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Semi-natural mesic grasslands of Bystrytsya valley (Ukrainian Carpathians)

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Abstract: We present the syntaxonomic overview of semi-natural mesic grassland communities (*Arrhenatheretalia elatioris* and *Nardetalia strictae* orders) from the Bystrytsya Nadvirnianska river valley in the Ukrainian Carpathians. We collected 55 phytosociological relevés in the 2015 vegetation season using Braun-Blanquet approach. Analyses were conducted by semi-supervised K-means classification method and detrended correspondence analysis. Seven grassland types in four alliances were distinguished in the dataset. The *Arrhenatherion elatioris* alliance involved two associations. Unploughed, regularly long-term mown and sometimes extensively grazed grasslands of the *Anthoxantho odorati-Agrostietum tenuis* association were more frequent than *Poo-Trisetetum flavescentis* association developing on fallows (former arable fields). The intensive pastures classified as the *Lolio perennis-Cynosuretum cristati* association of the *Cynosurion cristati* alliance were rarely recorded, while the oligotrophic pastures of *Violion caninae* alliance were more frequent. They consisted of one well differentiated association of semi-wet extensively grazed grasslands of the *Polygalo vulgaris-*

Nardetum strictae association and mesophilous communities forming transitions from *Hyperico maculate-Deschampsietum flexuosae*, *Campanulo rotundifoliae-Dianthetum deltoidis* and associations to the *Nardo strictae-Agrostietum tenuis* alliance. Extensively grazed and often mown grasslands of *Campanulo abietinae-Nardetum strictae* association and extensive pastures of the *Antennario dioicae-Nardetum strictae* association belonging to the *Nardo strictae-Agrostion tenuis* alliance were recorded in higher altitudes. Didukh´s indicator values (DIV) and altitude were used to ecological differentiation of classified grassland types. The main environmental gradient was related to altitude and soil parameters, especially soil acidity and nutrient content (nitrogen) on the first ordination axis and to soil humidity on the second ordination axis.

Keywords: *Arrhenatherion elatioris*, *Cynosurion cristati*, meadows, *Nardo strictae-Agrostion tenuis*, pastures, semi-supervised methods, syntaxonomical classification, *Violion caninae*.

Introduction

Managed semi-natural temperate grasslands are habitats with very high species diversity reaching maximum global plant species in small plot sizes (WILSON et al. 2012). The species density of these habitats has been controlled over the centuries by multiple processes and mechanisms: by colonization, the species pool, spatial heterogeneity and anthropogenic effects of mowing, grazing and temporary abandonment of arable fields (GRACE 1999, POSCHLOD 2015). While traditional management practices support high species richness and the occurrence of rare and endangered species (SCHAFFERS 2002), agricultural expansion and intensification in the last decades of 20th century have been major causes of global biodiversity loss and species endangerment (GREEN et al. 2005, TILMAN 1999). However, the agricultural practices negatively affecting biodiversity in the Central and Western Europe did not have such devastating effects in the Ukrainian Carpathians grasslands. The reasons these grasslands escaped devastation are found in the following historical backround. The specific landscape structure was strongly affected by collective farming 'kolkhozes' in many parts of the Ukrainian Carpathians in the last century (LERMAN et al. 2004). Meadows and pastures, which had never been ploughed remained in remote areas, far from villages and on deforested mountain ridges, the 'polonines' (TASENKEVICH 2009). These habitats were mostly mown traditionally by hand or extensively grazed by cattle. The collapse of the Soviet Union in 1991 enabled Ukraine's inhabitants return to traditional forms of land management (KUEMMERLE et al. 2006), but economic disadvantages of agricultural methods and emigration for employment caused the increasing trend of grassland abandonment. Although this trend affected to some extent also remote mountain grasslands (KRICSFALUSY 2013), the Ukrainian Carpathians retained most of the characteristic mosaic of traditionally managed pastures, meadows, fallows and small fields (ŠKODOVÁ et al. 2015).

Phytosociological research (such as that by ALJECHIN 1951) based on the Russian phytosociological school, and this approach dominated research in the Ukrainian Carpathians in the last century. The relevés were often recorded unsystematically, with unknown or extremely variable plot sizes, so that their comparison with newly-obtained data is extremely difficult (ŠKODOVÁ et al. 2015). Recently, local studies of grassland vegetation in this area were published using the BRAUN-BLANQUET (1921) approach (ZARZYCKI 2002, SOLOMAKHA et al. 2004, CHORNEY et al. 2005, MILKINA & LYAKH 2008a, KUZEMKO 2009, TOKARYUK et al. 2009, DERZHYPILSKY et al. 2011, KUZEMKO et al. 2014, ROLEČEK et al. 2014 and ŠKODOVÁ et al. 2015). Finally, ZAJAC et al. (2016) analysed all accessible phytosociological relevés from the Ukrainian Carpathians and adjacent areas in a complex synthesis of semi-natural mesic grasslands.

Some regions, however, still require phytosociological research. The Bystrytsya river valley is a site almost undisturbed by industrial activities and collective farming. The major part of the area occurs grasslands, which have never been ploughed and these sites form a unique mosaic of communities, which are rare in the rest of Europe (CHERNYAVSKYY & SHPYLCHAK 2011). Despite that fact, only little phytosociological research has been conducted in this area. Only one study using the Braun-Blanquet approach had been performed by KLIMUK et al. (2006) in the "Gorgany" Nature Reserve Park, which comprising a part of the study area.

This study is focussed on these valuable grasslands of the Bystrytsya river valley. It complements our 2009–2014 phytosociological research throughout the Ukrainian Carpathians territory published by ZAJAC et al. (2016). Our main aims are: i) to classify the major plant communities of mesic grasslands in the research area, ii) to evaluate the variability and describe the distribution and habitat conditions of delimited associations and iii) to analyse the main ecological gradients in species composition.

Material and methods

Study area

The study area covers the Bystrytsya Nadvirnianska river valley in Nadvornyanskyi rayon (the Ivano-Frankivsk district) located in the central part of the Ukrainian Carpathians called the Central Gorgany Mts (Fig. 1, KRUHLOV 2008). Most of the mountain massif is built by Carpathian flysch formed by conglomerates, sandstones and clay or marl shale layers of the Cretaceous periods. Quaternary alluvial-deluvial clay loams, clays and sand clays are widespread in the depressions. Dominant soil types in the territory are brown earths and podsol soils, pseudogleys and gleys are less common (TSARNENKO 1988, KLIMUK et al. 2006, CHERNYAVSKYY & SHPYLCHAK 2011).

Moderately high mountain ridges of the Central Gorgany Mts are regularly distributed from north-west to south-east. The highest peak is Dovbushanka Mt. at 1754.6 m a.s.l. (KLIMUK et al. 2006). High humidity in the Gorgany caused formation of a dense network of rivers and streams, where approximately 30

tributaries join the 94 km section of the Bystrytsya Nadvirnianska river (CHERNYAVSKYY & SHPYLCHAK 2011).

The study area located in the temperate continental climate. The mean monthly temperature of the warmest month, July is +16.4ºC and the coldest, January, is -7.6°C. The annual precipitation varies from 850 to 1000 mm, with the maximum in June and July and the dominant wind direction is north-western (KLIMUK et al. 2006, CHERNYAVSKYY & SHPYLCHAK 2011).

The valley of river Bystrytsya remain largely forested, with 80% of the total area covered by mostly spruce-dominated forests. Mixed forests are distributed only on the periphery of the study area (KRICSFALUSY 1999).

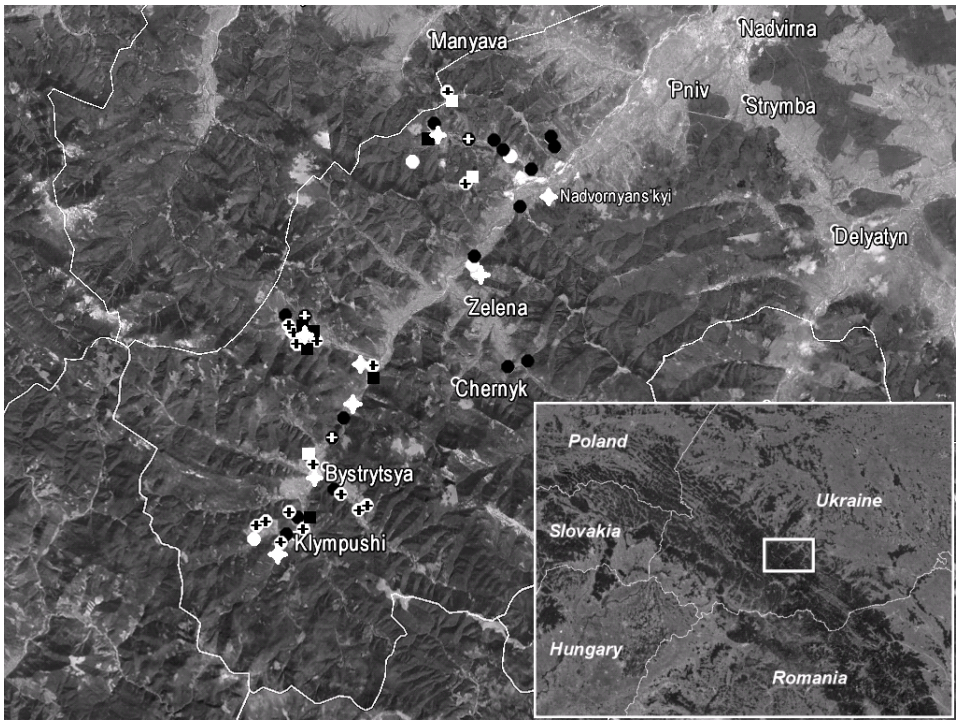

Fig. 1. Location of the study area and distribution of 55 relevés of mesic grasslands in the valley of Bystrytsya Nadvirnianska river (*Poo-Trisetetum flavescentis* - white circle, *Anthoxantho odorati-Agrostietum tenuis* - black circle, *Lolio perennis-Cynosuretum cristati* - black circle with white cross, *Campanulo abietinae-Nardetum strictae* - white circle with black cross, *Antennario dioicae-Nardetum strictae* - white square, *Polygalo vulgaris-Nardetum strictae* - black square, transitions between *Violion caninae* and *Nardo strictae-Agrostion tenuis* alliances - white cross

Vegetation sampling

We focused on the semi-natural mesic grassland communities of the orders *Arrhenatheretalia elatioris* (alliances *Arrhenatherion elatioris*, *Cynosurion cristati*)

and *Nardetalia strictae* (alliances *Violion caninae*, *Nardo strictae-Agrostion tenuis*). They were sampled in the 4×4 m plots in June 2015 at altitudes 536–1014 m a.s.l. following the Zürich-Montpellier school (BRAUN-BLANQUET 1964). Sites with homogenous species composition and environmental conditions were selected for sampling. Nine-degree cover-abundance scale (WESTHOFF & VAN DER MAAREL 1973) was used. The percentage cover of herb (E_1) and cryptogam layers (E_0), litter, open soil, excrement and bare rock was estimated for each plot. Information on management practice came from landowner interviews and from visual observation.

Nomenclature

The taxonomic nomenclature of vascular plants, mosses and lichens follows MARHOLD & HINDÁK (1998). The names of taxa missing in this Slovak list (*Arnica montana*, *Laserpitium krapfii*, *Phyteuma tetramerum* and *P. vagneri*) are used according to Euro+Med Plant Database (http://www.emplantbase.org/home.html). Narrowly defined species or subspecies were merged into the following broader taxa in the analyses: *Anthoxanthum odoratum* agg. (*A. alpinum*, *A. odoratum*), *Anthyllis vulneraria* (*A. vulneraria* subsp. *vulneraria*, *A. vulneraria* subsp. *carpathica*, *A. vulneraria* subsp. *polyphylla*), *Arabis hirsuta* agg. (*A. hirsuta*, *A. sagittata*), *Carex flava* agg. (*C. flava*, *C. lepidocarpa*, *C. viridula*), *Cuscuta* sp. div. (*C. epithymum*, *C. europaea*), *Euphrasia rostkoviana* agg. (*E. kerneri*, *E. officinalis* agg., *E. picta*, *E. rostkoviana*), *Galium verum* agg. (*G. verum*, *G. wirtgenii*), *Jacea phrygia* agg. (*J. phrygia*, *J. indurata*, *J. stenolepis*), *Leucanthemum vulgare* agg. (*L. vulgare*, *L. ircutianum*), *Luzula campestris* agg. (*L. camprestris*, *L. multiflora*), *Myosotis scorpioides* agg. (*M. laxa* subsp. *caespitosa*, *M. scorpioides*), *Pimpinella saxifraga* agg. (*P. nigra*, *P. saxifraga* s. str.), *Rubus* subgen. *Rubus* (*R. caesius*, *R. hirtus* s. lat. and *R. plicatus*). The syntaxonomic nomenclature is unified according to HEGEDÜŠOVÁ-VANTAROVÁ & ŠKODOVÁ (2014), and the full names for the syntaxa missing in the cited source are given in Tab. 1.

Data processing

The dataset of 55 relevés was stored in Turboveg (HEENEKENS & SCHAMINÉE 2001) and analysed by JUICE 7.0.127 program (TICHÝ 2002, TICHÝ & HOLT 2006). The expert system for identification of grassland syntaxa of Slovakia (JANIŠOVÁ et al. 2007a, HEGEDÜŠOVÁ VANTAROVÁ & ŠKODOVÁ 2014) was used for syntaxonomic identification of relevés. Finally, the semi-supervised K-means method (LLOYD 1957) with fixed centroids, three pseudo-species cut-off levels (0%, 5% and 25%) and Hellinger transformation recommended by TICHÝ et al. (2014) was used for the classification. Cryptogams, woody species and taxa determined only at the genera level (excepting *Alchemilla* spec. div.) were removed from the dataset before analysis. Only relevés clearly designated by expert system to the target associations formed initial *a priori* groups. Our expert knowledge was used to re-evaluate the typical relevés in the *a priori* groups to correct imbalances between formal definitions in the Slovak expert system and

the species pool of the study area. This step resulted to the set of 5 *a priori* groups consisting of 3 to 9 typical relevés with recognized associations of the target vegetation.

In the first step of the semi-supervised K-means, relevés most similar to typical relevés in each of the 5 *a priori* groups were found, and the final number of distinguished clusters was set at 6: the 5 *a priori* and one new-generated cluster for the remaining relevés. The classification process was repeated in 50 cycles. A further 13 relevés were assigned to the 5 *a priori* groups in this step, so the *a priori* groups now contained 42 relevés.

In the second run of semi-supervised K-means analysis, the enlarged 5 *a priori* groups were used with parameters identical to the previous analysis. The final number of distinguished clusters was intentionally set at 12 to find any new associations. This was subsequently reduced in further analytic cycles to find the optimal number of well-delimited clusters. Finally, the total number of clusters was reduced to 6 well-interpretable associations and 1 transitional cluster. The distinguished vegetation types are listed in Tab. 1.

The main environmental gradients of species composition were analysed by detrended correspondence analysis (DCA, square-root transformation of cover data and down-weighting of rare species) in the CANOCO 5 package (ŠMILAUER & LEPŠ 2014). Ecological interpretation of ordination axes was supported by supplementary variables: 1) the average non-weighted Didukh indicator values (DIV, DIDUKH 2011) for light, continentality, thermal climate (temperature), nitrogen, acidity (pH), soil humidity, 2) altitude and 3) management treatment: grazing intensity as numeric (0 ungrazed, 1 - grazed after mowing, 2 - extensively grazed, 3 - intesively grazed), mowing and ploughing as categorial variables (0 - no management, 1 - yes). These variables were plotted on the DCA ordination diagram. Following taxa without defined DIV were not used for calculation: *Gentianella lutescens*, *Hieracium lachenalii*, *H. sabaudum*, *Phyteuma tetramerum*, *Pilosella bauhinii*, *P. schultesii*, *Rubus* subgen. *Rubus* and all bryophyte species. Supplementary variables were correlated by the Spearman correlation coefficient with the first two ordination axes. Bonferroni correction was applied following multiple correlations to control the familywise error rate setting critical values of α at 0.005 (0.05/10 variables).

The diagnostic species in the final clusters and the most frequent species with at least 20% frequency in any column were displayed in the shortened synoptic table (Tab. 2) using frequency and fidelity values of species in the vegetation units (SOKAL & ROHLF 1995, CHYTRÝ et al. 2002). Species determined only at the genera level were excluded from the synoptic table with the exception of *Alchemilla* spec. div. and *Cladonia* species. The *phi* coefficient (TICHÝ & CHYTRÝ 2006) was calculated and virtually standardized to equal size of each target group at 14.29% of the total dataset. Only species with *phi* ≥ 0.25 were considered as diagnostic. The significance of higher species frequency in a particular cluster was calculated by Fisher's exact test. Species with random occurrence ($p < 0.05$) were excluded from the diagnostic species list. The complete table of phytosociological relevés is listed in Tab. 3.

Results

Syntaxonomic classification

Six of the seven total clusters in the study area were identified as well-delimited associations of semi-natural mesic grasslands (Tab. 1). The seventh cluster, containing heterogeneous relevés transitional between two alliances and several associations, was not classified at association level, because the floristic differences in particular relevés were insufficient to classify new associations by accepted classification methods.

Tab. 1. Syntaxonomic interpretation of delimited clusters and survey of units identified in the area.

Molinio-Arrhenatheretea R. Tx. 1937
Arrhenatheretalia R. Tx. 1931
Arrhenatherion elatioris Luquet 1926
1 *Poo-Trisetetum flavescentis* Knapp ex Oberd. 1957
2 *Anthoxantho odorati-Agrostietum tenuis* Sillinger 1933
Cynosurion cristati R. Tx. 1947
3 *Lolio perennis-Cynosuretum cristati* R. Tx. 1937
Nardetea strictae Rivas Goday in Rivas Goday et Rivas-Mart. 1963
Nardetalia strictae Oberd. ex Preising 1949
Nardo strictae-Agrostion tenuis Sillinger 1933
4 *Campanulo abietinae-Nardetum strictae* (Pałczyński 1962) Hadač et al. 1988
5 *Antennario dioicae-Nardetum strictae* (Svoboda 1939) Ujházy et Kliment in Janišová et al. 2007
Violion caninae Schwickerath 1944
6 *Polygalo vulgaris-Nardetum strictae* Oberd. 1957
7 Transitions between *Violion caninae* Schwickerath 1944 and *Nardo strictae-Agrostion tenuis* Sillinger 1933 alliances (including *Hyperico maculati-Deschampsietum flexuosae* Balátová-Tuláčková 1985, *Campanulo rotundifoliae-Dianthetum deltoidis* Balátová-Tuláčková 1980 and *Betonico officinalis-Agrostietum capillaris* Blažková et Březina 2003)

Cluster description

1. *Poo-Trisetetum flavescentis* (5 relevés)

Grasslands developed on former arable fields after abandonment are dominated by *Festuca rubra* and *Dactylis glomerata* grasses, while *Arrhenatherum elatius* occurs only rarely. The following common species were constantly present: the herbs of nutrient-rich sites (*Trifolium repens*, *T. dubium*, *Leontodon hispidus*, *Taraxacum* sect. *Rudetalia*), boreal-subatlantic species (*Stellaria graminea*, *Cruciata glabra* and *Cerastium holosteoides*) and species of the *Arrhenatherion elatioris* alliance (*Trifolium pratense*, *Ranunculus acris*, *Plantago lanceolata*, *Leucanthemum vulgare* agg., *Campanula patula*, *Anthoxanthum odoratum* agg., *Achillea millefolium*). Periodic occurrence were typical for montane species of the *Polygono bistortae-Trisetion flavescentis*

alliance (*Astrantia major*, *Cardaminopsis halleri*, *Trollius altissimus*). This grassland type was species-rich with 41–50 vascular species per plot and average of 47 species. The moss layer normally attained total cover of 10–30 (–80)%, with the most common species *Atrichum undulatum*, *Rhytidiadelphus squarrosus*, *Pleurozium schreberi* and *Climacium dendroides*.

The fallows are sparsely distributed in the research area mainly near the settlements and these are regularly mown once or twice a year. They mostly occupy montane and submontane belts at 550–700 m a.s.l. on slopes with 5–20° inclination and various aspects.

2. *Anthoxantho odorati-Agrostietum tenuis* (15 relevés)

This community was occured on stands with mid-range main environmental conditions. This environment and management practices caused relatively high vascular plant heterogeneity and species richness. The stands usually lack distinct dominant species and only *Festuca rubra* were occured with higher cover. The mesophilous species of the *Arrhenatherion elatioris* alliance were very common (*Trifolium pratense*, *Leucanthemum vulgare* agg., *Cruciata glabra*, *Briza media*, *Prunella vulgaris*, *Plantago lanceolata* and *Leontodon hispidus*). Floristic similarity to the *Violion caninae* alliance was indicated by the following oligotrophic species (*Polygala vulgaris*, *Viola canina*, *Thymus pulegioides*, *Carex pallescens* and *Potentilla erecta*). Several species typical for extensive pastures of the *Nardo strictae-Agrostion tenuis* alliance were occured with higher constancy on the occasionally pastured stands (*Nardus stricta, Pilosella officinarum, Danthonia decumbens* and *Carex pilulifera*). Mountain species of the *Polygono bistortae-Trisetion flavescentis* alliance were sporadically present in grasslands at higher altitudes (*Astrantia major*, *Cardaminopsis halleri* and *Gentiana asclepiadea*). These grasslands were species rich with mean number of vascular plant species per relevé of 46 (range 36–67). The moss layer was usually well developed with *Thuidium assimile* and *Rhytidiadelphus squarrosus* species the most frequent and total cover varying between 10 and 70%.

This grassland community is the most common in the explored area. It is distributed from submontane to the montane belts at 530–900 m a.s.l. on slopes with inclination between 3 and 35° and mostly with southern to eastern aspects. Most of these stands have never been ploughed, but regularly mown once or twice per year and occasionally grazed after the mowing. These traditional forms of management are indispensable for the conservation of this community.

3. *Lolio perennis-Cynosuretum cristati* (3 relevés)

This grasslands type was developed on pastures frequently trampled and manured by cattle. The floristic structure was relatively homogenous, containing the species well adapted to heavy trampling and high soil nutrient content (*Poa annua*, *Bellis perennis*, *Ranunculus repens*, *Prunella vulgaris*, *Cynosurus cristatus*, *Trifolium repens* and *Prunella vulgaris*). Some species of mesic grasslands were present with higher constancy (*Trifolium pratense*, *Plantago lanceolata*, *Festuca rubra*, *Cerastium holosteoides*, *Agrostis capillaris*, *Alchemilla* spec. div. and *Achillea millefolium*). The average number of vascular species per

relevé was 32 (range 28–37) and moss layer cover varied from 7–75% with the most frequent species being *Rhytidiadelphus squarrosus*, *Plagiomnium undulatum, Climacium dendroides* and *Atrichum undulatum.*

Intensive grazing caused the typical physiognomy and species composition of this grasslands type which is very common and widespread across the Ukrainian Carpathians (ZAJAC et al. 2016). However, it is relatively sparse in the study area, where it is mainly distributed along river flood-plain slopes of 1–3° at 600–975 m a.s.l.

4. *Campanulo abietinae-Nardetum strictae* (15 relevés)

These grasslands were dominated by *Nardus stricta* and *Anthoxanthum odoratum* agg., with occurrence of species typical in Eastern Carpathians communities (Dacian migroelement) such as C*ampanula abietina*, *Scorzonera rosea* and *Viola dacica*. Montane species of the *Nardo-Agrostion tenuis* alliance were constantly frequent (*Trommsdorffia uniflora*, *Astrantia major*, *Arnica montana*, *Achillea distans* and *Gentiana clusii*) together with other oligotrophic graminoids (*Festuca rubra*, *Agrostis capillaris*, *Carex pilulifera*, *Luzula luzuloides*, *L. campestris* agg.). In addition, common species of mesic grasslands were more abundant on regularly mown plots (*Leucanthemum vulgare* agg., *Cruciata glabra*, *Trifolium pratense* and *Plantago lanceolata*). The species composition was completed by species of the *Violion caninae* alliance (*Polygala vulgaris*, *Thymus pulegioides* and *Carex pallescens*), the *Nardetea strictae* class (*Veronica officinalis*, *Potentilla erecta* and *Potentilla aurea*) and forest fringe species (*Anemone nemorosa*). The average number of vascular plant species per plot was 38 (range 26–59). The well developed moss layer covered 5–95%, with the following most common species *Pleurozium schreberi*, *Rhytidiadelphus squarrosus* and *Hylocomnium splendens.*

The stands are mostly extensively grazed by cattle and mown once or twice per year. The community is distributed at the higher altitudes of 800–1000 m a.s.l., mostly in the montane belt on slopes with 2–40° inclination and with various aspects.

5. *Antennario dioicae-Nardetum strictae* (3 relevés)

These were low pastures dominated by *Nardus stricta* and *Festuca ovina* and oligotrophic herbs such as *Antennaria dioica*, *Potentilla aurea* and *Carlina acaulis.* The *Vaccinium myrtillus*, *V. vitis-idaea* acidophilous dwarf-shrubs were also frequent in this community. The species composition included species of the *Violion caninae* alliance (*Viola canina*, *Polygala vulgaris*, *Potentilla erecta*, *Thymus pulegioides*, *Carex pilulifera* and *Pilosella officinarum*) and also common mesotrophic species of low-productive meadows (*Briza media*, *Jacea pratensis*, *Leucanthemum vulgare* agg. and *Pimpinella saxifraga* agg.). The average species richness of vascular plants was 32 (range 23–39 species) and the moss layer was usually well developed with up to 70% cover with the *Dicranum polysetum* rather frequent.

This community was occasionally recorded on gentle 5–12° slopes with southern to western aspects at higher montane altitudes (850–950 m a.s.l.). The stands are either mildly grazed by a few cattle or abandoned for a short time.

6. *Polygalo vulgaris-Nardetum strictae* (6 relevés)

This comprised grasslands dominated by *Nardus stricta* with constant occurrence of common mesic species of *Arrhenatherion elatioris* (*Festuca rubra*, *Anthoxanthum odoratum* agg., *Agrostis capillaris*, *Trifolium pratense*, *T. repens* and *Prunella vulgaris*) and *Violion caninae* alliances (*Luzula campestris* agg., *Potentilla erecta*, *Polygala vulgaris*, *Carex pallescens* and *C. pilulifera*). There was a higher frequency of hygrophilous species commonly distributed in semi-wet and wet grasslands typical for this association (*Carex nigra*, *C. echinata*, *C. panicea*, *Dactylorhiza majalis*, *Lychnis flos-cuculi*, *Holcus lanatus* and *Juncus conglomeratus*). There was an average of 39 vascular plant species per relevé (range 36–42 species), with total moss layer cover from 3 to 90%. The most frequent species were *Rhytidiadelphus squarossus*, *Pleurozium schreberi*, *Climacium dendroides* and the hygrophilous *Aulacomnium palustre* or *Sphagnum flexuosum* species regularly occured in these stands.

This association was recorded on low-productive meadows which are regularly mown, extensively grazed and unfertilized. The typical stands of this community are flat valley sites and gentle slopes (up to 2° in our dataset) at submontane and montane belt altitudes from 580 to 820 m a.s.l.

7. Transitions between *Violion caninae* and *Nardo strictae-Agrostion tenuis* alliances (including *Hyperico maculati-Deschampsietum flexuosae*, *Campanulo rotundifoliae-Dianthetum deltoidis* and *Betonico officinalis-Agrostietum capillaris*) (8 relevés)

The oligotrophic low-productive pastures and meadows were dominated by *Nardus stricta* and *Festuca rubra* hosting numerous oligotrophic and acidophilous species of the *Violion caninae* alliance (*Veronica officinalis*, *Pilosella officinarum*, *Thymus pulegioides*, *Viola canina* and *Luzula campestris*) and also the *Nardetalia strictae* order (*Potentilla erecta*, *Carex pallescens* and *C. pilulifera*). The regularly mown stands were characterised by higher abundance of oligotrophic and mesotrophic meadow species of the *Arrhenatherion elatioris* alliance (*Trifolium repens*, *Plantago lanceolata*, *Anthoxanthum odoratum* agg., *Achillea millefolium*, *Trifolium pratense* and *Prunella vulgaris*). In addition, strong competitive species (*Nardus stricta*, *Hypericum maculatum*, *Potentilla erecta* and *Vaccinium myrtillus*) and some woody species (*Prunus* sp.) were more frequent in ungrazed plots. There was an average of 35 vascular species per relevé (range 25–41 species). *Pleurozium schreberi*, *Hylocomium splendens* and *Dicranum polysetum* were the most frequent and dominant moss-species.

These grasslands are mainly extensively grazed by cattle and often mown once or twice a year. They are on moderate 0–7° slopes with varied aspects and mostly at submontane and montane altitudes of 400 to 800 m a.s.l.

Indirect gradient analysis

The detrended correspondence analysis graph detected the main gradients in studied vegetation species composition (DCA, Fig. 2). Total inertia in the DCA was 2.26 and eigenvalues were 0.256 (axis 1) and 0.173 (axis 2). The unimodal method was chosen because DCA resultant gradient length was long at 2.9 for the first axis. This explained 11.3% of the variance of species data and the second axis explained 7.7%. The average Didukh indicator values for soil humidity, acidity (pH), nitrogen, thermal climate, continentality, light and altitude were plotted on the ordination diagram together with the management treatments (grazing intensity, mowing and ploughing). With the exception of the mowing and ploughing nominal variables, these were correlated post-hoc with the ordination axes to reveal the main environmental gradients in our data set. The first axis was significantly positively correlated with altitude (correlation coefficient: 0.58) and also negatively correlated with indicator values for nitrogen (-0.85), thermal climate (-0.81), acidity (-0.80), continentality (-0.76) and light (-0.41). The main environmental gradient was related to altitude and soil parameters, especially soil acidity and nutrient content (nitrogen).

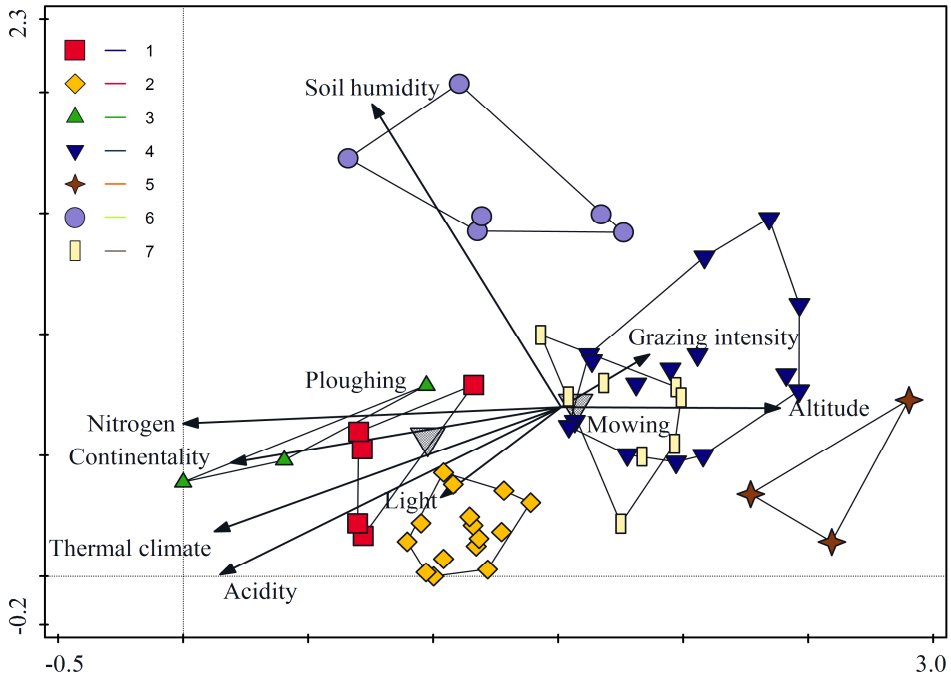

Fig. 2. DCA biplot of the seven delimited clusters showing the first two ordination axes with passive projection of altitude, management treatments and Didukh´s indicator values. (1 - *Poo-Trisetetum flavescentis*, 2 - *Anthoxantho odorati-Agrostietum tenuis*, 3 - *Lolio perennis-Cynosuretum cristati*, 4 - *Campanulo abietinae-Nardetum strictae*, 5 - *Antennario dioicae-Nardetum strictae*, 6 - *Polygalo vulgaris-Nardetum strictae*, 7 - transitions between *Violion caninae* and *Nardo strictae-Agrostion tenuis* alliances

The relevés of *Campanulo abietinae-Nardetum strictae*, *Antennario dioicae-Nardetum strictae* grasslands and transitions between *Violion caninae* and *Nardo strictae-Agrostion tenuis* occurring at higher altitudes on nutrient-poor acid soils were shifted on the right section of the ordination graph and communities of *Arrhenatherion elatioris* and *Cynosurion cristati* alliances were on the left (*Poo-Trisetetum flavescentis*, *Anthoxantho odorati-Agrostietum tenuis* and *Lolio perennis-Cynosuretum cristati*). This left area highlighted decreasing altitude and increasing DIV values for nitrogen, pH and temperature.

The second ordination axis was significantly positively correlated with soil humidity DIV (0.79) and negatively correlated with DIV for pH (-0.62), thermal climate (-0.52) and light (-0.43). Relevés of *Polygalo vulgaris-Nardetum strictae* association, hosting many moisture-demanding species, were depicted in the upper part of the ordination space, while mesic grasslands of drier habitats containing several thermophilous species (*Anthoxantho odorati-Agrostietum tenuis*) were shifted along the second axis to the lower part of the diagram.

Discussion

Syntaxonomic definition of clusters

We delimited 3 associations (*Poo-Trisetetum flavescentis*, *Anthoxantho odorati-Agrostietum tenuis* and *Lolio perennis-Cynosuretum cristati*), which occur very commonly in many European countries (UHLIAROVÁ et al. 2014, HÁJKOVÁ et al. 2007, ELLMAUER & MUCINA 1993). These were confirmed by ZAJAC et al. (2016) in the Ukrainian Carpathians. SOLOMAKHA (2008) listed the *Poo-Trisetetum flavescentis* community in the national syntaxonomical survey of Ukraine as *Trifolio-Festucetum rubrae* which is considered a partial synonym of this association (ŠKODOVÁ et al. 2015). These grasslands are more common in the western part of the Ukrainian Carpathians, where large areas of arable land were grass-covered after the abolition of agricultural cooperatives in 1990 (ŠKODOVÁ et al. 2015, ZAJAC et al. 2016). Relevé 14 (Tab. 3) in the *Poo-Trisetetum flavescentis* association cluster is a transitional grassland containing species of the *Arrhenatherion elatioris*, *Nardo-Agrostion tenuis* and *Polygono bistortae-Trisetion flavescentis* alliances. The grasslands of *Polygono bistortae-Trisetion flavescentis* in their typical form were not recorded in the study area and also throughout Ukrainian Carpathians (ZAJAC et al. 2016).

Syntaxonomical classification of the *Anthoxantho odorati-Agrostietum tenuis* association at the alliance level differs in European countries (*Arrhenatherion elatioris*, *Violion caninae*, *Cynosurion cristati*, UHLIAROVÁ et al. 2014, WILLNER et al. 2013, HÁJKOVÁ et al. 2007). We are following a syntaxonomic concept of Uhliarová et al. (2014) classifing this association in the *Arrhenatherion elatioris* alliance. The most likely reason is that this community forms a vegetation continuum between mown grasslands of *Arrhenatherion elatioris* or *Bromion erecti* alliances and the grazed pastures of *Violion caninae* or *Cynosurion cristati* alliances (HÁJKOVÁ et al. 2007). In Ukraine, it is reported in the *Cynosurion cristati* alliance (SOLOMAKHA 2008). Combination of mowing and grazing is currently the most frequent management form of the study area stands.

Tab. 2. Shortened synoptic table of semi-natural mesic grasslands in the Bystrytsya valley (Ukrainian Carpathians Mts) Only diagnostic species sorted according to decreasing frequency (with frequency at least 20 % in one column) are shown. Fidelities ≥ 40% are displayed in **bold.**

Cluster No.	1	2	3	4	5	6	7
No. of relevés	5	15	3	15	3	6	8
Poo-Trisetetum flavescentis							
Campanula patula	**100**	73	33	7	.	33	50
Stellaria graminea	**100**	60	.	40	33	17	63
Ranunculus acris	**100**	53	33	40	.	67	13
Cerastium holosteoides	100	40	100	47	.	50	50
Alchemilla spec. div.	100	80	100	47	.	33	25
Acetosa pratensis	**100**	67	.	47	.	17	38
Dactylis glomerata	**80**	33	.	.	.	.	.
Taraxacum sect. *Ruderalia*	60	27	67	.	.	.	.
Phyteuma spicatum	**60**	7	.	20	.	.	.
Carex sylvatica	**40**	.	.	.	.	.	.
Bromus hordeaceus	**40**	.	.	.	.	.	.
Anthriscus sylvestris	**40**	.	.	.	.	.	.
Primula veris	**40**	7	.	.	.	.	.
Phleum pratense	**40**	7	.	7	.	.	.
Crepis biennis	**40**	7	.	.	.	.	.
Vicia cracca	**40**	7	.	.	.	.	.
Anthoxantho odorati-Agrostietum tenuis							
Briza media	20	100	.	60	100	67	63
Carlina acaulis	40	87	.	47	67	.	50
Ranunculus polyanthemos	40	**87**	33	67	.	17	25
Pimpinella saxifraga agg.	40	**87**	33	13	67	.	25
Lotus corniculatus	40	73	33	13	33	17	25
Plantago media	.	**67**	67	.	.	.	13
Linum catharticum	.	**67**	.	.	.	.	.
Campanula glomerata	40	**60**	.	.	.	.	.
Betonica officinalis	.	60	.	20	.	33	38

Tab. 2. – cont.

Cluster No.	1	2	3	4	5	6	7
No. of relevés	5	15	3	15	3	6	8
Sisyrinchium montanum	20	**53**	.	13	.	.	13
Trifolium montanum	.	**47**	.	.	.	.	.
Filipendula vulgaris	20	**47**	.	.	.	.	.
Galium verum agg.	.	**40**	.	.	.	.	.
Trifolium pannonicum	.	**40**	.	.	.	.	.
Listera ovata	20	**40**	.	.	.	.	.
Knautia arvensis	20	**33**	.	.	.	.	.
Silene nutans	.	**27**	.	.	.	.	.
Peucedanum oreoselinum	.	**27**	.	.	.	.	.
Arrhenatherum elatius	20	27	.	.	.	.	.
Festuca rupicola	.	**20**	.	.	.	.	.
Lolio perennis-Cynosuretum cristati							
Ranunculus repens	20	.	**100**	.	.	.	.
Cynosurus cristatus	60	53	**100**	.	.	17	.
Bellis perennis	.	.	**100**	.	.	.	.
Poa annua	.	.	**100**	.	.	.	.
Festuca pratensis	20	13	**67**	.	.	.	.
Carum carvi	20	7	**67**	.	.	.	.
Sagina procumbens	.	.	**67**	.	.	.	.
Veronica serpyllifolia	.	.	**67**	7	.	.	.
Campanulo abietinae-Nardetum strictae							
Hypericum maculatum	60	60	33	100	67	.	88
Luzula luzuloides	40	13	.	**87**	33	17	25
Campanula abietina	.	13	.	**73**	.	50	25
Scorzonera rosea	.	7	.	**73**	.	.	.
Laserpitium krapfii	.	.	.	**67**	.	17	13
Anemone nemorosa	.	20	.	60	33	17	50
Cardaminopsis halleri	40	27	.	60	33	17	.
Trommsdorffia uniflora	.	.	.	40	33	.	13

Tab. 2. – cont.

Cluster No.	1	2	3	4	5	6	7
No. of relevés	5	15	3	15	3	6	8
Phyteuma vagneri	.	7	.	**33**	.	.	.
Viola dacica	.	.	.	**33**	.	.	.
Achillea distans	.	.	.	**33**	.	17	.
Poa chaixii	.	.	.	**27**	.	.	.
Antennario dioicae-Nardetum strictae							
Antennaria dioica	.	.	.	7	**100**	.	.
Vaccinium vitis-idaea	.	.	.	20	**100**	.	13
Festuca ovina	.	27	.	7	**100**	.	38
Potentilla aurea	.	7	33	33	**100**	.	38
Hieracium umbellatum	.	7	.	13	**67**	17	.
Polygalo vulgaris-Nardetum strictae							
Carex nigra	.	.	.	.	.	**100**	.
Carex echinata	.	.	.	.	.	**100**	.
Carex panicea	20	60	33	27	67	**100**	63
Dactylorhiza majalis	20	20	.	20	.	**100**	.
Carex ovalis	20	.	.	.	.	**67**	.
Equisetum sylvaticum	20	7	.	13	.	**67**	.
Juncus conglomeratus	.	.	.	.	.	**50**	.
Pilosella schultesii	20	.	.	7	.	**50**	.
Pedicularis sylvatica	.	.	.	.	33	**50**	.
Acetosa arifolia	20	.	.	27	.	**50**	13
Myosotis nemorosa	40	7	.	7	.	**50**	.
Scirpus sylvaticus	.	.	.	.	.	**33**	.
Crepis paludosa	.	.	.	.	.	**33**	.
Transitions between *Nardo strictae-Agrostion tenuis* and *Violion caninae*							
Veronica officinalis	40	20	67	80	33	50	100
Pilosella officinarum	20	60	33	67	100	33	100
Acetosella vulgaris	.	.	.	.	.	.	**38**

Tab. 2. – cont.

Cluster No.	1	2	3	4	5	6	7
No. of relevés	5	15	3	15	3	6	8
Diagnostic species for two associations							
Leontodon hispidus	**100**	93	67	20	33	.	63
Holcus lanatus	**100**	27	.	7	.	**100**	75
Trisetum flavescens	**80**	53	.	.	.	.	.
Lychnis flos-cuculi	60	7	.	.	.	**83**	13
Pilosella aurantiaca	.	.	.	53	.	**83**	13
Other species							
Festuca rubra agg.	100	100	100	100	33	100	100
Anthoxanthum odoratum agg.	100	93	67	93	67	100	100
Potentilla erecta	80	87	33	100	100	100	100
Agrostis capillaris	80	87	100	93	33	100	88
Luzula campestris agg.	100	100	67	80	33	100	88
Carex pallescens	100	93	33	80	67	83	88
Polygala vulgaris	80	93	33	87	100	83	75
Leucanthemum vulgare agg.	100	100	67	80	100	33	63
Thymus pulegioides	80	100	33	80	100	33	88
Trifolium repens	100	93	100	47	.	100	100
Plantago lanceolata	100	93	100	47	33	83	88
Trifolium pratense	100	100	100	53	.	83	75
Nardus stricta	20	60	67	87	100	100	100
Carex pilulifera	20	60	33	100	100	67	100
Cruciata glabra	100	100	33	67	67	17	63
Prunella vulgaris	80	93	100	40	.	100	75
Achillea millefolium	100	73	100	40	33	50	88
Viola canina	40	87	67	40	100	33	88
Rhinanthus serotinus	60	53	.	47	33	83	38
Gymnadenia conopsea	20	73	.	47	33	50	25
Danthonia decumbens	20	67	67	20	67	17	63
Jacea phrygia agg.	60	47	33	40	.	67	25

Tab. 2. – cont.

Cluster No.	1	2	3	4	5	6	7
No. of relevés	5	15	3	15	3	6	8
Vaccinium myrtillus	20	13	.	60	100	33	75
Arnica montana	.	7	.	73	100	67	50
Astrantia major	80	60	.	40	33	.	.
Veronica chamaedrys	80	40	67	40	.	17	13
Jacea pratensis	60	53	33	7	67	17	50
Hypochaeris radicata	60	60	67	20	.	.	13
Rhinanthus minor	60	53	.	13	33	33	13
Gentiana asclepiadea	20	20	.	33	.	50	13
Trifolium dubium	60	27	.	7	.	50	13
Euphrasia rostkoviana agg.	20	40	.	20	.	17	13
Gentianella lutescens	.	47	.	7	33	.	38
Deschampsia cespitosa	40	7	**33**	13	.	50	13
Picea abies (juv.)	.	13	.	40	.	17	.
Trifolium medium	.	27	.	13	33	.	13
Crepis conyzifolia	.	7	.	27	33	.	25
Trollius altissimus	.	13	.	20	33	.	13
Maianthemum bifolium	20	.	.	27	33	.	.
Betula pendula (juv.)	.	27	.	.	.	17	13
Pyrethrum clusii	.	7	.	13	33	.	25
Hieracium sabaudum	.	.	.	13	.	33	25
Bryophytes (E_0)							
Polytrichum formosum	20	.	.	.	.	.	.
Thuidium delicatulum	20	7	.	.	.	.	.
Brachythecium glareousum	20	.	.	.	.	.	.
Plagiomnium undulatum	.	.	**67**	.	.	.	.
Didimodon rigidulus	.	.	33	.	.	.	.
Eurhynchium hyans	.	.	33	.	.	.	.
Brachythecium rivulare	.	.	33	.	.	.	.
Hypnum cupresiforme	.	.	33	7	.	.	13

Tab. 2. – cont.

Cluster No.	1	2	3	4	5	6	7
No. of relevés	5	15	3	15	3	6	8
Thuidium recognitum	.	.	.	7	33	.	13
Pohlia nutans	.	.	.	.	33	17	.
Leucobryum glaucum	.	.	.	.	33	.	13
Ceratodon purpureus	.	.	.	7	33	.	.
Cladonia species	.	.	.	13	33	.	.
Polytrichum commune	.	.	.	7	.	**50**	13
Aulacomnium palustre	.	.	.	13	.	**50**	.
Sphagnum flexuosum	.	.	.	.	.	**33**	.
Atrichum undulatum	80	.	67	7	.	17	13
Abietinella abietina	20	33	.	7	.	.	13
Calliergonella cuspidata	20	20	.	.	.	17	.
Cirriphyllum pilliferum	20	20	33	7	.	17	.
Dicranum polysetum	.	13	.	27	67	.	50
Plagiomnium affine	20	7	33	33	33	.	13
Thuidium assimile	20	67	33	7	.	17	25
Climacium dendroides	60	33	67	20	.	67	13
Hylocomium splendens	40	33	33	87	.	17	63
Rhytidiadelphus squarrosus	60	53	100	60	.	67	25
Pleurozium schreberi	60	40	33	87	33	67	100

Tab. 3. Recorded relevés of semi-natural mesic grasslands in the Bystrytsya valley (Ukrainian Carpathians Mts).

Species/Relevé Nr.							
		1 1	2	1 1	1		
	84710	101561800123052	630	05650493797486 4	303	679792	52881294
	62048	822000224044640	268	06684062882404 6	068	860448	26486228
Poo-Trisetetum flavescentis							
Campanula patula	+1++1	++.+.++++++.++.	..r	....+.........	...	..+.+.	+.+..+m.
Stellaria graminea	++++1	+++.+++..+.++..	...	.+..+r...++..+.	.+.	.+....	+.++..++
Ranunculus acris	+1++1	++++.++1...1...	..+	...+.r.+.++.1..	...	..11ba	.....1..
Cerastium holosteoides	++1+1	.+..+++.....+1.	1++	++.++....+rr...	...	..+.+r	r.+..++.
Alchemilla spec. div.	11+ma	a1.a++1a.+ma.1+	+a+	.b.+....1++.1+.	...	....++	.....++.
Acetosa pratensis	+1++1	+.+..+++1++.+1.	...	.1..++.+1+...+.	...	..+...	+++.....
Dactylis glomerata	mbb.1	+....+.+....1.+	...	....	...	......	....
Taraxacum sect. *Ruderalia*	..+r+	..+....r..r...r	.a1	....	...	......	....
Phyteuma spicatum	.+.++	.....+.........	...	.....r.r.....a.	...	......	....
Primula veris	.+..r	..............a	...	....	...	......	....
Phleum pratense	..+.+	.............+.	...	.............+.	...	......	....
Crepis biennis	+...1	.......+.......	...	....	...	......	....
Vicia cracca	.+..+	1..............	...	....	...	......	....
Anthoxantho odorati-Agrostietum tenuis							
Briza media	.+...	111m11111111++m	...	++++11.+.+1....	+11	+++..+	.111+..+
Carlina acaulis	+.r..	+1+r1.++++r++.r	...	..+.1+1.++..+..	.+1	......	.++++...
Ranunculus polyanthemos	.+..+	+++.++++a+1++.+	+..	+1+1++...++.11.	...	.....+	.11.....
Pimpinella saxifraga agg.	...++	++11+11++++.1.1	.+.	.........++....	.+r	......	.++.....
Lotus corniculatus	.1+..	+a1..+1.++1.+++	..+	.........+1....	.+.	.+....	.....+.+
Plantago media	.....	.11+r+++..1.+.1	.11	....	...	......	.+......
Linum catharticum	.....	.m+.++m.+.1++.1	...	....	...	......	....
Campanula glomerata	.+..a	+.+..+++...r+++	...	....	...	......	....
Betonica officinalis	.....	..1+.1.1a1b.a.+	...	.....1...++....	...	..+..+	.+r1....
Sisyrinchium montanum	.+...	.+1.1r.++.r...+	...	.........rr....	...	......	.......r
Trifolium montanum	.....	..a.+.++..b.1.1	...	....	...	......	....
Filipendula vulgaris	.+...	a.1....aa1..1.b	...	....	...	......	....
Galium verum agg.	.....	1.r.....1r..m.1	...	....	...	......	....
Trifolium pannonicum	.....	..1.r...111.r..	...	....	...	......	....

Tab. 3. – cont.

Species/Relevé Nr.	1 1 1 1 1 1 1 1 84710 101561800123052 630 056504937974864 303 679792 52881294 62048 822000224044640 268 066840628824046 068 860448 26486228
Listera ovata	...+.|r..+++....++...|...|..............|...|......|........
Knautia arvensis	.1...|+......++...1.+|...|..............|...|......|........
Silene nutans	.....|++.....r....+..|...|..............|...|......|........
Peucedanum oreoselinum	.....|..1.....aa....3|...|..............|...|......|........
Arrhenatherum elatius	....a|+......+....a.1|...|..............|...|......|........
Festuca rupicola	.....|........1...+.a|...|..............|...|......|........
Lolio perennis-Cynosuretum cristati	
Ranunculus repens	+....|..............|+a+|..............|...|......|........
Cynosurus cristatus	.1+.+|+...+++.+++.+..|1aa|..............|...|....+.|........
Bellis perennis	.....|..............|111|..............|...|......|........
Poa annua	.....|..............|a1+|..............|...|......|........
Festuca pratensis	+....|.....+1........|.a+|..............|...|......|........
Carum carvi	+....|..........+....|.1+|..............|...|......|........
Veronica serpyllifolia	.....|..............|r.+|..............r|...|......|........
Campanulo abietinae-Nardetum strictae	
Hypericum maculatum	.+.+1|..+...++a+++1+.|+..|1+1++11+1+++a1m|.++|......|++.1+1++
Luzula luzuloides	.1.+.|.+...+........|...|11a1b.aba1a.ba+|a..|1.....|.+...1..
Campanula abietina	.....|....r......r...|...|+1m+.r..a1+1.1+|...|++...+|.+.....+
Scorzonera rosea	.....|.r............|...|+.++..++.1++1b.|...|......|........
Laserpitium krapfii	.....|..............|...|.+1.+.+.r+++.b1|...|+.....|..+.....
Anemone nemorosa	.....|.+.m.1........|...|a+a1+..1.ra...r|.+.|.....r|.a1..a.r
Cardaminopsis halleri	.+..+|.....++.+...+..|...|+r.+r...+++.++.|..+|....+.|........
Trommsdorffia uniflora	.....|..............|...|.3+.3.ab+......|+..|......|..+.....
Phyteuma vagneri	.....|.r............|...|1..a...1.ar....|...|......|........
Viola dacica	.....|..............|...|+...1....1+.+..|...|......|........
Achillea distans	.....|..............|...|.....+...+1.++.|...|+.....|........
Poa chaixii	.....|..............|...|++.1........1..|...|......|........
Antennario dioicae-Nardetum strictae	
Antennaria dioica	.....|..............|...|....r..........|b+1|......|........

Tab. 3. – cont.

Species/Relevé Nr.		1 1	1	1 1	1		
	84710	101561800123052	630	056504937974864	303	679792	52881294
	62048	822000224044640	268	066840628824046	068	860448	26486228
Vaccinium vitis-idaea	.....	....	...	....+1+........	+a+	......	.b......
Festuca ovina	.....	.r.1......1+...	...	....1..........	bbb	......	.ab.+...
Potentilla aurea	.....	.+.............	r..	+.......++..1a.	r++	......	11....1.
Hieracium umbellatum	.....	....r..........	...	....1...+......	r+.	.+....	....
Polygalo vulgaris-Nardetum strictae							
Carex nigra	.....	....	...	....	...	11111a	....
Carex echinata	.....	....	...	....	...	1+++++	....
Carex panicea	...1.	..+m+++.+.+.+.+	r..	...1.1....++...	+1.	a11111	.+.1+1.+
Dactylorhiza majalis	...+.	r..r.r.........	...	...+.....r.r...	...	+++r1+	....
Carex ovalis	..+..	....	...	....	...	+..aa+	....
Equisetum sylvaticum	+....	.....+.........	...	...+....+......	...	.+1++.	....
Juncus conglomeratus	.....	....	...	....	...	..+1+.	....
Pilosella schultesii	..+..	....	...	.........+.....	...	r+.+..	....
Pedicularis sylvatica	.....	....	...	....	1..	++.1..	....
Acetosa arifolia	..+..	....	...	...........++1+	...	+.+.1.	.......1.
Myosotis nemorosa	r...+	......r........	...	...+...........	...	..++1.	....
Transitions between *Nardo strictae-Agrostion tenuis* and *Violion caninae*							
Veronica officinalis	..++.	....+.+......1.	m.r	++++..+.1+++1++	+..	..+r+.	1++m+11+
Pilosella officinarum	...1.	+..a11+..11.1.1	a..	+.+1+.1.111++..	11+	+.+...	b1+a+a11
Acetosella vulgaris	.....	....	...	....	...	......	+..1..+.
Leontodon hispidus	11am+	baabaaa1a1mb1b.	.ba	.1.......+1....	r..	......	.1.1.1+1
Holcus lanatus	ab+a1	1....1.1....1..	...	....+..........	...	+111a1	.++.r11+
Trisetum flavescens	1a.+a	+1...1.11.a.1.+	...	....	...	......	....
Lychnis flos-cuculi	+..++	.....+.........	...	....	...	+.11+1	......+.
Pilosella aurantiaca	.....	....	...	+..+....++.++a+	...	.+++1+	......+.
Other species							
Festuca rubra agg.	3+ba+	baa1b1bbaaaa1ba	b+a	1b13ab113a1abaa	.a.	aaa1ab	a3aaba3a
Anthoxanthum odoratum agg.	11aaa	aabmaaaaab.1aa+	1.1	bb13a1.1bbababa	.1+	a11aa1	+11m+ma1
Potentilla erecta	1++b.	b11a111+a+m1.a.	1..	amam1amabaa+ba1	aaa	11a11a	ba11mab1

Tab. 3. – cont.

Species/Relevé Nr.		1 1	1	1 1	1		
	84710	101561800123052	630	056504937974864	303	679792	52881294
	62048	822000224044640	268	066840628824046	068	860448	26486228
Agrostis capillaris	a.a+1	11ba11a1+111.1.	11b	1111111.a1111a1	.1.	11111+	1.111aa1
Luzula campestris agg.	1++1+	1+11++a+m+++m1+	+.+	.1+1+a1.a++1.++	.+.	+1a+1+	.1+++1a1
Carex pallescens	11+a+	1++1++a++.1+1++	+..	+1.1.1+++++++.+	.++	111.+1	1++1+1+.
Polygala vulgaris	++++.	m111++1mm+11+m.	+..	+++1+11.1+++++.	+++	++m+.+	.1+1+.+1
Leucanthemum vulgare agg.	ba1m1	b1+1++1+11+1ab1	.1+	+1+1+++.1++.1+.	+++	++....	.+11+..+
Thymus pulegioides	1+++.	1a11+1a+11m1m+m	1..	11+1+++.a1a+a..	+1a	+.1...	.111++11
Trifolium repens	11b+1	+1+m+111a+1a+1.	bba	1..+1....1+.+a.	...	++1+1+	++1++1+1
Plantago lanceolata	1111a	111.+111a1a11+1	aa1	+1.1....111..+.	.+.	++1+.+	.++++a++
Trifolium pratense	+1aaa	11+1+1aa114a11+	+1a	+1.+1....11+.1.	...	.++1b1	++1..++1
Nardus stricta	...1.	.+a11+1.11.+...	1.r	3a3b3333.+b4.+b	333	b4ab1b	b3ba4ba3
Carex pilulifera	...1.	1+11.1...11+.+.	+..	a1a1+1ba+++11+1	a11	a+m+..	1+++11+1
Cruciata glabra	1m+a1	11+1a+11am1++11	..r	1m.m1a..+1+.+1.	.+1	+.....	.1+1.1.1
Prunella vulgaris	11.+1	+++mm+a+.+a++11	mma	.+.++...+++....	...	m+1+1+	+.+m.+++
Achillea millefolium	+++1m	++++.+.+++..1++	aa1	.+.++....+++...	.+.	.+++..	++++.+++
Viola canina	+.+..	1++.1++++11+++.	+r.	.+..+++..++....	++1	..+..+	+++++m.+
Rhinanthus serotinus	..11+	.a..++1++...11.	...	.+..+...++.+.+r	.+.	+1a+1.	..1...++
Gymnadenia conopsea	...1.	.1+r+++.r1+rr..	...	++.rr.1..r.r...	.+.	+.+..1	...r.r..
Danthonia decumbens	...+.	.rr11+1...++.a+	11.	+.....1.......+	.++	.+....	a.+1a+..
Jacea phrygia agg.	1.1.+	++.1.1a....1.a.	.r.	.1.a.1...11.+..	...	.+11.1	.+.....+
Vaccinium myrtillus	...1.	...+.....+.....	...	a.a.+111..a+..a	baa	1+....	11+1.m.1
Arnica montana	.....	......r........	...	b.ar.1a+.1+1.1a	r+1	1+1..r	.r.++.+.
Astrantia major	+1.+b	1.1b.a+..+b+.+.	...	...1r+...a1..1.	..+	......	....
Veronica chamaedrys	++1.1	.r..rr...+.++..	.rr	+...+r...+..++.	...	.....+	.r......
Jacea pratensis	+..+a	1..a1..raa+...1	+..	....+..........	.++	1.....	..+1+..r
Hypochaeris radicata	+.1+.	++...r+++..r.1r	1.+	......+.++.....	...	......	...1....
Rhinanthus minor	1+..1	+++1.+...+++...	...	....r.........r	..r	....+1	.+......
Gentiana asclepiadea	.+...	..r+.....+.....	...	..+..+.+....1.+	...	1+...+	+.......
Trifolium dubium	31+..	+1...1.r.......	...	....+..........	...	..1r+.	......+.
Euphrasia rostkoviana agg.	+....	++..++m+.......	...	.+.......++....	...	....+.	.....+..

Tab. 3. – cont.

Species/Relevé Nr.							
		1 1	1	1 1	1		
	84710	101561800123052	630	056504937974864	303	679792	52881294
	62048	822000224044640	268	066840628824046	068	860448	26486228
Gentianella lutescens	.....	++.1+rr.......+	...	.r.............	.+.	......	..+r...r
Deschampsia cespitosa	..++.	.............1.	.+.	........1...+..	...	..+++.	......1.
Picea abies (juv.)	.....	.....rr........	...	r.rr..+..r..r..	...	....r.	....
Trifolium medium	.....	....b..+...1+..	...	.....+....+....	.+.	......	..+.....
Crepis conyzifolia	.....	.....+.........	...	.......+.++a...	.+.	......	...r..1.
Trollius altissimus	.....	......+....r...	...	.+...a......+..	..1	......	.r......
Maianthemum bifolium	...r.	....	...	+..+...+....m..	..r	......	....
Betula pendula (juv.)	.....	..r..r..r..+...	...	....	...	+.....	...+....
Pyrethrum clusii	.....	......+........	...	..+..+.........	..1	......	...r...+
Hieracium sabaudum	.....	....	...	..+...........+	...	++....	...+...+
Heracleum sphondylium	....r	..+.....+.1....	...	............+..	...	......	....
Traunsteinera globosa	.....	.....r...r.....	...	.....r+..r.....	...	......	....
Salix aurita (juv.)	.....	.....r.........	...	.......r.......1	...	+.....	.......+
Carex caryophyllea	.+...	.......++...1..	...	....	...	......	....
Gladiolus imbricatus	.....	..+.....1+.....	...	.....+.........	...	......	....
Succisa pratensis	.....	..+......1.....	...	....r..........	.1.	......	....
Primula elatior	.....	...+.......1...	...	.....+.........	..r	......	....
Platanthera bifolia	.....	.....r...r.....	...	.......+.......	...	......	.......r.
Crocus heuffelianus	.....	.....r.........	...	.+.1+..........	...	......	....
Hieracium lachenalii	.....	....	...	......+.....+..	...	......	+.....r.
Solidago virgaurea	.....	....	...	.............1+	...	.....r	...+....
Ophioglossum vulgatum	.+...	......+....+...	...	....	...	......	....
Dactylorhiza fuchsii	.r...	..+......r.....	...	....	...	......	....
Phyteuma tetramerum	....a	.............1.	...	.+.............	...	......	....
Aposeris foetida	.....	....	...	.........a1....	...	......	......+..
Fragaria vesca	.....	....	...	............+..	..r	......	......+..
Hieracium sp.	.....	....	...	.......r...+..+	+.+	......	....
Prunus sp. (juv.)	.r.r.	......r.....rr.	...	....	...	......	....+r+.
Soldanella sp.	.....	....	...	.....m.+.......	..+	......	....

Tab. 3. – cont.

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Species/Relevé Nr.                      1   1             1 1   1          1
                                 84710|101561800123052|630|056504937974864|303|679792|52881294
                                 62048|822000224044640|268|066840628824046|068|860448|26486228

Bryophytes (E0)
Pleurozium schreberi             a+.1.|.a.3.a..a1.+...|a..|+.33a+1.3ba+431|.b.|1+a1..|451babb+
Atrichum undulatum               ++.+a|...............|.+a|.......+.......|...|.....+|..+.....
Hylocomnium splendens            a..3.|a1...bb.....b.|..b|ba33a11a1a114..|...|1.....|.+aaa.1.
Rhytidiadelphus squarrosus       +.b3.|ab33.+...4.1.1.|a3b|a4.b1..+3b...41|...|b.4.33|.+...b..
Abietinella abietina             ..a..|.b..b.+...a1...|...|..........1....|...|......|.a.....
Polytrichum commune              .....|...............|...|1..............|...|b..1.1|.+......
Calliergonella cuspidata         +....|+.....1...a..|...|...............|...|...3.|........
Climacium dendroides             ++.+.|..1.++..1....+.|1.+|...+....+1.....|...|..1111|......+.
Thuidium assimile                +....|+.++1.+1..ab1+.|1..|.+.............|...|....1.|...a..+.
Cirriphyllum pilliferum          .b...|...1....+1.....|1..|.+.............|...|....1.|........
Dicranum polysetum               .....|....1.....+....|...|..a.a.++.......|.1+|......|..++.r.1
Hypnum cupresiforme              .....|...............|.3.|.......+.......|...|......|.....b..
Rhytidium rugosum                .....|..........+...4|...|...............|...|.+....|........
Cladonia sp.                     .....|...............|...|......4..+.....|1..|......|........
Plagiomnium affine               ..+..|......+........|+..|+.+....+.++....|..+|......|.......+
Thuidium recognitum              .....|...............|...|........+......|..a|......|..1.....
Aulacomnium palustre             .....|...............|...|......+....+...|...|+.+1..|........
```

Species in less than three relevés only:

Carex sylvatica 21: r, 7: +; *Bromus hordeaceus* 43: +, 4: +; *Anthriscus sylvestris* 43: +, 4: +; *Sagina procumbens* 31: r, 54: +; *Scirpus sylvaticus* 45: +, 37: 1; *Crepis paludosa* 37: r, 47: 1; *Plantago major* 43: r, 31: +; *Acer pseudoplatanus* juv. 21: r, 6: r; *Glechoma hederacea* 4: 1, 18: +; *Holcus mollis* 25: +, 12: a; *Equisetum arvense* 55: +, 41: +; *Juniperus communis* juv. 31: r, 48: r; *Polygonatum verticillatum* 50: +, 28: r; *Angelica sylvestris* 28: +, 40: b; *Homogyne alpina* 20: +, 48: m; *Salix caprea* juv. 26: r, 44: +; *Veronica arvensis* 43: +; *Alopecurus pratensis* 43: +; *Aegopodium podagraria* 43: +; *Rubus* subgen. *Rubus* 43: r; *Fraxinus excelsior* juv. 21: r; *Cardamine pratensis* 35: +; *Viola arvensis* 35: r; *Lolium perenne* 4: +; *Selinum carvifolia* 4: r; *Ononis arvensis* 6: 1; *Melampyrum nemorosum* 6: +; *Helianthemum nummularium* 6: r; *Carex flava* agg. 25: +; *Pimpinella major* 55: r; *Filipendula ulmaria* 55: r; *Cirsium oleraceum* 41: +; *Molinia caerulea* 1: +; *Carex hirta* 5: +; *Anthyllis vulneraria* agg. 12: 1; *Salvia verticillata* 3: 1; *Galium mollugo* agg. 3: +; *Carex ornithopoda* 3: +; *Clinopodium vulgare* 3: +; *Daucus carota* 3: +; *Viola hirta* 3: +; *Echium vulgare* 3: r; *Arabis hirsuta* agg.

3: r; *Digitalis grandiflora* 3: r; *Ranunculus nemorosus* 27: a; *Medicago falcata* 10: 1; *Helianthemum gradiflorum* ssp. *obscurum* 10: +; *Campanula persicifolia* 10: +; *Tragopogon orientalis* 10: r; *Leontodon autumnalis* 31: 1; *Poa pratensis* 31: 1; *Cirsium arvense* 18: 1; *Potentilla reptans* 18: +; *Phleum rhaeticum* 50: +; *Populus tremula* juv. 50: r; *Parnassia palustris* 20: +; *Pedicularis hacquetii* 20: +; *Pseudorchis albida* 16: +; *Scorzonera humilis* 16: +; *Alnus glutinosa* juv. 49: r; *Sorbus aucuparia* juv. 49: r; *Omalotheca sylvatica* 49: r; *Cirsium waldsteinii* 40: 1; *Calamagrostis arundinacea* 40: 1; *Pilosella bauhinii* 23: +; *Athyrium filix-femina* 23: r; *Lycopodium clavatum* 19: +; *Eleocharis palustris* 34: r; *Rhinanthus alectorolophus* 37: +; *Salix cinerea* juv. 37: r; *Caltha palustris* 37: r; *Poa palustris* 47: 1; *Geum rivale* 47: +; *Equisetum fluviatile* 47: +; *Chaerophyllum hirsutum* 47: +; *Juncus effusus* 14: +; *Myosotis scorpioides* agg. 14: +; *Carex brizoides* 14: +; *Luzula sylvatica* 26: r; *Dianthus carthusianorum* 42: +; *Crataegus monogyna* juv. 11: r; *Ranunculus bulbosus* 24: +; *Trommsdorffia maculata* 24: +; *Picris* sp. 22: +; *Calamagrostis* sp. 19: a; *Achillea* sp. 12: +; *Myosotis* sp. 21: r, 20: +; *Cuscuta* sp. div. 6: r; *Euphorbia* sp. 6: +, 20: +; *Jacea* sp. 21: 1, 6: 1; *Carex* sp. 30: 1, 31: 1; *Galium* sp. 40: +; *Festuca* sp. 12: 1; *Thuidium delicatulum* E_0 35: 1, 10: +; *Rhytidiadelphus triquetrus* E_0 11: 1; *Plagiomnium undulatum* E_0 18: +, 54: +; *Fissidens taxifolius* E_0 1: +, 36: +; *Amblystegium serpens* E_0 1: +; *Brachythecium glareousum* E_0 4: a; *Polytrichum formosum* E_0 7: +; *Leucobryum glaucum* E_0 19: 3, 8: +; *Dicranum bonjeanii* E_0 9: +, 25: +; *Scleropodium purum* E_0 11: +; *Pohlia nutans* E_0 15: 1, 14: 1; *Ceratodon purpureus* E_0 16: 1, 15: 1; *Brachythecium rivulare* E_0 18: 1; *Eurhynchium hyans* E_0 18: 1; *Didymodon rigidulus* E_0 18: 1; *Plagiomnium ellipticum* E_0 20: +; *Tortella tortuosa* E_0 30: +; *Sphagnum flexuosum* E_0 38: +, 37: 1; *Sphagnum palustre* E_0 38: +; *Polytrichum pallidisetum* E_0 38: 1; *Racomitrium canescens* E_0 44: +; *Plagiomnium cuspidatum* E_0 46: +

Location of relevés

Relevé number; Locality; Altitude (m a. s. l.); Aspect (°); Slope (°); Cover total (%); Cover herb layer (%); Cover moss layer (%); Field number; Latitude (°); Longitude (°); Date (year/month/day); Author code
List of Authors: AK: Anna Kuzemko, IŠ: Iveta Škodová, JS: Janka Smatanová, RK: Roman Kish, MZ: Milan Zajac
NA- data is not available

2; Pasichna, Ivano-Frankivsk region, Ukraine; 595; 210; 25; NA; 95; 10; 2015/01-16; 48.5956389; 24.4018056; 20150609; JS, AK
4; Pasichna, Ivano-Frankivsk region, Ukraine; 582; NA; NA; NA; 95; 10; 2015/02-16; 48.5915833; 24.4083056; 20150609; JS, AK
6; Pasichna, Ivano-Frankivsk region, Ukraine; 536; 156; 20; NA; 95; 10; 2015/03-16; 48.5804167; 24.4238611; 20150609; JS, AK
8; Pasichna, Ivano-Frankivsk region, Ukraine; 564; NA; NA; NA; 90; 20; 2015/04-16; 48.5886944; 24.4112778; 20150609; JS, AK
10; Sokolovytsya, Ivano-Frankivsk region, Ukraine; 648; 35; 5; NA; 88; 70; 2015/05-16; 48.5921111; 24.4396389; 20150610; JS, AK
12; Sokolovytsya, Ivano-Frankivsk region, Ukraine; 617; 70; 3; NA; 85; 35; 2015/06-16; 48.5909167; 24.4394444; 20150610; JS, AK
14; Zelena, Ivano-Frankivsk region, Ukraine; 637; 340; 20; 98; 98; 80; 2015/07-16; 48.5420833; 24.37505; 20150609; IŠ, RK
16; Zelena, Ivano-Frankivsk region, Ukraine; 687; 250; 7; 75; 75; 20; 2015/08-16; 48.5409167; 24.3766389; 20150609; IŠ, RK
18; Zelena, Ivano-Frankivsk region, Ukraine; 583; NA; NA; 98; 98; 20; 2015/09-16; 48.544; 24.3744444; 20150609; IŠ, RK
20; Pasichna, Ivano-Frankivsk region, Ukraine; 562; 321; 30; 100; 99; 75; 2015/12-16; 48.5663611; 24.4124444; 20150609; IŠ, RK
22; Pasichna, Ivano-Frankivsk region, Ukraine; 584; 20; 3; 96; 90; 60; 2015/11-16; 48.5687778; 24.4330833; 20150609; IŠ, RK

24; Zelena, Zelenytsya Verknya, Priluky, Ivano-Frankivsk region, Ukraine; 720; NA; 20; 98; 97; 30; 2015/12-16; 48.4951111; 24.3991944; 20150609; RK
26; Zelena, Zelenytsya Verknya, Priluky, Ivano-Frankivsk region, Ukraine; 684; 0; 0; 95; 80; 50; 2015/13-16; 48.6015278; 24.3613889; 20150609; MZ
28; Zelena, Zelenytsya Verknya, Priluky, Ivano-Frankivsk region, Ukraine; 677; 0; 0; 90; 85; 50; 2015/14-16; 48.6018889; 24.3618889; 20150609; MZ
30; Zelena, Zelenytsya Verknya, Priluky, Ivano-Frankivsk region, Ukraine; 953; 180; 5; 60; 55; 5; 2015/15-16; 48.6188889; 24.3735278; 20150609; MZ
32; Zelena, Zelenytsya Verknya, Priluky, Ivano-Frankivsk region, Ukraine; 942; 45; 3; 85; 85; 5; 2015/16-16; 48.6194444; 24.374; 20150609; MZ
34; Zelena, Zelenytsya Verknya, Priluky, Ivano-Frankivsk region, Ukraine; 748; 90; NA; 95; 95; 25; 2015/17-16; 48.60475; 24.3619722; 20150609; MZ
36; Zelena, Zelenytsya Verknya, Priluky, Ivano-Frankivsk region, Ukraine; 608; NA; 1; 98; 98; 70; 2015/18-16; 48.5972222; 24.3876389; 20150609; MZ
38; Sokolovytsya, Ivano-Frankivsk region, Ukraine; 956; 298; 12; 81; 70; 50; 2015/19-16; 48.5799444; 24.38225; 20150610; MZ, IŠ
40; Sokolovytsya, Ivano-Frankivsk region, Ukraine; 896; 338; 8; 90; 85; 3; 2015/20-16; 48.5796111; 24.3809444; 20150610; MZ, IŠ
42; Sokolovytsya, Ivano-Frankivsk region, Ukraine; 568; 90; 10; NA; 100; 30; 2015/21-16; 48.5899722; 24.3443611; 20150610; JS, AK
44; Maksimets, Ivano-Frankivsk region, Ukraine; 822; 30; 10; NA; 85; 10; 2015/22-16; 48.52625; 24.2446389; 20150611; JS, AK
46; Maksimets, Ivano-Frankivsk region, Ukraine; 823; 65; 15; NA; 75; 15; 2015/23-16; 48.5250556; 24.2455556; 20150611; JS, AK
48; Maksimets, Ivano-Frankivsk region, Ukraine; 810; NA; NA; 80; 10; 2015/24-16; 48.525; 24.2469167; 20150611; JS, AK
50; Zelena, Zelenytsya Verknya, Priluky, Ivano-Frankivsk region, Ukraine; 705; 360; 4; 96; 95; 80; 2015/25-16; 48.49475; 24.3863611; 20150611; RK
52; Klympushi, Ivano-Frankivsk region, Ukraine; 824; 72; 5; 80; 70; 60; 2015/26-16; 48.4294722; 24.2163333; 20150612; JS, IŠ
54; Klympushi, Ivano-Frankivsk region, Ukraine; 842; 158; 25; 95; 95; 25; 2015/27-16; 48.4325556; 24.2183056; 20150612; JS, IŠ
56; Klympushi, Ivano-Frankivsk region, Ukraine; 837; 6; 10; 99; 98; 70; 2015/28-16; 48.4334722; 24.2195278; 20150612; JS, IŠ
58; Klympushi, Ivano-Frankivsk region, Ukraine; 817; 304; 10; 95; 80; 80; 2015/29-16; 48.4336944; 24.2272222; 20150612; JS, IŠ
60; Maksimets, Ivano-Frankivsk region, Ukraine; 855; 135; 10; 93; 90; 30; 2015/30-16; 48.5296111; 24.2415833; 20150611; MZ
62; Maksimets, Ivano-Frankivsk region, Ukraine; 975; 180; 3; 95; 95; 30; 2015/31-16; 48.5286111; 24.2550556; 20150611; MZ
64; Maksimets, Ivano-Frankivsk region, Ukraine; 813; 90; 3; 99; 98; 60; 2015/32-16; 48.5201944; 24.2520278; 20150611; MZ
66; Maksimets, Ivano-Frankivsk region, Ukraine; 875; 90; 5; 90; 85; 70; 2015/33-16; 48.5195; 24.2475; 20150611; MZ
68; Maksimets, Ivano-Frankivsk region, Ukraine; 849; 135; 2; 95; 90; 60; 2015/34-16; 48.5178611; 24.2494444; 20150611; MZ
70; Zhary, Ivano-Frankivsk region, Ukraine; 856; 180; 5; 98; 98; 30; 2015/35-16; 48.4346111; 24.1993611; 20150612; MZ
72; Zhary, Ivano-Frankivsk region, Ukraine; 993; 90; 6; 85; 85; 10; 2015/36-16; 48.4399167; 24.2014444; 20150612; MZ
74; Maksimets, Ivano-Frankivsk region, Ukraine; 807; NA; NA; NA; 85; 10; 2015/37-16; 48.5252778; 24.2473333; 20150611; JS, AK
76; Maksimets, Ivano-Frankivsk region, Ukraine; 787; NA; NA; NA; 95; 7; 2015/38-16; 48.5221389; 24.2505278; 20150611; JS, AK

78; Bystrytsya, Dovzhinets, Ivano-Frankivsk region, Ukraine; 812; 271; 7; 98; 90; 95; 2015/39-16; 48.4410833; 24.2708889; 20150613; IŠ
80; Bystrytsya, Dovzhinets, Ivano-Frankivsk region, Ukraine; 802; 42; 40; 97; 85; 90; 2015/40-16; 48.4495; 24.2582778; 20150613; IŠ
82; Bystrytsya, Dovzhinets, Ivano-Frankivsk region, Ukraine; 789; 135; 35; 85; 80; 20; 2015/41-16; 48.4504722; 24.2575278; 20150613; IŠ
84; Bystrytsya, Ivano-Frankivsk region, Ukraine; 777; 225; 5; 97; 95; 30; 2015/42-16; 48.4628889; 24.24475; 20150613; MZ, JS
86; Maksimets, Ivano-Frankivsk region, Ukraine; 684; 122; 5; 99; 99; 30; 2015/45-16; 48.5048056; 24.29575; 20150611; IŠ, RK
88; Maksimets, Ivano-Frankivsk region, Ukraine; 809; 130; 5; 95; 90; 35; 2015/46-16; 48.5056667; 24.2907778; 20150611; IŠ, RK
90; Maksimets, Ivano-Frankivsk region, Ukraine; 682; NA; NA; 99; 98; 70; 2015/47-16; 48.5; 24.2952222; 20150611; IŠ, RK
92; Maksimets, Ivano-Frankivsk region, Ukraine; 704; NA; NA; 98; 98; 30; 2015/48-16; 48.4888611; 24.2766944; 20150611; IŠ
94; Klympushi, Ivano-Frankivsk region, Ukraine; 775; NA; NA; 100; 99; 80; 2015/49-16; 48.4378611; 24.2349444; 20150611; JS, IŠ
96; Bystrytsya, Dovzhinets, Ivano-Frankivsk region, Ukraine; 920; NA; NA; 95; 75; 70; 2015/50-16; 48.4428611; 24.2769444; 20150613; IŠ
98; Zhary, Ivano-Frankivsk region, Ukraine; 1014; 45; 2; 90; 90; 40; 2015/53-16; 48.4413611; 24.2061111; 20150612; MZ
100; Zhary, Ivano-Frankivsk region, Ukraine; 968; 135; 5; 92; 90; 40; 2015/54-16; 48.4421944; 24.2225; 20150612; MZ
102; Zhary, Ivano-Frankivsk region, Ukraine; 901; 158; 6; 95; 95; 50; 2015/55-16; 48.4391111; 24.2300556; 20150612; MZ
104; Bystrytsya, Ivano-Frankivsk region, Ukraine; 813; 135; 3; 96; 94; 30; 2015/56-16; 48.46375; 24.2439444; 20150613; MZ, JS
106; Bystrytsya, Ivano-Frankivsk region, Ukraine; 843; 135; 5; 85; 83; 30; 2015/57-16; 48.46475; 24.2428889; 20150613; MZ, JS
108; Bystrytsya, Ivano-Frankivsk region, Ukraine; 738; NA; NA; 97; 93; 50; 2015/58-16; 48.47375; 24.2591944; 20150613; MZ, JS
110; Bystrytsya, Ivano-Frankivsk region, Ukraine; 706; 135; 4; 98; 96; 30; 2015/59-16; 48.4833056; 24.2706667; 20150613; MZ, JS

The *Lolio perennis-Cynosuretum cristati* is commonly reported in several regional studies in the Ukrainian Carpathians (DERZHIPILSKY et al. 2011, SOLOMAKHA et al. 2004, CHORNEY et al. 2005, ŠKODOVÁ et al. 2015) and also from the Gorgany National Nature Reserve as the association *Festuco-Cynosuretum* (KLIMUK et al. 2006), which is a partial synonym of *Lolio perennis-Cynosuretum cristati* association (HÁJKOVÁ et al. 2007, JANIŠOVÁ et al. 2007a). However, the species composition of these grasslands published by KLIMUK et al. (2006) is similar to the *Anthoxantho odorati-Agrostietum tenuis* association. The name *Festuco-Cynosuretum* used also Solomakha (2008) in his vegetation survey. Relevé No. 62 (Tab. 3) here could be classified as transitional to the *Violion caninae* alliance.

The *Campanulo abietinae-Nardetum strictae* association is recognized in Slovakia and Poland (KLIMENT & UJHÁZY 2014). Montane grasslands from the Gorgany Mts (KLIMUK et al. 2006) and other parts of the Ukrainian Carpathians (DERZHYPILSKY et al. 2011, SOLOMAKHA et al. 2004) with very similar species composition have usually been assigned to *Hypochaerido uniflorae-Nardetum strictae*, which is a synonym for *Campanulo abietinae-Nardetum strictae* (KLIMENT & UJHÁZY 2014). ŠKODOVÁ et al. (2015) and ZAJAC et al. (2016) have listed these grasslands from the Ukrainian Carpathians under the current name. This association was found within the study area in two variants. The pasture type in relevés 40, 44, 46, 96, 100 (Tab. 3) is dominated by *Nardus stricta*, *Carex pilulifera* and oligotrophic species such as *Danthonia decumbens* and *Vaccinium myrtillus*, and the species-richer meadow variant in relevés 56, 64, 72, 78, 80 and 98 is characterised by higher abundance of *Molinio-Arrhenatheretea* species (including *Ranunculus acris*, *Plantago lanceolata*, *Trifolium pratense*, *Stellaria graminea*, *Acetosa pratensis*, *Prunella vulgaris* and *Achillea millefolium*). Certainly, there are also some transitional relevés included in the dataset. These two variants correspond floristically to *Violo declinatae-Nardetum* Simon 1966 and *Scorzonero roseae-Festucetum nigrescentis* (Puşcaru et al. 1956) Coldea 1987 associations listed in the Romanian syntaxonomical overview (COLDEA et al. 2012). The local absence of *Dianthus barbatus* ssp. *compactus* in this association is very interesting, because this is a diagnostic species, which commonly occurs in the *Campanulo abietinae-Nardetum strictae* in the Ukrainian Carpathians (ZAJAC et al. 2016). This species is listed also in the formal definitions of the expert system for identification of grassland syntaxa of Slovakia. This is the reason, why the major part of *Campanulo abietinae-Nardetum strictae* relevés were not identified to the *a priori* groups by expert system and the expert knowledge was necessarily used to re-evaluate the typical relevés of this association. In contrast, occurrence of *Laserpitium krapfii* is characteristic for this community in our study area. KLIMUK et al. (2006) classified grasslands with presence of this species as com. *Laserpitium alpinum-Agrostis tenuis*.

The *Antennario dioicae-Nardetum strictae* association had previously been accepted only in Slovak syntaxonomical surveys (MUCINA & MAGLOCKÝ 1985,

KLIMENT & UJHÁZY 2014). ZAJAC et al. (2016) have published this association from the Ukrainian Carpathians for the first-time. It is a well-differentiated type of extensive drier pastures with specific floristic composition of oligotrophic species also in the Bystrytsya valley region.

Polygalo vulgaris-Nardetum strictae is a rare community in the central and eastern Europe because grasslands dominated by *Nardus stricta* with some hygrophilous species are not very frequent (ZAJAC et al. 2016). Classification of wet mat-grass grasslands is not consistent throughout Europe (ELLMAUER 1993, MATUSZKIEWICZ 2001, DONIȚĂ et al. 2005, KRAHULEC et al. 2007), because they are transitional between three classes: the *Nardetea strictae*, *Molinio-Arrhenatheretea* and *Scheuzerio-Caricetea fuscae* (UJHÁZY & KLIMENT 2014). Relevés of this association in the Ukrainian Carpathians are classified in the *caricetosum fuscae* sub-association (ZAJAC et al. 2016). SOLOMAKHA (2008) classified wet grasslands with *Nardus stricta* to the oceanic *Nardo-Juncetum squarrosi* association. However, occurrence of this association in the Eastern Carpathians is unlikely because due to sub-continental climate.

The last cluster (7) includes transitional communities between the *Violion caninae* and *Nardo strictae-Agrostion tenuis* alliances which were not matched the formal definitions of target vegetation associations. Reléves No. 16, 26, 48, 84 and 88 (Tab. 3) could be classified as *Hyperico maculati-Deschampsietum flexuosae* refered from the Ukrainian Carpathians by ZAJAC et al. (2016). This association is characteristic by absence of thermophilous and xerophilous species and by occasional occurrence of montane species (KLIMENT & UJHÁZY 2014), which is valid for the majority of the cluster. Relevés No. 22 and 25 could be classified as transitional to the *Campanulo rotundifoliae-Dianthetum deltoidis* and relevé Nr. 92 to the *Betonico officinalis-Agrostietum capillaris*, which have also been recently published from Ukrainian Carpathians by ŠKODOVÁ et al. (2015) and ZAJAC et al. (2016). Although these associations are not clearly separated in our dataset because of the low number of relevés, their occurrence in the study area is expected.

KLIMUK et al. (2006) listed several grassland communities in the Gorgany Mts without specified syntaxonomical rank. Species composition of com. *Laserpitium alpinum-Agrostis tenuis* is similar to communities of alliance *Nardo-Agrostion tenuis* (especially *Campanulo abietinae-Nardetum strictae*). Grasslands between 1000 and 1200 m a.s.l. altitudes with dominant *Festuca rubra* are assigned to com. *Luzula luzuloides-Festuca rubra*. These relevés were classified as *Campanulo abietinae-Nardetum strictae* in the large scale classification of semi-natural mesic grasslands of the Eastern Carpathians (ZAJAC et al. 2016). Many descriptions of associations in local classification studies of Ukrainian Carpathians vegetation (SOLOMAKHA et al. 2004, CHORNEY et al. 2005, DERZHYPILSKY et al. 2011) do not follow the International Code of Phytosociological Nomenclature rules (WEBER et al. 2000). These syntaxa are mainly based on dominant species and mostly correspond to other validly described associations or lower units (ZAJAC et al. 2016).

Management

High floristic heterogeneity and transitional character of many communities is often due to the traditional management of grasslands classified in the *Arrhenatherion elatioris*, *Violion caninae* and *Nardo strictae-Agrostion tenuis* alliances. Traditional management includes especially grazing after the first or second mowing. The syntaxonomic classification of these stands is quite difficult because the vegetation often shares features of several different syntaxa (ŠKODOVÁ & HEGEDÜŠOVÁ VANTAROVÁ 2014). In contrast to the western parts of the Ukrainian Carpathians, oligotrophic species-rich communities (*Anthoxantho odorati-Agrostietum tenuis*, *Campanulo abietinae-Nardetum strictae*) are widely spread in the study area as a consequence of old traditional management practices. This area was one of the hotspots of resistance by the Organization of Ukrainian Nationalists against the Soviet Union and minimum soviet collectivization impact conserved the traditionally managed landscape structure for decades (KATCHANOVSKI 2009). Grasslands on the fallow fields of *Poo-Trisetetum flavescentis* were only rarely recorded and they were occured primarily on small plots in the vicinity of houses and farms. The age of these grasslands varied, depending on farming management practices. Some areas employed a special soil management regime where fallow meadows are ploughed after several years and transformed into cultivated fields while neighbouring fields are left fallow and only managed by mowing (ŠKODOVÁ et al. 2015).

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