Numeric syntaxonomical analysis of communities of the *Molinia caerulea* complex in Southwestern of Ukraine

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Abstract

The aims of the paper are: i) to establish the coenotic affinity of each species of the *Molinia caerulea* complex in the southwest of Ukraine, ii) to present the results of a comparative analysis of the syntaxa in which include *Molinia*, iii) to explain possible reasons for the expansion of *Molinia caerulea* in the studied area. The study area ranges from the basins of the Upper Prut River to the Upper Siret River in Ukraine. To determine the coenotical affinity of the studied species, 134 relevés were analysed. The data analysis was carried out using the Modified TWINSPAN algorithm provided by the JUICE software. Ecological features of the communities were analyzed by means of a DCA-ordination and phytoindication assessment. It was revealed that in the studied region the species of the *Molinia caerulea* complex are characterized by a relatively wide coenotic and ecological range and that they can be attributed to different communities of 4 vegetation classes: *Molinio-Arrhenatheretea* (*Polygono bistortae-Trisetion flavescentis, Molinion cearuleae, Arrhenatherion elatioris* alliances), *Festuco-Brometea* (*Bromion erecti* alliance), *Mulgedio-Aconitetea* (*Calamagrostion villosae* alliance), *Oxycocco-Sphagnetea* (*Sphagnion magellanici* alliance). This paper presents the results of the floristic composition analyses outlines some ecological peculiarities and discusses the conservational values of the identified syntaxa.

Izvleček

Namen članka je: i) ugotoviti cenološko pripadnost vseh vrst kompleksa *Molinia caerulea* v jugozahodni Ukrajini, ii) predstaviti rezultate primerjalne analize sintaksonov z vrstami rodu *Molinia*, iii) razložiti možne vzroke za razširjanje vrste *Molinia caerulea* v preučevanem območju. Raziskovano območje se razteza med porečjema zgornjega dela rek Prut in Siret v Ukrajini. Za določitev cenološke pripadnosti preučevanih vrst smo analizirali 134 popisov. Podatke smo analizirali z modificiranim TWINSPAN algoritmom v programu JUICE. Ekološke značilnosti smo analizirali z DCA ordinacijo in fitoindikatorji. Ugotovili smo, da imajo vrste kompleksa *Molinia caerulea* v preučevanem območju relativno širok cenotski in ekološki razpon in njihove združbe lahko uvrščamo v štiri razrede: *Molinio-Arrhenatheretea* (zveze *Polygono bistortae-Trisetion flavescentis, Molinion cearuleae, Arrhenatherion elatioris*), *Festuco-Brometea* (zveza *Bromion erecti*), *Mulgedio-Aconitetea* (zveza *Calamagrostion villosae*), *Oxycocco-Sphagnetea* (zveza *Sphagnion magellanici*). V članku predstavljamo rezultate vrstne sestave, izpostavljamo ekološke posebnosti in razpravljamo o naravovarstvenih vrednostih obravnavanih sintaksonov.

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Introduction

A decrease in human activity on meadows and pastures in southwestern Ukraine, during the last 20 years, has led to successional changes in grassland communities: Large areas of grasslands have become overgrown with shrub and woody vegetation. This trend has negative consequences for conservation and restoration concerns of meadow communities, like wet and semi-dry *Molinia* (purple moor-grass) meadows (Prots & Kagalo 2012) in this region. These meadows form tall, herb- and species-rich communities dominated by *Molinia caerulea* s.l. and develop under the influence of mowing. Such communities are common in the mountain forest belt and in the foothills ranging from altitudes of 200–1350 m a.s.l. They can develop under dry and wet soil conditions. In recent years, *Molinia* meadows have been expanding in the study area. In many cases, the grass species has been observed to change its life strategy and starts to spread rather aggressively to adjacent habitats (Dančak et al. 2012). This trend requires more detailed study.

Molinia is known to expand into neighboring habitats in Western and Central Europe. Particularly, it spreads to ombrotrophic bogs in the Netherlands, which is caused by excessive nitrification (Tomassen et al. 2003). Furthermore, its spread onto heathlands (Friedrich et al. 2011), moorland and subalpine grasslands of Western and Central Europe was observed in connection with changes of habitat management regimes (Chambers et al. 1999, Marrs et al. 2004, Jacquemyn et al. 2005, Hejcman et al. 2010). *Molinia caerulea* exhibits a high ecological plasticity which allows it to survive in various habitats (Abu Salim et al. 1995, Taylor et al. 2001).

Most of the syntaxonomical reviews declare *Molinia caerulea* as a diagnostic species of the *Molinion* alliance, *Molinietalia* order, *Molinio-Arrhenatheretea* class (Oberdorfer 1957, Horvat et al. 1974, Mucina et al. 1993, Coldea et al. 1997, Borhidi et al. 2012, Päzolt & Jansen 2004, Řezníčková 2007, 2014). However, this species shows also relatively high constancies in the syntaxa of other classes, primarily the *Scheuchzerio-Caricetea nigrae* Tüxen 1937 (syn. *Parvo-Caricetea* Westhoff in Westhoff et Den Held 1969), *Oxycocco-Sphagnetea* Br.-Bl. et Tx. ex Westhoff et al. 1946 and *Calluno-Ulicetea* Br.-Bl. et Tx. ex Klika et Hadač 1944 (incl. *Nardetea strictae* Oberd. 1949) (Hájek & Háberová 2001, Šoltés et al. 2001, Berg 2004, Koska & Timmermann 2004, Krahulec et al. 2007, Hájek & Hájková 2011, Hájková et al. 2011, Kliment & Ujházy 2014, Valachovič & Hegedüšová Vantarová 2014). These communities are characterized by moderately to very wet habitat conditions. However, some authors noted a participation of the *Molinia caeru*-

lea agg. in communities in much drier habitats. They can be assigned to the *Molinion alliance* as a *Molinietum caerulae* variant *Bromus erectus* (Havlova 2006) or *Galio veri-Molinietum* Kącki 2007 (Kącki 2007, 2012). Or, alternatively, to the *Bromion erecti* alliance of the *Brometalia erecti* order, in the *Festuco-Brometea* class as the *Brachypodio pinnati-Molinietum arundinaceae* association Klika 1939 (Chytrý et al. 2007b, Škodová & Ujházy 2014). In the latter case, as the name suggests, *Molinia caerulea* agg. refers to *M. arundinacea*. Thus, it is important to consider the structure of the *Molinia caerulea* taxonomic complex.

In Central Europe, this complex includes three species that differ in morphology and in the number of chromosomes they carry: *Molinia caerulea* (L.) Moench, *M. arundinacea* Schrank subsp. *arundinacea* and *M. arundinacea* subsp. *freyi* (Dančak et al. 2012). They are perennial grasses that form large dense tufts. In Ukraine they are characterized by a broad ecological amplitude ranging from wetlands, wet meadows to forests (Prokudin 1977). The European variant of the *Molinia* genus is represented by *M. caerulea*, in Ukraine, which is a strong competitor in wet nutrient-poor meadows (Landolt 1977, Taylor et al. 2001, Marrs et al. 2004, Havlova 2006). This competitiveness of the *M. caerulea* can also be explained by the presence of hydrocyanic acid stored in its stems and inflorescences (Tsvelev 1976). Hence, the species is inedible for animals. However, Dančak et al. (2012) suggest a high probability of *M. arundinacea* Schrank subsp. *arundinacea* Schrank occurring in the Ukraine, as well. According to Tsvelev (1976), the subspecies *Molinia caerulea* subsp. *litoralis* (Host) Paul is present in the Carpathians. In contrast to *M. caerulea;* this subspecies grows in open forests, forest clearings, and placers in the lower and middle mountain belts. The author suggests that the priority name of the species is *M. arundinacea* Schrank, although, this is more likely to be *M. arundinacea* Schrank subsp. *arundinacea* (Schrank) K. Richt.

There are no detailed studies on *M. caerulea* for the study area, yet. But, there is some fragmentary information on the chorology and coenotic affinity of *M. caerulea* in Bukovina and surrounding areas by some researchers (Herbich 1859, Knapp 1872, Berezovskaya 1952, Artemchuk 1954, Shelyag-Sosonko 1960, Horokhova et al. 1974, Yakymchuk 1974, Termena et al. 1992, Tokaryuk et al. 2009).

In particular, Berezovskaya (1952) provides a detailed description of communities with *M. caerulea,* in both low and high or dominant densities in the Mihidra River valley at the area of Vyzhnytsya district of Chernivtsi region. Also, Artemchuk (1954) notes "a significant participation of the *M. caerulea*" in vegetation cover of the Mihidra

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River valley, an "insignificant participation in the herbage of *M. caerulea*" in the valley of the Siret River and its occurrence in the communities of mountain meadows in vicinity of the Ploska village, Putyla district, Chernivtsi region. Yakymchuk (1974) notes *M. caerulea* in meadow communities of the Prut River valley within Kosiv and Nadvirna districts of the Ivano-Frankivsk region. Horokhova et al. (1974) indicate that *Molinia* meadows are distributed in the Valley of Small Siret River (Chernivtsi region). Tokaryuk et al. (2009) made the first attempt to apply the Braun-Blanquet classification of the *Molinio-Arrhenatheretea* class communities to coenoses with *M. caerulea* in the Prut-Siret interfluve (Bukovina Pre-Carpathians). In the same area Roleček et al. (2014) characterized the most species-rich communities with *M. caerulea* aggr. and, preliminarily, assigned them to the *Brachypodio-Molinietum* association. Their similarity to the communities of this association in the White Carpathians is also noted.

A review of the literature reveals that *Molinia caerulea* complexes in south-western Ukraine include one of the two species – *M. arundinacea* and *M. caerulea* – which differ significantly in their coenotic affinity and their preferred environmental conditions as well as in their distribution patterns and population strategy. Of particular interest is. With special regard to the expansion of *Molina caerulea* complex types to atypical habitats caused by climate change or anthropogenic influences, the aims of the paper are: i) establishing the coenotic affinity of the species of the *Molinia caerulea* complexes in the southwest of Ukraine, ii) comparing of syntaxa and their participation and iii) explaining possible reasons for the expansion of the *Molinia caerulea* s.l. in the study area.

Study area

The studied area was set in the basins of the Upper Prut River and Upper Siret River within Ukraine (Figure 1).

The Prut River basin covers an area of 27500 km² of which 9,200 km² lie on Ukraine territory (Solovei et al. 2009). The studied sites in the Upper Prut river system are located in the mountains, in the foothills and in the plains of the basin up to the border of Ukraine (Kostenyuk 2012). The total area of the Siret River basin is 44,835 km², with 2,070 km² in the Ukraine. The upper part of the Siret basin is located in the Eastern Carpathians, near the Pokuttya-Bukovyna Carpathians and the Bukovyna Upland. This amounts to a total extend of 11,270 km².

Brown soils of low thickness (approx. 30 – 40 cm) form the predominant soil type in the studied area. Below follows a layer of gravel and stones. Generally, the water permeability of the soil is low.
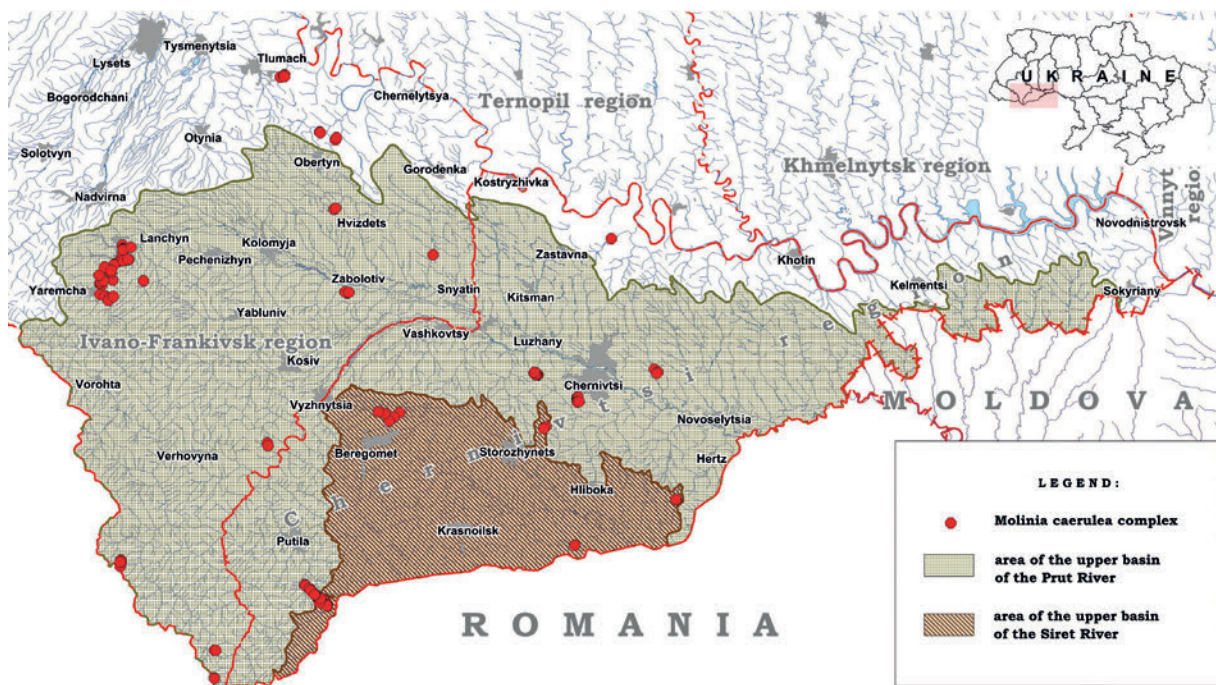

Figure 1: Study area and sites of relevés with participation of the *Molinia caerulea* complex.
Slika 1: Raziskovano območje in lokacije popisov z vrstami kompleksa *Molinia caerulea*.

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According to the physical and geographic zoning of Ukraine, the study area is located within the Prut-Dniester upland of the West-Ukrainian area of deciduous forests of the East European Plain. It includes five physiographic regions (Pre-Carpathian upland, Outer-Carpathian, Watershed-Verkhovynska, Polonyna-Chornohora, Marmaroska) of the Ukrainian Carpathians (Marynych et al. 2003). According to the geobotanical zoning of Ukraine, the river basins of Upper Prut and Upper Siret are located in the Maramorosh-Chornohora-Svidovets County characterized by sessile and common oak, beech, larch and spruce forests as well as subalpine and alpine vegetation. Furthermore, they flow through both Opillya-Kremenets County and the Pokuttia-Medobory County (European broadleaved forest region) rich in beech and hornbeam-oak forests, true and steppe meadows as well as meadow steppes. And finally, the river basins are also part of the Bessarabian County with oak and beech forests, steppe meadows and meadow steppes (Eurasian steppe region) (Didukh & Shelyag-Sosonko 2003). The potentially natural vegetation would be made up offorests like mixed oak-hornbeam forests (F3) or beech and mixed beech forests of both of lowland to submontane types (F5a) and of mountain to alti-mountain types, partially with fir and spruce (F5b) (Bohn et al. 2004).

Climatically, the study area belongs to Ukrainian Carpathians as a sub-region of the Atlantic-Continental region. Atlantic and Mediterranean cyclones cause a significant amount of annual precipitation (in different parts of the sub-region precipitation varies from 600–800 to 1400–1500 mm) depending on local geographical conditions (dissected mountain massifs, their different aspect, slopes and altitude). The average annual temperatures vary from +3 to + 8 °C (Rudenko 2007). Over the past 50 years the average mean annual temperature of the region has increased by 1.1 °C. Additionally, changes in atmospheric circulation processes, in the recent decades, have led to a redistribution of air masses in the Carpathian region resulting in decreasing precipitation rates in the Pre-Carpathians (Antonov 2002).

Methods

The data for the present study is compiled of 134 relevés surveyed by the authors according to the Braun-Blanquet method, from 2004 to 2015. Additionally, historical relevés from the archive of the Department of Botany, Forestry and Landscape management of the Chernivtsi National University and relevés collected at the territory of the Chernivtsi region of Ukraine were gathered from the literature sources (Berezovskaya 1952, Yakymchuk 1974) (See Figure 1). Although these archived and literary relevés were collected according to the methodology of the Soviet geobotanical school, they were suitable for modern phytosociological studies after minor data refinements. The plot sizes for relevés newly recorded by the authors were either 16 or 25 m², while the older relevés were 100 m². Geographic coordinates and the altitude for the new relevés was recorded using GPS navigation (different models) or GoogleEarth software in case of the old relevés. All relevés were entered into the Ukrainian Grassland Database, registered in GIVD as EU-UA-001 (Kuzemko 2012) and the Database of semi-dry grasslands in Ukrainian Pre-Carpathians (EU-UA-002). The relevés are stored in TURBOVEG format (Hennekens & Schaminee 2001). Nomenclature of plant taxa corresponds to the checklist of Cherepanov (1995).

Analyses were carried out in the programme JUICE (Tichý 2002). The classification was performed using the modified algorithm TWINSPAN (Roleček et al. 2009) with the calculation of the clusters heterogeneity based on the Simpson coefficient. The number of clusters was determined by the algorithm OPTIMCLASS (Tichý et al. 2010) and confirmed by the analysis of the obtained dendrograms.

Diagnostic species of the vegetation units (clusters) were identified with the help of their fidelity value expressed as the phi coefficient (Tichý & Chytrý 2006). Species with coefficient values above 0.25 were considered to be diagnostic and values above 0.5 as a highly diagnostic. The size of all groups was standardized to equal size. Statistically insignificant values were excluded using Fisher's exact test at $p > 0.05$. Identification of the syntaxa was carried out using data of surveys of grassland vegetation from the Ukraine (Kuzemko 2009), as well as from neighboring countries – Romania (Coldea et al. 1997), Hungary (Borhidi et al. 2012), Czech Republic (Chytrý 2007a), Poland (Kącki 2007, 2012), and Slovakia (Hegedüšová Vantarová & Škodová 2014).

Ordination analysis was performed using the method of DCA-ordination in the R-project software, integrated in the JUICE programme. For the ecological evaluation of the syntaxa, the ecological scales of Didukh (2011) comprised of 12 factors were used (i.e., soil water regime, variability of damping, soil acidity, total salt regime, carbonate content of the soil, nitrogen content of the soil, thermo-regime, humidity of the climate (ombroregime), continentality of the climate, cryo-regime and light). The geographical distribution of plant communities was projected with the help of GIS MapInfo software and the shape file created by the TURBOVEG programme.

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Species were categorised as rare or endangered if they were listed in the International protected lists – Annexes of Bern Convention on the Conservation of European Wildlife and Natural Habitats and Habitat Directive (Council Directive 92/43/EEC of 21 May 1992), current edition of the Red Data Book of Ukraine (Didukh 2009) and in the list of species that are subject to regional protection in the Chernivtsi region (Andrienko & Peregrym 2012).

Results

Syntaxonomy

The classification analysis yielded nine clusters which were identified as associations (Table 1, Electronic Appendix).

Table 1: Synoptic table of the syntaxa with participation of the *Molinia caerulea* s.l. in south-western Ukraine (numeric values correspond to phi coefficient × 100; only diagnostic species with a value above 0.25 phi coefficient are shown; phi coefficient values for the highly diagnostic species are highlighted in bold).

Tabela 1: Sinoptična tabela sintaksonov z vrsto *Molinia caerulea* s.l. v jugozahodni Ukrajini (številčne vrednosti predstavljajo fi koeficient × 100; prikazane so samo diagnostične vrednosti s fi koeficientom nad 0,25; fi koeficienti za pomembne diagnostične vrste so prikazani krepko).

Syntaxa/Sintaksoni:

1 – *Vaccinio uliginosi-Pinetum mugo*
2 – *Junco-Molinietum*
3 – *Sphagno compacti-Molinietum caeruleae*
4 – *Crepido mollis-Agrostietum capillaris*
5 – *Anthoxantho odorati-Agrostietum tenuis*
6 – *Galietum borealis*
7 – Com. *Molinia arundinacea*
8 – *Poo-Trisetetum flavescentis*
9 – *Brachypodio pinnati-Molinietum arundinaceae*

Syntaxa number	1	2	3	4	5	6	7	8	9
Number of relevés	4	8	5	13	41	7	15	14	27
Carex pauciflora	**93.5**	---	---	---	---	---	---	---	---
Pinus mugo	**85.3**	---	---	---	---	---	---	---	---
Oxycoccus palustris	**85.3**	---	---	---	---	---	---	---	---
Vaccinium uliginosum	**85.3**	---	---	---	---	---	---	---	---
Melampyrum saxosum	**85.3**	---	---	---	---	---	---	---	---
Andromeda polifolia	**68.6**	---	---	---	---	---	---	---	---
Sphagnum cuspidatum	**68.6**	---	---	---	---	---	---	---	---
Eriophorum vaginatum	**68.6**	---	---	---	---	---	---	---	---
Eriophorum latifolium	**68.6**	---	---	---	---	---	---	---	---
Vaccinium vitis-idaea	**52.1**	---	---	---	---	---	---	---	---

Syntaxa number	1	2	3	4	5	6	7	8	9
Listera cordata	47.8	---	---	---	---	---	---	---	---
Pleurozium schreberi	47.8	---	---	---	---	---	---	---	---
Carex flava	---	**90.5**	---	---	---	---	---	---	---
Parnassia palustris	---	**84.9**	---	---	---	---	---	---	---
Juncus articulatus	---	**80.8**	---	---	---	---	---	---	---
Epipactis palustris-	---	**80.2**	---	---	---	---	---	---	---
Eriophorum polystachyon	---	**75.5**	---	---	---	---	---	---	---
Crepis paludosa	---	**72.8**	---	---	---	---	---	---	---
Equisetum palustre	---	**68.3**	---	---	16	---	---	---	---
Dactylorhiza majalis	---	**66.7**	---	---	---	---	---	---	---
Cirsium oleraceum	---	**55.3**	---	---	---	---	---	---	---
Juncus inflexus	---	48.4	---	---	---	---	---	---	---
Carex paniculata	---	47.8	---	---	---	---	---	---	---
Cirsium palustre	---	47.8	---	---	---	---	---	---	---
Cirsium rivulare	---	47.8	---	---	---	---	---	---	---
Carex nigra	---	47.8	---	---	---	---	---	---	---
Succisa pratensis	---	45.1	---	---	11.4	---	---	19.1	---
Juncus effusus	---	43	---	---	---	---	---	---	---
Myosotis palustris	---	43	---	---	---	---	---	---	---
Poa chaixii	---	---	**88.3**	---	---	---	---	---	---
Hypericum alpigenum	---	---	**75.6**	---	---	---	---	---	---
Galium hercynicum	---	---	**75.6**	---	---	---	---	---	---
Deschampsia cespitosa	---	---	**65.9**	---	5.9	---	---	---	---
Avenella flexuosa	---	---	**61.1**	---	---	---	---	---	---
Homogyne alpina	---	---	**61.1**	---	---	---	---	---	---
Arnica montana	---	---	**58.9**	---	---	---	---	---	---
Galium album	---	---	**55**	---	---	---	---	---	---
Bistorta major	---	---	**51.5**	---	---	---	---	---	---
Viola declinata	---	---	**50.1**	---	---	---	---	---	---
Potentilla aurea	---	---	42.6	---	---	---	---	---	---
Festuca ovina	---	---	42.6	---	---	---	---	---	---
Phleum alpinum	---	---	42.6	---	---	---	---	---	---
Achillea carpatica	---	---	42.6	---	---	---	---	---	---
Urtica dioica	---	---	42.6	---	---	---	---	---	---
Luzula sudetica	---	---	37.9	---	---	---	---	---	---
Dianthus compactus	---	---	---	**58.1**	---	---	---	---	---
Scorzonera rosea	---	---	---	40.8	---	---	---	---	---
Silene nutans	---	---	---	37.3	---	---	---	---	---
Medicago lupulina	---	---	---	37.3	---	---	---	---	---
Stellaria holostea	---	---	---	33.8	---	---	---	---	---
Lotus corniculatus	---	---	---	28	18.2	---	---	---	---
Rhinanthus alectorolophus	---	---	---	---	**72.5**	---	---	---	---
Euphrasia vernalis	---	---	---	---	**69.5**	---	---	---	---
Polygala vulgaris	---	---	---	---	**68.4**	---	---	---	---
Sisyrinchium septentrionale	---	---	---	---	**64.1**	---	---	---	---
Cynosurus cristatus	---	---	---	---	**55.9**	---	---	---	---
Daucus carota	---	---	---	---	**51.9**	---	---	---	---
Sieglingia decumbens	---	---	---	---	48	---	---	---	---
Leontodon danubialis	---	---	---	---	46.3	---	---	---	---
Ranunculus acris	---	---	---	---	45.2	---	---	---	---
Gentiana pneumonanthe	---	---	---	---	44.7	---	---	---	---

Syntaxa number	1	2	3	4	5	6	7	8	9
Thymus roegneri	---	---	---	---	44.7	---	---	---	---
Leontodon autumnalis	---	---	---	---	42.1	---	---	---	---
Senecio jacobaea	---	---	---	---	40.2	---	---	---	---
Nardus stricta	---	---	---	---	39.8	---	---	---	---
Ranunculus flammula	---	---	---	---	39.3	---	---	---	---
Trifolium pratense	---	---	---	---	37.5	---	---	---	---
Agrostis canina	---	---	---	---	37	---	---	---	---
Trifolium medium	---	---	---	---	36.9	---	---	---	---
Chrysaspis dubia	---	---	---	---	36.4	---	---	---	---
Carex distans	---	---	---	---	33.1	---	---	---	---
Potentilla argentea	---	---	---	---	33.1	---	---	---	---
Prunella vulgaris	---	---	---	---	32.3	---	---	---	---
Ononis arvensis	---	---	---	---	32.1	---	---	---	---
Phleum nodosum	---	---	---	---	29.6	---	---	---	---
Leucanthemum vulgare	---	---	---	---	29.3	---	---	---	---
Trifolium repens	---	---	---	---	29	---	---	---	---
Centaurium erythraea	---	---	---	---	28	---	---	---	---
Centaurea jacea	---	---	---	---	27	---	---	---	---
Carex lachenalii	---	---	---	---	26.1	---	---	---	---
Hieracium pilosella	---	---	---	---	25.6	---	---	---	---
Viola tricolor	---	---	---	---	25.6	---	---	---	---
Dactylorhiza maculata	---	---	---	---	25.6	---	---	---	---
Carex aquatilis	---	---	---	---	25.6	---	---	---	---
Chrysaspis aurea	---	---	---	---	25.6	---	---	---	---
Juncus tenuis	---	---	---	---	25.6	---	---	---	---
Juncus conglomeratus	---	---	---	---	25.1	---	---	---	---
Heracleum sphondylium	---	---	---	---	---	**77.8**	---	---	---
Galium boreale	---	---	---	---	---	**55.2**	---	---	21.4
Veratrum album	---	---	---	---	---	**52.1**	---	---	---
Dianthus stenocalyx	---	---	---	---	---	**51.2**	---	---	---
Phalacroloma annuum	---	---	---	---	---	49.8	18.1	---	---
Veronica chamaedrys	---	---	---	25	---	47.9	---	22	---
Calamagrostis arundinacea	---	---	---	---	---	47.8	---	---	---
Gladiolus imbricatus	---	---	---	---	---	47.7	22.3	---	---
Equisetum pratense	---	---	---	---	---	47.5	---	---	---
Valeriana officinalis	---	---	---	---	---	44.1	---	---	---
Geranium sylvaticum	---	---	---	---	---	36.5	---	---	---
Poa pratensis	---	---	---	---	---	36	---	---	---
Arrhenatherum elatius	---	---	---	---	---	27.7	24.9	---	---
Equisetum telmateia	---	---	---	---	---	---	**68.6**	---	---
Laserpitium latifolium	---	---	---	---	---	---	**64.4**	---	---
Dianthus membranaceus	---	---	---	---	---	---	**63.2**	---	---
Pteridium aquilinum	---	---	---	---	---	---	**60.6**	---	---
Peucedanum oreoselinum	---	---	---	---	---	---	**57.4**	---	---
Adenophora liliifolia	---	---	---	---	---	---	**55.5**	---	---
Convallaria majalis	---	---	---	---	---	---	49.4	---	---
Pedicularis exaltata	---	---	---	---	---	---	49.4	---	---
Ferulago sylvatica	---	---	---	---	---	---	45.6	---	---
Helianthemum ovatum	---	---	---	---	---	---	42.6	---	---
Lathyrus niger	---	---	---	---	---	---	38.3	---	---
Veratrum nigrum	---	---	---	---	---	---	37.5	---	---

Syntaxa number	1	2	3	4	5	6	7	8	9
Oberna behen	---	---	---	---	---	---	34.9	---	---
Stellaria media	---	---	---	---	---	---	34.7	---	---
Geranium pratense	---	---	---	---	---	---	34.7	---	---
Iris graminea	---	---	---	---	---	---	34.7	---	---
Thalictrum lucidum	---	---	---	---	---	---	33.4	---	---
Betonica officinalis	---	---	---	---	---	---	33.2	---	---
Campanula persicifolia	---	---	---	---	---	---	32.8	---	---
Trifolium montanum	---	---	---	---	---	---	30.7	---	24.9
Allium scorodoprasum	---	---	---	---	---	---	29.7	---	---
Campanula rapunculoides	---	---	---	---	---	---	27.7	---	---
Lilium martagon	---	---	---	---	---	---	27.2	---	---
Traunsteinera globosa	---	---	---	---	---	---	---	**63.2**	---
Helictotrichon praeustum	---	---	---	---	---	---	---	**52.3**	---
Trollius europaeus	---	---	---	15.9	---	---	---	**51.1**	---
Rumex acetosa	---	---	---	---	---	---	---	47.6	---
Pimpinella major	---	---	---	---	---	---	---	45.9	---
Stellaria graminea	---	---	---	---	---	---	---	45.5	---
Trifolium pannonicum	---	---	---	---	---	---	---	44	---
Ranunculus polyanthemos	---	---	---	---	---	---	---	42.7	18.1
Pimpinella saxifraga	---	---	---	---	---	---	---	42.5	---
Cuscuta europaea	---	---	---	---	---	---	---	40.6	---
Viola montana	---	---	---	---	---	---	---	36.7	---
Polygonatum verticillatum	---	---	---	---	---	---	---	36.4	---
Galeopsis tetrahit	---	---	---	---	---	---	---	35.9	---
Campanula patula	---	---	---	---	17.6	---	---	32.1	---
Trisetum flavescens	---	---	---	---	---	---	---	31.6	---
Potentilla erecta	---	---	---	18.7	---	---	15.4	29.8	---
Euphrasia picta	---	---	---	---	---	---	---	27.1	---
Peucedanum cervaria	---	---	---	---	---	---	---	---	**80**
Centaurea scabiosa	---	---	---	---	---	---	---	---	**67.9**
Salvia verticillata	---	---	---	---	---	---	---	---	**67.8**
Genista tinctoria	---	---	---	---	---	---	---	---	**67.7**
Asperula cynanchica	---	---	---	---	---	---	---	---	**65**
Salvia pratensis	---	---	---	---	---	---	---	---	**61.6**
Cirsium pannonicum	---	---	---	---	---	---	---	---	**60.3**
Bupleurum falcatum	---	---	---	---	---	---	---	---	**59.2**
Carex montana	---	---	---	---	---	---	---	---	**58.8**
Veronica spicata	---	---	---	---	---	---	---	---	**58.6**
Thesium linophyllon	---	---	---	---	---	---	---	---	**57.9**
Scabiosa ochroleuca	---	---	---	---	---	---	---	---	**53.7**
Geranium sanguineum	---	---	---	---	---	---	---	---	**53.6**
Linum flavum	---	---	---	---	---	---	---	---	**52.2**
Festuca valesiaca	---	---	---	---	---	---	---	---	48.7
Melampyrum cristatum	---	---	---	---	---	---	---	---	48.7
Securigera varia	---	---	---	---	---	---	---	---	47.9
Prunella grandiflora	---	---	---	---	---	---	---	---	47.9
Inula ensifolia	---	---	---	---	---	---	---	---	46
Asyneuma canescens	---	---	---	---	---	---	---	---	45
Allium oleraceum	---	---	---	---	---	---	---	---	41.2
Onobrychis viciifolia	---	---	---	---	---	---	---	---	41
Seseli libanotis	---	---	---	---	---	---	---	---	41

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Syntaxa number	1	2	3	4	5	6	7	8	9
Inula salicina	---	---	---	---	---	---	---	---	39.7
Euphorbia klokovii	---	---	---	---	---	---	---	---	38.1
Euphorbia cyparissias	---	---	---	---	---	---	---	---	38
Euphorbia angulata	---	---	---	---	---	---	---	---	36.9
Pulsatilla patens	---	---	---	---	---	---	---	---	36.6
Thalictrum minus	---	---	---	---	---	---	---	---	36.6
Veronica teucrium	---	---	---	---	---	---	---	---	36.6
Inula hirta	---	---	---	---	---	---	---	---	36.6
Elytrigia intermedia	---	---	---	---	---	---	---	---	33.7
Senecio umbrosus	---	---	---	---	---	---	---	---	33.7
Polygala comosa	---	---	---	---	---	---	---	---	33.1
Medicago falcata	---	---	---	---	---	---	21.3	---	32.4
Pulmonaria mollis	---	---	---	---	---	---	---	---	32.2
Lembotropis nigricans	---	---	---	---	---	---	---	---	31.6
Teucrium chamaedrys	---	---	---	---	---	---	---	---	31.6
Campanula bononiensis	---	---	---	---	---	---	---	---	31.6
Adonis vernalis	---	---	---	---	---	---	---	---	31.6
Carex humilis	---	---	---	---	---	---	---	---	31.6
Chamaecytisus blockianus	---	---	---	---	---	---	---	---	31.6
Valeriana collina	---	---	---	---	---	---	---	---	31.6
Equisetum arvense	---	---	---	---	---	---	---	---	29.8
Leontodon hispidus	---	---	---	---	---	---	---	---	29.7
Stachys recta	---	---	---	---	---	---	---	---	28.8
Chamaecytisus albus	---	---	---	---	---	---	---	---	28.7
Agrimonia eupatoria	---	---	---	---	---	---	---	---	28.1
Crepis praemorsa	---	---	---	---	---	---	---	---	25.8
Ranunculus auricomus	---	---	---	---	---	---	---	---	25.8
Rosa gallica	---	---	---	---	---	---	---	---	25.8
Euphorbia virgultosa	---	---	---	---	---	---	---	---	25.8
Galium tinctorium	---	---	---	---	---	---	---	---	25.8
Gypsophila altissima	---	---	---	---	---	---	---	---	25.8
Euphorbia esula	---	---	---	---	---	---	---	---	25.8
Hylotelephium maximum	---	---	---	---	---	---	---	---	25.8
Linaria vulgaris	---	---	---	---	---	---	---	---	25.8
Vaccinium myrtillus	36.8	---	47	---	---	---	---	---	---
Lathyrus pratensis	---	48.6	---	---	---	35.7	---	---	---
Filipendula ulmaria	---	45.1	---	---	---	40	---	---	---
Carex pallescens	---	32.6	---	---	25.7	---	---	---	---
Astrantia major	---	25.7	---	25	---	---	---	43.8	---
Festuca rubra	---	---	48.2	---	**54.8**	---	---	---	---
Campanula serrata	---	---	---	**61.5**	---	---	---	42.7	---
Luzula luzuloides	---	---	---	**57.9**	---	---	---	40.4	---
Hieracium umbellatum	---	---	---	44.2	---	---	---	**58.9**	---
Pyrethrum clusii	---	---	---	42.9	---	---	---	39	---
Carlina acaulis	---	---	---	42.3	---	---	---	**56.7**	---
Angelica sylvestris	---	---	---	42.2	---	---	---	44.8	---
Anthoxanthum odoratum	---	---	---	40	48	---	---	---	---
Achillea millefolium	---	---	---	32.4	---	---	---	32.8	---
Trifolium alpestre	---	---	---	30.7	---	---	---	37.2	---
Centaurea phrygia	---	---	---	28.6	---	---	---	39.1	---
Hypericum maculatum	---	---	---	28.1	---	---	---	37.1	---

Syntaxa number	1	2	3	4	5	6	7	8	9
Phleum pratense	---	---	---	26.4	---	---	---	36.6	---
Crepis conyzifolia	---	---	---	25	---	---	---	56.4	---
Holcus lanatus	---	---	---	---	32.6	---	27.4	---	---
Sanguisorba officinalis	---	---	---	---	**57.5**	31.1	---	16.4	---
Dactylis glomerata	---	---	---	---	40.3	30.9	18.7	---	---
Lysimachia vulgaris	---	---	---	---	33	37.1	---	---	---
Potentilla alba	---	---	---	---	---	**51.1**	---	26.5	---
Anthericum ramosum	---	---	---	---	---	51	---	**51**	---
Brachypodium pinnatum	---	---	---	---	---	48.6	---	**52.6**	---
Filipendula vulgaris	---	---	---	---	---	45.1	---	39	---
Pyrethrum corymbosum	---	---	---	---	---	33	---	35	---
Primula elatior	---	---	---	---	---	30.3	---	29.2	---
Plantago media	---	---	---	---	---	29.8	---	26.6	---
Campanula glomerata	---	---	---	---	---	29.4	---	35.1	---
Knautia arvensis	---	---	---	---	---	---	---	42.8	32.6
Serratula tinctoria	---	---	---	---	---	**52.8**	31.2	---	27.5

Cluster 1 – association *Vaccinio uliginosi-Pinetum mugo* Lutz 1956 (alliance *Sphagnion magellanici* Kästner et Flößner 1933, order *Sphagnetalia medii* Kästner et Flößner 1933, class *Oxycocco-Sphagnetea* Br.-Bl. et Tx. ex Westhoff et al. 1946).

The cluster includes four relevés from the mountain valley (polonyna) Hytanka in the Ivano-Frankivsk region at more than 1500 m a.s.l. Communities of the association are rare and unique to the region, like bushes with *Pinus mugo* and *Rhododendron hirsutum* (*Mugo-Rhododendretum hirsuti*), for instance. Communities of this association occupy small areas in forest complexes of the *Piceion excelsae* Pawłowski et al. 1928 alliance, *Piceetalia excelsae* Pawłowski et al. 1928 order, and *Vaccinio-Piceetea* Br.-Bl. in Br.-Bl. et al. 1939 class. The *Molinia caerulea* complex is characterised by *M. caerulea* (L.) Moench s.str. The mean coverage of the *Molinia caerulea* s.l. amounts to 12.3±6.4%. The mean number of species of the relevés of Cluster 1 is 9.25±1.89 with altogether four rare species (Table 2).

Cluster 2 – *Junco-Molinietum* R.Tx 1954 (*Molinion caeruleae* Koch 1926, *Molinietalia* Koch 1926, *Molinio-Arrhenatheretea* Tx. 1937).

The cluster includes eight relevés, which are mostly from the Ivano-Frankivsk and the Chernivtsi region in the mountains at 856 to 1550 m a.s.l. and partially also from wetlands or often from gentle slopes in the plain of Dzyurkach (at 432 m a.s.l.). In the lower mountains (Ploska, Pasichna), communities of this association only cover small areas and are surrounded by species-rich grass-forb mountain haylands of the *Arrhenatherion elatioris* alliance. At the bottom of the subalpine zone (Hnyetyesa mountain), they are surrounded by spruce forests of the *Piceion excelsae* alliance, *Piceetalia excelsae* order,

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Vaccinio-Piceetea class and by subalpine tall-herb meadows of the *Calamagrostion villosae* alliance, *Calamagrostietalia villosae* order, *Mulgedio-Aconitetea* class. The *Molinia caerulea* complex is characterised by *M. caerulea* s.str. The mean coverage of the *Molinia caerulea* s.l. amounts to 34.5±28.5%, and mean number of the species in relevés amounts to 25.25±3.77 with eight rare species were revealed (see Table 2).

Cluster 3 – *Sphagno compacti-Molinietum caeruleae* Wagnerová in Berciková 1976 (*Calamagrostion villosae* Pawłowski et al. 1928, *Calamagrostietalia villosae* Pawłowski et al. 1928, *Mulgedio-Aconitetea* Hadač et Klika in Klika et Hadač 1944).

Cluster includes five relevés recorded in the Chernivtsi region in the mountains at more than 1500 m a.s.l. Communities of this cluster form mosaic complexes with coenoses of the *Homogyno alpinae-Nardetum strictae* Mráz 1956 association, *Nardo strictae-Agrostion tenuis* Sillinger 1933 alliance, *Nardetea strictae* Rivas Goday in Rivas Goday et Rivas-Mart. 1963 class. The *Molinia caerulea* complex is characterised by *M. caerulea* s.str. Mean cover with *Molinia caerulea* s.l. is 1.3±0.7% and the mean number of species in the relevés is 14.2±4.09 including three rare species (see Table 2).

Cluster 4 – *Crepido mollis-Agrostietum capillaris* Ružičková 2004 (*Polygono bistortae-Trisetion flavescentis* Br.-Bl. et R. Tx. ex Marshall 1947, *Poo alpinae-Trisetetalia* Ellmauer et Mucina 1993, *Molinio-Arrhenatheretea* Tx. 1937).

This cluster includes 13 relevés surveyed in the mountains (992 to 1101 m a.s.l.). Relevés of this cluster were close to communities of the *Nardo-Agrostion tenuis* alliance of the *Nardetea strictae* class and the *Arrhenatherion elatioris* alliance of the *Molinio-Arrhenatheretea* class. The *Molinia caerulea* complex is characterised by *M. caerulea* s.str. The mean cover of *Molinia caerulea* s.l. is 37.8±25.1% and the mean number of species per relevé is 29.85±9.90. Six species were identified as rare (see Table 2).

Cluster 5 – *Anthoxantho odorati-Agrostietum tenuis* Sillinger 1933 (*Arrhenatherion elatioris* Luquet 1926, *Arrhenatheretalia* Pawłowski et al. 1928, *Molinio-Arrhenatheretea* Tx. 1937).

The cluster includes 41 relevés from 1949 and 1967 which are from literary and archive sources. The data were collected in the Chernivtsi and Ivano-Frankivsk regions in the valleys of the Myhidra and Prut rivers, mainly from hayfields. These grassland complexes are also quite common in the lower mountains, prevalent on slopes of varying steepness and aspects with a wide range of environmental and edaphic conditions. The *Molinia caerulea* complex is characterised by *M. caerulea* s.str. and *M. arundinacea*. The mean cover of *Molinia caerulea* s.l.

is 18.9±20.9%and the mean number of species per relevé is 32.37±6.57. In communities of this association, eleven rare species were found (see Table 2).

Cluster 6 – *Galietum borealis* Nowiński 1928 (*Molinion caeruleae* Koch 1926, *Molinietalia* Koch 1926, *Molinio-Arrhenatheretea* Tx. 1937).

The cluster includes seven relevés, which are mainly from the plain in the Chernivtsi region (at 273–431 m a.s.l.). Only one relevé is from Ivano-Frankivsk region. The found communities are common in river valleys, alongside roads, between forests and at the foot of the mountains. The *Molinia caerulea* complex is characterised by the *M. caerulea* s.str. and *M. arundinacea*. The mean cover of *Molinia caerulea* s.l. is 33.9±24.8%, mean number of species is 35.14±13.67. In communities of this association, five rare species were revealed (see Table 2).

Cluster 7 – Com. *Molinia arundinacea* (*Molinion caeruleae* Koch 1926, *Molinietalia* Koch 1926, *Molinio-Arrhenatheretea* Tx. 1937).

Cluster 7 includes 15 relevés which are mainly from the Chernivtsi region (only three relevés from the Ivano-Frankivsk region). Most of the relevés are located on the territory of the tract "Dzyurkach" near the city of Chernivtsi. The communities predominantly represent abandoned hayfields on level ground (295–435 m a.s.l.). The peculiarity of the floristic composition of communities belonging to this unit did not allow us to find analogues among the previously described associations. Thus, we consider it as community without rank. These unique grass-forb species-rich meadow complexes have developed under the influence of regular mowing and have replaced cut beech and oak forests. As a result of the ongoing decline of the traditional management, however, scrub encroachment increases and the meadows start to be overgrown by trees and shrubs. This explains the presence of many species typical of forest-edges forests in the floristic composition of this cluster. The communities border with the meadow communities of the *Arrhenatherion elatioris* alliance. The *Molinia caerulea* complex is characterised by the *M. arundinacea* Shrank. The mean cover of *Molinia caerulea* s.l. is 21.7±26.6%. The mean number of species is 37.0±12.2. In communities of this association, twelve rare species were identified (see Table 2).

Cluster 8 – *Poo-Trisetetum flavescentis* Knapp ex Oberd. 1957 (*Arrhenatherion elatioris* Luquet 1926, *Arrhenatheretalia* Pawłowski et al. 1928, *Molinio-Arrhenatheretea* Tx. 1937).

The cluster includes 14 relevés recorded in the mountains at altitudes from 900 to 1111 m a.s.l. These meadow communities with *Molinia caerulea* were identified and described for the territory of Putyla low mountains in

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the site "Ploska". Here, they are confined mostly to the southeastern and southwestern slopes where they are prevalent in large areas characterized by long-term traditional management (mowing) and fertilization that has allowed a high species richness to develop. The *Molinia caerulea* complex is characterised by the *M. arundinacea*. The mean cover of *Molinia caerulea* s.l. is 30.0±21.0%, and the mean species number is 38.5±5.98. In this cluster, six rare species were identified (see Table 2).

Cluster 9 – *Brachypodio pinnati-Molinietum arundinaceae* Klika 1939 (*Bromion erecti* Koch 1926, *Brometalia erecti* Koch 1926, *Festuco-Brometea* Br.-Bl. et Tx. ex Soó 1947).

This cluster includes 27 relevés in the Chernivtsi and Ivano-Frankivsk regions. All relevés were in the plains (at 167–303 m a.s.l.) on the predominantly southern slopes. They occupy small areas, surrounded by the meadow communities of the *Arrhenatherion elatioris* alliance and semi-dry grasslands of the *Cirsio-Brachypodion pinnati* Hadač et Klika, 1944 alliance of the *Festuco-Brometea* Br.-Bl. et Tx. ex Soó 1947 class. The *Molinia caerulea* complex is characterised by the *M. caerulea* s.str. and *M. arundinacea*. The mean cover of *Molinia caerulea* s.l. is 23.50±30.30%. The mean species number is 39.15±13.47. Altogether, fifteen rare species were identified in this cluster (see Table 2).

Ordination

The result of the ordination analysis (Figure 2) shows a clear separation of clusters into two groups.

Clusters 1–5 and cluster 8 representing the "wet" type (Figure 3), and clusters 6, 7 and 9, which belong to the "dry" type (Figure 4), are projected on the right and left side, respectively, in the ordination diagrams. The syntaxa of the "wet" type are also characterised by high rates of climate humidity (ombroregime) and soil aeration. The syntaxa of the "dry" group are associated with alkaline soil conditions, a high carbonate content in soil, a high salt regime of soil, a high thermal regime and continentality. Clusters 4–8 are positioned in the central part of the ordination diagram showing that their ecological amplitude are mostly overlapped to different extents. These clusters are assigned to the *Molinio-Arrhenatheretea* class. However, those clusters assigned to other classes – 1 (*Oxycocco-Sphagnetea*), 3 (*Mulgedio-Aconithetea*), and 9 (*Festuco-Brometea*) – are considerably distant to each other. There is only a slight overlap of cluster 9 with cluster 7 and, to a lesser extent, with cluster 6, which is quite logical considering a floristic similarity of the Com. *Molinia arundinacea* and *Brachypodio pinnati-Molinietum arundinaceae* associations.
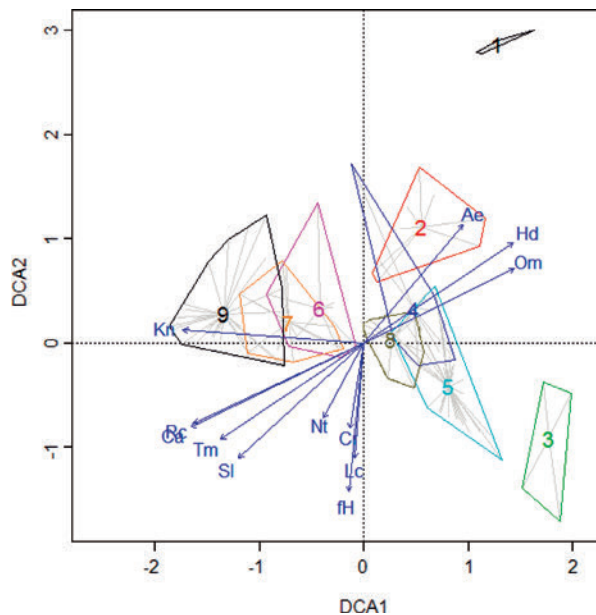
Figure 2: DCA-ordination of the dataset with centroids of the clusters. Number of the centroids corresponds to the numbers of syntaxa in the Table 1. Ecological vectors: Hd - soil water regime, fH – variability of damping, Rc - soil acidity, Sl - total salt regime, Ca - carbonate content in soil, Nt - nitrogen content in soil, Tm - thermoregime, Om - humidity of climate (ombroregime), Kn - continentality of climate, Cr - cryoregime and Lc - light. Eigenvalues: 1st axis (DCA1) 0.4932, 2nd axis (DCA2) 0.2840.

Slika 2: DCA ordinacija s centroidi klastrov. Številka centroida odgovarja številki sintaksona v Tabeli 1. Ekološki vektorji: Hd – režim vode v tleh, fH – variablinost vlažnosti, Rc – kislost tal, Sl – skupen režim soli, Ca – vsebnost karbonata v tleh, Nt – vsebnost dušika v tleh, Tm – termorežim (količina sevanja), Om – vlažnost klime (padavinski režim), Kn – kontinentalnost klime, Cr – kriorežim (temperatura) in Lc – svetloba. Lastne vrednosti: 1 os (DCA1) 0.4932, 2 os (DCA2) 0.2840.

Nature conservation values

Rare and endangered species make up more than 10% of the species in the studied commmunities and represent about 5% of the number of vascular plants included in the third edition of the Red Data Book of Ukraine (Didukh 2009) (Table 2). Only one species, *Gymnadenia conopsea*, characterised by a broad ecological amplitude, occurs in communities of six associations. The other rare species are componen with ts of only one (61% of species), two (19.5%) or three (17.1%) associations.

Thus, communities of mesic and semi-dry grasslands with participation of the *Molinia caerulea* s.l. are habitats with a high density of rare floristic component in the region. This particulary applies to communities of *Anthoxantho odorati-Agrostietum tenuis* (cluster 5), Com. *Molinia arundinacea* (cluster 7) and *Brachypodio pinnati-Molinietum arundinaceae* (cluster 9).

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Figure 3: "Wet" type of the purple moor-grass meadows (association *Junco-Molinietum*) in Huzulska Verkhovyna, a mountain ridge Verkhnia Ploska, Putyla district, Chernivtsi region. Photo: A. I. Tokariuk.

Slika 3: "Vlažni" tip travišč z modro stožko (asociacija *Junco-Molinietum*) v območju Huzulska Verkhovyna, gorski greben Verkhnia Ploska, okrožje Putyla, regija Chernivtsi. Foto: A. I. Tokariuk.

Figure 4: "Dry" type of purple moor-grass meadows (ass. *Brachypodio pinnati-Molinietum arundinaceae*) in "Maliovanka" site in vicinity of Zavoloka villiage, Storozhynets district, Chernivtsi region. Photo: A.A. Kuzemko.

Slika 4: "Suhi" tip travišč z modro stožko (asociacija *Brachypodio pinnati-Molinietum arundinaceae*) na območju "Maliovanka" v bližini vasi Zavoloka, okrožje Storozhynets, regija Chernivtsi region. Foto: A.A. Kuzemko.

Table 2: Frequency of rare and endangered species in syntaxa with participation of *M. caerulea* s.l. in south-west of Ukraine. (Protected status: RDBU – species included in the Red Data Book of Ukraine (2009), RR - regionally rare species, N 2000 – species listed in Annexes of the Habitats Directive).

Tabela 2: Frekvenca redkih in ogroženih vrst v sintaksonih z vrsto *M. caerulea* s. l. v jugozahodni Ukrajini. (Zaščiten status: RDBU – vrste vključene v Rdečo knjigo Ukrajine (2009), RR – regionalno redke vrste, N 2000 – vrste vključene v Dodatek Direktive o habitatih).

Species name	Protected status	Syntaxa number								
		1	2	3	4	5	6	7	8	9
Achillea carpatica	RR	-	-	20	-	-	-	-	-	-
Aconitum anthora	RR	-	-	-	-	-	-	-	-	4
Adenophora lilifolia	N 2000, RR	-	-	-	-	-	-	33	-	-
Adonis vernalis	RDBU	-	-	-	-	-	-	-	-	11
Andromeda polifolia	RR	50	-	-	-	-	-	-	-	-
Arnica montana	N 2000	-	-	40	-	2	-	-	-	-
Asyneuma canescens	RR	-	-	-	-	-	-	-	-	22
Botrychium lunaria	RDBU	-	-	-	8	-	-	-	-	-
Campanula serrata	N 2000, RR	-	13	-	85	-	-	-	64	-
Carex pauciflora	RDBU	100	13	-	-	-	-	-	-	-
Chamaecytisus albus	RDBU	-	-	-	-	-	-	13	-	19
Chamaecytisus blockianus	RDBU	-	-	-	-	-	-	-	-	11
Clematis integrifolia	RR	-	-	-	-	-	-	-	-	4
Colchicum autumnale	RDBU	-	-	-	-	5	14	7	-	-
Dactylorhiza cordigera	RDBU	-	13	-	-	-	-	-	-	-
Dactylorhiza maculata	RDBU	-	-	-	-	7	-	-	-	-
Dactylorhiza majalis	RDBU	-	50	-	-	2	-	-	-	-
Dianthus compactus	RR	-	-	-	54	-	-	-	21	-
Dianthus stenocalyx	RR	-	-	-	-	-	29	-	-	-
Epipactis palustris	RDBU	-	88	-	-	5	-	20	-	-
Galatella linosyris	RR	-	-	-	-	-	-	-	-	4
Gentiana pneumonanthe	RR	-	-	-	-	22	-	-	-	-
Gladiolus imbricatus	RDBU	-	-	-	-	22	57	33	-	-
Gymnadenia conopsea	RDBU	-	25	-	38	7	-	27	43	15
Gymnadenia densiflora	RDBU	-	13	-	-	-	-	-	-	-
Iris hungarica	N 2000, RR	-	-	-	-	-	-	-	-	4
Iris sibirica	RDBU	-	13	-	-	2	14	-	-	-
Leopoldia comosa	RR	-	-	-	-	-	-	7	-	-
Lilium martagon	RDBU	-	-	-	15	-	-	20	-	4
Melampyrum saxosum	RR	50	-	-	-	-	-	-	-	-
Muscari botryoides	RDBU	-	-	-	-	-	-	-	-	4
Ophioglossum vulgatum	RR	-	-	-	-	2	-	-	-	-
Oxycoccus palustris	RR	75	-	-	-	-	-	-	-	-
Pedicularis exaltata	RDBU	-	-	-	-	-	-	27	-	-
Platanthera bifolia	RDBU	-	-	-	-	2	-	-	-	-
Pulsatilla grandis	RDBU, BERN	-	-	-	-	-	-	7	-	4
Pulsatilla patens	RDBU, BERN	-	-	-	-	-	-	-	-	15
Scorzonera purpurea	RR	-	-	-	-	-	-	-	7	4
Senecio umbrosus	RR	-	-	-	-	-	-	7	-	19
Traunsteinera globosa	RDBU	-	-	-	-	-	-	-	43	-
Veratrum nigrum	RR	-	-	-	-	-	14	27	-	-
Viola declinata	RR	-	-	40	8	-	-	-	7	-
Total number		4	8	3	6	11	5	12	6	15

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Discussion

Our results showed that *Molinia caerulea* s.l. has a very broad ecological and coenotic amplitude and occurs in communities of four classes – *Molinio-Arrhenatheretea*, *Mulgedio-Aconitetea*, *Oxycocco-Sphagnetea* and *Festuco-Brometea,* in the south-western part of Ukraine. More often, *Molinia* is related to hay meadows of the *Arrhenatherion elatioris* alliance, but not to wet meadows of the *Molinion caeruleae* alliance, which are typical habitat for *Molinia caerulea*. The communities of the latter are also present in the studied region, although much rarer.

The results obtained on the expansion of *Molinia caerulea* s.l. to non-typical habitats confirm the data from Western and Central Europe (Chambers et al. 1999, Jacquemyn et al. 2005, Hejcman et al. 2010 etc.). This development can be explained by the changes of traditional management regimes of the meadows: the Carpathian meadows were traditionally used as hayfields and haymaking served as a regulatory tool to control the distribution of *Molinia caerulea*. In recent years, haymaking has declined, therein fascilitating the spread of *Molinia* spread to abandoned hayfields. In the mountains, *Molinia* communities that grow near to the timber line are quite stable because the altitude prevents shrubs and trees from overgrowing them rapidly. But in the plains, the process of succession occurs more quickly (Bagniuk & Didukh 2002, Felbaba-Klushyna 2009).

There are interesting changes of the mean coverage of *Molinia caerulea* in different syntaxa. A low coverage in a non-typical habitat of the *Mulgedio-Aconitetea* and *Oxycocco-Sphagnetea* classes of 1% and 12.3% respectively is quite plausible. In communities of the *Molinio-Arrhenatheretea* class, coverage of *Molinia* is higher and varies from 18.9% to 38.7%. The lowest average values of coverage within this class is shown by communities of the *Anthoxantho odorati-Agrostietum tenuis*, which was identified on the base of historical relevés for the 1949 and 1967. There is evidence that the participation of *Molinia caerulea* s.l. in meadow phytocenoses was lower in the middle of the last century that it is today because of mowing. The highest average coverage (38.7%) was demonstrated by the communities of *Crepido mollis-Agrostietum capillaris*. This is due to a lack of proper management of the respective sites, which leads to a excessive overgrowth of this species. The mean cover values of the *Molinia caerulea* s.l. in communities of *Bromion erecti* are comparable to those of the *Molinio-Arrhenatheretea* class.

Such prominent role of purple moor-grass in communities of semi-dry grasslands is obviously related to the fact that the *Molinia caerulea* complex, is characterised by two species – *Molinia caerulea* (L.) Moench and *Molinia arundinacea* Schrank (Dančak et al. 2012) in south-western Ukraine and, as in Central Europe. The former grows predominantly in wet and swampy habitats, whereas latter grows in mesic and semi-dry habitats. This is confirmed in this study by the results of the vegetation classification, by structural features of the syntaxa as well as by the results of the ordination. The communities with participation of these species independently demonstrate directed dynamics in the recent decades. In particular, our study revealed the decreasing trend of communities dominated by *Molinia caerulea*, one the one hand, while, on the other hand, the area of plant communities dominated by *M. arundinacea* is increasing. Factors that affect communities dominated by *M. caerulea* in the Carpathian Mountains and surrounding areas include the economic development of river valleys, accompanied by destruction of habitats and followed by urban or agricultural development (Bagniuk & Didukh 2002). In addition, higher temperatures and decreasing precipitation induced by climate change have lead to the drainage of wet habitats and caused a reduction of potential habitats for *M. caerulae* communities. The same factors promote the growth and spread of *M. arundinacea* and its communities which are prevalent in xero-mesic habitats on karst terrain, in dry and semi-dry grasslands habitats. The region of the Transdniestria and Pre-Carpathians as well as low mountains of Ukrainian Carpathians have been subject to the afore mentioned changes (Morgoch 2001, Kobiv 2009). In the foothills of the Carpathians this trend threatens communities in the Dzyurkach and Pidokruh tract, in the vicinity of Chernivtsi, where these unique and extremely species-rich grassland communities, with up to 90 species per 9 m² occur (Roleček et al. 2014). The floristic composition of these communities harbour a number of rare and endangered species including 14 species of orchids. *Molinia arundinacea*, however, forms monodominant communities resulting in a loss of biodiversity.

Hence, maintaining the traditional management regime of typical habitats of *Molinia caerulea* s.l. in the south-western regions of Ukraine should is crucial for their conservation. The management of the communities with participation of *Molinia arundinacea* and *M. caerulea* s.str., should be different. To slow down the spread of *Molinia arundinacea,* mowing should take place in June or July, before seed maturation. For communities with *Molinia caerulea* s.str.,* mowing after the maturation of seeds (August-September) will promote the production of sufficient seeds for the diasporas bank to maintain a stable populations of this species. In summary, this suggested regime will help regulate the cover of purple moor-grass and its spread to atypical habitats, on the one hand. On the other hand, it will maintain the high species diversity of these communities including already regionally and nationally endangered species.

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Appendix Table 1: Phytocoenotic table of the syntaxa with participation of the *Molinia caerulea* s.l. in southwestern of Ukraine (clusters 1–5).

Appendix Table 2: Phytocoenotic table of the syntaxa with participation of the *Molinia caerulea* s.l. in southwestern of Ukraine (clusters 6–9).