* shoots per 1 m^2 is 20 shoots, the area is up to 10 ares, there was a long-standing lowland fire (5 years?).
- Relevé 18. 26.05.2021. Shevchyk V.L., Solomakha I.V., Solomakha V.A. The object of the Emerald Network «Divychky» (50.037639N 31.112900E). The slope is covered with sand dunes with Formica polyctena anthills.
- Relevé 19. Jakushenko D. (2017). Contributions to the thermophillous fringe communities (*Trifolio-Geranietea sanguinei*) in Belarus. *Biodiv.Res.Conserv*. 45: 35–48. Belarus, Minsk region, Lagoysk district, 4,5 km at Kazyry village (54.19.362N 27.55.639E). Table 2 relevé 3.
- Relevé 20. Dembicz I., Kozub L., Zaniewski P. (2013). New locality of *Thesium ebracteatum* (*Santalaceae*) in Mazowsze province. *Fragmenta floristica et geobotanica polonica*, 133–136. Poland (52.43.38N 21.23.55E). Table 1.
- Relevé 21. Jasik M., Dite D. (2017). Nova lokalita *Thesium ebracteatum* na Slovensku. *Bull. Slov. Bot. Spolocn. Roc.* 39(1): 73–78. Slovenia (48.35.52.7N 19.21.48.9E). Table 1 relevé 1.
- Relevés 22–33. Zolotareva N.V., Koroliuk A.Yu., Yamalov S.M. (2019). Communities of the class *Festuco-Brometea* Br.-Bl. et Tx. ex Soo 1947 Mesyagutovskoy and Krasnoufymskoy Forest-Steppe (Middle Pre-Ural region). Vegetation of Russia, 37: 29–78.
- 22. 14.07.2008. Russia, Sverdlovsk region, Krasnoufimsky district, env. village Podgornaya, Sopka «Ostrenkaya» (56.43N 57.47E). Table 4 relevé 8.
  - 23. 08.07.2010. Russia, Sverdlovsk region, Krasnoufimsky district, env. village Podgornaya, Sopka «Izvestnaya» (56.43N 57.47E). Table 4 relevé 10.
  - 24. 23.06.2014. Sverdlovsk region, Krasnoufimsky district, env. village Tatar Emanzelga, Mount Kambaskantau (56.15N 57.55E). Table 4 relevé 11.
  - 25. 08.06.1993. Russia, Republic of Bashkortostan, Mechetlinsky district, 4 km southwest of the village. Novomuslyumovo, Mount Northern Munchug (55.54N 58.25E). Table 7 relevé 1.
  - 26. 06.07.2008. Republic of Bashkortostan, Duvansky district, 6.5 km southwest of the village Ozero (55.27N 58.02E). Table 7 relevé 3.
  - 27. 18.06.2005. Republic of Bashkortostan, Salavatsky district, 3 km northwest of the Nasibash village (55.11N 58.14E). Table 7 relevé 9.
  - 28. 14.07.2008. Sverdlovsk region, Krasnoufimsky district, near the village of Podgornaya, Sopka «Ostrenkaya» (56.43N 57.47E). Table 9 relevé 16.
  - 29. 14.07.2008. Sverdlovsk region, Krasnoufimsky district, near the village of Podgornaya, Sopka «Ostrenkaya» (56.43N; 57.47E). Table 9 relevé 18.
  - 30. 05.07.2010. Sverdlovsk region, Krasnoufimsky district, vicinity of the village of Podgornaya, Sopka «Bolshaya» (56.43N 57.47E). Table 9 relevé 20.
  - 31. 10.07.2008. Sverdlovsk region, Krasnoufimsky district, vicinity of the village of Podgornaya, Sopka «Bolshaya» (56.18N 57.58E). Table 9 relevé 21.
  - 32. 09.06.2009. Sverdlovsk region, Krasnoufimsky district, environs of Sredny Bugalysh village, Asentau mountain (56.18N 57.58E). Table 9 relevé 24.
  - 33. 06.07.2008. Republic of Bashkortostan, Duvansky district, 6.5 km from the Ozero village (55.28N 58.04E). Table 10 relevé 1.

Appendix 3. Taxonomic and nomenclatural crosswalk.

Original name/concept	**Current name/concept**
Acinos arvensis	*Clinopodium acinos*
Aconogonon alpinum	*Persicaria alpina*
Amoria montana	*Trifolium montanum*
Anthemis subtinctoria	*Cota tinctoria*
Betonica officinalis	*Stachys officinalis*
Bromopsis inermis	*Bromus inermis*
Centaurea sibirica	*Psephellus sibiricus*
Cerasus fruticosa	*Prunus fruticosa*
Chamaecytisus ruthenicus	*Cytisus ruthenicus*
Chameecytisus ratisbonensis	*Cytisus ratisbonensis*
Conyza canadensis	*Erigeron canadensis*
Coronaria flos-cuculi	*Silene flos-cuculi*
Dianthus versicolor	*Dianthus chinensis*
Elytrigia lolioides	*Elymus lolioides*
Elytrigia repens	*Elymus repens*
Erigeron podolicus	*Erigeron acris podolicus*
Euphorbia gmelini	*Euphorbia esula*
Euphorbia subtilis	*Euphorbia microcarpa*
Filipendula stepposa	*Filipendula ulmaria picbaueri*
Helictotrichon schellianum	*Helictotrichon hookeri*
Hylotelephium triphyllum	*Sedum telephium*
Koeleria cristata	*Koeleria pyramidata*
Lupinaster pentaphyllus	*Trifolium lupinaster*
Nepeta pannonica	*Nepeta nuda*
Pilosella vailantii	*Pilosella vaillantii*
Potentilla goldbachii	*Potentilla thuringiaca*
Primula macrocalyx	*Primula veris macrocalyx*
Pulsatilla patens	*Anemone patens*
Salvia stepposa	*Salvia dumetorum*
Scorsonera purpurea	*Podospermum purpureum*
Senecio jacobea	*Jacobaea vulgaris*
Seratula gmelinii	*Klasea radiata gmelinii*
Trommsdorffia maculata	*Hypochaeris maculata*
Veronica teucrium	*Veronica austriaca teucrium*
Viscaria vulgaris	*Silene viscaria*

Appendix 4. Table of phytoindicative parameters of relevés.

Relevé numbers	Hd	Rc	Sl	Nt	Lc	Nv	Hm	fH	Ae	Ca	Tm	Kn	Om	Cr
1	32,59	48,59	29,76	30,7	65,79	48,8	29,14	54,77	20,18	48,23	56,54	48,45	55,62	48,46
2	27,63	52,81	32,74	24,15	70,59	52,18	27,23	55,75	17,93	50,71	59,26	53,75	52,3	48,67
3	34,36	53,55	32,85	32,66	64,21	45,65	29,86	53,1	20,68	45,87	56,67	49,66	53,55	49,2
4	34,34	48,24	29,44	29,13	62,93	50,92	28,84	51,38	19,36	43,81	56,93	48,43	53,47	50,06
5	31,88	46,31	32	31,44	68,44	45	36,44	57,07	18,93	49,29	55,88	52,31	53,71	47,86
6	30,7	53,86	35,63	29,01	70,94	48,81	30,41	60,22	19,87	50,35	58,45	50,97	52,49	49,2
7	37,3	46,94	28,24	29,84	63,05	47,4	28,25	51,07	20,13	46,09	59,38	43,79	59,78	54,55
8	35,67	49,84	28,97	33,26	65,58	47,32	31,9	54,47	19,05	48,66	56,63	49,61	56,85	51,85
9	38,67	52,47	34,71	38,53	64,28	46,57	28,99	55,58	25,83	49,24	54,25	44,16	55,62	48,19
10	36,28	53,93	34,33	31,18	65,82	46,48	26,67	58,21	23,96	50,45	56,8	51,47	52,86	49,97
11	39,23	55,53	30,06	35,29	60,66	50,05	32	53,07	26,41	52,89	58,54	42,51	55,6	56,2
12	33,04	54,79	31,89	35,34	66,24	44,63	33,18	55,28	19,46	54,89	53,8	50,78	56,49	49,61
13	29,65	53,07	33,03	32,9	68,11	42,52	36,68	59,53	19,45	54,46	58,49	48,61	52,62	52,42
14	32,86	54,2	33,88	32,48	67,34	49,86	27,09	58,19	20,18	51,84	56,21	49,63	55,6	49,29
15	36,65	47,06	32,79	31,39	63,82	44,91	34,78	53,29	27,05	43,93	58,45	43,08	49,91	52,68
16	33,83	49,86	32,54	32,9	65,04	44,3	35	54,37	18,86	47,84	56,98	50,52	52,44	47,37
17	31,16	45,93	30,11	28,74	65,01	49,04	32,18	58,87	19,76	49,07	56,74	48,9	54,66	49,81
18	30,84	50,12	29,67	29,56	67,38	48,04	35,01	55,51	20,27	50,7	56,3	49,98	53,83	50,13
19	40,8	48,98	24,97	31,04	58,25	57,21	24,62	44,78	26,83	43,03	51	41,54	62,26	48,81
20	42,02	52,81	38,35	36,87	66,71	48,71	32,75	54,3	33,53	43,1	51,19	40,41	53,98	49,21
21	43,25	54	36,74	41,85	64,85	46,53	33,42	51,63	31,22	50,72	54	43,55	56,89	50,53
22	33,7	62,9	36,61	35,4	64,72	53,91	29,86	52,03	26,45	56,84	56,42	49,27	52,53	45,21
23	34,94	60,85	36,06	35,35	64,73	50,85	33,38	53,35	27,65	56,23	55,19	47,44	53,31	45,64
24	34,2	65,42	36,4	34,58	62,2	54,52	28,81	53,18	26,39	58,88	55,85	50,7	53,01	43,27
25	30,98	68,19	37,8	35,41	61,54	57,28	25,01	52,08	25,84	60,72	57,73	51,58	50,41	45,02
26	32,9	66,27	36,19	37,98	59,75	53,86	29,96	51,9	25,35	62,26	56,23	48,47	52,24	43,32
27	31,05	66,95	37,18	34,04	64,62	50,96	30,21	53,47	25,79	59,49	59,32	50,56	52,08	48,02
28	30,17	64,41	37,13	31,03	61,7	57,46	26,43	53,13	22,62	63,55	55,21	49,53	50,36	41,31
29	31,42	66,26	37,58	29,66	59,97	57,44	23,51	52,11	24,42	66,68	55,92	48,81	51,19	42,73
30	29,09	64,32	37,33	32,74	62,84	51,27	29,59	53,96	22,73	64,76	56,3	49,36	49,82	43,82
31	30,13	61,99	37,96	29,5	61,59	49,73	25	54,79	24,54	62,1	56,44	47,59	50,55	44,54
32	30,03	62,97	38,65	28,9	63,69	51,29	22,73	54,47	22,63	63,22	55,45	49,63	50,34	43,53
33	27,4	68,39	39,19	30,61	64,18	56,05	25,63	53,81	24,36	66,19	60,85	52,17	49,78	46,17