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Pseudosteppes and related grassland vegetation in the Pamir-Alai and western Tian Shan Mts – the borderland of the Irano-Turanian and Euro-Siberian regions

Pseudosteppen und verwandte Graslandvegetation im Pamir-Alai und im westlichen Tian-Shan-Gebirge - dem Grenzgebiet der irano-turanischen und euro-sibirischen Florenregionen

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Abstract

The aim of our study was to complete the syntaxonomical scheme for grassland vegetation of the lowland, montane and alpine zones in the Pamir-Alai and western Tian Shan Mts in Tajikistan and Kyrgyzstan with some remarks on its environmental predictors. A total of 198 relevés were sampled in 2013–2018 using the seven-degree cover-abundance scale of the Braun-Blanquet approach. They were classified with k-means algorithm with tranforming cover values to three level scale of the following intervals 0%, 5% and 25% and total inertia as a measure of cluster heterogeneity. Diagnostic species were identified using the phi coefficient as a fidelity measure. Non-metric Multidimensional Scaling (NMDS) was used to explore the relationships between the distinguished groups. A total of 7 pseudo-steppe, three typical steppe and three meadow communities were distinguished in the study area, grouped in four orders. Seven of them are established as new associations: *Brayo pamiricae-Stipetum glareosae*, *Eremuretum bucharici*, *Hordeo bulbosi-Astragaletum retamocarpi*, *Potentillo orientalis-Eremuretum fusci*, *Achnathero caraganae-Delphinietum semibarbati*, *Eremuro tianschanici-Delphini-etum biternati* and *Cryptosporo falcatae-Brachypodietum distachyi.* The pseudosteppes were included in a new alliance – the *Vulpio persicae-Caricion pachystylidis.* The meadows have been divided into three communities: *Ligularia alpigena-Euphorbia alatavica* comm., *Euphorbia lamprocarpa* comm. and *Carum carvi-Hordeum turkestanicum* comm. The main factors differentiating the species composition of the researched vegetation are altitude, share of annual vs. perennial species, proportion of Euro-Siberian to Irano-Turanian plants and latitudinal position. We have completed the vegetation survey of

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the dry and mesic grasslands in the middle and western part of Middle Asia and have fostered the progress in finding the borderland between the boreo-temperate and mediterranean-like (Irano-Turanian) grasslands of the western Asian and central Asian subregions of the Irano-Turanian region.

Keywords: alpine vegetation, grasslands, meadows, Middle Asia, phytogeography, pseudosteppes, steppe, syntaxonomy

Erweiterte deutsche Zusammenfassung am Ende des Artikels

1. Introduction

Middle Asia is a region located in the landlocked, central part of the Asian continent and comprises Kyrgyzstan, Tajikistan, Uzbekistan, Turkmenistan, southern Kazakhstan, western China and northern Afghanistan. Its southern and eastern parts encompass the high mountains of the Pamir-Alai and Tian Shan. According to the ten-volume study of the flora of the former Soviet part of the Middle Asia, more than 9000 vascular plant species are known from this region (KHASSANOV 2015). Owing to the diverse relief, geomorphology and extremely variable microclimatic condition, the region harbors a high number of endemic species. In Tajikistan alone, ca. 30% of the entire flora of vascular plants are accepted as endemics of the country, with more than 360 growing in steppe vegetation (NOWAK et al. 2020). The species pool of grasslands in this country reaches about 2000 species (ca. 1350 in steppes, 370 in meadows and pastures, and 265 in alpine swards). Due to this extraordinary richness, the mountains of Middle Asia have been recognised as one of the 35 hotspots of biodiversity (MITTERMEIER et al. 2006). At the same time, the vegetation this region is exposed to the high risks linked to climate change (BAETTIG et al. 2007) with the near-lowest adaptive capacity to climate instability (FAY & PATEL 2008).

Grass dominated communities cover an immense part of the Earth and are distributed from the equator to the polar circle (SQUIRES et al. 2018). Including the savannas and other non-forest vegetation with sparse shrubs and well developed grassy undergrowth, this type of graminoid dominated vegetation covers ca. 40% of the terrestrial surface of the globe (PANUNZI 2008). Grasslands provide many goods and services which can be categorised into two broad groups: economic and non-economic (GIBSON 2009). The major role of grassland in terms of economy is the production of forage for domestic livestock. Middle Asian countries, such as Tajikistan and Kyrgyzstan, are territories where free-grazing livestock still remains the principal source of income of their pastoral societies. From the perspective of non-economic values, grasslands are essential for nutrient cycling, primary production, sequestration of carbon dioxide, maintenance of soil fertility, removal of air pollutants, and prevention from water and wind erosion. Grasslands are home to a number of wildlife and habitat to many endangered plant species. In Middle Asia, grasslands are important habitats for instance for ornamental tulips such as *Tulipa hissarica*, *T. kaufanniana*, *T. liniifolia*, *T. maximowiczii* and others (STANYUKOVICH 1982, NOWAK et al. 2020).

In Middle Asia, approximately 2 million km^2 are covered by grasslands (WESCHE et al. 2016). They mostly contribute to the landscapes of the steppe and forest-steppe zone in the central and northern parts of the region; however, they are also an important component of the southern and western foothills of Pamir-Alai and Tian Shan (BRAGINA et al. 2018). Additionally, in the mountains of Middle Asia, grasslands develop also on wetlands (grassy fens, mires), thermophilous swards that resemble Mediterranean communities, alpine swards and pastures (KOROVIN 1961, 1962; STANYUKOVICH 1982, AGAKHANJANZ & BRECKLE 2003, WAGNER 2009). Recently, several studies have been conducted on steppe vegetation in

Pamir-Alai and western Tian Shan, and three main groups of steppe vegetation have been identified: 1) high-altitude arid steppes, 2) dry, thermophilous steppes of the montane and subalpine belt, and 3) mountain steppes of semi-arid areas (NOWAK et al. 2016, 2018). The classification of meadows and pastures has yet to be completed, despite being a prominent vegetation type in the region, and their typology would be very useful in ecological, pastoral and conservation terms (BIURRUN et al. 2019). Particularly the grasslands of the southern outskirts of the region and their relation to the steppe communities of the northern plains and mediterranean secondary grasslands, including pseudosteppes, has to be resolved. Pseudosteppes were defined in Spain as thermo-mesomediterranean, intrazonal, secondary grasslands and herblands on deep calcareous soils of colline and montane belts in mediterranean-like climates with long dry summer period. These grasslands grow mainly on loessic or organic, fertile substrates with calcareous bedrock, where the terminal stage of vegetation is shrubland (SAN MIGUEL 2008, MUCINA et al. 2016).

This vegetation has been almost completely neglected in recent studies on vegetation classification in former Soviet Union areas (e.g. MIRKIN & NAUMOVA 2012). The mesophilous grasslands extend along all the ranges, creating distinct phytocoenoses from the colline to the alpine belt. They are extremely species-rich, harbouring up to 80 species per 100 square metre plot (A. Nowak, pers. observation). In the alpine belt, between 2500 and 4000 m a.s.l., depending on the mountain range, mesic alpine swards occur with the domination of *Achillea bucharica*, *Aconitum rotundifolium*, *Agrostis canina*, *Anemone protracta*, *Aster serpentimontanus*, *Calamagrostis alajica*, *Eritrichium villosum*, *Gagea jaeschkei*, *G. leucantha*, *G. olgae*, *G. setifolia*, *Hedysarum cisdarvasicum*, *Lagotis ikonnikovii*, *Linum olgae*, *Lloydia serotina*, *Myosotis asiatica*, *Paeonia intermedia*, *Pedicularis sarawschanica*, *P. verae*, *Polygala hybrida*, *Pulsatilla campanella* and *Tulipa turkestanica* (AFANASJEV 1956, SIDORENKO 1971). They are sporadically mown or grazed. Despite being very distinct in terms of phytogeography and additionally important for the livelihood of the local people, the alpine meadows and swards were scarcely studied. Only the work of WAGNER (2009) in Aksu-Jabagly Nature Reserve in the western Tian Shan produced some important insights and shows nine distinct plant communities belonging to steppe (e.g. *Nepeta pannonica-Thalictrum minus* and *Allium barszczewskii-Polygala comosa*) and meadow-forb vegetation (e.g. *Dactylis glomerata-Karatavia kultiassovii* and *Nepeta mariae-Aconogonon coriarium*). Another important study was conducted by VANSELOW (2011, 2016) in the high Pamir, which describes several vegetation units of pastures including alpine mats with *Kobresia* spp. Other pasture vegetation communities were revealed in the research of BORCHARDT et al. (2011). They show the variation mainly of tall-forbs (*Aconogono coriarium-Prangos pabularia-Galium aparine* and *Ligularia thompsoni-Dactylis glomerata* communities) as well as steppes (*Carex turkestanica-Arenaria serpyllifolia*). However, these studies did not aggregate the communities into higher-level units and harmonise them with the known orders and classes. Still, the hierarchical system of all Middle Asian grasslands is challenging to the vegetation ecologist, despite being crucial for communication and application in conservation (DE CÁCERES et al. 2018).

In this paper, we attempt to classify the pseudosteppe vegetation in the Pamir-Alai and western Tian Shan Mts and to relate it to steppe and alpine meadow communities. We aimed at addressing the following questions during our study: (1) What is the diversity of grassland vegetation of the montane and alpine zones in the Pamir-Alai and western Tian Shan Mts?

(2) What are the basic habitat conditions of the described plant communities? (3) What is the species composition and structure of the vegetation plots? (4) Which species have important diagnostic value for the described syntaxa?

2. Study area

The vegetation survey was conducted in the central part of Middle Asia (southern and eastern Kyrgyzstan and Tajikistan) within an area of ca. 200,000 km^2 (Fig. 1). As one of the study's aims was to compare the grassland phytocoenoses of the northern parts of the region with strong temperate climate influences with the west Pamir-Alai mountains southern foothills with the Irano-Turanian climate, the research area includes the south-western ranges of the Tian Shan and Pamir-Alai Mts. It falls into the colline (around Ferghana Basin), montane and alpine zones of the Kyrgyz Mts, Kakshaal Mts, At-Bashi Mts, Trans-Ili Alatau Mts, Kyungey Ala-Too Mts, Talas Mts, Suusamyr Mts, Terkey Ala-Too Mts, Songkol Mts, Fergana Mts, Alai Mts and Chatkal Mts in Kyrgyzstan and the Peter I Mts, Yazgulem Mts, Alichur Mts, Shugnan Mts, Trans-Alai Mts and Sarikol Mts in Tajikistan. The mountainous landscape and the history of human activity, particularly the grazing of sheep, cows and horses, creates suitable habitats for different types of graminoid communities. In this area there are mainly steppes, however hay meadows also contribute importantly to the landscape of intermediate altitudes, with the alpine swards and mats in subalpine and alpine belts used generally as summer pastures. Additionally, the wide terraces of lowland river valleys and also floodplains of the alpine rivers offer a suitable habitat for grassland development. The studied sites differ considerably in terms of aspect, inclination, bedrock type and altitude. The vegetation plots were located between 319 and 4016 m a.s.l. (mean 1,721).

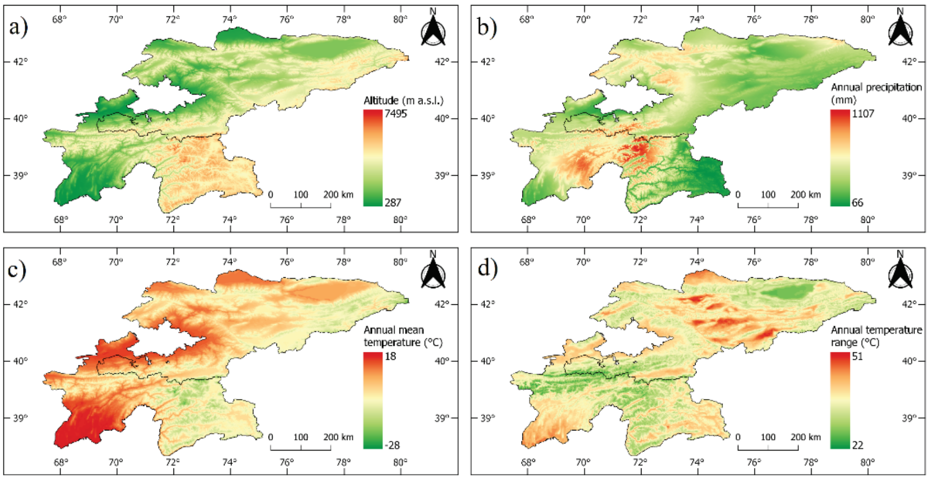

Fig. 1. Maps of **a)** elevation (m a.s.l.), **b)** annual precipitation (mm), **c)** annual mean temperature (°C) and **d)** annual temperature range (°C) in the study area – Tajikistan and Kyrgyzstan. Maps are based on raster data from WorldClim (FICK & HIJMANS 2017) and digital elevation model (JARVIS et al. 2008).

Abb. 1. Karten der **a)** Höhenlage (m ü. HN), **b)** jährlichen Niederschläge (mm), **c)** mittleren jährlichen Temperatur (°C) und **d)** jährlichen Temperaturamplitude (°C) im Untersuchungsgebiet – Tajikistan and Kyrgyzstan. Die Karten basieren auf den Rasterdaten des WorldClim (FICK & HIJMANS 2017) und einem digitalen Höhenmodell (JARVIS et al. 2008).

The study area is situated in a transition zone between the Temperate and Irano-Turanian types of macrobioclimates with the first one characterised by summer- rather than winter rain and higher continentality (DJAMALI et al. 2012). However, four main types of climate within the research area can be identified:

(1) warm, continental, Irano-Turanian climate in the Ferghana Basin. In the classification of Köppen, this area is included in the warm continental zone. The surroundings of Jalalabad and Osh are characterised by winter precipitation that peaks in March, with up to 80 mm, and a yearly average of 200–250 mm. The temperature reaches 20 °C in April and rises to an average of 34 °C in June, July and August. During these months the precipitation is scarce with 0–10 mm per month. Snow and frost occur from December to February with the averages not below -3 °C, and with the extreme value of -27 °C in some years;

(2) warm humid, continental climate in the Tian Shan and Pamir-Alai ranges. In these areas, the average temperature in June is around 22 °C in colline and montane zones and decreases to 10 °C in alpine belt. The lower limit of perpetual snow in the western Tian Shan is at an altitude of 3000–3300 m a.s.l. Annual precipitation ranges here from about 500 mm on the northern macro-slope to ca. 1000 mm on the southern one;

(3) cold semi-arid climates of the Issik-kul Basin, Suusamyr Valley, central and western parts of the Alai Valley, foothills and plateaus at colline, montane and subalpine belts. These areas are clearly distinguished by moderate precipitation, with an average of 200–400 mm per year. The distribution of the rain during the year is similar to temperate climate with a max. in May–July when it reaches up to 70 mm. The temperatures exceed the values of 20 °C mm only in summer, with the annual average of 10 °C;

(4) cold desert climate of the easternmost sections of the Alai Valley and eastern Pamirian Plateau. In our opinion, also the surroundings of Balykchy in the western part of the Issik-kul Basin should be included in this zone, despite that the elevation here is 2000 metres lower than in eastern Pamir. Unlike the West Pamir or Tian Shan ranges, this area is distinguished by significant aridity and less than 100 mm mean annual precipitation; only in May and August does the average monthly rain exceed 20 mm. The average temperature in a year slightly exceeds 0 °C, with minimums dropping down far below -30 °C in January–February (LATIPOVA 1968, NARZIKULOV & STANYUKOVICH 1968, SAFAROV 2003).

However, within all these zones a lot of local deviations and anomalies occur caused by wind conditions, orography and altitudinal differences. These climatic and bioclimatic terms determine the vegetation with the treeless formations as dominant in colline and montane belts as well as a considerable share of meadows and pastures in alpine zone.

3. Methods

The research was conducted in the years 2013–2018. Altogether, 198 relevés were collected in the Pamir-Alai (Tajikistan) and western Tian Shan Mts (Kyrgyzstan). The size of each vegetation relevé was 10 m^2, which follows the approach of the GrassPlot consortium and is considered useful in grassland classification (DENGLER et al. 2018a). In each relevé, all vascular plant species and mosses were recorded using the seven-degree cover-abundance scale of the Braun-Blanquet approach (WESTHOFF & VAN DER MAAREL 1973). The geographical coordinates were measured for each plot with the help of a GPSMAP 60CSx device with an accuracy of ±5 m, using the WGS84 map datum. The field survey covers a broad range of habitats in relation to altitudinal range, bedrock type, exposition and inclination.

Data were stored in the Vegetation of Middle Asia database (NOWAK et al. 2017) and analysed in R (R CORE TEAM 2019) and JUICE software (TICHÝ 2002). In order to understand the distribution of samples and relations between them, the authors performed an unsupervised *k*-means analysis with

Hellinger transformation. *K*-means partitioning computes a non-hierarchical clustering by minimisation of the variance within group. This method determines the partition of objects into *k* groups, where the objects within each group or cluster are more similar to one another than to objects in the other clusters (MacQueen 1967). The number of clusters was determined according to gap statistics using *clusGap* function in 'cluster' package (Maechler et al. 2019) in R. The algorithm indicated 13 groups as most optimal for the analyzed data set (Supplement E5), which corresponds well to our field experience. The original over abundance scale was transformed using the three step interval scale with pseudospecies levels of 0%, 5% and 25%. As our research has a pioneer character in the study area, we did not apply any refinements in the classification by moving some relevés between clusters using some iterative relocation methods or deletion of any outliers. With insufficient field experience to identify atypical or fragmentary stands, we believe that our approach is the most justified.

Plant species determined only to the genus level were excluded from the analysis (*Cuscuta* sp., *Dianthus* sp., *Didymodon* sp., *Hieracium* sp., *Taraxacum* sp., *Tortula* sp.). Diagnostic species were identified using the *phi* coefficient as a fidelity measure (Chytrý et al. 2002). The size of all groups was standardised to equal size and Fisher exact test ($p < 0.05$) was applied. Species with a *phi* coefficient higher than 0.20 were considered diagnostic for a particular cluster. Plants diagnostic for the alliance *Vulpio persici-Caricion pachystilis* were selected according to their fildelity value and frequency in all five clusters belonging to the alliance (i.e., having a frequency higher than 10% and a *phi* coefficient higher than 5 in at least 2 clusters). However, the final assignment of highly diagnostic taxa used for the definition of communities was supported by expert knowledge as several species that meet the formal requirements occur in different vegetation types in Middle Asia, so they were excluded from the diagnostic group (e.g. taxa typical for steppes – *Alyssum dasycarpum*, *Bromus oxyodon*, *B. lancolatus*, *Diarthron vesiculosus*, *Origanum tytthanthum*; meadows – *Hypericum perforatum*, *Vicia angustifolia*; ruderal or segetal – *Salvia sclarea*, *Veronica arvensis*). Species with a higher frequency than 40% were defined as constant. Non-metric multidimensional scaling (NMDS) based on Euclidean distance was performed in order to assess the floristic relationships among the pseudosteppe and meadow types using the function *metaMDS* in the 'vegan' package (Oksanen et al. 2019). We decided to exclude cluster 1 from the analysis as a distinctly different group of desert steppe – it obscured the Figure. Prior to the analysis, cover values were Hellinger-transformed. The final ordination was run with 999 random starts with the use of two dimensions (stress value = 0.199). Next, we fitted environmental variables post hoc to the ordination axes to explore their associations with each vegetation type using the function *envfit* with 999 permutations in the 'vegan' package (Oksanen et al. 2019). Climatic data were extracted from the WorldClim database (Fick & Hijmans 2017) and altitudinal data from a digital elevation model (Jarvis et al. 2008). We determined the medians and SD of the measured environmental and vegetation parameters (altitude, inclination, geographical position, temperature, precipitation, species richness per plot, ground vegetation cover, share of annual and perennial plants and phytogeographical elements in each plot) for all communities. The differences between groups in relative cover of annual and perennial plants and phytogeographical elements were assessed using Kruskal–Wallis rank sum test (function *kruskal.test*) with multiple comparison method based on the Bonferroni procedure using the function *pairw.kw* in the 'asbio' package (Aho 2019) in R.

A synoptic table with fidelity measured by the *phi* coefficient and percentage frequency for diagnostic and frequent taxa for a certain cluster is given (Supplement S1). Only species with a *phi* coefficient ≥ 0.20 and frequency ≥ 20% are shown. For newly-described associations, the ICPN was adhered to according to Weber et al. (2000). All mentioned syntaxa are arranged into a syntaxonomic overview. Distribution maps of all grassland types within the study area are presented in Supplement E4. Environmental and vegetation parameters are presented in Supplement E6. Plant communities were depicted in photographs (Fig. 5 and Supplement E7).

The nomenclature of the vascular plants follows generally Cherepanov (1995) and for *Bromus* spp. The Plant List (2019). The names of syntaxa are used in accordance with Gadghiev et al. (2002), Ermakov (2012) and Nowak et al. (2018).

4. Results

4.1 Clasification of the vegetation units

Our classification resulted in delimitation of 13 plant communities that were well-defined in terms of species composition (Fig. 2, Supplement S1). As our study was focused on warm and subhumid areas, we formally describe new syntaxa only for pseudosteppe units. Other communities that were clearly separated by the clustering algorithm have been left rankless (mesic boreo-temperate meadows) or were included in previously described typical steppe vegetation (NOWAK et al. 2018). One exception is cluster 10 (*Medicago sativa-Poa trivialis*) that falls into the pseudosteppe group but represents anthropogenic hay grasslands, has insufficient sample numbers and cannot be definitely fitted into the hierarchical system. Another exception is the semi-arid steppe of *Brayo pamiricae-Stipetum glareosae* (cluster 1) that in our opinion makes a very distinct, well defined desert steppe community that can be included in the high altitude arid steppe class *Ajanio-Cleistogenetea songoricae* (syn. *Stipetea glareoso-gobicae*, HILBIG 2000). Plots of this community were not shown in the graph as they are substantially different and extend particularly the altitudinal gradient standing as outlier in relation to other communities. The NMDS run for all other samples revealed relationships between distinct plots and gradients along the two most significant axes of the ordination (Fig. 2). Phytocoenoses preferring the most fertile habitats (deep, humid soils at moderate elevations) that are composed of Western Irano-Turanian species such as *Astragalus lepsensis*, *Euphorbia alatvica*, *Cerastium tianschanicum* or *Potentilla asiae-mediae* (communities of *Euphorbia lamprocarpa*, *Ligularia alpigena-Euphorbia alatavica* and *Carum carvi-Hordeum turkestanicum*) are concentrated in the upper left part of the graph. The opposite side is occupied by plots of *Astragalo lithophili-Stipetum zalesskii*, *Eremuro tianschanici-Delphinietum biternati* and *Stipetum bungeanae*, representing more dry and arid habitats, inhabited by a considerable share of Euro-Siberian and Central-Asian plants like *Festuca valesiaca*, *Elymus caninus*, *Botriochloa ischaemum*, *Bromus squarrosus* or *Artemisia pectinata* (Fig. 2). In the upper right position are plots of typical pseudosteppes (e.g. *Eremuretum bucharici*, *Hordeo bulbosi-Astragaletum retamocarpi*) that are related to the warmest and subhumid conditions at the lowest elevations (lowland and colline belt). These plots are characterised by the highest species number, relatively high total cover of herb layer and deep, loessic soils. The upper right outlier is the association *Cryptosporo falcatae-Brachypodietum distachyi* that occupies the warmest habitats in Tajikistan in hilly land at colline altitudes. This is a kind of ephemeroid vegetation with the peak of vegetation cover in early spring.

4.2 Description of the communities

A. High-altitude arid steppe pastures

1. *Brayo pamiricae-Stipetum glareosae* ass. nova hoc loco

Diagnostic species: *Artemisia leucotricha*, *Braya pamirica*, *Stipa glareosa*, *S. orientalis*

Constant species: *Stipa glareosa*, *S. orientalis*

Floristic and habitat characteristics: We recorded plots of this association in the high plateau of Eastern Pamir in Tajikistan with continental, very cold and dry climate. It occupies flat and arid terraces and gentle slopes with scarce organic matter content (Fig. 5a).

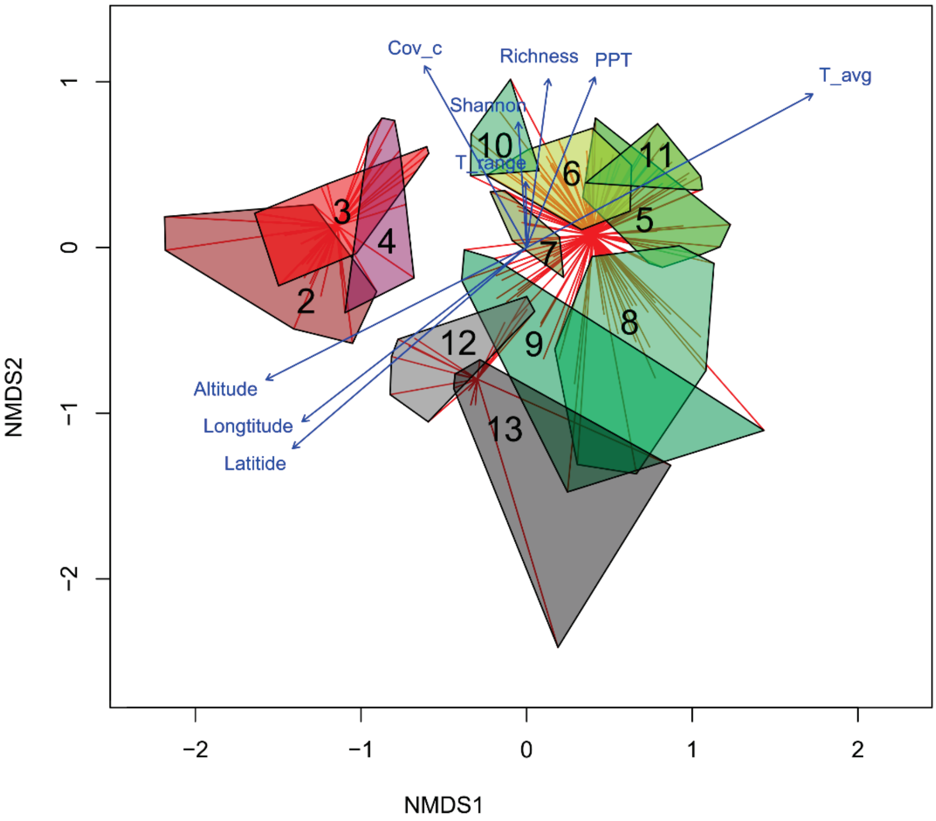

Fig. 2. NMDS ordination of 12 grassland communities. Red spider diagrams represent three types of grassland vegetation: meadows and pastures (2, 3, 4), pseudosteppes (5, 6, 7, 8, 9, 10, 11) and steppes (12, 13). Environmental variables are indicated by arrows and only significant are shown ($p < 0.05$). The ordination was run with the use of two dimensions with stress value = 0.199. Abbreviations: 2 − *Ligularia alpigena-Euphorbia alativica* community; 3 − *Euphorbia lamprocarpa* community; 4 − *Carum carvi-Hordeum turkestanicum* community; 5 − *Eremuretum bucharici*; 6 – *Hordeo bulbosi-Astragaletum retamocarpi*; 7 − *Potentillo orientalis-Eremuretum fusci*; 8 − *Achnathero caraganae-Delphinietum semibarbati*; 9 − *Eremuro tianschanici-Delphinietum biternati*; 10 – *Medicago sativa-Poa trivialis community*; 11 – *Cryptosporo falcatae-Brachypodietum distachyi*; 12 – *Astragalo lithophili-Stipetum zalesskii*; 13 − *Stipetum bungeanae*, Cov_c – cover herb layer (%), PPT – annual precipitation, Richness – species richness, Shannon – Shannon index, T_avg – annual mean temperature, T_range – temperature annual range.

Abb. 2. NMDS Ordination der 12 Graslandgesellschaften. Die roten Spinnendiagramme repräsentieren die drei Arten von Graslandvegetation: Wiesen und Weiden (2, 3, 4), Pseudosteppen (5, 6, 7, 8, 9, 10, 11) und Steppen (12, 13). Signifikante Umweltvariablen ($p < 0{,}05$) sind durch Pfeile dargestellt. Die Ordination wurde für zwei Dimensionen durchgeführt mit einem Stress-Wert = 0,192. Abkürzungen: 2 − *Ligularia alpigena-Euphorbia alativica*-Ges.; 3 − *Euphorbia lamprocarpa*-Ges.; 4 − *Carum carvi-Hordeum turkestanicum*-Ges.; 5 − *Eremuretum bucharici*; 6 – Hor*deo bulbosi-Astragaletum retamocarpi*; 7 − *Potentillo orientalis-Eremuretum fusci*; 8 − *Achnathero caraganae-Delphinietum semibarbati*; 9 − *Eremuro tianschanici-Delphinietum biternati*; 10 – *Medicago sativa-Poa trivialis*-Ges.; 11 – *Cryptosporo falcatae-Brachypodietum distachyi*; 12 – *Astragalo lithophili-Stipetum zalesskii*; 13 − *Stipetum bungeanae*, Cov_c – Krautschichtdeckung (%), PPT – jährliche Niederschläge, Richness – Artendiversität, Shannon – Shannon Index, T_avg – mittlere Jahrestemperatur, T_range – jährliche Temperaturamplitude.

The plots have sparse cover and a patchy physiognomy with an average vegetation cover of 27%. The association is not species rich, with not more than 9–10 species per plot. Semi-desert taxa frequently contribute to this community (*Krascheninnikovia ceratoides*, *Ajania tibetica*, *Astragalus chomutowii*) and alpine plants of arid areas (*Acantholimon diapensioides*, *Gypsophila capituliflora*, *Astragalus orthanthoides*). The name giving *Braya pamirica*, despite not being the most frequent, is endemic for highly elevated plateaus of Eastern Pamir and very occasionally occurs in alpine semi-deserts, screes or river-beds. The *Brayo pamiricae-Stipetum glareosae* is extensively grazed by yaks, camels and, more rarely, goats.

Typus relevé: (relevé number 2 in Supplement E1). 10 July 2018; Murghab: 37.63777 N; 72.95125 E; 3,854 m a.s.l.; plot area 10 m^2; species richness: 8; species composition: *Stipa glareosa* 2, *Artemisia leucotricha* 1, *Astragalus chomutovii* 1, *A. orthanthoides* 1, *Krascheninnikovia ceratoides* 1, *Oxytropis trichosphaera* 1, *Stipa orientalis* 1, *Braya pamirica* +.

B. Mesic mown and grazed meadows and pastures on fertile soils

2. *Ligularia alpigena-Euphorbia alativica* community

Diagnostic species: *Euphorbia alatavica*, *Cerastium tianschanicum*, *Ligularia alpigena*, *Astragalus lepsensis*, *Galium tianschanicum*, *Cobresia pamiroalaica*

Constant species: *Myosotis asiatica*, *Cerastium tianschanicum*, *Geranium regelii*

Floristic and habitat characteristics: This heterogenous vegetation includes different phytocoenoses of alpine meadows on fertile mineral-rich soils. Similar to the European communities, they are grazed by cattle, sheep and, sporadically, goats, and are very rarely mown. The patches of this vegetation were found in the alpine belt at an elevation of ca. 3000 m a.s.l. The plots were rich in species (more than 30 on average), with the highest average diversity and considerable vegetation cover (90% on average). The community of *Ligularia alpigena* and *Euphorbia alatavica* occurs in the northern outskirts of the study area and is probably related to alpine grasslands of eastern Tian Shan and Altai. Dominant plants as well as the most frequent ones are typical montane Euro-Siberian and Irano-Turanian species (Fig. 3a) such as *Astragalus alpinus*, *Cerastium tianschanicum*, *Hordeum turkestanicum*, *Leontopodium ochroleucum*, *Myosotis asiatica*, *Poa alpina*, *Phleum alpinum*, *Polygonum alpinum*, *Thalictrum alpinum* and *Veronica alpina*. As in our opinion the sampled plots represent only a small part of the alpine meadow diversity in the Tian Shan Mts, we decided to leave it as a rankless community that needs further research.

3. *Euphorbia lamprocarpa* community

Diagnostic species: *Euphorbia lamprocarpa*, *Alchemilla bungei*, *Geranium regelii*

Constant species: *Geranium regelii*, *Trifolium repens*, *Poa pratensis*

Floristic and habitat characteristics: During the research, several plots of the community were recorded in the valley near Ken-Djylga in the eastern Alai range. This type of vegetation is used as a pasture for cattle and sheep. The physiognomy, high total plant cover and species composition reveal the forb character of this pasture. We decided to leave it as rankles until further research on tall-herb vegetation in Middle Asia will be completed. The plots of the *Euphorbia lamprocarpa* community were moderately rich in species, found in valley bottoms of mid-elevations (ca. 2500 m a.s.l.) on fertile, deep soils. Despite some typical meadow species such as *Achillea millefolium*, *Artemisia dracunculus*, *Dactylis*

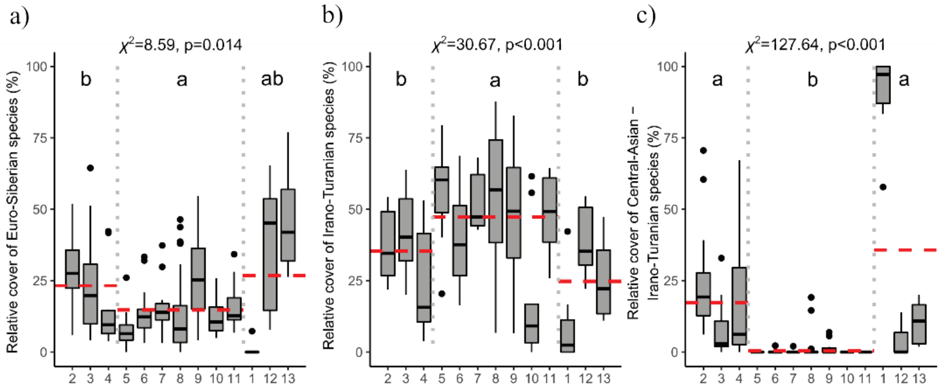

Fig. 3. Boxplots showing relative cover of **a)** Euro-Siberian, **b)** Irano-Turanian and **c)** Central-Asian – Irano-Turanian species for clusters with median (line), quartiles, outliers and the range of data. Red line indicates mean values of vegetation groups: meadows and pastures (2, 3, 4), pseudosteppes (5, 6, 7, 8, 9, 10, 11) and steppes (1, 12, 13). The values of χ^2 and *p* for statistical tests for vegetation groups are shown. Different letters indicate significant differences among the vegetation groups. The abbreviations of the clusters are explained in Figure 2.

Abb. 3. Die Boxplots zeigen die relative Deckung der **a)** euro-sibirischen, **b)** irano-turanischen und **c)** zentralasiatisch – irano-turanischen Arten für die Cluster mit dem Median (Linie), Quartilen, Außreißern und der Verteilung der Daten. Rote Linien zeigen die Mittelwerte der Vegetationseinheiten: Wiesen und Weiden (2, 3, 4), Pseudosteppen (5, 6, 7, 8, 9, 10, 11) und Steppen (1, 12, 13). Dargestellte $\chi 2$ und p-Wert beziehen sich auf statistische Tests der Vegetationseinheiten. Unterschiedliche Buchstaben zeigen dabei signifikante Unterschiede zwischen den Vegetationseinheiten an. Abkürzungen s. Abbildung 2.

glomerata, *Linum olgae*, *Poa alpina*, *P. pratensis*, *Trifolium pratense* and *T. repens*, a great share of forbs (e.g., *Geranium regelii*, *Hedysarum flavescens*, *Ligularia narynensis*, *L. thompsonii*, *Phlomis pratensis* and *Polygonum coriarium*) were noted within the plots.

4. *Carum carvi-Hordeum turkestanicum* community

Diagnostic species: *Alopecurus pratensis*, *Carum carvi*, *Hordeum turkestanicum*, *Potentilla asiae-mediae*, *Tragopogon turkestanicum*

Constant species: *Alopecurus pratensis*, *Carum carvi*, *Festuca pratensis*, *Geranium regelii*, *Hordeum turkestanicum*, *Medicago falcata*, *Poa pratensis*

Floristic and habitat characteristics: This community shows the greatest resemblance to fen vegetation. It occupies the wettest sites in the valley bottoms or on flat terraces and gentle slopes. Mowing is rather infrequent here and grazing rather uncommon – mainly by sheep and goats in late summer or autumn. The community of *Hordeum turkestanicum* creates a dense mat at the upper montane belt on peaty soils (Fig. 5d). It has a moderate species richness and diversity. Frequent and dominant taxa include *Medicago sativa* and *Trifolium pratense*. Species typical for fens are *Inula caspica* and *Plantago griffithii*.

C. Thermo-mesomediterranean secondary perennial pseudosteppes on deep calcareous soils of colline and montane belts in mediterranean-like climates (including Irano-Turanian) with long dry summer period

Alliance: *Vulpio persicae-Caricion pachystylidis* all. nova hoc loco

Typus association: *Eremuretum bucharici* S. Świerszcz et al. (this paper)

These grasslands grow mainly in colline and montane belts on loessic or organic, fertile soil with calcareous bedrock, where the terminal stage of vegetation is shrubland. In Middle Asia they occur in the western foothills of Pamir-Alai, the Ferghana Valley and the western slopes of the Tian Shan Mts. In this area, the average annual temperature is above 10 ºC, winters are mild, with the minimum temperature dropping rarely below -5 ºC, the beginning of the vegetation season is relatively humid in comparison to other areas, particularly the eastern, highly elevated plateaus of Pamir. The precipitation peaks one or two months earlier than in the Central Asianregions, where the highest amount of rain falls in the summer period. The continentality index is higher in Tibet or in Gobi desert if compared to Pamir-Alai. The structure of this pseudosteppes is apparently determined by grasses, however the perennial and bulbous plants of Irano-Turanian origin (e.g., *Eremurus* sp., *Phlomoides* sp., *Elaeosticta* sp., *Tulipa* sp., *Ungernia* sp.) have a considerable share. This syntaxon can be considered as an eastern (Irano-Turanian) outpost of the Mediterranean communities of *Cymbopogono-Brachypodietalia ramosi* Horvatič 1963.

Diagnostic taxa: *Aphanopleura capillifolia*, *Artemisia kochiiformis*, *Astragalus kabadianus*, *Carex pachystylis*, *Convolvulus subhirsutus*, *Elytrigia intermedia*, *Gagea ova*, *G. pseudophila*, *G. vegeta*, *Galium ghilanicum*, *Goldbachia pendula*, *Haplophyllum dubium*, *Hypecoum trilobum*, *Korovinia tenuisecta*, *Lolium persicum*, *Medicago orbicularis*, *Phlomis bucharica*, *Poa bulbosa*, *Ranunculus pinnatisectus*, *R. sewerzowii*, *R. tenuilobus*, *Vicia ervilla*, *Vulpia persica*

5. *Eremuretum bucharici* ass. nova hoc loco

Diagnostic species: *Allium bucharicum*, *Consolida leptocarpa*, *Cymatocarpus popovii*, *Eremurus bucharicus*, *Gagea graminifolia*, *Haplophyllum griffithianum*, *Heterocaryum subsessile*, *Jurinea bucharica*, *Koelpinia macrantha*, *Leptaleum filifolium*, *Nonea macropoda*, *Phlomoides baldschuanica*, *Russowia sogdiana*, *Solenanthus plantaginifolius*

Constant species: *Avena trichophylla*, *Bromus lanceolatus*, *Diarthron vesiculosum*, *Phlomis bucharica*, *Poa bulbosa*, *Vulpia persica*

Floristic and habitat characteristics: This is the most thermophilous community distributed in the south-western part of Tajikistan, occurring exclusively in the colline belt (average altitude ca. 650 m a.s.l.). The average yearly temperature is around 18 ºC, however the precipitation still has a fairly high amount, achieving ca. 500 mm throughout the year. The community develops on fertile, deep, loessic soils, is rich in species and diverse (ca. 35 taxa per plot) and has up to 85% average cover of vegetation (Supplement E6, Fig. 5e). In addition to the diagnostic species, the most abundant are *Aegilops triuncialis*, *Artemisia kochiiformis*, *Carex pachystylis*, *Eremurus comosus*, *Lolium persicum* and *Medicago orbicularis*. The pseudosteppe of *Eremurus bucharica* is used as a mown meadow and also as pasture for goats and sheep.

Typus relevé: (relevé number 10 in Supplement E2). 1 May 2018; Dangara: 37.73189 N; 69.45248 E; 705 m a.s.l.; plot area 10 m^2; species richness: 43; species composition: *Vulpia persica* 3, *Avena trichophylla* 2, *Convolvulus subhirsutus* 2, *Eremurus bucharicus* 2, *Poa bulbosa* 2, *Soleanthus plantaginifolius* 2, *Alcea baldschuanica* 2, *Carex pachystylis* 1, *Helichrysum maracandicum* 1, *Hordeum spontaneum* 1, *Medicago orbicularis* 1, *Phlomis bucharica* 1, *Aphanopleura capillifolia* 1, *Psolarea drupacea* 1, *Cynodon dactylon* 1, *Diarthron vesiculosum* 1, *Vulpia villosa* 1, *Astragalus oxyglottis* +, *Anemone bucharica* +, *Euphorbia franchetti* +, *Filago pyramidata* +, *Gagea ova* +, *Bromus oxyodon* +, *Anagallis foemina* +, *Inula macrophylla* +, *Carthamus lanatus* +, *Medicago rigidula* +, *Nigella bucharica* +, *Onobrychis pulchella* +, *Arenaria serpyllifolia* +, *Pimpinella peregrina* +, *Pleurogynella flaviflora* +, *Cousinia microcarpa* +, *Prosopis farcta* +, *Cousinia sclerophylla* +, *Ranunculus severtzovii* +, *Crepis pulchra* +, *Strigosella trichocarpa* +, *Trigonella orthoceras* +, *Valerianella ovczinnikovii* +, *Vicia angustifolia* +, *Cryptospora falcata* +, *Astragalus filicaulis* +.

6. *Hordeo bulbosi-Astragaletum retamocarpi* ass. nova hoc loco

Diagnostic species: *Astragalus retamocarpus*, *Cruciata pedemontana*, *Hordeum bulbosum*, *Lathyrus aphaca*, *Medicago denticulata*, *Prangos bucharica*, *Prangos fedtschenkoana*, *Ungernia tadshikorum*, *Valerianella ovczinnikovii*

Constant species: *Avena trichophylla*, *Hordeum bulbosum*, *Poa bulbosa*, *Veronica arvensis*, *Vicia angustifolia*, *Vulpia persica*

Floristic and habitat characteristics: The *Hordeo bulbosi-Astragaletum retamocarpi* was found as a common pseudosteppe in hilly landscapes of the Hissaro-Darvasian geobotanical subregion of Tajikistan in the montane belt of Aktau, Karatau, Karateginian and the southern foothills of the Hissar Mts. It is the species richest community of pseudosteppe in Tajikistan with more than 35 species on average per plot and is dominated apparently by Irano-Turanian taxa (Fig. 3b) with considerable contribution of endemics e.g. *Ungernia tadshikorum*, *Astragalus corydalinus*, *A. maverranagri*, *A. ovczinnikovii* and *Jurinea bucharica*. This typical pseudosteppe is occasionally used as a mown grassland (once a year in spring) and then grazed by sheep and goats.

Typus relevé: (relevé number 35 in Supplement E2). 29 April 2018; Dangara: 38.13724 N; 69.4054 E; 944 m a.s.l.; plot area 10 m^2; species richness: 39; species composition: *Avena trichophylla* 4, *Astragalus retamocarpus* 3, *Hordeum bulbosum* 2, *Vulpia persica* 2, *Astragalus ammophilus* 1, *A. korovinianus* 1, *Drabopsis nuda* 1, *Elaeosticta allioides* 1, *Gagea pseudophila* 1, *Heterocaryum szovitsianum* 1, *Linum corymbulosum* 1, *Lolium cuneatum* 1, *Medicago lanigera* 1, *Onobrychis pulchella* 1, *Prangos bucharica* 1, *Russovia sogdiana* 1, *Soleanthus turkestanica* 1, *Brachypodium distachyon* 1, *Medicago rigidula* 2, *Bromus sterilis* +, *Cerastium dentatum* +, *Consolida barbata* +, *Cryptospora falcata* +, *Cuscuta* sp. +, *Cynodon dacylon* +, *Galium ghilanicum* +, *Galium spurium* +, *Poa bulbosa* +, *Ranunculus tenuilobus* +, *Taraxacum nuratavicum* +, *Astragalus rytilobus* r, *Minuartia meyeri* r, *Papaver pavoninum* r, *Thlaspi perfoliatum* r, *Valerianella ovczinnikovii* r, *Veronica arvensis* r, *Vicia angustifolia* r, *Ceratodon purpureus* d r, *Bryum pallens* d +.

7. *Potentillo orientalis-Eremuretum fusci* ass. nova hoc loco

Diagnostic species: *Cynodon dactylon*, *Eremurus brachystemon*, *E. fuscus*, *E. stenophyllus*, *Filago arvensis*, *Medicago lupulina*, *Potentilla orientalis*, *Strigosella hispida*, *Vinca erecta*

Constant species: *Carex stenophylloides*, *Cynodon dactylon*, *Filago arvensis*, *Medicago lupulina*, *Poa bulbosa*, *Arenaria serpyllifolia*

Floristic and habitat characteristics: Stands of this community occur in central and eastern Tajikistan in the montane and subalpine belts on mesic, loamy soils. It is a species poor community with moderate plant cover in comparison to other pseudosteppes and meadows. It is somehow related to forb vegetation, yet is intensively grazed and has the physiognomy of typical perennial pseudosteppe (Fig. 4b). The contribution of species typical for pseudosteppe habitats is evidenced by the presence of *Achillea biebersteinii*, *Aphanopleura capillifolia*, *Artemisia persica*, *Bromus lanceolatus*, *Cynodon dactylon*, *Poa bulbosa* and *Carex pachystylis*. Due to intensive grazing by cattle, horses, sheep and goats, a considerable share of nitrophilous taxa typical for degraded habitats was observed within plots (e.g. *Acanthocephalus benthamianus*, *Anagallis arvensis*, *Ceratocephalus testiculatus*, *Filago arvensis*, *Geranium pusillum*, *Medicago lupulina* and *Veronica arvensis*).

Typus relevé: (relevé number 51 in Supplement E2). 2 June 2015; Novobod: 38.9533 N; 70.14361 E; 1302 m a.s.l.; plot area 10 m^2; species richness: 13; species composition: *Eremurus fuscus* 4, *Potentilla orientalis* 3, *Medicago lupulina* 2, *Cynodon dactylon* 2, *Filago arvensis* 1, *Arenaria serpyllifolia* 1, *Poa bulbosa* 1, *Carex stenophylloides* 1, *Vulpia persica* 1, *Cerastium dentatum* +, *Anagallis arvensis* +, *Veronica arvensis* +, *Eremurus brachystemon* +.

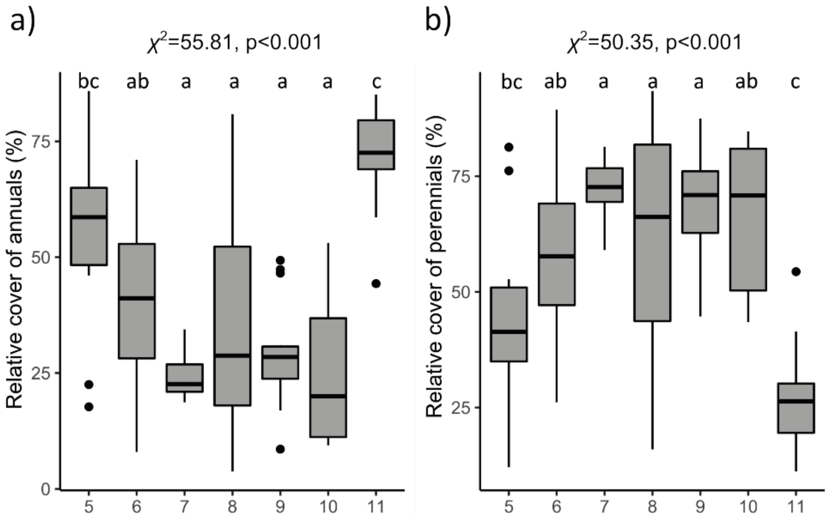

Fig. 4. Boxplots showing species relative cover of **a)** annuals and **b)** perennials within pseudosteppes types with median (line), quartiles, outliers and the range of data. The values of χ^2 and *p* for statistical tests are shown. Different letters indicate significant differences among the clusters. The abbreviations of the clusters are explained in Figure 2.

Abb. 4. Die Boxplots zeigen die relative Deckung der **a)** Annuellen und **b)** Perennen innerhalb der Pseudosteppen-Typen mit dem Median (line), Quartilen, Außreißern und der Verteilung der Daten. Dargestellte $\chi 2$ und p-Wert beziehen sich auf statistische Tests der Cluster. Unterschiedliche Buchstaben zeigen dabei signifikante Unterschiede zwischen den Clustern. Abkürzungen s. Abbildung 2.

Fig. 5. Photographs of the grassland vegetation belonging to the **a)** *Brayo pamiricae-Stipetum glareosae* in Kurteskei Valley to the east from Alichur, TJK (cluster 1); **b)** *Astragalo lithophili-Stipetum zalesskii* in Suusamyr Valley, 2350 m a.s.l., KRG (cluster 12); **c)** *Eremuro tianschanici-Delphinietum biternati* S. near Toktogul, 1350 m a.s.l., KRG (cluster 9); **d)** *Carum carvi-Hordeum turkestanicum* community in Naryn Valley, 2100 m a.s.l., KRG (cluster 4); **e)** *Eremuretum bucharici*, Karatau Mts, 650 m a.s.l., TJK (cluster 5); **f)** *Cryptosporo falcatae-Brachypodietum distachyi* near Pandz, 420 m a.s.l., TJK (cluster 11) (Photos: A. Nowak, 2015–2018).

Abb. 5. Fotos von Graslandgesellschaften: **a)** *Brayo pamiricae-Stipetum glareosae* S. Świerszcz et al. 2019 im Kurteskei-Tal östlich von Alichur, TJK (Cluster 1); **b)** *Astragalo lithophili-Stipetum zalesskii* A. Nowak et al. 2018 im Suusamyr-Tal, 2350 m ü. HN., KRG (Cluster 12); **c)** *Eremuro tianschanici-Delphinietum biternati* S. Świerszcz et al. 2019 in der Nähe von Toktogul, 1350 m ü. HN., KRG (Cluster 9); **d)** *Carum carvi-Hordeum turkestanicum*-Ges. im Naryn-Tal, 2100 m ü. HN., KRG (Cluster 4); **e)** *Eremuretum bucharici* S. Świerszcz et al. 2019, Karatau-Gebirge, 650 m ü. HN., TJK (Cluster 5); **f)** *Cryptosporo falcatae-Brachypodietum distachyi* in der Nähe von Pandz, 420 m ü. HN., TJK (Cluster 11) (Fotos: A. Nowak, 2015–2018).

8. *Achnathero caraganae-Delphinietum semibarbati* ass. nova hoc loco

Diagnostic species: *Achnatherum caragana*, *Artemisia kochiiformis*, *Carex pachystylis*, *Delphinium semibarbatum*, *Kochia iranica*, *Taeniatherum asperum*, *T. crinitum*

Constant species: *Botriochloa ischaemum*, *Carex pachystylis*, *Diarthron vesiculosum*, *Poa bulbosa*

Floristic and habitat characteristics: The plots of the association were found in colline and montane belts in dry and warm locations of the surroundings of the Ferghana Valley, Zeravshan River Valley and the southern foothills of Hissar range. These relatively dry conditions resemble the typical steppe habitats, which is reflected by the presence of steppe grasses including *Botriochloa ischaemum*, *Stipa arabica*, *S. drobovii*, *S. hohenackeriana* and *S. capillata*, which are, however, not frequent. The *Achnathero caraganae-Delphinietum semibarbati* prefers mesic, loamy or loessic soils with a well-developed organic soil layer and sometimes considerable gravel debris. Despite the dry condition, a number of perennials were found in this association with *Astragalus babatagi*, *Convolvulus pseudocantabrica*, *Delphinium semibarbatum*, *Elaeosticta ferganensis*, *Eremurus comosus*, *E. suvorovii* and *Onobrychis pulchella* as the most frequent. This community is used mainly for grazing by sheep and goats, sporadically horses and cattle as well. It is frequently burned.

Typus relevé: (relevé number 79 in Supplement E2). 29 June 2017; Toktogul: 42.0277 N; 72.8333 E; 1631 m a.s.l.; plot area 10 m^2; species richness: 29; species composition: *Stipa capillata* 3, *Artemisia ferganensis* 2, *Botriochloa ischaemum* 2, *Crupina vulgaris* 2, *Delphinium semibarbatum* 2, *Elaeosticta ferganensis* 2, *Linum corymbulosum* 2, *Poa bulbosa* 2, *Achnatherum caragana* 2, *Eremurus tianschanicus* 1, *Gentiana olivieri* 1, *Diarthron vesiculosum* 1, *Onobrychis pulchella* 1, *Convolvulus pseudocantabrica* 1, *Elytrigia intermedia* 1, *Taeniatherum crinitum* 1, *Galium transcaucasicum* +, *Centaurea squarrosa* +, *Kochia iranica* +, *Krascheninnikovia ceratoides* +, *Lactuca serriola* +, *Lathyrus inconspicua* +, *Ceratocarpus arenarius* +, *Artemisia glanduligera* +, *Cousinia umbrosa* +, *Alyssum dasycarpum* +, *Galium tenuissimum* +, *Xanthium italicum* +, *Bryum pallens* d 1.

9. *Eremuro tianschanici-Delphinietum biternati* ass. nova hoc loco

Diagnostic species: *Bromus squarrosus*, *Delpninium biternatum*, *Elaeosticta ferganensis*, *E. samarcandica*, *Eremurus tianschanicus*, *Hymenolyma trichophyllum, Korovinia ferganensis*

Constant species: *Botriochloa ischaemum*, *Bromus squarrosus*, *Delpninium biternatum*, *Elytrigia trichophora*

Floristic and habitat characteristics: This community occurs mainly in southern and central Kyrgyzstan in the montane and colline belts (average elevation of 1100 m a.s.l.) of the Ferghana and Alai ranges. It prefers mesic habitats with deep loessic or loamy soils in warm sites. The community presents colourful stands with a lot of decorative perennials such as *Eremurus* sp., *Delphinium* sp., *Linum corymbulosum*, *Salvia desrta* and *Nepeta cataria* etc. (Fig. 5c). It is moderately rich, with more than 30 species per plot. This type of pseudosteppe is sporadically mown and used as typical pasture for sheep and horses, sometimes goats. Many species of very restricted ranges contribute to this association (e.g. *Astragalus alaicus*, *Echinops karatavicus*, *Elaeosticta ferganensis*, *E. samarcandica*, *Phlomoides cephalariifolia*, *Goldbachia pendula*, *Korovinia ferganensis* and *Salvia schmalchausenii*), making it very distinct from other pseudosteppes.

Typus relevé: (relevé number 100 in Supplement E2). 29 June 2017; Bala-Chychkan: 41.93805 N; 72.92222 E; 1143 m a.s.l.; plot area 10 m^2; species richness: 32; species composition: *Delphinium biternatum* 3, *Crupina vulgaris* 2, *Convolvulus pseudocantabrica* 2, *Hymenolyma trichophyllum* 2, *Onobrychis pulchella* 2, *Stipa capillata* 2, *Achnatherum caragana* 1, *Aegilops crassa* 1, *Ae. triuncialis* 1, *Elaeosticta ferganensis* 1, *Eremurus tianschanicus* 1, *Haplophyllum acutifolium* 1, *Heteropappus canescens* 1, *Artemisia ferganensis* 1, *Linum corymbulosum* 1, *Botriochloa ischaemum* 1, *Centaurea squarrosa* 1, *Taeniatherum crinitum* 1, *Camelina sylvestris* +, *Draba huetii* +, *Alcea nudiflora* +, *Medicago sativa* +, *Anagallis arvensis* +, *Salsola orientalis* +, *Scutellaria przewalskii* +, *Setaria pumila* +, *Silene tachtensis* +, *Galium pamiroalaicum* +, *Bromus sewerzowii* +, *Tragopogon capitatus* +, *Potentilla transcaspia* +, *Syntrichia ruralis* d 1.

10. *Medicago sativa-Poa trivialis* community

Diagnostic species: *Bromus sterilis*, *Medicago sativa*, *Poa trivialis*

Constant species: *Bromus sterilis*, *Cynodon dactylon*, *Medicago sativa*, *Plantago lanceolata*, *Poa trivialis*, *Trifolium pratense*, *Vicia angustifolia*

Floristic and habitat characteristics: This community was found in the western Tajikistan in several sites close to human settlements. It reflects the strong human impact with a number of species sown as it is used as a hay grassland. The plant cover is relatively high, despite the community is often growing under the canopy of planted trees (e.g. *Malus sieversii*, *Populus alba*, *Juglans regia*). Species that are typical for wetlands (*Carex diluta*, *Euphrasia pectinata*, *E. rostkoviana*, *Poa trivialis*, *Trifolium repens*) reflect the irrigation of this habitat. In some plots the forb species have considerable contribution to this community e.g. *Ranunculus laetus*, *Thermopsis dolichocarpa* and *Cousinia mulgediifolia*.

D. Circum-Mediterranean calciphilous annual and ephemeroid swards and grasslands

11. *Cryptosporo falcatae-Brachypodietum distachyi* ass. nova hoc loco

Diagnostic species: *Aphanopleura capillifolia*, *Aristida adscensionis*, *Brachypodium distachyon*, *Cryptospora falcata*, *Eremurus suvorovii*

Constant species: *Avena trichophylla*, *Brachypodium distachyon*, *Cryptospora falcata*, *Cynodon dactylon*, *Euphorbia franchetii*, *Koelpinia linearis*, *Medicago rigidula*, *Vicia angustifolia*

Floristic and habitat characteristics: Like the association of *Eremurus bucharicus*, this community occupies the warmest habitats in Tajikistan, however at slightly higher elevation, mainly in the montane belt (mean altitude of ca. 900 m a.s.l.). This results in higher precipitation at ca. 650 mm per year. The main difference between *Cryptosporo falcatae-Brachypodietum distachyi* and *Eremuretum bucharici* is the higher share of annuals that can be explained by the distinct relief of its habitat (Fig. 4a). It grows on much steeper slopes were the plant cover is scarcer, so the bareland can be easily inhabited by annuals. Among them, the most common are *Aphanopleura capillifolia*, *Aristida adscensionis*, *Arnebia coerulea*, *Bromus lanceolatus*, *B. oxyodon*, *B. tectorum*, *Cryptospora falcata*, *Galium nupercreatum*, *Hypogomphia bucharica*, *Koelpinia linearis*, *Vulpia persica*, *V. villosa* and many others (Fig. 5f). This community is used as moderately grazed pasture for sheep and goats.

Typus relevé: (relevé number 5 in Supplement E3). 29 April 2018; Obi-Kiik: 38.27138 N; 69.64555 E; 922 m a.s.l.; plot area 10 m^2; species richness: 30; species composition: *Brachypodium distachyon* 3, *Bromus lanceolatus* 2, *Cryptospora falcata* 2, *Cynodon dactylon* 2, *Eremurus suvorovii* 2, *Medicago rigidula* 2, *Phlomis bucharica* 2, *Avena trichophylla* 2, *Arnebia coerulea* 1, *Phlomoides labiosa* 1, *Bromus oxyodon* 1, *Galium spurium* 1, *Hypogomphia purpurea* 1, *Koelpinia linearis* 1, *Lallemantia royleana* 1, *Medicago lanigera* 1, *M. orbicularis* 1, *Bromus tectorum* 1, *Onosma baldschuanica* 1, *Consolida barbata* 1, *Allium barszczewskii* 1, *Lathyrus aphaca* +, *Lens orientalis* +, *Lolium cuneatum* +, *Medicago denticulata* +, *Psolarea drupacea* +, *Carthamus lanatus* +, *Vicia angustifolia* +, *Barbula unguiculata* d +, *Bryum caespiticum* d +.

E. Mountain steppes of semi-arid areas

12. *Astragalo lithophili-Stipetum zalesskii* A. Nowak et al. 2018

Diagnostic species: *Festuca valesiaca*, *Stipa kirghisorum*, *S. zalesskii*

Constant species: *Carex turkestanica*, *Festuca valesiaca*, *Stipa zalesskii*

Floristic and habitat characteristics: This is a typical steppe community of alpine elevations occurring mainly in Central Tian Shan (Fig. 5b). It is used as typical pasture for horses and sheep. It was described from the Suusamyr Valley (NOWAK et al. 2018).

13. *Stipetum bungeanae* A. Nowak et al. 2018

Diagnostic species: *Artemisia pectinata*, *A. turanica*, *Leymus angustus*, *Stipa bungeana*

Constant species: *Agropyron repens*, *Artemisia pectinata*, *Carex turkestanica*

Floristic and habitat characteristics: This type of steppe vegetation occupies the most arid environments almost deprived of organic matter in the substrate (NOWAK et al. 2018). Several plots dominated by *Artemisia pectinata* were grouped with *Stipa bungeana* communities. As they are geographically indistinct, we decided to merge them altogether under the name of *Stipetum bungeanae*. Further research in semi-deserted steppes may reveal some differences between these plots.

5. Discussion

5.1 The steppes, pseudosteppes and meadow puzzle

The strongly heterogeneous environment – considering the geomorphology, bioclimate, soil, postglacial history and biogeography in addition to a long history of pastoralism (reaching 8000 years) and grassland management in the region – considerably influences the vegetation cover, particularly steppes and meadows in Middle Asia (MIRZABAEV et al. 2016). Sheep, goats, horses, yaks, cows and camels were grazed by nomadic and later by agrarian peoples primarily on natural grassland and then, after burning and logging of the native woods, on vast secondary pasturelands (DAKHSHLEYGER 1980, MIRZABAEV et al. 2016). Hay meadow management was introduced in Middle Asia as late as in the 19th century, as a technique introduced by European settlers (DAKHSHLEYGER 1980) and is still very traditional, without the application of intensive fertilisation, seeding and multiple hay cuttings per year (WAGNER 2009). It is also unique in the region that with exception of small plots of typical hay meadows (mostly close to the homesteads), all other grasslands are more or less frequently grazed, at least once in summer, but often several times during the year. In effect, this unusual combination of a wide range of environmental conditions and management practices, contributed to the development of distinct grassland types with highly differentiated and diverse species sets.

The most distinct vegetation in our data set are the typical steppes growing in treeless areas, particularly *Brayo-Stipetum glareosae* that occupy the high-altitude semi-deserts of the Eastern Pamir and Alai Valley. In addition, the subalpine *Stipetum bungeanae* found in leeward dry areas of eastern Kyrgyzstan and the alpine *Astragalo lithophili-Stipetum zalesskii* are clearly distinct. The majority of these steppes occur at higher latitudes (Supplement E6). This is reflected by a larger contribution of Euro-Siberian (*Acroptilon repens*, *Myosotis stricta*, *Stipa capillata*, *Phleum phleoides*) and smaller Irano-Turanian species in comparison to pseudosteppes (Fig. 3a–c). There is only one exception, i.e. the *Brayo pamiricae-Stipetum glareosae*, where the share of Euro-Siberian species is negligible, while the Central Asian species are dominant (e.g. *Stipa glareosa*, *S. orientalis*, *Krasheninnikovia ceratoides*). In terms of species composition, this vegetation is closely related to steppes of Central Asia reported from Mongolia and Kazakhstan (e.g. HILBIG 1995, 2000; VON WEHRDEN et al. 2009, WERGER & VAN STAALDUINEN 2012).

Within the shrubland zone with the thermophilous scrubs and thickets (*Amygdalus bucharica*, *Calophaca grandiflora*, *Cercis griffithii*, *Ficus carica*, *Pistacia vera* and *Punica granatum*) as a potential natural vegetation type, there are suitable conditions for development of the secondary grasslands when the shrubs are cleared by man (similarly to the grasslands replacing the maquis and garrigue of the Mediterranean). Due to the expansion of pasturelands in the past, these steppe-like grasslands outside the steppe zone cover almost all the vast foothills of the Hissar, Darvas, Babatag, Aktau and Karatau ranges. In Middle Asia they thrive under extensive grazing on deep loessic soils on calcareous substrates within the warm, subhumid Irano-Turanian climate. Despite the long dry period, as in the Mediterranean, they keep the dense vegetation cover all year round. Only sporadically, when the grazing is too intensive, these grasslands disappear and, in consequence, this bareland can contribute to the dust storms. Despite the physiognomic and management similarities to the Mediterranean, the patches of pseudosteppe in Middle Asia are strongly governed by regional species pools. Besides a number of endemic species that they harbor (e.g. *Elaeosticta samarcandica*, *Astragalus bucharicus*, *A. harpilobus*, *A. ovczinnikovii*, *Eremurus bucharicus*, *Gagea olgae*, *G. emarginata* and *Limonium komarovii*), they are often dominated by typical Irano-Turanian taxa absent from the Mediterranean (e.g. *Delphinium biternatum*, *Eremurus tianschanicus*, *E. suvorovii*, *Elaeosticta ferganensis*, *E. fuscus*, *Gagea vegeta*, *G. pseudophila*, *Carex pachystylis*, *Phlomis bucharica* and *Vulpia persica*). Also, spring geophytes like tulips (e.g. *Tulipa tubergeniana* and *T. dasystemon*) feature in this vegetation type in Middle Asia. However, despite the significant geographical distance between these two regions (western Mediterranean and eastern Irano-Turanian), both areas share a number of taxa of considerable contribution in the communities, such as *Aegilops triuncialis*, *Botriochloa ischaemum*, *Bromus squarrosus*, *Linum corymbulosum*, *Medicago lupulina* and *Cynodon dactylon*. A common feature also is the presence of representatives of the *Eremurus* and *Phlomoides* genera.

The share of geophytes is much smaller in ephemeral pseudosteppes on the steep slopes of the southern ranges of Pamir-Alai. Due to soil erosion the vegetation cover is distinctively lower and annuals have a greater contribution. As in the Mediterranean, these pseudosteppes have a more pioneer character and due to grazing, soil erosion, and more arid conditions they almost completely disappear in late summer until the winter rains green it again. Our plots – dominated by *Cryptospora falcata* and *Vulpia persica* as far as the habitat requirements, structure and management are considered – are mostly similar to Iberian *Stipo-Trachynietea distachyae* communities. They are also ephemeroid with great contribution of therophytes (Fig. 4). A large ratio of annual to perennial species is the basis for grouping the association *Cryptosporo falcatae-Brachypodietum distachyi* within the class *Stipo-Trachynietea distachyae*. Whether our plots can be included in some Crimean or central Mediterranean groups (e.g. *Diantho humilis-Velezion rigidae* Korzhenevskii et Klyukin ex Didukh et Mucina 2014, *Vulpio ciliatae-Crepidion neglectae* Poldini 1989, *Hypochoeridion achyrophori* Biondi et Guerra 2008) is for now an unresolved issue that needs further studies in the eastern Mediterranean and western Irano-Turanian regions. We include it temporarily in the first alliance as the habitat conditions and climatic features are most similar (KORZHENEVSKII 1990). We presume that phytogeographic criteria may play a major role in the syntaxonomic classification and relation between the alliances.

The meadow plots in our study also have distinct species composition. The shared species include e.g. *Cerastium tianschanicum*, *Helictotrichon pubescens*, *Potentilla stanjukoviczii*, *Aster serpentimontanus* and *Carum carvi*. However, this group reveals rather a heterogenic structure with some features of tall-herbs (comm. *Euphorbia lamprocarpa*), fens (comm. *Carum carvi-Hordeum turkestanicum*) and typical alpine meadows (*Ligularia alpigena-Euphorbia alatavica*). The definite classification and characterisation of these communities needs further research in the alpine belt of the Central Tian Shan and Altay Mts. and establishing the relations with fen, forb (forbs of the steppe and semidesert zones of Eastern Europe - *Althaeetalia officinalis*), alpine swards and hay meadows (*Poo alpinae-Trisetetalia*), *Kobresia* mats (*Kobresietalia capilliformis*) and boreo-temperate grasslands of *Molinio-Arrhenatheretea* meadows, mainly the steppic meadows of *Galietalia veri* or mesic meadows of continental forest-steppe zone *Carici macrourae-Crepidetalia sibiricae*.

Due to considerable environmental gradients (DJAMALI et al. 2012), our study area is internally heterogenous with clear vegetation patterns along altitude, precipitation and temperature gradients. As we found, pseudosteppes develop at higher temperatures (mean, min and max) and precipitation levels, and at lower elevation compared to steppes and meadows (Fig. 1). The associations of the *Eremuretum bucharici* and *Cryptosporo falcatae-Brachypodietum distachyi* occur at the lowest altitude and in the highest temperature compared to the other pseudosteppe types. The majority of the sampled plots were located in the southwestern part of the research area (Supplement E4). On the other hand, the *Eremuro tianschanici-Delphinietum biternati*, *Achnathero caraganae-Delphinietum semibarbati* and *Medicago sativa-Poa trivialis* are associated with lower precipitation than others. The meadows described in this paper occur in places with lower mean annual precipitation and temperature than those described by WAGNER (2009) from the Kazakh part of western Tian Shan. The influence of climatic conditions is reflected in the participation of phytogeographical elements. The meadow communities described from Kyrgyzstan and Tajikistan are characterised by a significantly lower proportion of Euro-Siberian and Central-Asian– Irano-Turanian species and a higher cover of typical species of the Irano-Turanian range compared to those described in Kazakhstan (WAGNER 2009).

The described grassland communities differ in species richness: pseudosteppes occurring in southern regions on low altitudes with high temperature and relatively high precipitation, are characterised by the highest species richness among all three types of grasslands (Supplement E6). On the other hand, steppes occurring on higher elevations with low mean temperature and precipitation are the most species poor (Supplement E6). DENGLER et al. (ined. 2018b) also found that average richness of Mediterranean pseudosteppes is relatively high compared to other grasslands types (more than 30 species of vascular plants in 10 m^2), that show structural similarities between both pseudosteppe areas. One of the most important drivers that can explain the observed pattern of species richness is temperature, which on a regional scale can be unimodally related with alpha-diversity of grasslands (KUZEMKO et al. 2016). We can assume that our study covered a part of the temperature gradient, thus we observed a positive relationship between the temperature and species richness. In addition, precipitation is usually a predictor of species richness with positive or unimodal relationship (POLYAKOVA et al. 2016), which can also be found in our dataset.

Substantial areas of rangelands in Central Asia have been already degraded, and both climate warming and intensification of land use are serious threats for the biodiversity of grasslands in this region (MIRZABAEV et al. 2016). In Tajikistan, overgrazing, water shortage and soil erosion, have degraded ca. 40% of natural grasslands (BRAGINA et al. 2018). Only highly mobile (rotational) extensive grazing can prevent local overgrazing and degradation of the vegetation cover (MIRZABAEV et al. 2016), but its maintenance can be difficult taking into account increasing grazing intensity in the recent years (BRAGINA et al. 2018).

5.2 Syntaxonomical synopsis

A. High altitude arid steppe pastures

Class: *Ajanio-Cleistogenetea songoricae* (Mirkin in Kashapov et al. 1987) Mirkin et al. 1988
Order: *Ajanio-Cleistogenetalia songoricae* (Mirkin in Kashapov et al. 1987) Mirkin et al. 1988
Alliance: *Piptathero gracilis-Artemision brevifoliae* Eberhardt 2004
1. *Brayo pamiricae-Stipetum glareosae* S. Świerszcz et al. (cluster 1)

B. Mesic mown and grazed meadows and pastures on fertile soils

Class: *Molinio-Arrhenatheretea* Tx. 1937
Order: *Poo alpinae-Trisetetalia* Ellmauer et Mucina 1993
Alliance: *Poion alpinae* Gams ex Oberd. 1950
2. *Ligularia alpigena-Euphorbia alatavica* community (cluster 2)
3. *Euphorbia lamprocarpa* community (cluster 3)
4. *Carum carvi-Hordeum turkestanicum* community (cluster 4)

C. Thermo-mesomediterranean secondary perennial pseudosteppes on deep calcareous soils of colline and montane belts in mediterranean-like climates (including Irano-Turanian) with long dry summer period

Class: *Lygeo sparti-Stipetea tenacissimae* Rivas-Mart. 1978 nom. conserv. propos.
Order: *Cymbopogono-Brachypodietalia ramosi* Horvatič 1963
Alliance: *Vulpio persicae-Caricion pachystylidis* S. Świerszcz et al.
5. *Eremuretum bucharici* S. Świerszcz et al. (cluster 5)
6. *Hordeo bulbosi-Astragaletum retamocarpi* S. Świerszcz et al. (cluster 6)
7. *Potentillo orientalis-Eremuretum fusci* S. Świerszcz et al. (cluster 7)
8. *Achnathero caraganae-Delphinietum semibarbati* S. Świerszcz et al. (cluster 8)

9. *Eremuro tianschanici-Delphinietum biternati* S. Świerszcz et al. (cluster 9)
10. *Medicago sativa-Poa trivialis* community (cluster 10)

D. Circum-Mediterranean calciphilous annual and ephemeroid swards and grasslands

Class: *Stipo-Trachynietea distachyae* S. Brullo in S. Brullo et al. 2001
Order: *Ptilostemono stellati-Vulpietalia ciliatae* Mucina ined.
Alliance: *Diantho humilis-Velezion rigidae* Korzhenevskii et Kliukin ex Didukh et Mucina 2014
11. *Cryptosporo falcatae-Brachypodietum distachyi* (cluster 11)

E. Mountain steppes of semi-arid areas

Class: *Cleistogenetea squarrosae* Mirkin et al. ex Korotkov et al. 1991
Order: *Stipetalia krylovii* Kononov et al. 1985
Alliance: unknown
12. *Astragalo lithophili-Stipetum zalesskii* A. Nowak et al. 2018 (cluster 12)
13. *Stipetum bungeanae* A. Nowak et al. 2018 (cluster 13)

6. Conclusions

Our study has expanded the knowledge on grasslands in the Pamir-Alai and western Tian Shan Mts. and contributed to the consistent hierarchical classification of the vegetation in this region (NOWAK et al. 2016). Typical steppes, pseudosteppes and pasture grasslands reveal considerable diversity, and have a transitional position between the Western Asian subregion and Central Asian subregion within the Irano-Turanianregion. The pattern of grassland vegetation is further complicated due to the extraordinary relief of this mountainous region which hosts one of the longest elevational gradients in the world. In many cases, particularly the deep depressions surrounded by ranges of 4000–5500 m a.s.l., the puzzle of environmental conditions that influence species composition is almost unresolvable (e.g. in the Fergana Valley, Kulab Hills or Shartuz depression). On the other hand, the homogenization of species composition at highest altitudes, mainly above 4000 m, renders a clear separation of grasslands, screes, alpine meadows, semi-deserts or even mires and rocky vegetation hardly possible. To obtain a consistent classification of grasslands of Middle Asia and fill the above mentioned gaps, further research is required, especially on alpine pasture and meadow communities, both in Middle Asia and adjacent areas such as Central Asia and the western Irano-Turanian region. The potential inclusion of other environmental factors and management regime into studies would also be very valuable for a more detailed delimitation and description of grassland vegetation units. However, despite these shortages in knowledge and data availability, our work represents a large step towards establishing of a comprehensive hierarchical syntaxonomic system for the graminoid vegetation of Middle Asia.

Erweiterte deutsche Zusammenfassung

Einleitung – Mittelasien ist eine Region im Inneren des asiatischen Kontinents. Laut der zehnbändigen Studie zur Flora des ehemaligen sowjetischen Teils Mittelasiens (KHASSANOV 2015) sind aus dieser Region mehr als 9000 Gefäßpflanzenarten mit einer hohen Anzahl von Endemiten bekannt.

Aufgrund dieses außergewöhnlichen floristischen Reichtums wurden die Berge Mittelasiens als einer der 35 Hotspots der biologischen Vielfalt anerkannt (MITTERMEIER et al. 2006). In Mittelasien sind ungefähr 2 Millionen km² von Grasland bedeckt (WESCHE et al. 2016). Kürzlich wurden mehrere Studien zur Steppenvegetation im Pamir-Alai und im westlichen Tian-Shan durchgeführt. Drei Hauptgruppen der Steppenvegetation wurden unterschieden: hochgelegene trockene Steppen, trockene, thermophile Steppen des montanen und subalpinen Gürtels und Bergsteppen semi-arider Gebiete (NOWAK et al. 2016, 2018). Die Klassifikation aller Wiesen und Weiden ist noch nicht endgültig bearbeitet. Insbesondere die Grasländer in den südlichen Randgebieten und ihre Beziehung zu den Steppengemeinschaften der nördlichen Ebenen sowie zu den sekundären mediterranen Grasländern einschließlich der Pseudosteppen müssen noch geklärt werden. In diesem Artikel wird versucht, die Pseudosteppen-Vegetation im Pamir-Alai- und westlichen Tian-Shan-Gebirge zu klassifizieren und mit Steppen- und alpinen Rasengesellschaften in Beziehung zu setzen.

Untersuchungsgebiet – Das Untersuchungsgebiet befindet sich im zentralen Teil Mittelasiens (Süd- und Ostkirgisistan und Tadschikistan) und umfasst eine Fläche von ca. 200.000 km^2 (Abb. 1). Da eines der Ziele der Studie darin bestand, die Grasland-Phytocoenosen der nördlichen Teile der Region unter stark gemäßigten Klimaeinflüssen mit den südlichen Ausläufern des westlichen Pamir-Alai-Gebirges unter iranisch-turanischem Klima zu vergleichen, umfasst das Untersuchungsgebiet die südwestlichen Bereiche des Tian-Shan-Gebirges (Kirgisistan) und des westlicen Pamir-Alai-Gebirges (Tadschikistan).

Methoden – In den Jahren 2013–2018 wurden insgesamt 198 Vegetationsaufnahmen durchgeführt. Die Größe jedes Plots betrug 10 m^2, was dem Ansatz des GrassPlot-Vegetationskonsortiums folgt und bei der Klassifizierung von Grasland nützlich sein kann (DENGLER et al. 2018a). Alle Gefäßpflanzen und Moose wurden unter Verwendung der 7-stufigen Skala von Braun-Blanquet (WESTHOFF & VAN DER MAAREL 1973) erfasst. Die Daten wurden in der Vegetation of Middle Asia-Datenbank (NOWAK et al. 2017) gespeichert und mit der Software R (R CORE TEAM 2019) und JUICE (TICHÝ 2002) analysiert. Um die Verteilung der Daten und die Beziehungen zwischen ihnen zu verstehen, führten wir eine unüberwachte k-Mittelwert-Analyse durch. Der Algorithmus zeigte 13 Gruppen als optimal für den analysierten Datensatz an (Anhang E5) und passt gut zu unserer Felderfahrung. Eine nichtmetrische mehrdimensionale Skalierung (NMDS) basierend auf der Euclidean-Distanzmatrix wurde durchgeführt, um die floristischen Beziehungen zwischen Pseudosteppen und Wiesen zu bewerten. Als nächstes wurden Umweltvariablen post-hoc an die Ordnungsachsen sowie Umweltvariablen als Kovariablen angepasst, um ihre Assoziationen mit jedem Vegetationstyp zu untersuchen (JARVIS et al. 2008). Für alle Gesellschaften wurden Median und die Standardabweichung der gemessenen Umwelt- und Vegetationsparameter (Höhe, Neigung, Artenreichtum pro Plot, Bodenvegetationsbedeckung, geografische Position, Temperatur, Niederschlag, Anteil von einjährigen und mehrjährigen Pflanzen und von pflanzengeografischen Elemente in jedem Plot) bestimmt. Die Nomenklatur der Gefäßpflanzen folgt allgemein CHEREPANOV (1995) und für *Bromus* spp. THE PLANT LIST (2019). Die Namen der Syntaxa entsprechen GADGHIEV et al. (2002), ERMAKOV (2012) und NOWAK et al. (2018).

Ergebnisse – Unsere Klassifikation ergab eine Abgrenzung von 13 hinsichtlich ihrer Artenzusammensetzung genau definierter Pflanzengesellschaften: Hochlagen- und Steppenweiden – *Brayo pamiricae-Stipetum glareosae*; mesische Wiesen und Weiden auf fruchtbaren Böden – *Ligularia alpigena-Euphorbia alativica*-Ges., *Euphorbia lamprocarpa*-Ges., *Carum carvi-Hordeum turkestanicum*-Ges.; thermo-mesomediterrane sekundäre mehrjährige Pseudosteppen – *Eremuretum bucharici*, *Hordeo bulbosi-Astragaletum retamocarpi*, *Potentillo orientalis-Eremuretum fusci*, *Achnathero caraganae-Delphinietum semibarbati*, *Eremuro tianschanici-Delphinietum biternati*, *Medicago sativa-Poa trivialis*-Ges. und circum-mediterrane kalkliebende einjährige und ephemere Rasen und Grasländer – *Cryptosporo falcatae-Brachypodietum distachyi*.

Diskussion – Sowohl die stark heterogene Umwelt in Bezug zu Geomorphologie, Bioklima, Boden, postglazialer Geschichte und Biogeographie als auch die lange Geschichte des Pastoralismus (bis zu 8000 Jahre) und der Graslandbewirtschaftung in der Region beeinflussen die Vegetationsausprägung insbesondere der Steppen und Wiesen in Mittelasien erheblich (MIRZABAEV et al. 2016). Die ungewöhnliche Kombination verschiedener Standortsbedingungen und Bewirtschaftungsweisen trug zur Entwicklung unterschiedlicher Graslandtypen mit großen, stark differenzierten Artengruppen bei.

Die eigenständigste Vegetation in unserem Datensatz sind die typischen Steppen baumloser Gebiete, insbesondere das *Brayo-Stipetum glareosae*, welche die hochgelegenen Halbwüsten des östlichen Pamir- und Alai-Tals besiedeln. Darüber hinaus sind das subalpine *Stipetum bungeanae*, das in Lee-Trockengebieten in Ostkirgisistan vorkommt, und das alpine *Astragalo lithophili-Stipetum zalesskii* sehr deutlich abgegrenzt. Die meisten dieser Steppen befinden sich in höheren Breiten. Dies spiegelt sich in einem größeren Anteil euro-sibirischer und einem kleineren Anteil irano-turanischer Arten im Vergleich zu den Pseudosteppen wider.

Der Anteil an Geophyten ist bei kurzlebigen Pseudosteppen an den steilen Hängen der südlichen Ketten des Pamir-Alai viel geringer. Wie im Mittelmeerraum haben diese Pseudosteppen Pioniercharakter und vertrocknen aufgrund von Beweidung, Bodenerosion und trockeneren Bedingungen im Spätsommer fast vollständig, bis der Winterregen sie wieder ergrünen lässt. Unsere Plots – dominiert von *Cryptospora falcata* und *Vulpia persica* – ähneln hinsichtlich Lebensraumanforderungen, Struktur und Management größtenteils den iberischen *Stipo-Trachynietea distachyae*-Gesellschaften; diese sind ebenfalls kurzlebig, mit einem großen Anteil an Therophyten. Ein großes Verhältnis von einjährigen zu mehrjährigen Arten ist die Grundlage für die Einordnung des *Cryptosporo falcatae-Brachypodietum distachyi* in die Klasse *Stipo-Trachynietea distachyae*. Ob unsere Aufnahmen in verschiedene Syntaxa auf der Krim oder im zentralen Mittelmeerraum eingeordnet werden können, ist derzeit noch ein ungelöstes Problem, das weitere Untersuchungen im östlichen Mittelmeerraum und im westlichen iranisch-turanischen Raum erfordert. Wir nehmen sie provisorisch in den ersten Verband (*Diantho humilis-Velezion rigidae*) auf, da hier die Lebensraumbedingungen und das Klima am ähnlichsten sind (KORZHENEVSKII, 1990). Vermutlich spielen pflanzengeografische Kriterien eine wichtige Rolle bei der syntaxonomischen Klassifikation und Beziehung zwischen den Verbänden.

Auch die Wiesen in unserer Studie zeigen eine eigenständige Artenzusammensetzung. Ihr gemeinsamer Satz von Arten umfasst z. B. *Cerastium tianschanicum*, *Helictotrichon pubescens*, *Potentilla stanjukoviczii*, *Aster serpentimontanus* und *Carum carvi*. Diese Artengruppe zeigt jedoch eher eine heterogene Struktur mit einigen Merkmalen von Hochstaudenfluren (*Euphorbia lamprocarpa*-Ges.), Mooren (*Carum carvi-Hordeum turkestanicum*-Ges.) und typischen alpinen Rasen (*Ligularia alpigena-Euphorbia alativica*-Ges.). Die endgültige Klassifikation und Charakterisierung dieser Gesellschaften erfordert weitere Untersuchungen im alpinen Gürtel des zentralen Tian-Shan- und Altai-Gebirges und den Vergleich mit Moorgesellschaften, Krautfluren der Steppen- und Halbwüstenzonen Osteuropas (*Althaeetalia officinalis*), alpinen Rasen und Heuwiesen (*Poo alpinae-Trisetetalia*), *Kobresia*-Matten (*Kobresietalia capilliformis*) und boreo-gemäßigten Wiesen der *Molinio-Arrhenatheretea*, hauptsächlich den Steppenwiesen der *Galietalia veri* oder den mesophilen Wiesen der kontinentalen Waldsteppenzone der *Carici macrourae-Crepidetalia sibiricae*.

Aufgrund erheblicher Umweltgradienten ist unser Untersuchungsgebiet intern heterogen, mit klaren Vegetationsmustern entlang von Höhen-, Niederschlags- und Temperaturgradienten. Pseudosteppen entwickeln sich bei höheren Temperaturen und Niederschlägen sowie in geringerer Höhe im Vergleich zu Steppen und Wiesen. Die in diesem Artikel beschriebenen Wiesen treten an Orten mit niedrigerem mittleren Jahresniederschlag und niedrigerer Temperatur auf als die von WAGNER (2009) beschriebenen aus dem kasachischen Teil des westlichen Tian-Shan.

Unsere Studie hat das Wissen über die Grasländer im Pamir-Alai- und westlichen Tian-Shan-Gebirge erweitert und zur gefestigten hierarchischen Vegetationsklassifikation in der Region beigetragen (NOWAK et al. 2016). Die syntaxonomische Stellung einiger der unterschiedenen Gesellschaften ist noch unklar, sodass weitere Untersuchungen zur Vegetation Mittelasiens erforderlich sind, insbesondere zu Pseudosteppen- und Wiesengesellschaften. Auch die mögliche Einbeziehung anderer Umweltfaktoren und des Bewirtschaftungsregimes in weitere Studien wäre für eine detailliertere Abgrenzung und Beschreibung der Grasland-Vegetationseinheiten sehr wertvoll.

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Author contributions

A.N., S.Ś. and M.N. planned the research. A.N., M.N., SŚ, G.S., Z.K., I.D and K.W. conducted the field sampling and identified the plant species, S.Ś and G.S. performed the statistical analyses, S.N. prepared the analytical tables, while all the authors participated in the writing of the manuscript and veryfication of plants in herbarium.

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Supplements

Supplement S1. Synoptic table of pseudosteppes and related grassland vegetation in the Pamir-Alai and western Tian-Shan Mts.

Beilage S1. Synoptische Tabelle der Pseudosteppen und der verwandten Graslandvegetation im Pamir-Alai und dem westlichen Tian-Shan Gebirge.

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. Steppes.

Anhang E1. Steppen.

Supplement E2. Thermo-mesomediterranean secondary perennial pseudosteppes on deep calcareous soils.

Anhang E2. Thermo-mesomediterrane sekundäre mehrjährige Pseudosteppen auf tiefgründigen kalkhaltigen Böden.

Supplement E3. Circum-Mediterranean calciphilous annual and ephemeroid swards and grasslands.

Anhang E3. Circum-mediterrane kalkliebende einjährige und ephemere Rasen und Grasländer.

Supplement E4. Distribution maps of detected 13 plant communities of pseudosteppes, steppes and meadows vegetation within study area.

Anhang E4. Verbreitungskarten von 13 nachgewiesenen Pflanzengesellschaften von Pseudosteppen, Steppen sowie Wiesen und Weiden im Untersuchungsgebiet.

Supplement E5. Plot showing gap statistic curve. The gap statistic identifies 13 clusters as optimal for the k-means algorithm.

Anhang E5. Diagramm mit der Lückenstatistikkurve. Die Lückenstatistik identifiziert 13 Cluster als optimal für den k-Mittelwert-Algorithmus.

Supplement E6. Boxplots showing median, quartiles, outliers and the range of environmental and vegetation parameters of clusters within vegetation groups: meadows, pseudosteppes and steppes. **Anhang E6.** Boxplots mit Median, Quartilen, Ausreißern und dem Bereich der Umwelt- und Vegetationsparameter von Clustern innerhalb von Vegetationsgruppen: Wiesen und Weiden, Pseudosteppen und Steppen.

Supplement E7. Photographs of the vegetation belonging to the grassland communities considered in this paper.

Anhang E7. Fotos der Vegetation der Graslandgesellschaften, die in diesem Artikel betrachtet werden.

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Supplement S1. Synoptic table of pseudosteppes and related grassland vegetation in the Pamir-Alai and western Tian-Shan Mts; 1 − *Brayo pamiricae-Stipetum glareosae*; 2 − *Ligularia alpigena-Euphorbia alatavica* community; 3 − *Euphorbia lamprocarpa* community; 4 − *Carum carvi-Hordeum turkestanicum* community; 5 − *Eremuretum bucharici*; 6 − *Hordeo bulbosi-Astragaletum retamocarpi*; 7 − *Potentillo orientalis-Eremuretum fusci*; 8 − *Achnathero caraganae-Delphinietum semibarbati*; 9 − *Eremuro tianschanici-Delphinietum biternati*; 10 – *Medicago sativa-Poa trivialis* community; 11 – *Cryptosporo falcatae-Brachypodietum distachyi*; 12 – *Astragalo lithophili-Stipetum zalesskii*; 13 − *Stipetum bungeanae*. The *phi* coefficient values (in superscript) in the table are multiplied by 100 and only shown when positive. Main values are species frequencies (in percentages). Diagnostic species were marked with bold fonts. The assignment for particular class and its abbreviations followed EuroVegChecklist (Mucina et al. 2016). CLE - *Cleistogenetea squarrosae*; ACS - *Ajanio-Cleistogenetea songoricae.*

Beilage S1. Synoptische Tabelle der Pseudosteppen und der verwandten Graslandvegetation im Pamir-Alai und im westlichen Tian-Shan-Gebirge; 1 − *Brayo pamiricae-Stipetum glareosae*; 2 − *Ligularia alpigena-Euphorbia alativica* -Gesellschaft; 3 − *Euphorbia lamprocarpa* -Gesellschaft; 4 − *Carum carvi-Hordeum turkestanicum* -Gesellschaft; 5 − Eremuretum bucharici; 6 – Hordeo bulbosi-Astragaletum retamocarpi; 7 − Potentillo orientalis-Eremuretum fusci; 8 − Achnathero caraganae-Delphinietum semibarbati; 9 − Eremuro tianschanici-Delphinietum biternati; 10 – *Medicago sativa-Poa trivialis* -Gesellschaft; 11 – Cryptosporo falcatae-Brachypodietum distachyi; 12 – Astragalo lithophili-Stipetum zalesskii; 13 − Stipetum bungeanae. Die Werte der *phi* Koeffizienten (hochgestellt) in der Tabelle sind mit 100 multipliziert und nur gezeigt, wenn sie positiv sind. Die Hauptwerte sind Stetigkeiten (in Prozent). Diagnostische Arten sind durch Fettdruck hervorgehoben. Die Zuordnung zur jeweiligen Klasse und ihre Abkürzungen folgen der EuroVegChecklist (Mucina et al. 2016). CLE - *Cleistogenetea squarrosae*; ACS - *Ajanio-Cleistogenetea songoricae*.

Group number		1	2	3	4	5	6	7	8	9	10	11	12	13
No. of relevés		10	15	14	11	18	30	11	29	17	9	15	11	8
Brayo pamiricae-Stipetum glareosae														
Stipa glareosa	ACS	100^{78}	.	.	.	.	.	.	.	.	.	.	.	.
Stipa orientalis	ACS	$90^{44,9}$	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia leucotricha	ACS	$50^{37,6}$	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus chomutowii	ACS	$60^{33,1}$	.	.	.	.	.	.	7	.	.	.	.	.
Krascheninnikovia ceratoides	?	90^{33}	.	.	.	.	.	.	14	18	.	.	.	25
Acantholimon diapensioides	ACS	60^{33}	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis trichosphaera	ACS	$40^{29,8}$	.	.	.	.	.	.	.	.	.	.	.	.
Elymus dasystachys	ACS	$40^{29,8}$	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus orthanthoides	ACS	$30^{25,8}$	.	.	.	.	.	.	.	.	.	.	.	.
Ajania tibetica	ACS	$30^{25,8}$	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis chiliophylla	ACS	20^{21}	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum mezianum	?	20^{21}	.	.	.	.	.	.	.	.	.	.	.	.
Gypsophila capituliflora	ACS	20^{21}	.	.	.	.	.	.	.	.	.	.	.	.
Braya pamirica	ACS	$30^{20,5}$	.	.	.	.	.	.	.	.	.	.	.	.
Ligularia alpigena-Euphorbia alativica **community**														
Euphorbia alatavica	MOL	.	$60^{39,6}$	14	.	.	.	.	.	.	.	.	.	.
Cerastium tianschanicum	MOL	.	$53^{39,2}$	$50^{19,3}$	9	.	.	.	.	.	.	.	.	.
Ligularia alpigena	MOL	.	$53^{38,3}$	.	.	.	.	.	.	.	.	.	9	.
Astragalus lepsensis	MOL	.	$47^{37,2}$	.	.	.	.	.	.	.	.	.	.	.
Galium tianschanicum	MOL	.	$53^{37,1}$	7	.	.	.	.	.	.	.	.	.	.
Cobresia pamiroalaica	KOB	.	$53^{36,4}$	7	.	.	.	.	.	.	.	.	.	.
Helictotrichon pubescens	MOL	.	$47^{34,9}$	$29^{8,1}$	.	.	.	.	.	.	.	.	.	.
Potentilla stanjukoviczii	KOB	.	$47^{34,8}$	$36^{13,1}$	.	.	.	.	.	.	.	.	.	.
Gentiana turkestanorum	MOL	.	$60^{34,7}$	7	.	.	.	.	.	.	.	.	.	.
Roegneria schrenkiana	MOL	.	$13^{34,1}$	.	.	.	.	.	.	.	.	.	.	.
Leontopodium ochroleucum	KOB	.	$53^{32,7}$	.	18	.	.	.	.	.	.	.	$27^{7,1}$	.
Aster serpentimontanus	MOL	.	$67^{32,3}$	21	.	.	.	.	.	.	.	.	.	.
Cobresia capillifolia	KOB	.	$20^{32,2}$	7	.	.	.	.	.	.	.	.	.	.
Helictotrichon fedtschenkoi	MOL	.	$27^{30,5}$	.	.	.	.	.	.	.	.	.	.	.
Oxytropis pagobia	MOL	.	$33^{28,8}$	.	.	.	.	.	.	.	.	.	.	.
Melandrium apetalum	KOB	.	$40^{27,9}$	.	.	.	.	.	.	.	.	.	.	.
Artemisia aschurbajevii	KOB	.	$53^{27,8}$	14	.	.	.	.	.	.	.	.	.	.
Bupleurum rosulare	MOL	.	$27^{27,1}$	.	.	.	.	.	.	.	.	.	.	.
Pedicularis uliginosa	SCH	.	$27^{27,1}$	.	.	.	.	.	.	.	.	.	.	.
Ptilagrostis subsessiliflora	KOB	.	$13^{26,3}$	.	.	.	.	.	.	.	.	.	.	.
Stipa regeliana	KOB	.	$20^{25,3}$	.	.	.	.	.	.	.	.	.	.	.
Viola altaica	KOB	.	$33^{25,1}$	.	.	.	.	.	.	.	.	.	.	.
Gentiana kaufmanniana	MOL	.	$40^{24,8}$	.	.	.	.	.	.	.	.	.	.	.
Festuca rupicola	KOB	.	$27^{24,3}$	.	.	.	.	.	.	.	.	.	.	.
Minuartia verna	KOB	.	$27^{24,3}$	.	.	.	.	.	.	.	.	.	.	.
Roegneria czimganica	MOL	.	$40^{23,6}$	.	.	.	.	.	.	.	.	.	.	.
Oxytropis microsphaera	MOL	.	$13^{22,2}$	.	.	.	.	.	.	.	.	.	.	.
Potentilla nervosa	MOL	.	$13^{22,2}$	.	.	.	.	.	.	.	.	.	.	.
Myosotis alpina	MOL	.	$13^{22,2}$	.	.	.	.	.	.	.	.	.	.	.
Euphrasia rostkoviana	MOL	.	$27^{20,6}$	.	.	.	.	.	.	.	11	.	.	.
Papaver croceum	KOB	.	$27^{20,6}$	.	.	.	.	.	.	.	.	.	.	.
Festuca tianschanica	KOB	.	$27^{20,6}$	14	.	.	.	.	.	.	.	.	.	.
Euphorbia lamprocarpa **community**														
Euphorbia lamprocarpa	MOL	.	.	$29^{42,5}$	.	.	.	.	.	.	.	.	.	.
Alchemilla bungei	MOL	.	$20^{6,8}$	$29^{35,2}$	.	.	.	.	.	.	.	.	.	.
Geranium regelii	MOL	.	$73^{23,2}$	93^{44}	$64^{15,9}$	.	.	.	.	.	.	.	.	.
Ligularia thompsonii	MOL	.	13	$50^{34,6}$	.	.	.	.	.	.	.	.	.	.
Veronica porphyriana	?	.	.	$43^{33,6}$	.	.	.	.	.	.	.	.	18	.
Polygonum nitens	MOL	.	$33^{10,9}$	$57^{31,7}$	.	.	.	.	.	.	.	.	.	.
Thymus proximus	MOL	.	20^{4}	$36^{30,5}$	.	.	.	.	.	.	.	.	$27^{12,4}$	.
Achillea millefolium	MOL	.	.	$64^{30,2}$	18	.	.	.	.	24	.	.	36^{6}	.
Mentha asiatica	SCH	.	.	$29^{29,1}$	.	.	.	.	.	.	.	.	.	.
Trifolium repens	SCH	.	7	$64^{26,8}$	$36^{8,2}$	.	13	9	.	6	$67^{18,6}$	.	.	.
Valeriana dubia	MOL	.	7	$29^{25,3}$	.	.	.	.	.	.	.	.	.	.
Cynoglossum viridiflorum	MOL	.	.	21^{25}	.	.	.	.	.	.	.	.	.	.
Linum olgae	MOL	.	7	$14^{24,6}$	.	.	.	.	.	.	.	.	.	.
Galium turkestanicum	MOL	.	7	$50^{23,2}$	$36^{11,5}$	6	10	.	.	18	11	.	18	.
Ligularia narynensis	MOL	.	.	14^{23}	.	.	.	.	.	.	.	.	.	.
Nepeta cataria	MOL	.	.	$21^{22,8}$	.	.	.	.	.	12	.	.	.	.
Koeleria gracilis	CLE	.	.	$29^{22,7}$	.	.	.	.	.	.	.	.	.	.
Dracocephalum nutans	MOL	.	$27^{19,6}$	$21^{22,6}$	.	.	.	.	.	.	.	.	.	.
Phleum alpinum	MOL	.	$27^{12,3}$	$43^{22,5}$	.	.	.	.	.	.	.	.	.	.
Inula rhizocephala	MOL	.	7	$29^{21,9}$	.	.	.	.	.	.	.	.	.	.
Polygonum coriarium	MOL	.	.	$14^{21,6}$	.	.	.	.	.	.	.	.	.	.
Dactylis glomerata	MOL	.	.	$29^{21,3}$	.	.	$33^{17,3}$	.	.	12	22	.	.	.
Primula olgae	SCH	.	$27^{17,1}$	$36^{21,2}$	.	.	.	.	.	.	.	.	.	.
Ceratodon purpureus	?	.	$60^{8,3}$	$79^{20,7}$	.	$44^{6,4}$	20	36	10	35	22	.	.	.
Silene graminifolia	MOL	.	$33^{13,6}$	$50^{20,6}$	.	.	.	.	.	.	.	.	.	.
Carum carvi-Hordeum turkestanicum **community**														
Hordeum turkestanicum	SCH	.	$67^{22,4}$	29	$73^{47,7}$	.	.	.	.	.	.	.	.	.
Carum carvi	MOL	.	.	21	73^{55}	6	.	9	.	6	.	.	.	.
Alopecurus pratensis	MOL	.	.	.	$64^{40,2}$	.	.	.	.	.	.	.	.	.
Potentilla asiae-mediae	MOL	.	.	.	$45^{39,4}$	.	.	.	.	.	.	.	.	.
Onobrychis viciifolia	MOL	.	.	7	$45^{34,7}$	.	.	9	.	.	.	.	.	.
Lepidium latifolium	ART	.	.	.	$45^{33,6}$	.	.	.	.	.	.	.	.	.
Brachythecium rivulare	SCH	.	.	.	$55^{32,6}$	.	.	.	.	.	.	.	.	.
Tragopogon turkestanicus	MOL	.	.	.	45^{28}	.	.	.	.	.	.	.	.	.
Festuca pratensis	MOL	.	.	14	73^{27}	.	.	.	.	.	$44^{19,4}$	.	.	.
Thermopsis turkestanica	MOL	.	.	.	$18^{25,9}$	.	.	.	.	.	.	.	.	.
Agrostis alba	MOL	.	.	7	$55^{25,7}$	.	.	.	.	.	.	.	.	.
Rhinanthus songaricus	MOL	.	.	7	$36^{25,2}$	.	.	.	.	6	.	.	.	.
Poa angustifolia	MOL	.	$20^{9,9}$	.	$36^{24,1}$	.	.	.	.	.	.	.	.	.
Cirsium incanum	ART	.	.	.	$45^{21,8}$	.	.	9	.	.	11	.	.	.
Inula caspica	MOL	.	.	.	$27^{21,3}$	.	.	.	.	.	.	.	.	.
Erigeron petroiketes	?	.	20^{3}	.	$36^{20,5}$	.	.	.	.	.	.	.	36^{14}	.
Poa relaxa	ASP	.	.	.	18^{20}	.	.	.	.	.	.	.	.	.
Stipa krylovii	CLE	.	.	.	18^{20}	.	.	.	7	.	.	.	.	.
Eremuretum bucharici														
Eremurus bucharicus	LYG	.	.	.	.	$44^{37,7}$	13	.	.	.	.	.	.	.
Phlomoides baldschuanica	LYG	.	.	.	.	$28^{35,1}$	.	.	.	.	.	.	.	.
Koelpinia macrantha	LYG	.	.	.	.	$33^{34,7}$	.	.	.	.	.	7	.	.
Leptaleum filifolium	LYG	.	.	.	.	$33^{29,9}$	.	9	.	.	.	.	.	.
Solenanthus plantaginifolius	LYG	.	.	.	.	$22^{27,5}$	7	.	.	.	.	.	.	.
Russowia sogdiana	LYG	.	.	.	.	$22^{27,3}$	3	.	.	.	.	.	.	.
Pleurogynella flaviflora	LYG	.	.	.	.	$56^{26,3}$	10	.	.	.	.	7	.	.
Phlomis bucharica	LYG	.	.	.	.	$61^{26,1}$	10	.	$28^{6,6}$	.	.	$47^{17,7}$	.	.
Aegilops triuncialis	LYG	.	.	.	.	$39^{25,7}$	17	.	17	24	.	.	.	.
Hypecoum trilobum	LYG	.	.	.	.	$28^{25,4}$	.	.	.	.	.	.	.	.
Cymatocarpus popovii	LYG	.	.	.	.	$22^{23,8}$	.	.	.	.	.	.	.	.
Medicago orbicularis	LYG	.	.	.	.	50^{23}	20^{5}	9	.	.	22	33^{9}	.	.
Ranunculus pinnatisectus	LYG	.	.	.	.	$28^{22,9}$	.	.	.	.	.	.	.	.
Prosopis farcta	LYG	.	.	.	.	$33^{22,5}$	.	.	.	.	.	7	.	.
Cousinia sclerophylla	LYG	.	.	.	.	$50^{21,4}$	.	.	.	12	.	13	18	.
Eremurus comosus	?	.	.	.	.	$11^{21,3}$	3	.	3	.	.	.	.	.
Consolida leptocarpa	LYG	.	.	.	.	$22^{21,1}$	.	.	.	.	.	.	.	.
Galium transcaucasicum	LYG	.	.	.	.	$33^{20,8}$	.	.	3	6	.	.	9	.
Convolvulus subhirsutus	LYG	.	.	.	.	$11^{20,2}$	.	.	.	.	.	.	.	.
Haplophyllum griffithianum	LYG	.	.	.	.	$11^{15,7}$	.	.	.	.	.	.	.	.
Nonea macropoda	LYG	.	.	.	.	$22^{16,2}$	.	.	3	.	.	.	.	.
Allium bucharicum	LYG	.	.	.	.	$11^{12,4}$	.	.	.	.	.	.	.	.
Jurinea bucharica	LYG	.	.	.	.	$11^{9,3}$	7	.	.	.	.	.	.	.
Heterocaryum subsessile	LYG	.	.	.	.	$33^{19,4}$	.	.	.	.	.	7	.	.
Gagea graminifolia	LYG	.	.	.	.	$28^{19,7}$	.	.	.	.	.	.	.	.
Hordeo bulbosi-Astragaletum retamocarpi														
Hordeum bulbosum	LYG	.	.	.	.	22	$83^{57,3}$	9	.	24	.	20	.	.
Lathyrus aphaca	LYG	.	.	.	.	6	$67^{40,1}$	.	.	.	11	13	.	.
Scandix pecten-veneris	PAR	.	.	.	.	6	57^{27}	.	.	.	11	20	.	.
Ungernia tadshikorum	LYG	.	.	.	.	.	$13^{26,6}$	.	.	.	.	.	.	.
Thermopsis dolichocarpa	MOL	.	.	.	.	.	$20^{25,8}$	.	.	.	11	.	.	.
Medicago denticulata	LYG	.	.	.	.	.	$33^{21,3}$	.	.	.	.	13	.	.
Astragalus retamocarpus	LYG	.	.	.	.	.	$7^{20,4}$	.	.	.	.	.	.	.
Prangos bucharica	LYG	.	.	.	.	6	$17^{16,8}$	.	.	.	.	.	.	.
Valerianella ovczinnikovii	LYG	.	.	.	.	11	$30^{18,8}$	.	.	.	.	13	.	.
Prangos fedtschenkoana	LYG	.	.	.	.	.	$13^{19,1}$	.	.	.	.	.	.	.
Cruciata pedemontana	LYG	.	.	.	.	$28^{7,8}$	$43^{19,9}$	.	3	.	.	7	.	.
Potentillo orientalis-Eremuretum fusci														
Eremurus fuscus	LYG	.	.	.	.	.	.	$100^{90,2}$	.	.	.	.	9	.
Medicago lupulina	LYG	.	.	7	9	.	.	$73^{48,4}$	.	$29^{6,1}$	.	.	27	.
Vinca erecta	?	.	.	.	.	.	.	$27^{29,6}$	.	.	.	.	.	.
Cynodon dactylon	CLE	.	.	.	.	33	$60^{2,7}$	$64^{28,3}$	17	12	56	$87^{18,6}$	.	.
Filago arvensis	?	.	.	7	.	.	.	$64^{24,5}$	7	18	.	.	.	.
Strigosella hispida	LYG	.	.	.	.	6	.	$18^{24,3}$	.	.	.	13	.	.
Eremurus brachystemon	LYG	.	.	.	.	.	3	$36^{24,1}$	.	.	.	.	.	.
Eremurus stenophyllus	LYG	.	.	.	.	.	.	27^{23}	.	.	.	.	.	.
Potentilla orientalis	ART.	.	13	21	18	.	.	$36^{22,8}$	3	6	.	.	9	$50^{8,3}$
Artemisia rutifolia	ASP	.	7	.	.	.	.	$27^{22,6}$	.	.	.	.	.	.
Carex stenophylloides	LYG	.	7	.	.	6	20	$55^{22,2}$	3	6	22	7	.	12
Achnathero caraganae-Delphinietum semibarbati														
Carex pachystylis	LYG	.	.	.	.	$50^{7,1}$	20	36	$69^{45,8}$	.	.	.	27	.
Taeniatherum asperum	LYG	.	.	.	.	.	.	.	$24^{33,7}$	.	.	.	.	.
Delphinium semibarbatum	LYG	.	.	.	.	.	.	.	$31^{30,2}$	.	.	.	.	.
Taeniatherum crinitum	LYG	.	.	.	.	17	10	9	$38^{27,5}$	18	.	7	.	.
Kochia iranica	LYG	.	.	.	.	.	.	.	$34^{25,8}$	.	.	.	.	.
Achnatherum caragana	LYG	.	.	.	.	.	.	.	$17^{23,5}$	$24^{11,6}$	.	.	.	.
Artemisia kochiiformis	LYG	.	.	.	.	11	.	.	28^{22}	$24^{6,9}$	.	13	.	.
Eremuro tianschanici-Delphinietum biternati														
Bromus squarrosus	LYG	.	.	.	.	.	.	.	.	$82^{52,2}$	.	.	.	.
Delphninium biternatum	LYG	.	.	.	.	.	.	.	3	$41^{40,5}$	.	.	18	.
Eremurus tianschanicus	LYG	.	.	.	.	.	13	.	14	$41^{29,7}$	.	.	.	.
Elaeosticta ferganensis	LYG	.	.	.	.	.	.	.	7	$35^{29,1}$	.	.	.	.
Hymenolyma trichophyllum	LYG	.	.	.	.	.	.	.	.	$24^{28,7}$	.	.	.	.
Alcea nudiflora	?	.	.	.	.	.	.	.	.	$47^{28,3}$	.	.	.	.
Artemisia glanduligera	LYG	.	.	.	.	.	.	.	10	$24^{27,5}$	.	.	.	.
Salvia deserta	?	.	.	7	.	.	.	.	.	29^{26}	.	.	.	.
Hyalea pulchella	LYG	.	.	.	.	.	.	.	.	$12^{24,9}$	.	.	.	.
Aegilops tauschii	LYG	.	.	.	.	.	.	.	.	$24^{22,8}$	.	.	.	.
Elaeosticta samarcandica	LYG	.	.	.	.	.	.	.	.	$12^{22,6}$	.	.	.	.
Linum corymbulosum	LYG	.	.	.	.	6	10	9	14	$53^{22,3}$	.	20	27	.
Korovinia ferganensis	LYG	.	.	.	.	.	.	.	.	$18^{21,6}$	.	.	.	.
Bothriochloa ischaemum	CLE	.	.	.	.	11	33	.	$41^{5,7}$	$59^{21,4}$	11	40	9	12
Centaurea squarrosa	CLE	.	.	.	.	6	13	.	24	$53^{20,7}$	11	7	$36^{7,7}$	.
Brassica elongata	?	.	.	.	.	.	.	.	.	$24^{20,6}$	.	.	.	.

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Fortsetzung auf der Rückseite

Group number		1	2	3	4	5	6	7	8	9	10	11	12	13
No. of relevés		10	15	14	11	18	30	11	29	17	9	15	11	8
***Medicago sativa-Poa trivialis* community**														
Poa trivialis	MOL	.	7	.	18	6	37^{10}	9	7	.	$78^{43,1}$	.	.	25
Bromus sterilis	LYG	.	.	.	.	17	$40^{13,2}$	.	14	.	67^{40}	27	.	.
Populus alba	POP	.	.	.	.	.	.	.	.	.	$56^{34,7}$	.	.	.
Medicago sativa	ART	.	.	.	$45^{16,7}$	.	20	.	3	$47^{4,6}$	$67^{33,9}$	.	27	.
Carex diluta	MOL	.	.	.	.	.	.	.	.	.	$56^{32,4}$	.	.	.
Plantago lanceolata	MOL	.	.	29	18	.	$53^{8,6}$	36	3	35	$78^{30,5}$	.	27	.
Daucus carrota	ART	.	.	14	.	.	7	.	.	.	$56^{28,7}$	.	.	.
Sonchus arvensis	ART	.	.	.	.	.	7	.	.	.	$44^{27,8}$	.	.	.
Prunella vulgaris	MOL	.	.	.	.	.	.	.	.	.	$33^{27,2}$	.	.	.
Elaeagnus angustifolia	POP	.	.	.	.	.	.	.	.	.	22^{27}	.	.	.
Barbula unguiculata d	?	.	.	.	.	.	10	.	.	.	$33^{26,6}$	$20^{4,6}$	.	.
Stellaria media	PAR	.	.	.	.	.	$10^{1,1}$	.	.	.	$22^{25,2}$	.	.	.
Brachythecium mildeanum	?	.	.	.	.	.	.	.	3	.	$33^{24,4}$	.	.	.
Equisetum arvense	MOL	.	.	.	.	.	.	.	.	.	11^{24}	.	.	.
Ranunculus laetus	MOL	.	.	$29^{16,8}$	9	.	7	9	.	.	$33^{23,4}$	.	.	.
Taraxacum agg.	MOL	.	$53^{1,8}$	7	$82^{15,8}$	.	13	$64^{13,5}$	17	.	$67^{22,3}$	.	27	.
Aegilops cylindriaca	MOL	.	.	.	.	11	.	.	.	.	$33^{21,7}$	.	.	.
Cryptosporo falcatae-Brachypodietum distachyi														
Cryptospora falcata	TRA	.	.	.	.	$39^{10,1}$	3	.	3	.	.	$87^{53,5}$	.	.
Brachypodium distachyon	TRA	.	.	.	.	17	10	.	.	.	.	$67^{48,8}$	.	.
Eremurus suvorovii	LYG	.	.	.	.	.	10	.	7	.	.	$40^{34,5}$	.	.
Aristida adscensionis	TRA	.	.	.	.	.	.	.	.	.	.	$33^{32,9}$	.	.
Koelpinia linearis	TRA	.	.	.	.	6	.	27	21	18	.	$67^{32,5}$	.	.
Arnebia coerulea	TRA	.	.	.	.	11	.	.	7	.	.	$47^{28,9}$	.	.
Medicago rigidula	TRA	.	.	.	.	$33^{11,5}$	$27^{6,4}$	.	.	.	.	$67^{28,3}$	.	.
Garhadiolus papposus	TRA	.	.	.	.	.	3	.	10	.	.	$60^{28,2}$	.	.
Galium nupercreatum	TRA	.	.	.	.	.	.	.	3	.	.	$27^{26,1}$	.	.
Scilla puschkinioides	?	.	.	.	.	.	.	.	3	.	.	$53^{25,9}$	.	.
Euphorbia franchetii	TRA	.	.	.	.	$28^{7,2}$	17	.	10	.	.	$73^{22,7}$	.	.
Hypogomphia bucharica	TRA	.	.	.	.	11	.	.	.	.	.	$20^{21,5}$	.	.
Hypogomphia purpurea	TRA	.	.	.	.	.	.	.	.	.	.	20^{21}	.	.
Ferula gigantea	?	.	.	.	.	6	.	.	3	.	.	$20^{20,3}$	.	.
Consolida barbata	TRA	.	.	.	.	.	3	.	3	.	.	$33^{20,1}$	.	.
Aphanopleura capillifolia	TRA	.	.	.	.	$50^{11,9}$	.	36^{13}	17	.	.	$\mathbf{53^{21,4}}$	.	.
***Astragalo lithophili-Stipetum zalesskii* A. Nowak et al. 2018**														
Stipa zalesskii	CLE	.	.	.	.	.	.	.	.	.	.	.	$36^{52,1}$	.
Festuca valesiaca	CLE	.	7	$29^{1,8}$	18	.	.	.	10	.	.	.	$82^{44,9}$	.
Stipa kirghisorum	CLE	.	.	.	.	.	.	.	.	.	.	.	$18^{36,6}$	.
Elytrigia trichophora	CLE	.	.	7	.	.	.	.	.	$59^{16,3}$	.	.	$45^{32,7}$	$38^{7,5}$
Schistidium apocarpum d	?	.	.	.	.	.	.	.	.	.	.	.	$45^{30,6}$	.
Scabiosa songorica	CLE	.	.	.	.	.	.	.	.	$18^{10,8}$	.	.	$27^{28,6}$	.
Astragalus lithophilus	CLE	.	.	.	.	.	.	.	.	.	.	.	$36^{28,4}$	.
Scorzonera parviflora	CLE	.	.	.	.	.	.	.	.	.	.	.	$27^{24,6}$	.
Lichenes indet.	-	.	.	.	.	.	.	.	10	.	.	.	$36^{24,5}$	.
Euphrasia regelii	?	.	13	.	.	.	.	.	.	.	.	.	$36^{23,6}$	.
Achillea biebersteinii	CLE	.	.	.	.	.	.	$45^{14,6}$	7	$35^{13,8}$	.	.	45^{22}	.
Erigeron pallidus	CLE	.	.	.	.	.	.	.	.	.	.	.	$27^{21,3}$	.
Crepis multicaulis	?	.	$20^{7,8}$	7	.	.	.	.	.	.	.	.	$36^{20,4}$	.
Artemisia santolinifolia	CLE	.	.	.	.	.	.	.	.	.	.	.	18^{20}	.
Helictotrichon desertorum	CLE	.	.	.	.	.	.	.	.	.	.	.	18^{20}	.
***Stipetum bungeanae* A. Nowak et al. 2018**														
Artemisia pectinata	CLE	.	.	.	.	.	.	.	.	.	.	.	.	$75^{71,6}$
Leymus angustus	CLE	.	.	.	.	.	.	.	.	.	.	.	.	62^{44}
Stipa bungeana	CLE	.	.	.	.	.	.	.	.	.	.	.	.	$75^{36,9}$
Elymus caninus	?	.	.	.	.	.	.	.	.	.	.	.	.	25^{36}
Potentilla canescens	CLE	.	.	.	.	.	.	.	.	.	.	.	.	$50^{31,7}$
Artemisia turanica	CLE	.	.	.	.	.	.	.	.	$29^{10,2}$	.	.	.	$75^{30,1}$
Agropyron repens	?	.	.	.	$45^{7,2}$	.	.	.	.	$35^{4,5}$	11	7	18	$75^{29,4}$
Lappula consanguinea	CLE	.	13	.	.	.	.	.	7	.	.	.	.	$62^{26,9}$
Astragalus tibetanus	?	.	.	7	.	.	.	.	.	6	.	.	9	$50^{24,3}$
Hedysarum jaxarticum	CLE	.	.	.	.	.	.	.	.	.	.	.	.	$25^{21,2}$
Torularia korolkovii	CLE	.	.	.	.	.	.	.	.	.	.	.	.	$25^{21,2}$
All. *Vulpio persici-Caricion pachystilis*														
Vulpia persica	LYG	.	.	.	.	$44^{23,3}$	60^{21}	$45^{2,9}$	.	.	11	$40^{12,4}$	.	.
Lolium persicum	LYG	.	.	.	.	11	$17^{9,3}$	.	.	.	$33^{21,3}$	$27^{7,8}$	.	.
Poa bulbosa	?	.	.	.	.	$100^{34,9}$	$93^{14,1}$	$91^{17,5}$	$66^{8,4}$	24	22	7	45	12
Gagea vegeta	LYG	.	.	.	.	11	27^{12}	.	$21^{8,5}$	.	.	.	.	.
Gagea pseudophila	LYG	.	.	.	.	$22^{12,1}$	$13^{7,7}$	.	3	.	.	.	.	.
Astragalus kabadianus	LYG	.	.	.	.	$11^{10,6}$	.	.	3	.	.	.	.	.
Korovinia tenuisecta	LYG	.	.	.	.	.	.	.	3	$18^{18,4}$	.	.	.	.
Haplophyllum dubium	LYG	.	.	.	.	$28^{15,9}$	.	.	$17^{7,9}$	.	.	.	.	.
Vicia ervilla	LYG	.	.	.	.	.	$13^{10,3}$	.	7	.	.	.	.	.
Ranunculus sewerzowii	LYG	.	.	.	.	$28^{16,6}$	.	.	$14^{8,6}$	.	.	.	.	.
Gagea ova	LYG	.	.	.	.	$39^{19,8}$	10	9	3	.	.	.	.	.
Galium ghilanicum	LYG	.	.	.	.	$39^{18,2}$	$27^{5,6}$	.	3	.	.	27	.	.
Goldbachia pendula	LYG	.	.	.	.	.	.	.	.	$12^{16,1}$	.	.	.	.
Ranunculus tenuilobus	LYG	.	.	.	.	17	$40^{17,6}$	.	3	.	.	13	.	.
Elytrigia intermedia	TRA	.	.	.	.	.	3	.	$21^{16,4}$	12	.	.	.	.
Others														
Artemisia tenuisecta	CLE	.	.	.	.	.	.	.	3	.	.	.	$27^{32,5}$	$75^{20,4}$
Carex turkestanica	CLE	10	27	29	.	.	.	.	.	$47^{8,7}$	.	.	$91^{25,2}$	$75^{22,9}$
Arenaria serpyllifolia	TRA	.	.	7	.	$50^{4,2}$	17	82^{21}	10	12	.	27	$73^{20,9}$	.
Myosotis asiatica	MOL	.	$60^{40,6}$	$50^{22,5}$	.	.	.	.	.	.	.	.	.	.
Phlomis pratensis	MOL	.	$60^{31,4}$	$29^{22,4}$	9	.	.	.	.	.	.	.	.	.
Poa alpina	MOL	.	$47^{28,9}$	$43^{24,3}$	.	.	.	.	.	.	.	.	.	.
Astragalus alpinus	MOL	.	$67^{27,5}$	$43^{30,2}$	.	.	.	.	.	.	.	.	.	.
Gentiana karelinii	MOL	.	$60^{25,5}$	$29^{22,4}$	.	.	.	.	.	.	.	.	.	.
Medicago falcata	CLE	.	.	.	$64^{30,1}$	.	.	.	.	.	.	.	.	$62^{24,1}$
Trifolium pratense	MOL	.	.	$29^{2,5}$	$55^{27,5}$	.	.	9	.	6	$89^{41,6}$	.	.	.
Poa pratensis	MOL	.	7	71^{22}	$64^{20,7}$	.	7	9	.	.	$67^{19,5}$	.	.	.
Avena trichophylla	LYG	.	.	7	.	$78^{26,5}$	$50^{23,2}$	.	14	12	.	$67^{16,9}$	.	.
Papaver pavoninum	ASP	.	.	.	.	6	7	18	.	6	.	33^{19}	.	.
Lallemantia royleana	LYG	.	.	.	.	$33^{13,5}$	.	9	7	.	.	$47^{18,9}$	.	.
Psolarea drupacea	LYG	.	.	.	.	$33^{10,6}$	7	.	14	.	.	$40^{17,9}$	.	.
Lolium cuneatum	LYG	.	.	.	9	.	27^{14}	.	.	.	.	$27^{17,6}$	.	.
Trigonella verae	LYG	.	.	.	.	.	7	.	$14^{6,6}$	.	.	$27^{17,1}$	.	.
Heterocaryum szovitsianum	?	.	.	.	.	17	17	.	14	.	.	$40^{16,8}$	.	.
Bromus oxyodon	LYG	.	.	.	.	28^{6}	13	$27^{5,4}$	.	.	.	$27^{16,8}$	.	.
Carthamus lanatus	LYG	.	.	.	.	11	.	.	.	6	.	$27^{16,5}$	.	.
Trigonella arcuata	LYG	.	.	.	.	.	10	.	10	.	11	$33^{16,4}$	.	.
Galium spurium	?	.	.	7	.	22	$50^{9,6}$	36	7	6	33	60^{16}	.	.
Pimpinella peregrina	LYG	.	.	.	.	17	$40^{10,5}$	9	.	.	33	$60^{15,3}$	.	.
Astragalus filicaulis	LYG	.	.	.	.	$39^{15,5}$	13	.	7	.	.	$33^{13,7}$	.	.
Strigosella trichocarpa	CLE	.	.	.	.	17	.	.	14	.	.	$27^{13,6}$	.	.
Anagallis foemina	PAR	.	.	.	.	$44^{15,1}$	10	.	3	.	.	33^{13}	.	.
Onobrychis pulchella	CLE	.	.	.	.	28	30	.	$31^{5,6}$	24	.	40^{13}	18	.
Astragalus rytilobus	LYG	.	.	.	.	17	3	.	$17^{7,4}$	.	.	$27^{11,2}$	.	.
Roemeria refracta	PAR	.	.	.	.	$22^{17,3}$	.	.	.	.	.	$20^{11,1}$	.	.
Diarthron vesiculosum	CLE	.	.	.	.	$56^{13,1}$	13	18	$41^{9,6}$	6	11	$53^{10,7}$	18	.
Lens orientalis	LYG	.	.	.	.	17	$17^{8,4}$	.	.	.	.	$27^{10,4}$	.	.
Vicia angustifolia	MOL	.	.	.	27	28	$93^{17,3}$	9	7	.	$78^{19,6}$	$80^{9,4}$	.	.
Crepis pulchra	MOL	.	.	.	.	22	$23^{2,6}$	27	.	.	22	$33^{8,9}$	9	.
Veronica arvensis	PAR	.	.	.	.	22	$67^{6,6}$	$55^{15,1}$	10	.	11	$47^{6,6}$	.	.
Gagea gageoides	LYG	.	.	.	.	.	27^{14}	.	7	.	.	20	.	.
Pohlia nutans d	?	.	7	.	9	$28^{4,9}$	30^{12}	.	7	18	11	7	.	.
Origanum tytthanthum	CLE	.	.	7	.	.	$23^{7,4}$	$27^{16,6}$	.	$24^{7,1}$	.	7	.	.
Geranium pusillum	PAR	.	.	.	.	11	$17^{4,3}$	$27^{13,6}$	3	6	11	7	.	.
Rochelia cardiosepala	CLE	.	.	.	.	6	$23^{1,1}$	$55^{19,1}$	7	18	11	7	.	.
Erophila verna	CLE	.	.	.	.	11	$37^{14,6}$	.	3	.	.	7	.	.
Crupina vulgaris	CLE	.	.	.	.	.	$23^{2,7}$	.	10	$35^{14,6}$	.	27	18	.
Convolvulus arvensis	PAR	.	.	14	9	.	$27^{2,1}$	27	.	$35^{5,3}$	33	.	.	38
Myosotis stricta	CLE	.	.	.	9	.	$17^{2,1}$	.	10	.	.	.	$27^{15,4}$	.
Stipa capillata	CLE	.	.	.	9	.	.	.	10	$24^{16,8}$	.	.	$36^{17,5}$	.
Bromus lanceolatus	CLE	.	.	7	.	56^{10}	30	$55^{12,7}$	7	$53^{13,4}$	.	40	.	.
Turgenia latifolia	PAR	.	.	7	.	.	.	9	.	35^{20}	.	.	.	.
Alyssum dasycarpum	CLE	.	.	.	.	$22^{13,7}$	.	.	7	$18^{7,5}$	.	.	.	.
Hypericum perforatum	MOL	.	.	14	.	.	$40^{9,9}$	9	.	47^{36}	.	27	9	.
Tragopogon capitatus	CLE	.	.	.	.	.	3	.	7	$24^{10,4}$	22	.	.	.
Erodium cicutarium	CLE	.	.	.	.	28^{11}	7	18	14	.	.	7	.	.
Drabopsis nuda	CLE	.	.	.	.	.	$30^{14,5}$	.	7	.	.	7	.	.
Bryum caespiticum d	?	.	7	.	.	22	$43^{10,7}$	.	48^{14}	$53^{7,1}$	11	20	27	50
Didymodon rigidulum d	?	.	.	.	.	11	27^{14}	.	$24^{7,6}$	.	11	20	.	.
Alyssum campestre	CLE	.	.	.	.	.	.	.	.	$24^{17,6}$	.	.	9	.
Bromus sewerzowii	CLE	.	.	.	.	.	.	.	.	$24^{19,4}$	.	7	.	.
Camelina sylvestris	CLE	.	.	7	.	.	.	.	.	$24^{15,5}$	.	.	.	.
Hordeum spontaneum	PAR	.	.	.	.	$28^{19,2}$	7	.	.	.	11	.	.	.
Veronica campylopoda	ASP	.	.	.	.	$22^{16,2}$	7	.	.	.	.	.	.	.
Astragalus campylotrichus	CLE	.	.	.	.	$22^{18,8}$	.	.	.	.	.	.	.	.
Serratula procumbens	ACS	20^{19}	.	.	.	.	.	.	.	.	.	.	.	.
Cerastium dentatum	CLE	.	.	.	.	11	$40^{14,7}$	27	.	.	.	.	.	.
Rumex conglomeratus	?	.	.	.	$27^{16,7}$	.	3	.	.	.	11	.	.	.
Bongardia chrysogonum	LYG	.	.	.	.	11	$30^{14,9}$	.	3	.	.	13	.	.
Elaeosticta hirtula	?	.	.	.	.	11	$20^{5,4}$	36^{11}	3	18	.	7	.	.
Bromus japonicus	PHR	.	.	7	$27^{16,7}$	.	.	9	.	.	.	.	.	.
Lactuca serriola	PAR	.	.	.	$27^{8,5}$	17	.	.	7	$24^{6,9}$	11	7	9	.
Elaeosticta allioides	CLE	.	.	.	.	6	17	27	14	24	.	7	27	.
Artemisia absinthium	PAR	.	.	7	$55^{15,8}$	.	.	.	.	12	.	.	.	$50^{19,7}$
Taraxacum nuratavicum	LYG	.	.	.	.	17	$53^{16,6}$	.	10	.	33	27	.	.
Erysimum diffusum	CLE	.	.	$29^{5,7}$	.	.	.	18	3	$35^{11,3}$	.	.	$36^{11,8}$	.
Heteropappus canescens	CLE	.	.	.	.	.	7	.	.	$29^{7,3}$	11	.	$64^{18,9}$	$50^{12,4}$
Artemisia persica	CLE	.	.	.	.	.	.	27^{14}	$21^{17,3}$	.	.	.	.	.
Ephedra glauca	?	.	.	.	.	.	.	.	.	.	.	.	.	$25^{18,7}$
Chondrilla aspera	CLE	.	.	.	.	.	.	.	.	.	.	.	.	$25^{18,7}$
Astragalus mucidus	CLE	.	.	.	.	.	.	9	.	$18^{7,8}$	.	.	$27^{16,1}$	.
Thlaspi perfoliatum	CLE	.	.	7	.	17	$50^{17,3}$	.	.	.	.	20	9	.
Gentianopsis vvedensky	SCH	.	$33^{18,3}$	14	9	.	.	.	.	.	.	.	.	.
Cousinia mulgediifolia	CLE	.	.	.	.	.	3	9	17^{9}	.	22	7	.	.
Alyssum desertorum	LYG	.	.	.	.	6	10	$45^{17,4}$	$17^{10,9}$	.	.	.	.	.
Medicago xvaria	?	.	.	.	$36^{19,8}$	.	.	.	.	.	.	.	.	$25^{9,3}$
Pulsatilla campanella	MOL	.	$20^{8,8}$	$21^{17,9}$	9	.	.	.	.	.	.	.	.	.
Potentilla transcaspia	CLE	.	.	$36^{11,1}$	.	.	.	.	.	$29^{10,8}$	.	.	$27^{7,3}$	25
Lathyrus cicera	LYG	.	.	.	.	17	$47^{17,7}$	.	3	.	.	27	.	.
Aulacospermum simplex	MOL	.	$33^{15,8}$	$21^{17,5}$	.	.	.	.	.	.	.	.	.	.
Artemisia dracunculus	MOL	.	13	$29^{8,6}$	27	.	.	27	.	12	.	.	27	.
Gentiana olivieri	CLE	.	.	.	.	22	$50^{17,6}$	18	17	18	.	7	.	.
Plantago griffithii	MOL	.	13	$29^{11,1}$	$27^{15,6}$	.	.	.	.	.	.	.	.	.
Draba lanceolata	MOL	.	$27^{11,6}$	$29^{14,8}$	.	.	.	.	.	.	.	.	.	.
Phragmites australis	PHR	.	.	7	9	.	$13^{3,6}$	.	.	.	$22^{10,8}$	.	.	.
Agrimonia asiatica	CLE	.	.	.	.	.	.	.	.	.	$33^{17,6}$	.	.	.
Malus sieversii	?	.	.	.	.	.	.	.	.	.	$22^{17,6}$	.	.	.
Vicia tenuifolia	MOL	.	.	14	18	.	7	.	.	6	33^{16}	.	.	.
Medicago minima	CLE	.	.	.	.	.	.	.	.	6	$22^{17,9}$	.	.	.
Prunus persica	?	.	.	.	.	6	3	.	.	.	$44^{19,7}$	.	.	.
Poterium lasiocarpum	MOL	.	.	7	.	.	$43^{18,4}$	9	.	.	$56^{17,8}$	.	.	.
Euphrasia pectinata	MOL	.	.	.	.	.	.	.	.	6	$22^{17,9}$	.	.	.
Vicia michauxii	PAR	.	.	.	.	6	$17^{9,8}$	.	.	.	$22^{10,8}$	.	.	.
Bromus tectorum	CLE	.	.	.	.	6	13	.	17	$53^{9,7}$	$44^{11,6}$	27	9	.
Leptorhabdos parviflora	CLE	.	.	.	.	6	$23^{4,7}$	9	.	18	$33^{15,1}$	7	.	.
Calamagrostis pseudophragmites	PHR	.	.	.	.	.	.	.	.	.	$22^{13,8}$	.	$18^{10,9}$	.
Pedicularis ludwigii	CLE	.	$40^{15,2}$	$21^{16,7}$	.	.	.	.	.	12	.	.	.	.
Festuca rubra	MOL	.	$40^{12,1}$	$57^{19,3}$	18	.	.	.	.	.	.	.	9	.
Lithospermum officinale	PAR	.	.	$21^{18,9}$	.	.	.	.	.	.	.	.	.	.
Thalictrum foetidum	MOL	.	7	$36^{15,1}$	$45^{18,5}$	.	.	.	.	.	.	.	.	.
Erigeron allochrous	MOL	.	.	21^{15}	.	.	.	.	.	6	.	.	.	.
Codonopsis clematidea	SCH	.	.	$21^{18,9}$	.	.	.	.	.	.	.	.	.	.
Agrostis canina	MOL	.	$20^{7,6}$	$36^{19,8}$	.	.	.	.	.	.	.	.	.	.
Androsace lactiflora	MOL	.	$27^{14,9}$	$21^{12,6}$	.	.	.	.	.	.	.	.	.	.
Galium pamiroalaicum	MOL	.	7	29	$36^{16,9}$	.	10	18	.	$29^{3,7}$	.	.	$36^{7,9}$	.
Convolvulus pseudocantabrica	CLE	.	.	.	.	6	.	.	$21^{11,4}$	12	.	13	9	.
Haplophyllum acutifolium	CLE	.	.	.	.	.	7	.	10	$35^{15,9}$	.	7	18	.
Bryum pallens d	?	.	13	.	18	11	13	.	31^{7}	.	11	7	27	38
Syntrichia ruralis d	?	.	13	7	27	22	10	$55^{8,5}$	$41^{7,6}$	53^{9}	44	20	.	12
Scutellaria przewalskii	CLE	.	7	.	.	.	.	.	.	6	.	.	.	$25^{14,6}$
Allium barsczewskii	CLE	.	.	.	.	11	20	9	$31^{7,9}$	18	.	27	9	.
Anagallis arvensis	PAR	.	.	.	.	.	.	$55^{18,4}$	.	$47^{16,8}$	.	.	.	.
Bunium persicum	CLE	.	.	.	.	11	$33^{19,6}$	9	14	6	.	7	18	.
Polygonum alpinum	MOL	.	$27^{19,6}$	7	.	.	.	.	.	.	.	.	.	.
Medicago meyeri	CLE	.	.	.	.	.	.	.	.	$24^{19,4}$	.	.	.	.
Peganum harmala	?	.	.	.	9	.	.	.	3	.	.	.	.	$25^{18,8}$
Allium verticillatum	CLE	.	.	.	.	.	.	.	10^{6}	.	.	.	$27^{15,6}$	.

Rare species not listed (see tables of associations and communities)

Supplement E1. Steppes. Explanations: M - Murghab; A - Alichur; B - Balykchy; KK - Kara-Koo; ST - Sary-Tash; S - Suusamyr; K - Khaidarkan; O - Osor; BS - *Brayo pamiricae-Stipetum glareosae*; Sb - *Stipetum bungeanae*; AS - *Astragalo lithophili-Stipetum zalesskii*

Anhang E1. Steppen. Erläuterungen: M - Murghab; A - Alichur; B - Balykchy; KK - Kara-Koo; ST - Sary-Tash; S - Suusamyr; K - Khaidarkan; O - Osor; BS - *Brayo pamiricae-Stipetum glareosae*; Sb - *Stipetum bungeanae*; AS - *Astragalo lithophili-Stipetum zalesskii*

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	FREQUENCY rel. 1−10	FREQUENCY rel. 11−18	FREQUENCY rel. 19−29
Plot number	186	191	190	187	183	188	189	185	184	192	167	164	162	163	166	165	175	176	181	182	197	198	196	195	135	137	138	139	136			
day	9	10	10	10	9	10	10	9	9	10	6	6	6	6	6	6	3	3	8	8	15	15	15	15	1	1	2	2	1			
Date: month	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7			
year	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2017	2017	2017	2017	2017	2017	2018	2018	2018	2018	2018	2018	2018	2018	2017	2017	2017	2017	2017			
Altitude (m)	4010	3854	3861	3870	4016	3870	3861	4010	4016	3854	1974	1945	1935	1936	1970	1952	1635	1635	3130	3130	2329	2329	2320	2320	2081	2100	1418	1425	2098			
Aspect	-	-	nw	se	se	se	nw	-	se	-	-	-	-	-	-	-	-	-	-	-	w	w	nw	nw	-	n	ne	n	s			
Slope (degrees)	-	-	5	3	3	3	4	-	3	-	-	-	-	-	-	-	-	-	-	-	10	10	16	15	-	10	35	10	15			
Cover of tree layer (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Cover of shrub layer (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	3	-	-	-	-	-	-	-	-	-	-			
Cover of herb layer (%)	33	32	32	36	35	32	37	32	31	30	70	70	75	70	75	60	11	10	71	72	91	91	80	95	90	80	85	85	80			
Cover of moss layer (%)	-	-	-	-	-	-	-	-	-	-	4	5	5	5	4	5	-	-	-	1	6	1	7	7	1	5	5	3	1			
Relevé area (m^2)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10			
Number of species	10	8	6	7	9	6	7	9	8	7	20	20	17	14	18	17	6	8	16	16	27	27	21	27	20	20	25	31	24			
Locality	M	A	A	M	M	M	A	M	M	A	B	B	B	B	B	B	KK	KK	ST	ST	S	S	S	S	K	K	K	O	O			
Association/Community	BS	BS	BS	BS	BS	BS	BS	BS	BS	BS	Sb	Sb	Sb	Sb	Sb	Sb	Sb	Sb	AS	AS	AS	AS	AS	AS	AS	AS	AS	AS	AS			
Ass. Brayo pamiricae-Stipetum glareosae																																
Stipa glareosa	2	2	3	3	2	2	3	2	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	100	-	-
Stipa orientalis	1	1	1	.	1	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	90	-	-
Artemisia leucotricha	.	1	.	1	1	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	50	-	-
All. Piptathero gracilis-Artemision brevifoliae																																
Astragalus chomutowii	1	1	.	1	.	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	60	-	-
Serratula procumbens	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	-	-
Ass. Stipetum bungeanae																																
Artemisia pectinata	.	.	.	.	.	.	.	.	.	.	2	3	4	4	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	-	75	-
Stipa bungeana	.	.	.	.	.	.	.	.	.	.	1	1	+	+	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	-	75	-
Artemisia turanica	.	.	.	.	.	.	.	.	.	.	+	+	1	1	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	-	75	-
Leymus angustus	.	.	.	.	.	.	.	.	.	.	+	2	+	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	-	62	-
Peganum harmala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	-	25	-
All. Ajanio-Cleistogenenion songoricae																																
Torularia korolkovii	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	25	-
Achnatherum splendens	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	13	-
O. Ajanio-Cleistogenetalia songoricae & Cl. Ajanio-Cleistogenetea songoricae																																
Krascheninnikovia ceratoides	+	1	1	1	1	1	.	1	+	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	90	25	-
Acantholimon diapensioides	1	.	.	.	+	.	+	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	60	-	-
Elymus dasystachys	1	.	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	40	-	-
Oxytropis trichosphaera	.	1	1	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	40	-	-
Potentilla canescens	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	-	50	-
Ajania tibetica	1	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30	-	-
Astragalus orthanthoides	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30	-	-
Elymus caninus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	-	25	-
Gypsophila capituliflora	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	-	-
Oxytropis chiliophylla	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	-	-
Polygonum mezianum	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	-	-
Braya pamirica	.	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30	-	-
Astragalo lithophili-Stipetum zalesskii																																
Festuca valesiaca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	1	1	1	1	3	2	.	.	2	-	-	82
Stipa zalesskii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	3	3	.	.	.	.	.	-	-	36
Astragalus lithophilus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	-	-	36
Euphrasia regelii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	-	-	36
Thymus proximus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	1	.	.	.	.	.	-	-	27
Artemisia dracunculus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	+	.	.	.	.	.	-	-	27
Astragalus mucidus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	+	.	-	-	27
Stipa kirghisorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	-	-	18
Sporadic: *Artemisia maracandica* 21(1); *Eremurus fuscus* 24; *Helichrysum maracandicum* 23.																																
O. Stipetalia krylovii & Cl. Cleistogenetea squarrosae																																
Elytrigia trichophora	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	3	2	+	2	3	-	38	45
Achillea biebersteinii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	2	1	1	-	-	45
Schistidium apocarpum d	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	1	1	1	.	.	.	.	.	-	-	45
Galium pamiroalaicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	-	-	36
Crepis multicaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	1	1	.	.	.	.	.	-	-	36
Scabiosa songorica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	3	2	.	-	-	27
Scorzonera parviflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	-	-	27
Leontopodium ochroleucum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	1	.	.	.	.	.	-	-	27
Erigeron pallidus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	.	.	.	.	.	.	-	-	27
Stipa kirghisorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	-	-	18
Artemisia pamirica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	-	-	18
Helictotrichon desertorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	-	-	18
Artemisia santolinifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	-	-	18
Linaria transiliensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	-	-	18
Koeleria cristata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	-	-	9
Others																														-	-	-
Carex turkestanica	.	.	.	.	1	.	.	.	.	.	1	1	2	1	2	+	.	.	1	1	1	1	.	1	+	2	1	1	2	10	75	91
Heteropappus canescens	.	.	.	.	.	.	.	.	.	.	1	.	+	.	+	+	.	.	.	.	.	1	1	1	.	+	+	+	+	-	50	64
Artemisia tenuisecta	.	.	.	.	.	.	.	.	.	.	.	1	1	+	+	1	.	+	.	.	.	.	.	.	3	3	.	.	3	-	75	27
Agropyron repens	.	.	.	.	.	.	.	.	.	.	2	1	+	1	2	1	.	.	.	.	.	.	.	.	.	2	.	.	2	-	75	18
Arenaria serpyllifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	+	1	1	1	.	2	-	-	73
Bryum caespiticum d	.	.	.	.	.	.	.	.	.	.	.	+	+	1	1	.	.	.	.	+	.	.	.	.	.	.	1	1	.	-	50	27
Poa bulbosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	2	2	1	1	1	-	13	45
Bryum pallens d	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	+	-	38	27
Medicago falcata	.	.	.	.	.	.	.	.	.	.	1	+	+	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	-	62	-
Astragalus tibetanus	.	.	.	.	.	.	.	.	.	.	1	+	.	.	1	+	.	.	.	1	.	.	.	.	.	.	.	.	.	-	50	9
Lappula consanguinea	.	.	.	.	.	.	.	.	.	.	+	+	1	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	-	62	-
Potentilla transcaspia	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	1	+	.	.	+	-	25	27
Potentilla orientalis	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	-	50	9
Stipa capillata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	1	.	.	.	.	.	-	-	36
Lichenes indet. d	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	-	-	36
Artemisia absinthium	.	.	.	.	.	.	.	.	.	.	1	.	.	+	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	-	50	-
Erigeron petroiketes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	+	.	.	.	.	.	-	-	36
Erysimum diffusum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	1	.	.	.	+	-	-	36
Achillea millefolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	1	+	.	.	.	.	.	-	-	36
Centaurea squarrosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	+	.	-	-	36
Plantago lanceolata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	2	-	-	27
Linum corymbulosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	2	2	.	-	-	27
Medicago sativa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	2	.	-	-	27
Carex pachystylis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	-	-	27
Taraxacum agg.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	+	.	.	.	.	.	.	-	-	27
Myosotis stricta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	1	.	.	.	.	.	-	-	27
Cousinia integrifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	+	-	-	27
Medicago lupulina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	1	-	-	27
Convolvulus arvensis	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	-	38	-
Acroptilon repens	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	-	13	18
Allium verticillatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	-	-	27
Elaeosticta allioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	-	-	27
Phleum phleoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	-	-	18
Delpninium biternatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	-	-	18
Ziziphora pamiroalaica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	-	-	18
Crupina vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	-	-	18
Haplophyllum acutifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	-	-	18
Androsace pavlovskyi	+	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	-	-
Hedysarum jaxarticum	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	25	-
Gentianella turkestanorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	-	-	18
Calamagrostis pseudophragmites	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	-	-	18
Diarthron vesiculosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	-	-	18
Bunium persicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	-	-	18
Serratula sogdiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	-	-	18
Onobrychis pulchella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	-	-	18
Medicago x *varia*	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	25	-
Poa trivialis	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	25	-
Chondrilla aspera	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	25	-
Ephedra glauca b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	-	25	-
Scutellaria przewalskii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	-	25	-
Bothriochloa ischaemum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	-	13	-
Dianthus tianschanicus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	-	-	18
Oxytropis lehmanni	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	-	-	18
Veronica porphyriana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	-	-	18
Meniocus linifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	-	-	18
Cousinia sclerophylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	-	-	18
Galium turkestanicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	-	-	18

Sporadic: *Allium barsczewskii* 28(1); *Allium filifolium* 21; *Allochrusa paniculata* 28; *Alyssum campestre* 26; *Artemisia vulgaris* 11; *Astragalus alopecias* 27; *Astragalus dignus* 4(3); *Astragalus sarytagius* 19; *Astragalus taldycensis* 19; *Braya rosea* 10; *Bromus tectorum* 25(1); *Bupleurum exaltatum* 20; *Calamagrostis epigejos* 15; *Caragana turfanensis* b 18; *Carduus nutans* 22; *Carex stenophylloides* 14; *Chardinia orientalis* 28(1); *Convolvulus pseudocantabrica* 28(1); *Crepis pulchra* 19; *Dipsacus fullonum* 27; *Draba nemoralis* 24; *Dracocephalum diversifolia* 13; *Echium vulgare* 13; *Eremopyrum distans* 18(1); *Eremostachys speciosa* 24; *Erigeron bellidiflorus* 19(1); *Eryngium macrocalyx* 28; *Euphorbia falcata* 27; *Festuca rubra* 23; *Galium transcaucasicum* 22; *Hedysarum baldshuanicum* 29; *Hieracium* sp. 21; *Hypericum perforatum* 28; *Inula macrophylla* 28(1); *Ixiolirion tataricum* 24; *Kochia scoparia* 14; *Lactuca serriola* 27; *Leontice ewersmannii* 28; *Ligularia alpigena* 21(1); *Lindelophia stylosa* 11(1); *Poa lipskyi* 19(1); *Poa pamirica* 20; *Potentilla tephroleuca* 20; *Pseudohandelia umbellifera* 29; *Psychrogeton cabulicus* 9; *Rochelia leiocarpa* 23; *Silene longicalycina* 21; *Syntrichia ruralis* d 16(1); *Taraxacum jaschikuliense* 9(1); *Thlaspi perfoliatum* 28; *Tulipa dasystemon* 20; *Verbascum songorica* 29.

Locality (Longitude, Latitude): 1 - (73.84174; 38.2696); 2 - (72.95125; 37.63777); 3 - (73.10159; 37.63777); 4 - (73.93885; 37.96175); 5 - (73.84266; 38.27139); 6 - (73.93894; 37.96165); 7 - (73.10164; 37.63777); 8 - (73.8416; 38.26966); 9 - (73.84249; 38.27136); 10 - (72.9512; 37.63777); 11 - (76.65222; 42.09333); 12 - (76.65138; 42.09583); 13 - (76.65527; 42.09555); 14 - (76.65694; 42.09694); 15 - (76.65111; 42.09388); 16 - (76.6525; 42.09583); 17 - (76.18618; 42.37296); 18 - (76.18613; 42.37299); 19 - (73.23291; 39.67622); 20 - (73.23276; 39.67628); 21 - (73.84274; 42.26855); 22 - (73.84277; 42.26843); 23 - (73.84138; 42.27047); 24 - (73.84122; 42.27045); 25 - (71.39361111; 39.96083); 26 - (71.39416; 39.96194); 27 - (72.73638; 40.36138); 28 - (72.73444; 40.35972); 29 - (71.39305; 39.96138).

Supplement E2. Thermo-mesomediterranean secondary perennial pseudosteppes on deep calcareous soils. Explanations: K - Kurgonteppa; D - Dangara; P - Panj; Gi - Gissar; V - Vose; Ok - Obi-kiik; Ba - Baldzhuvon; H - Horongon; Ch - Chorbogh; Du - Dushanbe; I - Istaravshan; Va - Varzob; PB - Pushiyon-Bolo; So - Sorihozor; Kh - Khovilling; N - Navobod; Dz - Dzhergatol; Su - Sudzhina; Z- Zeravshan; Bu -Buragen; Gu - Gusar; T - Toktogul; B - Bokonbayev; G - Gushgarf; A - Ayni; JA- Jalal-Abad; Sa - Say; Gl - Gulcha; SM - Sary Mogul; M - Margedar;. Eb - *Eremuretum bucharici*; HA - Ass. *Hordeo bulbosi-Astragaletum retamocarpi* ; PE - *Potentillo orientalis-Eremuretum fusci* ; AD - *Achnathero caraganae-Delphinietum semibarbati* ; ED - *Eremuro tianschanici-Delphinietum biternati* ; MP - Comm. *Medicago sativa-Poa trivialis*

Anhang E2. Thermo-mesomediterrane sekundäre mehrjährige Pseudosteppen auf tiefgründigen kalkhaltigen Böden. Erläuterungen: K - Kurgonteppa; D - Dangara; P - Panj; Gi - Gissar; V - Vose; Ok - Obi-kiik; Ba - Baldzhuvon; H - Horongon; Ch - Chorbogh; Du - Dushanbe; I - Istaravshan; Va - Varzob; PB - Pushiyon-Bolo; So - Sorihozor; Kh - Khovilling; N - Navobod; Dz - Dzhergatol; Su - Sudzhina; Z- Zeravshan; Bu -Buragen; Gu - Gusar; T - Toktogul; B - Bokonbayev; G - Gushgarf; A - Ayni; JA- Jalal-Abad; Sa - Say; Gl - Gulcha; SM - Sary Mogul; M - Margedar;. Eb - Eremuretum bucharici; HA - Ass. *Hordeo bulbosi-Astragaletum retamocarpi* ; PE - *Potentillo orientalis-Eremuretum fusci* ; AD - *Achnathero caraganae-Delphinietum semibarbati* ; ED - *Eremuro tianschanici-Delphinietum biternati* ; MP - *Medicago sativa-Poa trivialis*-Gesellschaft

Species	FREQUENCY rel. 1–18	FREQUENCY rel. 19–48	FREQUENCY rel. 49–59	FREQUENCY rel. 60–88	FREQUENCY rel. 89–105	FREQUENCY rel. 106–114
O. Cymbopogono-Brachypodion ramosi & Cl. Lygeo sparti-Stipetea tenacissimae						
Bromus lanceolatus	56	30	55	7	53	-
Avena trichophylla	78	50	-	14	12	-
Plantago lanceolata	-	53	36	3	35	78
Diarthron vesiculosum	56	13	18	41	6	11
Onobrychis pulchella	28	30	-	31	24	-
Taraxacum nuratavicum	17	53	-	10	-	33
Aegilops triuncialis	39	17	-	17	24	-
Taeniatherum crinitum	17	10	9	38	18	-
Allium barsczewskii	11	20	9	31	18	-
Rochelia cardiosepala	6	23	55	7	18	11
Poterium lasiocarpum	-	43	9	-	-	56
Scandix pecten-veneris	6	57	-	-	-	11
Linum corymbulosum	6	10	9	14	53	-
Bunium persicum	11	33	9	14	6	-
Lathyrus cicera	17	47	-	3	-	-
Elaeosticta allioides	6	17	27	14	24	-
Cerastium dentatum	11	40	27	-	-	-
Elaeosticta hirtula	11	20	36	3	18	-
Alyssum desertorum	6	10	45	17	-	-
Pleurogynella flaviflora	56	10	-	-	-	-
Astragalus filicaulis	39	13	-	7	-	-
Geranium pusillum	11	17	27	3	6	11
Bromus oxyodon	28	13	27	-	-	-
Bongardia chrysogonum	11	30	-	3	-	-
Psolarea drupacea	33	7	-	14	-	-
Heterocaryum szovitsianum	17	17	-	14	-	-
Anagallis foemina	44	10	-	3	-	-
Cousinia sclerophylla	50	-	-	-	12	-
Haplophyllum acutifolium	-	7	-	10	35	-
Drabopsis nuda d	-	30	-	7	-	-
Gagea gageoides	-	27	-	7	-	-
Convolvulus pseudocantabrica	6	-	-	21	12	-
Cousinia mulgediifolia	-	3	9	17	-	22
Alyssum dasycarpum	22	-	-	7	18	-
Astragalus rytilobus	17	3	-	17	-	-
Tragopogon capitatus	-	3	-	7	24	22
Lens orientalis	17	17	-	-	-	-
Thermopsis dolichocarpa	-	20	-	-	-	11
Daucus carota	-	7	-	-	-	56
Lathyrus inconspicua	6	10	-	10	-	-
Trigonella arcuata	-	10	-	10	-	11
Sonchus arvensis	-	7	-	-	-	44
Astragalus korovinianus	6	17	-	-	-	-
Veronica campylopoda	22	7	-	-	-	-
Salvia deserta	-	-	-	-	29	-
Phlomoides labiosa	-	10	-	7	-	-
Aegilops cylindriaca	11	-	-	-	-	33
Astragalus maverranagri	-	10	-	7	-	-
Jurinea baldschuanica	6	3	-	10	-	-
Astragalus babatagi	17	-	-	3	-	-
Iris lineata	6	7	-	3	-	-
Solenanthus turkestanica	-	10	-	3	-	-
Handelia trichophylla	-	-	-	14	-	-
Astragalus campylotrichus	22	-	-	-	-	-
Filago pyramidata	11	-	-	7	-	-
Trigonella geminiflora	-	-	18	7	-	-
Bromus sewerzowii	-	-	-	-	24	-
Veronica reuteriana	-	10	-	-	-	-
Artemisia ferganensis	-	-	-	7	6	-
Prunella vulgaris	-	-	-	-	-	33
Trigonella orthoceras	17	-	-	-	-	-
Anemone bucharica	6	7	-	-	-	-
Allium verticillatum	-	-	-	10	-	-
Plantago arachnoidea	-	-	-	7	6	-
Silene baldshuanica	17	-	-	-	-	-
Scorzonera songorica	-	3	-	7	-	-
Astragalus taschkendicus	6	3	-	-	-	-
Astragalus corydalinus	-	7	-	-	-	-
Elaeosticta conica	-	7	-	-	-	-
Didymodon rigidulum d	-	-	-	-	12	-
Valerianella vvedenskyi	6	-	-	3	-	-
Haplophyllum alberti-regelii	6	-	-	3	-	-
Trigonella grandiflora	11	-	-	-	-	-
Jurinea bipinnatifida	11	-	-	-	-	-
Trigonella noeana	-	3	-	3	-	-
Phlomoides cephalariifolia	-	-	-	-	12	-
Nigella bucharica	11	-	-	-	-	-
Semenovia bucharica	-	7	-	-	-	-
Others						
Cynodon dactylon	33	60	64	17	12	56
Vicia angustifolia	28	93	9	7	-	78
Bryum caespiticum d	22	43	-	48	53	11
Syntrichia ruralis d	22	10	55	41	53	44
Bothriochloa ischaemum	11	33	-	41	59	11
Veronica arvensis	22	67	55	10	-	11
Gentiana olivieri	22	50	18	17	18	-
Ceratodon purpureus d	44	20	36	10	35	22
Galium spurium	22	50	36	7	6	33
Arenaria serpyllifolia	50	17	82	10	12	-
Bromus tectorum	6	13	-	17	53	44
Taraxacum agg.	-	13	64	17	-	67
Centaurea squarrosa	-	13	-	24	53	11
Hypericum perforatum	-	40	9	-	47	-
Convolvulus arvensis	28	30	-	7	18	11
Pimpinella peregrina	-	27	27	-	35	33
Pohlia nutans d	17	40	9	-	-	33
Didymodon rigidulum d	11	27	-	24	-	11
Thlaspi perfoliatum	17	50	-	-	-	-
Carex stenophylloides	6	20	55	3	6	22
Bryum pallens d	11	13	-	31	-	11
Crupina vulgaris	-	23	-	10	35	-
Crepis pulchra	22	23	27	-	-	22
Leptorhabdos parviflora	6	23	9	-	18	33
Dactylis glomerata	-	33	-	-	12	22
Medicago rigidula	33	27	-	-	-	-
Origanum tytthanthum	-	23	27	-	24	-
Anagallis arvensis	-	-	55	-	47	-
Erophila verna	11	37	-	3	-	-
Achillea biebersteinii	-	-	45	7	35	-
Euphorbia franchetii	28	17	-	10	-	-
Koelpinia linearis	6	20	-	7	18	11
Ixiolirion tataricum	6	-	27	21	18	-
Erodium cicutarium	28	7	18	14	-	-
Trifolium repens	-	13	9	-	6	67
Astragalus oxyglottis	11	13	-	17	-	-
Aegilops squarrosa	11	7	-	17	-	11
Trifolium pratense	-	-	9	-	6	89
Elytrigia trichophora	-	-	-	-	59	-
Galium pamiroalaicum	-	10	18	-	29	-
Lactuca serriola	17	-	-	7	24	-
Artemisia persica	-	-	27	21	-	-
Cryptospora falcata	39	3	-	3	-	-
Poa pratensis	-	7	9	-	-	67
Lindelophia macrostyla	-	20	18	-	6	-
Lallemantia royleana	33	-	9	7	-	-
Erysimum diffusum	-	-	18	3	35	-
Galium aparine	-	17	-	10	-	11
Carex turkestanica	-	-	-	-	47	-
Hordeum spontaneum	28	7	-	-	-	11
Galium turkestanicum	6	10	-	-	18	11
Lolium cuneatum	-	27	-	-	-	-
Salvia sclarea	-	13	9	-	18	-
Heteropappus canescens	-	7	-	-	29	11
Alcea nudiflora	-	-	-	-	47	-
Vicia michauxii	6	17	-	-	-	22
Myosotis stricta	-	17	-	10	-	-
Stipa capillata	-	-	-	10	24	-
Artemisia glanduligera	-	-	-	10	24	-
Convolvulus lineatus	-	3	18	14	-	-
Agropyron repens	-	-	-	-	35	11
Turgenia latifolia	-	-	9	-	35	-
Veronica capillipes	-	17	-	7	-	-
Krascheninnikovia ceratoides	-	-	-	14	18	-
Strigosella trichocarpa	17	-	-	14	-	-
Stipa arabica	6	-	-	10	12	-
Tortula sp. d	6	7	-	7	-	11
Ranunculus laetus	-	7	9	-	-	33
Hordeum geniculatum	6	7	-	10	-	-
Barbula unguiculata d	-	10	-	-	-	33
Polygonum fimbrilliferum	-	10	-	7	-	11
Trachynia distachya	17	10	-	-	-	-
Prosopis farcta	33	-	-	-	-	-
Vicia tenuifolia	-	7	-	-	6	33
Ceratocephalus testiculatus	-	3	18	10	-	-
Cousinia pulchella	-	10	-	-	18	-
Trigonella verae	-	7	-	14	-	-
Alyssum calycinum	11	3	-	10	-	-
Phleum graecum	-	10	-	3	12	-
Callipeltis cucullaris	-	-	18	7	12	-
Trichodesma incanum	6	13	-	3	-	-
Phragmites australis	-	13	-	-	-	22
Prunus persica c	6	3	-	-	-	44
Papaver pavoninum	6	7	18	-	6	-
Eremurus suvorovii	-	10	-	7	-	-
Hordeum leporinum	6	7	-	3	-	11
Artemisia dracunculus	-	-	27	-	12	-
Alcea baldschuanica	6	13	-	-	-	-
Populus alba c	-	-	-	-	-	56
Stellaria media	-	10	-	-	-	22
Glycyrrhiza glabra	6	13	-	-	-	-
Potentilla transcaspia	-	-	-	-	29	-
Serratula chartacea	-	10	-	-	-	11
Artemisia turanica	-	-	-	-	29	-
Adonis aestivalis	11	10	-	-	-	-
Carex diluta	-	-	-	-	-	56
Veronica arguteserrata	-	13	9	-	-	-
Holosteum glutinosum	17	7	-	-	-	-
Ziziphora tenuior	6	3	18	3	-	-
Gagea dschungarica	6	10	-	3	-	-
Poa annua	-	17	-	-	-	-
Veronica polita	11	10	-	-	-	-
Eremurus comosus	11	3	-	3	-	-
Vexibia alopecuroides	-	10	-	3	-	-
Bromopsis tytthólepis	-	13	-	-	-	-
Achillea millefolium	-	-	-	-	24	-
Festuca pratensis	-	-	-	-	-	44
Roemeria refracta	22	-	-	-	-	-
Aegilops tauschii	-	-	-	-	24	-
Allium stipitatum	-	13	-	-	-	-
Sideritis montana	6	-	-	-	18	-
Bromus scoparius	6	3	-	7	-	-
Brachythecium mildeanum d	-	-	-	3	-	33
Alyssum campestre	-	-	-	-	24	-
Brassica elongata	-	-	-	-	24	-
Ranunculus leptorrhynchus	6	7	-	3	-	-
Cnicus benedictus	17	3	-	-	-	-
Allium sordidiflorum	11	-	-	3	6	-
Encalypta vulgaris d	6	-	9	3	6	-
Medicago lanigera	-	13	-	-	-	-
Astragalus ammophilus	-	3	-	10	-	-
Acroptilon repens	-	3	-	3	12	-
Garhadiolus papposus	-	3	-	10	-	-
Astragalus mucidus	-	-	9	-	18	-
Salsola collina	-	-	-	10	6	-
Medicago meyeri	-	-	-	-	24	-
Arnebia coerulea	11	-	-	7	-	-
Holosteum umbellatum	11	7	-	-	-	-

Supplement E3. Circum-Mediterranean calciphilous annual and ephemeroid swards and grasslands. O - Obikik; SD - to S from Dushanbe; N - Nurek; B - Baljuvon; D - Dangara; BC - *Cryptosporo falcatae-Brachypodietum distachyi*

Anhang E3. Circum-mediterrane kalkliebende einjährige und ephemere Rasen und Grasländer. O - Obikik; SD - to S from Dushanbe; N - Nurek; B - Baljuvon; D - Dangara; BC - *Cryptosporo falcatae-Brachypodietum distachyi*

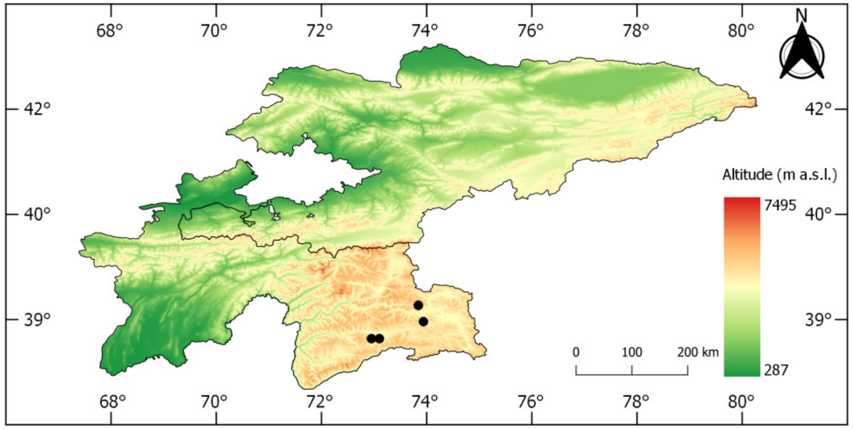
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	FREQUENCY
Plot number	61	62	1	17	38	36	6	37	35	34	5	60	18	2	59	
day	3	3	28	2	29	29	29	29	29	29	29	2	2	28	2	
Date: month	5	5	4	5	4	4	4	4	4	4	4	5	5	4	5	
year	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Altitude (m)	827	1028	656	815	922	842	895	845	946	948	904	803	811	672	789	
Aspect	e	w	e	ne	-	e	w	e	s	sw	sw	nee	ne	e	e	
Slope (degrees)	30	22	32	35	-	55	44	50	44	70	42	42	21	32	30	
Cover of tree layer (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Cover of shrub layer (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Cover of herb layer (%)	80	80	75	85	85	80	55	80	70	70	55	65	85	65	75	
Cover of moss layer (%)	12	1	1	-	2	5	-	1	-	1	-	5	-	1	20	
Relevé area (m^2)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Number of species	40	44	36	33	30	25	33	27	28	30	36	30	32	34	45	
Locality	O	SD	N	O	B	D	B	D	D	D	B	O	O	N	O	
Association/Community	CB	CB	CB	CB	CB	CB	CB	CB	CB	CB	CB	CB	CB	CB	CB	
																rel.
Ass. Cryptosporo falcatae-Brachypodietum distachyi																1–15
Cryptospora falcata	2	2	2	2	2	.	1	2	2	3	+	2	1	1	.	87
Brachypodium distachyon	.	.	.	4	3	1	1	2	+	+	2	1	3	.	.	67
Aphanopleura capillifolia	+	1	1	1	.	.	1	.	.	.	.	2	.	2	+	53
Eremurus suvorovii	.	.	.	.	2	3	1	2	.	.	1	1	.	.	.	40
Aristida adscensionis	2	2	.	1	.	.	.	.	.	.	.	.	1	.	+	33
All. Diantho humilis-Velezion rigidae																
Allium gypsodictyum	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	13
O. Ptilostemono stellati-Vulpietalia ciliatae & Cl. Stipo-Trachynietea distachyae																
Euphorbia franchetii	.	+	1	r	.	1	+	.	+	.	+	+	1	r	1	73
Medicago rigidula	.	+	1	+	2	.	.	1	1	2	+	.	1	+	.	67
Galium nupercreatum	.	+	1	.	.	.	.	.	.	.	.	1	.	.	2	27
Lolium cuneatum	.	.	.	.	+	.	1	2	.	.	.	.	.	.	1	27
Trigonella verae	1	1	.	.	.	.	.	.	.	.	.	1	.	.	+	27
Strigosella trichocarpa	.	+	.	.	.	.	.	1	+	.	.	+	.	.	.	27
Hypogomphia bucharica	.	.	1	.	.	.	.	.	.	2	1	.	.	.	.	20
Vulpia villosa	.	.	+	.	.	.	.	.	.	.	.	.	.	2	+	20
Hypogomphia purpurea	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	20
Medicago lanigera	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	20
Filago lagopus	.	.	.	+	.	.	.	.	.	.	.	.	+	r	.	20
Veronica bucharica	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	13
Valerianella cymbocarpa	.	.	r	.	.	.	.	.	.	.	.	.	.	r	.	13
Others																
Cynodon dactylon	1	2	r	1	2	.	1	+	+	.	2	2	2	1	2	87
Vicia angustifolia	+	+	.	1	+	+	1	.	+	+	+	.	r	r	+	80
Avena trichophylla	+	+	.	r	2	1	3	2	.	.	1	.	+	1	.	67
Koelpinia linearis	.	1	1	+	1	.	.	1	2	2	1	1	.	.	1	67
Galium spurium	1	.	.	1	1	+	1	.	.	.	+	+	1	.	1	60
Garhadiolus papposus	+	.	1	1	.	+	.	1	+	+	+	.	.	+	.	60
Pimpinella peregrina	+	+	1	+	.	+	.	.	+	+	.	.	r	1	.	60
Diarthron vesiculosum	+	+	.	+	.	.	.	.	.	1	.	1	1	r	1	53
Scilla puschkinioides	.	.	1	r	.	.	+	1	.	.	+	+	r	1	.	53
Phlomis bucharica	.	.	.	.	2	2	1	1	.	.	1	+	+	.	.	47
Arnebia coerulea	.	.	+	.	1	+	.	.	1	2	1	.	.	+	.	47
Lallemantia royleana	.	.	.	.	1	1	1	1	1	.	1	.	.	r	.	47
Veronica arvensis	+	+	r	+	.	.	.	.	.	.	.	+	r	.	+	47
Vulpia persica	2	1	2	.	.	.	1	.	.	.	1	.	.	.	3	40
Bothriochloa ischaemum	.	.	+	1	.	.	.	.	2	2	.	+	.	2	.	40
Bromus lanceolatus	1	.	.	.	2	.	.	1	+	1	.	.	.	.	1	40
Onobrychis pulchella	2	1	.	.	.	.	+	1	1	.	.	+	.	.	.	40
Psolarea drupacea	1	.	1	.	+	1	.	.	.	.	+	.	.	1	.	40
Heterocaryum szovitsianum	+	1	+	.	.	.	.	.	.	.	+	+	.	.	+	40
Papaver pavoninum	1	.	r	.	.	.	.	.	1	2	.	.	.	r	.	33
Trigonella arcuata	.	+	.	r	.	.	1	2	.	.	.	.	r	.	.	33
Medicago orbicularis	1	1	.	.	1	.	.	.	.	.	+	1	.	.	.	33
Astragalus filicaulis	.	.	1	.	.	.	.	1	+	+	.	.	.	+	.	33
Anagallis foemina	+	+	+	.	.	.	.	.	.	.	+	.	.	.	1	33
Crepis pulchra	+	+	.	.	.	.	1	.	.	.	.	+	.	.	+	33
Consolida barbata	+	.	.	.	1	.	+	.	.	+	+	.	.	.	.	33
Bromus oxyodon	.	.	.	.	1	2	.	2	.	.	.	.	1	.	.	27
Bromus tectorum	.	.	2	.	1	2	.	+	.	.	.	.	.	.	.	27
Lolium persicum	.	.	+	.	.	.	.	.	2	+	.	.	.	1	.	27
Galium ghilanicum	.	.	1	1	.	.	.	.	.	.	.	.	1	1	.	27
Carthamus lanatus	.	.	.	.	+	.	+	.	1	1	.	.	.	.	.	27
Bromus sterilis	+	.	.	.	.	.	1	.	.	.	+	.	.	.	+	27
Allium barsczewskii	.	.	.	.	1	+	+	.	.	.	+	.	.	.	.	27
Lathyrus cicera	+	.	.	r	.	.	1	.	.	.	.	.	.	.	+	27
Crupina vulgaris	+	+	.	.	.	.	.	.	+	+	.	.	.	.	.	27
Astragalus rytilobus	.	.	+	.	.	.	+	.	.	+	+	.	.	.	.	27
Lens orientalis	.	.	.	.	+	+	.	.	+	+	.	.	.	.	.	27
Hypericum perforatum	+	+	.	r	.	.	.	.	.	.	.	.	r	.	.	27
Taraxacum nuratavicum	.	.	.	r	.	.	r	+	.	.	.	.	.	.	+	27
Arenaria serpyllifolia	.	.	.	r	.	.	r	.	.	.	.	.	.	r	+	27
Ferula gigantea	.	.	.	.	.	2	.	1	.	.	.	.	+	.	.	20
Hordeum bulbosum	.	.	.	.	.	1	.	.	.	1	.	.	.	.	1	20
Roemeria refracta	.	1	.	.	.	.	.	.	1	.	.	.	.	+	.	20
Syntrichia ruralis d	.	+	.	.	.	.	.	.	.	.	.	1	.	.	1	20
Lathyrus inconspicua	.	.	.	.	.	.	.	1	1	+	.	.	.	.	.	20
Scandix pecten-veneris	.	.	.	.	.	.	.	.	.	.	.	.	r	1	1	20
Filago pyramidata	1	+	.	.	.	.	.	.	.	.	.	.	.	.	+	20
Bryum caespiticum d	1	.	.	.	+	.	.	.	.	.	.	.	.	.	+	20
Didymodon rigidulum d	.	.	.	.	.	1	.	+	.	+	.	.	.	.	.	20
Gagea gageoides	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	20
Barbula unguiculata d	.	.	+	.	+	.	.	.	.	.	.	.	.	+	.	20
Thlaspi perfoliatum	+	+	.	.	.	.	.	.	.	.	.	.	.	r	.	20
Euphorbia sogdiana	+	.	.	.	.	.	.	.	.	.	.	+	r	.	.	20
Lamium amplexicaule	.	+	.	.	.	.	.	.	.	.	.	.	.	r	+	20
Linum corymbulosum	.	.	+	.	.	.	.	.	.	.	r	.	.	.	+	20
Veronica polita	.	.	.	r	.	.	.	.	.	.	.	+	r	.	.	20
Convolvulus pseudocantabrica	.	.	.	.	.	1	.	.	.	3	.	.	.	.	.	13
Astragalus taschkendicus	.	.	.	1	.	.	.	.	.	.	.	.	2	.	.	13
Artemisia kochiiformis	.	.	.	.	.	1	.	2	.	.	.	.	.	.	.	13
Erianthus ravennae	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	13
Cousinia sclerophylla	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	13
Nigella bucharica	.	1	.	.	.	.	.	.	.	.	.	.	.	.	+	13
Conringia planisiliqua	.	.	+	.	.	.	.	.	.	.	.	.	.	1	.	13
Medicago denticulata	.	.	.	.	+	.	.	.	.	.	1	.	.	.	.	13
Phlomoides labiosa	.	.	.	.	1	.	.	.	+	.	.	.	.	.	.	13
Galium tenuissimum	.	.	.	.	.	+	.	1	.	.	.	.	.	.	.	13
Bromopsis tyttholepis	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	13
Astragalus oxyglottis	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	13
Astragalus babatagi	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	13
Bunium intermedium	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	13
Jurinea baldschuanica	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	13
Trigonella orthoceras	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	13
Valerianella vvedenskyi	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	13
Galium aparine	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	13
Bongardia chrysogonum	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	13
Lathyrus aphaca	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	13
Ranunculus tenuilobus	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	13
Papaver litvinovii	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	13
Cousinia pulchella	.	+	.	.	.	.	.	.	.	.	.	.	r	.	.	13
Valerianella ovczinnikovii	.	.	.	r	.	.	.	.	.	.	.	.	+	.	.	13
Cnicus benedictus	.	.	.	.	.	.	r	.	.	.	.	.	.	+	.	13
Strigosella hispida	.	.	.	r	.	.	.	.	.	.	.	.	r	.	.	13

Sporadic: *Acanthocephalus amplexifolius* 15(1); *Acroptilon repens* 2; *Agropyron repens* 15; *Aloina brevirostris* 3; *Alyssum calycinum* 10; *Anchusa azurea* 7; *Arabidopsis wallichii* 11(r); *Artemisia vulgaris* 15; *Astragalus hissaricus* 13(r); *Astragalus korovinianus* 12; *Astragalus mirabilis* 4; *Astragalus viridiflorus* 12(2); *Bromus sewerzowii* 3(r); *Bryum pallens* d 3(r); *Bunium persicum* 2; *Capparis spinosa* 13(r); *Carex stenophylloides* 10(1); *Centaurea squarrosa* 9; *Cousinia mulgediifolia* 2; *Crambe kotschyana* 15(2); *Cruciata pedemontana* 11(r); *Drabopsis nuda* 2; *Elaeosticta allioides* 1; *Elaeosticta hirtula* 11; *Erodium cicutarium* 14(r); *Erophila verna* 2; *Gentiana olivieri* 12(1); *Geranium pusillum* 15; *Haplophyllum acutifolium* 8(1); *Haplophyllum robustum* 11; *Heterocaryum subsessile* 1; *Hordeum geniculatum* 6(1); *Iris lineata* 8(1); *Lathyrus tuberosus* 7(1); 0*Koelpinia macrantha* 3(1); *Lactuca serriola* 1; *Lallemantia baldschuanica* 10(2); *Leptorhabdos parviflora* 14(r); *Malva neglecta* 7(r); *Melilotus dentatus* 11; *Onosma albicaulis* 7(1); *Onosma baldshuanica* 5(1); *Origanum tytthanthum* 15; *Pleurogynella flaviflora* 15; *Poa bulbosa* 2(1); *Poaceae* sp. 3(r); *Pohlia nutans* d 1(1); *Prosopis farcta* 1; *Ranunculus arvensis* 11(r); *Rochelia cardiosepala* 15; *Serratula chartacea* 4; *Silybum marianum* 10; Strigosella africana 4(r); *Taeniatherum crinitum* 6(2); *Tortula muralis* d 15(2); *Trigonella noeana* 9; *Triticum* sp. 1; *Tulipa tubergeniana* 3(1); *Veronica capillipes* 14(r); *Viola occulta* 13;

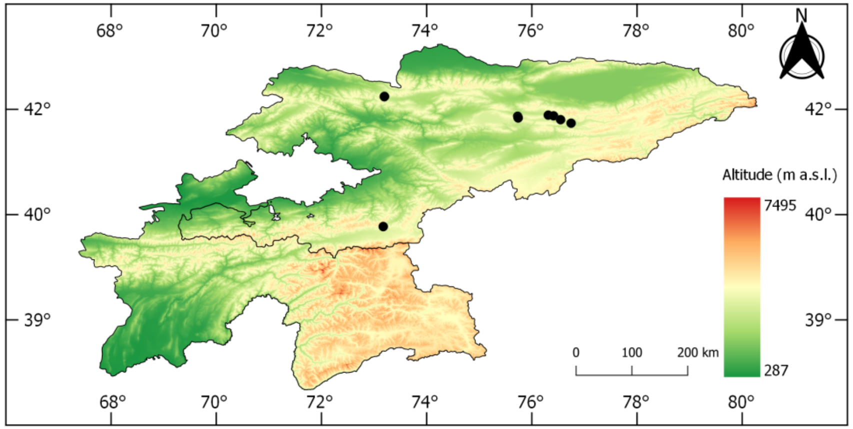
Locality (Longitude, Latitude): 1 - (68.65916; 38.21166); 2 - (68.7233; 38.36952); 3 - (69.18909; 38.35777); 4 - (68.65314; 38.20092); 5 - (69.64555; 38.27138); 6 - (69.4246; 38.1506); 7 - (69.64561; 38.27149); 8 - (69.4336; 38.1556); 9 - (69.40575; 38.13555); 10 - (69.40555; 38.13555); 11 - (69.64571; 38.27154); 12 - (68.65861; 38.20444); 13 - (68.65318; 38.20078); 14 - (69.18898; 38.35767); 15 - (68.65277; 38.19138).

Supplement E4. Distribution maps of detected 13 plant communities of pseudosteppes, steppes and meadows vegetation within study area. Maps are based on raster data from digital elevation model (JARVIS et al. 2008).

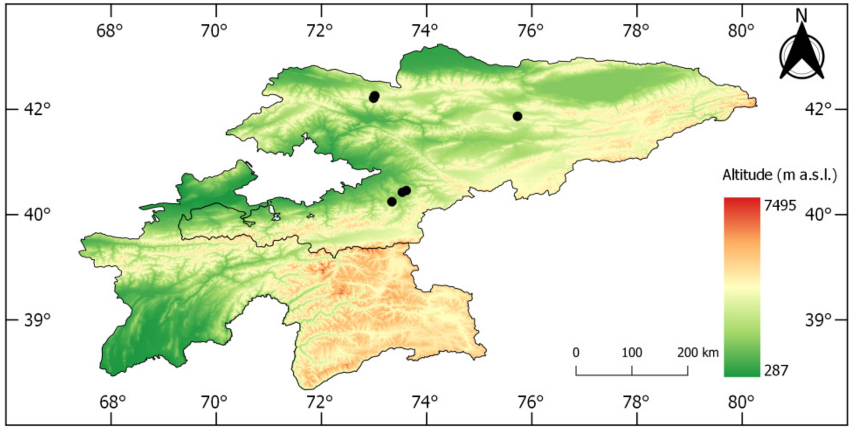
Anhang E4. Verbreitungskarten von 13 nachgewiesenen Pflanzengesellschaften von Pseudosteppen, Steppen sowie Wiesen und Weiden im Untersuchungsgebiet. Die Karten basieren auf den Rasterdaten von einem digitalen Höhenmodell (JARVIS et al. 2008).



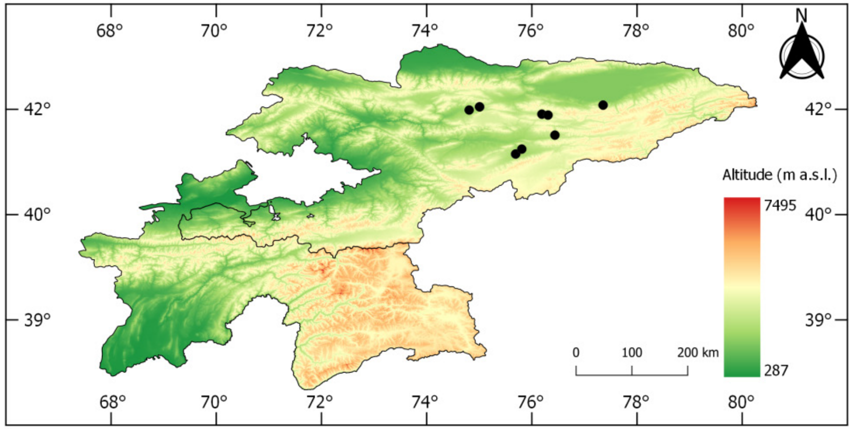
Brayo pamiricae-Stipetum glareosae (cluster 1)



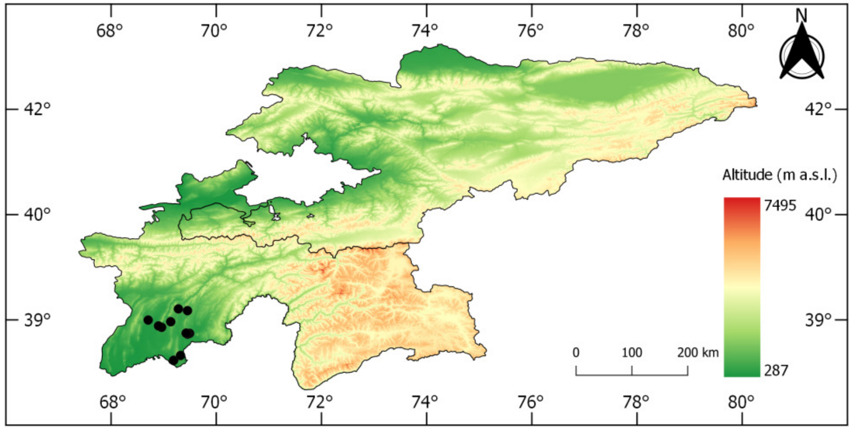
Ligularia alpigena-Euphorbia alativica community (cluster 2)



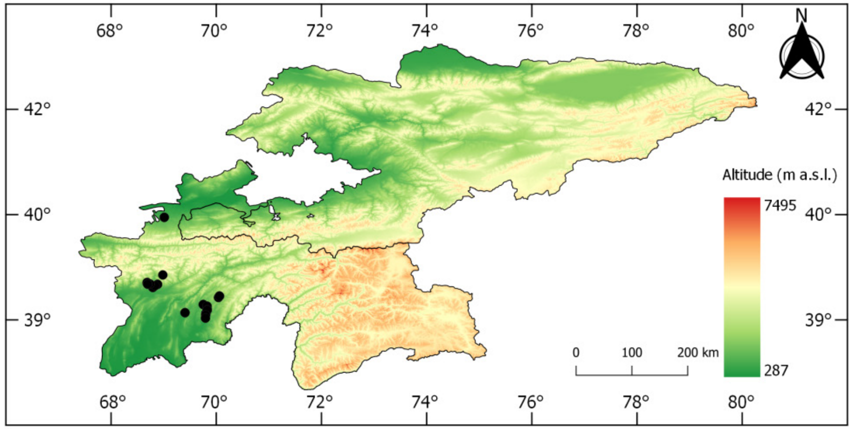
Euphorbia lamprocarpa community (cluster 3)



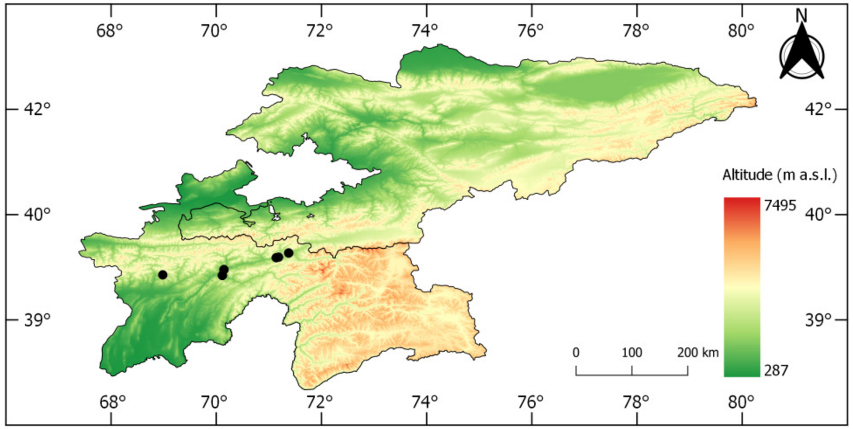
Carum carvi-Hordeum turkestanicum community (cluster 4)



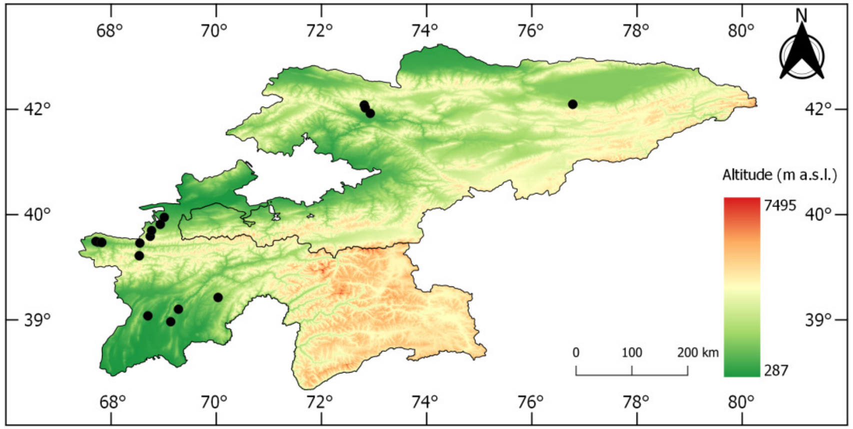
Eremuretum bucharici (cluster 5)



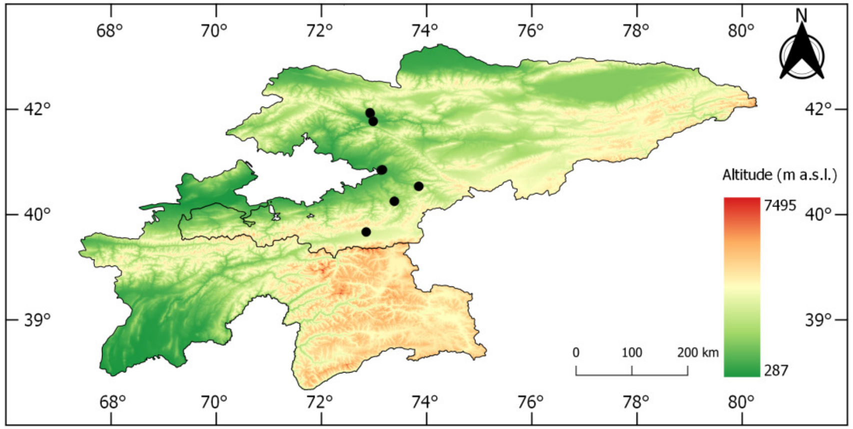
Hordeo bulbosi-Astragaletum retamocarpi (cluster 6)



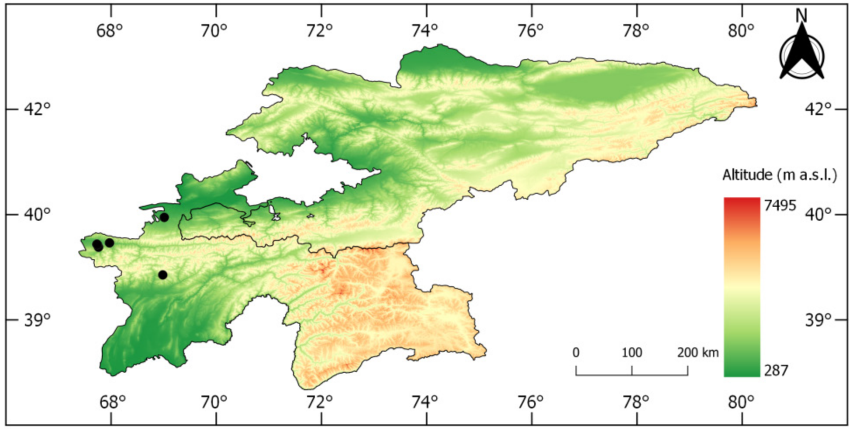
Potentillo orientalis-Eremuretum fusci (cluster 7)



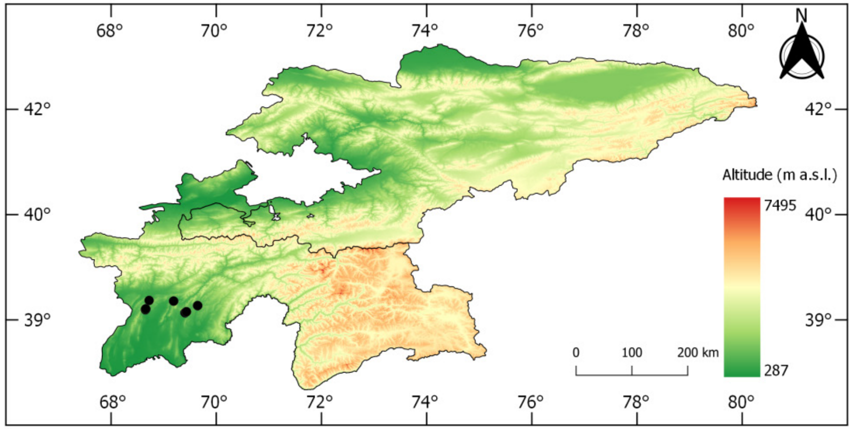
Achnathero caraganae-Delphinietum semibarbati (cluster 8)



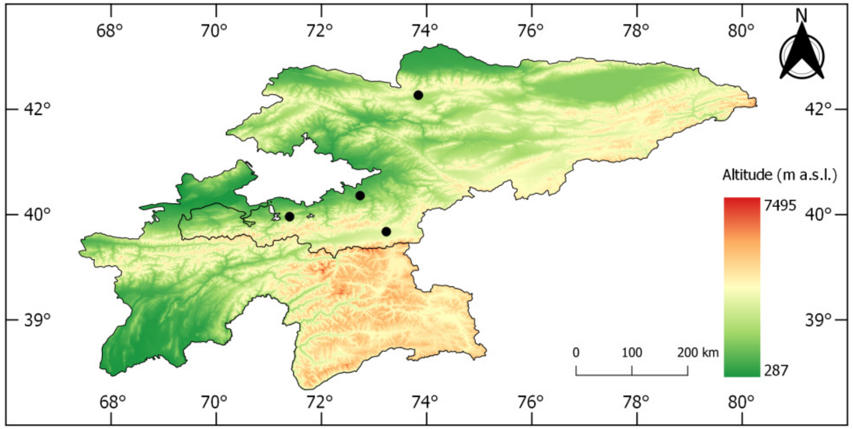
Eremuro tianschanici-Delphinietum biternati (cluster 9)



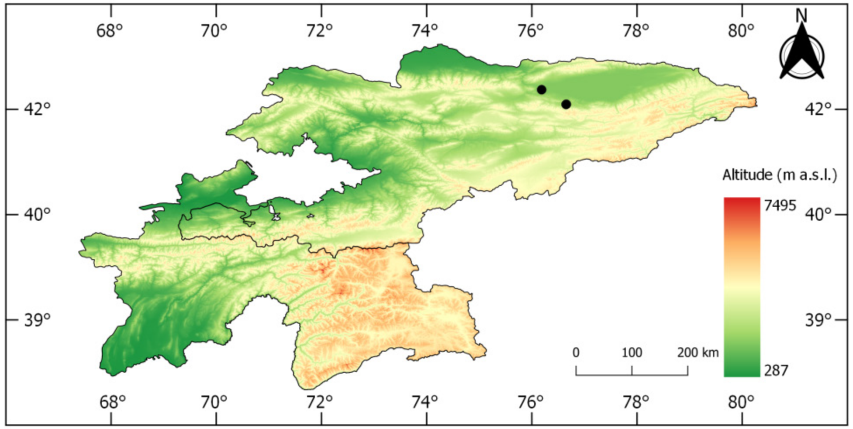
Medicago sativa-Poa trivialis community (cluster 10)



Cryptosporo falcatae-Brachypodietum distachyi (cluster 11)



Astragalo lithophili-Stipetum zalesski (cluster 12)



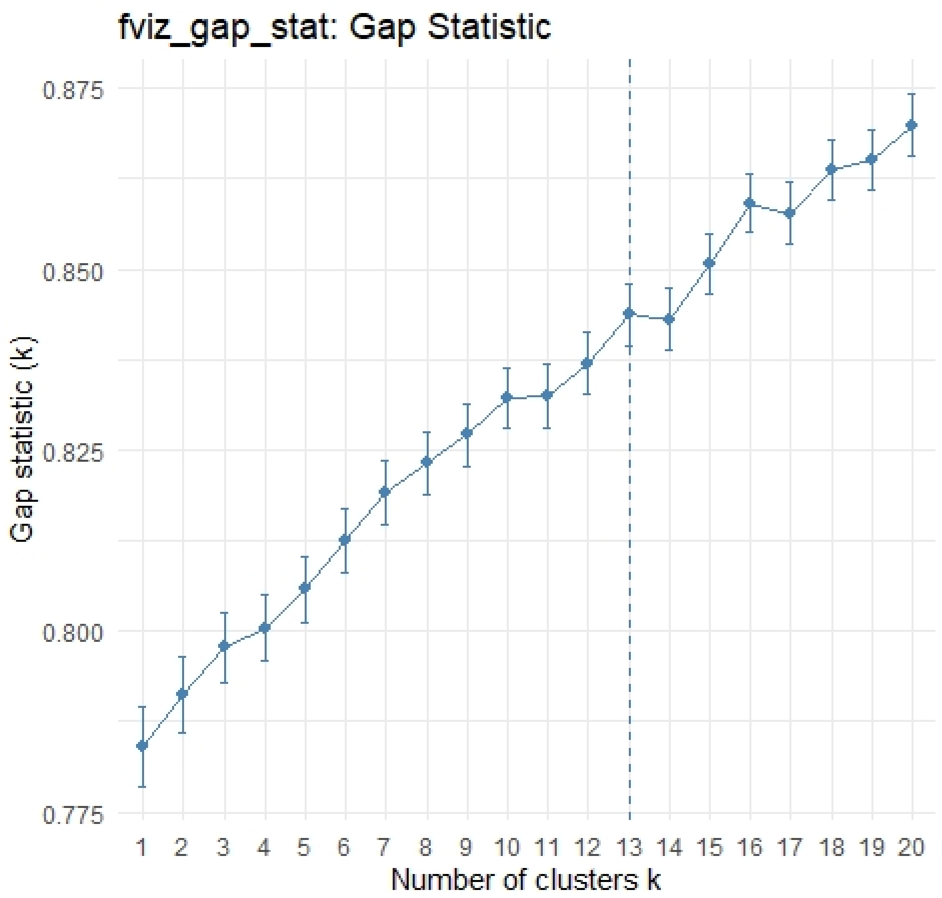
Stipetum bungeanae (cluster 6)

References

JARVIS, A., REUTER, H.I., NELSON, A., & GUEVARA, E. (2008): Hole-filled SRTM for the globe Version 4, available from the CGIAR-CSI SRTM 90m Database (http://srtm.csi.cgiar.org).

Supplement E5. Plot showing gap statistic curve. The gap statistic identifies 13 clusters as optimal for the k-means algorithm.

Anhang E5. Diagramm mit der Lückenstatistikkurve. Die Lückenstatistik identifiziert 13 Cluster als optimal für den k-Mittelwert-Algorithmus.

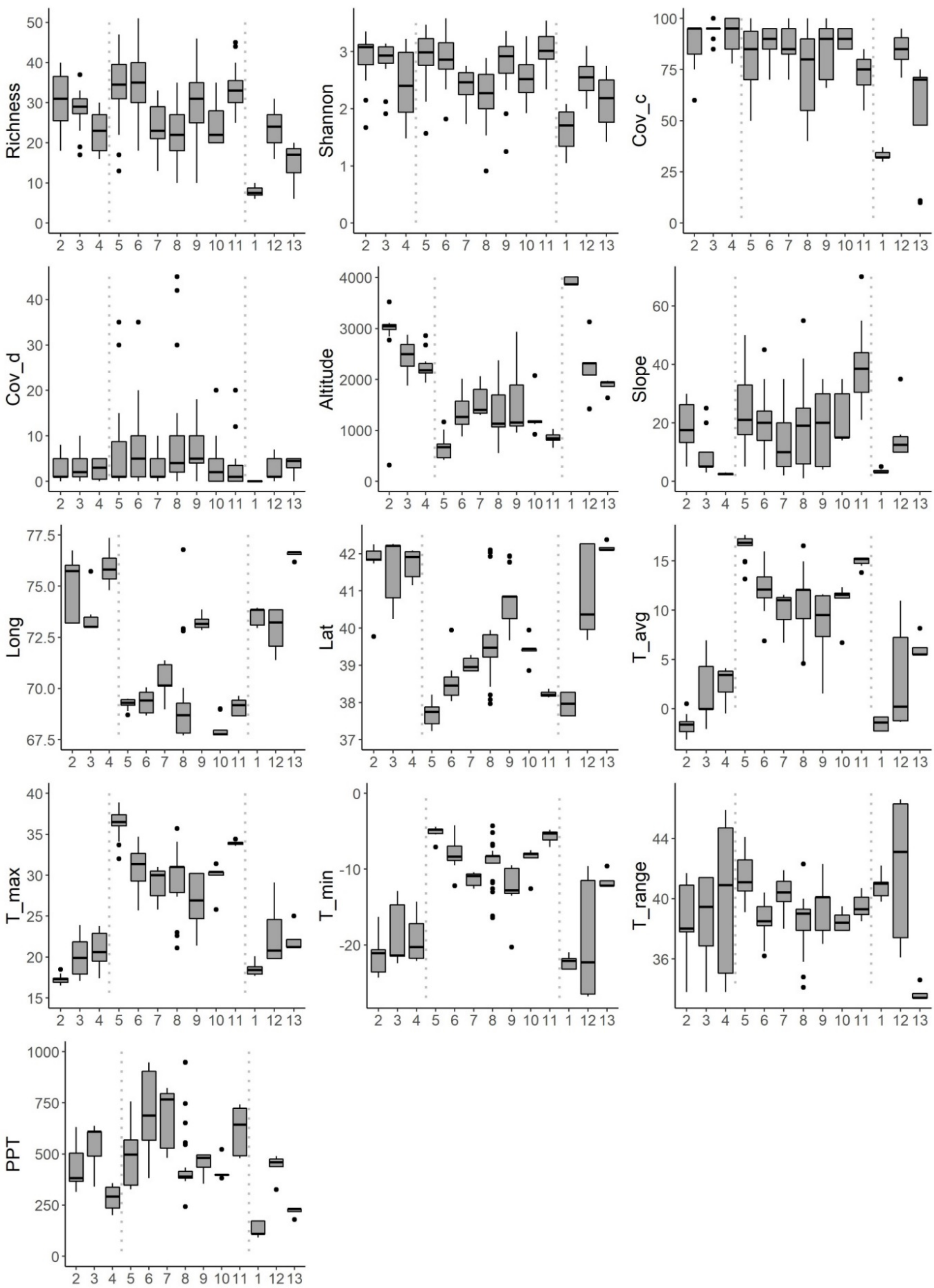


Supplement E6. Boxplots showing median (line), quartiles, outliers and the range of environmental and vegetation parameters of clusters within vegetation groups: meadows (2, 3, 4), pseudosteppes (5, 6, 7, 8, 9, 10, 11) and steppes (1, 12, 13).

Anhang E6. Boxplots mit Median (Linie), Quartilen, Ausreißern und dem Bereich der Umwelt- und Vegetationsparameter von Clustern innerhalb von Vegetationsgruppen: Wiesen und Weiden (2, 3, 4), Pseudosteppen (5, 6, 7, 8, 9, 10, 11) und Steppen (1, 12, 13).

The abbreviations of the clusters / Die Abkürzungen der Cluster: 1 − *Brayo pamiricae-Stipetum glareosae*; 2 − *Ligularia alpigena-Euphorbia alativica* community; 3 − *Euphorbia lamprocarpa* community; 4 − *Carum carvi-Hordeum turkestanicum* community; 5 − *Eremuretum bucharici*; 6 – *Hordeo bulbosi-Astragaletum retamocarpi*; 7 − *Potentillo orientalis-Eremuretum fusci*; 8 − *Achnathero caraganae-Delphinietum semibarbati*; 9 − *Eremuro tianschanici-Delphinietum biternati*; 10 – *Medicago sativa-Poa trivialis* community; 11 – *Cryptosporo falcatae-Brachypodietum distachyi*; 12 – *Astragalo lithophili-Stipetum zalesskii*; 13 − *Stipetum bungeanae*.

The abbreviations of the environmental and vegetation parameters / Die Abkürzungen der Umwelt- und Vegetationsparameter: Richness – species richness, Shannon – Shannon index, Cov_c – cover herb layer (%), Cov_d – cover moss layer (%), Altitude – altitude(m a.s.l.), Slope – slope (°), Long – longtitude, Lat – latitude, T_avg – annual mean temperature, T_max – max temperature of warmest month, T_min – min temperature of coldest month, T_range – annual temperature range, PPT – annual precipitation.



Supplement E7. Photographs of the vegetation belonging to the grassland communities considered in this paper. All pictures taken by A. Nowak.

Anhang E7. Fotos der Vegetation der Graslandgesellschaften, die in diesem Artikel betrachtet werden. Alle Bilder von A. Nowak.

Ligularia alpigena-Euphorbia alativica community near Otmok Pass, 3300 m a.s.l., KRG (cluster 2)

Hordeo bulbosi-Astragaletum retamocarpi S. Świerszcz et al. 2019, Hodzhamumin Mt neat Vose, 950 m a.s.l., TJK (cluster 6)

Potentillo orientalis-Eremuretum fusci S. Świerszcz et al. 2019 as the alpine pastures in the Talas Range, approx. 2,200m a.s.l., KRG (cluster7)

Achnathero caraganae-Delphinietum semibarbati S. Świerszcz et al. 2019 near Karakol, 1200 m a.s.l., KRG (cluster 8)

Medicago sativa-Poa trivialis community, Ak-Suu Valley, 850 m a.s.l., TJK (cluster 10)

Stipetum bungeanae A. Nowak et al. 2018 in Issyk-Kul Basin, 1650 m a.s.l., KRG (cluster 13)