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The dry grasslands (*Festuco-Brometea*) of the North Caucasus: first data on numerical classification and biodiversity patterns

Steppen- und Trockenrasenvegetation (*Festuco-Brometea*) im Nordkaukasus: erste Daten zur Syntaxonomie und Biodiversität

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Abstract

The North Caucasus is still one of the least studied regions in Europe regarding syntaxonomy. We investigated dry grasslands in the central part of the North Caucasus, namely in the Stavropol Kray region of Russia. We sampled 47 vegetation plots (relevés) of 10 m^2 size (3.16 × 3.16 m) at elevations from 470 to 1150 m a.s.l. To determine the scale-dependent species richness patterns, we recorded five nested-plot series of 0.0001 to 100 m^2 in different dry grassland types (one in xero-mesic, one in xeric, two in rocky grasslands on limestones, one in rocky grasslands on chalk outcrops). To obtain a more comprehensive understanding of higher-level syntaxa, we collected other available data from published sources from the Stavropol Kray and the Northern Caucasus. In total, we collected 392 additional relevés from the Republic of Karachay-Cherkessia, Stavropol Kray, Krasnodar Kray, Republic of Kabardino-Balkaria, Republic of North Ossetia-Alania and Dagestan Republic regions. We analyzed the dataset using Modified TWINSPAN with different settings until we received ecologically meaningful units. This yielded in five main cluster that correspond to the major steppe vegetation types: 1) desert steppes; 2) true steppes; 3) mountain steppes of Dagestan and the intermontane basins of the Central Caucasus; 4) rocky grasslands; 5) semi-dry and dry grasslands on deep soils. Considering that these vegetation types are quite unique and different from those described in previous literature, we describe here a new order of Caucasian and Crimean xerophilous rocky grasslands on calcareous outcrops (*Asphodelino tauricae-Euphorbietalia petrophilae*), three new alliances (*Artemisio chamaemelifoliae-Bromopsion variegatae*, *Helianthemo buschii-Cephalarion coriaceae*, *Onosmo caucasicae-Asphodelinion tauricae*) and nine new associations.

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Erweiterte deutsche Zusammenfassung am Ende des Artikels

1. Introduction

Rich flora and high level of endemism of the Caucasus flora (around 6300 species and 1600 endemics, SCHATZ et al. 2009) attracted many botanists starting from the end of 18th century. The first of them in the North Caucasus were J.A. Güldenstädt in 1771, S.G. Gmelin in 1772 and P.S. Pallas in 1793 (LYIHVAR 2018). Extensive floristic material has been accumulated in the 19th century due to numerous works of BIEBERSTEIN (1808), STEVEN (1812), KOCH (1843), BECKER (1868), LIPSKY (1894), SCHMALHAUSEN (1897) and others. The number of floristic studies in the North Caucasus significantly increased in 20th century (LYIHVAR 2018).

Despite the fairly well studied flora of the North Caucasus, the vegetation was not so well explored. The exploration of vegetation patterns started at the end of the 19th century (KUZNETSOV 1890, LIPSKIY 1894). Works on the peculiarities of the steppe vegetation distribution and their typification in the central part of the North Caucasus appeared in the first part of the 20th century (VERNANDER 1946, KONONOV 1953, 1971, NOVOPOKROVSKIY 1906, 1925, 1926, PRASOLOV 1909, TANFILEV 1971, FLEROV & BALANDIN 1931). Authors identified mainly grass-sagebrush (semi-desert) steppes in the Northern part of the region, forb-bunchgrass and bunchgrass steppes in the pre-mountain part of Caucasus, and mountain forest-steppes or meadow-steppes. One of the most comprehensive studies of the vegetation of North Caucasus was done by SHIFFERS (1953). Major part of her book is devoted to different types of dry grasslands with 55 relevés.

High-mountain meadow steppes were studied by N.L. Tsepkova (TSEPKOVA 1987, 2005) in the Glavny and Bokovoy ranges. She proposed three new associations. Later, this author studied dry grasslands on the Djinalskiy Range (a part of the Pastbishnyi Range). In this study she proposed two associations which could be assigned to the *Cirsio-Brachypodion* alliance (TSEPKOVA 2012, 2018). Grassland vegetation of the Skalisty Range (Karachay-Cherkessia) was studied by DEMINA et al. (2017). These authors published 15 relevés of semi-dry grasslands. Grassland vegetation of the intermontane basins of the Central Caucasus were studied within North Ossetia-Alania region, within the elevation range 1750–2560 m a.s.l. (BELONOVSKAYA et al. 2016, GRACHEVA et al. 2018). Steppe of the Stavropolsky Kray was studied by DZYBOV (2018), who analysed the vegetation according to the zonation: in semi-desert, dry steppe, forb-bunchgrass and meadow steppe zones. Also, he published 213 relevés of dry grasslands from different regions of Stavropolsky Kray.

Dry grasslands of the Central Caucasus were hardly studied using the Braun-Blanquet methodology. In total, there were only five associations invalidly described by N.L. Tsepkova (TSEPKOVA 1987, 2005, 2012, 2018). Two of these associations aimed to unite the specific type of dry grasslands – mountain steppes distributed on higher altitudes of the North Caucasus: '*Artemisio chamaemelifoliae-Caricetum humilis*' and '*Artemisio chamaemelifoliae-Plantaginetum atratae*'. One association '*Bothryochloa ischaemi-Salvietum canescentis*' was described on the pastures of the Bylym Arid Basin. It unites relict steppe communities with high proportion of *Lamiaceae* species, which are considered as glacial relicts. In addition, two associations were described in xero-mesic grasslands – '*Carici michelii-Bromopsietum ripariae*' and '*Astragalo demetrii-Brachypodietum*

rupestris'. Thus, the North Caucasus remains one of the most poorly studied regions in Europe from the point of view of syntaxonomy of the steppe vegetation, which also concerns other vegetation types.

The aims of this study are: (1) to show biodiversity patterns from the study region, including parameters of the species-area curve and richness values; (2) vegetation classification of dry grasslands of the Central Caucasus, proposing a classification scheme.

2. Material and Methods

2.1 Study area

The research area is situated in the central part of the North Caucasus. There are several ranges running from South-West to North-East: 1) Main Range (Glavnyy or Vodorazdelnyy) with elevations from 4500 to 5200 m a.s.l.; 2) Bokovoy (Peredovoy) Range; 3) Skalistyy (Yurskiy) (2500–3500 m a.s.l.); 4) Pastbishnyy (Melovoi, Lesistyy or "Chernye Gory") with elevations 1300–1750 m a.s.l.; 5) specific geomorphological region "Pyatigoriye", differs by the presence of low mountains (500–1400 m a.s.l.) of volcanic origin ("laccolites"); 6) Stavropol Plateau (up to 832 m – Strizhament Mount); 7) two low mountain ranges – Beshpagirskaya and Prikalausskaya. Finally, within the Caspian Lowland, the relief becomes flat with elevations of 10–200 m (SHIFFERS 1953, DZYBOV 2018). The Skalistyy Range is composed of Jurassic outcrops, crowned with solid limestones of the Upper Jurassic. From the north they are covered by Lower Cretaceous deposits. The area to the north of the Pastbishnyy Range is composed of Upper Cretaceous limestones. Further to the north, the next ridges are composed of Tertiary sandstones, limestones and marls (SHIFFERS 1953). In the Caspian Lowland, the main soil-forming material is loess (DZYBOV 2018).

We focused on the central part of the North Caucasus, namely, the region of "Pyatigoriye" and Borgustanskiy Range, belonging to the Pastbishnyy Range. The elevations in our study area varied from 470 to 1150 m a.s.l. (Fig. 1).

According to soil and geographical zoning of the Caucasus, the study area belong to the Stavropol group of Priazovsko-Predkavkazaskaya province of the zone of chernozems in forest-steppe soil-geographical region (KUPRICHENKOV 2005). Marl, limestones, sandstones, shales, gypsum-bearing clays are parent rocks. The soil cover consists of gray forest soils, chestnut soils and common chernozems.

The climate in the study area is temperate continental, the average January temperature is -4.1 °C, and the July average temperature is 21.7 °C. Annual precipitation is around 500 mm with a maximum in June. Relative humidity in July is 63%, in January 81%. Snow cover is unstable (RUSEEVA 1971).

The potential natural vegetation in the study region in the lower altitudes is represented by oak and oak-hornbeam forests (with *Quercus robur*, *Q. petraea*, *Q. hartwissiana*, *Carpinus betulus*). In the higher altitudes, they are replaced by beech and beech-fir forests (with *Fagus orientalis* and *Abies nordmanniana*) (SHIFFERS 1953).

2.2 Data collection

In May and June 2019, we sampled dry grasslands in the pre-mountain zone of the North Caucasus (Stavropolsky Kray, Russia). We made 47 relevés of 10 m^2 size (3.16 × 3.16 m) in homogeneous conditions at elevations from 470 to 1150 m a.s.l. All the vascular plants, terricolous bryophyte and lichen species were sampled using percentage scale. In addition, we measured the following site characterestics: latitude, longitude, altitude, aspect, inclination, total cover, herb layer cover, cryptogam layer cover, litter cover and maximum height of herbs (Supplement S1). To determine the relationship of species richness patterns to plot size, we recorded five nested-plot series of 0.0001 to 100 m^2 (seven different plot sizes in each series: 0.0001, 0.001, 0.01, 0.1, 1, 10 and 100 m^2) in different types of the dry grasslands according to the EDGG standard (DENGLER et al. 2016). The sites were selected independently with expected species richness and not aiming to deliberately obtain a species record count.

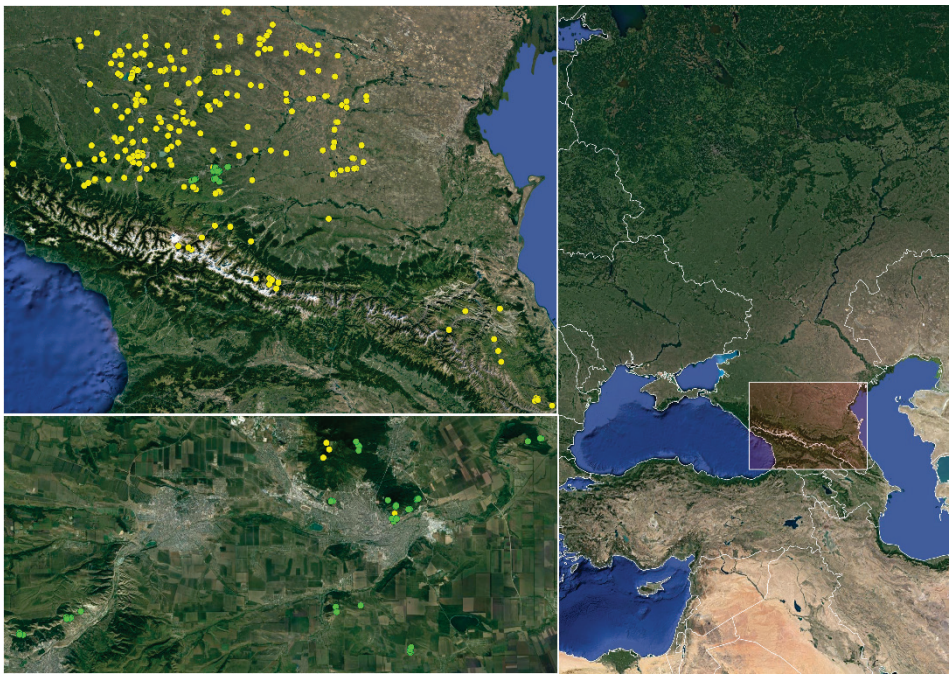


Fig. 1. The study area. Green dots represent authors' relevés, yellow dots represent relevés from literature sources. Map data ©2019 Google, ORION-ME.

Abb. 1. Das Untersuchungsgebiet. Grüne Punkte stehen für Vegetationsaufnahmen der Autoren, gelbe Punkte für Vegetationsaufnahmen aus Literaturquellen. Kartendaten ©2019 Google, ORION-ME.

In order to classify our data to high-level syntaxa, we also collected other available vegetation plot data from published sources from the North Caucasus (also beyond its central part) from Karachay-Cherkessia Republic, Stavropol Kray, Krasnodar Kray, Kabardino-Balkaria Republic, Republic of North Ossetia-Alania and Dagestan Republic regions (SHIFFERS 1953, TSEPKOVA 1987, 2005, 2012, 2018, ASHIBOKOVA 2009, BELONOVSKAYA et al. 2016, DEMINA et al. 2017, DZYBOV 2018, GRACHEVA et al. 2018). We digitalized the relevés, added the approximate georeferences based on the locality descriptions and included them to the Eastern European Steppe Database (VYNOKUROV et al. 2020). The majority of them did not have the information about plot size and did not include the cryptogam species records.

In total, 439 relevés that could be assigned to the *Festuco-Brometea* were collected. We excluded relevés with less than 11 species from the analysis to avoid incomplete vegetation plots. In addition, we excluded relevés with a high cover of typical meadow or ruderal species (e.g. *Anisantha tectorum*, *Anthoxanthum odoratum*, *Buglossoides arvensis*, *Calamagrostis arundinacea*, *Chorispora tenella*, *Elytrigia repens*, *Festuca pratensis*, *Trisetum flavescens*). The final cleaned dataset consisted of 413 relevés.

2.3 Data analysis

We used the Modified TWINSPAN classification (ROLEČEK et al. 2009) implemented in the JUICE program (TICHÝ 2002) with three pseudospecies cut levels (0%, 5% and 20% cover) and the mean between-plot Soerensen dissimilarity index as a measure of cluster heterogeneity. Diagnostic species were determined using the phi coefficient of association (CHYTRÝ et al. 2002). It was calculated using the presence-absence data with a virtual standardization of all plot groups to equal size (TICHÝ & CHYTRÝ 2006). Species with $phi > 0.2$ were considered as diagnostic for a particular vegetation type,

providing that the p-value from Fisher's exact test was lower than 0.001. Diagnostic species with *phi* > 0.5 were considered as highly diagnostic (marked bold in the list of diagnostic species). Constant species were selected with their frequency > 30%, highly constant species (with frequency > 50%) are marked bold in the list of constant species. Dominant species were selected with their cover > 30% and minimum frequency 10% in the vegetation plots. For the numerical analysis, all the cryptogams were removed, as well as the plant records determined only at the genus level. Additionally, we united some narrow taxonomic concepts of species to the wider aggregates (Supplement E1). The first stage aimed to identify the main vegetation units. To define the association-level syntaxa we performed the second stage of the analysis where we focused only on those previously obtainded clusters which contained our own vegetation plots and reapplied Modified TWINSPAN classification with the same parameters. For the DCA analysis, we used the R programming language (R CORE TEAM 2018) with the package *vegan* (version 2.5-6) (OKSANEN et al. 2019) using the function *decorana* with basic parameters. In order to quantify local β-diversity, we used the 'slope' of the species-area relationships, namely z-value as a fitted parameter of a power law ($S = c * A^z$, with S = species richness, A = area, c and z being fitted parameters) (RICCOTA et al. 2002). We calculated z-values in double-log space (linearized version of power model) considered as overall z-value: $\log_{10}S = \log_{10}c + z * \log_{10}A$ (DENGLER 2009).

Species names of vascular plants are given by CHEREPANOV (1995). We did not accept some species that are considered as independent in the list of Cherepanov but at the same time, are considered as synonyms according to the Euro+Med PlantBase (emplantbase.org), namely *Lotus caucasicus*, *Sideritis comosa* and *Plantago urvillei*. For the bryophytes we used checklist of mosses of East Europe and North Asia by IGNATOV et al. (2006).

We follow MUCINA et al. (2016) for the names and authors of syntaxa unless mentioned otherwise.

3. Results and discussion

3.1 Flora

During the field research in 2019 in our 47 vegetation plots we found 414 species (including the species determined only to the genus level): 365 vascular plants (88%), 28 bryophytes (7%) and 21 lichens (5%). The most frequent graminoid species were *Stipa pulcherrima*, *Carex humilis*, *Bromopsis riparia*, and *Koeleria macrantha*. The most frequent forbs were *Teucrium chamaedrys*, *T. polium*, *Stachys recta*, *Thesium arvense*, *Bilacunaria microcarpa*, *Filipendula vulgaris*. The following genera had a higher number of species: *Veronica* (11), *Centaurea* (8), *Galium* (8), *Allium* (7), *Astragalus* (6), *Seseli* (6), *Stipa* (6), and *Viola* (6). Among the bryophytes, the most common species were *Trichostomum crispulum*, *Bryum argenteum*, *Tortula ruralis*, *Tortella inclinata*; among the lichens *Placidium fingens*, *Collema tenax*, *Psora decipiens* and *Toninia physaroides*.

We also found many endangered and rare species; some of them are new records in this area, such as *Ononis pusilla* (Zolotoy Kurgan and Lysaya Mountains). Four lichen species were new for the Central Caucasus region: *Cladonia magyarica*, *Collema minor*, *Heppia lutosa* (on calciferous schists on moist, sloping rocks), *Scytinium schraderi* (on mosses or soil in dry, calcareous habitats, over limestones and in short calcareous turf). Two species of lichens were new findings for the Stavropol Kray: *Cladonia symphycarpa* (on calcareous substratum, either on soil or rock outcrops) and *Scytinium intermedium* (thinly scattered in the lowlands and uplands, among short vegetation on calcareous soil). 13 species from our relevés are preserved on the national level of conservation: *Asphodeline taurica*, *A. tenuior*, *Crambe cordifolia*, *Elytrigia stipifolia*, *Eremurus spectabilis*, *Stipa pulcherrima*, *S. pennata* etc. (marked ** in the Supplement S1). 25 species are listed in the regional red list of the

Stavropol Krai: *Diphelypaea coccinea*, *Iberis taurica*, *Stipa caucasica*, *Bromopsis gordjaginii*, *Scutellaria orientalis* etc. (those of them that are not included in the national level conservation list are marked with * symbol in the Supplement S1).

3.2 Species richness patterns

Mean total species richness varied between 1.8 species in the smallest plots (0.0001 m^2) and 68.8 species in the largest plots (100 m^2). The maximum recorded species richness values for all taxonomic groups were, respectively, 3, 5, 11, 23, 37, 83 and 85 species in 0.0001, 0.001, 0.01, 0.1, 1, 10 and 100 m^2 (Table 1). The maximum recorded species richness for vascular plants in plot size 10 m^2 was 82 species, which is quite high in comparison with other natural and semi-natural grasslands in the Palaearctic (KUZEMKO et al. 2016). On the contrary to the former reports for other Palaearctic dry grasslands (TURTUREANU et al. 2014, KUZEMKO et al. 2016, POLYAKOVA et al. 2016, DEMBICZ et al. 2021), our mean and maximum species richness values for bryophytes were lower than average for all the grain sizes. Species richness values for lichens were also less than average but not so much as in Central Podillia and Transylvania (TURTUREANU et al. 2014, KUZEMKO et al. 2016).

The overall z-values of the species-area curve (all taxa, across all grain sizes) ranged from 0.252 to 0.327, with a mean of 0.267 (Fig. 2). Mean overall z-value is slightly higher than in other examples in the Palaearctic grasslands: in Khakassia, Russia, the values were 0.197–0.345 (mean: 0.258) (POLYAKOVA et al. 2016), in Transsylvania, Romania: 0.159–0.264 (mean: 0.207) (TURTUREANU et al. 2014), in Podillia, Ukraine: 0.185–0.340 (mean: 0.243) (KUZEMKO et al. 2016), in Bulgaria: 0.185–0.324 (mean: 0.243) (DEMBICZ et al. 2021).

3.3 Vegetation classification

In order to assign our 47 vegetation plots to higher-level syntaxa we performed a numerical analysis using all the collected and cleaned 413 relevés including those from literature sourses, as described in the Methods section. Modified TWINSPAN yielded five main clusters, which can be interpreted as commonly distinguished vegetation types of steppes and steppe-like grasslands that occur in the region of North Caucasus: desert steppes, true

Table 1. Mean, minimum and maximum species richness in the plots. *: 10 m² plots included into the nested-plot series.

Tabelle 1. Mittlere, minimale und maximale Artenzahl in den Aufnahmeflächen. *: in die Serie von genesteten 10 m² -Plots eingeschlossen.

Area (m^2)	*n*	All species			Vascular plants			Bryophytes	Lichens
		Mean	Min.	Max.	Mean	Min.	Max.	Mean	Mean
0.0001	10	1.8	0	3	1.8	0	3	0.0	0.0
0.001	10	2.5	0	5	2.4	0	5	0.1	0.0
0.01	10	5.0	1	11	4.8	0	11	0.2	0.0
0.1	10	13.0	8	23	12.4	8	19	0.3	0.3
1	10	25.2	17	37	24.0	14	33	0.6	0.6
10*	10	46.9	30	62	43.9	27	62	2.3	0.7
10	47	48.43	30	83	44.7	26	82	2.3	1.4
100	5	68.8	47	85	63.4	44	80	4.0	1.4

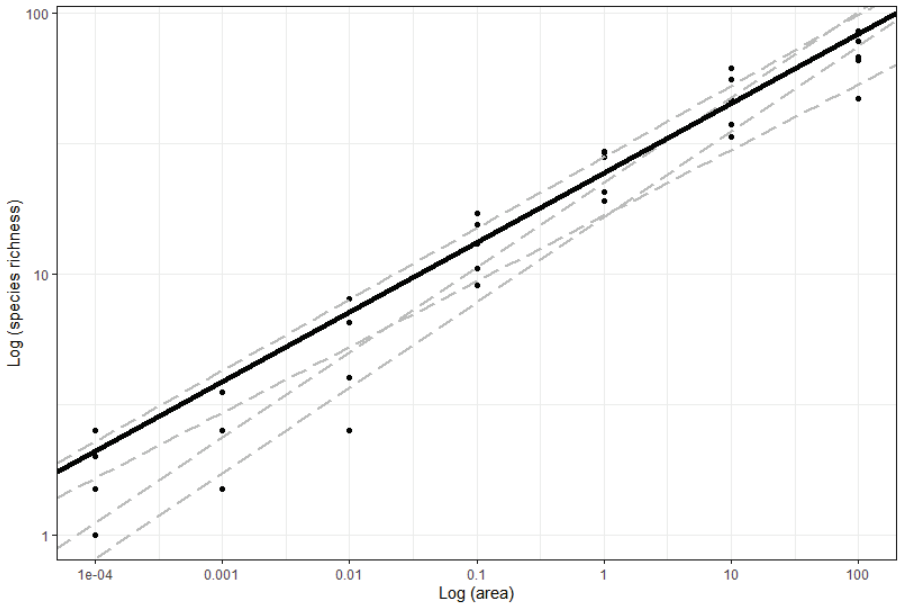


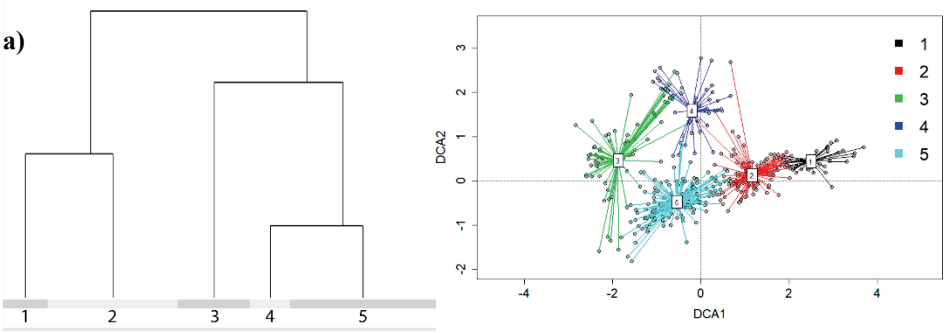
Fig. 2. Species-area curves (all taxa, across all grain sizes) for five separate biodiversity series (grey long dashed) and mean overall z-value (black solid line).

Abb. 2. Art-Arealkurven (alle Taxa, über alle Flächengrößen) für fünf separate Biodiversitätsserien (grau, gestrichelt) und den mittleren Gesamt-z-Wert (schwarze durchgezogene Linie).

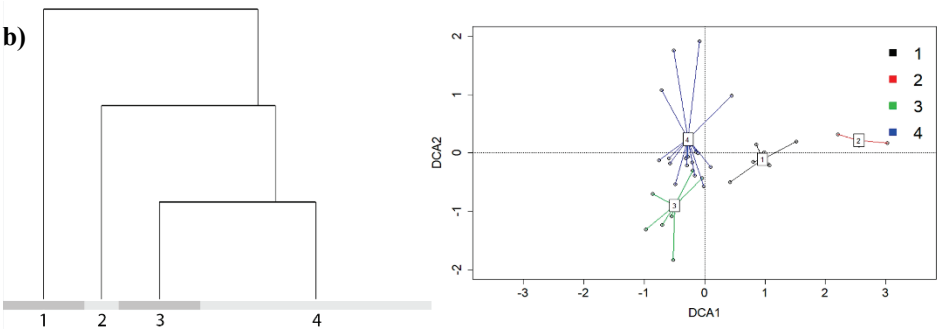
steppes, mountain steppes, rocky grasslands, xero-mesic and mexo-xeric grassland communities (Fig. 3a (Modified TWINSPAN dendrogram and DCA ordination), Supplement E2 (synoptic table with diagnostic species of the selected clusters)). Their syntaxonomical position only partly fits into the European classification system (MUCINA et al. 2016).

The first cluster represents the driest communities of this region and corresponds to desert steppes with dominance and high frequency of *Artemisia* species (*A. taurica*, *A. lerchiana*). This vegetation is transitional between true steppes and desert vegetation of the class *Artemisietea lerchianae* Golub 1994 and should be classified within *Tanaceto achilleifolii-Stipetalia lessingianae* Lysenko et Mucina in Mucina et al. 2016 (dry steppe grasslands of the semi-desert transitional zone) and its alliance *Tanaceto achilleifolii-Stipion lessingianae* Royer ex Lysenko et Mucina in Mucina et al. 2016 (continental temperate dry steppe grasslands of the transitional steppe to desert zone) (Fig. 5). None of our own relevés belonged to this cluster.

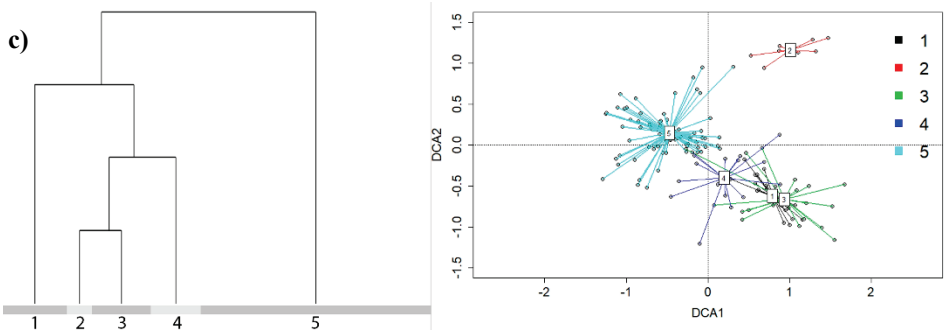
The second cluster comprises true steppe vegetation: bunchgrass and forb-bunchgrass steppes, which are highly affected by intensive grazing in this region, which lead to the high frequency of ruderal species in the vegetation plots. Frequent species for this cluster are typical steppe species: *Marrubium peregrinum*, *Phlomis pungens*, *Artemisia austriaca* etc. An order *Galatello villosae-Stipetalia lessingianae* Vynokurov 2021 has recently been described (VYNOKUROV 2021) uniting true steppe vegetation of Eastern Europe. Thus, we can assign the plots of the second cluster to this order and to the alliance *Stipo lessingianae-Salvion nutantis* Vynokurov 2014. As only three relevés from our own data belong to the true steppe vegetation, it seems that is not possible to classify them more precisely at the association level.



a) 1 – desert steppes, 2 – true steppes, 3 – mountain steppes, 4 – rocky grasslands, 5 – xero-mesic and meso-xeric grasslands.



b) 1 – *Helianthemo buschii-Genistetum compacti*, 2 – *Astracantho denundatae–Salvietum canescentis*, 3 – *Gypsophilo glomeratae-Stipetum caucasicae*, 4 – *Galio biebersteinii-Asphodelinetum tauricae.*



c) 1 – *Ranunculo caucasicae-Brachypodietum rupestris*, 2 – *Cruciato pedemontanae-Brizetum elatioris*, 3 – transitional cluster, 4 – *Dictamno caucasici-Caricetum humilis*, 5 – *Festucion valesiaceae*

Fig. 3. Modified TWINSPAN dendrogram (left) and DCA ordination (right) after analysing **a)** the whole dataset, **b)** rocky grasslands, **c)** xero-mesic and meso-xeric grasslands.

Abb. 3. Modifizierte TWINSPAN-Dendrogram (links) und DCA-Ordination (rechts) nach **a)** Analyse des gesamten Datensatzes, **b)** der felsigen Grasländer und **c)** der xero-mesischen und meso-xerischen Grasländer.

The third cluster represents endemic mountain steppes of Dagestan and intermontane basins of Central Caucasus. It was characterized in several publications from Dagestan (SHIFFERS 1953), North Ossetia-Alania (BELONOVSKAYA et al. 2016, GRACHEVA et al. 2018) and Kabardino-Balkaria (TSEPKOVA 1987, 2005) regions. N.L. Tsepkova proposed two invalidly published associations that fit into this unit. It is possible that this vegetation type can be classified as a new order, but another study with a bigger dataset would be needed to test this solution. Though none of our own relevés belonged to this cluster, here we describe a new alliance *Artemisio chamaemelifoliae-Bromopsion variegatae* representing Caucasian mountain steppes and two associations based on the data from literature sourses (below in section 3.4) (Fig. 5).

The fourth cluster corresponds to rocky grasslands. This vegetation type is an analogue of Central-European *Stipo pulcherrimae-Festucetalia pallentis* but it strongly differs from the latter by the presence of a number of endemic species and the absence of the typical Central-European ones. Twenty-nine of our vegetation plots belonged to this cluster. Further dividing of this cluster using Modified TWINSPAN algorithm revealed four new subclusters interpretable at the association level (Fig. 3b). The first subcluster represents rocky grasslands on cretaceous limestone outcrops of the Pastbishny range in the North Caucasus. As it is clearly separated floristically, ecologically and geographically, we describe a new alliance *Helianthemo buschii-Cephalarion coriaceae* with one new association *Helianthemo buschii-Genistetum compactae* (section 3.4). It is differentiated by the presence of some species that do not occur or are rare at lower altitudes: *Asphodeline tenuior*, *Astragalus lasioglottis*, *Campanula sarmatica*, *Elytrigia stipifolia*, *Genista compacta*, *Hedysarum biebersteinii*, *Helianthemum buschii*, *Onobrychis ruprechtii*. The second subcluster of the rocky group represents the invalidly published '*Astracantho denundatae–Salvietum canescentis*' and unites relict steppe communities in the Bylym Arid Basin (in Russian: Bylymskaya aridnaya kotlovina) between the Bokovoy and Skalisty ranges. The third subcluster represents open rocky grasslands on limestone outcrops of the foothills of the Mashuk and Beshtau Mounts (new association *Gypsophilo glomeratae-Stipetum caucasicae*). The last subcluster of the rocky group unites more developed dry grasslands on the limestone outcrops of the laccolite mountains. We describe this unit as a new association *Galio biebersteinii-Asphodelinetum tauricae*. The last three associations we unite into a new alliance *Onosmo caucasicae-Asphodelinion tauricae* (section 3.4). Rocky grasslands of the North Caucasus share a number of species that are characteristic for Crimean rocky grasslands of the alliances *Androsaco tauricae-Caricion humilis* Didukh in Mucina et Didukh 2014 and partly *Veronico multifidae-Stipion ponticae* Didukh in Didukh et Mucina 2014: *Artemisia caucasica*, *Asphodeline taurica*, *Cephalaria coriacea*, *Euphorbia petrophila*, *Galium biebersteinii* etc. (DIDUKH & MUCINA 2014). Therefore, we describe a new order *Asphodelino tauricae-Euphorbietalia petrophilae* aimed to unite Crimean and Caucasian rocky grasslands.

The fifth cluster obtained in the first stage of the analysis combines semi-dry grasslands of *Brachypodietalia pinnati* (in Russian literature often called steppic meadows) and dry and semi-dry grasslands of *Festucetalia valesiacae* (in Russian literature often called meadow-steppes) (Fig. 3c). 15 out of our relevés belonged to this cluster. Further dividing of this unit using Modified TWINSPAN algorithm yielded five meaningful subclusters. The first four of them well fit into the *Cirsio-Brachypodion pinnati* (*Brachypodietalia pinnati*). The last of them can be classified within the *Festucion valesiacae* (*Festucetalia valesiacae*). The first subcluster represents xero-mesic communities of Dzhinalsky Range. Two invalidly published names match to this cluster – '*Carici michelii-Bromopsietum ripariae*' and

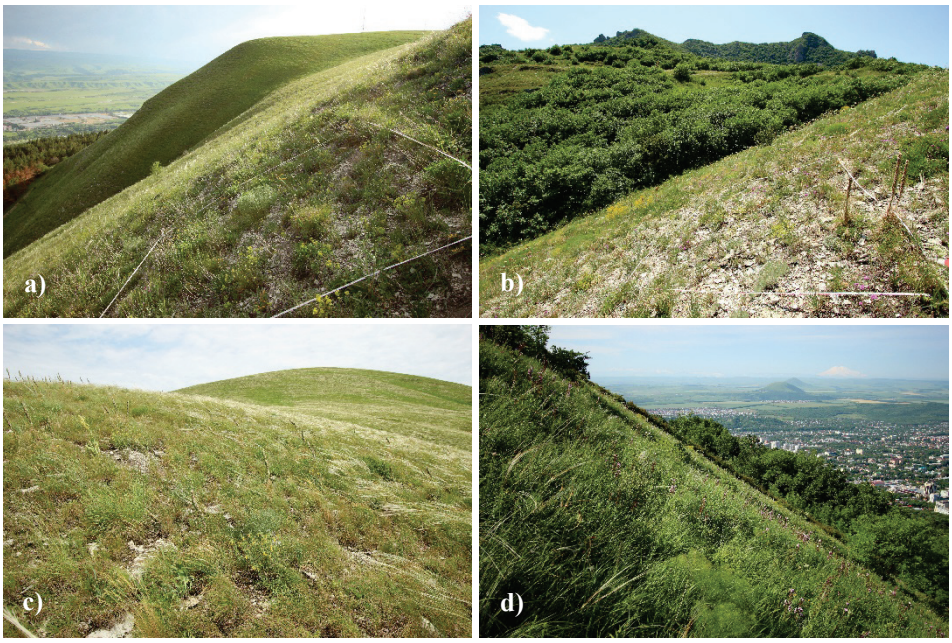


Fig. 4. a) Community of *Helianthemo buschii-Genistetum compactae* on Borgustan Range. **b)** Community of *Gypsophilo glomeratae-Stipetum caucasicae* (*Onosmo caucasicae-Asphodelinion tauricae*) on the mountain Beshtau ("Kozii Skaly"). **c)** Community of *Galio biebersteinii-Asphodelinetum tauricae* (*Onosmo caucasicae-Asphodelinion tauricae*) on the mountain Zolotoy Kurgan. **d)** Xero-mesic grassland communities of *Dictamno caucasici-Caricetum humilis* (*Cirsio-Brachypodion pinnati*) on the upper slope of Mashuk Mountain, Piatigorsk city. On the horizon – mountains Yutsa, Dzhutsa and Elbrus (Photos: D. Vynokurov, June 2019).

Abb. 4. a) Bestand des *Helianthemo buschii-Genistetum compactae* im Borgustan-Gebirge. **b)** Bestand des *Gypsophilo glomeratae-Stipetum caucasicae* (*Onosmo caucasicae-Asphodelinion tauricae*) auf dem Beshtau-Berg ("Kozii Skaly"). **c)** Bestand des *Gypsophilo glomeratae-Stipetum caucasicae Galio biebersteinii-Asphodelinetum tauricae* (*Onosmo caucasicae-Asphodelinion tauricae*) auf dem Zolotoy Kurgan-Berg. **d)** Xero-mesophytische Graslandgesellschaften des *Dictamno caucasici-Caricetum humilis* (*Cirsio-Brachypodion pinnati*) auf dem Oberhang des Mashuk-Berges bei der Stadt Piatigorsk. Am Horizont sind die Berge Yutsa, Dzhutsa und Elbrus erkennbar (Fotos: D. Vynokurov, Juni 2019).

'*Astragalo demetrii-Brachypodietum rupestris*' (TSEPKOVA 1987). However, we couldn't find any strong floristic differences between them. Thus, we describe a new association *Ranunculo caucasicae-Brachypodietum rupestris* based on the published data (section 3.4). The second subcluster represents the most mesic dry grasslands from Skalisty Range with a clear block of diagnostic species including *Cruciata pedemontana*, *Briza elatior*, *Bromopsis erecta*, *Euphrasia pectinata*, *Seseli libanotis*, *Pyrethrum coccineum*. We describe this unit as a new association *Cruciato pedemontanae-Brizetum elatioris* based on data from literature (DEMINA et al. 2017). The third subcluster is transitional, as it shares common species with the first and fourth subclusters and overlap with them on DCA ordination space (Fig. 3c). The fourth subcluster unites xero-mesic communities of lower altitudes of the North Caucasus (laccolite mountains), which we describe as a new association *Dictamno caucasici-Caricetum humilis*. The last subcluster represents dry grasslands of the *Festucion valesiaceae*. The vegetation plots classified within this alliance are well distributed accord-

ing the literature sources in the piedmont zone of the North Caucasus. As only a few of our vegetation plots belonged to this unit and no syntaxa were published which could fit it, it is not possible to classify them more precisely to the association level in the current study.

Thus, our own 47 vegetaion plots were distributed as follows: 3 belonged to the second cluster representing true steppes and assigned to the order *Galatello villosae-Stipetalia lessingianae*; 29 – to the fourth cluster of rocky grasslands of the new order *Asphodelino tauricae-Euphorbietalia petrophilae*; 15 – to the fifth cluster representing dry and semi-dry grasslands of *Brachypodietalia pinnati* and *Festucetalia valesiacae*.

3.4 Vegetation checklist and diagnoses of new syntaxa

Summarizing, all the dry grasslands in the central part of the Northern Caucasus belong to the class *Festuco-Brometea*, and can be classified within five orders and seven alliances.

1. *Tanaceto achilleifolii-Stipetalia lessingianae Lysenko* et Mucina in Mucina et al. 2016

Desert steppes

Diagnostic species: ***Achillea biebersteinii***, *Agropyron desertorum*, ***Alyssum turkestanicum***, ***Anisantha tectorum***, *Apera interrupta*, ***Artemisia lerchiana***, *A. taurica*, *Bassia sedoides*, *Bromus japonicus*, ***B. squarrosus***, ***Carex stenophylla***, *Centaurea diffusa*, ***Ceratocarpus arenarius***, *Chenopodium album*, *Descurainia sophia*, *Eragrostis minor*, *Eremopyrum triticeum*, *Erodium cicutarium*, *Euphorbia humifusa*, *E. seguierana*, *Herniaria incana*, *Holosteum umbellatum*, *Kochia prostrata*, *Lactuca saligna*, *L. tatarica*, *Lagoseris sancta*, *Lappula patula*, *Medicago minima*, *Myosotis micrantha*, ***Poa bulbosa***, *Polygonum patulum*, ***Ranunculus oxyspermus***, *Salsola australis*, *S. laricina*, *Stipa lessingiana*, *Tanacetum millefolium*, *Taraxacum erythrospermum*, *Tribulus terrestris*, *Trigonella orthoceras*, *Tulipa gesneriana*, ***Veronica verna***

Constant species: *Arenaria serpyllifolia,* ***Artemisia austriaca***, *Falcaria vulgaris*, *Festuca valesiaca* aggr., *Galium humifusum*

Dominant species: *Artemisia lerchiana*, *Poa bulbosa*

1.1 *Tanaceto achilleifolii-Stipion lessingianae* Royer ex Lysenko et Mucina in Mucina et al. 2016

Dry steppes in the transitional zone between true steppes and deserts

Diagnostic, constant and dominant species: same as for the order

2. *Galagello villosae-Stipetalia lessingianae* Vynokurov 2021

Pontic-Caspian true steppe vegetation

Diagnostic species: *Achillea nobilis*, *Ambrosia artemisiifolia*, ***Artemisia austriaca***, *A. lerchiana*, *A. taurica*, *Astragalus austriacus*, *A. calycinus*, *Berteroa incana*, *Bothriochloa ischaemum*, *Bromus japonicus*, *Cardaria draba*, *Carduus hamulosus*, *Centaurea diffusa*, *Chondrilla juncea*, *Convolvulus arvensis*, *Conyza canadensis*, *Crepis rhoeadifolia*, *Delphinium speciosum*, *Elytrigia repens*, *Eryngium campestre*, *Euphorbia seguierana*, *Gagea minima*, *Galium humifusum*, *Goniolimon tataricum*, *Inula britannica*, *Lactuca serriola*, *Marrubium peregrinum*, *Medicago lupulina*, *M. minima*, *Melilotus officinalis*, *Plantago lanceolata*, *Poa angustifolia*, *Polygonum aviculare*, *Potentilla argentea*, *Psammophiliella muralis*, *Salvia aethiopis*, *S. nemorosa* aggr., *Stipa lessingiana*, *Trifolium arvense*, *Tulipa biebersteiniana*, *Vicia villosa*, *Xeranthemum annuum*

Constant species: *Achillea millefolium* aggr., *Arenaria serpyllifolia*, *Bromopsis riparia*, ***Festuca valesiaca* aggr., *Koeleria macrantha*,** *Medicago falcata*, *Poa bulbosa*, *Stipa capillata*, *Teucrium polium*, *Thesium arvense*, ***Thymus marschallianus***

Dominant species: *Bothriochloa ischaemum*, *Festuca valesiaca* aggr.

2.1 *Stipo lessingianae-Salvion nutantis* Vynokurov 2014

Eastern European true steppe vegetation

Diagnostic, constant and dominant species: same as for order

3. Order Unknown

Mountain steppes

3.1 *Artemisio chamaemelifoliae-Bromopsion variegatae* Vynokurov all. nov. hoc loco

Mountain steppes of the intermontane basins of the North Caucasus

Holotypus hoc loco: *Potentillo pimpinelloides-Artemisietum chamaemelifoliae* Tsepkova in Vynokurov et al. 2021 (see below)

Diagnostic species: ***Alchemilla caucasica*,** *A. sericata*, *Alyssum tortuosum*, *Amoria ambigua*, *Anthemis marschalliana*, *Anthoxanthum odoratum*, *Artemisia campestris*, ***A. chamaemelifolia*,** *Aster alpinus*, *Astragalus oreades*, *A. polyphyllus*, *Astrantia maxima*, *Ballota nigra*, ***Bromopsis variegata*,** *Bupleurum falcatum*, *Calamagrostis arundinacea*, *Carum carvi*, *Centaurea cheiranthifolia*, *C. ciscaucasica*, *C. daghestanica, Dianthus cretaceus, Dracocephalum ruyschiana, Elytrigia gracillima*, *Euphorbia leptocaula*, ***Festuca ovina*,** *F. woronowii*, *Galium verum*, *Gypsophila elegans*, *Helictotrichon versicolor*, *Linum hypericifolium*, *Luzula multiflora*, *Medicago glutinosa*, ***Myosotis alpestris*,** *Nonea echioides*, *Onobrychis biebersteinii*, *O. petraea*, *Pastinaca armena*, *Pedicularis sibthorpii*, *Pentaphylloides fruticosa*, *Phleum montanum*, ***Plantago atrata*,** *Poa alpina*, *P. annua*, *Potentilla crantzii*, *P. pimpinelloides*, *Primula ruprechtii*, *Pulsatilla albana*, *Ranunculus oreophilus*, *Rhynchocorys orientalis*, *Rumex acetosella*, ***Scabiosa caucasica*,** *Sedum oppositifolium*, *S. spurium*, *S. subulatum*, *Sempervivum caucasicum*, *S. pumilum*, *Stachys macrantha*, *Stipa daghestanica*, *Tephroseris caucasigena*, *Teucrium orientale*, *Thymus collinus*, *Tragopogon reticulatus*, *Trifolium canescens*, *Veronica chamaedrys*, ***V. gentianoides*,** *V. propinqua*, *Vicia semiglabra*

Constant species: ***Achillea millefolium* aggr.,** *Bromopsis riparia*, ***Campanula sibirica*, *Carex humilis*, *Festuca valesiaca* aggr.,** *Koeleria macrantha*, *Lotus corniculatus*, *Phleum phleoides*, ***Salvia verticillata***

Dominant species: no clearly defined dominants

3.1.1 *Potentillo pimpinelloides-Artemisietum chamaemelifoliae* Tsepkova ass. nov. hoc loco

Mountain meadow steppes of the Main Range (Glavnyy) and Bokovoy Range. Communities are distributed on the rocky slopes of S, SW and SE aspects and inclination 20–35° within the subalpine belt of the Central Caucasus, in the altitudes 1800–2200 m a.s.l. (TSEPKOVA 2005).

Synonym: *Artemisio chamaemelifoliae-Plantaginetum atratae* Tsepkova 2005 nom. inv. (Art. 5)

Holotypus hoc loco: Russia, Kabardino-Balkar Republic, Elbrussky District, right slope of the Adyl-Su River Valley, altitude: 2150 m a.s.l., aspect: 210°, inclination: 33°, 07.08.1988, author of the relevé: N.L. Tsepkova:
Achillea millefolium 1, *Alchemilla sericata* 1, *Alyssum tortuosum* +, *Amoria ambigua* 1, *Anthemis cretica* s.l. +, *A. marschalliana* s.l. +, *Anthyllis vulneraria* +, *Artemisia chamaemelifolia* 1, *Astragalus oreades* 1, *Bromopsis variegata* 2, *Bupleurum falcatum* +, *Campanula rapunculoides* +, *C. sibirica* +, *Carex humilis* 1, *Centaurea cheiranthifolia* 1, *C. dealbata* 1, *Cerastium arvense* +, *Cruciata laevipes* +, *Dianthus capitatus* +, *Dracocephalum ruyschiana* +, *Euphorbia iberica* +, *Euphrasia pectinate* +, *Festuca valesiaca* 2, *Galium verum* 1, *Huynhia pulchra* +, *Hypericum perforatum* +, *Jurinea arachnoidea* +, *Koeleria cristata* 1, *Lotus corniculatus* +, *Medicago falcata* +, *Melandrium latifolium* +, *Myosotis sylvatica* +, *Oberna behen* +, *Origanum vulgare* +, *Pastinaca armena* +, *Phleum phleoides* 1, *Plantago atrata* 1, *Polygala caucasica* +, *Potentilla crantzii* 1, *P. pimpinelloides* 1, *Primula veris* +, *Rhynchocorys orientalis* +, *Salvia verticillata* 1, *Scabiosa caucasica* 1, *S. ochroleuca* +, *Sedum spurium* +, *Seseli transcaucasicum* +, *Stachys macrantha* +, *S. recta* +, *Stipa pulcherrima* +, *Thalictrum foetidum* +, *Thymus marschallianus* 1, *Trifolium alpestre* +, *T. pratense* 1, *Trommsdorfia maculata* +

Diagnostic species: ***Alchemilla sericata*****,** *Alyssum tortuosum*, *Amoria ambigua*, *Anthemis cretica*, *A. marschalliana*, *Anthyllis vulneraria*, ***Artemisia chamaemelifolia*****,** *Astragalus captiosus*, *A. oreades*, ***Bromopsis variegata*****,** *Bupleurum falcatum*, *Campanula sibirica*, *Carex humilis*, ***Centaurea cheiranthifolia*****,** *C. dealbata*, *Cerastium arvense*, *Dianthus capitatus*, ***Dracocephalum ruyschiana*****, *Euphrasia pectinata*, *Gypsophila elegans*,** *Huynhia pulchra*, *Lotus corniculatus*, ***Melandrium latifolium*****, *Myosotis sylvatica*, *Oberna behen*,** *Onobrychis biebersteinii*, ***Pastinaca armena*****,** *Phleum phleoides*, ***Plantago atrata*****, *Poa annua*, *Potentilla crantzii*, *P. pimpinelloides*, *Rhynchocorys orientalis*, *Rumex acetosella*,** *Salvia verticillata*, ***Scabiosa caucasica*****,** *Sedum album*, ***S. spurium*****, *Sempervivum caucasicum*,** *Teucrium orientale*, *Trifolium pratense*, ***Trommsdorfia maculata***

Constant species: ***Achillea millefolium*** **aggr.,** *Cruciata laevipes*, ***Festuca valesiaca*** **aggr., *Galium verum, Hypericum perforatum*, *Koeleria macrantha*,** *Origanum vulgare*, *Scabiosa ochroleuca*, *Seseli transcaucasicum*, ***Stachys recta*****, *Thymus marschallianus*,** *Trifolium alpestre*

Dominant species: *Festuca valesiaca* aggr.

3.1.2 *Centaureo ciscaucasicae-Artemisietum chamaemelifoliae* Tsepkova ass. nov. hoc loco

Mountain steppes of the Skalisty Range. The localities with this type of communities are characterized by the strong dissection of the relief, large steepness of the slopes and moderate grazing impact (TSEPKOVA 1987).

Synonym: *Artemisio chamaemelifoliae-Caricetum humilis* Tsepkova 1987 nom. inv. (Art. 1)

Holotypus hoc loco: Russia, Kabardino-Balkar Republic, Elbrussky District, 6 km upstream the river Baksan from Tyrnyauz town, altitude: 1400 m a.s.l., aspect: 180°, 27.07.1982, author of the relevé: N.L. Tsepkova:
Achillea millefolium 1, *Alyssum tortuosum* 1, *Artemisia chamaemelifolia* 1, *A. marschalliana* 1, *Astragalus polyphyllus* 1, *Ballota nigra* 1, *Bromopsis variegata* 1, *Carex humilis* 1, *Centaurea ciscaucasica* 1, *Festuca valesiaca* 1, *Galium verum* 1, *Onosma caucasica* 1, *Phleum phleoides* 1, *Phlomis pungens* 1, *Sedum subulatum* 1, *Sempervivum pumilum* 1, *Stipa capil-*

lata 2, *Teucrium chamaedrys* 1, *T. orientale* 1, *T. polium* 1, *Thymus daghestanicus* 1, *Verbascum phoenicium* 1, *Vincetoxicum hirundinaria* 1

Diagnostic species: ***Alyssum tortuosum*****,** ***Artemisia campestris*****,** ***A. chamaemelifolia*****,** ***Astragalus polyphyllus*****,** ***Ballota nigra*****,** *Bromopsis variegata*, *Carex humilis*, ***Centaurea ciscaucasica*****,** ***Fallopia convolvulus*****,** *Nepeta cyanea*, ***Sedum oppositifolium*****,** ***S. subulatum*****,** ***Sempervivum pumilum*****,** ***Teucrium orientale*****,** *Thalictrum foetidum*, *Thymus daghestanicus*, ***Verbascum phoenicium*****,** ***Veronica propinqua***

Constant species: *Achillea millefolium* aggr., ***Festuca valesiaca*** **aggr.,** ***Galium verum*****,** *Koeleria macrantha*, *Phleum phleoides*, ***Phlomis pungens*****,** ***Stipa capillata*****,** *Teucrium polium*

Dominant species: no clearly defined dominants

4. ***Asphodelino tauricae-Euphorbietalia petrophilae*** **Vynokurov ord. nov. hoc loco**

Calcareous rocky grasslands of the North Caucasus and Crimea mountais

Holotypus hoc loco: *Onosmo caucasicae-Asphodelinion tauricae* Vynokurov et Lysenko in Vynokurov et al. 2021 (see below)

Diagnostic species: *Acinos arvensis*, *Agropyron cristatum*, ***Allium albidum*****,** *A. saxatile*, *Alyssum calycinum*, *A. hirsutum*, *Androsace koso-poljanskii*, *Anthyllis vulneraria*, ***Arabis recta*****,** *Artemisia caucasica*, *Asperula arvensis*, ***A. biebersteinii*****,** ***Asphodeline taurica*****,** *A. tenuior*, *Astragalus demetrii*, *A. lasioglottis*, ***Bilacunaria microcarpa*****,** *Bromopsis biebersteinii*, *Carex caryophyllea*, *C. humilis*, *Centaurea kubanica*, *C. leucophylla*, *C. marschalliana*, *Cephalaria coriacea*, *Dictamnus caucasicus*, *Elytrigia stipifolia*, *Ephedra procera*, *Erucastrum armoracioides*, *Erysimum canescens*, ***Euphorbia petrophila*****,** *Gagea taurica*, *Galium biebersteinii*, *G. mollugo*, *Genista compacta*, *Gypsophila glomerata*, *Hedysarum biebersteinii*, *Helianthemum buschii*, *Holosteum umbellatum*, *Inula ensifolia*, *Iris aphylla*, *I. pumila*, *Linum tenuifolium*, *Melica taurica*, *Meniocus linifolius*, *Minuartia hybrida*, *Muscari neglectum*, *Onobrychis ruprechtii*, *Onosma caucasica*, *Orthanthella lutea*, *Poa badensis*, *Potentilla arenaria*, *Pseudomuscari pallens*, *Rhamnus pallasii*, *Sanguisorba minor*, *Saxifraga tridactylites*, *Scutellaria orientalis*, *Sedum acre*, ***S. hispanicum*****,** *Seseli tortuosum*, ***S. varium*****,** *Stipa caucasica*, *S. pulcherrima*, *Teucrium chamaedrys*, *T. polium*, *Thesium arvense*, *Thymus daghestanicus*, *T. pastoralis*, ***Veronica praecox*****,** *Viola kitaibeliana*, *Zosima orientalis*

Constant species: *Arenaria serpyllifolia*, *Bothriochloa ischaemum*, *Bromopsis riparia*, *Campanula sibirica*, *Festuca valesiaca* aggr., ***Koeleria macrantha*****,** *Medicago falcata*, *Stachys recta*

Dominant species: no clearly defined dominants

4.1 ***Helianthemo buschii-Cephalarion coriaceae*** **Vynokurov et Lysenko all. nov. hoc loco**

Rocky grasslands on cretaceous limestone outcrops of the Pastbishny range in the North Caucasus

Holotypus hoc loco: *Helianthemo buschii-Genistetum compactae* Vynokurov et Lysenko in Vynokurov et al. 2021 (see below)

Diagnostic species: ***Androsace koso-poljanskii*****,** ***Asperula biebersteinii*****,** ***Asphodeline tenuior*****,** ***Astragalus demetrii*****,** ***A. lasioglottis*****,** ***Bilacunaria microcarpa*****,** ***Bromopsis biebersteinii*****,** ***Campanula sarmatica*****,** ***Centaurea leucophylla*****,** ***Cephalaria coriacea*****,** ***Coronilla coronata*****,** ***Elytrigia stipifolia*****,** *Ephedra procera*, ***Erucastrum armoracioides*****,** ***Euphorbia petrophila*****,** ***Galium mollugo*****,** ***Genista compacta*****,** ***Hedysarum biebersteinii*****,**

Helianthemum buschii*, *Inula ensifolia*, *Linum nervosum*, *L. tenuifolium*, *Onobrychis ruprechtii*, *Pseudomuscari pallens*, *Scutellaria orientalis, *Teucrium polium*, ***Thymus daghestanicus*, *Viola ambigua***

Constant species: *Allium saxatile*, *Aster amellus*, *Bupleurum falcatum*, ***Campanula sibirica*, *Carex humilis*,** *Chamaecytisus ruthenicus*, ***Medicago falcata*, *Salvia verticillata*,** *Seseli tortuosum*, ***Stachys recta*, *Stipa pulcherrima*, *Teucrium chamaedrys*,** *Thesium arvense*

Dominant species: no clearly defined dominants

4.1.1 *Helianthemo buschii-Genistetum compacti* Vynokurov et Lysenko ass. nov. hoc loco

Communities of this association occupy SE and S steep slopes (20–40°) and are distributed on Borgustan Range on the elevations 900–1150 m a.s.l. (Fig. 4a). Their distinguishing feature is abscens of cryptogam layer.

Holotypus hoc loco: relevé 10 in Supplement S1 (this paper); Russia, Stavropolsky Kray, Predgorny District, vicinity of Podkumok village, slopes of the Borgustan Range, 43.965500 N 42.744880 E, altitude: 998 m a.s.l., aspect: 130°, inclination: 33°, 08.06.2019, author of the relevé: D. Vynokurov

Diagnostic, constant and dominant taxa = diagnostic, constant and dominant species of the alliance

4.2 *Onosmo caucasicae-Asphodelinion tauricae* Vynokurov et Lysenko all. nov. hoc loco

Rocky grasslands on the foothills of the Caucasus and laccolite mountains

Holotypus hoc loco: *Galio biebersteinii-Asphodelinetum tauricae* Vynokurov et Lysenko in Vynokurov et al. 2021 (see below)

Diagnostic species: *Acinos arvensis*, *Agropyron cristatum*, ***Allium albidum*,** *A. saxatile*, ***Alyssum calycinum*, *A. hirsutum*,** *Anthyllis vulneraria*, ***Arabis recta*,** *Artemisia caucasica*, *Asperula arvensis*, *A. biebersteinii*, ***Asphodeline taurica*,** *Bilacunaria microcarpa*, *Carex caryophyllea*, *Centaurea kubanica*, *Dictamnus caucasicus*, *Erysimum canescens*, *Gagea taurica*, *Galium biebersteinii*, *Gypsophila glomerata*, *Holosteum umbellatum*, *Iris aphylla*, *I. pumila*, *Melica taurica*, *Meniocus linifolius*, *Minuartia hybrida*, ***Muscari neglectum*,** *Onobrychis cyri*, *Onosma caucasica*, *Orthanthella lutea*, ***Poa badensis*,** *Potentilla arenaria*, *Rhamnus pallasii*, *Sanguisorba minor*, *Saxifraga tridactylites*, *Sedum acre*, ***S. hispanicum*,** *Seseli tortuosum*, *S. varium*, *Sideritis montana*, *Stipa caucasica*, *S. pulcherrima*, *Teucrium chamaedrys*, *T. polium*, *Thesium arvense*, ***Thymus pastoralis*, *Veronica praecox*,** *Vinca herbacea*, *Viola kitaibeliana*, *Zosima orientalis*

Constant species: *Alyssum turkestanicum*, ***Arenaria serpyllifolia*,** *Bothriochloa ischaemum*, ***Bromopsis riparia*,** *Campanula sibirica*, ***Carex humilis*,** *Euphorbia petrophila*, ***Festuca valesiaca* aggr.,** *Jurinea arachnoidea*, ***Koeleria macrantha*,** *Stachys recta*

Dominant species: no clearly defined dominants

Diagnostic taxa: *Allium albidum*, *Asphodeline taurica*, *Euphorbia petrophila*, *Gypsophila glomerata*, *Meniocus linifolius*, *Onosma caucasica*, *Poa badensis*, *Sedum hispanicum*, *Thymus pastoralis*, *Zosima orientalis*

4.2.1 *Gypsophilo glomeratae-Stipetum caucasicae* Vynokurov et Lysenko ass. nov. hoc loco

Rocky grasslands on limestone outcrops of the foothills of the Mashuk and Beshtau Mounts (Fig. 4b). Communities of the association occupy E, SE and S slopes of the inclination

15–35°. They are sparse (maximum 70% total cover) and are characterized by low cryptogam layer cover (up to 10%).

Holotypus hoc loco: relevé 11 in Supplement S1 (this paper); Location: Russia, Stavropolsky Kray, Pyatigorsk city, foothill of the Mashuk mountain ("Gora Goriachaya"), travertine outcrops, 44.038736°N 43.088995°E, altitude: 582 m a.s.l., aspect: 80°, inclination: 15°, 27.05.2019; Authors of the relevé: D. Vynokurov, T. Lysenko, Z. Dutova, D. Shylnikov

Diagnostic species: ***Acinos arvensis*****,** *Allium albidum*, ***A. fuscoviolaceum*****,** ***Alyssum hirsutum*****,** ***Arabis recta*****,** *Asperula biebersteinii*, ***Asphodeline taurica*****,** *Centaurea kubanica*, *C. marschalliana*, ***Erysimum canescens*****,** ***Euphorbia petrophila*****,** ***Gypsophila glomerata*****,** *Holosteum umbellatum*, ***Meniocus linifolius*****,** ***Minuartia hybrida*****,** ***Onosma caucasica*****,** *Poa badensis*, *Sanguisorba minor*, ***Sedum hispanicum*****,** ***Silene supina*****,** ***Stipa caucasica*****,** *Teucrium polium*, ***Veronica praecox*****,** ***Zosima orientalis***

Constant species: ***Alyssum turkestanicum*****,** ***Arenaria serpyllifolia*****,** *Bilacunaria microcarpa*, *Bothriochloa ischaemum*, *Bromopsis riparia*, ***Campanula sibirica*****,** *Cleistogenes serotina*, *Jurinea arachnoidea*, *Koeleria macrantha*, *Linum austriacum*, ***Poa bulbosa*****,** *Reseda lutea*, *Seseli tortuosum*, ***Stachys recta*****,** *Teucrium chamaedrys*, *Thesium arvense*, *Thymus pastoralis*

Dominant species: *Stipa pulcherrima*

4.2.2 *Galio biebersteinii-Asphodelinetum tauricae* Vynokurov et Lysenko ass. nov. hoc loco

Developed dry grasslands on the limestone outcrops of the laccolite mountains (Fig. 4c). Communities occupy slopes of different aspect and inclination (3–28°). On the contrary to the previous association, they are characterized by higher proportion of cryptogam layer cover (up to 60%). Also, among other described associations, the current one is distinguishing by the highest maximum height of herbs (Supplement S1).

Holotypus hoc loco: relevé 29 in Supplement S1 (this paper); Location: Russia, Stavropolsky Kray, near Inozemtsevo settlement, Mount Beshtau, "Kozii skaly", 44.09473°N 43.05048°E, altitude: 843 m a.s.l., aspect: 240°, inclination: 14°, 09.06.2019; Authors the relevé: D. Vynokurov, T. Lysenko, Z. Dutova

Diagnostic species: *Acinos arvensis*, *Agropyron cristatum*, *Ajuga chia*, *Allium albidum*, *A. saxatile*, *Alopecurus vaginatus*, ***Alyssum calycinum*****,** *A. hirsutum*, *Anacamptis pyramidalis*, *Anthyllis vulneraria*, *Arabis recta*, *Asperula arvensis, A. biebersteinii*, *Asphodeline taurica*, *Bilacunaria microcarpa*, *Carex caryophyllea*, *Dictamnus caucasicus*, *Galium biebersteinii*, *Holosteum umbellatum*, *Iberis taurica*, *Iris aphylla*, *I. pumila*, ***Melica taurica*****,** *Microthlaspi perfoliatum*, ***Muscari neglectum*****,** *Onobrychis cyri*, *Orthanthella lutea*, *Poa badensis*, *Potentilla arenaria*, *Rhamnus pallasii*, *Rumex horizontalis*, *Saxifraga tridactylites*, *Sedum hispanicum*, *Seseli varium*, *Stipa pulcherrima*, *Teucrium chamaedrys*, *Thesium arvense*, *Thymus markhotensis*, *T. pastoralis*, *Veronica praecox*, *Vinca herbacea*, *Viola kitaibeliana*

Constant species: ***Arenaria serpyllifolia*****,** *Bothriochloa ischaemum*, ***Bromopsis riparia*****,** *Campanula sibirica*, ***Carex humilis*****,** *Centaurea leucophylla*, ***Festuca valesiaca*** **aggr.,** *Jurinea arachnoidea*, ***Koeleria macrantha*****,** *Medicago falcata*, *Onosma caucasica*, *Potentilla recta*, *Sanguisorba minor*, *Sideritis montana*, *Stachys recta*, ***Teucrium polium*****,** *Thalictrum minus*

Dominant species: *Rhamnus pallasii*

4.2.3 *Astracantho denundatae–Salvietum canescentis* Tsepkova ass. nov. hoc loco

Relict steppe communities in the Bylym Arid Basin. They are distributed on the slopes of different aspects (TSEPKOVA 1987).

Synonym: *Bothryochloo ischaemi–Salvietum canescentis* Tsepkova 1987 nom. inv. (Art. 1)

Holotypus hoc loco: Russia, Kabardino-Balkar Republic, Elbrussky District, 1 km to the North from Bylym village, altitude: 1400 m a.s.l., aspect: 180°, 20.07.1982, author of the relevé: N.L. Tsepkova:
Allium albidum 1, *Alyssum tortuosum* 1, *Artemisia marschalliana* 1, *Astracantha denudata* 1, *Bothriochloa ischaemum* 2, *Carex humilis* 1, *Euphorbia seguierana* 1, *Festuca valesiaca* 2, *Kochia prostrata* 1, *Koeleria macrantha* 1, *Onobrychis bobrovii* 1, *Rhamnus pallasii* 1, *Salvia canescens* 2, *Setaria pumila* 1, *Sideritis comosa* 1, *Stipa capillata* 1, *Teucrium polium* 1, *Thymus elisabethae* 1

Diagnostic species: ***Astracantha denudata*, *Onobrychis bobrovii*, *Rhamnus pallasii*, *Salvia canescens*, *Thymus elisabethae***

Constant species: *Allium albidum*, *Alyssum tortuosum*, ***Artemisia campestris*, *Bothriochloa ischaemum*,** *Carex humilis*, *Ephedra procera*, ***Euphorbia seguierana*,** *Festuca valesiaca* aggr., *Kochia prostrata*, ***Koeleria macrantha*,** *Scutellaria orientalis*, *Seseli petraeum*, *Setaria pumila*, ***Sideritis montana*, *Stipa capillata*,** *S. pulcherrima*, *Teucrium orientale*, ***T. polium*, *Vincetoxicum hirundinaria***

Dominant species: *Salvia canescens*

5. *Brachypodietalia pinnati* Korneck 1974

Xero-mesic grasslands on deep calcareous soils of Europe

Diagnostic species: *Achillea millefolium* aggr., *Anemone sylvestris*, *Argyrolobium biebersteinii*, *Astrantia trifida*, *Brachypodium pinnatum*, *Briza elatior*, *B. media*, *Campanula bononiensis*, *Carex tomentosa*, *Centaurea dealbata*, *C. phrygia*, *Chaerophyllum aureum*, *Clematis integrifolia*, *Cota triumfettii*, *Cruciata laevipes*, *C. pedemontana*, *Dactylis glomerata*, *Erysimum cuspidatum*, *Festuca pratensis*, ***Filipendula vulgaris*,** *Fragaria moschata*, *F. viridis*, *Galium rubioides*, *G. verum*, ***Geranium sanguineum*,** *Helianthemum nummularium*, *Helictotrichon pratense*, ***H. pubescens*,** *Hieracium piloselloides*, *Holcus lanatus*, *Inula aspera*, *Iris pontica*, *Laser trilobum*, *Linum perenne*, *Lotus corniculatus*, *Onobrychis iberica*, *O. inermis*, *Origanum vulgare*, *Pastinaca sativa*, *Pedicularis chroorrhyncha*, *P. condensata*, *Phleum phleoides*, *P. pratense*, *Pimpinella saxifraga*, *Plantago media*, *Poa pratensis*, *Polygala anatolica*, *P. major*, *Primula veris*, *Prunella grandiflora*, *Pyrethrum coccineum*, *P. corymbosum*, *Ranunculus caucasicus*, *R. polyanthemos*, *Sanguisorba officinalis*, *Securigera varia*, *Seseli transcaucasicum*, *Stachys officinalis*, *Tragopogon major*, *Trifolium medium*, *T. pratense*, *Veronica orientalis*, *V. peduncularis*, *Vicia abbreviata*, *V. cracca*, *V. tenuifolia*, *Vincetoxicum funebre*, *V. hirundinaria*, *Viola hirta*

Constant species: *Bromopsis riparia*, ***Carex humilis*,** *Euphorbia nicaeensis*, ***Festuca valesiaca aggr.*,** *Koeleria macrantha*, *Medicago falcata*, *Poa angustifolia*, ***Salvia verticillata*, *Stachys recta*,** *Teucrium chamaedrys*, *Thalictrum minus*, *Thymus marschallianus*

Dominant species: *Brachypodium pinnatum*

5.1 *Cirsio-Brachypodion pinnati* Hadač et Klika in Klika et Hadač 1944

Xero-mesic grasslands on deep calcareous soils of Central and southeastern Europe

Diagnostic, constant and dominant species: same as for order

5.1.1 *Ranunculo caucasicae-Brachypodietum rupestris* Tsepkova ass. nov. hoc loco

Xero-mesic communities of Dzhinalsky Range (belonging to Pastbishnyy Range). They are distributed on the gentle slopes (up to 20°) on the altitudes 900-1000 m a.s.l. (TSEPKOVA 2012, 2018).

Synonyms: *Carici michelii-Bromopsietum ripariae* Tsepkova 2018 nom. inv. (Art. 2b), *Astragalo demetrii-Brachypodietum rupestris* Tsepkova 2012 nom. inv. (Arts. 2b, 3b)

Holotypus hoc loco: Russia, Kabardino-Balkar Republic, Zolsky District, vicinity of Zalukodes village, North-Eastern spurs of the Dzhinalsky Range, slopes of the Zolka Yuzhnaya River Valley (43.831611 N 43.118694 E), altitude 914 m a.s.l., 30.05.2006, author of the relevé: N.L. Tsepkova:

Achillea millefolium 1, *Anemone sylvestris* +, *Astragalus demetrii* +, *Brachypodium rupestre* 5, *Carex humilis* +, *Centaurea dealbata* 1, *Cruciata laevipes* +, *Dactylis glomerata* 1, *Elytrigia repens* 1, *Euphorbia seguierana* +, *E. stepposa* +, *Filipendula vulgaris* 1, *Fragaria viridis* +, *Geranium sanguineum* +, *Helictotrichon pubescens* 1, *Lotus corniculatus* 1, *Medicago falcata* 2, *Peucedanum ruthenicum* +, *Phleum phleoides* 1, *Plantago media* 1, *Poa angustifolia* 1, *Polygala anatolica* +, *Primula macrocalyx* +, *Ranunculus caucasicus* +, *Salvia verticillata* 1, *Scutellaria oreophila* +, *Securigera varia* 1, *Seseli transcaucasicum* 1, *Stachys atherocalyx* +, *Vincetoxicum funebre* +, *V. hirundinaria* +

Diagnostic species: *Agrimonia eupatoria*, *Anemone sylvestris*, *Anthemis cretica*, *Astragalus demetrii*, *Centaurea dealbata*, *Clematis integrifolia*, *Cruciata laevipes*, ***Dactylis glomerata*****,** *Euphorbia nicaeensis*, *Filipendula vulgaris*, *Fragaria viridis*, *Galium rubioides*, *Geranium sanguineum*, ***Helictotrichon pubescens*****,** *Iris pumila*, *Lotus corniculatus*, *Origanum vulgare*, ***Pedicularis condensata*****,** *Plantago media*, ***Poa pratensis*****,** *Polygala anatolica*, *Primula veris*, ***Ranunculus caucasicus*****,** *Sanguisorba officinalis*, *Scutellaria orientalis*, *Seseli transcaucasicum*, *Thalictrum simplex*, *Trifolium pratense*, *Veronica orientalis*, *Vicia tenuifolia*, ***Vincetoxicum funebre*****,** *V. hirundinaria*

Constant species: ***Achillea millefolium* aggr.,** *Amoria ambigua*, ***Brachypodium pinnatum*****, *Bromopsis riparia*, *Carex humilis*,** *C. michelii*, ***Elytrigia repens*****,** *Falcaria vulgaris*, *Festuca valesiaca* aggr., ***Galium verum*****, *Koeleria macrantha*,** *Medicago falcata*, ***Phleum phleoides*****,** *Phlomoides tuberosa*, ***Poa angustifolia*****, *Salvia verticillata*, *Stachys recta*,** *Taraxacum officinale*, ***Thalictrum minus*****,** *Thymus marschallianus*, *Vinca herbacea*

Dominant species: *Brachypodium pinnatum*

5.1.2 *Cruciato pedemontanae-Brizetum elatioris* Vynokurov ass. nov. hoc loco

Xero-mesic grasslands of Skalistyy Range (Kuban river basin)

Holotypus hoc loco: Karachay-Cherkessia, Skalisty Range, slopes of the Malyi Zelenchuk River Valley, altitude 1250 m a.s.l., 2016 (Demina et al. 2017, table 1, relevé 7):

Achillea millefolium +, *Agrimonia eupatoria* +, *Agrostis tenuis* 1, *Alopecurus vaginatus* 3, *Alyssum trichostachyum* +, *Amoria ambigua* +, *Anthoxanthum odoratum* 1, *Betula pendula* 1, *Brachypodium pinnatum* 4, *Briza elatior* 1, *Bromopsis erecta* +, *B. riparia* +, *Bupleurum falcatum* +, *Campanula bononiensis* +, *C. praealta* +, *C. sarmatica* +, *Carex humilis* +, *Centaurea leucophylla* 1, *C. orientalis* 1, *Cichorium intybus* +, *Clinopodium vulgare* +,

Cruciata pedemontana 1, Dactylis glomerata 1, Daucus carota +, Elytrigia caespitosa 1, *E. repens* 1, *Erysimum cuspidatum* +, *Euphorbia* species +, *E. stepposa* 1, *Euphrasia pectinata* +, *Festuca pratensis* 1, *F. rupicola* 2, *Filipendula vulgaris* 2, *Galium mollugo* +, *G. rubioides* 3, *G. verum* 1, *Gymnadenia conopsea* +, *Hieracium piloselloides* +, *Hypericum perforatum* +, *Inula aspera* 1, *Jurinea arachnoidea* +, *Leucanthemum vulgare* +, *Linum austriacum* +, *Melampyrum argyrocomum* 1, *Onobrychis viciifolia* 1, *Origanum vulgare* 1, *Ostrya carpinifolia* +, *Pedicularis sibthorpii* +, *Phleum pratense* 1, *Plantago lanceolata* 1, *P. media* 1, *Poa angustifolia* +, *P. compressa* +. *Polygala major* +, *Poterium polygamum* +, *Prunella vulgaris* +, *Pyrethrum coccineum* +. *Ranunculus polyanthemos* +, *R. repens* +, *Reseda lutea* +, *Rhinanthus minor* +, *Salvia verticillata* 3, *Scabiosa bipinnata* +, *Scorzonera hispanica* +, *Securigera varia* +, *Seseli libanotis* +, *Stachys germanica* +, *S. recta* +, *Stipa pulcherrima* +, *Teucrium nuchense* +, *Thymus marschallianus* 3, *Tilia begoniifolia* +, *Tragopogon dasyrhynchus* +, *Vicia tenuifolia* +

Diagnostic species: ***Agrostis tenuis*****,** *Anemonastrum narcissiflorum*, *Argyrolobium biebersteinii*, ***Astrantia trifida*****,** *Asyneuma campanuloides*, ***Briza elatior*****, *Bromopsis erecta*****, *Campanula bononiensis*****,** *C. glomerata*, *Centaurea leucophylla*, *C. phrygia*, ***Clinopodium vulgare*****, *Cruciata pedemontana*****,** *Dactylorhiza euxina*, *D. urvilleana*, *Draba sibirica*, *Elytrigia caespitosa*, ***Euphrasia pectinata*****, *Festuca pratensis*****,** *Filipendula vulgaris*, *Galium octonarium*, ***Hieracium piloselloides*****,** *Inula aspera*, *Leucanthemum vulgare*, *Melampyrum arvense*, *Muscari armeniacum*, ***Onobrychis viciifolia*****,** *Origanum vulgare*, *Pedicularis wilhelmsiana*, ***Phleum pratense*****, *Polygala major*****, *Prunella vulgaris*****, *Pyrethrum coccineum*****,** *P. corymbosum*, ***Ranunculus polyanthemos*****, *Rhinanthus minor*****,** *Scorzonera hispanica*, ***Seseli libanotis*****,** *Stachys officinalis*, *Trifolium caucasicum*, *Veratrum lobelianum*, *Vicia tenuifolia*, ***Vincetoxicum juzepczukii***

Constant species: ***Achillea millefolium*** **aggr.,** *Alyssum calycinum*, *A. trichostachyum*, ***Amoria ambigua*****, *A. montana*****, *Brachypodium pinnatum*****, *Bupleurum falcatum*****,** *Campanula sibirica*, ***Carex humilis*****,** *Centaurea orientalis*, *Cephalaria gigantea*, *Dactylis glomerata*, *Elytrigia repens*, *Erysimum cuspidatum*, *Euphorbia nicaeensis*, *Festuca valesiaca* aggr., *Galium humifusum*, ***G. verum*****, *Geranium sanguineum*****,** *Helictotrichon pubescens*, *Inula ensifolia*, *Jurinea arachnoidea*, *Linum austriacum*, ***Lotus corniculatus*****,** *Pedicularis sibthorpii*, *Plantago lanceolata*, ***P. media*****,** *Poa compressa*, *Potentilla recta*, *Reseda lutea*, *Rumex acetosa*, ***Salvia verticillata*****,** *Scabiosa bipinnata*, ***Securigera varia*****,** *Sideritis montana*, ***Stachys recta*****,** *Stipa pulcherrima*, ***Teucrium chamaedrys*****, *Thymus marschallianus*****,** *Tragopogon dasyrhynchus*, ***Trifolium pratense***

Dominant species: *Alopecurus vaginatus*, *Brachypodium pinnatum*, *Festuca valesiaca* aggr., *Galium rubioides*, *Onobrychis tournefortii*, *O. viciifolia*, *Salvia verticillata*, *Thymus marschallianus*

5.1.3 *Dictamno caucasici-Caricetum humilis* Vynokurov et Lysenko ass. nov. hoc loco

Xero-mesic grasslands of the laccolite mountains in a piedmont zone of the North Caucasus. Communities of the association occur on the altitudes 570–1150 m a.s.l., on slopes of different aspect and with inclination up to 30° (Fig. 4d). They differ from the other described associations by the highest cover of litter.

Holotypus hoc loco: relevé 43 in Supplement S1 (this paper); Location: Russia, Stavropolsky Kray, Pyatigorsk city, Mashuk Mountain, middle slope of western aspect, 44.05352°N 43.08136°E, altitude: 846 m a.s.l., aspect: 270°, inclination: 30°, 10.06.2019; Author of the relevé: D. Vynokurov

Diagnostic species: *Allium saxatile*, *Alopecurus vaginatus*, *Carex schkuhrii*, *C. tomentosa*, *Centaurea dealbata*, *C. orientalis*, *Dictamnus caucasicus*, ***Dracocephalum austriacum*****,** *Erysimum cuspidatum*, *Euphorbia condylocarpa*, *Filipendula vulgaris*, *Fragaria moschata*, *Galatella linosyris*, *Geranium sanguineum*, *Inula aspera*, *Iris aphylla*, *I. pontica*, *Laser trilobum*, *Linum nervosum*, *Melampyrum arvense*, *Microthlaspi perfoliatum*, *Onobrychis inermis*, *Pedicularis chroorrhyncha*, *Pyrethrum corymbosum*, *Rosa pimpinellifolia*, *Rumex horizontalis*, ***Serratula radiata*****,** *Seseli peucedanoides*, *Stachys officinalis*, *Stipa pennata*, *Trifolium alpestre*, ***Veronica peduncularis*****,** ***Vicia abbreviata*****,** *Vinca herbacea*, *Vincetoxicum hirundinaria*, *V. schmalhausenii*, ***Viola hirta***

Constant species: ***Achillea millefolium*** **aggr.,** *Alyssum calycinum*, *Bilacunaria microcarpa*, ***Brachypodium pinnatum*****,** *Bromopsis riparia*, *Campanula sibirica*, ***Carex humilis*****,** *Elytrigia intermedia*, *Euphorbia nicaeensis*, ***Festuca valesiaca*** **aggr.,** *Fragaria viridis*, ***Galium verum*****,** *Helictotrichon pubescens*, *Hypericum perforatum*, *Jurinea arachnoidea*, *Koeleria macrantha*, *Lotus corniculatus*, ***Medicago falcata*****,** *Peucedanum ruthenicum*, ***Phleum phleoides*****,** *Phlomoides tuberosa*, *Plantago media*, *Polygala anatolica*, ***Potentilla recta*****,** *Primula veris*, *Salvia verticillata*, ***Securigera varia*****,** ***Stachys recta*****,** *Stipa pulcherrima*, ***Teucrium chamaedrys*****,** *Thalictrum minus*, *Thymus marschallianus*, *Vicia cracca*

Dominant species: *Brachypodium pinnatum*

6. ***Festucetalia valesiacae*** **Soó 1947**

Xeric and meso-xeric grasslands

Diagnostic species: *Achillea millefolium* aggr., *A. nobilis*, *Adonis vernalis*, *Agrimonia eupatoria*, *Ajuga genevensis*, *Allium paczoskianum*, *Amoria repens*, *Asperula graveolens*, *Bothriochloa ischaemum*, *Carex michelii*, *Carlina vulgaris*, *Centaurea orientalis*, *C. troitzkyi*, *Cerastium holosteoides*, *Cerinthe minor*, *Cichorium intybus*, *Clinopodium vulgare*, *Convolvulus arvensis*, *Crataegus curvisepala*, *Daucus carota*, *Dianthus pallidiflorus*, *D. ruprechtii*, *Echium russicum*, *Elytrigia repens*, *Eryngium campestre*, ***Euphorbia iberica*****,** *E. nicaeensis*, *Filipendula vulgaris*, *Fragaria viridis*, *Genista patula*, *Gladiolus imbricatus*, *Helictotrichon adzharicum*, *Hieracium echioides*, *Hieracium x robustum*, *Inula hirta*, *Leontodon hispidus*, *Lotus corniculatus*, *Medicago falcata*, *Muscari muscarimi*, *Myosotis amoena*, *Oberna multifida*, *Onobrychis arenaria*, *Paeonia tenuifolia*, *Peucedanum ruthenicum*, *Phlomoides tuberosa*, *Plantago lanceolata*, *P. media*, *Poa angustifolia*, *P. compressa*, *Polygala caucasica*, *Potentilla argentea*, ***P. humifusa*****,** *Rosa canina*, *Salvia nemorosa* aggr., *Sanguisorba minor*, *Scabiosa ochroleuca*, *S. ucranica*, *Securigera varia*, *Senecio jacobaea*, *Serratula radiata*, *Stipa capillata*, *S. tirsa*, *Teucrium chamaedrys*, *Thalictrum minus*, *Thymus marschallianus*, *Tragopogon dasyrhynchus*, *Verbascum lychnitis*, *Veronica austriaca*, *V. spicata*, *Vicia angustifolia*

Constant species: *Acinos arvensis*, *Amoria ambigua*, *A. montana*, *Arenaria serpyllifolia*, *Brachypodium pinnatum*, ***Bromopsis riparia*****,** *Campanula sibirica*, ***Carex humilis*****,** *Centaurea dealbata*, *Falcaria vulgaris*, *Festuca pratensis*, ***Festuca valesiaca*** **aggr.,** *Galium humifusum*, ***G. verum*****,** *Geranium sanguineum*, ***Hypericum perforatum, Koeleria macrantha*****,** *Linum nervosum*, *Origanum vulgare*, *Phleum phleoides*, *Phlomis pungens*, *Potentilla recta*, ***Salvia verticillata*****,** ***Stachys recta*****,** *Stipa pulcherrima*, ***Teucrium polium*****,** *Thesium arvense*

Dominant species: *Bothriochloa ischaemum*, *Brachypodium pinnatum*, *Carex humilis*, *Festuca valesiaca* aggr., *Stipa pulcherrima*

6.1 *Festucion valesiacae* Klika 1931

Xeric and meso-xeric grasslands in the Forest-Steppe zones of Europe

Diagnostic, constant and dominant species: same as for order

Classification scheme of the *Festuco-Brometea* class vegetation in the North Caucasus:

Order: *Tanaceto achilleifolii-Stipetalia lessingianae* Lysenko et Mucina in Mucina et al. 2016

Alliance: *Tanaceto achilleifolii-Stipion lessingianae* Royer ex Lysenko et Mucina in Mucina et al. 2016

Order: *Galagello villosae-Stipetalia lessingianae* Vynokurov 2021

Alliance: *Stipo lessingianae-Salvion nutantis* Vynokurov 2014

Order Unknown

Alliance: *Artemisio chamaemelifoliae-Bromopsion variegatae* Vynokurov in Vynokurov et al. 2021

Ass. *Potentillo pimpinelloides-Artemisietum chamaemelifoliae* Tsepkova in Vynokurov et al. 2021

Ass. *Centaureo ciscaucasicae-Artemisietum chamaemelifoliae* Tsepkova in Vynokurov et al. 2021

Order: *Asphodelino tauricae-Euphorbietalia petrophilae* Vynokurov in Vynokurov et al. 2021

Alliance: *Helianthemo buschii-Cephalarion coriaceae* Vynokurov et Lysenko in Vynokurov et al. 2021

Ass. *Helianthemo buschii-Genistetum compacti* Vynokurov et Lysenko in Vynokurov et al. 2021

Alliance: *Onosmo caucasicae-Asphodelinion tauricae* Vynokurov et Lysenko in Vynokurov et al. 2021

Ass. *Gypsophilo glomeratae-Stipetum caucasicae* Vynokurov et Lysenko in Vynokurov et al. 2021

Ass. *Galio biebersteinii-Asphodelinetum tauricae* Vynokurov et Lysenko in Vynokurov et al. 2021

Ass. *Astracantho denundatae–Salvietum canescentis* Tsepkova in Vynokurov et al. 2021

Order: *Brachypodietalia pinnati* Korneck 1974

Alliance: *Cirsio-Brachypodion pinnati* Hadač et Klika in Klika et Hadač 1944

Ass. *Ranunculo caucasicae-Brachypodietum rupestris* Tsepkova in Vynokurov et al. 2021

Ass. *Cruciato pedemontanae-Brizetum elatioris* Vynokurov in Vynokurov et al. 2021

Ass. *Dictamno caucasici-Caricetum humilis* Vynokurov et Lysenko in Vynokurov et al. 2021

Order: *Festucetalia valesiacae* Soó 1947

Alliance: *Festucion valesiacae* Klika 1931

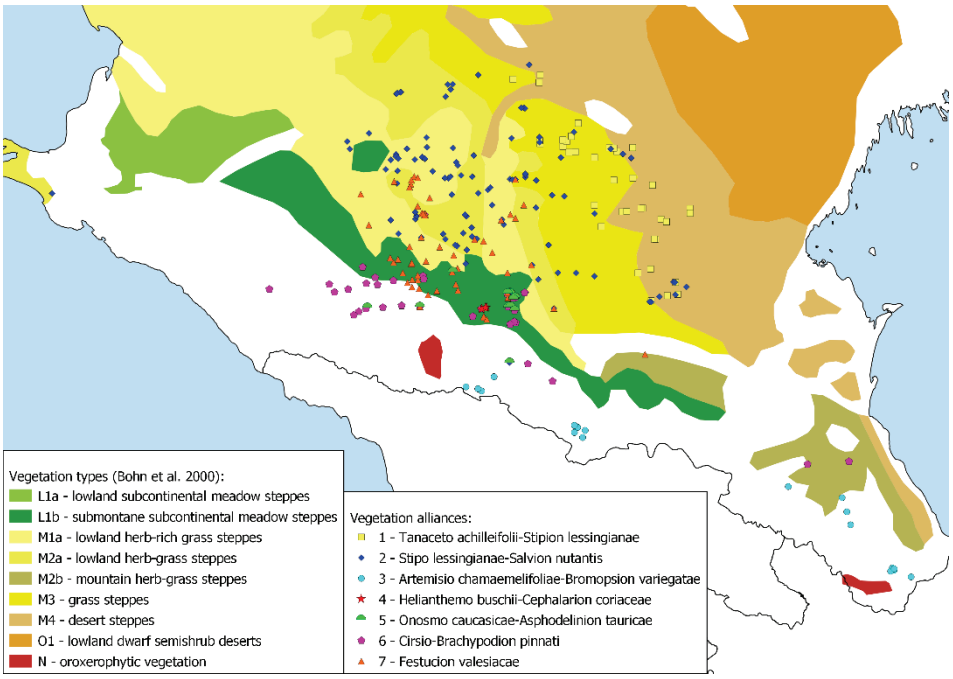


Fig. 5. Geographical distribution of the vegetation plots classified to the alliance level. Vegetation types based on the potential natural vegetation map of Europe (BOHN et al. 2000).

Abb. 5. Geografische Verteilung der Vegetationsaufnahmen, die der Verbandsebene zugeordnet sind. Die Vegetationstypen basieren auf der Karte der potenziellen natürlichen Vegetation Europas (BOHN et al. 2000).

4. Conclusions

Our analysis has shown that the diversity of dry grasslands in the North Caucasus can be united into the following steppe types: desert steppes, true steppes, mountain steppes, rocky grasslands, meadow steppes (xero-mesic and meso-xeric dry grasslands). In our study region, rocky grasslands and xero-mesic grasslands were most common. Rocky grasslands we assigned to the new order *Asphodelino tauricae-Euphorbietalia petrophilae*. There are two alliances within this order that we describe as new: *Helianthemo buschii-Cephalarion coriaceae*, which represents rocky grasslands on cretaceous limestone outcrops of the Pastbishny range, and *Onosmo caucasicae-Asphodelinion tauricae*, which combines rocky grasslands on the foothills of the Caucasus and laccolite mountains. Xero-mesic communities are classified within the *Cirsio-Brachypodion* alliance. A new association *Dictamno caucasici-Caricetum humilis* is described. Also, here we describe another association which belong to this alliance previously invalidly published by N.L. Tsepkova. Other steppe vegetation types in our study region were not common; therefore, we do not focus on them. Desert steppes should be classified within the order *Tanaceto achilleifolii-Stipetalia lessingianae*, true steppes – within the order *Galatello villosae-Stipetalia lessingianae*. In addition, the analysis has shown that mountain steppes of the Caucasus should be considered as a specific alliance *Artemisio chamaemelifoliae-Bromopsion variegatae*.

Erweiterte deutsche Zusammenfassung

Einleitung – Die reiche Flora und der hohe Grad an Endemismus der Flora des Nordkaukasus zogen bereits ab dem Ende des 18. Jahrhunderts viele Botaniker an. Trotz der recht gut bekannten Flora des Nordkaukasus ist die Vegetation weniger gut erforscht. Publikationen über die Besonderheiten der Steppenvegetation und deren Typisierung im zentralen Teil des Nordkaukasus begannen in der ersten Hälfte des 20. Jh. zu erscheinen (VERNANDER 1946, KONONOV 1953, 1971, NOVOPOKROVSKIY 1906, 1925, 1926, PRASOLOV 1909, TANFILEV 1971, FLEROV & BALANDIN 1931, SHIFFERS 1953). Hauptsächlich identifizierten die Autoren Gras-Salbei-Busch-Steppen (Halbwüsten) im nördlichen Teil der Region, Strauchgras- und Straußgrassteppen im Vorgebirgsteil des Kaukasus und Bergwaldsteppen oder Wiesensteppen. Erste Versuche der Klassifizierung von Trockenrasen nach dem Braun-Blanquet-Ansatz begannen erst Ende des 20. und Anfang des 21. Jahrhunderts. Insgesamt gab es nur fünf Assoziationen, die von N.L. Tsepkova ungültig beschrieben wurden (TSEPKOVA 1987, 2005, 2012, 2018). Somit bleibt der Nordkaukasus im Hinblick auf die Syntaxonomie der Steppenvegetation eine der am schlechtesten untersuchten Regionen Europas. Die Ziele dieser Studie waren: (1) das Aufzeigen von Biodiversitätsmustern, einschließlich Arten-Areal-Kurven und Artenreichtum und (2) die Vegetationsklassifikation von Trockenrasen des Zentralkaukasus.

Material und Methoden – Wir konzentrierten uns auf den zentralen Teil des Nordkaukasus, und zwar auf die Region "Pyatigoriye" und das Borgustanskiy-Gebirge, das zum Pastbishnyy-Gebirge gehört. Es wurden 47 Aufnahmen von je 10 m² Größe (3,16 × 3,16 m) in Höhen von 470 bis 1150 m ü.d.M. erfasst. Um die Beziehung von Artenreichtum zur Flächengröße zu bestimmen, nahmen wir fünf ineinander verschachtelte Serien von 0,0001 bis 100 m² (sieben Größen pro Serie) unter Berücksichtigung der Homogenität der beprobten Fläche nach dem EDGG-Standard auf (DENGLER et al. 2016). Die Flächen wurden unabhängig voneinander ausgewählt, mit dem Ziel, den zu erwartendenArtenreichtum zu berechnen. Außerdem sammelten wir weitere Vegetationsdaten aus dem Nordkaukasus. Der endgültige bereinigte Datensatz besteht aus 413 Aufnahmen. Wir verwendeten die modifizierte TWINSPAN-Klassifikation (ROLEČEK et al. 2009), die im JUICE-Programm (TICHÝ 2002) implementiert ist mit drei Pseudo-Arten Cut-Levels (0 %, 5 % und 20 % Deckung) und dem mittleren Sörensen-Index als Maß für die Cluster-Heterogenität. Diagnostische Arten wurden mit Hilfe des phi-Koeffizienten bestimmt (CHYTRÝ et al. 2002). Für die DCA-Analyse verwendeten wir die Programmiersprache R (R CORE TEAM 2018) mit dem Paket vegan (OKSANEN et al. 2019). Wir berechneten die z-Werte im doppeltlogarithmischen Raum (linearisierte Version des Power-Modells) als Maß für die Arten-Areal-Beziehung.

Ergebnisse und Diskussion – In den 47 Vegetationsaufnahmen fanden sich 414 Arten (einschließlich der nur bis zur Gattungsebene bestimmten Taxa): 365 Gefäßpflanzen (88 %), 28 Moose (7 %) und 21 Flechten (5 %). Der mittlere Artenreichtum variierte zwischen 1,8 Arten in den kleinsten Parzellen (0,0001 m²) und 68,8 in den größten Parzellen (100 m²). Die z-Werte der Arten-Flächen-Kurve (alle Taxa, über alle Flächengrößen) reichten von 0,252 bis 0,327, mit einem Mittelwert von 0,267. Das modifizierte TWINSPAN Verfahren ergab fünf Hauptcluster auf höherer syntaxonomischer Ebene (Abb. 3a, Anhang E2). Sie repräsentieren die folgenden Typen von Trockenrasen: Wüstensteppen, echte Steppen, Gebirgssteppen, felsiges Grasland und Halbtrockenrasen, die den Ordnungen *Tanaceto achilleifolii-Stipetalia lessingianae*, *Galatello villosae-Stipetalia lessingianae*, *Asphodelino tauricae-Euphorbietalia petrophilae* (in der Arbeit neu beschrieben), *Brachypodietalia pinnati* und *Festucetalia valesiacae* zugeordnet werden können. In Anbetracht der Einzigartigkeit dieser Vegetationstypen und der Tatsache, dass sie sich von den in der bisherigen Literatur beschriebenen deutlich unterscheiden, beschreiben wir hier eine neue Ordnung, drei neue Verbände (*Artemisio chamaemelifoliae-Bromopsion variegatae*, *Helianthemo buschii-Cephalarion coriaceae*, *Onosmo caucasicae-Asphodelinion tauricae*) und neun neue Assoziationen.

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Author contributions

D.V. conceived the idea of this study. Vegetation plots were recorded in May and June 2019 by D.V., T.L., Z.D. D.S. determined critical vascular plant taxa, G.D. determined bryophytes, I.U. and G.U. the lichens. D.V. and T.L. classified the vegetation and determined the diagnostic species. D.V. led the writing. All authors revised the manuscript and approved the final version.

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Supplements

Supplement S1. Vegetation table of the authors' relevés.

Beilage S1. Vegetationstabelle der Aufnahmen der Autorinnen und Autoren.

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

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

Supplement E1. Species aggregates, used for the numerical analysis.

Anhang E1. Artenaggregate, die für die numerischen Analysen verwendet wurden.

Supplement E2. Synoptic table (*phi* values) of the main vegetation units of the class *Festuco-Brometea* in the region of North Caucasus.

Anhang E2. Übersichtstabelle (*phi*-Werte) der Hauptvegetationseinheiten der Klasse *Festuco-Brometea* in der Region Nordkaukasus.

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Supplement S1. Vegetation table of the authors' relevés. Explanations: D.s.: differential species, hl: herb layer, ml: moss layer, s: shrub layer, **: preserved on the national level of conservation, *: listed in the red list of the Stavropol Krai.

Beilage S1. Vegetationstabelle der Aufnahmen der Autorinnen und Autoren. Erläuterung: D.s.: Differentialarten, hl: Krautschicht, ml: Moosschicht, s: Strauchschicht, **: auf nationaler Ebene geschützt, *: gelistet in der Roten Liste der Region Stavropol.

Relevé number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Date (year/month/day)		20190604	20190604	20190609	20190601	20190601	20190608	20190608	20190608	20190608	20190608	20190527	20190529	20190529	20190529	20190531	20190607	20190607	20190527	20190528	20190528	20190528	20190529	20190529	20190603	20190605	20190605	20190606	20190609	20190609	20190609	20190609	20190528	20190530	20190530	20190530	20190601	20190604	20190605	20190605	20190606	20190606	20190610	20190610	20190531	20190531	20190531	20190608
Altitude (m)		469	496	751	1063	1143	900	935	974	989	998	582	591	562	558	574	569	572	606	609	602	595	576	582	580	789	810	855	822	843	843	755	578	953	971	971	1153		742	850	670	842	851	846	551	551	550	898
Aspect (degrees)		40	220	180	190	145	135	130	130	130	130	80	125	135	135	180	180	180	45	90	120	135	155	155	115	130	225	135	242	240	180	180	120	210	80	100	40	70	145	270	25	20	270	270	0	0	0	90
Slope (degrees)		20	21	32	37	30	36	34	20	35	33	15	24	30	30	21	33	30	3	5	15	15	12	17	26	16	25	28	24	14	14	24	27	19	13	10	18		26	10	24	28	30	30	0	0	0	15
Cover total (%)		80	80	70	35	40	40	30	35	30	35	35	70	60	25	35	35	30	80	40	70	80	60	75	55	50	35	60	40	30	30	80	85	85	100	95	100	100	80	70	95	80	100	80	70	50	60	85
Cover herb layer (%)		80	80	70	35	40	40	30	35	30	35	30	70	60	25	30	35	30	80	30	50	80	55	75	55	40	25	60	35	25	30	80	85	85	100	95	100	100	80	70	95	80	100	80	70	50	60	85
Cover cryptogam layer (%)		7	3	3								10	3		2	10	2	2	10	15	60	15	10	1	5	20	15	7	7	10	2	2						1				7			1		1	
Cover litter layer (%)		30		90	15	15	10	20	20	10	15	5	40	40	5	10	20	10	85	10	15	30	20	70	30	15	15	15	25	15	20	70	90	95	100	90	100	100	10	20	90	90	98	99	3	3	5	60
Maximum height herbs (cm)		56	73	108		61	67	61	74	64	62	52	80	74	70		116	76	85	80	108	102	83	98	110	70	102	76	86	91	79	102	107	76	99	99		96	124	94	160	72	113	112		70	62	59
Latitude		44.09985	44.09996	44.09082	43.95224	43.95235	43.96996	43.96513	43.96473	43.96542	43.9655	44.03874	44.03979	44.03735	44.03736	44.04688	44.03928	44.03936	44.05453	44.05397	44.05434	44.05425	44.0397	44.03978	44.0465	43.93958	43.94119	43.96937	44.09382	44.09473	44.09753	44.09089	44.05454	44.04874	44.04972	44.04936	43.95373	44.0977	43.93882	43.94294	43.97429	43.97331	44.05342	44.05352	44.05278	44.05307	44.05255	43.96415
Longitude		43.24193	43.24057	43.05082	42.69992	42.6962	42.76028	42.7499	42.74874	42.74495	42.74488	43.089	43.08974	43.08755	43.0876	43.10425	43.09069	43.09055	43.11189	43.11142	43.11186	43.11218	43.08562	43.0855	43.10286	43.10448	43.10474	43.02778	43.05125	43.05048	43.04811	43.05095	43.11324	43.08937	43.0899	43.09002	42.69614	43.2277	43.10505	43.10568	43.05285	43.02685	43.08147	43.08136	43.0239	43.02187	43.02192	42.74557
Field form ID		CAU 022	CAU 023	CAU2041	CAU 017	CAU 019	CAU 033	CAU 034	CAU 035	CAU1036	CAU2036	CAU 001	CAU 007	CAU 008	CAU 009	CAU 020	CAU1032	CAU2032	CAU 002	CAU 003	CAU 004	CAU 005	CAU1010	CAU2010	CAU 021	CAU 026	CAU 027	CAU 030	CAU 038	CAU 039	CAU 040	CAU1041	CAU 006	CAU 011	CAU 012	CAU 013	CAU 018	CAU 024	CAU 025	CAU 028	CAU 031	CAU 029	CAU1042	CAU2042	CAU 014	CAU 015	CAU 016	CAU 037
D.s. of *Stipo lessingianae-Salvion nutantis* and *Galagello villosae-Stipetalia lessingianae*																																																
Seseli tortuosum	hl	0.2	0.5	.	0.1	0.2	.	0.1	.	.	.	.	.	0.5	0.2	.	0.2	.	.	.	.	.	0.5	0.5	0.3	0.2	0.5	0.5	.	.	.	.	.	0.5	0.2	.	.	.	.	0.5	.	.	.	.	.	.	.	.
Festuca valesiaca	hl	55	20	30	.	.	.	.	.	.	.	.	5	1	.	.	.	.	.	.	.	.	.	.	1	7	1	.	0.5	1	0.1	40	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	3
Jurinea arachnoidea	hl	0.1	0.3	.	.	.	.	.	0.3	.	.	.	.	0.3	.	.	0.3	0.3	.	0.5	.	0.2	.	0.1	.	.	.	0.2	.	0.5	.	.	.	.	.	.	.	.	.	.	.	0.3	.	0.5	.	.	.	0.3
Bothriochloa ischaemum	hl	1	7	.	.	.	.	.	.	.	.	.	1	7	.	0.5	.	.	15	15	1	0.5	.	0.3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Viola kitaibeliana	hl	0.3	0.1	0.5	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	0.1	.	.	0.1	.	.	.	.	0.1	.	0.2	.	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erophila verna	hl	0.1	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.1	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gagea taurica	hl	0.1	0.1	.	.	.	.	.	.	.	.	.	0.1	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	0.3	0.2	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus illyricus	hl	0.2	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.5	.	0.5	.	0.2	.	.	.	0.3	.	.	.	.	.	.	.	.
Medicago minima	hl	0.2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.1	.	.	.	.	0.2	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex supina	hl	3	3	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cerastium semidecandrum	hl	0.2	0.1	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Milium vernale	hl	0.1	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica arvensis	hl	0.1	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thymus x dimorphus	hl	20	7	.	.	.	.	.	.	.	.	.	.	.	.	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D.s. of *Helianthemo buschii-Genistetum compacti* and *Helianthemo buschii-Cephalarion coriaceae*																																																
**Scutellaria polyodon*	hl	.	.	.	5	0.5	3	0.5	0.2	0.2	0.5	.	.	.	2	.	.	.	.	.	.	0.3	.	.	.	.	0.5	.	0.2	.	0.2	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus demetrii	hl	.	.	.	0.5	0.5	0.5	0.3	1	0.1	0.5	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	7	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Inula ensifolia	hl	.	.	.	.	0.5	.	0.5	0.5	1	1	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	0.5	3	.	.	.	0.1	.	.	.	.	.	.	.	.	1	2	.	.	.	.
Bromopsis biebersteinii	hl	.	.	.	2	3	7	3	0.2	0.5	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	30	.	.	.	.	.	.	.	.	.	.	.
Coronilla coronata	hl	.	.	.	.	0.3	.	0.2	.	0.5	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	0.2	0.5	0.3	.	.	.	0.5
Linum tenuifolium	hl	.	.	.	0.2	.	.	0.2	0.2	0.3	0.3	.	.	.	.	0.1	.	.	.	0.1	0.1	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cephalaria coriacea	hl	.	.	.	7	7	.	0.5	0.5	0.5	2	3	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
***Elytrigia stipifolia*	hl	.	.	.	3	2	10	0.3	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Galium mollugo	hl	.	.	.	0.2	0.2	0.5	0.5	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	0.1
Genista compacta	hl	.	.	.	7	7	.	0.1	0.5	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helianthemum buschii	hl	.	.	.	2	3	.	0.5	0.5	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus lasioglottis	hl	.	.	.	.	0.5	0.1	0.2	0.3	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
**Hedysarum biebersteinii*	hl	.	.	.	.	.	.	0.5	0.3	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Onobrychis ruprechtii	hl	.	.	.	.	0.5	1	0.3	.	0.2	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pseudomuscari pallens	hl	.	.	.	0.1	0.5	0.1	.	0.2	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erucastrum armoracioides	hl	.	.	.	.	0.5	.	0.2	0.5	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
***Asphodeline tenuior*	hl	.	.	.	0.3	.	.	.	0.5	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D.s. of *Gypsophilo glomeratae-Stipetum caucasicae*																																																
Alyssum hirsutum	hl	.	0.2	.	.	.	.	.	.	.	.	.	0.1	0.2	0.2	0.5	0.5	.	.	.	.	.	0.2	0.1	0.2	0.1	0.2	0.5	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Meniocus linifolius	hl	.	0.2	.	.	.	.	.	0.1	.	.	0.1	0.1	0.1	0.2	0.2	0.1	0.5	.	.	.	.	0.2	0.1	0.1	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Onosma caucasica	hl	.	.	.	5	.	.	.	.	.	.	1	0.3	2	1	5	0.5	0.1	.	.	12	0.3	.	.	.	3	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erysimum canescens	hl	.	.	.	.	.	.	.	0.1	.	.	.	0.1	0.2	0.5	.	0.5	0.3	.	.	.	0.1	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gypsophila glomerata	hl	.	.	.	.	.	.	.	0.5	.	.	1	0.1	0.5	10	4	5	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
**Stipa caucasica*	hl	.	.	.	.	.	.	.	15	.	.	5	.	5	3	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zosima orientalis	hl	.	.	.	.	.	.	.	.	.	.	0.5	0.1	.	0.5	.	0.3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D.s. of *Galio biebersteinii-Asphodelinetum tauricae*																																																
Allium globosum	hl	.	.	.	0.2	.	0.1	.	.	.	0.1	.	.	.	.	.	.	.	0.1	0.2	0.2	0.1	.	.	.	25	0.5	.	0.1	0.3	1	.	.	0.1	.	.	.	.	.	.	.	.	0.1	0.2	.	.	.	0.1
**Thymus pastoralis*	hl	.	.	.	.	.	.	.	.	.	.	.	1	10	2	.	.	.	20	5	20	10	5	1	.	0.2	7	3	.	.	.	.	.	.	.	0.5	.	.	0.5	3	.	2	.	.	.	.	.	.
Galium biebersteinii	hl	.	0.2	.	.	.	.	.	0.2	.	.	.	1	.	.	0.2	.	.	0.5	.	0.1	0.1	0.2	.	0.1	.	0.2	.	0.3	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ajuga chia	hl	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	0.2	.	.	.	0.5	1	0.2	0.5	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthyllis macrocephala	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.1	.	.	.	.	0.2	0.1	.	0.5	0.5	0.5	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.
Melica taurica	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	0.5	10	1	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	0.3	.	.	.	.	.	.	.	.
Tortella inclinata	ml	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	40	.	.	.	.	6	.	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D.s. of *Onosmo caucasicae-Asphodelinion tauricae*																																																
Acinos arvensis	hl	.	.	.	.	.	.	.	.	.	.	0.1	0.1	0.1	0.1	0.2	0.1	0.1	.	0.1	0.3	0.5	0.1	0.1	.	0.3	0.2	0.5	0.3	0.5	0.2	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poterium polygamum	hl	.	.	.	.	.	.	.	.	.	.	0.2	.	0.5	2	1	5	10	0.5	0.2	2	1	.	.	3	1	2	.	.	0.5	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	0.1	0.3	0.5	0.2
***Asphodeline taurica*	hl	.	.	.	.	.	.	.	.	.	.	.	0.5	0.5	.	3	0.5	0.5	0.5	0.5	.	.	0.5	0.5	1	3	2	5	3	1	3	.	.	1	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.
Sedum hispanicum	hl	.	.	0.2	.	.	.	.	.	.	.	.	0.1	0.1	0.1	0.2	0.2	0.1	.	.	0.1	.	0.1	.	0.1	0.2	0.1	.	0.3	0.1	0.3	0.5	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.
Allium albidum	hl	.	.	.	.	.	.	.	0.5	.	.	.	0.5	1	1	0.2	0.3	.	.	.	0.5	0.1	1	.	1	2	3	.	0.5	0.3	0.3	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Holosteum marginatum	hl	.	.	.	.	.	.	.	.	.	.	0.1	0.1	0.1	0.2	0.1	.	.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Placidium fingens	ml	.	0.5	.	.	.	.	.	.	.	.	3	.	.	.	4	.	0.5	.	.	0.1	0.1	0.1	.	.	5	3	.	1	2	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa badensis	hl	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	0.1	0.3	.	.	3	.	.	.	.	.	1	.	.	0.5	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Saxifraga tridactylites	hl	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.1	.	.	.	0.1	0.1	.	.	.	.	.	.	.	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Toninia physaroides	ml	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	3	0.5	.	.	.	.	.	3	.	0.1	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D.s. of *Asphodelino tauricae-Euphorbietalia petrophilae*																																																
Bilacunaria microcarpa	hl	.	0.5	.	0.2	0.2	.	3	0.5	2	1	.	0.5	0.3	.	1	.	.	.	.	.	0.1	.	.	1	0.1	0.1	3	3	5	.	5	.	.	.	.	0.1	.	0.5	.	.	.	3	1	.	.	.	0.2
Asperula biebersteinii	hl	.	.	.	0.1	0.2	1	0.5	0.3	0.5	0.3	0.5	.	.	0.5	0.3	.	0.3	.	0.5	0.5	.	0.1	0.2	.	.	.	.	0.5	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
**Euphorbia petrophila*	hl	.	.	.	0.1	7	.	1	2	3	2	10	.	1	2	5	2	0.3	0.3	.	.	.	.	.	0.2	.	.	.	0.2	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Seseli varium	hl	.	.	.	.	.	0.3	.	0.3	.	.	.	3	.	.	.	0.2	.	0.5	0.5	1	0.3	.	.	0.2	.	.	.	1	0.3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Collema tenax	ml	.	.	.	.	.	.	.	0.1	0.1	.	8	.	.	0.1	0.5	.	0.5	.	5	.	.	.	.	.	.	2	.	1	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thymus daghestanicus	hl	.	.	.	0.5	.	.	0.2	.	3	.	15	.	.	.	.	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D.s. of *Dictamno caucasici-Caricetum humilis* and *Cirsio-Brachypodion pinnati*																																																
Dictamnus caucasicus	hl	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	0.1	.	.	0.1	.	0.2	5	0.5	5	3	.	.	0.5	.	.	.	.	7	.	.	.	0.5	.	0.5	5	3	1	5	5	.	.	.	.
Geranium sanguineum	hl	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	0.1	1	.	.	.	.	.	.	.	.	.	.	0.1	2	5	60	30	15	.	0.5	40	1	7	15	.	.	.	7
Hypericum perforatum	hl	.	0.2	.	.	.	.	0.1	.	.	.	.	0.1	.	.	0.1	.	.	.	0.1	.	0.1	.	.	.	.	.	0.1	.	.	.	.	.	0.1	0.3	0.1	.	0.1	.	0.3	.	.	.	0.1	0.1	.	.	.
Brachypodium rupestre	hl	.	.	.	.	.	.	.	.	1	0.5	.	.	.	.	.	.	.	2	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	1	40	1	.	10	.	.	10	.	40	30	.	0.5	.	20
Vincetoxicum hirundinaria	hl	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	0.2	.	0.5	0.5	1	3	0.5	1	2	0.5	.	.	.	.
Melampyrum arvense	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.3	0.2	.	.	.	.	.	0.5	0.2	.	0.1	0.3	.	0.1	.	1	.	.	.	.	0.2	0.5	.	.	.	0.1
Centaurea dealbata	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	10	40	5	1	20	.	4	.	3	0.3	3	.	.	.	2
Peucedanum ruthenicum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	0.3	0.5	.	1	0.3	1	0.2	.	.	.	.	0.3
Serratula radiata	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	5	.	.	5	10	0.3	0.5	2	0.3	1	3	.	.	.	0.5
Rosa pimpinellifolia	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	0.5	.	.	.	.	1	.	.	.	.	.	.	0.3	.	2	0.3	.	1	.	1	.	0.5	.	.	.	0.5
Pyrethrum corymbosum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.3	.	.	.	.	.	.	1	.	.	0.3	1	.	.	.	0.5	1	0.5	.	.	.	0.3
Veronica peduncularis	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.2	1	.	0.1	0.2	.	.	0.3	.	1	2	.	.	.	.
Erysimum cuspidatum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	1	0.2	0.2	.	.	.	0.1	.	0.1	.	0.1	.	.	.	.
Stachys officinalis	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	0.3	5	3	.	5	.	1	.	.	.	.	.	.
Trifolium alpestre	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	0.5	0.5	3	.	.	.	.	.	1	0.5	.	.	.	.
Brachypodium pinnatum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	65	1	0.1	.	.	.	.	.	.	15	.	.	.	10	.	.
D.s. of *Festucion valesiacae* and *Festucetalia valesiacae*																																																
Euphorbia stepposa	hl	.	.	.	.	.	1	0.1	.	.	.	.	.	0.5	.	.	.	.	.	.	.	2	.	3	0.2	.	.	0.5	0.5	0.2	.	.	0.5	1	0.2	.	.	.	0.1	15	1	.	.	.	0.1	0.5	5	2
Thymus marschallianus	hl	.	.	1	.	.	0.5	.	0.5	.	.	.	.	.	.	.	1	2	.	0.5	.	.	.	.	5	.	.	.	5	.	1	0.5	.	0.5	.	.	.	0.2	.	.	.	.	1	0.5	1	0.3	0.5	0.5
Festuca rupicola	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	0.5	5	.	.	.	15	.	.	.	.	.	.	.	.	0.1	10	.	5	0.5	5	.	3	7	20	15	.
Thalictrum minus	hl	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	0.5	0.2	.	.	0.5	.	.	.	0.2	.	.	.	.	.	0.1	0.5	1	1	.	.	.	.	0.1	.	0.1
Polygala anatolica	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	1	.	.	0.1	.	.	.	.	.	.	.	.	.	.	0.2	0.1	.	.	.	.	0.5	0.1	0.1	.	0.2	0.1	0.5
Plantago media	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	0.5	1	0.5	0.5	.	.	3	0.5	0.3	0.5
Carex michelii	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	2	0.5	.	.	.	.	.	.	.	1	1	.	.	2	.	.	.	.	.	5	.	5	.
Euphorbia condylocarpa	hl	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	0.1	.	.	0.7	0.3	.	0.1	.	.	0.1	0.2
Fragaria viridis	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	5	0.5	.	.	.	2	3	7	.	3	0.5
Scabiosa bipinnata	hl	.	.	.	.	0.1	0.3	.	.	.	.	.	.	.	.	.	0.5	.	.	.	0.5	.	.	.	.	.	.	.	.	.	0.3	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	0.2	.	0.5
Veronica teucrium	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	0.1	.	.	.	1	0.5	1	.	.	.	0.2	0.5	0.5
Falcaria vulgaris	hl	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	0.5	.	.	.	.	0.2	.	.	.	.	.	0.1	.	0.5	0.3
Echium russicum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	0.1	.	0.5	1	.	0.5
Lotus corniculatus	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	0.2	.	0.5	0.2	1
Plantago lanceolata	hl	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	0.2	.	.	.	.	.	.	.	0.2	0.1	0.2
Leontodon hispidus	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.1	.	.	.	.	0.2	0.2	0.5
Onobrychis inermis	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	0.3	1	.	.	0.2	0.5
Astragalus austriacus	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	2	3	0.5
Cerinthe minor	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	1	0.5
Eryngium campestre	hl	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	0.2	.	.
Euphorbia seguierana	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	0.1	.	.
Galium humifusum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	0.5	0.2	.
Marrubium peregrinum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	1	0.3
**Adonis vernalis*	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	0.5	.
Agrimonia eupatoria	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	0.2
Salvia tesquicola	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	.	.

Continued on back page

Fortsetzung auf der Rückseite

Relevé number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
D.s. of *Festuco-Brometea* (with high constancy)																																																
Teucrium chamaedrys	hl	.	.	0.3	3	1	0.5	.	.	0.5	.	1	.	0.5	.	.	4	.	.	0.5	5	5	10	1	7	0.5	2	1	1	0.5	2	.	3	2	.	0.5	2	3	0.5	.	2	5	2	3	0.1	3	.	1
***Stipa pulcherrima*	hl	.	.	.	.	1	.	2	3	1	7	.	40	.	.	2	.	.	30	0.5	1	5	10	20	15	5	5	15	0.5	3	3	0.5	.	50	.	.	5	3	1	0.5	7	.	10	10	50	5	.	.
Teucrium polium	hl	.	5	.	0.3	0.5	0.2	0.5	0.5	1	0.5	0.3	3	20	1	1	1	0.2	3	1	0.3	0.1	4	1	1	.	0.3	1	0.5	3	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.3
Stachys recta	hl	.	.	.	0.2	0.5	0.2	0.2	0.2	.	.	.	1	5	0.5	.	0.2	0.1	.	.	.	0.3	0.5	1	.	.	.	.	1	.	0.5	0.2	.	0.3	.	.	0.2	0.2	0.2	0.2	0.2	0.3	0.5	0.5	0.2	0.2	0.2	0.5
Carex humilis	hl	.	.	.	5	12	.	15	5	10	15	.	.	.	.	.	.	.	20	.	5	3	5	1	5	.	2	3	0.5	1	7	.	.	5	.	30	5	.	.	2	10	20	30	15	.	.	.	50
Thesium arvense	hl	.	.	0.2	0.3	0.2	0.2	.	.	.	.	.	.	0.1	0.1	.	1	.	0.5	0.2	0.5	0.1	0.3	.	0.2	0.1	0.1	.	0.2	0.2	0.2	0.5	.	.	.	.	.	.	.	.	.	0.5	0.2	0.1	0.2	0.2	0.1	0.5
Bromopsis riparia	hl	0.3	3	7	.	.	.	.	.	.	.	.	1	.	0.5	.	2	.	5	.	0.1	0.1	.	1	.	1	0.2	.	1	1	1	5	.	2	.	1	.	.	0.1	.	.	.	.	.	1	5	5	2
Medicago falcata	hl	.	0.5	6	0.2	.	0.5	0.2	0.3	.	.	.	.	.	.	.	.	.	0.3	.	.	2	0.5	3	.	.	.	0.5	0.5	.	.	10	0.3	.	.	.	1	1	0.5	0.5	0.3	.	0.1	1	.	.	.	0.5
Filipendula vulgaris	hl	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	0.5	5	.	.	0.2	.	.	0.5	.	.	.	.	3	5	15	.	5	3	0.2	1	1	30	0.5	2	0.2	0.3	0.2	0.5
Arabis recta	hl	.	0.2	0.1	.	.	.	.	.	.	.	0.1	.	0.1	0.2	0.3	.	0.1	0.1	.	0.1	0.1	.	.	0.1	0.1	.	0.1	1	0.1	0.2	0.5	.	.	.	.	.	0.1	.	0.5	.	.	.	0.1	.	.	.	.
Galium verum	hl	.	0.3	3	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	3	.	.	.	.	.	1	.	.	.	0.3	.	.	3	3	1	3	0.5	7	1	1	1	3	1	2	1	.	.	.	1
Koeleria macrantha	hl	3	0.5	0.5	.	.	.	.	.	.	.	.	2	1	.	.	.	0.5	3	2	1	1	.	.	0.5	0.5	0.5	5	0.5	1	0.5	5	.	1	.	3	.	.	.	.	.	.	.	.	.	.	.	.
Veronica praecox	hl	.	0.1	1	.	.	.	.	.	.	.	0.1	0.1	0.1	0.1	0.2	0.1	0.2	.	0.1	0.2	0.1	0.1	.	0.1	0.1	0.1	0.1	0.2	.	0.5	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Alyssum calycinum	hl	.	0.2	0.5	.	.	.	.	.	.	.	.	0.2	.	.	0.2	.	.	.	0.1	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.2	3	0.2	0.5	0.5	.	0.2	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.
Arenaria serpyllifolia	hl	0.5	0.5	1	.	.	.	.	.	.	.	.	0.1	0.1	0.1	0.1	.	.	.	.	0.1	.	0.2	0.1	0.1	0.1	.	0.2	0.5	0.2	0.2	0.5	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	0.1
Campanula sibirica	hl	.	.	.	0.2	.	.	0.5	0.2	.	0.1	.	.	0.1	0.5	0.2	0.5	0.3	.	0.2	.	0.2	.	.	0.5	.	.	.	0.2	0.3	.	.	.	.	.	.	.	.	.	.	0.3	0.5	.	.	.	0.1	.	0.1
Securigera varia	hl	.	.	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	0.1	0.3	.	.	.	0.5	.	.	.	1	0.5	0.5	1	.	1	1	1	.	.	.	2	2	1	0.2	0.1	0.5
Vinca herbacea	hl	.	.	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	0.1	0.2	0.2	0.2	0.3	.	.	0.5	0.2	.	.	1	0.5	1	.	.	.	0.5	0.5	1	.	.	0.3	1	.	.	.	0.5
Centaurea orientalis	hl	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	0.2	0.3	0.5	0.3	.	.	.	0.3	.	.	1	.	2	.	1	.	0.5	0.2	0.5	0.2	.	0.5	1	.	0.3	.	0.3
Bryum sp.	ml	1	0.5	.	.	.	.	.	.	.	.	3	2	.	.	0.5	0.1	0.1	0.5	.	0.1	1	.	.	0.1	0.1	.	0.1	0.1	2	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Microthlaspi perfoliatum	hl	0.1	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	0.1	0.1	.	.	0.1	.	.	.	0.1	.	.	0.1	0.1	0.3	0.1	.	0.1	0.2	.	0.2	.	.	0.1	0.1	.	.	.	.
**Centaurea leucophylla*	hl	.	.	.	.	2	15	15	5	10	10	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	0.3	0.5	.	.	.	.	.	5	.	7	.	2	.	1	.	1	.	.	0.5
***Iris aphylla*	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	0.5	0.5	0.3	0.5	0.5	.	.	0.5	0.2	0.5	.	.	1	1	.	.	1	.	.	3	.	.	.	0.5	.	.	.	0.5
Salvia verticillata	hl	.	.	.	0.1	0.5	1	0.5	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	5	.	1	3	1	1	0.1	0.5	0.3	1
Linum nervosum	hl	.	.	.	1	0.2	.	0.3	.	0.2	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	1	0.5	0.5	.	0.2	0.2	0.5	0.3	0.3	.	.	.
Muscari neglectum	hl	0.5	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.5	0.2	.	.	.	0.5	.	0.1	0.5	0.3	0.1	0.3	.	.	.	0.2	.	.	.	0.5	.	0.3	.	.	.	.	.	.
Potentilla recta	hl	0.5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	0.2	.	.	.	0.5	.	.	.	0.5	.	.	.	1	.	.	.	.	.	0.1	0.1	0.2	.	0.2	0.1	0.2	.	.	0.2	.
Achillea millefolium	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	1	0.2	0.5	1	0.5	0.1	0.3	.	1	.	.	0.5	0.5	3	0.5
Alyssum turkestanicum	hl	0.2	0.1	0.1	.	.	.	.	.	.	.	0.1	0.1	0.1	.	0.1	.	.	.	0.1	.	.	.	.	0.1	.	.	.	0.5	0.1	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Inula aspera	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	0.1	0.2	0.2	.	5	1	.	1	3	1	.	0.3	.	1	0.1
Phleum phleoides	hl	0.5	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	0.5	.	.	.	.	.	.	3	.	1	.	3	1	5	.	.	.	5	.	1	.	.	.	0.2
Holosteum umbellatum	hl	0.5	0.2	0.5	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	0.1	.	0.1	.	.	.	.	.	.	0.1	0.3	0.5	0.2	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa bulbosa	hl	1	0.5	0.3	.	.	.	.	.	.	.	1	1	1	2	0.1	.	2	.	0.5	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
***Iris pumila*	hl	.	0.3	.	0.1	.	.	0.2	.	.	.	.	0.5	.	.	.	.	.	.	.	.	0.2	0.2	0.2	.	2	0.5	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phlomoides tuberosa	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	2	0.5	1	.	1	1	.	.	0.2	4
Agropyron pectinatum	hl	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	15	.	.	.	.	.	0.5	5	.	1	1	.	0.2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cleistogenes bulgarica	hl	0.5	.	.	.	.	.	.	.	.	.	.	.	5	.	0.2	1	.	.	.	.	.	1	1	2	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortula ruralis	ml	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	0.5	3	2	.	.	.	.	.	.	1	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viola ambigua	hl	.	.	.	.	0.5	.	0.2	0.1	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	0.3	0.2	0.3
Amygdalus nana	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	0.5	.	.	.	.	.	0.5	.	.	.	0.5	.	.	.	.	.	.	.	.	0.5	.
Other species																																																
Trichostomum crispulum	ml	.	4	.	.	.	.	.	.	.	.	1	0.1	.	.	0.5	.	.	1	.	.	.	5	1	.	.	5	.	.	3	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elytrigia intermedia	hl	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	0.5	40	15	15	.	.	7	.	.	.	0.3
Psora decipiens	ml	.	0.5	.	.	.	.	.	.	.	.	1	.	.	0.1	2	.	.	.	0.1	.	.	0.1	.	.	2	.	.	0.1	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhamnus pallasii	hl	.	.	.	.	.	.	.	3	.	.	.	1	.	.	.	.	.	.	0.5	.	50	40	20	0.5	.	.	.	0.3	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.
Rumex horizontalis	hl	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.3	0.1	.	.	.	.	.	0.3	.	.	.	1	.	0.5	0.5	0.1	.	0.5	.	.	.	.	.	.	.	.	.	.
Chamaecytisus ruthenicus	hl	.	.	.	0.2	0.2	.	.	.	.	0.5	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	2	.	.	.	1	1	.	.	.	.	.	.
Scorzonera stricta	hl	.	0.5	.	.	.	.	.	.	.	.	.	0.5	.	.	0.2	.	.	0.1	.	.	.	.	.	.	0.2	.	.	0.5	0.3	.	.	.	.	.	.	.	0.3	.	.	.	.	.	.	.	.	.	.
Aster amellus	hl	.	.	.	.	.	0.2	.	.	0.2	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	0.2	0.5	0.3	.	.	.	.
Bryum argenteum	ml	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	0.1	.	.	.	.	.	.	.	.	3	0.1	0.5	0.1	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.
Weissia sp.	ml	.	.	.	.	.	.	.	.	0.1	0.1	.	.	.	.	.	.	0.1	7	.	.	.	.	.	2	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1
Onobrychis cyri	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	0.1	.	.	.	0.3	.	.	.	.	.	.	.	0.5	.	0.5	.	.	.	.	.	.	.	.	.	0.1	.	.
Potentilla arenaria	hl	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	1	0.5	0.5	.	.	0.5	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Primula macrocalyx	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	0.3	.	.	.	1	0.5	0.2	0.3	.	.	.	.
Vincetoxicum schmalhausenii	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	0.5	1	0.3	.	1	.	.	.	.	1
Alopecurus vaginatus	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	0.5	0.1	.	.	.	.
**Artemisia caucasica*	hl	.	.	.	5	.	.	.	.	.	.	0.5	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Camelina microcarpa	hl	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.5	.	0.1	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.
Cuscuta sp.	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.1	.	.	.	.	0.1	.	.	.	.	.	0.2	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dianthus pseudarmeria	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	0.5	.	.	.	.	.	.	.	.	.	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Didymodon rigidulus	ml	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	1	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dracocephalum austriacum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	1	.	.	.	.	.	5	1	0.5	.	.	.	.
Minuartia hybrida	hl	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.1	.	0.1	.	0.1	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis chroorrhyncha	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	0.5	.	0.2	.	.	0.3	.	0.2	.	.	.	.	.
Pyrethrum coccineum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	0.1	.	5	.	.	.	0.5	.	0.5	.	.	.	.	.
Thymus markhotensis	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	5	.	.	.	5	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.
Verbascum lychnitis	hl	.	.	.	.	.	.	.	.	.	.	.	.	0.5	1	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	0.2	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.
Vicia abbreviata	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	0.5	0.3	0.3	0.2	.	.	.	.
Viola hirta	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	0.5	0.5	1	.	0.2	.	.	.	.	.	.
Anemone sylvestris	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	0.2	.	0.3	.	.	.	.	0.1
Cladonia rangiformis	ml	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	15	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
**Clematis integrifolia*	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	0.5	0.5	.	0.2	.	.	.	.	.
Clinopodium vulgare	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	0.1	.	.	0.2	.	.	.	.	.	.	0.3
Cruciata laevipes	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	0.2	.	.	.	.	0.1	.	.	.	.	0.5
Fragaria moschata	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	7	3	0.3	.	.	.	.	.	.	.	.	.	.	.	.
Galatella dracunculoides	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	0.5	.	0.3	.	.	.	.	.	.	0.2
Galatella linosyris	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	0.2	0.5	.	.	.	.
Galium rubioides	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	0.5	0.1	.	.	.	.	.	.	.
Helictotrichon pubescens	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	0.1	.	.	.	0.5	3	.	.	.	.	.	.
Hylotelephium caucasicum	hl	.	.	0.2	0.1	.	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Iris pontica	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	0.3	0.2	.	.	.	0.3
Laser trilobum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	0.5	5	1	.	.	.	.
Linum alexeenkoanum	hl	.	.	.	.	.	.	.	0.5	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.
Myosotis suaveolens	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	0.2	.	0.1	.	.	.	.	.	0.3
***Orchis tridentata*	hl	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.
Orobanche sp.	hl	.	.	0.1	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.
Phascum cuspidatum	ml	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.
Phlomis pungens	hl	.	.	.	.	.	0.5	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2
Pleurochaete sqaurrosa	ml	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	7	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pterygoneurum ovatum	ml	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	1	0.5	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scorzonera taurica	hl	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.
Sedum acre	hl	.	.	.	.	.	.	.	.	.	.	2	.	.	0.5	.	.	.	.	0.5	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Seseli sp.	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.1	0.5	.	.	.	.	.	0.5
Sideritis comosa	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	0.1	.	.	.	.	0.2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Silene sp.	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	0.5	.	.	0.3	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
***Stipa pennata*	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	15	.	.	3	.	.	.	.	.	.	.
Tortula sp.	ml	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	1	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.
Valerianella dentata	hl	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.
Aegonychon purpureocaeruleum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	0.5
Allium fuscoviolaceum	hl	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Allium paniculatum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	0.3	.	0.1	.	.	.	.	.	.
Allium rotundum	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.3	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Androsace koso-poljanskii	hl	.	.	.	.	.	.	.	0.5	0.5	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arabis sagittata	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1
Asperula arvensis	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	0.1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus bungeanus	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	0.2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium sp.	ml	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.
Buglossoides arvensis	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	0.1	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bupleurum exaltatum	hl	.	.	.	.	.	0.1	.	.	0.2	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Campanula sarmatica	hl	.	.	.	0.1	.	.	.	.	0.3	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex tomentosa	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	1	.	.	.	0.1	.	.	.	.	.	.
Catapyrenium sp.	ml	.	.	.	.	.	.	.	0.1	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Centaurea kubanica	hl	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Centaurea marschalliana	hl	.	.	.	0.5	.	.	.	.	.	.	.	10	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia magyarica	ml	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	3	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Convolvulus lineatus	hl	.	.	.	.	.	0.1	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.
Dianthus caucaseus	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.2	0.1	.	.	.	.
Elytrigia trichophora	hl	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.
Encalypta vulgaris	ml	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	5	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia iberica	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	0.5	.	.	1	.	.	.	.	.
Gyalolechia species	ml	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.5	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leptogium schraderi	ml	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Linum austriacum	hl	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.1	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melandrium album	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	0.5	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.
Orchis sp.	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	0.1	.	.	.	.	.
Orthanthella lutea	hl	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	0.1	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pleconax subconica	hl	.	0.3	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa compressa	hl	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.
Quercus petraea	hl	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Reseda lutea	hl	.	.	.	.	.	.	.	.	.	.	.	0.5	0.3	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex acetosa	hl	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	0.2	.	.	.	.	.	.
Seseli libanotis	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	.	.	0.1	0.5	.	.	.	.	.	.	.
Seseli peucedanoides	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	0.2	.	.	.	.	.	.	0.1	.	.	.	.	.
Sideritis montana	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.2	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Silene italica	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.1	.	0.5	.	.	.	.	.	.	.	.	.	.
Stipa capillata	hl	.	40	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thymelaea passerina	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.
Tortella tortuosa	ml	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	2	.	0.1	.	.	.	.
Veronica spicata	hl	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia grossheimii	hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	0.1	.	0.5	.	.	.	.	.	.	.	.	.	.

Sporadic species (1-2 occurrences) with relevé numbers:

Shrub layer: *Rosa pimpinellifolia* 21: 2, 40: 0.2; *Rhamnus pallasii* : 19: 2; *Prunus stepposa* : 37: 2; *Berberis vulgaris* : 22: 2.

Juvenile woody species: *Prunus stepposa* 32: 0.1; *Quercus petraea* 34: 0.1.

Herb layer: *Acer campestre* 41: 0.1; *Acer pseudoplatanus* 15: 0.1; *Alchemilla languida* 41: 1; *Allium erubescens* 1: 0.2, 33: 0.1; *Allium* sp. 22: 0.1, 23: 0.1; *Alyssum tortuosum* 29: 3, 47: 0.2; *Alyssum trichostachyum* 41: 0.1, 47: 0.2; *Amoria montana* 41: 3; ***Anacamptis pyramidalis* 19: 0.1, 20: 0.1; *Anisantha sterilis* 19: 0.1; *Anisantha tectorum* 22: 0.1; *Anthemis rigescens* 26: 0.1; *Artemisia marschalliana* 6: 3, 17: 0.2; *Asparagus verticillatus* 32: 0.5; *Asperula molluginoides* 36: 3, 40: 10; *Asperula taurica* 20: 1; *Astragalus brachylobus* 2: 0.5; *Astragalus danicus* 41: 0.1; *Astrantia major* 36: 0.2; *Asyneuma campanuloides* 41: 3; *Briza media* 40: 0.1, 41: 5; **Bromopsis gordjaginii* 36: 1; *Bromopsis inermis* 35: 0.1; *Bromus squarrosus* 3: 0.2, 31: 0.1; *Bupleurum falcatum* 40: 0.2, 41: 0.2; *Bupleurum rotundifolium* 3: 0.2, 31: 1; *Campanula glomerata* 36: 0.2, 40: 1; *Carduus crispus* 47: 0.2; *Carex caryophyllea* 19: 0.5, 20: 0.3; *Carlina vulgaris* 47: 0.1; *Centaurea holophylla* 4: 0.3; *Centaurea sibirica* 6: 0.5; *Centaurea* sp. 47: 0.2; *Cerastium arvense* 41: 0.2; *Cerastium nemorale* 3: 0.5; *Cerastium* sp. 1: 1; *Chamaenerion caucasicum* 39: 5; *Cirsium arachnoideum* 34: 0.5; *Clematis lathyrifolia* 32: 1; *Conringia austriaca* 23: 0.2; *Convolvulus arvensis* 46: 0.1; ***Crambe cordifolia* 40: 12; *Crataegus* sp. 37: 0.5; *Crocus reticulatus* 2: 0.1, 40: 0.1; *Cruciata glabra* 47: 0.1; *Crupina vulgaris* 2: 0.1; *Dianthus capitatus* 27: 0.2, 39: 2; *Dianthus* sp. 1: 0.3, 6: 0.1; *Dianthus speciosus* 12: 0.1; **Diphelypaea coccinea* 33: 0.3, 34: 0.1; *Draba nemorosa* 3: 0.1, 39: 0.1; *Draba sibirica* 41: 0.2; *Echinops ruthenicus* 41: 0.5; *Ephedra distachya* 2: 3; *Ephedra procera* 6: 2, 8: 0.2; ***Eremurus spectabilis* 27: 1, 38: 7; *Fallopia convolvulus* 6: 0.1, 39: 0.1; *Fraxinus excelsior* 34: 0.1, 46: 0.1; *Gagea* sp. 3: 0.1; *Galium spurium* 3: 0.3, 31: 0.1; *Galium valantioides* 36: 3; *Galium verticillatum* 15: 0.1; *Genista patula* 40: 0.7; *Genista tinctoria* 36: 0.5; **Gladiolus tenuis* 47: 0.3; *Goniolimon tataricum* 47: 0.2; *Gypsophila acutifolia* 8: 0.2; *Helianthemum nummularium* 36: 0.5; *Hieracium echioides* 29: 0.2; *Hieracium* sp. 37: 0.1; **Iberis taurica* 29: 0.2, 30: 0.5; *Inula germanica* 32: 1; *Iris germanica* 37: 1; ***Iris notha* 37: 0.5, 38: 2; *Knautia montana* 36: 0.2; *Kohlrauschia prolifera* 28: 0.1, 31: 0.2; *Lactuca serriola* 19: 0.1; *Lagoseris sancta* 3: 0.2, 31: 0.5; *Lamium amplexicaule* 3: 0.1; *Lappula barbata* 16: 0.1, 17: 0.2; *Linaria genistifolia* 39: 0.3; *Linum* sp. 22: 0.1, 23: 0.1; *Lotus caucasicus* 36: 0.5, 44: 3; *Medicago orbicularis* 3: 0.2; *Melica transsilvanica* 33: 2, 36: 3; *Myosotis micrantha* 14: 0.1; *Nepeta cyanea* 6: 1; *Nepeta grandiflora* 34: 1; *Nepeta pannonica* 38: 0.2; *Oberna cserei* 22: 0.3, 23: 0.2; *Onobrychis vassilczenkoi* 7: 0.2, 17: 0.5; *Ononis pusilla* 24: 0.2; *Origanum vulgare* 39: 0.5, 40: 0.7; *Ornithogalum kochii* 25: 0.2; *Ornithogalum ponticum* 3: 0.2; *Orobanche alsatica* 18: 0.1, 21: 0.1; *Orobanche colorata* 38: 0.1; *Oxytropis pilosa* 27: 0.5; ***Paeonia tenuifolia* 2: 0.3, 39: 25; *Papaver laevigatum* 15: 0.1, 24: 0.1; *Papaver stevenianum* 3: 0.1, 31: 0.1; *Pastinaca pimpinellifolia* 36: 1; *Peucedanum tauricum* 35: 0.1; *Pimpinella nigra* 35: 0.1, 36: 0.5; *Pimpinella saxifraga* 41: 0.2; *Plantago atrata* 41: 0.2; *Plantago urvillei* 43: 0.5; *Polygala sosnowskyi* 47: 0.2; Potentilla crantzii 41: 0.3; *Prunus divaricata* 32: 0.1; *Prunus stepposa* 37: 0.5, 38: 20; *Puschkinia scilloides* 34: 0.1; *Ranunculus baidarae* 41: 0.2; *Ranunculus polyanthemos* 41: 1; *Rhinanthus aestivalis* 41: 0.5; *Rochelia retorta* 1: 0.1; *Rosa* sp. 2: 0.5; *Salvia canescens* 4: 5; *Sanguisorba officinalis* 36: 1; *Scleranthus annuus* 15: 0.1; *Scorzonera* sp. 47: 0.2; *Sedum album* 21: 0.1; *Sedum spurium* 27: 20; *Senecio jacobaea* 47: 0.2; *Seseli transcaucasicum* 36: 0.5; *Sesleria* sp. 40: 1.5, 41: 0.5; *Silene densiflora* 39: 0.5; *Silene supina* 11: 1, 14: 1; *Stipa lessingiana* 45: 7; *Stipa tirsa* 46: 60; *Tephroseris subfloccosa* 34: 1, 36: 1; *Thalictrum foetidum* 4: 0.5, 30: 0.8; *Tragopogon dasyrhynchus* 36: 0.5; *Trifolium arvense* 1: 0.2; *Trifolium medium* 37: 1, 38: 0.3; *Trifolium pratense* 41: 1, 46: 0.1; *Trisetum flavescens* 41: 0.2; *Turritis glabra* 28: 0.2; *Valeriana officinalis* 40: 0.5; *Verbascum phoenicium* 39: 0.5; *Veronica caucasica* 4: 0.1, 47: 0.1; *Veronica chamaedrys* 34: 0.1; *Veronica dentata* 47: 0.5; *Veronica multifida* 6: 1; *Veronica* sp. 23: 0.5; Veronica verna 3: 0.1; *Vicia angustifolia* 1: 0.5; *Vicia tetrasperma* 1: 0.1, 42: 0.1; *Viola arvensis* 13: 0.1; *Viola odorata* 34: 0.5; *Viola somchetica* 42: 0.5, 43: 0.2.

Moss layer: *Abietinella abietina* 41: 0.1; *Bryum moravicum* 43: 0.1; *Campylium chrysophyllum* 18: 1, 41: 4; *Cladonia foliacea* 1: 0.5, 20: 1; *Cladonia furcata* 20: 5; *Cladonia symphycarpa* 1: 0.5; *Collema cristatum* 30: 0.1; *Collema minor* 15: 0.5; *Didymodon acutus* 22: 5, 29: 3; *Ditrichum flexicaule* 18: 1; *Encalypta pilifera* 27: 0.2; *Encalypta* sp. 13: 0.1; *Endocarpon pusillum* 14: 1, 16: 0.3; *Eurhynchium hians* 43: 0.1; *Fissidens dubius* 41: 3; *Grimmia pulvinata* 16: 1, 19: 0.2; *Grimmia* sp. 21: 0.1; *Heppia lutosa* 12: 0.5; *Hypnum vaucheri* 28: 2; *Leptogium gelatinosum* 41: 0.1; *Rhynchostegium* sp. 3: 0.1; *Scytinium intermedium* 29: 0.2; *Stereodon* sp. 19: 0.1, 20: 0.5; *Tortula caninervis* 20: 1; *Trichostomum connivens* 24: 3, 28: 1; *Xanthoria* sp. 15: 0.1.

Supplement E1. Species aggregates, used for the numerical analysis.

Anahng E1. Artenaggregate, die für die numerischen Analysen verwendet wurden.

Achillea millefolium	*Achillea millefolium, A. setacea*
Agropyron cristatum	*Agropyron cristatum, A. pectinatum*
Allium saxatile	*Allium saxatile, A. globosum*
Anthemis cretica	*Anthemis iberica, A. cretica ag.*
Anthemis marschalliana	*Anthemis sosnovskyana, A. marschalliana*
Anthyllis vulneraria	*Anthyllis macrocephala, A. vulneraria, A. lachnophora*
Artemisia campestris	*Artemisia campestris, A. marschalliana*
Aster amellus	*Aster amellus, A. bessarabicus*
Astrantia major	*Astrantia major, A. biebersteinii*
Brachypodium pinnatum	*Brachypodium pinnatum, B. rupestre*
Bupleurum falcatum	*Bupleurum falcatum, B. exaltatum, B. polyphyllum*
Campanula sibirica	*Campanula hohenackeri, C. sibirica, C. praealta*
Centaurea cheiranthifolia	*Centaurea cheiranthifolia, C. fischeri*
Centaurea phrygia	*Centaurea phrygia, C. abbreviata*
Centaurea stoebe	*Centaurea rhenana, C. biebersteinii*
Cota triumfettii	*Anthemis dumetorum, A. rigescens*
Elytrigia intermedia	*Elytrigia intermedia, E. trichophora*
Euphorbia nicaeensis	*Euphorbia stepposa, E. glareosa*
Festuca valesiaca	*Festuca valesiaca, F. rupicola*
Galium verum	*Galium verum, G. ruthenicum*
Koeleria macrantha	*Koeleria macrantha, K. cristata*
Lotus corniculatus	*Lotus corniculatus, L. caucasicus, L. ambiguus*
Marrubium peregrinum	*Marrubium peregrinum, M. praecox*
Medicago falcata	*Medicago falcata, M. romanica*
Melampyrum arvense	*Melampyrum arvense, M. argyrocomum*
Muscari armeniacum	*Muscari armeniacum, M. szovitsianum*
Onobrychis arenaria	*Onobrychis arenaria, O. tanaitica*
Peucedanum ruthenicum	*Peucedanum ruthenicum, P. tauricum*
Pimpinella saxifraga	*Pimpinella saxifraga, P. nigra*
Plantago atrata	*Plantago atrata, P. saxatilis*
Plantago media	*Plantago urvillei, P. media*
Potentilla humifusa	*Potentilla humifusa, P. adenophylla*
Primula veris	*Primula veris, P. macrocalyx*
Prunus spinosa	*Prunus spinosa, P. stepposa*
Salvia nemorosa	*Salvia nemorosa, S. tesquicola*
Sanguisorba minor	*Poterium polygamum, P. sanguisorba*
Scutellaria orientalis	*Scutellaria oreophila, S. orientalis, S. polyodon*
Sideritis montana	*Sideritis comosa, S. montana*
Teucrium chamaedrys	*Teucrium chamaedrys, T. nuchense*
Veronica austriaca	*Veronica dentata, V. jacquinii, V. teucrium*
Vicia cracca	*Vicia cracca, V. grossheimii, V. variabilis*

Supplemen E2. Synoptic table (*phi* values) of the main vegetation units of the class Festuco-Brometea in the region of North Caucasus.

Anhang E1. Übersichtstabelle (*phi* -Werte) der Hauptvegetationseinheiten der Klasse Festuco-Brometea in der Region Nordkaukasus.

Column number	1	2	3	4	5	6
Number of relevés	43	127	68	37	64	74
Ceratocarpus arenarius	75.2	---	---	---	---	---
Poa bulbosa	64.4	16.6	---	---	---	---
Veronica verna	60.0	---	---	---	---	---
Alyssum turkestanicum	59.3	---	---	---	---	---
Achillea biebersteinii	55.6	11.9	---	---	---	---
Bromus squarrosus	53.4	---	---	---	---	---
Artemisia lerchiana	50.9	15.0	---	---	---	---
Anisantha tectorum	49.3	---	---	---	---	---
Ranunculus oxyspermus	47.8	---	---	---	---	---
Kochia prostrata	47.7	---	---	---	---	---
Bassia sedoides	47.4	---	---	---	---	---
Carex stenophylla	46.7	---	---	---	---	---
Salsola australis	44.3	---	---	---	---	---
Tanacetum millefolium	41.9	---	---	---	---	---
Agropyron desertorum	41.0	---	---	---	---	---
Eremopyrum triticeum	40.0	---	---	---	---	---
Artemisia taurica	36.5	17.4	---	---	---	---
Chenopodium album	34.0	---	---	---	---	---
Eragrostis minor	34.0	---	---	---	---	---
Apera interrupta	34.0	---	---	---	---	---
Taraxacum erythrospermum	33.2	---	---	---	---	---
Polygonum patulum	32.0	---	---	---	---	---
Lagoseris sancta	31.4	---	---	---	---	---
Trigonella orthoceras	31.4	---	---	---	---	---
Myosotis micrantha	31.2	---	---	---	---	---
Descurainia sophia	31.1	---	---	---	---	---
Erodium cicutarium	31.1	---	---	---	---	---
Herniaria incana	30.5	12.5	---	---	---	---
Tulipa gesneriana	28.7	---	---	---	---	---
Tribulus terrestris	28.7	---	---	---	---	---
Lactuca tatarica	28.7	---	---	---	---	---
Lappula patula	28.3	---	---	---	---	---
Salsola laricina	28.1	---	---	---	---	---
Lactuca saligna	27.9	---	---	---	---	---
Euphorbia humifusa	26.4	---	---	---	---	---
Erophila verna	21.8	---	---	---	---	---
Artemisia austriaca	---	50.6	---	---	---	---
Galium humifusum	---	35.1	---	---	---	---
Marrubium peregrinum	---	33.3	---	---	---	---
Goniolimon tataricum	---	31.2	---	---	---	---
Inula britannica	---	30.0	---	---	---	---
Salvia aethiopis	---	29.4	---	---	---	---
Chondrilla juncea	---	28.7	---	---	---	---
Ambrosia artemisiifolia	---	28.6	---	---	---	---
Xeranthemum annuum	---	28.5	---	---	---	---
Melilotus officinalis	---	26.6	---	---	---	---
Medicago lupulina	---	24.6	---	---	---	---
Carduus hamulosus	---	24.6	---	---	---	---
Vicia villosa	---	24.4	---	---	---	---
Astragalus calycinus	---	24.2	---	---	---	---
Trifolium arvense	---	23.0	---	---	---	---
Cardaria draba	---	22.5	---	---	---	---
Polygonum aviculare	---	22.4	---	---	---	---
Tulipa biebersteiniana	---	22.3	---	---	---	---
Psammophiliella muralis	---	21.5	---	---	---	---
Setaria pumila	---	21.3	---	---	---	---
Lactuca serriola	---	20.7	---	---	---	---

Berteroa incana	---	20.0	---	---	---	---
Gagea minima	---	20.0	---	---	---	---
Artemisia chamaemelifolia	---	---	77.1	---	---	---
Plantago atrata	---	---	73.5	---	---	---
Bromopsis variegata	---	---	60.2	---	---	---
Myosotis alpestris	---	---	54.1	---	---	---
Festuca ovina	---	---	53.2	---	---	---
Veronica gentianoides	---	---	51.8	---	---	---
Alchemilla caucasica	---	---	50.4	---	---	---
Scabiosa caucasica	---	---	50.3	---	---	---
Centaurea cheiranthifolia	---	---	49.4	---	---	---
Ranunculus oreophilus	---	---	49.4	---	---	---
Helictotrichon versicolor	---	---	43.7	---	---	---
Phleum montanum	---	---	43.5	---	---	---
Anthemis marschalliana	---	---	42.2	---	---	---
Trifolium canescens	---	---	42.2	---	---	---
Teucrium orientale	---	---	41.8	---	---	---
Astragalus oreades	---	---	40.6	---	---	---
Thymus collinus	---	---	40.6	---	---	---
Potentilla crantzii	---	---	40.1	---	---	---
Gypsophila elegans	---	---	39.5	---	---	---
Pulsatilla albana	---	---	38.9	---	---	---
Poa alpina	---	---	38.4	---	---	---
Aster alpinus	---	---	37.2	---	---	---
Stachys macrantha	---	---	36.5	---	---	---
Sedum subulatum	---	---	35.4	---	---	---
Artemisia campestris	---	---	34.5	---	---	---
Potentilla pimpinelloides	---	---	33.6	---	---	---
Pentaphylloides fruticosa	---	---	33.6	---	---	---
Bupleurum falcatum	---	---	33.5	---	---	---
Sedum oppositifolium	---	---	31.6	---	---	---
Ballota nigra	---	---	31.6	---	---	---
Anthoxanthum odoratum	---	---	31.2	---	---	---
Carum carvi	---	---	31.1	---	---	---
Sempervivum pumilum	---	---	29.5	---	---	---
Calamagrostis arundinacea	---	---	29.3	---	---	---
Onobrychis petraea	---	---	28.7	---	---	---
Centaurea ciscaucasica	---	---	28.1	---	---	---
Astragalus polyphyllus	---	---	27.3	---	---	---
Elytrigia gracillima	---	---	27.3	---	---	---
Luzula multiflora	---	---	27.1	---	---	---
Tragopogon reticulatus	---	---	27.1	---	---	---
Linum hypericifolium	---	---	26.9	---	---	---
Astrantia maxima	---	---	26.7	---	---	---
Veronica caucasica	---	---	25.5	---	---	---
Sempervivum caucasicum	---	---	24.9	---	---	---
Alchemilla sericata	---	---	24.9	---	---	---
Dianthus cretaceus	---	---	24.9	---	---	---
Dracocephalum ruyschiana	---	---	24.9	---	---	---
Veronica propinqua	---	---	24.9	---	---	---
Onobrychis biebersteinii	---	---	24.7	---	---	---
Rhynchocorys orientalis	---	---	24.7	---	---	---
Rumex acetosella	---	---	23.4	---	---	---
Nepeta cyanea	---	---	22.5	---	---	---
Pedicularis sibthorpii	---	---	22.5	---	---	17.4
Sedum spurium	---	---	22.4	---	---	---
Centaurea daghestanica	---	---	22.2	---	---	---
Nonea echioides	---	---	22.2	---	---	---
Stipa daghestanica	---	---	22.2	---	---	---
Poa annua	---	---	22.2	---	---	---
Vicia semiglabra	---	---	22.2	---	---	---
Euphorbia leptocaula	---	---	22.2	---	---	---
Primula ruprechtii	---	---	22.2	---	---	---
Tephroseris caucasigena	---	---	22.2	---	---	---
Festuca woronowii	---	---	22.2	---	---	---
Medicago glutinosa	---	---	22.2	---	---	---
Campanula sibirica	---	---	21.9	---	---	15.1

Pastinaca armena	---	---	21.0	---	---	---
Asperula biebersteinii	---	---	---	67.1	---	---
Allium albidum	---	---	---	64.2	---	---
Veronica praecox	---	---	---	63.9	---	---
Sedum hispanicum	---	---	---	62.2	---	---
Euphorbia petrophila	---	---	---	61.8	---	---
Asphodeline taurica	---	---	---	60.3	---	---
Bilacunaria microcarpa	---	---	---	59.7	---	---
Arabis recta	---	---	---	56.9	---	---
Seseli varium	---	---	---	56.5	---	---
Onosma caucasica	---	---	---	49.9	---	---
Thymus pastoralis	---	---	---	49.8	---	---
Rhamnus pallasii	---	---	---	48.2	---	---
Alyssum hirsutum	---	---	---	46.9	---	---
Linum tenuifolium	---	---	---	46.3	---	---
Seseli tortuosum	---	---	---	46.2	---	---
Galium biebersteinii	---	---	---	44.9	---	---
Allium saxatile	---	---	---	44.3	---	---
Poa badensis	---	---	---	44.0	---	---
Stipa pulcherrima	---	---	---	44.0	---	17.7
Alyssum calycinum	---	---	---	43.9	---	---
Muscari neglectum	---	---	---	43.3	---	---
Cephalaria coriacea	---	---	---	41.5	---	---
Erysimum canescens	---	---	---	41.2	---	---
Centaurea leucophylla	---	---	---	40.6	---	---
Saxifraga tridactylites	---	---	---	40.3	---	---
Gypsophila glomerata	---	---	---	39.3	---	---
Scutellaria orientalis	---	---	---	38.2	---	---
Melica taurica	---	---	---	38.2	---	---
Stipa caucasica	---	---	---	37.3	---	---
Hedysarum biebersteinii	---	---	---	37.3	---	---
Genista compacta	---	---	---	37.3	---	---
Helianthemum buschii	---	---	---	37.3	---	---
Viola kitaibeliana	---	---	---	37.2	---	---
Thesium arvense	---	---	---	37.0	---	---
Meniocus linifolius	---	---	---	36.5	---	---
Potentilla arenaria	---	---	---	35.0	---	---
Elytrigia stipifolia	---	---	---	35.0	---	---
Artemisia caucasica	---	---	---	35.0	---	---
Minuartia hybrida	---	---	---	33.9	---	---
Onobrychis ruprechtii	---	---	---	33.9	---	---
Pseudomuscari pallens	---	---	---	33.9	---	---
Astragalus lasioglottis	---	---	---	33.9	---	---
Bromopsis biebersteinii	---	---	---	33.6	---	---
Astragalus demetrii	---	---	---	33.6	17.8	---
Iris aphylla	---	---	---	31.8	---	---
Zosima orientalis	---	---	---	31.6	---	---
Iris pumila	---	---	---	30.5	---	---
Orthanthella lutea	---	---	---	30.3	---	---
Sedum acre	---	---	---	30.3	---	---
Asperula arvensis	---	---	---	30.3	---	---
Gagea taurica	---	---	---	29.5	---	---
Erucastrum armoracioides	---	---	---	28.8	---	---
Agropyron cristatum	---	12.2	---	27.0	---	---
Dictamnus caucasicus	---	---	---	26.7	---	---
Inula ensifolia	---	---	---	26.2	---	---
Centaurea marschalliana	---	---	---	26.2	---	---
Androsace koso-poljanskii	---	---	---	26.2	---	---
Centaurea kubanica	---	---	---	26.2	---	---
Ephedra procera	---	---	---	26.2	---	---
Carex caryophyllea	---	---	---	26.2	---	---
Asphodeline tenuior	---	---	---	26.2	---	---
Thymus daghestanicus	---	---	---	26.0	---	---
Galium mollugo	---	---	---	24.5	---	---
Carex humilis	---	---	13.2	22.8	14.9	19.1
Anthyllis vulneraria	---	---	---	22.2	---	---
Helictotrichon pubescens	---	---	---	---	55.0	---

Geranium sanguineum	---	---	---	---	52.8	---
Vincetoxicum hirundinaria	---	---	---	---	46.3	---
Polygala anatolica	---	---	---	---	44.7	---
Poa pratensis	---	---	---	---	43.1	---
Dactylis glomerata	---	---	---	---	39.5	---
Ranunculus caucasicus	---	---	---	---	38.8	---
Vincetoxicum funebre	---	---	---	---	38.3	---
Centaurea dealbata	---	---	---	---	37.8	---
Trifolium pratense	---	---	---	---	37.6	---
Sanguisorba officinalis	---	---	---	---	36.4	---
Pedicularis condensata	---	---	---	---	36.3	---
Galium rubioides	---	---	---	---	34.7	---
Pyrethrum coccineum	---	---	---	---	34.6	---
Cruciata pedemontana	---	---	---	---	32.6	---
Seseli transcaucasicum	---	---	---	---	32.0	---
Briza media	---	---	---	---	31.8	---
Veronica peduncularis	---	---	---	---	30.5	---
Clematis integrifolia	---	---	---	---	30.5	---
Vicia tenuifolia	---	---	---	---	28.8	---
Erysimum cuspidatum	---	---	---	---	28.7	---
Helianthemum nummularium	---	---	---	---	28.4	---
Anemone sylvestris	---	---	---	---	28.4	---
Chaerophyllum aureum	---	---	---	---	28.2	---
Onobrychis iberica	---	---	---	---	28.2	---
Laser trilobum	---	---	---	---	27.9	---
Pimpinella saxifraga	---	---	---	---	26.6	---
Centaurea phrygia	---	---	---	---	26.0	---
Polygala major	---	---	---	---	25.9	---
Ranunculus polyanthemos	---	---	---	---	25.8	---
Astrantia trifida	---	---	---	---	25.7	---
Veronica orientalis	---	---	---	---	25.7	---
Carex tomentosa	---	---	---	---	25.7	---
Holcus lanatus	---	---	---	---	25.4	---
Briza elatior	---	---	---	---	24.5	---
Pyrethrum corymbosum	---	---	---	---	23.6	---
Viola hirta	---	---	---	---	23.2	---
Hieracium piloselloides	---	---	---	---	22.9	---
Linum perenne	---	---	---	---	22.9	---
Fragaria moschata	---	---	---	---	22.9	---
Pedicularis chroorrhyncha	---	---	---	---	22.9	---
Pastinaca sativa	---	---	---	---	22.9	---
Vicia abbreviata	---	---	---	---	22.9	---
Iris pontica	---	---	---	---	22.9	---
Prunella grandiflora	---	---	---	---	22.7	---
Phleum pratense	---	---	---	---	22.7	---
Cota triumfettii	---	---	---	---	22.5	---
Primula veris	---	---	---	---	22.3	---
Helictotrichon pratense	---	---	---	---	22.0	---
Tragopogon major	---	---	---	---	21.1	---
Argyrolobium biebersteinii	---	---	---	---	21.1	---
Campanula bononiensis	---	---	---	---	21.1	---
Onobrychis inermis	---	---	---	---	21.1	---
Trifolium medium	---	---	---	---	20.9	---
Potentilla humifusa	---	---	---	---	---	58.9
Euphorbia iberica	---	---	---	---	---	52.9
Scabiosa ochroleuca	---	---	---	---	---	51.3
Polygala caucasica	---	---	---	---	---	49.4
Hieracium echioides	---	---	---	---	---	46.1
Agrimonia eupatoria	---	---	---	---	---	45.8
Inula hirta	---	---	---	---	---	45.0
Rosa canina	---	---	---	---	---	44.8
Onobrychis arenaria	---	---	---	---	---	43.4
Carex michelii	---	---	---	---	---	43.2
Clinopodium vulgare	---	---	---	---	---	42.9
Adonis vernalis	---	---	---	---	---	40.8
Serratula radiata	---	---	---	---	---	40.4
Centaurea orientalis	---	---	---	---	---	39.4

Veronica austriaca	---	---	---	---	---	38.3
Echium russicum	---	---	---	---	---	38.3
Euphorbia nicaeensis	---	---	---	---	---	37.8
Leontodon hispidus	---	---	---	---	---	37.5
Peucedanum ruthenicum	---	---	---	---	---	36.8
Hieracium x robustum	---	---	---	---	---	36.6
Potentilla argentea	---	18.7	---	---	---	36.4
Crataegus curvisepala	---	---	---	---	---	36.1
Stachys recta	---	---	---	---	16.5	35.9
Tragopogon dasyrhynchus	---	---	---	---	---	35.5
Muscari muscarimi	---	---	---	---	---	35.4
Cerinthe minor	---	---	---	---	---	35.1
Dianthus pallidiflorus	---	---	---	---	---	34.9
Daucus carota	---	---	---	---	---	34.7
Thalictrum minus	---	---	---	---	---	34.5
Phlomoides tuberosa	---	---	---	---	---	34.5
Stipa tirsa	---	---	---	---	---	33.9
Poa compressa	---	---	---	---	---	33.9
Vicia angustifolia	---	---	---	---	---	33.5
Veronica spicata	---	---	---	---	---	33.3
Hypericum perforatum	---	---	---	---	---	33.0
Centaurea troitzkyi	---	---	---	---	---	32.2
Cichorium intybus	---	17.3	---	---	---	32.2
Stipa capillata	---	17.3	---	---	---	31.5
Carlina vulgaris	---	---	---	---	---	31.1
Thymus marschallianus	---	---	---	---	---	31.1
Amoria repens	---	---	---	---	---	31.0
Genista patula	---	---	---	---	---	30.3
Paeonia tenuifolia	---	---	---	---	---	30.2
Senecio jacobaea	---	---	---	---	---	29.9
Medicago falcata	---	---	---	---	---	28.2
Amoria montana	---	---	---	---	---	28.0
Viola ambigua	---	---	---	---	---	27.6
Melica transsilvanica	---	---	---	---	---	27.5
Myosotis amoena	---	---	---	---	---	27.5
Bromopsis inermis	---	---	---	---	---	27.4
Viola odorata	---	---	---	---	---	27.3
Asperula graveolens	---	---	---	---	---	26.2
Elytrigia intermedia	---	---	---	---	---	25.7
Helictotrichon adzharicum	---	---	---	---	---	25.6
Cerastium holosteoides	---	---	---	---	---	25.6
Verbascum lychnitis	---	---	---	---	---	24.9
Galatella dracunculoides	---	---	---	---	---	24.4
Bromopsis riparia	---	---	---	---	---	24.4
Dianthus ruprechtii	---	---	---	---	---	24.1
Oberna multifida	---	---	---	---	---	23.9
Gladiolus imbricatus	---	---	---	---	---	23.9
Ajuga genevensis	---	---	---	---	---	23.3
Trifolium alpestre	---	---	---	---	---	23.0
Scabiosa ucranica	---	---	---	---	---	22.8
Echium vulgare	---	---	---	---	---	22.8
Phlomis pungens	---	---	---	---	---	22.2
Linum nervosum	---	---	---	---	---	21.9
Allium paczoskianum	---	---	---	---	---	20.9
Alyssum trichostachyum	---	---	---	---	---	20.6
Cruciata laevipes	---	---	---	---	18.5	20.6
Rosa pimpinellifolia	---	---	---	---	---	20.6
Bromus japonicus	39.9	32.8	---	---	---	---
Euphorbia seguierana	33.0	24.4	---	---	---	---
Centaurea diffusa	30.1	30.9	---	---	---	---
Holosteum umbellatum	30.0	---	---	38.3	---	---
Stipa lessingiana	29.9	25.2	---	---	---	---
Medicago minima	29.8	22.1	---	---	---	---
Bothriochloa ischaemum	---	33.7	---	---	---	30.4
Achillea nobilis	---	30.9	---	---	---	39.4
Eryngium campestre	---	29.5	---	---	---	41.1
Poa angustifolia	---	24.6	---	---	---	36.2

Salvia nemorosa aggr.	---	23.3	---	---	---	24.8
Elytrigia repens	---	22.9	---	---	---	31.0
Convolvulus arvensis	---	22.9	---	---	---	24.8
Plantago lanceolata	---	22.0	---	---	---	52.2
Festuca valesiaca aggr.	---	21.6	---	---	---	26.9
Amoria ambigua	---	---	29.3	---	---	28.0
Teucrium polium	---	---	---	44.5	---	24.6
Acinos arvensis	---	---	---	38.1	---	26.0
Teucrium chamaedrys	---	---	---	28.1	---	46.1
Sanguisorba minor	---	---	---	23.0	---	36.6
Filipendula vulgaris	---	---	---	---	51.9	40.7
Brachypodium pinnatum	---	---	---	---	43.8	24.6
Origanum vulgare	---	---	---	---	43.8	25.6
Plantago media	---	---	---	---	38.3	39.8
Stachys officinalis	---	---	---	---	37.1	24.1
Galium verum	---	---	19.1	---	32.7	32.2
Lotus corniculatus	---	---	---	---	32.7	36.9
Phleum phleoides	---	---	---	---	30.6	21.4
Vicia cracca	---	---	---	---	28.1	20.3
Inula aspera	---	---	---	---	27.3	24.0
Securigera varia	---	---	---	---	25.7	46.9
Fragaria viridis	---	---	---	---	24.3	51.1
Festuca pratensis	---	---	---	---	24.1	30.7
Achillea millefolium aggr.	---	---	---	---	24.0	36.7
Salvia verticillata	---	---	21.6	---	22.0	30.2