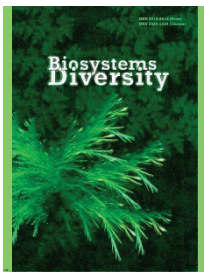

Biosystems Diversity

ISSN 2519-8513 (Print)
ISSN 2520-2529 (Online)
Biosyst. Divers.,
2020, 28(3), 298–319
doi: 10.15421/012039

Syntaxonomy and ecological differentiation of the pioneer vegetation of Ukraine. 2. *Helichryso-Crucianelletea maritimae*, *Festucetea vaginatae*, *Koelerio-Corynephoretea canescentis* classes

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Article info

Received 10.06.2020
Received in revised form 07.08.2020
Accepted 09.08.2020

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Dubyna, D. V., Dziuba, T. P., Iemelianova, S. M., & Tymoshenko, P. A. (2020). Syntaxonomy and ecological differentiation of the pioneer vegetation of Ukraine. 2. Helichryso-Crucianelletea maritimae, Festucetea vaginatae, Koelerio-Corynephoretea canescentis classes. Biosystems Diversity, 28(3), 298–319. doi:10.15421/012039

Pioneer psammophytic vegetation is usually developed on wind-drift sandy substrates such as arenas, spits, beaches, river terraces, and this vegetation occupies significant areas in all three natural zones of Ukraine. The *Koelerio-Corynephoretea canescentis* class was represented by 13 associations, 3 alliances and 1 order; *Festucetea vaginatae* class by 22 associations, 2 alliances and 1 order; *Helichryso-Crucianelletea maritimae* by 10 associations, 4 alliances and 1 order. The results of cluster analysis and synoptic tables of the classes are presented. 9 alliances are briefly described. Leading factors of territorial and ecological differentiation are identified. It was found that the territorial distribution of plant communities is influenced by the character of ecotope mesorelief, soil composition and humus horizon thickness, as well as the degree of eolian processes development. The main factors of their ecological differentiation are soil acidity, salt regime and ombroregime. Based on the results of DCA-ordination of syntaxa within certain vegetation classes, it was found that their distribution is influenced by factors that correlate with the environment-specific conditions. It has emerged that an ecological differentiation of syntaxa within *Festucetea vaginatae* is determined by the integrated effect of gradients, and soil salinity is leading among them. Temperature regime and climate continentality are leading factors in the distribution of syntaxa within the *Koelerio-Corynephoretea canescentis* class. The gradients of ombroregime and soil humidity have a significant impact. The distribution of communities of the *Helichryso-Crucianelletea maritimae* class in the ecological space is determined mainly by factors of variability of damping, ombroregime and climate continentality. The author's syntaxonomic concept assumes the independence of the studied classes: *Koelerio-Corynephoretea canescentis*, *Helichryso-Crucianelletea maritimae* and *Festucetea vaginatae*, considering that the leading factors of community differentiation of the *Festucetea vaginatae* and *Koelerio-Corynephoretea canescentis* classes are the origin (genesis) of sandy substrates, as well as soil acidity. Phytosociological analysis of a large number of relevés of coastal littoral vegetation also provides support for independence of the *Helichryso-Crucianelletea maritimae* and *Ammophiletea* classes different floristically and ecologically. A review of the psammophytic vegetation of Ukraine will determine the place of the selected syntaxonomic units in the pan-European system.

Keywords: psammophytic vegetation; classification; new-formed ecotope; ecological gradients; cluster analysis; DCA-ordination.

Introduction

Pioneer psammophytic vegetation developed on wind-drift sandy substrates such as arenas, spits, beaches, terraces, etc., performs extremely important functions: biological, ecological, regulatory, recreational, and many others. It stabilizes loose scattered soils, creates preconditions for the development of vegetation in subsequent successional stages. The geocomplexes on which such vegetation occurs are sites of biological diversity formation and conservation. They are habitats for many plant and animal species, ways for dispersing their genetic material, and also serve as migration routes by which alien species spread actively. New-formed arena ecotopes are the centers of formation of endemic floristic complexes; they are characterized by generic endemism.

Syntaxonomy of psammophytic vegetation in Europe has been developed in sufficient detail. Classification schemes and characteristics were presented for the territories of the Czech Republic (Chytrý, 2007), Slovakia (Valachovič et al., 1995), Germany (Berg et al., 2004), Poland (Matuszkiewicz, 2008), France (Bardat et al., 2004), Romania (Sanda et al., 2008), Italy (Biondi et al., 2014), Spain and Portugal (Rivas-Martínez et al., 2001), Bulgaria (Tzonev et al., 2009), Hungary (Borhidi, 2003), and other countries. An overview of syntaxonomic units of the highest and middle levels in Europe is presented in generalized works: "Vegetation of Europe..." (Mucina et al., 2016), for the class *Koelerio-Corynephoretea canescentis* – "Klasse *Koelerio-Corynephoretea* Klika in Klika et Novak 1941 – Sandtrockenrasen und Felsgrusfluren von der submeridionalen bis zur borealen Zone" (Dengler, 2004), *Helichryso-Crucianelletea maritimae* – "Classification of European and Mediterranean coastal dune vegetation" (Marcenò et al., 2018). However, discussions about syntaxonomic content and the structure of higher classification units of psammophytic vegetation are still ongoing.

The main areas of arenas in Ukraine are located in Polissia, and the smaller one in the forest-steppe zone. The largest continuous sand massifs in the steppe zone are located in the lower valley of the Dnieper River. This territory is called "Oleshkivsky Sands", and it occupies about 200 thousand hectares. Large areas are occupied by "Pridonetski Sands" (80 thousand ha) and sand areas on coasts, spits and islands of the Black and Azov Sea, Lower Danube and the Southern Bug River.

The macrorelief of sand massifs is mostly flat with small differences in elevation. However, the greatest importance in the distribution of plant communities belongs to the mesorelief of the sands, which is usually characterized by an alternation of high, up to 3–5 m, rounded (hills) or elongated dunes and fairly deep depressions. The topography and vegetation of wind-drift sands are mutually determining factors, since the absence of vegetation contributes to the dune formation, and their subsequent overgrowth promotes the formation of sand dunes, which over time are somewhat leveled in the hilly ones (Gordienko, 1969).

Pioneer psammophytic vegetation is represented in Ukraine by three classes: *Festucetea vaginatae*, *Helichryso-Crucianelletea maritimae* and *Koelerio-Corynephoretea canescentis*. The syntaxonomy of vegetation of *Festucetea vaginatae* and *Koelerio-Corynephoretea canescentis* classes in Ukraine has been the subject of studies conducted by many authors. J. Vicherek on the territory of the lower and middle Dnieper River described *Festucion beckeri* alliance with 4 associations and, in fact, made an attempt to validate *Festucetea vaginatae* class, first identified by R. von Soó in 1968 (Vicherek, 1972). *Secali-Stipetum borysthenicae* association and two alliances: *Verbascion pinnatifidi* and *Cynodonto-Teucrion polii* were described for the coastal dune area in the Crimean Peninsula (Korzhenevsky, 1986; Korzhenevsky & Klyukin, 1990). Arena landscapes of the "Biruchiy Island" spit in the Azov Sea were studied by Dubyna et al. (1995). On the territory of the spit, they identified 8 lower-rank syntaxa belonging to *Festucetea vaginatae* class, and two syntaxa attributed by the authors to *Chenopodietea* class. Three associations were described as new for science. Psammophytic vegetation of the Bilosaraiska Spit and the sea coast near Mariupol city was studied by Androsova & Solomakha (1996). Didukh & Korotchenko (1996) recorded a *Centaureo borysthenicae-Festucetum beckeri* association in the southern part of the forest-steppe zone of Ukraine, near the mouth of the Vorskla River and on islands of the Dniprodzerzhinsky and Pechenezhsky reservoirs. Umanets & Solomakha (1999a, 1999b) conducted their research in the 1990s in the Central Black Sea region. In the Black Sea Biosphere Reserve, the vegetation syntaxonomy included without limitation psammophytic coenoses of *Festucetea vaginatae* class, within which the authors distinguished the *Medicagini tenderiensis-Seselietalia tenderiensi* order containing two alliances: *Medicagini tenderiensis-Seselion tenderiensi* and *Melico chrysolepi-Ephedrion distachyae*. On the territory of the Danube Biosphere Reserve communities of 19 associations of the *Festucetea vaginatae* class were described (Dubyna et al., 1996, 2003). 11 associations of this class were identified on the territory of the National Nature Park "Dzharylhatskyi" (Dubyna & Dziuba, 2005a; Davydova, 2019). In the Pryazovia spits: Obitochna, Berdianska, Kryva, Bezymenna, Shyrokinska, Bilosaraiska, Stepanivska and Fedotova, Tyshchenko (2006) recorded the distribution of communities of 9 associations belonging to the *Festucetea vaginatae* class; while three associations were newly identified in the course of surveys conducted by the author. In the estuarine region of the Dnieper River, Chynkina (2003) identified communities of one association. In addition to the southern regions, coenoses of the class were also observed in the Middle Dnieper River region, on islands of the Dnieper River within Kyiv city (Tsukanova, 2005; Aleshkina, 2011), as well as on the territory of the Kaniv Nature Reserve (Shevchyk & Solomakha, 1996; Shevchyk et al., 1996) where the authors identified a *Artemisio dniproicae-Salicion acutifoliae* alliance. Its syntaxonomic status is debatable, since such communities involving shrubs are more often classified as *Salicetea purpureae* Moor 1958 (Mucina et al., 2016).

Phytocoenoses of sandy steppes were also observed in the northern steppe and forest-steppe zone of Ukraine, on the left bank of the Dnieper River (Bairak, 1998; Gomlya, 2005; Dziuba et al., 2010; Chusova, 2019); there the phytocoenoses occupy much smaller areas and are not characterized by coenotic diversity.

The syntaxonomic structure of the class has also been considered in generalized regional publications (Tymoshenko, 1999; Korzhenevsky et al., 2003; Dubyna et al., 2004; Solomakha, 2008; Dubyna et al., 2009).

Within the scope of final surveys on psammophytic vegetation in the Black Sea region, D. Dubyna and T. Dziuba in the "Prodrome of the vegetation of Ukraine" identified a new alliance *Artemisio arenariae-Festucion beckeri* in the *Festucetea vaginatae* class and isolated from one the class *Helichryso-Crucianelletea maritimae*, in which *Ephedro distachyae-Medicaginetalia romanicae* order was allocated for the Ukraine territory together with the alliance *Ephedro distachyae-Medicaginion romanicae* (Dubyna et al., 2019a). Unfortunately, the attempt of Korzhenevsky & Kvitnitskaya (2014) to validate the alliances *Verbascion pinnatifidi* Korzhenevsky et Klyukin 1990 and *Cynodonto-Teucrion polii* Korzhenevsky et Klyukin 1990, as well as the vegetation associations of aeolian landforms in the Crimea, were not completely successful since expressis verbis “typus" should have been used to indicate the type of syntaxon name, according to article 5 of the ICPN (Weber et al., 2000).

Coenoses of the *Koelerio-Corynephoretea canescentis* class were first studied in Ukraine by Vicherek (1972) using the Braun-Blanquet approach on riverside sands of the Middle Dnieper River, where he described the *Veronico dillenii-Corynephoretum* association with its two subassociations. Later, coenoses belonging to this class (within the boundaries of *Sedo-Scleranthetea* and *Festucetea vaginatae*) were described for the Kaniv Nature Reserve area (Shevchyk & Solomakha, 1996; Shevchyk et al., 1996). Didukh & Korotchenko (1996) noted the distribution of plant communities belonging to the same association in the southern part of the left-bank forest-steppe zone of Ukraine, in the lower valley of the Vorskla River, in the upper valley of the Berestova River, and on islands of the Dniprodzerzhinsky and Pechenizhsky reservoirs. On left bank of the Dnieper River, coenoses belonging to this class were recorded by Bayrak (1998) and Galchenko (2006). V. Shevchyk and V. Solomakha, and later V. Shevchyk with O. Polishko described the communities of *Thymo pallasiani-Centauretum sumensis* and *Cladonietum* associations as part of the vegetation on the Dnieper River pine-forest terrace which grows along the bank of the Kaniv Reservoir (Shevchyk et al., 1996; Shevchyk & Polishko, 2000; Polishko, 2001, 2005). On the Zhytomyr Polissia area, Yakushenko (2004) allocated the *Artemisio campestris-Dianthetum borbasii* association. Plant communities of the two associations were identified in area of the planned Korostyshivsky National Nature Park (Orlov & Yakushenko, 2005). Coenoses of the *Helichryso-Jasionetum* association were described on the territory of the Polissky Nature Reserve (Vorobyov et al., 1998), and of *Thymetum pulegioido-serpylli* association were identified in the Cheremsky Nature Reserve (Konishchuk, 2006). Senchylo (2010) analyzed mainly coenoses of the *Koelerio-Corynephoretea canescentis* class; the scientist performed phytocoenotic studies on 7 following plant associations in the Dnieper River floodplain area within the forest-steppe zone: *Artemisio dniproicae-Sedetum sexangularis*, *Centaureo borysthenicae-Festucetum beckeri*, *Veronico dillenii-Secaletum sylvestri*, *Chamaecytiso ruthenici-Festucetum beckeri*, *Thymo pallasiani-Centauretum sumensis*, *Sedo sexangulare-Festucetum beckeri*, *Diantho borbasii-Agrostietum syreistschikovii*. Among the syntaxonomic diversity of vegetation in the Pyryatinsky National Natural Park, Kovalenko (2016) identified communities of *Veronico dillenii-Secalietum sylvestris*, *Linario odorae-Agropyretum dasyanthi* and *Chamaecytiso ruthenicae-Festucetum beckeri* associations, which were assigned to the *Festucetea vaginatae* class. In Ukrainian Roztochia, Soroka (2008) identified *Spergulo vernalis-Corynephoretum* and *Diantho-Armerietum* associations.

Often plant communities of this class were described within *Sedo-Scleranthetea* and, contrariwise, phytocoenoses associated with areas of poor skeletal soils and crystalline outcrops were sensu lato assigned to *Koelerio-Corynephoretea canescentis* class. Also, the structures of *Festucetea vaginatae* and *Koelerio-Corynephoretea canescentis* classes were sometimes intermixed (Shevchyk et al., 1996; Gaiova, 2015; Kovalenko, 2016). Regional publications summarized the study of the class in Ukraine (Onyshchenko, 2006; Solomakha, 2008; Dubyna et al., 2019a).

One of the generalizing works on classified syntaxa of xerophytic psammophytic vegetation in the forest and forest-steppe zones of the plain area of Ukraine was Kuzemko (2009) which includes syntaxonomic processing of 391 relevés. On the basis of cluster analysis and comparison of synoptic tables, the author identified 12 association-level syntaxa within *Koelerio-Corynephoretea canescentis* class (incl. *Sedo-Scleranthetea* and *Festucetea vaginatae*) and two associations within *Molinio-Arrhenatheretea* class. Phytosociological materials from Ukraine consisting of 179 relevés were included in the large-scale analysis of coastal dune vegetation in the Baltic-Atlantic, Mediterranean and Black Sea regions (Marcenò et al., 2018). The authors analyzed a large database (11,769 vegetation plots) and created the first formal classification of European coastal dune vegetation, accompanied by an expert system. This allowed them to identify 18 middle-rank syntaxa (alliances) which belong to the classes *Ammophiletea*, *Honckenyo-Elymetea arenarii* and *Koelerio-Corynephoretea canescentis*, and providing a critical revision of the concept of the class *Ammophiletea* used in EuroVegChecklist.

The issues on syntaxonomic structure and independence of *Koelerio-Corynephoretea canescentis*, *Festucetea vaginatae*, and *Helichryso-Crucianelletea maritimae* classes are currently discussed. When they survey the areas where continental psammophytic steppes occupy significant areas and differ in phytocoenotic diversity, Ukrainian and Russian phytocoenologists are insistent on the independence of these classes (Demina, 2009, 2015; Dubyna et al., 2019a). Western European researchers more often adhere to a broad understanding of vegetation classes and suggest combining, in particular, *Koelerio-Corynephoretea canescentis* and *Festucetea vaginatae* (Mucina et al., 2016), as well as *Ammophiletea* and *Helichryso-Crucianelletea maritimae* (Marcenò et al., 2018). Phytocoenotic materials of the *Sedo-Scleranthetea* class very similar to *Koelerio-Corynephoretea canescentis* (Kuzemko, 2009; Kuzemko et al., 2014; Mucina et al., 2016) are subject to generalized analysis.

The analysis of significant databases of phytosociological relevés allows one to solve many issues on construction and effectiveness of vegetation classification (Lengyel et al., 2018; Willner et al., 2019; Bondareva et al., 2019; Landucci et al., 2020), biodiversity definition (Sabatini et al., 2018), biogeographic distribution of vegetation and its ecological affinity (Chytrý et al., 2019), and others. Currently, we have collected more than 1700 phytosociological relevés of psammophytic vegetation in Ukraine which includes more than 1000 relevés belonging to the classes *Festucetea vaginatae*, *Helichryso-Crucianelletea maritimae*, *Koelerio-Corynephoretea canescentis*, syntaxonomic processing of which, in our opinion, will make a certain contribution to studying of psammophytic vegetation in Europe and supplement its syntaxonomy.

In recent years, the ecological component of phytocoenoses has become increasingly used as an object of study and in classification proving (Çoban & Willner, 2019; Zhou et al., 2019; Willner et al., 2019), including for the study of vegetation dynamics (Cao et al., 2019), identifying the main ecological factors of plant communities' differentiation (Kuzemko et al., 2016; Korolyuk et al., 2018), assessing the impact of environment on the floristic richness in phytocoenoses (Jansons et al., 2016; Yousaf et al., 2016; Slezák et al., 2017). The method developed by Didukh (2012) for determining the main eco-factors of the distribution of plant communities by 12 gradients completes phytosociological studies of vegetation and allows us to determine the ecosystem state by indicators of their biotic components.

The purpose of the paper was to generalize the accumulated phytocoenotic materials and existing data on syntaxonomy of the pioneer psammophytic vegetation in Ukraine, to clarify its current state and to develop a syntaxonomic structure, to establish the leading factors of ecological differentiation of phytocoenoses on the basis of ordination analysis, as well as to discuss controversial issues related to the syntaxonomic content of the classes *Festucetea vaginatae*, *Koelerio-Corynephoretea canescentis*, *Helichryso-Crucianelletea maritimae*.

Materials and methods

The work is based on the materials of field studies carried out by the authors during 1984–2018 according to the Braun-Blanquet approach to floristic classification (Braun-Blanquet, 1964; Westhoff & van der Maarel, 1973). The standard size of plots was 4 × 4 m. Sometimes, in particular on elongated coastal zones and dunes, the plots have size 1 × 4 or 2 × 5 m. At the same time, requirements for structure uniformity of vegetation cover were met. Phytosociological analysis also included the relevés presented in abovementioned publications of J. Vicherek, O. Tyshchenko, Y. Didukh, I. Korotchenko, O. Senchylo, O. Umanets, I. Solomakha, V. Solomakha, A. Androsova, O. Orlova, D. Iakushenko, V. Shevchyk, O. Polishko, O. Bayrak, N. Galchenko, M. Soroka, A. Davydova, L. Gomlya, T. Chinkina, V. Korzhenevsky and A. Klyukin, and others. The database also included unpublished relevés of psammophytic vegetation from manuscripts and dissertations, kindly provided to us by A. Kuzemko, O. Kovalenko, O. Chusova, O. Senchylo, V. Kolomiychuk, T. Fitsailo, I. Goncharenko, V. Konishchuk, G. Tsukanova, Y. Gayova, D. Iakushenko, V. Konogray, I. Khomyak. The size of plots was not always specified in the relevés, but we used all the available ones.

The materials were ordered by development of a database of geobotanical relevés in TURBOVEG 2.79 (Hennekens & Schaminée, 2001). Interpretation of the phytosociological material was carried out in several steps. At the initial one, the entire database of geobotanical relevés of halophytic, psammophytic and littoral vegetation in Ukraine (7388 relevés) was processed and divided into smaller groups based on their floristic differences using the method of two-way indicator species analysis (TWINSPAN), in particular its modified algorithm (Hill, 1979; Tichý, 2002; Roleček et al., 2009) implemented in the JUICE 7.0 software package. "Pseudospecies" cut level was 0%, 5%, 15% and 30%. The Whittaker's beta was chosen as cluster heterogeneity measure (Whittaker, 1978). Further, the clusters were selected which corresponded to the classes of psammophytic vegetation, based on diagnostic species characteristics.

Since a significant number of relevés included only vascular plants, or when mosses and lichens were identidied only up to their genus, authors excluded mosses, lichens and algae species from processing in order to "align" the relevés. These species were added again at the final stages of compiling the phytocoenotic tables. Cluster analysis was carried out using the PC-ORD program after the rejection of a certain part of relevés related to *Ammophiletea* Br.-Bl. et Tx. ex Westhoff et al. 1946, *Salicetea purpureae* Moor 1958 (*Artemisio dniproicae-Salicetum acutifoliae* Shevchyk et Solomakha 1996), *Pyrolo-Pinetea sylvestris* Korneck 1974, *Sedo-Scleranthetea* Br.-Bl. 1955, relevés of ruderal vegetation, relevés attributed by the authors to communities, and also not containing dominant species at all. The Sörensen coefficient (Sörensen, 1948) was chosen as the similarity measure and grouping was performed using the "flexible" beta method at –0.25. This resulted in finding smaller groups approximately corresponding to the association's rank. Relevés of *Festucetea vaginatae* class were grouped according to Ward's method (Ward, 1963). Identification of diagnostic species in syntaxa was carried out in accordance with the fidelity index – the Phi coefficient (Willner et al., 2009), the threshold values of which were assumed at the level of 25. All relevé groups were standardized to equal size, and non-essential fidelity values were removed based on the Fisher exact test.

The taxonomic nomenclature was given by "Flora Europaea" (Tutin et al., 1964–1980). Some of the species (taxonomically problematic, narrow, considered differently by various authors) we have combined into aggregates. Specifically, *Medicago sativa* ssp. *falcata* agg. combined the species *M. kotovii* Wissjul., *M. romanica* Prodán, M. *tenderiensis* Opperman ex Klokov and actually *M. falcata* L. *Crepis tectorum* agg. includes *C. tectorum* L. and *C. ramosissima* D'urv. *Artemisia campestris* agg. combines *A. campestris* L., *A. marschalliana* Spreng. and *A. dniproica* Klokov.

Identification of the obtained phytocoenoses was carried out on the basis of their diagnostic species and floristic composition by comparison with foreign and Ukrainian publications (Demina, 2009, 2015; Mucina et al., 2016; Bulokhov, 2019; Dubyna et al., 2019a).

The method of DCA-ordination (Hill & Gauch, 1980; ter Braak & Smilauer, 2015) of the R-project software (Venables & Smith, 2008) through the JUICE software package was used to determine the features of ecological differentiation of communities. The calculation of environmental parameters was carried out according to phytoindication scale developed by Didukh (2011), which allows ordination analysis to be performed on 12 factors: soil humidity (Hd), variability of damping (fH), soil aeration (Ae), soil nitrogen content (Nt), soil acidity (Rc), salt regime (Sl), carbonate content (Ca), temperature regime (Tm), ombroregime (Om), climate continentality (Kn), cryoregime (Cr) and light intensity (Lc).

Results

Cluster analysis of psammophytic vegetation database includes 1785 relevés and allowed several classes to be identified (Fig. 1). In particular, clusters 1–4 corresponded to the class *Salicetea purpureae* (*Artemisio scopariae-Tamaricion ramosissimae*), 5–12 – *Ammophiletea*, 13–15 – *Cakiletea maritimae*, 16–20 and 32–35 – *Helichryso-Crucianelletea maritimae*, 21–31 – *Koelerio-Corynephoretea canescentis*, 36–41 and 49–70 – *Festucetea vaginatae*, 42–48 – *Stellarietea mediae* (ruderal vegetation on sandy soils).

At the next stage of processing, after exclusion of relevés related to *Ammophiletea*, *Salicetea purpureae*, *Pyrolo-Pinetea sylvestris*, relevés of disturbed habitats, as well as those that do not contain dominant species, phytocoenons with the studied classes remained: *Helichryso-Crucianelletea maritimae*, *Koelerio-Corynephoretea canescentis* and *Festucetea vaginatae* – 955 relevés (Fig. 2). Then we performed cluster analysis

separately per classes. It should be noted that a significant number of sample sites within the studied classes were identified by us as agglomerative groups representing the initial stages of sand overgrowth, or as rankless (basal/derrivate) communities (a total of 258 relevés), which were not included by the authors at this stage in the classification scheme.

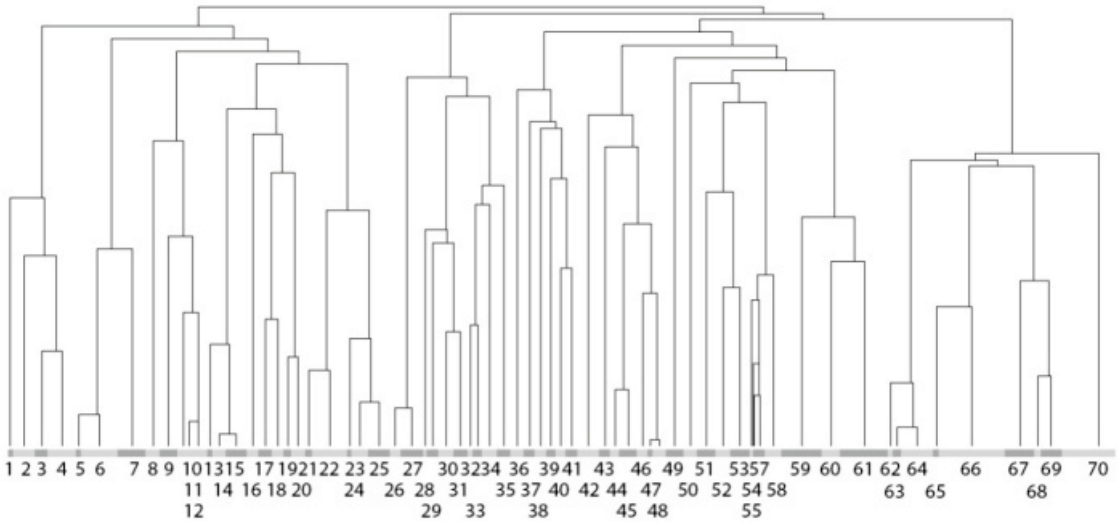

Fig. 1. Hierarchical cluster classification of relevés of psammophytic vegetation of Ukraine (1785 relevés) (PC-ORD)

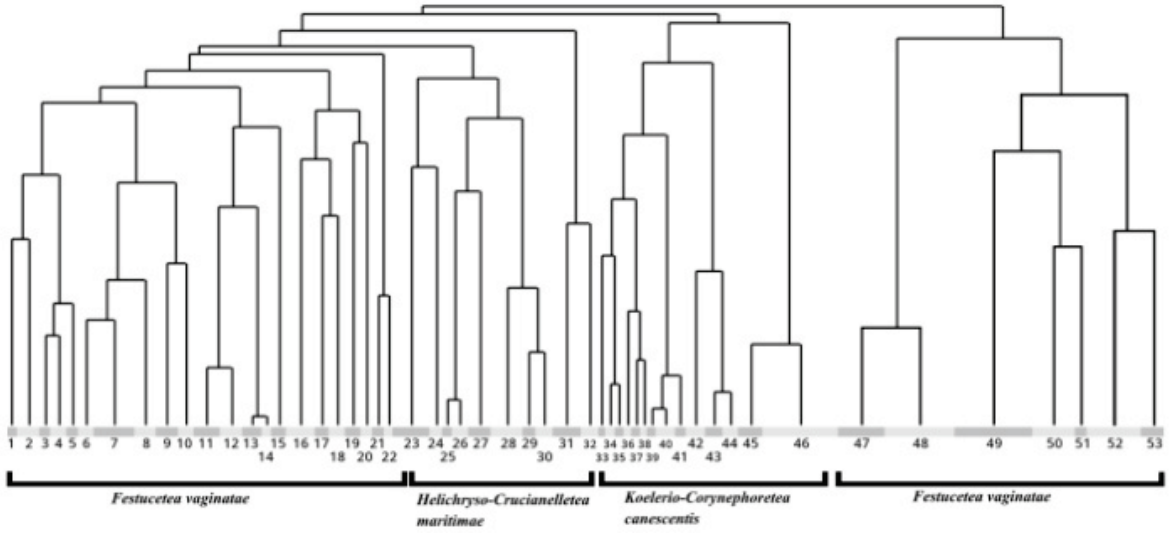

Fig. 2. Hierarchical cluster classification of psammophytic vegetation relevés of Ukraine (955 relevés) (PC-ORD)

Based on processing of phytocoenotic tables and cluster analysis results, a refined classification scheme of psammophytic vegetation of Ukraine was obtained.

Classification scheme of psammophytic vegetation of Ukraine

Koelerio-Corynephoretea canescentis Klika in Klika et Novák 1941
- *Corynephoretalia canescentis* Klika 1934
  - *Corynephorion canescentis* Klika 1931
    - *Veronico dillenii-Corynephoretum* Passarge 1960
    - *Corniculario aculeatae-Corynephoretum canescentis* Steffen 1931 (incl. *Helichryso-Jasionetum* sensu Vorobyov et al. 1998 non Libbert 1940)
  - *Armerion elongatae* Potsch 1962
    - *Diantho deltoidis-Armerietum elongatae* Krausch 1959
  - *Koelerion glaucae* Volk 1931
    - *Veronico dillenii-Secaletum sylvestris* Shevchyk et Solomakha 1996
    - *Chamaecytiso ruthenicae-Festucetum beckeri* Shevchyk et al. 1996
    - *Jasiono montanae-Thymetum serpylli* Bulokhov 2019 (*Thymetum pulegioido-serpylli* Konishchuk 2003 nom. inval. (syntax. syn.))
    - *Jasiono montanae-Festucetum ovinae* Klika 1941
    - *Corynephoro-Silenetum tataricae* Libbert 1931
    - *Artemisio campestris-Dianthetum borbasii* Yakushenko 2004
    - *Artemisio dniproicae-Sedetum sexangularis* Shevchyk et Solomakha in Shevchyk et al. 1996 (incl. *Sedo sexangulare-Festucetum* Solomakha, Shevchyk et Senchylo 1997 (art. 10); *Poetum bulbosae* Shevchyk et Polishko 2000 (syntax. syn.))
    - *Diantho borbasii-Agrostietum syreistschikovii* Vicherek 1972
    - *Thymo angustifolii-Festucetum beckeri* Vicherek 1972
    - *Centaureo borysthenicae-Festucetum beckeri* Vicherek 1972

Festucetea vaginatae Soó ex Vicherek 1972
- *Festucetalia vaginatae* Soó 1957
  - *Artemisio arenariae-Festucion beckeri* Dubyna et Dziuba in Dubyna et al. 2019
    - *Aperetum maritimae* Popescu, Sanda et Doltu 1980 (incl. *Apero maritimi-Chrysopogonetum grylli* Davydova 2019 p. p. (syntax. syn.)
    - *Dauco guttati-Chrysopogonetum grylli* Popescu, Sanda et Doltu 1980 (incl. *Apero maritimi-Chrysopogonetum grylli* Davydova 2019 (syntax. syn.))
    - *Carici colchicae-Holoschoenetum vulgaris* Sorbu et al. 1995
    - *Salici rosmarinifoliae-Holoschoenetum vulgaris* Mititelu et al. 1973 (incl. *Galio ruthenici-Salicetum rosmarinifoliae* I. Solomakha, Vorobyov et Moysienko 2015 nom. inval. (syntax. syn.))
    - *Allio guttati-Festucetum rupicolae* Umanets et Solomakha 1999
    - *Heliotropio dolosi-Brometum japonici* Dubyna, Neuhäuslová et Shelyag-Sosonko 1995
    - *Trago-Anthemietum ruthenicae* Pușcaru-Soroceanu et al. 1963
    - *Plantaginetum arenariae* (Buia et al. 1960) Popescu et Sanda 1987
    - *Linario odorae-Agropyretum dasyanthi* Vicherek 1972
    - *Cynodonto-Medicaginetum minimae* Popescu et Sanda 1975
    - *Secali-Cynodontetum dactyli* Dubyna, Neuhäuslová et Shelyag-Sosonko 1995
    - *Secali-Stipetum borysthenicae* Korzhenevsky ex Dubyna, Neuhäuslová et Shelyag-Sosonko 1995

Secaletum sylvestris Popescu et Sanda 1973
Secali sylvestri-Brometum tectorum Hargitai 1940
Centaureo odessanae-Caricetum colchicae Tyschenko 1999 (incl. *Secali sylvestri-Caricetum colchicae* Davydova 2019 (syntax. syn.))
Centaureo odessanae-Stipetum capillatae Dubyna, Neuhäuslová et Shelyag-Sosonko 1995
Poo bulbosae-Caricetum colchicae Dubyna, Neuhäuslová et Shelyag-Sosonko 1995
Achilleo setacei-Festucetum beckeri Chusova 2019 nom. inval. (art. 3b)
Centaureo gerberi-Chamaecytisetum borysthenici Demina 2009
Festucion beckeri Vicherek 1972
Festucetum beckeri Ad. Oprea 1998
Centaureo odessanae-Festucetum beckeri Vicherek 1972
Centaureo brevicipiti-Festucetum beckeri Vicherek 1972
Helichryso-Crucianelletea maritimae Géhu et al. in Sissingh 1974
Ephedro distachyae-Medicaginetalia romanicae Dubyna et Dziuba in Dubyna et al. 2019 (incl. *Medicagini tenderiensis-Seselietalia tenderiensi* Umanets et I. Solomakha 1999 (syntax. syn.))
Ephedro distachyae-Medicaginion romanicae Dubyna et Dziuba in Dubyna et al. 2019
Anisantho tectorum-Medicaginetum kotovii Tyschenko 1996
Anisantho tectorum-Helichrysetum arenariae Tyschenko 1999
Ephedro-Caricetum colchicae (Prodan 1939) Sanda et Popescu 1973
Scabiosion ucranicae Sanda et al. 1980
Scabioso ucranicae-Caricetum ligericae (Simon 1960) Krausch 1965
Secali sylvestri-Alyssetum borzaeani (Borza 1931) Morariu 1959
Medicagini tenderiensis-Seselion tenderiensi Umanets et I. Solomakha 1999 (incl. *Melico chrysolepi-Ephedrion distachyae* Umanets et I. Solomakha 1999 (syntax. syn.))
Medicagini tenderiensis-Seselietum tenderiensi Umanets et I. Solomakha 1999 (incl. *Sileno subconicae-Galietum tenderiensi* Umanets et I. Solomakha 1999 (syntax. syn.); *Elytrigio elongatae-Galietum tenderiensi* Umanets et I. Solomakha 1999 (syntax. syn.); *Consolido paniculatae-Anchusetum gmelini* Umanets et I. Solomakha 1999 (syntax. syn.))
Cynodonto-Teucrion polii (Korzhenevsky et Klyukin 1990) Korzhenevsky et Kvitnytskaya 2014 nom. inval. (art. 5) (incl. *Verbascion pinnatifidi* Korzhenevsky et Klyukin 1990 (syntax. syn.))
Cynodonto-Ajugetum chiae (Korzhenevsky et Klyukin 1990) Korzhenevsky et Kvitnytskaya 2014 nom. inval. (art. 5)
Carici liparicarpo-Centaureetum adpressae (Korzhenevsky et Klyukin 1990) Korzhenevsky et Kvitnytskaya 2014 nom. inval. (art. 5)
Astragalo borysthenici-Ephedretum distachyae (Korzhenevsky et Klyukin 1990) Korzhenevsky et Kvitnytskaya 2014 nom. inval. (art. 5)
Leymo-Verbascetum pinnatifidi (Korzhenevsky et Klyukin 1990) Korzhenevsky et Kvitnytskaya 2014 nom. inval. (art. 5)

Koelerio-Corynephoretea canescentis class includes pioneer communities on fluvioglacial and riverine sandy, shallow, weakly mobile soils, mostly dry and poor in nutrients, having acidic reaction. According to our results, the class in Ukraine include 1 order, 3 alliances and 13 associations (Fig. 3, Table 1).

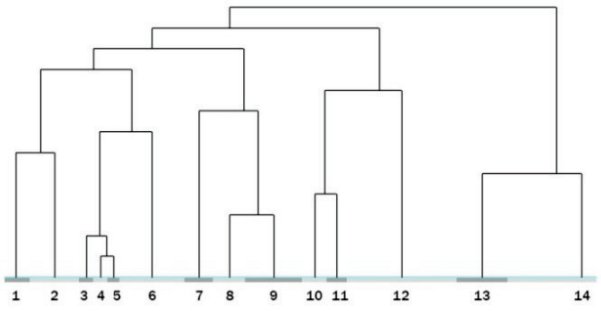

Fig. 3. Cluster analysis of phytosociological data of *Koelerio-Corynephoretea canescentis* class: clusters: 1 – *Veronico dillenii-Secaletum sylvestris* association; 2 – *Chamaecytiso ruthenicae-Festucetun beckeri*; 3 – *Diantho deltoidis-Armerietum elongatae*; 4 – *Jasiono montanae-Thymetum serpylli*; 5 – *Jasiono montanae-Festucetum ovinae*; 6 – *Corynephoro-Silenetum tataricae*; 7 – *Artemisio campestris-Dianthetum borbasii*; 8 – *Artemisio dniproicae-Sedetum sexangularis*; 9 – *Veronico dillenii-Secaletum sylvestris* (sensu Kovalenko); 10 – *Diantho borbasii-Agrostietum syreistschikovii*; 11 – *Thymo angustifolii-Festucetum beckeri*; 12 – *Centaureo borysthenicae-Festucetum beckeri*; 13 – *Veronico dillenii-Corynephoretum*; 14 – *Corniculario aculeatae-Corynephoretum canescentis*

Table 1
Synoptic table of the class *Koelerio-Corynephoretea canescentis*

No. of syntaxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of relevés	14	24	7	7	38	6	8	44	12	9	25	29	15	83
Aristolochia clematitis	42.4	–	–	–	–	–	–	–	–	–	–	–	–	–
Tragopogon ucrainicus	38.7	–	–	–	–	–	–	–	–	–	–	–	15.3	–
Vicia tetrasperma	32.3	–	–	–	–	–	–	–	–	–	–	–	–	–
Cardaminopsis arenosa	25.8	–	–	–	–	–	–	–	–	–	–	–	–	–
Salix acutifolia	25.8	–	–	–	–	–	–	–	–	–	–	–	–	–
Galium ruthenicum	25.8	–	–	–	–	–	–	–	–	–	–	–	–	–
Peucedanum oreoselinum	–	64.1	–	–	19.3	–	–	–	–	–	–	–	–	–
Verbascum densiflorum	–	63.7	–	–	–	–	–	–	–	–	–	–	–	–
Pulsatilla pratensis	–	59.8	–	–	–	–	–	–	–	–	–	–	–	–
Centaurea sumensis	–	56.3	–	–	–	–	–	–	–	–	–	–	–	–
Jurinea ewersmanii	–	52.6	–	–	–	–	–	–	–	–	–	–	–	–
Artemisia vulgaris	–	52.4	–	–	–	–	–	–	–	–	–	–	–	–
Poa angustifolia	–	50.8	–	–	–	–	–	19.3	–	–	–	–	–	–
Arabis glabra	–	44.3	–	–	–	–	–	–	–	–	–	–	–	–
Veronica spicata s. incana	–	43.6	–	–	–	–	–	–	–	–	–	–	–	–
Stellaria graminea	–	39.6	–	–	–	–	–	–	–	–	–	–	–	–
Viola tricolor s. matutina	–	37.7	–	–	–	–	–	–	–	–	–	–	–	–
Jurinea cyanoides s. tenuiloba	–	34.2	–	–	–	–	–	–	–	–	–	–	–	–
Silene nutans	–	33.6	–	–	–	–	–	–	–	–	–	–	–	–
Sedum telephium s. maximum	–	32.5	–	–	–	–	–	–	–	–	–	–	–	–
Vincetoxicum hirundinaria	–	30.9	–	–	–	–	–	–	–	–	–	–	–	–
Thesium ebracteatum	–	27.9	–	–	–	–	–	–	–	–	–	–	–	–
Luzula pallescens	–	27.9	–	–	–	–	–	–	–	–	–	–	–	–
Filipendula vulgaris	–	27.9	–	–	–	–	–	–	–	–	–	–	–	–
Stachys recta	–	27.9	–	–	–	–	–	–	–	–	–	–	–	–
Centaurea arenaria s. majorovii	–	27.9	–	–	–	–	–	–	–	–	–	–	–	–
Artemisia austriaca	–	27.9	–	–	–	–	–	–	–	–	–	–	–	–
Phleum phleoides	–	27.9	–	–	–	–	–	–	–	–	–	–	–	–
Euphorbia esula s. tommasiniana	–	27.9	–	–	–	–	–	–	–	–	–	–	–	–
Scorzonera purpurea	–	27.9	–	–	–	–	–	–	–	–	–	–	–	–
Sempervivum ruthenicum	–	27.8	–	–	–	–	–	–	–	–	–	–	–	–
Dianthus deltoides	–	–	96.0	–	–	–	–	–	–	–	–	–	–	–

No. of syntaxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of relevés	14	24	7	7	38	6	8	44	12	9	25	29	15	83
Armeria maritima s. elongata	–	–	83.6	–	–	–	–	–	–	–	–	–	–	–
Deschampsia cespitosa	–	–	74.4	–	–	–	–	–	–	–	–	–	–	–
Poa pratensis	–	–	74.4	–	–	–	–	–	–	–	–	–	–	–
Dactylis glomerata	–	–	63.1	–	–	–	–	–	–	–	–	–	–	–
Anthoxanthum odoratum	–	–	62.1	–	–	–	–	–	–	–	–	–	–	–
Agrostis capillaris	–	–	61.9	–	–	–	–	–	–	–	–	–	–	11.6
Elymus repens	–	–	54.0	–	–	–	–	16.8	–	–	–	–	–	–
Medicago lupulina	–	–	52.0	–	–	–	–	–	–	–	–	–	–	–
Thuidium abietinum	–	–	52.0	–	–	–	–	–	–	–	–	–	–	–
Cerastium arvense	–	–	52.0	–	–	–	–	–	–	–	–	–	–	–
Lolium perenne	–	–	52.0	–	–	–	–	–	–	–	–	–	–	–
Equisetum arvense	–	–	48.6	–	–	–	–	–	–	–	–	–	–	–
Veronica chamaedrys	–	–	40.8	–	11.9	–	–	–	–	–	–	–	–	–
Knautia arvensis	–	–	40.6	–	–	–	–	–	–	–	–	–	–	–
Rumex thyrsiflorus	–	–	39.5	–	–	–	–	19.7	–	–	–	–	–	–
Ranunculus acris	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Alyssum alyssoides	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Vicia hirsuta	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Festuca pratensis	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Lotus corniculatus	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Fragaria viridis	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Senecio sylvaticus	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Briza media	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Bromus commutatus	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Scirpus sylvaticus	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Alchemilla vallesiaca	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Plantago major	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Trisetum sibiricum	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Potentilla reptans	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Prunella vulgaris	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Leucanthemum vulgare	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Rubus caesius	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Centaurea jacea	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Plantago media	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Hylocomium splendens	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Agrimonia eupatoria	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Agrimonia procera	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Poa annua	–	–	36.6	–	–	–	–	–	–	–	–	–	–	–
Daucus carota	–	–	33.2	–	–	–	–	–	–	–	–	–	–	–
Clinopodium vulgare	–	–	25.0	–	–	–	21.4	–	–	–	–	–	–	–
Thymus pulegioides	–	–	–	53.1	–	–	–	–	–	–	–	–	–	–
Silene armeria	–	–	–	52.0	–	–	–	–	–	–	–	–	–	–
Galeopsis ladanum	–	–	–	52.0	–	–	–	–	–	–	–	–	–	–
Anthemis cotula	–	–	–	49.7	–	–	–	–	–	–	–	–	–	–
Silene vulgaris	–	–	–	44.3	–	–	–	–	–	–	–	–	–	–
Sedum telephium s. ruprechtii	16.2	–	–	37.7	–	–	–	–	–	–	–	–	–	–
Trifolium alpestre	–	–	–	36.6	–	–	–	–	–	–	–	–	–	–
Ononis arvensis	–	–	–	36.6	–	–	–	–	–	–	–	–	–	–
Potentilla collina	–	–	–	36.6	–	–	–	–	–	–	–	–	–	–
Dianthus arenarius s. pseudoserotinus	–	–	–	36.6	–	–	–	–	–	–	–	–	–	–
Jovibarba globifera s. globifera	–	–	–	36.6	–	–	–	–	–	–	–	–	–	–
Polypodium vulgare	–	–	–	36.6	–	–	–	–	–	–	–	–	–	–
Centaurea rhenana s. pseudomaculosa	–	–	–	33.6	–	–	–	–	–	–	–	–	–	–
Potentilla cinerea	–	23.4	–	32.6	–	–	–	–	–	–	–	17.8	–	–
Chondrilla juncea	–	15.9	–	30.6	11.4	–	–	–	–	–	20.7	18.8	–	–
Centaurea phrygia	–	–	–	–	63.5	–	–	–	–	–	–	–	–	–
Artemisia scoparia	–	–	–	–	57.6	–	–	–	–	–	–	–	–	–
Jasione montana	–	–	–	–	45.1	–	–	–	–	–	–	–	–	20.4
Pteridium aquilinum	–	–	–	–	35.5	–	–	–	–	–	–	–	–	–
Achillea millefolium	–	–	–	–	32.7	–	–	–	–	–	–	–	–	16.8
Anthericum ramosum	–	–	–	–	30.0	–	–	–	–	–	–	–	–	–
Oenothera rubricaulis	–	–	–	–	28.1	–	–	–	–	–	–	–	–	–
Allium oleraceum	–	–	–	–	27.2	–	–	–	–	–	–	–	–	–
Ajuga reptans	–	–	–	–	27.2	–	–	–	–	–	–	–	–	–
Scabiosa ochroleuca	–	–	–	–	–	100.0	–	–	–	–	–	–	–	–
Centaurea rhenana	–	–	–	–	–	98.1	–	–	–	–	–	–	–	–
Silene tatarica	–	–	–	–	–	80.8	–	15.1	–	–	–	–	–	–
Verbascum lychnitis	–	9.7	–	–	–	71.2	–	–	–	–	–	–	–	–
Medicago sativa s. falcata	–	–	–	–	–	69.4	–	–	–	–	–	–	–	–
Euphorbia esula	–	–	–	–	–	62.8	–	18.6	–	–	–	–	–	–
Koeleria macrantha	–	–	–	–	–	56.3	–	–	–	–	–	–	–	–
Viola arvensis	–	–	–	–	–	49.5	–	–	–	–	–	–	–	8.9
Silene latifolia s. alba	–	–	–	–	–	46.9	–	–	–	–	–	–	–	–
Senecio jacobaea	–	13.4	–	–	–	44.7	–	–	–	–	–	–	–	–
Leontodon hispidus	–	–	–	–	–	43.7	–	–	–	–	–	–	–	21.2
Erigeron annuus	–	–	–	–	–	43.1	–	4.5	–	–	–	–	–	–
Echium vulgare	–	–	–	–	–	34.5	24.2	–	–	–	–	–	–	–
Genista tinctoria	–	23.1	–	–	–	33.1	–	–	–	–	–	–	–	–
Poa compressa	–	–	–	–	–	–	85.0	–	–	–	–	–	–	–
Potentilla argentea	–	–	–	–	14.8	–	54.6	12.4	–	–	–	–	–	–

No. of syntaxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of relevés	14	24	7	7	38	6	8	44	12	9	25	29	15	83
Verbascum nigrum	–	–	–	–	–	–	48.6	–	–	–	–	–	–	–
Melampyrum nemorosum	–	–	–	–	–	–	48.6	–	–	–	–	–	–	–
Oenothera biennis	15.5	–	–	–	–	–	45.5	–	–	–	–	–	–	–
Quercus robur	–	–	–	–	–	–	42.9	–	–	–	–	–	–	7.2
Calamagrostis epigejos	–	16.2	–	–	–	–	40.3	13.3	–	–	–	–	–	–
Hieracium pilosella	–	–	23.8	–	–	–	35.8	–	–	–	–	–	–	17.0
Solidago virgaurea	–	–	–	–	–	–	34.9	–	–	–	–	–	–	18.1
Elytrigia intermedia	–	–	–	–	–	–	34.2	–	–	–	–	–	–	–
Polygonatum odoratum	–	–	–	–	–	–	34.2	–	–	–	–	–	–	–
Luzula pilosa	–	–	–	–	–	–	34.2	–	–	–	–	–	–	–
Lepidium campestre	–	–	–	–	–	–	32.5	–	–	–	–	–	–	–
Acinos arvensis	–	–	–	–	–	–	30.6	–	–	–	–	–	–	–
Bromus inermis	–	–	–	–	–	–	–	68.6	–	–	–	–	–	–
Tanacetum vulgare	–	–	–	–	–	–	–	62.4	–	–	–	–	–	–
Veronica spicata	–	–	–	–	–	–	–	51.6	–	–	–	–	–	–
Achillea cartilaginea	–	–	–	–	–	–	–	48.6	–	–	–	–	–	–
Eryngium planum	–	–	–	–	–	–	–	46.3	–	–	–	–	–	–
Gratiola officinalis	–	–	–	–	–	–	–	46.3	–	–	–	–	–	–
Veronica praecox	–	–	–	–	–	–	–	43.9	–	–	–	–	–	–
Atriplex prostrata	–	–	–	–	–	–	–	38.7	–	–	–	–	–	–
Veronica verna	–	–	–	–	–	–	–	36.9	–	–	–	–	–	–
Allium angulosum	–	–	–	–	–	–	–	32.6	–	–	–	–	–	–
Scirpus holoschoenus	–	–	–	–	–	–	–	29.1	–	–	–	–	–	–
Sedum argutum	–	–	–	–	–	–	–	26.3	–	–	–	–	–	–
Bromus squarrosus	–	–	–	–	–	–	–	26.1	–	–	–	–	–	–
Bromus hordeaceus	–	–	–	–	–	–	–	–	97.8	–	–	–	–	–
Spergularia rubra	–	–	–	–	–	–	–	–	97.5	–	–	–	–	–
Arenaria serpyllifolia v. stepicola	–	–	–	–	–	–	–	–	91.0	–	–	–	–	–
Spergula arvensis	–	–	–	–	–	–	–	–	90.5	–	–	–	–	–
Polygonum aviculare	–	–	–	–	–	–	–	–	80.9	–	–	–	–	–
Buglossoides arvensis s. arvensis	–	–	–	–	–	–	–	–	72.3	–	–	–	–	–
Carex praecox	–	–	–	–	–	–	–	–	54.4	–	–	–	–	–
Vicia cracca	–	14.4	–	–	–	–	–	–	46.9	–	–	–	–	–
Linaria vulgaris	–	13.4	–	–	–	–	–	–	44.7	–	–	–	–	–
Thesium procumbens	–	20.2	–	–	–	–	–	–	28.3	–	–	–	–	–
Taraxacum officinale	–	–	–	–	–	–	–	12.6	28.0	–	–	–	–	–
Hieracium umbellatum	–	6.5	–	–	–	–	–	–	–	84.3	–	–	–	–
Agrostis vinealis	–	–	–	–	–	–	–	16.6	–	70.1	–	–	–	–
Crepis tectorum agg.	–	–	–	–	–	–	–	–	–	52.7	–	–	–	–
Herniaria polygama	–	–	–	–	–	–	–	–	24.2	44.7	22.7	12.8	–	–
Linaria genistifolia	–	12.6	–	–	–	–	–	–	–	29.9	18.8	18.0	–	–
Thymus serpyllum s. serpyllum	–	–	–	–	–	–	–	–	–	–	93.4	–	–	–
Dianthus arenarius s. pseudosquarrosus	–	–	–	–	–	–	–	–	–	–	69.5	21.4	–	–
Jurinea cyanoides	–	–	–	–	–	–	–	–	–	–	69.4	21.6	–	–
Sedum telephium s. telephium	–	–	–	–	–	–	–	–	–	–	56.8	–	–	–
Androsace septentrionalis	–	–	–	–	–	–	–	–	–	–	47.6	–	–	–
Hierochloe stepporum	–	–	–	–	–	–	–	–	–	–	43.4	–	–	–
Astragalus arenarius	–	–	–	–	–	–	–	–	–	–	43.4	–	–	–
Sempervivum zeleborii	–	–	–	–	–	–	–	–	–	–	27.3	–	–	–
Thymus pallasianus	–	–	–	–	–	–	–	–	–	–	–	91.9	–	–
Minuartia viscosa	–	–	–	–	–	–	–	–	–	–	–	84.2	–	–
Agropyron cristatum s. sabulosum	–	–	–	–	–	–	–	–	–	–	–	75.4	–	–
Achillea micrantha	–	–	–	–	–	–	–	–	–	–	–	75.4	–	–
Polygonum arenarium s. arenarium	–	–	–	–	–	–	–	–	–	–	–	75.4	–	–
Alyssum tortuosum	–	–	–	–	–	–	–	–	–	–	–	75.4	–	–
Astragalus varius	–	–	–	–	–	–	–	–	–	–	–	75.4	–	–
Tragopogon brevirostris s. brevirostris	–	–	–	–	–	–	–	–	–	–	–	73.0	–	–
Syrenia cana	–	–	–	–	–	–	–	–	–	–	–	72.7	–	–
Dianthus platyodon	–	–	–	–	–	–	–	–	–	–	–	70.6	–	–
Cladonia subcariosa	–	–	–	–	–	–	–	–	–	–	–	70.6	–	–
Asperula graveolens	–	–	–	–	–	–	–	–	–	–	–	70.6	–	–
Senecio borysthenicus	–	–	–	–	–	–	–	–	–	–	–	69.9	–	–
Xanthopaemelia somloensis	–	–	–	–	–	–	–	–	–	–	–	68.1	–	–
Anchusa gmelinii	–	–	–	–	–	–	–	–	–	–	–	68.1	–	–
Dianthus squarrosus	–	–	–	–	–	–	–	–	–	–	–	65.6	–	–
Stipa borysthenica	–	–	–	–	–	–	–	–	–	–	–	64.9	–	–
Agropyron dasyanthum	–	–	–	–	–	–	–	–	–	–	–	62.9	–	–
Asperula leiograveolens	–	–	–	–	–	–	–	–	–	–	–	57.3	–	–
Scabiosa argentea	–	–	–	–	–	–	–	–	–	–	–	57.3	–	–
Syrenia montana	–	–	–	–	–	–	–	–	–	–	–	57.3	–	–
Seseli arenarium	–	–	–	–	–	–	–	–	–	–	–	54.3	–	–
Minuartia setacea	–	–	–	–	–	–	–	–	–	–	–	51.1	–	–
Allium guttatum	–	–	–	–	–	–	–	–	–	–	–	47.8	–	–
Gypsophila paniculata	–	–	–	–	–	–	–	–	–	–	18.3	44.8	–	–
Scorzonera ensifolia	–	–	–	–	–	–	–	–	–	–	–	44.2	–	–
Pulsatilla patens	–	–	–	–	–	–	–	–	–	–	–	43.7	–	–
Jurinea paczoskiana	–	–	–	–	–	–	–	–	–	–	–	40.3	–	–
Carex ligerica	–	–	–	–	–	–	–	12.9	–	–	16.1	39.0	–	–
Jurinea polyclonos	–	–	–	–	–	–	–	–	–	–	–	36.0	–	–
Artemisia tschernieviana	–	–	–	–	–	–	–	–	–	–	–	31.1	–	–

No. of syntaxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of relevés	14	24	7	7	38	6	8	44	12	9	25	29	15	83
Diploschistes scruposus	–	–	–	–	–	–	–	–	–	–	–	31.1	–	–
Cladonia pocillum	–	–	–	–	–	–	–	–	–	–	17.9	–	63.4	–
Cladonia degenerans	–	–	–	–	–	–	–	–	–	–	–	–	50.2	–
Cladonia mitis	–	–	–	–	–	–	–	–	–	–	–	–	–	38.4
Hypochoeris radicata	–	–	–	–	–	–	–	–	–	–	–	–	–	30.0
Cladonia rangiferina	–	–	–	–	–	–	–	–	–	–	–	–	–	28.1
Scleranthus perennis	–	–	–	–	–	–	–	–	–	–	–	–	–	26.5
Arenaria serpyllifolia	–	–	–	–	–	–	–	–	–	–	–	–	–	26.1
Dicranum scoparium	–	–	–	–	–	–	–	–	–	–	–	–	–	26.0
Logfia minima	–	–	–	–	–	–	–	–	–	–	–	–	–	26.0
Secale sylvestre	55.0	–	–	–	–	–	–	–	42.0	–	–	7.4	–	–
Anthemis ruthenica	40.9	–	–	–	–	–	–	32.7	–	–	–	–	–	–
Lepidium densiflorum	31.3	–	–	–	–	–	–	–	77.2	–	–	–	–	–
Asparagus officinalis	27.4	–	–	–	–	–	–	34.5	–	–	16.5	–	–	–
Chamaecytisus ruthenicus	–	47.9	–	–	–	–	–	–	36.6	–	–	–	–	–
Centaurea arenaria s. borysthenica	–	45.1	–	–	–	–	–	–	–	–	–	61.6	–	–
Galium verum	–	38.9	–	–	12.2	–	–	8.8	–	44.0	–	–	–	–
Rumex acetosa	–	25.4	–	–	–	30.1	20.8	–	–	–	–	–	–	–
Euphorbia cyparissias	–	–	29.2	–	29.7	–	–	–	–	–	–	–	–	–
Pinus sylvestris	–	–	–	41.7	–	30.8	–	–	–	–	–	–	–	3.8
Festuca ovina	–	–	24.2	33.8	49.6	–	–	–	–	–	–	–	–	–
Trifolium arvense	–	–	–	–	32.0	–	–	31.4	–	–	–	–	–	–
Sedum sexangulare	–	–	–	–	–	52.5	–	50.9	–	–	–	–	–	–
Berteroa incana	–	–	–	–	8.7	47.1	23.3	–	26.0	–	–	–	–	–
Carex hirta	–	–	–	–	–	45.6	42.1	–	–	–	–	–	–	7.8
Plantago lanceolata	–	–	–	–	–	33.5	–	8.9	15.9	25.7	–	–	–	–
Artemisia absinthium	–	–	–	–	–	30.6	35.4	10.8	–	–	–	–	–	–
Pinus sylvestris	–	–	–	–	–	28.9	47.2	–	–	–	–	–	–	7.0
Genista tinctoria	–	–	–	–	–	28.6	60.2	–	–	–	–	–	–	–
Sedum telephium	–	–	–	–	–	–	–	31.9	–	49.4	–	–	–	–
Scleranthus annuus	–	–	–	–	–	–	–	–	48.2	50.4	–	–	–	–
Sedum acre s. acre	–	–	–	–	–	–	–	–	–	70.7	28.3	–	–	–
Gypsophila muralis	–	–	–	–	–	–	–	–	–	62.7	13.0	25.9	–	–
Rumex acetosella s. acetosella v. tenuifolius	–	–	–	–	–	–	–	–	–	47.1	24.5	35.2	13.3	–
Silene conica	–	–	–	–	–	–	–	–	–	46.3	15.2	32.3	–	–
Polytrichum piliferum	–	–	–	–	–	–	–	–	–	40.5	35.8	–	20.7	11.9
Tortula ruralis	–	–	–	–	–	–	–	–	–	–	58.8	54.1	–	–
Coelocaulon aculeatum	–	–	–	–	–	–	–	–	–	–	56.1	50.4	–	–
Euphorbia seguierana	–	–	–	–	–	–	–	–	–	–	49.3	61.1	–	–
Alyssum minutum	–	–	–	–	–	–	–	–	–	–	49.3	48.4	–	–
Hieracium echioides	–	–	–	–	–	–	–	–	–	–	37.0	43.5	–	–
Silene borysthenica	–	–	–	–	–	–	–	–	–	–	36.9	43.3	–	–
Cerastium semidecandrum	–	19.6	–	–	–	–	–	–	–	–	36.5	45.5	–	–
Racomitrium canescens	–	–	–	–	–	–	–	–	–	–	29.1	–	35.8	–
Helichrysum arenarium	–	–	–	–	–	–	–	–	–	–	25.9	40.1	–	–
Corynephorus canescens	–	–	–	–	–	–	–	–	–	–	23.0	–	48.8	48.0
Festuca beckeri	19.3	35.8	–	–	–	–	–	–	–	–	46.2	46.2	–	–
Achillea collina	–	6.4	31.3	–	–	49.9	25.4	–	–	–	–	–	–	–
Thymus serpyllum	–	–	–	54.2	–	31.4	28.5	–	–	–	–	–	–	4.7
Sedum acre	–	–	–	32.2	7.7	–	25.8	28.5	15.8	–	–	–	–	–
Dianthus borbasii	–	–	–	–	–	–	34.0	21.1	–	34.0	29.5	–	–	–
Erophila verna	–	–	–	–	–	–	–	–	–	45.4	40.4	45.4	12.2	–
Ceratodon purpureus	–	–	–	–	–	–	19.3	–	–	41.9	41.9	31.5	21.8	–
Myosotis stricta	–	–	–	–	–	–	–	–	–	33.8	48.1	45.9	13.9	–
Bassia laniflora	–	–	–	–	–	–	–	–	–	32.9	45.0	56.2	–	–
Cladina arbuscula	–	–	–	–	–	–	–	–	–	29.2	44.5	36.7	–	–
Tragopogon brevirostris s. podolicus	–	–	–	–	–	–	–	–	–	27.3	50.8	49.5	–	–
Cladonia rangiformis	–	–	–	–	–	–	–	–	–	–	48.3	51.9	33.3	–
Artemisia campestris agg.	–	–	–	–	–	25.3	25.3	24.0	–	25.3	23.1	25.3	–	–
Poa bulbosa	–	–	–	–	–	–	–	–	37.9	43.0	28.4	38.8	–	–
Koeleria glauca	–	–	–	–	9.7	–	–	–	30.2	30.2	30.2	30.2	–	–
Cladonia foliacea	–	–	–	–	–	–	–	–	–	41.5	40.9	48.6	27.2	–
Veronica dillenii	12.6	–	–	–	–	–	–	–	32.6	32.6	28.1	30.7	32.6	–
Conyza canadensis	–	–	–	–	–	–	–	–	–	–	–	–	–	23.8
Cladonia coniocraea	–	–	–	–	–	–	–	–	–	–	–	–	–	23.7
Digitaria sanguinalis	–	–	–	–	–	–	–	–	–	–	–	–	–	21.2
Polytrichum juniperinum	–	–	–	–	–	–	–	–	–	–	–	–	–	21.2
Nardus stricta	–	–	–	–	–	–	–	–	–	–	–	–	–	21.2
Campanula patula s. abietina	–	–	–	–	–	–	–	–	–	–	–	–	–	21.2
Verbascum phlomoides	–	–	–	–	–	–	–	–	–	–	–	–	–	18.3
Calluna vulgaris	–	–	–	–	–	–	–	–	–	–	–	–	–	18.3
Cladonia mediterranea	–	–	–	–	–	–	–	–	–	–	–	–	–	18.3
Setaria viridis	–	–	–	–	–	–	–	–	–	–	–	–	–	18.3
Cladonia uncialis	–	–	–	–	–	–	–	–	–	–	–	–	–	18.3
Agrostis canina	–	–	–	–	–	–	–	–	–	–	–	–	–	17.0
Cladonia species	–	–	–	–	–	–	–	–	–	–	–	–	–	13.7
Logfia arvensis	–	–	–	–	–	–	–	–	–	–	–	–	–	12.8
Herniaria glabra	–	–	–	–	–	–	–	–	–	–	–	–	–	10.6
Erigeron acer	–	–	–	–	–	–	–	–	–	–	–	–	–	9.0
Brachythecium albicans	–	–	–	–	–	–	–	–	–	–	–	–	–	8.3

No. of syntaxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of relevés	14	24	7	7	38	6	8	44	12	9	25	29	15	83
Festuca rubra	–	–	–	–	–	–	–	–	–	–	–	–	–	8.3
Hypericum perforatum	–	–	–	–	–	–	–	–	–	–	–	–	–	5.6
Bromus tectorum	24.8	–	–	–	–	–	–	–	–	–	–	–	–	–
Bromus secalinus	–	–	–	–	–	–	–	20.6	–	–	–	–	–	–
Calamagrostis arundinacea	–	–	–	–	–	–	–	20.6	–	–	–	–	–	–
Draba nemorosa	–	–	–	–	–	–	–	20.6	–	–	–	–	–	–
Fallopia convolvulus	–	–	–	–	–	–	–	20.6	–	–	–	–	–	–
Rhinanthus minor	–	–	–	–	–	–	–	20.6	–	–	–	–	–	–
Lychnis viscaria	–	15.1	–	–	–	–	–	–	–	–	–	–	–	–
Carex pediformis s. rhizodes	–	–	–	–	22.1	–	–	–	–	–	–	–	–	–
Carex ericetorum	–	–	–	–	17.9	–	–	–	–	–	–	–	–	–
Pinus sylvestris	–	22.6	–	–	–	–	–	–	–	–	–	–	–	–
Juncus compressus	–	–	–	–	22.1	–	–	–	–	–	–	–	–	–
Campanula patula	–	–	–	–	18.4	–	–	–	–	–	–	–	–	–
Chenopodium rubrum	–	–	–	–	22.1	–	–	–	–	–	–	–	–	–
Glechoma hederacea	–	–	–	–	22.1	–	–	–	–	–	–	–	–	–
Dichanthium ischaemum	–	–	–	–	22.1	–	–	–	–	–	–	–	–	–
Cerastium fontanum s. vulgare	–	–	–	–	22.1	–	–	–	–	–	–	–	–	–
Teucrium chamaedrys	–	–	–	–	21.1	–	–	–	–	–	–	–	–	–
Spergula morisonii	–	–	–	–	–	–	–	–	–	–	–	–	24.9	–
Leontodon autumnalis	–	–	–	–	9.1	–	–	–	–	–	–	–	–	–
Festuca valesiaca	–	–	–	–	–	–	–	17.9	–	–	–	–	–	–
Descurainia sophia	–	–	–	–	22.1	–	–	–	–	–	–	–	–	–
Fragaria vesca	–	–	24.0	24.0	–	–	–	–	–	–	–	–	–	–

Notes: numbers mark syntaxa: 1 – *Veronico dillenii-Secaletum sylvestris*; 2 – *Chamaecytiso ruthenicae-Festucetum beckeri*; 3 – *Diantho deltoidis-Armerietum elongatae*; 4 – *Jasiono montanae-Thymetum serpylli*; 5 – *Jasiono montanae-Festucetum ovinae*; 6 – *Corynephoro-Silenetum tataricae*; 7 – *Artemisio campestris-Dianthetum borbasii*; 8 – *Artemisio dniproicae-Sedetum sexangularis*; 9 – *Veronico dillenii-Secaletum sylvestris* (sensu Kovalenko); 10 – *Diantho borbasii-Agrostietum syreistschikovii*; 11 – *Thymo angustifolii-Festucetum beckeri*; 12 – *Centaureo borysthenicae-Festucetum beckeri*; 13 – *Veronico dillenii-Corynephoretum*; 14 – *Cornicularo aculeatae-Corynephoretum canescentis*.

The alliance *Corynephorion canescentis* combines coenoses in the structure of which mosses and especially lichens play a significant role, and which develop on weakly mobile sandy soils on fluvioglacial deposits, mainly in the Ukrainian Polissia. The *Koelerion glaucae* alliance includes multi-species communities growing on neutral sandy soils which developed mainly on alluvial deposits. They are common in the Ukrainian Polissia and, less often, in the forest-steppe on the pine-forest terraces of rivers and natural levees. Their territorial differentiation is determined by the relief and soil reaction.

According to the results of ordination analysis of communities in the class *Koelerio-Corynephoretea canescentis*, it was found that temperature regime and climate continentality play a leading role in their ecological differentiation (Fig. 4). These parameters are most important for coenoses within *Corynephorion canescentis*. Also, the distribution of communities is significantly affected by the gradients of ombroregime and soil humidity. Communities of *Corynephoro-Silenetum tataricae*, *Thymo angustifolii-Festucetum beckeri*, *Jasiono montanae-Thymetum serpylli* and *Jasiono montanae-Festucetum ovinae* associations are more "sensitive" to changes in these parameters. Communities of the last two syntaxa will also respond to concentration of available nitrogen forms in soil substrate. Variability of damping (fH) can be considered the leading ecological factor for the coenoses *Diantho borbasii-Agrostietum syreistschikovii*, *Veronico dillenii-Secaletum sylvestris* and *Chamaecytiso ruthenicae-Festucetun beckeri*. Communities of the *Diantho deltoidis-Armerietum elongatae* association were described on the territory of the Ukrainian Roztochia on specific moraine deposits, and their distribution in the ecological space determines content of carbonates and other salts in the soil. *Diantho deltoidis-Armerietum elongatae*, *Corynephoro-Silenetum tataricae*, *Artemisio dniproicae-Sedetum sexangularis* and *Thymo angustifolii-Festucetum beckeri* communities differ significantly in their ecological amplitude (Fig. 4).

Table 2

Synoptic table of the *Festucetea vaginatae* class

No. of syntaxa	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
Number of relevés	10	17	20	13	18	4	9	43	9	10	14	5	10	7	5	12	10	13	21	8	47	16	10	10	10	92	47
Juncus bufonius	51	21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Trifolium fragiferum	44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Aster tripolium	44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sonchus palustris	44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Carex extensa	44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Barbarea stricta	44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Odontites verna s. serotina	41	–	–	–	–	–	–	–	–	–	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Medicago lupulina	41	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15	–	–	–	–	–
Limonium bellidifolium	38	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Plantago major	37	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Agrostis gigantea s. maeotica	34	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phragmites australis	34	19	–	–	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rumex acetosa	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Inula britannica	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Elytrigia intermedia	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Aster sedifolius s. dracunculoides	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Xanthium strumarium	29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cirsium ukranicum	28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bromus squarrosus	28	16	–	–	14	–	–	–	–	–	25	–	–	–	–	–	–	–	–	–	–	14	–	–	–	–	–
Chrysopogon gryllus	22	85	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Picris hieracioides s. hieracioides	–	36	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Asparagus litoralis	–	35	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Convolvulus lineatus	–	34	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Orchis morio s. picta	–	34	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Plantago maritima	21	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Schoenus nigricans	–	32	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rumex acetosella	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18	–	–	–	–	–	12

No. of syntaxa	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
Number of relevés	10	17	20	13	18	4	9	43	9	10	14	5	10	7	5	12	10	13	21	8	47	16	10	10	10	92	47
Orchis coriophora	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lactuca tatarica	–	–	35	–	–	–	–	–	–	–	19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fallopia dumetorum	–	–	–	73	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Solidago virgaurea	–	–	–	41	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhamnus catharticus	–	–	–	39	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tanacetum vulgare	–	–	–	39	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Verbascum orientale	–	–	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Verbascum chaixii s. austriacum	–	–	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Viola lavrenkoana	–	–	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Veronica spicata s. barrelieri	–	–	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jurinea longifolia	–	–	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Viola hymettia	–	–	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cuscuta monogyna	–	–	–	–	40	–	–	–	–	–	20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vincetoxicum fuscatum	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Festuca rubra	–	–	–	–	38	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stipa borysthenica	–	–	–	–	36	–	–	–	–	–	20	–	–	–	–	–	–	–	–	–	22	–	22	–	18	–	–
Medicago minima	–	–	–	–	–	90	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ajuga chamaepitys s. chia	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Potentilla humifusa	–	–	–	–	–	70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Carduus uncinatus	–	–	–	–	–	63	–	–	–	–	8	–	–	–	–	–	–	–	–	18	–	12	–	–	–	–	–
Potentilla astracanica	–	–	–	–	–	62	–	–	–	–	–	–	–	–	–	–	–	–	–	18	–	23	–	–	–	–	–
Silene conica s. subconica	–	–	–	–	9	52	–	9	–	–	10	–	–	–	–	–	–	–	–	15	–	–	–	–	–	–	–
Cruciata pedemontana	–	–	–	–	–	49	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Aegilops lorentii	–	–	–	–	–	49	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Allium scorodoprasum s. rotundum	–	–	–	–	–	49	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hordeum murinum	15	–	–	–	–	41	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Linum austriacum s. euxinum	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	19	–	–	–	–	–	–	–
Asperula tenella	–	–	–	–	–	36	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Crepis foetida s. rhoeadifolia	–	–	–	–	–	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15	–	–	–	–	–
Elymus elongatus	12	–	–	–	–	–	52	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Consolida regalis	–	–	–	–	–	–	46	–	–	–	–	–	–	–	–	24	–	–	–	–	–	–	–	–	–	–	–
Artemisia santonica	–	–	–	–	14	–	41	–	–	–	24	–	–	–	–	–	–	–	–	–	–	12	–	–	–	–	–
Cuscuta europaea	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Asparagus maritimus	–	–	–	–	–	–	30	–	–	–	25	–	–	–	–	–	–	–	–	21	7	–	–	–	–	–	–
Plantago cornuti	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Camelina rumelica	–	–	–	–	–	–	28	–	–	–	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gypsophila perfoliata	23	–	14	–	–	–	27	6	–	–	–	–	–	–	–	–	–	–	–	19	–	–	–	–	–	–	–
Vicia cracca	–	–	–	–	–	–	–	–	41	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Alyssum desertorum	–	–	–	–	–	–	–	15	41	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Centaurea biebersteinii s. biebersteinii	–	–	–	–	–	–	–	–	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Allium scorodoprasum s. waldsteinii	–	–	–	–	–	–	–	–	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cannabis sativa v. spontanea	–	–	–	–	–	–	–	–	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Saponaria officinalis	–	–	–	–	–	–	–	–	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tragopogon ucrainicus	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Centaurea arenaria s. borysthenica	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	19	–	–	–	–	–	–	–	–	–
Festuca rupicola	–	–	–	–	–	–	–	–	–	93	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Daucus carota	–	–	–	–	–	–	–	–	–	59	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Agrostis gigantea	–	–	–	–	–	–	–	–	–	52	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phleum phleoides	–	–	–	–	–	–	–	–	–	46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thalictrum simplex	–	–	–	–	–	–	–	–	–	44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Potentilla recta	–	–	–	–	–	–	–	–	–	43	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bromus inermis	–	–	–	–	–	–	–	–	–	42	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vicia tetrasperma	–	–	–	–	–	–	–	–	–	42	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Asparagus officinalis s. officinalis	–	–	–	–	–	–	–	–	–	38	–	–	–	–	–	–	–	–	–	–	–	–	24	–	–	–	–
Apera spica-venti	–	–	–	–	–	–	–	22	–	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Linaria vulgaris	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	23	–	–	–	–	–	–	–	–	–
Festuca pratensis	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Potentilla species	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Teucrium chamaedrys	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Astragalus arenarius	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Centaurea triniifolia	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Centaurium erythraea	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Erigeron acer	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lavatera thuringiaca	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Carex melanostachya	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Trifolium campestre	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Coelocaulon species	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Heliotropium dolosum	–	–	–	–	–	–	–	–	–	–	97	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lepidium campestre	–	–	–	–	–	–	–	–	–	–	88	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bromus japonicus	–	–	–	–	–	–	19	–	–	–	77	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Aeluropus littoralis	–	–	–	–	–	–	–	–	–	–	75	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lithospermum arvense	–	–	–	–	–	–	–	–	–	–	72	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Diplotaxis muralis	–	–	–	–	–	–	–	–	–	–	64	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sisymbrium altissimum	–	–	–	–	–	–	–	–	–	–	59	–	–	–	–	–	–	–	–	21	–	–	–	–	–	–	–
Allium pervestitum	–	–	–	–	–	–	–	–	–	–	42	–	–	–	–	–	–	–	–	–	–	21	–	–	–	–	–
Orobanche cernua	–	–	–	–	–	–	–	–	–	–	37	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Artemisia pontica	–	–	–	–	–	–	–	–	–	–	37	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Elymus uralensis s. viridiglumis	–	–	17	21	17	–	–	–	–	–	37	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Melilotus alba	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–	12	–	–	–	–	–
Asparagus tenuifolius	–	–	–	–	–	–	–	–	–	–	26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

No. of syntaxa	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
Number of relevés	10	17	20	13	18	4	9	43	9	10	14	5	10	7	5	12	10	13	21	8	47	16	10	10	10	92	47
Polygonum arenarium s. pulchellum	–	–	–	–	–	–	–	–	–	–	26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Halimione verrucifera	–	–	–	–	–	–	–	–	–	–	26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thesium linophyllon	–	–	–	–	–	–	–	–	–	–	26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tragus racemosus	–	–	–	–	–	–	–	–	–	–	–	72	–	–	–	–	–	–	–	–	10	–	–	–	–	–	–
Lotus tenuis	–	–	–	–	–	–	–	–	–	–	–	66	–	–	–	–	–	–	–	–	–	–	–	–	20	–	–
Eragrostis pilosa	–	–	–	–	–	–	–	–	–	–	–	48	–	–	22	–	–	–	–	–	–	–	–	–	–	–	–
Corispermum ucrainicum	–	–	–	–	10	–	24	–	–	–	–	45	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thlaspi arvense	–	–	–	–	–	–	–	–	–	–	–	34	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Corispermum nitidum	–	–	–	–	–	–	–	–	–	–	–	–	99	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Linaria odora	–	–	–	–	–	–	–	–	–	–	–	–	99	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tribulus terrestris	–	–	–	–	–	–	–	–	–	–	24	–	77	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Linaria dulcis	–	–	–	–	–	–	–	–	–	–	–	–	–	93	–	–	–	–	–	–	–	–	–	–	–	–	–
Jurinea ewersmanii	–	–	–	–	–	–	–	–	–	–	–	–	–	75	–	–	–	–	–	–	–	–	–	–	–	–	–
Digitaria sanguinalis	–	–	–	–	–	–	–	–	–	–	–	–	–	72	–	–	–	–	–	–	–	–	–	–	–	–	–
Silene borysthenica	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	12	–	–	20	20	–	–
Jurinea cyanoides s. tenuiloba	–	–	–	–	–	–	–	–	–	–	–	–	–	59	–	–	–	–	–	–	–	–	–	–	–	–	–
Ambrosia artemisiifolia	–	–	–	–	–	–	–	–	–	–	–	–	–	55	–	–	–	20	–	–	–	–	–	–	–	–	–
Lactuca serriola	–	–	–	16	–	–	–	–	–	–	–	–	–	51	–	–	–	–	–	–	–	–	–	–	–	–	–
Calamagrostis epigejos	–	–	7	24	–	–	–	–	–	14	–	–	–	38	–	–	–	20	–	–	–	–	–	–	–	–	–
Sisymbrium orientale	–	–	–	–	–	–	–	–	16	–	–	–	–	–	69	–	–	–	–	–	–	–	–	–	–	–	–
Anchusa officinalis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	58	–	–	–	–	–	–	–	–	–	–	–	–
Achillea collina	–	–	–	–	–	–	–	–	–	–	–	–	–	–	52	–	–	–	–	–	–	–	–	–	–	–	–
Sisymbrium polymorphum	–	11	9	–	–	–	–	–	–	14	–	–	–	–	50	–	–	–	–	–	–	–	–	–	–	–	–
Inula salicina	–	16	–	–	–	–	–	–	–	–	–	–	–	–	29	–	–	–	–	–	–	–	–	–	–	–	–
Ephedra distachya	–	–	–	–	10	–	–	–	–	–	11	–	–	–	–	54	–	–	–	24	–	24	18	–	–	–	–
Dianthus capitatus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–	–
Dianthus bessarabicus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–	–
Onobrychis arenaria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–	–
Marrubium pestalozzae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–	–
Sinapis alba	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–	–
Echinops ritro	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	17	–	–	–	–	–	14
Thymus dimorphus	–	–	22	–	16	–	–	–	–	–	22	–	–	–	–	27	–	–	–	24	–	–	–	–	–	–	–
Achillea setacea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	89	–	–	–	–	–	–	–	–	–	–
Potentilla argentea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	78	24	–	–	–	–	–	–	–	–	–
Hieracium pilosella	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	76	–	–	–	–	–	–	–	–	–	–
Poa angustifolia	–	–	–	–	–	–	–	–	–	21	–	–	–	–	–	–	73	–	–	–	–	–	–	–	–	–	–
Trifolium arvense	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	72	–	–	–	4	–	–	–	–	–	–
Cerastium fontanum s. vulgare	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	–	–	–	–	–	–	–	–	–	–
Taraxacum officinale	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	57	–	–	–	–	–	–	–	–	–	–
Artemisia austriaca	–	–	–	–	–	–	–	–	–	–	–	21	–	–	–	–	56	–	–	–	–	20	–	–	–	–	–
Jurinea consanguinea s. arachnoidea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	54	–	–	–	–	–	–	–	–	–	–
Sedum acre	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	46	–	–	–	–	–	–	–	–	–	–
Poa annua	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	44	–	–	–	–	–	–	–	–	–	–
Galium album	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	44	–	–	–	–	–	–	–	–	–	–
Thesium arvense	–	–	–	–	–	–	–	–	–	–	15	–	–	–	–	–	41	–	–	–	7	–	–	–	–	–	–
Stellaria graminea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	39	–	–	–	–	–	–	–	–	–	–
Herniaria glabra	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	36	17	–	–	–	–	–	–	–	–	–
Sanguisorba officinalis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–
Convolvulus arvensis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–
Jurinea polyclonos	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	73	–	–	–	–	–	–	–	–	–
Achillea nobilis	–	–	–	–	–	–	–	–	–	–	–	–	–	22	–	–	14	66	–	–	–	–	–	–	–	–	–
Centaurea arenaria s. majorovii	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	61	10	–	–	–	–	–	–	–	–
Asparagus officinalis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	58	–	–	–	–	–	–	–	–	–
Jasione montana	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	56	–	–	8	–	–	–	–	–	–
Tragopogon ruthenicus s. tanaiticus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	47	–	–	–	–	–	–	–	–	–
Agrostis vinealis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	47	–	–	–	–	–	–	–	–	–
Gypsophila paniculata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14	–	42	–	–	10	–	–	–	–	–	–
Reseda lutea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	39	–	–	–	–	–	–	–	–	–
Verbascum thapsus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	38	–	–	–	–	–	–	–	–	–
Salix acutifolia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	37	–	–	–	–	–	–	–	–	–
Potentilla cinerea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29	–	–	–	–	–	–	–	–	11
Geranium robertianum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Aster amellus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Pulsatilla vulgaris	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Astragalus sulcatus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Viola ambigua	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Potentilla thyrsiflora	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Silene chlorantha	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Equisetum arvense	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Elymus hispidus s. barbulatus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Melissa officinalis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Poa compressa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Delphinium cuneatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	–	–
Melilotus officinalis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25	–	–	–	–	–	–	–	–	–
Leymus racemosus s. sabulosus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	39	–	–	18	–	–	–	–	–
Elymus farctus s. bessarabicus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	37	–	–	–	–	–	–	–	–
Eryngium maritimum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	36	–	–	–	–	–	–	7	–
Astrodaucus littoralis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–
Festuca arundinacea s. orientalis	–	–	19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–

No. of syntaxa	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
Number of relevés	10	17	20	13	18	4	9	43	9	10	14	5	10	7	5	12	10	13	21	8	47	16	10	10	10	92	47
Stipa capillata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	85	–	–	–	–	–	–	–
Coronilla varia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	59	–	–	–	–	–	–	–
Dianthus pseudarmeria	–	–	–	–	17	–	–	–	–	–	16	–	–	–	–	–	–	–	–	55	–	–	–	–	–	–	–
Allium flavum s. tauricum	–	–	–	–	19	–	–	–	–	–	11	–	–	–	–	–	–	–	–	48	–	–	–	–	–	–	–
Trigonella monspeliaca	–	–	–	–	17	–	–	–	–	–	14	–	–	–	–	–	–	–	–	42	–	–	–	–	–	–	–
Descurainia sophia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	39	–	–	–	–	–	–	–
Silene chersonensis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	38	–	–	–	–	–	–	–
Buglossoides arvensis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35	–	–	–	–	–	–	–
Alcea rugosa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35	–	–	–	–	–	–	–
Cladonia species	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21	–	–	–	34	–	–	–	–	–	–	–
Gagea arvensis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–
Gagea dubia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–
Saxifraga tridactylites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–
Salvia aethiopis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–
Agropyron cimmericum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–
Cirsium alatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–
Cirsium vulgare	20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25	–	–	–	–	–	–	–
Ceratodon purpureus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	–	–	–	–	–
Cladonia convoluta	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	45	–	–	–	–	–	–
Allium paniculatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	–	–	–	–	–	–
Neofuscelia species	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	41	–	–	–	–	–	–
Scorzonera ensifolia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	33	–	–	–	–	12	–
Achillea micrantha	–	–	–	–	–	–	–	–	–	–	–	–	18	–	–	–	–	16	–	–	27	–	–	18	23	–	–
Rumex confertus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	–	–	–	–	–
Crepis sancta	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	–	–	–	–	–
Artemisia absinthium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	–	–	–	–	–
Papaver dubium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	–	–	–	–	–
Cichorium intybus	23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23	–	–	–	–	41	–	–	–	–	–
Lepidium latifolium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	38	–	–	–	–	–
Koeleria macrantha	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35	–	–	–	–	–
Chenopodium opulifolium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35	–	–	–	–	–
Falcaria vulgaris	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21	–	–	–	–	34	–	–	–	–	–
Lamium amplexicaule	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	33	–	–	–	–	–
Echium vulgare	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15	–	–	20	–	26	–	–	–	–	–
Bassia prostrata	–	–	–	–	–	–	–	8	–	–	–	–	–	–	–	–	–	–	–	–	–	25	–	–	–	–	–
Elymus farctus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	83	–	–	–	–
Artemisia tschernieviana	–	–	–	–	–	–	–	–	–	–	24	–	–	–	–	–	–	–	–	–	–	–	76	–	–	–	–
Alyssum borzaeanum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	74	–	–	–	–
Asperula setulosa	–	–	–	–	7	–	–	–	–	–	22	–	–	–	–	–	–	–	–	23	–	–	70	–	–	–	–
Silene exaltata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	–	62	–	–	–	–
Orobanche coerulescens	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	54	–	–	–	–
Onosma arenaria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12	–	49	–	–	–	–
Leymus racemosus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	44	–	–	–	–
Linaria genistifolia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18	23	27	17	–	–	–
Inula salicina s. aspera	–	–	–	–	–	–	–	–	–	21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
Rumex acetosella s. acetosella v. tenuifolius	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	–	–	20	55	–	–
Vicia hirsuta	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	54	–	–
Centaurium pulchellum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	46	–	–
Veronica spicata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	42	–	–
Verbascum phoeniceum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	42	–	–
Echinops ritro s. ruthenicus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17	–	–	18	40	–	–
Scabiosa ochroleuca	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	–	–	22	31	–	–
Thalictrum minus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	–	–
Euphorbia cyparissias	–	–	–	–	21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
Centaurea rhenana	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29
Chamaecytisus ruthenicus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
Apera spica-venti s. maritima	58	9	10	–	–	42	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lotus corniculatus	35	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35	–	–	–	–	–	–	–	–	–	–
Matricaria perforata	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	–	–	–
Milium vernale	21	31	–	35	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Scirpus holoschoenus	–	14	32	25	–	–	–	–	–	14	16	–	–	–	–	–	–	–	–	15	–	–	–	–	32	–	–
Salix rosmarinifolia	–	–	–	63	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	63	–	–	–
Galium ruthenicum	–	–	–	41	–	–	–	–	–	38	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21	–	–
Conyza canadensis	–	–	–	29	–	–	–	–	–	–	–	–	–	47	–	–	–	–	–	–	–	–	–	–	–	–	–
Arabidopsis toxophylla	–	–	–	–	38	–	–	–	–	–	29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bassia sedoides	–	–	–	–	32	–	–	–	–	–	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Arenaria serpyllifolia	–	–	–	–	26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	41	–	–	–	–	–	–	–
Thlaspi perfoliatum	–	–	–	–	26	–	–	–	–	–	49	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Anthemis ruthenica	–	–	–	–	7	40	–	–	–	–	–	56	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Limonium meyeri	–	–	–	–	–	34	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	39	–	–	–	–	–
Arenaria serpyllifolia s. leptoclados	–	–	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14	21	–	–	52	–	–
Marrubium peregrinum	–	–	–	–	–	30	–	–	–	–	61	–	–	–	–	–	–	–	–	21	–	–	–	–	–	–	–
Poa bulbosa	–	–	–	–	–	29	–	–	–	–	–	–	–	–	–	–	20	19	–	–	–	–	–	–	29	–	4
Artemisia taurica	–	–	–	–	–	–	56	–	–	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Senecio vernalis	–	–	–	–	–	–	34	–	–	–	50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Galium humifusum	–	–	–	–	–	–	34	–	–	–	20	–	–	–	–	–	–	–	11	–	–	39	–	–	–	–	–
Xanthopaemelia camschadalis	–	–	18	–	10	–	28	–	–	–	51	–	–	–	–	19	–	–	–	17	–	–	–	–	–	–	–
Anthemis arvensis	–	–	–	–	–	–	–	30	32	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Linum perenne	–	–	–	–	–	–	–	–	–	45	–	–	–	–	–	–	–	–	–	–	–	–	33	–	–	–	–

No. of syntaxa	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
Number of relevés	10	17	20	13	18	4	9	43	9	10	14	5	10	7	5	12	10	13	21	8	47	16	10	10	10	92	47
Picris hieracioides	–	–	–	–	–	–	–	–	–	25	49	–	–	–	–	–	–	–	–	–	–	–	18	–	–	–	–
Eragrostis minor	–	–	–	–	–	–	–	–	–	–	63	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–
Alyssum hirsutum	–	–	13	–	15	–	24	–	–	–	38	–	–	–	–	–	–	–	–	36	–	18	–	–	–	–	–
Silene spergulifolia	–	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–
Syrenia cana	–	–	–	–	–	–	–	–	–	–	29	–	–	–	–	–	–	–	–	–	12	–	–	–	37	–	–
Crambe maritima	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	–	–	–	17	–	–	30	–	–	–	–	–
Lappula squarrosa	–	–	–	–	–	–	–	–	–	–	–	60	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–
Lithospermum officinale	–	–	–	–	–	–	16	–	–	–	–	33	–	–	51	–	–	–	–	–	–	–	–	–	–	–	–
Achillea asplenifolia	–	10	–	–	18	–	–	–	–	–	13	28	–	–	–	–	–	–	–	26	–	–	–	–	–	–	–
Seseli tortuosum	–	–	–	–	19	–	–	–	–	–	–	28	–	–	–	17	–	–	9	29	–	–	–	–	–	–	–
Polygonum arenarium s. arenarium	–	–	–	–	–	–	–	–	–	–	–	–	73	–	–	–	–	–	–	–	–	–	39	–	–	–	–
Agropyron dasyanthum	–	–	–	–	–	–	–	–	–	–	–	–	45	–	–	–	–	–	–	–	30	–	–	18	24	7	–
Anchusa gmelinii	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	24	–	–	–	31	–	–
Syrenia montana	–	–	–	–	–	–	–	–	–	–	–	–	32	–	–	–	–	–	–	–	22	–	38	–	15	–	–
Polygonum arenarium	–	–	–	–	–	–	–	–	–	–	–	–	–	70	–	–	–	–	–	–	40	–	–	–	–	–	–
Veronica verna	–	–	–	–	–	–	–	–	–	–	–	–	–	58	–	–	57	–	–	–	–	–	–	–	–	–	–
Centaurea apiculata s. adpressa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	37	–	–	–	–	–	–	–	44	–	–	–	–
Medicago sativa s. falcata	–	–	–	–	16	–	–	–	–	–	20	–	–	–	21	33	–	–	–	29	–	–	16	–	–	–	–
Gypsophila muralis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	41	–	–	–	–	–	–	–	–	–
Eryngium campestre	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	34	–	–	36	–	23	–	–	–	–	–
Berteroa incana	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	30	–	–	–	23	–	–	–	–	–
Chamaecytisus borysthenicus	–	–	–	16	–	–	–	–	–	–	–	–	–	–	–	–	–	32	–	–	14	–	–	65	–	–	–
Hieracium echioides	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	20	–	–	21	29	–	–
Centaurea margaritacea s. breviceps	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	32	25	–	–
Jurinea albicaulis s. laxa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	47	–	–	42	–	–	–
Alyssum tortuosum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	–	–	–	40	–	–
Minuartia viscosa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	39	–	–	61	20	–	–
Thymus pallasianus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35	–	–	60	–	–	8
Cladina arbuscula	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	34	–	–	–	72	–	–
Thymus borysthenicus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	–	–	–	–	36	25
Helichrysum arenarium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23	17	–	–	25	–	–	27	23	8	13
Seseli arenarium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12	–	57	12	44	–	–
Silene conica	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13	–	46	–	36	–	–
Herniaria polygama	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23	–	–	38	28	–	–
Cladonia subcariosa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21	–	–	36	61	–	–
Cerastium semidecandrum	–	–	–	–	–	–	–	–	–	–	–	–	–	15	–	–	13	–	–	–	10	–	24	35	35	–	–
Goniolimon graminifolium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21	–	–	31	31	–	–
Scabiosa argentea	–	–	–	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25	–	–	31	42	–	–
Astragalus varius	–	–	–	–	12	–	–	–	–	–	9	–	–	–	–	–	16	–	–	–	6	–	–	27	45	–	–
Dianthus platyodon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22	–	–	26	26	12	–
Cerastium pumilum s. glutinosum	–	35	16	–	–	58	–	–	–	–	26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Plantago lanceolata	–	–	–	–	–	46	–	–	–	–	26	–	–	–	–	–	46	–	–	–	–	–	–	–	–	–	–
Bassia hirsuta	–	–	–	–	–	–	40	–	–	–	53	–	–	–	–	29	–	–	–	–	–	–	–	–	–	–	–
Cynanchum acutum	–	–	21	–	–	–	30	–	–	–	29	–	–	–	–	21	–	–	–	28	–	–	–	–	–	–	–
Teucrium polium	–	–	–	–	20	–	29	–	–	–	44	–	–	–	–	15	–	–	–	34	–	–	–	–	–	–	–
Bromus tectorum	–	–	–	–	–	–	27	5	18	–	7	19	27	27	–	–	11	–	–	–	–	9	–	–	–	–	–
Plantago arenaria	–	–	–	–	–	–	–	–	–	–	–	–	49	49	49	–	–	–	–	–	–	–	–	–	–	–	–
Erophila verna	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	37	–	–	–	28	–	–	–	56	–	–
Myosotis stricta	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	33	–	–	–	20	–	–	51	51	–	–
Centaurea arenaria s. odessana	–	–	–	–	15	–	–	–	–	–	–	–	–	–	–	–	–	–	19	44	–	40	38	–	–	–	–
Bassia laniflora	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	33	–	–	49	35	–	–
Veronica dillenii	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	57	57	–	–
Tragopogon brevirostris s. brevirostris	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23	–	–	–	–	–	28	–	–	38	44	–	–
Agropyron cristatum s. sabulosum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	–	–	26	73	–	–
Senecio borysthenicus	–	–	–	–	–	–	–	–	–	–	–	–	25	–	–	–	–	–	–	–	27	–	–	37	50	–	–
Cladonia foliacea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21	–	47	47	47	–	–
Xanthopaemelia somloensis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13	–	46	31	39	–	–
Alyssum minutum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15	–	29	50	43	–	–
Cladonia rangiformis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15	–	28	44	39	–	8
Coelocaulon aculeatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23	–	25	57	51	–	–
Centaurea diffusa	–	–	5	–	–	45	33	–	–	–	30	–	–	–	–	14	29	–	–	–	–	–	–	–	–	–	–
Cynodon dactylon	10	13	–	–	14	31	31	–	–	10	25	–	–	–	14	13	–	–	–	26	–	–	–	–	–	–	–
Artemisia campestris agg.	–	–	–	–	–	–	–	–	28	–	–	–	–	–	–	–	–	–	–	–	28	–	–	28	28	10	19
Tortula ruralis	–	–	–	–	–	18	10	–	–	–	29	–	–	–	–	11	–	–	–	18	11	10	29	29	29	–	–
Asperula graveolens	–	–	–	–	–	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	30	–	–	48	31	–	–
Koeleria glauca	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	–	–	20	–	–	26	–	18	27	27	–	27

Notes: only plant species having diagnostic value were listed; due to the table's width restriction, phi values were listed to integer; numbers mark syntaxa: 1 – *Aperetum maritimae*; 2 – *Dauco guttati-Chrysopogonetum grylli*; 3 – *Carici colchicae-Holoschoenetum vulgaris*; 4 – *Salici rosmarinifoliae-Holoschoenetum vulgaris*; 5 – *Secali-Stipetum borysthenicae*; 6 – *Cynodonto-Medicaginetum minimae*; 7 – *Secali-Cynodontetum dactyli*; 8 – *Secaletum sylvestris*; 9 – *Secali sylvestri-Brometum tectorum*; 10 – *Allio guttati-Festucetum rupicolae*; 11 – *Heliotropio dolosi-Brometum japonici*; 12 – *Trago-Anthemietum ruthenicae*; 13 – *Linario odorae-Agropyretum dasyanthi*;14 – *Linario odorae-Agropyretum dasyanthi* (sensu Kovalenko); 15 – *Plantaginetum arenariae*; 16 – *Poo bulbosae-Caricetum colchicae*; 17 – *Achilleo setacei-Festucetum beckeri*; 18 – *Centaureo gerberii-Chamaecytisetum borysthenici*; 19 – *Centaureo odessanae-Caricetum colchicae*; 20 – *Centaureo odessanae-Stipetum capillatae*; 21 – *Centaureo brevicipiti-Festucetum beckeri* var. *typica*; 22 – *Centaureo odessanae-Festucetum beckeri* (sensu Kolomiychuk et al.); 23 – *Centaureo odessanae-Festucetum beckeri* (Vicherek relevés); 24 – *Centaureo brevicipiti-Festucetum beckeri salicetosum rosmarinifoliae*; 25 – *Centaureo brevicipiti-Festucetum beckeri inuletosum sabuletorum*; 26 – *Festucetum beckeri* var. *typica*; 27 – *Festucetum beckeri* var. *Koeleria glauca*.

The class *Festucetea vaginatae* combines communities of sandy steppes and sandy meadows. In Ukraine, these coenoses are common in the steppe zone on the lower Dnieper River arenas, in the Black Sea region and the Azov Sea regions. These coenoses are less common on riverine sands. According to our study, in Ukraine, the class includes one order, two alliances and 22 associations. Cluster analysis suggests that *Artemisio arenariae-*

Festucion beckeri alliance is comprised of 4–5 sub-alliances, but it is not still possible to identify clear diagnostic blocks (Fig. 5, Table 2). The leading factors of territorial differentiation of phytocoenoses also determining their coenotic diversity are the mesorelief patterns (elements of dunes, interdunal depressions, flat areas in arenas), soil type, its humus content and density, as well as the degree of aeolian processes influence. The hyperspace of ecological conditions from humid (deep depressions) to semi-desert (dune tops) contributes to their significant coenotic richness and diversity. The alliance *Festucion beckeri* includes coenoses occurring on sandy areas of low hilly coastal and riverine dunes which consist of non-carbonate soils. The alliance *Artemisio arenariae-Festucion beckeri* includes steppe plant communities occurring on sandy and sandy-shell soils of the Black Sea and the Azov Sea coastal areas.

According to the results obtained from ordination analysis of *Festucetea vaginatae* associations it was found that the ecological differentiation of syntaxa within the class is determined by the complex influence of ecological factors, and most of plant communities develop under similar environmental conditions (Fig. 6). The general leading factor is the soil salinity regime. Moisture, content of carbonates in the soil and its aeration are of crucial importance to the communities existing in *Allio guttati-Festucetum rupicolae* and *Achilleo setacei-Festucetum beckeri* associations. The distribution of *Aperetum maritimae*, *Dauco guttati-Chrysopogonetum grylli* and *Carici colchicae-Holoschoenetum vulgaris* coenoses in the ecological space is determined mainly by content of available nitrogen forms in the soil. Coenoses in the *Secaletum sylvestris* association are characterized by the widest ecological amplitude. Their placement is determined by the variability of damping and temperature conditions.

Coenoses belonging to *Helichryso-Crucianelletea maritimae* class occupy specific ecotopes in stabilized overgrown (grey) dunes and overgrown uprush berm crest areas on the coasts of the Black Sea and Azov Sea. In Ukraine, the class includes 1 order, 4 alliances and 10 associations (Fig. 7, Table 3).

Table 3

Synoptic table of *Helichryso-Crucianelletea maritimae* class

No. of syntaxa	1	2	3	4	5	6	7	8	9	10
Number of relevés	13	10	7	10	24	14	10	14	17	9
Onopordum tauricum	60.0	–	–	–	–	–	–	–	–	–
Matricaria perforata	59.2	–	–	–	–	–	–	–	–	–
Poa angustifolia	55.1	–	–	–	–	–	–	–	–	–
Cynanchum acutum	54.5	–	–	–	–	–	–	–	–	–
Seseli tortuosum	50.8	–	–	–	–	–	–	–	–	–
Falcaria vulgaris	46.9	–	–	–	–	–	–	–	–	–
Cerastium gracile	46.3	–	–	–	–	–	–	–	–	–
Allium flavum s. tauricum	46.3	–	–	–	–	–	–	–	–	–
Berteroa incana	45.0	–	–	–	–	–	–	–	–	–
Camelina microcarpa	41.3	–	–	–	–	–	–	–	–	–
Bromus squarrosus	40.7	–	–	–	–	–	–	–	–	–
Bassia laniflora	39.5	–	–	–	–	–	–	–	–	–
Allium scorodoprasum s. waldsteinii	37.5	–	–	–	–	–	–	–	–	–
Phragmites australis	37.5	–	–	–	–	–	–	–	–	–
Galium humifusum	35.3	–	–	–	–	–	–	–	–	–
Crambe maritima	32.8	–	–	–	–	–	–	–	–	–
Alyssum desertorum	32.4	–	–	–	–	–	–	–	–	–
Odontites verna s. serotina	29.5	–	–	–	–	–	–	–	–	–
Elymus repens	28.8	–	–	–	–	–	–	–	–	–
Helichrysum arenarium	–	51.1	–	20.0	–	–	–	–	–	–
Veronica verna	–	42.9	–	–	–	–	–	–	–	–
Arenaria serpyllifolia s. leptoclados	–	40.8	–	–	–	–	–	–	–	–
Silene spergulifolia	–	35.0	–	–	–	–	–	–	–	–
Conyza canadensis	–	26.3	–	–	–	–	–	–	–	–
Scabiosa argentea	–	–	86.2	16.8	–	–	–	–	–	–
Lithospermum officinale	–	–	57.5	–	–	–	–	–	–	–
Centaurea margaritacea s. breviceps	–	–	51.4	–	–	–	–	–	–	–
Medicago minima	–	–	49.1	–	–	–	–	–	–	21.2
Gypsophila paniculata	–	–	35.5	–	–	–	–	–	–	–
Asperula setulosa	–	–	–	100.0	–	–	–	–	–	–
Seseli arenarium	–	–	–	100.0	–	–	–	–	–	–
Artemisia tschernieviana	–	–	–	87.5	–	–	–	–	–	–
Elymus farctus	–	–	–	82.3	–	–	–	–	–	–
Cerastium semidecandrum	–	–	–	69.2	–	–	–	–	–	–
Silene conica	–	–	–	68.8	–	–	–	–	–	–
Alyssum minutum	–	–	–	68.8	–	–	–	–	–	–
Syrenia montana	–	22.3	–	58.9	–	–	–	–	–	–
Onosma arenaria	–	–	–	55.5	–	–	–	–	–	–
Polygonum arenarium s. arenarium	20.2	–	–	54.7	–	–	–	–	–	–
Orobanche coerulescens	–	–	–	45.9	–	–	–	–	–	–
Koeleria glauca	–	–	–	43.0	–	–	–	14.2	–	–
Asparagus officinalis s. officinalis	–	–	–	42.9	–	–	–	–	–	–
Festuca beckeri	–	–	–	42.8	–	–	–	–	14.5	–
Linum perenne	–	–	–	37.2	–	–	–	–	–	–
Picris hieracioides	–	–	–	37.2	–	–	–	–	–	–
Centaurea arenaria s. odessana	15.0	–	–	34.4	–	–	–	16.9	–	–
Echinops sphaerocephalus	–	–	–	–	39.1	–	–	–	–	–
Galium ruthenicum	–	–	–	–	33.8	–	–	–	–	–
Centaurea arenaria s. borysthenica	–	–	–	–	33.8	–	–	–	–	–
Glycyrrhiza glabra	–	–	–	–	27.5	–	–	–	–	–
Consolida regalis	–	–	–	–	27.5	–	–	–	–	–
Seseli campestre	–	–	–	–	–	87.7	–	–	–	–
Asperula graveolens	–	–	–	–	–	78.6	–	–	–	–
Galium tenderiense	–	–	–	–	–	74.3	–	–	–	–
Melica transsilvanica s. klokovii	–	–	–	–	–	63.5	–	–	–	–
Limonium meyeri	–	–	–	–	–	56.2	–	–	–	–
Anchusa gmelinii	–	–	–	–	–	51.4	–	–	–	–
Elymus elongatus	–	–	–	–	–	51.4	–	–	–	–
Eleocharis palustris	–	–	–	–	–	44.4	–	–	–	–
Cuscuta monogyna	–	–	–	–	–	44.4	–	–	–	–

No. of syntaxa	1	2	3	4	5	6	7	8	9	10
Number of relevés	13	10	7	10	24	14	10	14	17	9
Linaria dulcis	–	–	–	–	–	39.8	–	–	–	–
Papaver dubium s. laevigatum	–	–	–	–	–	36.7	–	–	–	–
Consolida paniculata	–	–	–	–	–	36.3	–	–	–	–
Artemisia scoparia	–	–	–	–	–	36.1	–	–	–	–
Scabiosa ochroleuca	–	–	–	–	–	36.1	–	–	–	–
Senecio vernalis	–	–	–	–	–	31.5	–	–	–	24.7
Bromus tectorum	–	24.2	–	–	–	30.9	–	21.3	–	–
Apera spica-venti s. maritima	–	–	–	–	–	26.4	–	–	–	–
Aster oleifolius	–	–	–	–	–	–	61.2	–	–	–
Echium vulgare	–	–	–	–	–	–	56.6	15.5	–	–
Anthemis cotula	–	–	–	–	–	–	52.8	–	–	–
Limonium latifolium	–	–	–	–	–	–	49.0	–	17.0	–
Dianthus marschallii	–	–	–	–	–	–	47.3	–	–	–
Goniolimon tataricum	–	–	–	–	–	–	43.5	–	–	–
Helianthemum salicifolium	–	–	–	–	–	–	43.0	–	–	–
Viola kitaibeliana	–	–	–	–	–	–	42.9	–	–	–
Salvia aethiopis	–	–	–	–	–	–	42.9	–	–	–
Scorzonera cana	–	–	–	–	–	–	42.9	–	–	–
Peganum harmala	–	–	–	–	–	–	42.9	–	–	–
Petrorhagia prolifera	–	–	–	–	–	–	42.9	–	–	–
Centaurea orientalis	–	–	–	–	–	–	42.9	–	–	–
Capsella bursa-pastoris	–	–	–	–	–	–	42.9	–	–	–
Satureja rumelica	–	–	–	–	–	–	42.9	–	–	–
Potentilla astracanica	–	–	–	–	–	–	39.5	–	–	–
Valerianella pumila	–	–	–	–	–	–	32.0	–	–	–
Asperula supina	–	–	–	–	–	–	–	91.9	–	–
Euphorbia esula s. tommasiniana	–	–	–	–	–	–	–	91.9	–	–
Carex liparocarpos	–	–	–	–	–	–	–	90.1	–	–
Linaria sabulosa	–	–	–	–	–	–	–	85.4	–	–
Thymus pannonicus	–	–	–	–	–	–	–	84.4	–	–
Clypeola jonthlaspi	–	–	–	–	–	–	–	83.2	–	–
Medicago praecox	–	–	–	–	–	–	–	78.6	–	–
Trigonella monspeliaca	–	–	–	–	–	–	–	77.3	–	–
Eragrostis minor	–	–	–	–	–	–	–	69.7	–	–
Erysimum diffusum	–	–	–	–	–	–	–	66.5	–	23.9
Arenaria serpyllifolia	–	–	–	–	–	–	–	63.4	–	–
Stipa capillata	–	–	–	–	–	–	–	63.1	–	–
Alcea rugosa	–	–	–	–	–	–	–	62.6	–	–
Sisymbrium orientale	–	–	–	–	–	–	–	61.8	–	–
Convolvulus lineatus	–	–	–	–	–	–	–	60.1	–	–
Erodium cicutarium	–	–	–	–	–	–	–	60.1	–	–
Setaria viridis	–	–	–	–	–	–	–	59.0	20.8	–
Thesium arvense	–	–	–	–	–	–	–	58.9	–	–
Leontodon hispidus	–	–	–	–	–	–	–	52.7	–	–
Lappula barbata	–	–	–	–	–	–	–	51.7	–	–
Achillea leptophylla	–	–	–	–	–	–	–	50.9	–	–
Psilurus incurvus	–	–	–	–	–	–	–	49.1	–	–
Minuartia hybrida	–	–	–	–	–	–	–	48.5	–	–
Hieracium umbellatum	–	–	–	–	–	–	–	48.5	–	–
Tribulus terrestris	–	–	–	–	–	–	–	45.9	–	–
Artemisia taurica	–	–	–	–	–	–	–	44.4	–	–
Minuartia glomerata	–	–	–	–	–	–	–	44.4	–	–
Erophila verna s. praecox	–	–	–	–	–	–	–	42.7	–	–
Cerastium pumilum s. glutinosum	–	–	–	–	–	–	–	41.9	–	–
Plantago lanceolata	–	–	–	–	–	–	24.0	41.6	–	–
Silene conica s. subconica	18.8	–	–	–	–	–	–	39.7	–	24.6
Papaver rhoeas	–	–	–	–	–	–	–	38.0	20.7	–
Heliotropium ellipticum	–	–	–	–	–	–	–	36.1	–	–
Cerastium fontanum s. vulgare	–	–	–	–	–	–	–	36.1	–	–
Artemisia austriaca	–	–	–	–	–	–	–	34.7	–	–
Artemisia campestris agg.	–	–	–	–	–	–	–	33.0	–	21.1
Centaurea diffusa	–	–	–	–	–	–	–	28.9	–	–
Salvia scabiosifolia	–	–	–	–	–	–	–	–	66.7	–
Centaurea sterilis	–	–	–	–	–	–	–	–	62.2	–
Apera spica-venti	–	–	–	–	–	–	–	–	57.4	–
Crataegus laciniata	–	–	–	–	–	–	–	–	52.2	–
Rosa canina	–	–	–	–	–	–	–	–	52.2	–
Adonis aestivalis	–	–	–	–	–	–	–	–	52.2	–
Melica ciliata s. monticola	–	–	–	–	–	–	–	–	46.6	–
Koeleria macrantha	–	–	–	–	–	–	–	–	46.6	–
Festuca rupicola	–	–	–	–	–	–	–	–	46.6	–
Arum elongatum	–	–	–	–	–	–	–	–	40.2	–
Anthriscus cerefolium	–	–	–	–	–	–	–	–	40.2	–
Sambucus nigra	–	–	–	–	–	–	–	–	40.2	–
Bromus hordeaceus s. hordeaceus	–	–	–	–	–	–	–	–	40.2	–
Alyssum calycocarpum	–	–	–	–	–	–	–	–	40.2	–
Trinia crithmifolia	–	–	–	–	–	–	–	–	40.2	–
Geum urbanum	–	–	–	–	–	–	–	–	40.2	–
Valerianella coronata	–	–	–	–	–	–	–	–	40.2	–
Dactylis glomerata	–	–	–	–	–	–	–	–	40.2	–
Galium aparine	–	–	–	–	–	–	–	–	40.2	–
Milium vernale	–	–	–	–	–	24.8	–	–	36.9	–
Agropyron cristatum s. ponticum	–	–	–	–	–	–	–	–	32.7	–
Thalictrum minus	–	–	–	–	–	–	–	–	32.7	–

No. of syntaxa	1	2	3	4	5	6	7	8	9	10
Number of relevés	13	10	7	10	24	14	10	14	17	9
Dactylis glomerata s. hispanica	–	–	–	–	–	–	–	–	32.7	–
Buglossoides arvensis	–	–	–	–	–	–	–	–	32.5	–
Lactuca tatarica	–	–	–	–	–	–	–	–	31.9	–
Carex ligerica	–	–	–	23.4	–	–	–	–	30.1	–
Agropyron cimmericum	–	–	–	–	–	–	–	–	27.1	–
Potentilla species	–	–	–	–	–	–	–	–	–	76.3
Linaria genistifolia s. genistifolia	–	–	–	–	–	–	–	–	–	64.7
Asperula tenella	–	–	–	–	–	–	–	–	–	64.7
Onosma tinctoria	–	–	–	–	–	–	–	–	–	60.1
Cerastium pumilum	–	–	–	–	–	–	–	–	–	60.1
Medicago lupulina	–	–	–	–	–	–	–	–	–	55.7
Cichorium intybus	–	–	–	–	–	–	–	–	–	49.8
Elymus farctus s. bessarabicus	–	–	–	–	–	–	–	–	–	49.8
Holosteum umbellatum	–	–	–	–	–	–	–	–	–	45.2
Crepis foetida s. rhoeadifolia	–	–	–	–	–	–	–	24.5	–	43.7
Hieracium echioides	–	–	–	–	–	–	–	–	19.0	42.8
Astrodaucus littoralis	–	–	–	–	–	–	–	–	–	30.1
Coronilla varia	–	–	–	–	–	–	–	18.3	–	26.3
Artemisia santonicum	57.2	–	–	–	–	25.6	–	–	–	–
Silene exaltata	53.3	–	–	54.0	–	–	–	–	–	–
Medicago sativa s. falcata	33.5	–	–	–	–	–	–	23.9	–	26.0
Gypsophila perfoliata	30.8	25.8	–	–	–	–	–	–	–	–
Potentilla argentea	30.8	25.8	–	–	–	–	–	–	–	–
Linaria genistifolia	29.5	–	–	43.2	–	–	–	–	–	–
Leymus racemosus s. sabulosus	–	47.0	–	–	32.9	–	–	–	–	–
Eryngium maritimum	–	32.6	–	–	–	–	–	–	–	48.2
Melilotus alba	–	28.7	–	–	–	–	–	–	–	56.0
Syrenia cana	–	–	50.6	–	–	27.3	–	–	–	–
Anthemis ruthenica	–	–	41.8	–	–	–	38.3	–	–	–
Festuca valesiaca	–	–	39.7	–	–	–	–	33.0	–	–
Alyssum borzaeanum	–	–	–	64.4	–	58.6	–	–	–	–
Ephedra distachya	–	–	–	–	34.3	34.3	–	–	–	–
Centaurea apiculata s. adpressa	–	–	–	24.8	–	30.8	–	30.8	–	–
Ajuga chamaepitys s. chia	–	–	–	–	–	–	71.8	46.9	–	–
Marrubium peregrinum	–	–	–	–	–	–	53.9	32.6	–	–
Cynodon dactylon	–	–	–	–	–	–	47.1	47.1	–	–
Linum austriacum s. euxinum	–	–	–	–	–	–	42.3	50.0	–	–
Rumex tuberosus	–	–	–	–	–	–	39.5	–	33.7	–
Echinops ritro	–	–	–	–	–	–	37.3	–	46.6	23.6
Eryngium campestre	–	–	–	–	–	–	36.9	41.1	–	–
Carduus uncinatus	–	–	–	–	–	–	35.5	58.8	–	24.3
Potentilla taurica	–	–	–	–	–	–	27.8	66.8	–	–
Silene densiflora	–	–	–	–	–	–	26.2	50.4	–	–
Sideritis montana s. montana	–	–	–	–	–	–	–	60.8	–	57.5
Thymus dimorphus	–	–	–	–	–	–	–	53.4	–	59.0
Teucrium polium	–	–	–	–	–	–	–	52.8	–	28.2
Silene syreistschikowii	–	–	–	–	–	–	–	47.5	–	39.2
Elymus uralensis s. viridiglumis	–	–	–	–	–	–	–	45.3	20.0	26.9
Stipa borysthenica	–	–	–	21.9	–	–	–	37.6	34.4	–
Allium guttatum	–	–	–	–	–	–	–	33.0	–	27.8
Alyssum tortuosum	–	–	–	–	–	–	–	29.5	–	44.4
Plantago arenaria	–	–	–	–	–	–	–	26.9	–	43.2
Verbascum pinnatifidum	–	–	–	–	–	–	–	23.3	46.8	55.7
Jurinea albicaulis s. laxa	–	–	–	–	–	–	–	–	39.9	57.3
Leymus racemosus	–	–	–	–	–	–	–	–	33.3	65.8
Astragalus onobrychis	26.1	–	–	–	–	–	–	–	33.8	41.9
Alyssum turkestanicum	–	–	–	–	–	–	–	54.9	41.7	29.9
Alyssum hirsutum	–	–	–	–	–	–	–	44.8	37.3	25.9
Chondrilla juncea	–	–	–	–	–	–	–	33.6	40.5	33.1
Astragalus varius	–	–	–	–	–	–	23.7	26.8	31.5	36.8
Secale sylvestre	–	–	–	–	–	–	–	–	24.4	20.9
Euphorbia seguierana	–	–	–	19.6	–	–	–	23.4	–	–
Astragalus cicer	–	–	–	–	23.0	–	–	–	–	–
Melica ciliata	–	–	–	–	–	–	–	–	23.8	–
Xanthium strumarium s. italicum	–	–	–	–	–	–	–	–	21.9	–
Poa bulbosa	–	–	–	–	–	–	–	15.7	13.5	–

Notes: numbers mark syntaxa: 1 – *Anisantho tectorum-Medicaginetum kotovii*; 2 – *Anisantho tectorum-Helichrysetum arenariae*; 3 – *Scabioso ucranicae-Caricetum ligericae*; 4 – *Secali sylvestri-Alyssetum borzaeani*; 5 – *Ephedro-Caricetum colchicae*; 6 – *Medicagini tenderiensis-Seselietum tenderiensi*; 7 – *Cynodonto-Ajugetum chiae*; 8 – *Carici liparicarpo-Centaureetum adpressae*; 9 – *Astragalo borysthenici-Ephedretum distachyae*; 10 – *Leymo-Verbascetum pinnatifidi*.

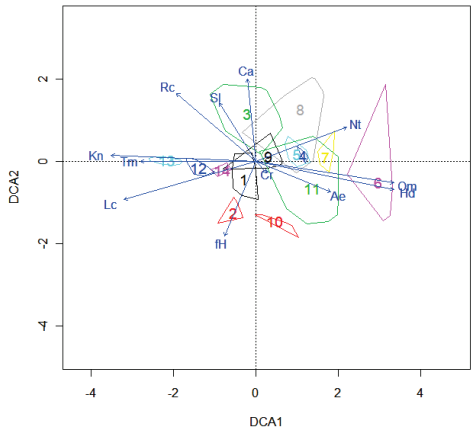

Fig. 4. Results of ordination analysis of syntaxa of the class *Koelerio-Corynephoretea canescentis*; numbers mark syntaxa: 1 – *Veronico dillenii-Secaletum sylvestris*; 2 – *Chamaecytiso ruthenicae-Festucetum beckeri*; 3 – *Diantho deltoidis-Armerietum elongatae*; 4 – *Jasiono montanae-Thymetum serpylli*; 5 – *Jasiono montanae-Festucetum ovinae*; 6 – *Corynephoro-Silenetum tataricae*; 7 – *Artemisio campestris-Dianthetum borbasii*; 8 – *Artemisio dniproicae-Sedetum sexangularis*; 9 – *Veronico dillenii-Secaletum sylvestris* (sensu Kovalenko); 10 – *Diantho borbasii-Agrostietum syreistschikovii*; 11 – *Thymo angustifolii-Festucetum beckeri*; 12 – *Centaureo borysthenicae-Festucetum beckeri*; 13 – *Veronico dillenii-Corynephoretum*; 14 – *Cornicularo aculeatae-Corynephoretum canescentis*; here and further the scale of ecological factors developed by Didukh (2011) was used: Hd – soil moisture; Nt – content of available nitrogen forms in the soil; Ca – content of carbonates; Rc – soil acidity; Sl – salt regime; fH – soil moisture variability; Ae – soil aeration; Lc – light intensity; Kn – climate continentality; Om – ombroregime; Tm – temperature regime; Cr – cryoregime; DCA1, DCA2 – ordination axes

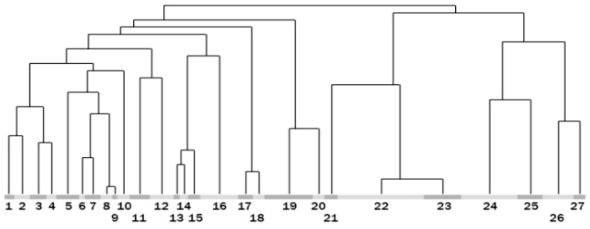

Fig. 5. Cluster analysis of phytosociological data of the *Festucetea vaginatae* class; clusters: 1 – *Aperetum maritimae*; 2 – *Dauco guttati-Chrysopogonetum grylli*; 3 – *Carici colchicae-Holoschoenetum vulgaris*; 4 – *Salici rosmarinifoliae-Holoschoenetum vulgaris*; 5 – *Secali-Stipetum borysthenicae*; 6 – *Cynodonto-Medicaginetum minimae*; 7 – *Secali-Cynodontetum dactyli*; 8 – *Secaletum sylvestris*; 9 – *Secali sylvestri-Brometum tectorum*; 10 – *Allio guttati-Festucetum rupicolae*; 11 – *Heliotropio dolosi-Brometum japonici*; 12 – *Trago-Anthemietum ruthenicae*; 13 – *Linario odorae-Agropyretum dasyanthi*; 14 – *Linario odorae-Agropyretum dasyanthi* (sensu Kovalenko); 15 – *Plantaginetum arenariae*; 16 – *Poo bulbosae-Caricetum colchicae*; 17 – *Achilleo setacei-Festucetum beckeri*;18 – *Centaureo gerberii-Chamaecytisetum borysthenici*; 19 – *Centaureo odessanae-Caricetum colchicae*; 20 – *Centaureo odessanae-Stipetum capillatae*; 21 – *Centaureo brevicipiti-Festucetum beckeri* var. *typica*; 22 – *Centaureo odessanae-Festucetum beckeri* (sensu Kolomiychuk); 23 – *Centaureo odessanae-Festucetum beckeri* (Vicherek relevés); 24 – *Centaureo brevicipiti-Festucetum beckeri salicetosum rosmarinifoliae*; 25 – *Centaureo brevicipiti-Festucetum beckeri inuletosum sabuletorum*; 26 – *Festucetum beckeri* var. *typica*; 27 – *Festucetum beckeri* var. *Koeleria glauca*

The *Ephedro distachyae-Medicaginion romanicae* alliance includes plant communities of stabilized coastal dunes and uprush berm crest areas covered with dense sand-shell soils in the Black Sea and Azov Sea. The *Medicagini tenderiensis-Seselion tenderiensi* alliance is presented by coenoses of mesophytic sand steppes on accumulative sand-shell macroforms in the northwest coast of the Black Sea. The *Scabiosion ucranicae* alliance is presented by coenoses of stabilized coastal dunes in the Western Black Sea Region. The *Cynodonto-Teucrion polii* alliance includes plant communities on young dunes, as well as on uprush limit parts of berm crest areas growing on washed sandy and shelly soils, enriched with detritus, on the Azov-Black Sea coast of Crimea.

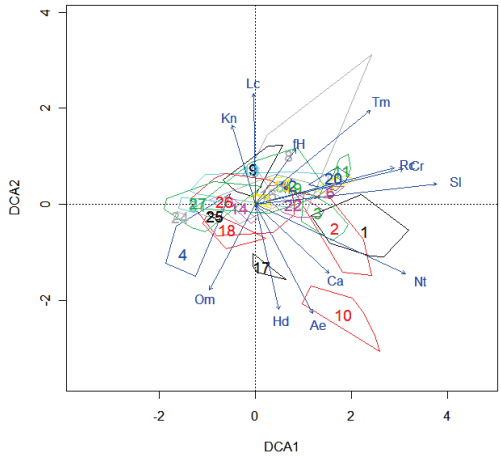

Fig. 6. Results of ordination analysis obtained for syntaxa of *Festucetea vaginatae* class; numbers mark syntaxa: 1 – *Aperetum maritimae*; 2 – *Dauco guttati-Chrysopogonetum grylli*; 3 – *Carici colchicae-Holoschoenetum vulgaris*; 4 – *Salici rosmarinifoliae-Holoschoenetum vulgaris*; 5 – *Secali-Stipetum borysthenicae*; 6 – *Cynodonto-Medicaginetum minimae*; 7 – *Secali-Cynodontetum dactyli*; 8 – *Secaletum sylvestris*; 9 – *Secali sylvestri-Brometum tectorum*; 10 – *Allio guttati-Festucetum rupicolae*; 11 – *Heliotropio dolosi-Brometum japonici*; 12 – *Trago-Anthemietum ruthenicae*; 13 – *Linario odorae-Agropyretum dasyanthi* (Vicherek relevés); 14 – *Linario odorae-Agropyretum dasyanthi* (sensu Kovalenko); 15 – *Plantaginetum arenariae*; 16 – *Poo bulbosae-Caricetum colchicae*; 17 – *Achilleo setacei-Festucetum beckeri*; 18 – *Centaureo gerberii-Chamaecytisetum borysthenici*; 19 – *Centaureo odessanae-Caricetum colchicae*; 20 – *Centaureo odessanae-Stipetum capillatae*; 21 – *Centaureo brevicipiti-Festucetum beckeri* var. *typica*; 22 – *Centaureo odessanae-Festucetum beckeri* (sensu Kolomiychuk et al.); 23 – *Centaureo odessanae-Festucetum beckeri* (Vicherek relevés); 24 – *Centaureo brevicipiti-Festucetum beckeri salicetosum rosmarinifoliae*; 25 – *Centaureo brevicipiti-Festucetum beckeri inuletosum sabuletorum*; 26 – *Festucetum beckeri* var. *typica*; 27 – *Festucetum beckeri* var. *Koeleria glauca*

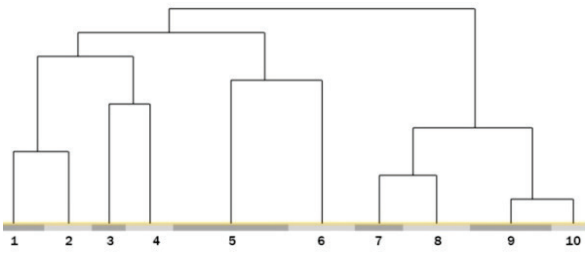

Fig. 7. Cluster analysis of phytosociological data of *Helichryso-Crucianelletea maritimae* class: 1 – *Anisantho tectorum-Medicaginetum kotovii*; 2 – *Anisantho tectorum-Helichrysetum arenariae*; 3 – *Scabioso ucranicae-Caricetum ligericae*; 4 – *Secali sylvestri-Alyssetum borzaeani*; 5 – *Ephedro-Caricetum colchicae*; 6 – *Medicagini tenderiensis-Seselietum tenderiensi*; 7 – *Cynodonto-Ajugetum chiae*; 8 – *Carici liparicarpo-Centaureetum adpressae*; 9 – *Astragalo borysthenici-Ephedretum distachyae*; 10 – *Leymo-Verbascetum pinnatifidi*

The leading factors of territorial differentiation of these communities are the landforms and their relative age, groundwater level, substrate density and type (sandy, shelly), as well as the degree of dune geomorphostructures stabilization depending on the activity of the sea and aeolian processes.

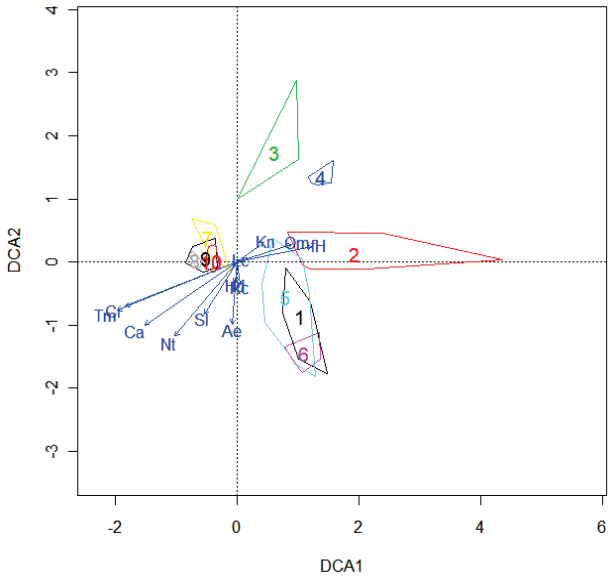

Fig. 8. Results obtained from ordination analysis of associations in the class *Helichryso-Crucianelletea maritimae*: 1 – *Anisantho tectorum-Medicaginetum kotovii*; 2 – *Anisantho tectorum-Helichrysetum arenariae*; 3 – *Scabioso ucranicae-Caricetum ligericae*; 4 – *Secali sylvestri-Alyssetum borzaeani*; 5 – *Ephedro-Caricetum colchicae*; 6 – *Medicagini tenderiensis-Seselietum tenderiensi*; 7 – *Cynodonto-Ajugetum chiae*; 8 – *Carici liparicarpo-Centaureetum adpressae*; 9 – *Astragalo borysthenici-Ephedretum distachyae*; 10 – *Leymo-Verbascetum pinnatifidi*

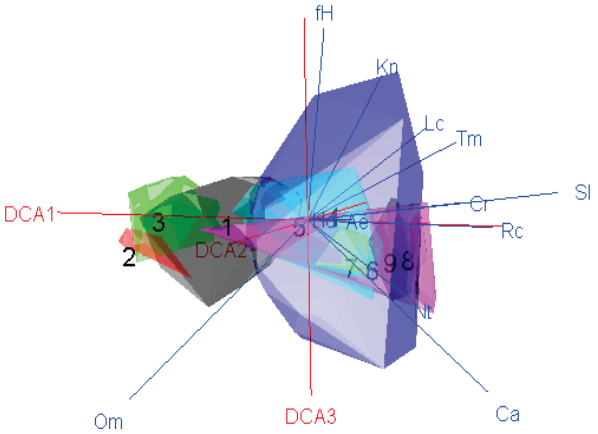

Fig. 9. Results of ordination analysis obtained for the classes *Festucetea vaginatae*, *Koelerio-Corynephoretea canescentis* and *Helichryso-Crucianelletea maritimae* by alliances: numbers mark alliances: 1 – *Koelerion glaucae*; 2 – *Armerion elongatae*; 3 – *Corynephorion canescentis*; 4 – *Artemisio arenariae-Festucion beckeri*; 5 – *Festucion beckeri*; 6 – *Ephedro distachyae-Medicaginion romanicae*; 7 – *Scabiosion ucranicae*; 8 – *Medicagini tenderiensis-Seselion tenderiensi*; 9 – *Cynodonto-Teucrion polii*

Within the ecological space, distribution of communities is mainly determined by the variability of damping, ombroregime and climate continentality factors (Fig. 8). They have a greater influence on the coenoses in *Anisantho tectorum-Helichrysetum arenariae*, *Scabioso ucranicae-Caricetum ligericae* and *Secali sylvestri-Alyssetum borzaeani* associations. In addition to these factors, *Anisantho tectorum-Medicaginetum kotovii*, *Ephedro-Caricetum colchicae* and *Medicagini tenderiensis-Seselietum tenderiensi* communities also depend on the degree of soil aeration, soil humidity and the content of various salts. *Anisantho tectorum-Helichrysetum arenariae*, *Scabioso ucranicae-Caricetum ligericae* and *Ephedro-Caricetum colchicae* syntaxa have greater stenotopy, while coenoses of *Cynodonto-Teucrion polii* alliance developing in the Crimea demonstrate stenotopy by most ecological parameters.

Discussion

Studies on the vegetation cover of natural zones in Eurasia are important for understanding the processes of their development and functioning at the continental scale (Erdős et al., 2018). Therefore, a critical analysis of the accumulated phytocoenological materials against the background of modern knowledge is important. At the present time, the syntaxonomic content of the classes *Festucetea vaginatae* and *Koelerio-Corynephoretea canescentis* is still a debatable issue, which is facilitated by the transitional position of their syntaxa and the belonging of certain diagnostic species of the highest classification ranks to the same genus, in particular, coenose-forming species *Festuca psammophila*, *F. polesica*, *F. vaginata*, and *F. beckeri*. As already noted, a number of European authors classified phytocoenoses of overgrown sands as belonging to the order *Festucetalia vaginatae* Soó 1957 in the class *Koelerio-Corynephoretea canescentis* (Dring et al., 2002; Borhidi, 2003; Biondi et al., 2014), when others classified them as entering into the class *Festuco-Brometea* (Rodwell et al., 2002; Tzonev et al., 2009). Complementary to Ukraine, scientists from the Czech Republic (Chytrý, 2007), Romania (Sanda et al., 2008) and Russia (Demina, 2009, 2011; Ermakov, 2012) recognized the class independence, where syntaxonomic diversity of sandy steppes is higher than that of Central Europe. According to the authors, the leading factors of differentiation of communities in *Festucetea vaginatae* and *Koelerio-Corynephoretea canescentis* classes are the origin (genesis) of sandy substrates, as well as a reaction of soil solution. In the habitats of coenoses of the class *Festucetea vaginatae*, sandy soils were developed by marine and river sediments and have an alkaline reaction. Communities of *Koelerio-Corynephoretea canescentis* class were developed mainly on fluvioglacial sands having acidic reaction. This was confirmed by the ordination analysis results of alliances in these classes (Fig. 9). Climatic conditions of their distribution are also important in the steppe (*Festucetea vaginatae*) and forest and forest-steppe zones (*Koelerio-Corynephoretea canescentis*), respectively.

Ordination analysis of psammophytic vegetation alliances allowed us to determine the main factors of ecological differentiation of the communities (Fig. 9). They are primarily soil acidity (Rc) and salt regime (Sl). Most of the alliances are located along the DCA1 axis, i.e. along these vectors. According to soil pH gradient, coenoses of the classes *Koelerio-Corynephoretea canescentis* and *Helichryso-Crucianelletea maritimae* occupy the opposite positions. Communities of *Festucetea vaginatae* are located in the center, occupying an intermediate position and overlapping most of the *Helichryso-Crucianelletea maritimae* syntaxa, which indicates that they occur under similar environmental conditions. However, as the graph shows, one of the main parameters for the latter class is the content of carbonates (Ca) and nitrogen (Nt) in the soil. It is reasonable to assume an influence of ombroregime (Om) on distribution of *Koelerio-Corynephoretea canescentis* communities associated with forest and forest-steppe zones.

Syntaxa ratio in the classes *Koelerio-Corynephoretea canescentis*, *Sedo-Scleranthetea* (vegetation of rock outcrops) and *Festucetea vaginatae* also remains debatable. Individual European authors recognize the class *Koelerio-Corynephoretea canescentis* in a broad sense, combining all orders into a single class (Borhidi, 2003). Most researchers combine *Koelerio-Corynephoretea canescentis* and *Sedo-Scleranthetea* into one (Rodwell et al., 2002; Dengler, 2004; Chytrý, 2007; Sanda et al., 2008; Tzonev et al., 2009). In the latest review of European vegetation, *Sedo-Scleranthetea* was assigned to a separate class, and *Festucetea vaginatae* was included in *Koelerio-Corynephoretea canescentis* as an order (Mucina et al., 2016). Slovak (Valachovič et al., 1995; Jarolímek & Šibík, 2008), Italian (Biondi et al., 2014), Spanish and Portuguese (Rivas-Martínez et al., 2001), Russian (Ermakov, 2012; Dulepova et al., 2018), as well as the majority of Ukrainian phytocoenologists maintain the position of the three classes being independent.

The syntaxonomic position of psammophytic communities with the participation of the shrub *Salix rosmarinifolia* (association *Salici rosmarinifoliae-Holoschoenetum vulgaris* Mititelu et al. 1973 and subassociation *Centaureo brevicepsis-Festucetum beckeri salicetosum rosmarinifoliae* Vicherek 1972) has to be clarified in the future. This is due to the fact that such coenoses were classified as *Salicetea arenariae*

Weber 1999 on the Atlantic coast area of Western Europe (Mucina et al., 2016), but in Ukraine some authors classified it to the class *Nerio-Tamaricetea* Br.-Bl. et O. de Bolòs 1958, the order *Salicetalia arenariae* Preising et Weber 1997, and to the provisionally allocated alliance *Scirpoido holoschoeni-Salicion rosmarinifoliae* I. Solomakha, Vorobyov et Moysienko 2015 prov. (Solomakha et al., 2015), and others classified it to the class *Festucetea vaginatae* (Dubyna et al., 2003, 2019a).

It should be noted that the position of *Jasiono montanae-Festucetum ovinae* Klika 1941 within *Koelerion glaucae* is obviously somewhat ambiguous; since there is clearly a transitional position of its communities to meso-xerophytic vegetation on shell skeletal silicate soils of the *Sedo-Scleranthetea* class. Czech scientists attributed this association to the alliance *Hyperico perforati-Scleranthion perennis* Moravec 1967 within the *Sedo-Scleranthetea* class (Sádlo & Chytrý, 2007), but in Ukraine they are described on sandy habitats having a weak acidic reaction of soil solution; so, the authors previously assigned these communities to the *Koelerio-Corynephoretea canescentis* class. Coenoflora composition and syntaxonomic position of the association *Festuco psammophilae-Koelerietum glaucae* sensu Gal'chenko 2006, non Klika 1931 remain unclear, since the diagnostic species given by the author was *Festuca valesiaca* (Galchenko, 2006), and the floristic composition differs significantly from the protolog. Further conducting of phytosociological studies of communities with the participation of such psammophytic coenose-forming species as *Festuca psammophila* and *F. polesica* are required, in particular, on the territory of the Ukrainian Polesie, which in this regard has not been sufficiently studied. Presumably, phytocoenoses of *Festuco psammophilae-Koelerietum glaucae* Klika 1931, *Spergulo-Festucetum psammophilae* Passarge 1960, *Diantho arenarii-Festucetum polesicae* R. Tx. 1937 and other associations should be distributed on the territory of Ukraine.

Probably, further research on communities in the little-known class *Pyrolo-Pinetea sylvestris* in Ukraine will allow us to determine the syntaxonomic position of associations *Thymo pallasiani-Centauretum sumensis* Shevchyk et Solomakha in Shevchyk, Solomakha et Voytuk 1996 and *Cladonietum* Shevchyk et Polishko 2000 nom. inval. (art. 3b) originally identified by the authors as part of *Koelerion glaucae* alliance (Shevchyk et al., 1996; Shevchyk & Polishko, 2000). Previously, according to results obtained from the analysis of psammophytic vegetation, the associations in their floral composition were closer to native dry pine forests on sandy soils developed on the sandy terraces of large rivers (*Koelerio glaucae-Pinion sylvestris* alliance Ermakov 1999, *Pyrolo-Pinetea sylvestris* class).

Class *Helichryso-Crucianelletea maritimae* has been allocated recently on the territory of Ukraine (Dubyna et al., 2019a). Previously, its communities were considered within the class *Festucetea vaginatae*. There are currently two orders were allocated in Western Europe: *Artemisio-Koelerietalia* Sissingh 1974 (sandy meadows and shrubs on the rich stabilized grey dunes on the coasts of the Atlantic Ocean and of the Northern, the Ligurian and the Adriatic seas) and *Crucianelletalia maritimae* Sissingh 1974 (Mediterranean, Cantabro-Francoatlantic dwarf shrubs and Xerothermic meadows on stabilized coastal grey dunes). Their plant communities differ significantly from those of the Black Sea region; because of this a separate order was proposed in the class for the territory of Ukraine: *Ephedro distachyae-Medicaginetalia romanicae* (Dubyna et al., 2019a). Although some researchers see no rationale for separation of this class and consider it as a synonym of *Ammophiletea* (Marcenò et al., 2018), the results obtained allow us to maintain the position of its ecological and floral isolation. Despite the fact that both of these high-rank syntaxa include several common species (*Eryngium maritimum*, *Leymus racemosus* ssp. *sabulosus*, *Ephedra distachya*), the class *Helichryso-Crucianelletea maritimae* is characterized by the presence of a block of diagnostic species that distinguish it from the complex of diagnostic species *Ammophiletea* and *Festucetea vaginatae*, at least on the territory of Ukraine. These species are the following: *Artemisia tschernieviana*, *Asparagus maritimus*, *Astragalus onobrychis*, *Centaurea apiculata* ssp. *adpressa*, *Erodium cicutarium*, *Medicago romanica* (~ *M. sativa* ssp. *falcata*), *Melica transsilvanica* ssp. *klokovii*, *Scabiosa argentea*, *Tamarix gracilis*, *Teucrium polium*, *Trachomitum sarmatiense*, *Verbascum pinnatifidum*. Ecologically stable dune communities also are distinct in that they do not experience periodic effects of sea waves, since they are protected by the berm crest, and their habitats have morphological differences. Most often, these are gently sloping uprush parts of berm crest and, to some extent, elevated sand deposits (dunes) anchored mostly by perennial vegetation. According to our data, communities of *Helichryso-Crucianelletea maritimae* class were even closer to *Festucetea vaginatae* than to *Ammophiletea*.

Worldwide, coastal dunes and other psammophytic habitats are recognized as highly vulnerable and dynamic ecosystems (Rannow & Neubert, 2014; Acosta & Ercole, 2015; Sarmati et al., 2019); in Ukraine and other countries they are systematically over-used. Inadequate land management contributes to the fact that these habitats are threatened with extinction, especially in the Mediterranean region (Sabatini et al., 2018). Frequent invasions of alien and atypical species into the structure of communities have been recorded; it resulted in their transformation and degradation (Dubyna et al., 2019b). All of this indicates the need for urgent actions to protect and preserve them.

Conclusion

Pioneer psammophytic vegetation of Ukraine is represented by 45 associations, 9 alliances and 3 orders belonging to 3 classes (*Koelerio-Corynephoretea canescentis*, *Helichryso-Crucianelletea maritimae* and *Festucetea vaginatae*). The main factors of territorial and ecological differentiation of pioneer psammophytic vegetation in Ukraine were identified. It was found that the territorial distribution of communities of *Koelerio-Corynephoretea canescentis*, *Festucetea vaginatae* and *Helichryso-Crucianelletea maritimae* were mainly influenced by ecotope mesorelief pattern, soil composition and the thickness of humic horizon, as well as the degree of aeolian processes development. The main factors of their ecological differentiation are soil acidity, salt content and ombroregime. Based on the results of DCA-ordination of syntaxa within certain vegetation classes, it was found that their distribution is influenced by factors that correlate with the environment-specific conditions. It was found that an ecological differentiation of syntaxa within *Festucetea vaginatae* is determined by the integrated effect of gradients, and soil salinity can be distinguished among these. The main factors in syntaxa distribution within the *Koelerio-Corynephoretea canescentis* class were temperature regime and climate continentality, as well as the gradients of ombroregime and soil humidity. The distribution of communities of *Helichryso-Crucianelletea maritimae* class in the ecological space is determined mainly by factors of variability of damping, ombroregime and climate continentality. Coenoses of *Secaletum sylvestris*, *Diantho deltoidis-Armerietum elongatae*, *Corynephoro-Silenetum tataricae*, *Artemisio dniproicae-Sedetum sexangularis*, *Thymo angustifolii-Festucetum beckeri*, *Anisantho tectorum-Helichrysetum arenariae*, *Scabioso ucranicae-Caricetum ligericae* and *Ephedro-Caricetum colchicae* associations were characterized by the widest ecological amplitude.

The authors adhere to the position of independence of the studied classes: *Koelerio-Corynephoretea canescentis*, *Helichryso-Crucianelletea maritimae* and *Festucetea vaginatae*, considering that the main factors of differentiation of communities in the classes *Festucetea vaginatae* and *Koelerio-Corynephoretea canescentis* were the origin (genesis) of sandy substrates, as well as the reaction of soil solution. Phytosociological analysis of a large number of coastal littoral vegetation relevés also provide support for independence of *Helichryso-Crucianelletea maritimae* and *Ammophiletea* classes based on their floristic and ecological differences.

The conducted research will allow the place of selected syntaxonomic units of the pioneer psammophytic vegetation of Ukraine to be determined in the pan-European system. The results of the work will be suitable for development of the Nature Reserve network and Eco-network of Ukraine, maintaining Prodrome of the vegetation of Ukraine, Prodrome of the vegetation of Europe, preparing the next volume of the publication "Vegetation of Ukraine" and "Green Data Book of Ukraine", for further study of successional and adaptation processes in extreme environmental conditions of pioneer habitats, establishing patterns of regenerative geosystems' development and finding out the ways to manage them. The ability of plant communities to indicate the environment state (phytoindication of environmental conditions), which in recent years has become an urgent sociological necessity, will allow the environmental situation in the regions to be monitored, as well help in as determining trends in their further changes.

The authors gratefully acknowledge A. Kuzemko, O. Kovalenko, O. Chusova, O. Senchylo, V. Kolomiychuk, T. Fitsailo, I. Goncharenko, V. Konischuk, G.

Tsukanova, Y. Gaiova, D. Iakushenko, V. Konogray, for the kindly provided relevés of psammophyte vegetation from their dissertation manuscripts.

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