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RESEARCH PAPER

Ephemeroid vegetation of the Kulan Plateau in the Badhyz Reserve (Turkmenistan)

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ABSTRACT

The results of long-terms vegetation studies of the Kulan plateau, which is located in the Badhyz reserve in the southeastern Turkmenistan, are presented. The geographical position of the region and the diversity of landscapes promoted to the formation of the specific flora, represented by various groups of Mediterranean, Iranian, Turanian, as well as Middle and Central Asian species. Very specific ephemeroid plant communities with *Poa bulbosa* и *Carex pachystylis* dominated in lower layer were syntaxonomically studied for the first time. The upper layer includes the tall herbs, especially *Ferula badrakema*, an endemic species of Badhyz. Communities were classified as the suballiance *Poo bulbosae–Ferulenion badrakemii* **suball. nov.** of the alliance *Vulpio persicae–Caricion pachystylidis* Świerszcz et al. 2020 of the order *Cymbopogono–Brachypodietalia ramosi* Horvatič 1963 of the class *Lygeo sparti–Stipetea tenacissimae* Rivas-Mart. 1978 nom. conserv. propos. Communities of grasses on slight turf sands are classified as part of the provisional alliance *Stipagrostion pennati* prov. The position of the alliance in the system of high-rank syntaxa has not yet been determined. The 5 new associations and 6 subassociations were allocated.

Keywords: Turkmenistan, Badhyz Reserve, Kulan Plateau, ephemeroid vegetation, suballiance *Poo bulbosae–Ferulenion badrakemii*, alliances *Vulpio persicae–Caricion pachystylidis*, *Stipagrostion pennati*

РЕЗЮМЕ

Полякова Н.В., Голованов Я.М., Ямалов С.М., Лебедева М.В., Шигапов З.Х. Эфемероидная растительность Куланьего плато Бадхызского заповедника (Туркменистан). Приведены результаты многолетних синтаксономических исследований Куланьего плато, которое располагается в Бадхызском заповеднике в Юго-Восточном Туркменистане. Географическое положение региона и разнообразие ландшафтов способствовало формированию своеобразной флоры, представленной различными группами средиземноморских, иранских, туранских, а также средне- и центральноазиатских видов. Впервые описаны специфические сообщества эфемеровой растительности с преобладанием в нижнем ярусе *Poa bulbosa* и *Carex pachystylis*. Верхний ярус представлен крупнотравьем, особое место среди которого занимает *Ferula badrakema* – эндемик Бадхыза. Растительность классифицирована в подсоюз *Poo bulbosae–Ferulenion badrakemii* **suball. nov.** союза *Vulpio persicae–Caricion pachystylidis* Świerszcz et al. 2020 порядка *Cymbopogono–Brachypodietalia ramosi* Horvatič 1963 и класса *Lygeo sparti–Stipetea tenacissimae* Rivas-Mart. 1978 nom. conserv. propos. Кроме того, сообщества злаковников на слабозадернованных песков классифицированы в состав провизорного союза *Stipagrostion pennati* prov. Положение союза в системе высших единиц пока не определено. Выделено 5 новых ассоциаций и 6 субассоциаций.

Ключевые слова: Браун-Бланке, Туркменистан, Бадхызский заповедник, Куланье плато, эфемероидная растительность, *Poo bulbosae–Ferulenion badrakemii*, *Vulpio persicae–Caricion pachystylidis*, *Stipagrostion pennati*

The Badhyz Upland (Turkmenistan), where the Badhyz Nature Reserve is located, borders the southeastern Karakum on the north, the foothills of the Paropamis on the south and the east, and the spurs of the eastern Kopet Dag on the west. The upland itself includes the spurs of the Kopet Dag – Khorasan Mountains (the Gezgyadyk Ridge, reaching heights of 1000 m a.s.l.), the actual hills of Badhyz and Karabil (up to 300–800 m a.s.l.), which are the northern spurs of the Paropamis. The geographical position of the region and the diversity of landscapes contributed to the formation of an unusually rich and unique flora with various groups of Mediterranean, Iranian, Turanian, as well as Middle and Central Asian species (Kamelin et al. 1989).

According to Takhtajan (1986), Badhyz belongs to Irano-Turanian Region, West-Asian subregion, Turan Province. The flora and vegetation of Badhyz has long been of interest to many scientists. The studies covered mainly the flora (Bochantsev et al. 1992) and, less often, the vegetation (Linchevsky 1935, Kamelin 1989). The main characteristic of Badhyz is the dominance of ephemeral and ephemeroid vegetation. The lowest levels of the vast sandy piedmont plains of Badhyz and Karabil are occupied by a combination of ephemeral-sedge-bluegrass communities (*Poa bulbosa*, *Carex pachystylis*, *Bromus* spp., *Anisantha* spp., *Taeniatherum* spp., *Aegilops* spp.) and *Calligonum* dominated communities (*Calligonum eriopodum*, *C. turkestanicum*) with ephemeral-sedge

cover (*Carex physodes*). Small areas of cobble and pebble plains (gravel barren lands) feature ephemeroid-wormwood communities with *Artemisia badhysi*. In such habitats, the most typical communities are the ephemeral-ephemeroid ones with the synusiae of perennial herbs (*Heteropappus canescens*, *Phlomoides labiosa* etc.).

In the higher foothills, very specific ephemeral-ephemeroid communities with the participation of giant umbellates reaching the height of 1.5–2 m are widespread. These are endemic species *Ferula badrakema*, *Dorema aitchisonii*, as well as other species of tall herbs – *Pseudohandelia umbellifera*, *Crambe kotschyana*. Small areas in the high foothills are occupied by pistachio open woods (*Pistacia vera*) with the ephemeral-ephemeroid cover (*Poa bulbosa*, *Carex pachystylis*, *Merendera* spp., *Corydalis* spp., *Tulipa* spp.) and perennials (*Cousinia raddeana*, *Elaeosticta allioides*) (Linchevsky 1935).

The Badhyz State Nature Reserve was established on December 3, 1941 with the aim of protecting and studying the biology of the Kulan and preserving the largest pistachio grove in the USSR on an area of 800 000 hectares. The total area of the reserve is currently 87 640 hectares. The protected area stretches in a 72-kilometer area from the Kyzyljar Canyon in the east to the Tedzhen River in the west. Its width varies from 5 to 22 km (Sokolov et al. 1990).

Since the establishment of the reserve, the researchers visiting it have always paid more attention to the pistachio open woods (Pulikhatum pistachio grove) and partly to the Eroylanduz Depression. The slightly hilly plateau, located in the eastern part of the reserve and called the Kulan, as well as its vegetation, in particular, remained poorly studied for a long time. As for the attempts to identify specific phytocoenons and systematize the vegetation, they were usually made at the level of mesocomplexes (Kamelin 1989), which applies both to the vegetation of the reserve and Badhyz as a whole.

Within the framework of the ecological-floristic method of classification, the vegetation of Turkmenistan, as well as that of the territories adjacent to the southern part of Turkmenistan (Afghanistan, Iran) and having similar natural and geographical conditions with Badhyz, has not yet been studied. From the above-mentioned regions, the information is provided only on the classification of certain vegetation types in Iran (Klein 1987, 1988, Akhani 2004, Akhani & Mucina 2015, Gholizadeh et al. 2020). The vegetation of the south of Central Asia (Tajikistan, Kyrgyzstan, etc.) also quite rarely was the object of syntaxonomic studies (Nowak et al. 2016, 2020a, Świerszcz et al. 2020, 2021, Naqinezhad et al. 2021). For the alpine, subalpine and subniveal vegetation of the Central Elburz (Iran), a number of different syntaxa belonging to the invalid classes *Oxytropidetea persicae* Klein 1987, *Prangetea ulopterae* Klein 1987, *Onobrychidetea cornutae* Klein 1987 (Klein, 1987, 1988, 1999) were described. Later, they were recorded in the Pamir-Alai and Tian Shan (Nowak et al. 2020b). There are no data on the syntaxonomy of the low-mountain and mid-mountain xerophytic vegetation of Turkmenistan and the Parapameisos Mountain System. All these facts determine the significant relevance of the authors' research. Our study aimed to develop syntaxonomic scheme of the Badhyz Nature Reserve ephemroidal vegetation as a significant part of the arid zone vegetation on the Eurasian continent.

MATERIAL AND METHODS

Study area

The study was carried out within the Kulan Plateau, which occupies about 36 thousand hectares (i.e. 41 %) of the reserve territory (Fig. 1). Its natural boundaries are: the Duzenkyr Ridge stretching far beyond the reserve area in the north; the cliff faces of the Eroylanduz and Namaksaar endorheic depressions in the south. The eastern boundary of the plateau within the reserve is the Kyzyljar Canyon (Fig. 2A), which is about 18 km long; in the west, the plateau borders on the pistachio plantations on the Ellibir Ridge, which is a continuation of the Duzenkyr Ridge; and in the southwest, on the cliff faces of the Shoraymak Depression.

The climate of this area, as well as the entire region as a whole, is sharply continental, characterized by hot dry summers, relatively severe winters and constant winds. According to the generally accepted opinion, "Badhyz" is translated as "the place where the wind rises." Mean monthly temperatures are +3.3°C in January and +30.9°C in July. The mean annual precipitation is about 250 mm. Precipitation falls mostly in the autumn-spring period; the dry season lasts from May to October. The soils in most of the reserve territory are typical grey soils, puff and crust solonchaks in the depressions, in some places on the

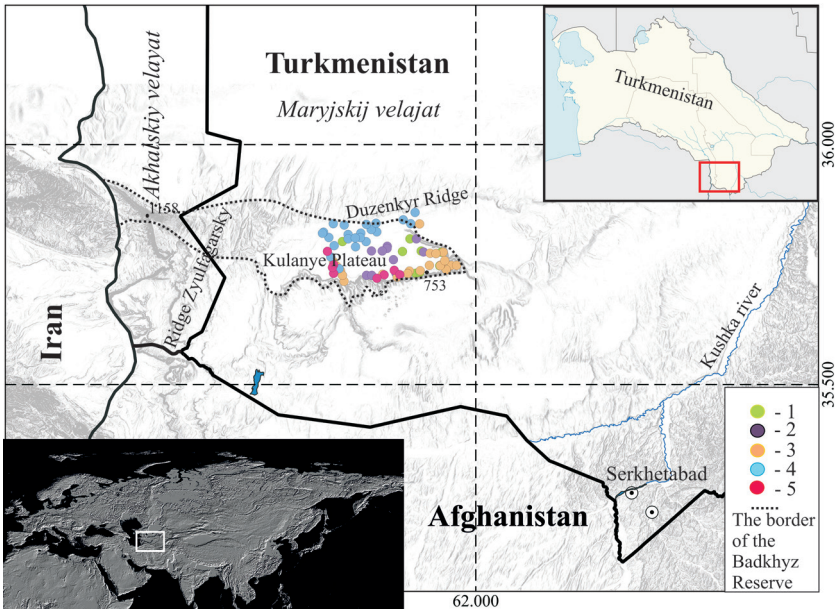

Figure 1 Map of the study area (circles show the locations of relevés. 1 – ass. *Atraphaxio badghysi–Stipagrostietum pennati* prov., 2 – ass. *Eremopyro bonaeparti–Ammothamnetum lehmannii*, 3 – ass. *Alysso turkestanici–Artemisietum badhysi*, 4 – ass. *Astragalo agametici–Caricetum pachystylidis*, 5 – acc. *Salsolo turkestanici—Caricetum pachystylidis*

Figure 2 Cliffs of the Kyzyljar Canyon (A); appearance of the communities of the suballiance *Poo bulbosae–Ferulenion badrakemii* dominated by *Ferula badrakema* (B) and the association *Alysso turkestanici–Artemisietum badhysi* (C) (photos by G.R. Livenstein and I.A. Mukhin)

plateau and in the depressions, there are desert sandy soils that are easily subject to the deflation processes.

The vegetation growth in the region begins after the first autumn rains, usually in November – December. In February – March, the first winter species bloom (according to the flowering group; Malysheva 1989). The maximum of the phytomass and the number of flowering species accounts for April. By the end of May, the vegetation fades, with the exception of a small group of summer, summer-autumn and autumn species (Malysheva 1989). Thus, the plateau acquires a solid gray-yellow color with darker patches of vegetation within rodent colonies.

According to Kamelin (1989), the plateau is occupied by a mesocomplex of tall-grass semi-savanna vegetation, the dominant and co-dominant species of which are *Carex pachystylis* and *Poa bulbosa*, while the plants of the upper sub-layer give it a peculiar appearance: *Ferula badrakema*, *Psoralea drupacea*, *Eremostachys labiosa*, *Hyalolaena lipskyi*.

Sampling and data analysis

The data was collected by N.V. Polyakova during the field seasons of 1990–1992. During this period, 152 relevés covering the entire territory of the Kulan Plateau including the Duzenkyr Ridge within the boundaries of the reserve were sampled. A small part of the releves (21) accounts for the territory of the Kyzyljarskiy Sanctuary, adjacent to the reserve from the east. The relevés were performed on the sample plots of 10×10 m. The sites were located on areas with homogeneous vegetation during route survey of the territory of the Badhyz Reserve. Routes crossed the various types of landscapes, leveled and hilly placors, steep slopes, and other habitats. Most of the plots were located in aligned areas, part of the site – on slopes, then it was noted in attributive information. There are no plant communities on the steep slopes. The coordinates of the plots were determined according geographical description using the program Google Earth Pro (7.3.4.8573) in WGS 84 coordinate system. Point coordinates are less precise than GPS, and have resolution about 1 km.

The abundance of the species was assessed by the Braun-Blanquet scale (Mirkin & Naumova 1998). The frequency of the species in syntaxa was assessed by a five-point scale: I – 1–20 %; II – 21–40 %; III – 41–60 %; IV – 61–80 %; V – 81–100 %. The classification was carried out by the Braun-Blanquet method (Braun-Blanquet 1964, Westhoff & Maarel 1978). When compiling synoptic tables, a scale of persistence in % was applied. The TURBOVEG (Hennekens 1995) and JUICE 7.1 (Tichý 2002) packages were used for storage and primary processing of the relevés. The description and naming of the new associations are made according the "International Code of Phytosociological Nomenclature. 4th edition" (Theurillat et al. 2021).

Primary classification was carried out using hierarchical agglomerative cluster analysis by the Ward (Ward 1963) binding method implemented in the JUICE 7.1 package (Tichý 2002). The Euclidean distance was chosen as a measure of similarity between the objects.

When performing cluster analysis and generating a synoptic table, we used a full set of data. For the characterizing tables, the most characteristic relevés were selected.

Potential diagnostic species were determined using the phi coefficient of association (Chytrý et al. 2002, Tichý & Chytrý 2006) and constancy ratio (Dengler 2003). The criteria for diagnostic species were basically the same as in Willner et al. (2017). However, after some trials it became clear that, in particular for geographically vicariant units, not all species formally meeting the criteria for diagnostic species could be used in the expert system (because they created a lot of miss-classified relevés), while in some cases the inclusion of species with lower fidelity considerably improved the performance. Thus, the main selection criterion for diagnostic species was their suitability to sharply discriminate the vegetation units along the chosen gradient, i.e. the ecological or geographical gradient that should be reflected in the classification.

To identify the patterns of ecological gradients of communities and their main types, the DCA-ordination (the CANOCO 4.5 software package) was used (Šmilauer & Lepš 2014). Soil types, topography, and slope exposure were considered as environmental variables. We gave the following values, characterizing soil types: drift sands (dunes) – 1, sandy soil – 2, sandy gray soil – 3, sandy loam gray soil – 4, clay gray soil – 5, ordinary gray soil – 6, sandy-crubble gray soil – 7, crubble gray earth – 8. Types of topography: placor – 1, hilly placor – 2, gentle slope – 3, steep slope – 4. Slope exposure values are given in the corresponding characterizing tables. If the descriptions were executed in an aligned area, no values were specified.

The species nomenclature mainly followed Cherepanov (1995). The life forms of the species are provided in accordance with the "Key to Plants of Turkmenistan" (Nikitin & Geldikhanov 1988).

RESULTS

Primary classification (cluster analysis)

According to the cluster analysis (Fig. 3), we distinguished 7 main groups, which were interpreted at the level of associations и subassociations.

The groups 1 to 4 represented communities on rubble and sandy areas of the Kulan Plateau.

Such soils are located within the zone adjacent to the cliff faces of Kyzyljar, Eroylanduz and Namaksaar, as well as in the areas of sand ridges, concentrated mainly in the southeastern part of the plateau, where the maximum density of wild ungulates is observed in winter and spring. A characteristic feature of the vegetation in these areas is that *Carex pachystylis* and some related species almost disappear from the herbaceous cover, however, in some places it is replaced by more psammophilous *Carex physodes* or, more often, *Carex subphysodes*, but they are not abundant, either. Associations of the alliance *Stipagrostion pennati* and the association *Alysso turkestanici–Artemisietum badhysi* of the alliance *Vulpio persicae–Caricion pachystylidis* with high constancy of therophytes are presented in these groups.

The groups from 5 to 7 included plant communities predominantly composed of hemicryptophytes on light and typical grey soils widespread on the plateau. High-humic grey soils with abundant tall herbs characteristic of them are confined to the northern and northwestern parts of the plateau. Light grey soils of varying thickness and composition with a sparser herb stand lie in a verge of the cliffs and in spots in the central part of the plateau. Physiognomically, the communities are distinguished by a specific combination of *Ranunculus sewerzowii*, *Pseudohandelia umbellifera*, *Aphanopleura leptoclada*, *Delphinium semibarbatum*, etc., against the background of a dense cover of *Poa bulbosa* and *Carex pachystylis*. The groups include the associations *Astragalo agametici–Caricetum pachystylidis* and *Salsolo turkestanici–Caricetum pachystylidis* with the corresponding subassociations.

Alliance *Stipagrostion pennati* prov.

The alliance in this paper stands out as a provisional unit. Subsequently, when accumulating a syntaxonomic data, its further validation is necessary.

This alliance combines pioneer sparse communities formed by perennial turf grasses with creeping underground shoots – *Sipagrostis pennata* and *S. karelinii*. These species are characteristic of slight turf sands and barhans. These species are the first to populate mobile sands. *S. pennata* is distributed throughout the desert zone, but is more characteristic of the middle desert subzone, and *S. karelinii* is predominantly distributed in the southern deserts. There are also concomitant species *Calligonum eriopodum*, *Antmodendron conollyi*, *Smirnowia turkestana* and *Eremosparton flaccidum*, and annual species of genera *Agriophyllum*, *Corispermum*.

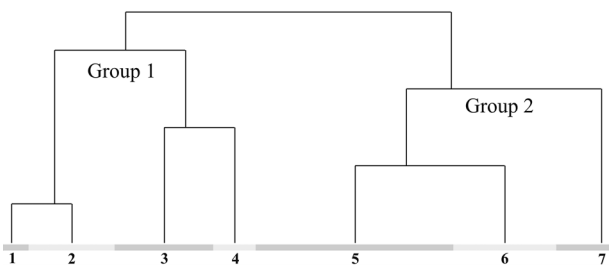

Figure 3 Cluster analysis dendrogram of the ephemeroid vegetation of the Kulan Plateau in the Badhyz Reserve (1–2 – alliance *Stipagrostion pennati* prov., 3–7 – alliance *Vulpio persicae–Caricion pachystylidis*

In the Kulan Plateau, the communities of the alliance are found on the especially light soils, as well as in the areas of blown sands, the communities with the participation of the psammophilous species *Ammothamnus lehmannii*, *Convolvulus dovaricatus*, *Astragalus maximowiczii*, and species of the genus *Calligonum* are widespread.

Diagnostic species for Kulan Plateu territory are: *Atraphaxis badghysi*, *Allium fibrosum*, *Arnebia transcaspica*, *Calligonum eriopodum*, *Carex physodes*, *Ceratocarpus utriculosus*, *Heliotropium arguzioides*, *Orobanche cumana*, *Stipagrostis pennata*.

Association *Atraphaxio badghysi–Stipagrostietum pennati* Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.** (Table 1, col. 1; Table 2, **holotypus** hoc loco – Table 2, rel. 8: 2.5 km S of the Kepelinskaya road, 05.15.1990, 35.803393ºN 61.862622ºE. Author – N. Polyakova)

Diagnostic species: *Arnebia transcaspica*, *Atraphaxis badghysi*, *Calligonum eriopodum*, *Carex physodes*, *Ceratocarpus utriculosus*, *Heliotropium arguzioides*, *Orobanche cumana*, *Stipagrostis pennata*.

It incorporates the communities that develop on sand dunes, undulating habitats, less often gentle slopes. Soils are sandy. The appearance of the communities is formed by *Stipagrostis pennata*, a psammophyte widespread in Central Asia. The diagnostic species *Atraphaxis badghysi* is listed in the Red Data Book of Turkmenistan (Annabayramov 2011). The composition includes such psammophytes as *Arnebia transcaspica*, *Calligonum eriopodum*, *Carex physodes*, *Heliotropium arguzioides*. The species abundance within the association varies considerably. On the blown sand dunes, the species composition is depleted, ranging from 2 to 5 species. Up to 20 species per site are observed on stable substrates.

The total cover (TC) varies from 25 to 75 %. The average height of the grass stand is low, 12–30 cm.

Association *Eremopyro bonaeparti–Ammothamnetum lehmannii* Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.** (Table 1, col. 2; Table 3, **holotypus** hoc loco – Table 3, rel. 6: 1.5 km W of the Pridorozhnaya trig point, 14.05.1991, 35.778078ºN 61.782368ºE. Author – N. Polyakova)

Diagnostic species: *Allium fibrosum*, *Ammothamnus lehmanii*, *Artemisia scoparia*, *Eremopyrum bonaepartis*, *Nigella integrifolia*, *Psylliostachys suworowii*, *Taeniatherum crinitum*, *Ziziphora tenuior*.

It encompasses the communities of disturbed pastures. The appearance of the communities is formed by *Artemisia scoparia*, a weedy and ruderal species characteristic of wastelands and pastures, found mainly on sandy soils. Also, a weed species is *Taeniatherum crinitum*. In the reserve, the communities of the associations are widespread on the slopes of the Duzenkyr ridge, occasionally, in the western part of the plateau, in the Kyzyljarskiy Sanctuary, in places of the former and current small cattle grazing. The companion species of the wormwood are *Eremostachys labiosa*, *Psoralea drupacea* and *Onobrychis micrantha*. Communities are transitional between the alliances *Stipagrostion pennati* and *Vulpio persicae–Caricion pachystylidis*.

The number of species per site varies from 20 to 32 (25 in average). The TC ranges from 40 to 70 %. The average height of the grass stand is low 10–30 cm.

Alliance *Vulpio persicae–Caricion pachystylidis* Świerszcz et al. 2020

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 the

Table 1. Restricted synoptic table of syntaxa of Kulan Plateau of the Badhyz Reserve. Diagnostic species (grey-shaded values) are those with Φ > 0.25; they are ranked by a decreasing value of Φ. Dots in part (a) of the table. indicate species absence, dashes in part (b) indicate negative fidelity or positive but non-significant fidelity at P < 0.001.

Sytaxa	Lf	(a) percentage frequency (constancy)									(b) phi coefficient (Φ × 100)								
		1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Number of relevés		8	20	13	6	4	10	46	21	24	8	20	13	6	4	10	46	21	24
Diagnostic species of the association *Atraphaxio badghysi–Stipagrostietum pennati*																			
Stipagrostis pennata	H	**88**	20	.	.	.	.	.	.	.	**80.3**	8.1	.	.	.	.	.	.	.
Atraphaxis badghysi	Nf	**50**	.	8	.	.	.	.	.	.	**62.9**	.	1.9	.	.	.	.	.	.
Ceratocarpus utriculosus	T	**38**	5	.	.	.	.	.	.	.	**54.6**	0.5	.	.	.	.	.	.	.
Calligonum eriopodum	Mf	**25**	.	.	.	.	.	.	.	.	**54.6**	0.5	.	.	.	.	.	.	.
Carex physodes	G	**50**	15	.	.	.	10	.	.	.	**53.3**	8.5	.	.	.	2.1	.	.	.
Arnebia transcaspica	T	**63**	5	15	.	25	10	.	.	.	**51.8**	.	2.4	.	12.5	.	.	.	.
Orobanche cumana	G	**25**	.	.	.	.	.	.	.	.	**42.7**	3.3	.	.	.	.	.	.	.
Heliotropium arguzioides	H	**25**	15	8	.	.	2	.	.	.	**30.1**	14.6	3.3	.	.	.	.	.	.
Diagnostic species of the association *Eremopyro bonaeparti–Ammothamnetum lehmannii*																			
Ammothamnus lehmanii	T	.	**45**	23	.	.	10	4	.	.	.	**49.3**	17.1	.	.	1.0	.	.	.
Psylliostachys suworowii	T	.	**60**	38	.	.	10	11	.	8	.	**46.4**	24.6	.	.	.	.	.	.
Taeniatherum crinitum	T	.	**35**	.	.	.	.	11	.	8	.	**43.1**	.	.	.	.	7.2	.	3.4
Artemisia scoparia	H,T	38	**75**	8	17	.	10	41	10	21	10.9	**41.8**	.	.	.	.	14	.	.
Ziziphora tenuior	T	.	**20**	.	.	.	.	.	4	.	.	**37.7**	.	.	.	.	3.6	.	.
Nigella integrifolia	T	.	**40**	8	.	.	.	.	.	25	.	**36.7**	.	.	.	.	4.2	.	18.6
Eremopyrum bonaepartis	T	25	**50**	.	.	.	10	20	.	29	10.1	**34.9**	.	.	.	.	4.7	.	14.2
Allium fibrosum	G	25	**35**	8	.	.	10	.	.	13	17.6	**29.4**	.	.	.	.	.	.	2.9
Diagnostic species of the association *Alysso turkestanici–Artemisietum badhysi*																			
Artemisia badhysi	Ch	13	15	**92**	**100**	**100**	**80**	2	.	.	.	.	**33.9**	**39.4**	**39.4**	**25.1**	.	.	.
Hypecoum trilobum	T	.	20	**31**	**50**	**50**	.	.	.	.	.	3.1	13.3	**31.5**	**31.5**	.	.	.	.
Alyssum turkestanicum	T	25	45	**62**	**67**	**100**	**80**	11	10	.	.	0.5	12.3	15.9	**39.7**	**25.4**	.	.	.
Diagnostic species of the subassociation *At.–Ab. zygophylletosum eurypterum* association *Alysso turkestanici–Artemisietum badhysi*																			
Zygophyllum eurypterum	Nf	.	10	38	**100**	75	10	.	.	.	.	.	10.1	**59.7**	39.6	.	.	.	.
Astragalus campylorhynchus	T	.	5	8	**50**	.	.	.	.	.	.	.	1	**59.8**	.	.	.	.	.
Cousinia congesta	H	.	10	15.	**50**	.	.	17	.	.	.	1.4	8.1	**51.2**	.	.	.	.	.
Alyssum dasycarpum	T	.	5	.	**50**	25	.	.	.	.	.	.	.	**51.1**	20	.	.	.	.
Diagnostic species of the subassociation *At.–Ab. stachyetosum trinervis* association *Alysso turkestanici–Artemisietum badhysi*																			
Cousinia badhysi	Ch	.	5	23	67	**100**	.	.	.	.	.	.	.	31.4	**97.6**	.	.	.	.
Astragalus xiphidioides	H	.	20	15	.	**75**	30	4	.	.	.	3.8	.	.	**56.7**	13.4	.	.	.
Tulipa lehmanniana	G	.	.	31	50	**100**	10	.	.	.	.	.	8.3	24.9	**68.2**	.	.	.	.
Stachys trinervis	Nf	.	.	23	17	**75**	.	.	.	.	.	.	10.9	4.2	**66**	.	.	.	.
Moraea sisyrinchium	G	.	.	31	.	**50**	.	.	.	.	.	.	27	.	**50.7**	.	.	.	.
Astragalus rubrifolius	H	.	.	.	.	**25**	.	.	.	.	.	.	.	.	**47.8**	.	.	.	.
Isatis emarginata	T	.	.	.	.	**25**	.	.	.	.	.	.	.	.	**43.4**	.	.	.	1.8
Trigonella geminiflora	T	.	.	.	.	**25**	.	.	.	.	.	3.3	.	.	**42.7**	.	.	.	.
Isatis bullata	T	.	.	.	.	**25**	.	.	.	.	.	.	.	.	**37.4**	.	.	9.7	.
Holosteum polygamum	T	.	5	**23**	**17**	**50**	**30**	.	.	.	.	.	9.4	2.9	**37**	16.5	.	.	.
Streptoloma desertorum	T	.	20	31	17	**50**	10	.	.	.	.	5.9	16.8	2.5	**36.3**	.	.	.	.
Diagnostic species of the subassociation *At.–Ab. artemisietosum turanicae* association *Alysso turkestanici–Artemisietum badhysi*																			
Artemisia turanica	Ch	.	5	15	.	25	**100**	2	10	.	.	.	.	.	7	**76.9**	.	.	.
Diarthron vesiculosum	T	.	10	8	.	.	**50**	26	.	.	.	.	.	.	.	**45.8**	18.1	.	.
Diagnostic species of the association *Astragalo agametici–Caricetum pachystylidis*																			
Astragalus agameticus	H	.	.	8	.	.	.	**43**	**86**	4	.	.	.	.	.	.	**27**	**68.1**	.
Erysimum badghysi	H	.	10	15	.	.	30	**63**	**90**	8	.	.	.	.	.	4.8	**32.1**	**54.8**	.
Delphinium semibarbatum	H	.	.	.	.	.	.	**65**	**100**	42	.	.	.	.	.	.	**34.7**	**63.7**	15.1
Hyalolaena lipskyi	H	.	5	.	.	.	10	**46**	**95**	4	.	.	.	.	.	.	**25.8**	**71.6**	.
Pseudohandelia umbellifera	H,T	.	10	38	17	.	40	**98**	**100**	67	.	.	.	.	.	.	**40.8**	**42.4**	18.4
Phlomoides labiosa	H	.	.	.	.	.	10	**50**	**43**	17	.	.	.	.	.	.	**38.3**	**30.8**	3.5
Diagnostic species of the subassociation *Aa.–Cp. psoraleae drupaceae* association *Astragalo agametici–Caricetum pachystylidis*																			
Psoralea drupacea	H	.	.	.	.	.	.	24	**67**	4	.	.	.	.	.	.	15.4	**64.7**	.
Onobrychis chorassanica	H	.	.	.	.	.	.	22	**57**	.	.	.	.	.	.	.	16.2	**60.5**	.
Heteropappus canescens	H	.	5	.	.	.	10	22	**48**	.	.	.	.	.	.	0.8	15	**46.4**	.
Gagea stipitata	G	.	.	.	.	.	.	7	**29**	.	.	.	.	.	.	.	4.8	**45.1**	.
Diagnostic species of the association *Salsolo turkestanici– Caricetum pachystylidis*																			
Salsola turkestanica	T	.	60	23	17	.	10	63	52	**92**	.	18.4	.	.	.	.	20.6	12.7	**41.8**
Erodium ciconium	T	.	30	.	.	25	.	24	.	**50**	.	15.8	.	.	10.8	.	9.7	.	**36**
Astragalus filicaulis	T	50	65	62	50	.	70	26	24	**100**	0.3	10.9	8.4	0.3	.	14.4	.	.	**35.6**
Diagnostic species of the suballiance *Poo bulbosae–Ferulenion badrakemii*																			
Ferula badrakema	H	13	60	69	83	100	80	85	24	92	.	.	1.5	12.1	24.7	9.6	13.2	.	18.4
Papaver pavoninum	T	38	90	92	100	75	80	43	19	79	.	16.4	18.1	24	4.9	8.8	.	.	8.1
Cousinia schistoptera	H,T	38	65	77	100	25	80	93	100	75	.	.	3.5	21.8	.	5.9	16.6	21.8	1.9
Astragalus barrowianus	H	63	85	38	50	50	90	85	48	29	2	18.2	.	.	.	21.8	18.1	.	.
Bongardia chrysogonum	G	25	10	69	33	100	50	26	71	33	.	.	16.1	.	37.9	2.5	.	17.7	.
Iris songarica	G	38	80	62	100	25	80	74	14	58	.	15.1	1.9	29.5	.	15.1	10.8	.	.
Phlomoides regeliana	H	.	15	31	50	50	40	50	10	46	.	.	.	13.3	13.3	5.8	13.3	.	10.2
Arnebia decumbens	T	13	80	69	50	.	60	85	100	88	.	14.1	6.4	.	.	.	17.6	28.6	19.6
Lallemantia royleana	T	13	65	46	17	25	30	11	.	54	.	28.1	13.4	.	.	0.8	.	.	19.7
Haplophyllum pedicellatum	H	25	25	15	33	.	60	54	24	50	.	.	.	1.1	.	21.3	17.1	.	13.8
Ixiolirion tataricum	G	.	.	8	33	25	10	7	14	4	.	.	.	24.8	15.4	.	.	3.4	.
Gagea afghanica	G	.	15	31	.	25	40	35	29	54	.	.	4.4	.	.	11.9	7.7	2.6	23.4

Table 1. Continued.

Syntaxa		1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Diagnostic species of the alliance *Vulpio persicae–Caricion pachystylidis*																			
Poa bulbosa	H	.	85	100	100	100	100	100	100	100	.	.	13.5	13.5	13.5	13.5	13.5	13.5	13.5
Carex pachystylis	G	.	20	23	.	.	60	100	100	96	.	.	.	.	.	11.2	39.6	39.6	36.7
Ranunculus sewerzowii	H	13	25	38	.	.	70	91	81	100	.	.	.	.	.	16.7	31.8	24.4	37.9
Other species																			
Bromus oxyodon	T	50	75	62	50	100	60	22	5	17	0.8	18.5	9	0.8	36.2	7.9	.	.	.
Anisantha tectorum	T	25	60	46	33	100	30	9	5	4	.	18.8	8.5	.	48.5	.	.	.	.
Erodium cicutarium	T	13	30	31	.	25	10	24	10	4	.	13.2	14	.	8.4	.	7.4	.	.
Centaurea belangeriana	T	25	20	54	83	.	40	7	10	25	.	.	19.1	42	.	8.4	.	.	.
Stipa hohenackeriana	H	.	15	46	50	.	50	26	5	4	.	.	20.9	24.2	.	24.2	3.7	.	.
Carex subphysodes	G	25	40	54	.	50	20	4	5	13	1.3	13.9	25.4	.	22.2	.	.	.	.
Hypecoum parviflorum	T	.	35	62	.	50	30	9	5	13	.	10.6	33.1	.	23.3	6.4	.	.	.
Senecio subdentatus	T	25	30	8	50	75	20	.	.	4	1.2	5.4	.	22.1	42.9	.	.	.	.
Aphanopleura leptoclada	T	.	85	23	33	.	80	74	38	67	.	28.8	.	.	.	25.3	21	.	15.8
Scabiosa olivieri	T	.	35	8	.	.	30	57	10	8	.	17.8	.	.	.	13.1	38.4	.	.
Holosteum glutinosum	T	13	35	31	33	.	20	.	.	8	.	19	14.9	17.4	.	4.3	.	.	.
Aegilops triuncialis	T	13	55	31	50	.	.	2	.	8	.	34.7	12.2	30	.	.	.	.	.
Lachnophyllum gossypinum	T	.	5	8	.	.	40	50	29	42	.	.	.	.	.	18.7	27.6	8.4	20.1
Leontice armeniaca	G	25	30	38	50	.	20	20	.	.	4.1	8.5	15.9	26.1	.	.	.	.	.
Scorzonera litwinowii	H	.	30	23	.	.	60	74	67	88	.	.	.	.	.	16.1	26.2	21	36.1
Allium leucosphaerum	G	.	40	.	50	.	50	65	86	79	.	.	.	6.4	.	6.4	17.3	32	27.3
Strigosella grandiflora	T	.	10	8	17	25	.	9	14	.	.	1	.	9.2	19.4	.	.	6.3	.
Acanthophyllum korshinskyi	Ch	.	10	46	33	25	.	9	.	.	.	.	33.4	20.2	11.6	.	.	.	.
Bromus pseudodanthoniae	T	.	20	15	17	.	10	9	.	.	.	15.9	9.9	11.6	.	2.8	1.1	.	.
Koelpinia linearis	T	.	30	8	.	25	30	13	.	4	.	19.2	.	.	13.8	19.2	0.9	.	.
Heterocaryum rigidum	T	.	5	15	17	25	.	4	.	13	.	.	6.8	8.3	18.3	.	.	.	13.3
Matthiola robusta	H	25	25	.	.	.	20	7	.	8	18.8	18.8	.	.	.	12.8	.	.	.
Allium caspium	G	.	10	8	.	.	.	22	14	8	.	4.3	1.1	.	.	.	20.7	10.3	2
Ziziphora persica	T	.	15	8	.	.	10	4	.	4	.	17.6	5.3	.	.	9.2	.	.	.
Bromus lanceolatus	T	.	20	8	.	.	10	13	.	.	.	22	3.2	.	.	6.7	11.4	.	.
Dorema aitchisonii	H	.	.	54	33	50	10	.	.	.	.	.	35.8	16.2	32.2	.	.	.	.
Onobrychis micrantha	T	.	.	8	.	.	.	15	10	4	.	.	6.5	.	.	.	20	9.8	0.2
Ceratocephala falcata	T	13	10	15	.	.	10	.	.	4	10.2	6.4	14.5	.	.	6.4	.	.	.
Cuminum setifolium	T	.	5	8	.	.	.	20	24	8	.	.	0.7	.	.	.	17	22.8	1.6
Hordeum leporinum	T	13	25	8	33	.	.	.	.	8	3.4	18.4	.	28.4	.	.	.	.	.
Haplophyllum affine	Ch	.	5	23	.	75	.	.	.	.	.	.	.	1.1	.	21.3	17.1	.	13.8
Atriplex moneta	T	.	.	8	33	25	.	.	.	.	.	.	0.5	35.3	24	.	.	.	.
Astragalus maximowiczii	H	38	15	38	.	.	.	.	.	.	32.1	5.7	33.3	.	.	.	.	.	.
Juno drepanophylla	G	.	.	.	.	.	.	24	52	46	.	.	.	.	.	.	10.7	40.1	33.3

Note. Syntaxa: 1 – association *Atraphaxio badghysi–Stipagrostietum pennati*, 2 – association *Eremopyro bonaeparti–Ammothamnetum lehmannii*, 3 – association *Alysso turkestanici–Artemisietum badhysi*, subassociation *typicum*, 4 – association *Alysso turkestanici–Artemisietum badhysi*, subassociation *At.–Ab. zygophylletosum eurypterum*, 5 – association *Alysso turkestanici–Artemisietum badhysi*, subassociation *At.–Ab. stachyetosum trinervis*, 6 – association *Alysso turkestanici–Artemisietum badhysi*, subassociation *At.–Ab. artemisietosum turanicae*, 7 – association *Astragalo agametici–Caricetum pachystylidis*, subassociation *typicum*, 8 – association Astragalo agametici–Caricetum pachystylidis, subassociation *Aa.–Cp. psoraleae drupaceae*, 9 – association *Salsolo turkestanici– Caricetum pachystylidis.*

Lf – Life forms: T – therophytes, H – hemicryptophytes, G – geoptophytes, Ch –chamaephytes, H, T – hemicryptophytes, therophytes, Nf – nanophanerophytes, Mf – mesophanerophytes.

Middle Asia they occur in the western foothills of Pamir-Alai, the Ferghana Valley and the western slopes of the Tian Shan Mts. (Świerszcz et al. 2020).

In the absence of a complete syntaxonomic scheme of the vegetation of Central Asia, we decided to classify the communities described by us as part of this alliance. Common species for Kulan plateau (Turkmenistan) and the Pamir-Alai and western Tian Shan Mountains (Świerszcz et al. 2020) are *Carex pachystylis*, *Hypecoum trilobum*, *Poa bulbosa*, *Ranunculus sewerzowii*. They can be considered as diagnostic species of the union on the territory of the Badkhyz Reserve.

Suballiance *Poo bulbosae–Ferulenion badrakemii*
Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov
suball. nov. The ass. *Alysso turkestanici–Artemisietum badhysi* Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.** (described in this paper) is chosen as the **Typus (holotypus)** hoc loco of this suballiance

Diagnostic species: *Astragalus barrowianus*, *A. filicaulis*, *Arnebia decumbens*, *Bongardia chrysogonum*, *Cousinia schistoptera*, *Ferula badrakema*, *Gagea afghanica*, *Haplophyllum pedicellatum*, *Iris songarica*, *Ixiolirion tataricum*, *Lallemantia royleana*, *Papaver pavoninum*, *Phlomoides regeliana*, *Salsola turkestanica.*

The suballiance encompasses the ephemeral vegetation of the Badhyz foothills. The communities of the suballiance are found on the entire area of the Kulan plateau. Apparently, in the future they will be described outside the reserve on the territory of the southeastern Turkmenistan and Afghanistan, within the Parapameisos and the Kopet Dag Mountain Ranges. The typical appearance of the alliance communities is shown in Figure 2B.

The communities have two explicit layers. The lower layer is dominated by *Poa bulbosa* and *Carex pachystylis*. The upper layer features tall grasses with a Badhyz endemic *Ferula badrakema* standing out. In the years of mass flowering and fruiting of the Ferula (it blooms only once in the 7th or 8th year of life, shooting a flower arrow up to 170 cm tall). The range of *Ferula badrakema* covers the southeast of Turkmenistan and the north of Afghanistan. It is encountered in the low foothills in the area of contact with sandy deserts, on sands and sandy-loessic soils (Borisova et al. 1932). In addition to the *Ferula*, the upper vegetation sublayer of the Kulan plateau is characterized by the species found in the foothills of southwestern Turkmenistan: *Astragalus agameticus*, *Hyalolaena lipskyi* (endem), as well as the plants with wider areals covering the foothill areas and the lower belt of the mountains of Central Asia (the Pamir-Altai, the Tien Shan, the Iranian plateau, etc.): *Eremostachys labiosa*, *Iris songarica* (Borisova et al. 1932).

In some parts of the plateau, the ferula and other tall herb species give way to dwarf shrubs (mainly *Artemisia* species).

Table 2. Association ***Atraphaxio badghysi–Stipagrostietum pennati***

Relévе area, m²	100	100	100	100	100	100	100	100	%
Total cover, %	70	75	55	70	25	65	30	45	
Average height herbs, sm	15	15	12	25	20	12	30	25	
Aspect	0	0	0	180	0	90	0	360	
Number of species	5	2	5	10	15	16	19	20	
TURBOVEG number	87	89	98	82	5	94	130	147	
Sequence number	1	2	3	4	5	6	7	**8***	
Diagnostic species of the association *Atraphaxio badghysi–Stipagrostietum pennati* and the alliance *Stipagrostion pennati*									
Stipagrostis pennata	1	1	2	2	1	·	3	3	88
Arnebia transcaspica	·	·	r	+	·	r	+	+	63
Atraphaxis badghysi	+	·	·	·	+	·	1	1	50
Carex physodes	·	·	r	r	·	·	+	+	50
Ceratocarpus utriculosus	·	·	·	+	·	·	+	+	38
Heliotropium arguzioides	·	·	·	·	·	·	1	+	25
Orobanche cumana	·	·	·	·	·	·	+	+	25
Calligonum eriopodum	r	1	·	·	·	·	·	·	25
Diagnostic species of the suballiance *Poo bulbosae–Ferulenion badrakemii* and the alliance *Vulpio persicae–Caricion pachystylidis*									
Astragalus barrowianus	·	·	·	+	+	r	1	+	63
Astragalus filicaulis	·	·	·	+	·	r	+	+	50
Cousinia schistoptera	·	·	·	·	1	·	+	+	38
Papaver pavoninum	·	·	·	·	+	·	+	+	38
Iris songarica	·	·	r	·	+	r	·	·	38
Bongardia chrysogonum	·	·	·	+	·	+	·	·	25
Haplophyllum pedicellatum	·	·	·	·	·	·	+	+	25
Other species									
Bromus oxyodon	·	·	·	+	·	1	+	+	50
Artemisia scoparia	·	·	·	·	1	·	+	+	38
Astragalus maximowiczii	·	·	·	·	+	·	1	+	38
Eremopyrum bonaepartis	·	·	·	·	·	·	+	+	25
Leontice armeniaca	·	·	·	+	·	+	·	·	25
Senecio subdentatus	·	·	·	·	·	·	+	+	25
Allium fibrosum	·	·	·	·	·	·	+	+	25
Matthiola robusta	·	·	·	·	·	·	+	+	25
Anisantha tectorum	·	·	·	·	r	·	·	+	25
Carex subphysodes	r	·	·	·	·	r	·	·	25
Centaurea belangeriana	·	·	·	·	r	r	·	·	25
Alyssum turkestanicum	·	·	·	·	r	r	·	·	25

Taxa in one relevé: *Aegilops triuncialis* 5 (+); *Arnebia decumbens* 5 (+); *Artemisia badhysi* 3 (r); *Astragalus unifoliolatus* 1 (r); *Ceratocephala falcata* 6 (r); *Erodium cicutarium* 6 (r); *Ferula badrakema* 6 (1); *Goldbachia laevigata* 4 (+); *Holosteum glutinosum* 6 (r); *Hordeum leporinum* 5 (+); *Lallemantia royleana* 6 (r); *Merendera robusta* 5 (+); *Ranunculus sewerzowii* 6 (2).

Localities of relevés. 1 – 400 m W of the Peschanaya trig point, 16.04.1991, 35.777909 N, 61.886097 E; **2** – 2.6 km E of the Peschanaya trig point, 16.04.1991, 35.775578ºN 61.928304ºE; **3** – 750 m W of the Lysaya trig point, 11.04.1991, 35.731466ºN 61.874960ºE; **4** – 600 m E of the Lysaya trig point, 18.04.1991, 35.733932ºN 61.883436ºE; **5** – 5.5 km S of the Kyzyljar lodge, 17.04.1991, 35.776959ºN 61.847001ºE; **6** – 1 km W of the Uglovaya trig point, 13.04.1991, 35.747228ºN 61.924763ºE; **7** – 2.5 km S of the Kepelinskaya road from 11 km of the Kyzyljar lodge, 08.06.1990, 35.797681ºN 61.721744ºE; **8** – 2.5 km S of the Kepelinskaya road, 15.05.1990, 35.803393ºN 61.862622ºE.

***** – **holotypus**: Turkmenistan, Mariysky Velayat, Badhyz Reserve, 2.5 km S of the Kepelinskaya road, 05.15.1990, 35.803393ºN 61.862622ºE. Author – N. Polyakova.

Association *Alysso turkestanici–Artemisietum badhysi*
Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.** (Table 1, col. 3–5; Tables 4–5, **holotypus** hoc loco – Table 4, rel. 14: cliff faces S of the Uglovaya trig point, 100 m from cliffs, 04.12.1991, 35.739601ºN 61.937981ºE. Author – N. Polyakova)

Diagnostic species: *Alyssum turkestanicum*, *Hypecoum trilobum*, *Artemisia badhysi* (dominant, codominant).

It incorporates the communities of the verge of the cliffs along the Kyzyljar canyon and endorheic depressions. Plant communities develop primarily on rubble and sandy shallow grey soils. The predominant species is *Artemisia badhysi*, which is confined to sandy and clay deserts, foothills, mountains, and is found throughout the territory of Turkmenistan. In the communities of the association, therophyte species *Anisantha tectorum*, *Bromus oxyodon*, *Eremopyrum bonaepartis*, *Psylliostachys suworowii*, *Taeniatherum crinitum*,

Table 3. Association ***Ammothamno lehmannii–Artemisietum scopariae***

Relévе area, m²	100	100	100	100	100	100	100	100	100	100	%
Total cover, %	55	70	40	60	40	45	40	60	70	40	
Average height herbs, sm	10	15	12	30	20	15	20	20	12	20	
Number of species	28	23	26	25	23	30	32	24	20	25	
TURBOVEG number	256	262	261	70	71	285	90	103	249	47	
Sequence number	1	2	3	4	5	**6***	7	8	9	10	
Diagnostic species of the association *Ammothamno lehmannii–Artemisietum scopariae*											
Artemisia scoparia	r	1	r	2	1	2	2	+	4	3	100
Psylliostachys suworowii	·	r	+	+	+	r	+	·	r	+	80
Eremopyrum bonaepartis	·	r	·	1	1	r	1	+	r	·	70
Taeniatherum crinitum	·	+	+	+	+	+	·	+	·	·	60
Ammothamnus lehmannii	2	·	2	+	·	r	2	·	·	·	50
Nigella integrifolia	·	r	·	·	+	r	·	·	·	1	40
Allium fibrosum	·	·	·	·	·	·	+	+	·	+	30
Ziziphora tenuior	·	·	·	·	+	·	·	·	+	+	30
Diagnostic species of the alliance *Stipagrostion pennati*											
Carex physodes	·	·	·	·	·	·	·	+	·	1	20
Stipagrostis pennata	·	·	·	+	·	·	·	+	·	·	20
Diagnostic species of the suballiance *Poo bulbosae–Ferulenion badrakemii* and the alliance *Vulpio persicae–Caricion pachystylidis*											
Papaver pavoninum	2	1	r	+	1	1	+	+	r	1	100
Astragalus barrowianus	1	+	r	2	2	r	+	+	·	1	90
Arnebia decumbens	1	·	r	3	2	·	+	2	r	1	80
Iris songarica	r	·	r	+	+	1	+	·	r	1	80
Poa bulbosa	r	1	1	·	·	1	·	+	r	1	70
Cousinia schistoptera	1	+	+	1	·	1	2	1	·	·	70
Lallemantia royleana	r	2	r	·	·	r	+	+	r	·	70
Ferula badrakema	·	r	r	+	+	1	·	·	·	1	60
Astragalus filicaulis	1	r	1	·	·	·	·	+	r	1	60
Salsola turkestanica	1	2	1	·	r	r	·	·	1	·	60
Ranunculus sewerzowii	·	·	·	·	·	r	·	+	·	r	30
Haplophyllum pedicellatum	r	+	·	·	·	·	·	·	·	·	20
Phlomoides regeliana	r	·	r	·	·	·	·	·	·	·	20
Other species											
Aphanopleura leptoclada	1	+	r	+	1	r	+	1	r	·	90
Bromus oxyodon	r	+	r	·	1	r	·	+	+	1	80
Aegilops triuncialis	r	r	r	+	1	·	r	·	+	·	70
Anisantha tectorum	·	·	·	r	1	2	1	2	·	r	60
Carex subphysodes	r	·	·	+	+	·	+	·	r	·	50
Alyssum turkestanicum	r	r	r	·	·	r	·	·	+	·	50
Senecio subdentatus	+	·	·	r	·	·	·	+	+	·	40
Allium leucosphaerum	+	·	·	+	+	+	·	·	·	·	40
Erodium ciconium	r	r	r	·	·	·	·	·	·	+	40
Scabiosa olivieri	r	·	·	·	·	r	·	·	·	1	30
Matthiola robusta	·	·	1	·	·	+	·	·	+	·	30
Hypecoum parviflorum	·	·	·	·	+	·	+	·	·	1	30
Bromus lanceolatus	·	·	·	1	·	·	+	·	·	+	30
Holosteum glutinosum	·	r	·	·	·	+	·	+	·	·	30
Hordeum leporinum	·	·	·	+	·	·	+	·	·	+	30
Hypecoum trilobum	+	r	·	r	·	·	·	·	·	·	30
Scorzonera litwinowii	·	r	+	·	·	r	·	·	·	·	30
Koelpinia linearis	r	·	·	·	r	·	·	+	·	·	30
Erodium cicutarium	·	·	·	·	r	+	·	·	·	·	20
Acanthophyllum korshinskyi	·	·	·	+	·	·	·	+	·	·	20
Ziziphora persica	·	·	·	·	·	+	·	+	·	·	20
Trisetaria cavanillesii	·	·	·	·	·	+	·	·	+	·	20
Astragalus xiphidioides	·	·	·	·	r	+	·	·	·	·	20
Strigosella hispida	·	·	r	·	r	·	·	·	·	·	20
Streptoloma desertorum	·	·	·	·	·	r	·	·	·	r	20

Taxa in one relevé: *Artemisia turanica* 4 (+); *Astragalus campylorhynchus* 1 (+); *Bromus pseudodanthoniae* 2 (+); *Carex pachystylis* 3 (1); *Centaurea belangeriana* 8 (1); *Cousinia congesta* 1 (1); *Diarthron vesiculosum* 3 (r); *Erysimum badghysi* 4 (+); *Gagea afghanica* 9 (r); *Heliotropium arguzioides* 6 (+); *Heteropappus canescens* 1 (+); *Lachnophyllum gossypinum* 3 (r); *Leontice armeniaca* 7 (+); *Lomelosia rhodantha* 8 (+); *Merendera robusta* 10 (+); *Polygonum paronychioides* 7 (+); *Pseudohandelia umbellifera* 10 (+); *Rheum turkestanicum* 4 (+); *Stipa hohenackeriana* 1 (+); *Strigosella grandiflora* 10 (r).

Localities of relevés. 1 – 1 km W of the Stolbovaya trig point, 08.05.1991, 35.731483ºN 61.833525ºE; **2** – 2.6 km W of the Kustarnikovaya trig point, 10.05.1991, 35.727284ºN 61.772028ºE; **3** – 1.6 km W of the Kustarnikovaya trig point, 10.05.1991, 35.727223ºN 61.783030ºE; **4** – 4 km S of the Kepelinskaya road, 09.05.1990, 35.787870ºN 61.815243ºE; **5** – 4.5 km S of the Kepelinskaya road, 09.05.1990, 35.783376ºN 61.814943ºE; **6** – 1.5 km W of the Pridorozhnaya trig point, 14.05.1991, 35.778078ºN 61.782368ºE; **7** – 2.5 km S of the Kyzyljar lodge, 15.05.1991, 35.803347ºN 61.875932ºE; **8** – 5.5 km S of the Kyzyljar lodge, 17.05.1990, 35.775970ºN 61.891032ºE; **9** – 3 km N of the Stolbavaya trig point, 06.05.1991, 35.759891ºN 61.828118ºE; **10** – 5 mn S от of the Kepelinskaya road, 24.04.1990, 35.778008ºN 61.804772 E.

* – **holotypus**. Turkmenistan, Mariysky Velayat, Badhyz Reserve, 1.5 km W of the Pridorozhnaya trig point, 14.05.1991, 35.778078ºN 61.782368ºE. Author – N. Polyakova.

Table 4. Association ***Alysso turkestanici–Artemisietum badhysi***, subassociations ***At.–Ab. zygophylletosum eurypterum, At.–Ab. stachyetosum trinervis, typicum***

Variant	*zygophylletosum eurypterum*							*stachyetosum trinervis*					*typicum*								
Relévе area, m²	100	100	100	100	100	100		100	100	100	100		100	100	100	100	100	100	100	100	
Total cover, %	55	70	55	55	60	60		60	70	55	70		50	55	60	65	70	75	60	15	
Average height herbs, sm	12	20	20	15	10	20	%	20	20	20	15	%	20	25	10	25	15	30	15	30	%
Aspect	0	0	0	0	0	0		0	0	0	0		360	0	0	90	0	23	0	0	
Number of species	25	23	22	21	21	23		24	23	26	22		22	31	23	21	32	27	24	28	
TURBOVEG number	81	8	84	68	79	9		7	13	14	6		135	152	11	16	12	15	96	88	
Sequence number	1	2	3	4	**5****	6		7	8	**9*****	10		11	12	13	**14***	15	16	17	18	
Diagnostic species of the association *Alysso turkestanici–Artemisietum badhysi*																					
Artemisia badhysi	2	3	3	3	3	3	100	1	1	2	1	100	2	2	2	4	4	3	3	2	100
Alyssum turkestanicum	·	r	r	·	r	r	67	r	1	1	r	100	1	r	2	r	1	r	1	·	88
Hypecoum trilobum	1	r	+	·	·	·	50	·	·	+	1	50	·	·	·	·	·	·	·	1	13
Diagnostic species of the subassociation *At.–Ab. zygophylletosum eurypterum*																					
Zygophyllum eurypterum	3	2	2	2	2	2	100	2	1	·	r	75	·	r	·	·	+	r	·	·	38
Alyssum dasycarpum	r	r	r	·	·	·	50	r	·	·	·	25	·	·	·	·	·	·	·	·	·
Cousinia congesta	·	·	·	+	r	r	50	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Astragalus campylorhynchus	·	·	+	·	+	r	50	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic species of the subassociation *At.–Ab. stachyetosum trinervis*																					
Cousinia badhysi	·	2	2	+	·	+	67	2	2	2	3	150	·	·	·	+	·	·	·	+	25
Tulipa lehmanniana	+	r	r	·	·	·	50	1	r	r	r	100	1	r	·	·	+	·	·	+	50
Stachys trinervis	·	·	·	+	·	·	17	2	3	3	1	75	·	·	·	r	+	·	·	·	25
Astragalus xiphidioides	·	·	·	·	·	·	·	+	·	r	r	75	·	·	·	·	+	·	·	·	13
Moraea sisyrinchium	·	·	·	·	·	·	·	·	r	r	·	50	+	·	·	·	+	·	·	+	38
Streptoloma desertorum	+	·	·	·	·	·	17	·	r	·	r	50	·	·	·	·	r	·	r	+	38
Holosteum polygamum	·	r	·	·	·	·	17	r	·	r	·	50	·	·	1	r	r	·	·	·	38
Isatis bullata	·	·	·	·	·	·	·	1	·	·	·	25	·	·	·	·	·	·	·	·	·
I. emarginata	·	·	·	·	·	·	·	·	·	+	·	25	·	·	·	·	·	·	·	·	·
Trigonella geminiflora	·	·	·	·	·	·	·	·	·	+	·	25	·	·	·	·	·	·	·	·	·
Astragalus rubrifolius	·	·	·	·	·	·	·	r	·	·	·	25	·	·	·	·	·	·	·	·	·
Diagnostic species of the suballiance *Poo bulbosae–Ferulenion badrakemii* and the alliance *Vulpio persicae–Caricion pachystylidis*																					
Poa bulbosa	r	1	1	1	2	2	100	1	1	1	1	100	1	1	2	1	1	2	2	1	100
Ferula badrakema	r	+	+	·	+	+	83	+	r	+	r	100	1	r	+	+	r	r	r	+	100
Papaver pavoninum	r	r	r	r	r	r	100	r	r	r	·	75	+	·	1	1	1	r	1	r	88
Cousinia schistoptera	r	r	r	+	+	+	100	+	·	·	·	25	1	·	·	·	1	r	+	+	63
Iris songarica	+	+	+	r	r	r	100	·	·	·	+	25	1	+	·	·	r	·	·	+	50
Bongardia chrysogonum	·	r	r	·	·	·	33	r	+	+	r	100	1	·	r	1	r	r	r	r	88
Astragalus filicaulis	r	·	·	·	1	1	50	·	·	·	·	60	·	r	1	·	·	1	1	1	50
Arnebia decumbens	r	r	r	·	·	·	50	·	·	·	·	·	1	+	1	·	r	·	r	·	63
Astragalus barrowianus	+	·	·	·	r	r	63	r	·	·	+	90	·	·	+	·	r	·	·	·	50
Phlomoides regeliana	·	+	+	·	·	+	50	·	·	+	+	50	+	·	·	·	+	·	·	1	38
Ixiolirion tataricum	·	r	r	·	·	·	33	+	·	·	·	25	+	·	·	·	·	·	·	·	13
Gagea afghanica	·	·	·	·	·	·	·	·	·	r	·	25	·	·	r	r	·	1	·	r	50
Ranunculus sewerzowii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1	1	r	1	1	·	63
Haplophyllum pedicellatum	·	+	+	·	·	·	33	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Other species																					
Bromus oxyodon	·	·	·	r	+	+	50	1	1	1	1	100	·	r	·	1	1	r	1	·	63
Anisantha tectorum	2	·	·	r	·	·	33	1	1	r	1	100	·	r	·	r	2	·	r	·	50
Senecio subdentatus	+	·	·	·	r	r	50	+	r	r	·	75	·	·	·	·	r	·	·	·	13
Acanthophyllum korshinskyi	·	·	·	·	+	r	33	·	·	r	·	25	·	r	·	+	+	+	·	·	50
Dorema aitchisonii	+	·	·	r	·	·	33	·	r	r	·	50	+	1	·	r	·	·	·	·	38
Lallemantia royleana	r	·	·	·	·	·	17	·	r	·	·	25	·	·	r	·	·	r	1	+	50
Centaurea belangeriana	r	+	r	·	+	+	83	·	·	·	·	·	·	·	1	·	1	r	r	r	63
Leontice armeniaca	+	+	+	·	·	·	50	·	·	·	·	·	·	·	r	·	+	+	·	·	38
Aphanopleura leptoclada	·	·	·	·	r	r	33	·	·	·	·	·	·	·	·	·	·	1	·	r	25
Aegilops triuncialis	·	·	·	2	1	1	50	·	·	·	·	·	·	+	·	·	·	·	·	·	13
Holosteum glutinosum	r	·	r	·	·	·	33	·	·	·	·	·	+	·	·	·	·	·	r	r	38
Stipa hohenackeriana	·	·	·	1	+	+	50	·	·	·	·	·	1	r	·	·	·	·	·	+	38
Hordeum leporinum	·	·	·	·	r	r	33	·	·	·	·	·	·	·	1	·	·	·	·	·	13
Haplophyllum affine	·	·	·	·	·	·	·	·	r	r	r	75	·	r	·	·	·	·	·	r	25
Hypecoum parviflorum	·	·	·	·	·	·	·	·	r	1	·	50	1	·	1	r	1	r	r	1	88
Carex subphysodes	·	·	·	·	·	·	·	·	1	1	·	50	·	r	r	·	·	1	1	1	63
Erodium cicutarium	·	·	·	·	·	·	·	·	+	·	·	25	·	·	r	·	1	·	r	·	38
Heterocaryum rigidum	+	·	·	·	·	·	17	·	·	r	·	25	·	·	·	+	·	·	·	·	13
Allium leucosphaerum	·	·	·	r	r	r	50	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Astragalus maximowiczii	·	·	·	·	·	·	·	·	·	·	·	·	+	+	+	·	+	·	·	·	50
Scorzonera litwinowii	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	+	·	+	38
Pseudohandelia umbellifera	+	·	·	·	·	·	17	·	·	·	·	·	·	·	·	·	+	+	+	+	50
Atriplex moneta	·	+	+	·	·	·	33	·	·	·	+	25	·	·	·	·	·	·	·	·	·
Strigosella grandiflora	+	·	·	·	·	·	17	r	·	·	·	25	1	·	·	·	·	·	·	·	13
Artemisia turanica	·	·	·	·	·	·	·	·	·	·	2	25	·	+	·	·	·	+	·	·	25
Arnebia transcaspica	·	·	·	·	·	·	·	·	r	·	·	25	·	·	·	·	·	+	·	+	25
Psylliostachys suworowii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	r	·	·	38
Astragalus nigricans	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·	·	25
Ceratocephala falcata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1	·	·	·	r	·	25

Taxa in one relevé: *Allium caspium* 16 (+); *A. fibrosum* 18 (+); *Ammothamnus lehmannii* 17 (r); *Artemisia scoparia* 1 (r), 17 (r); *Astragalus agameticus* 11 (1); *A. campylotrichus* 2 (r); *A. unifoliolatus* 12 (2); *Atraphaxis badghysi* 14 (+); *Bassia hyssopifolia* 18 (+); *Bromus lanceolatus* 11 (1); *B. pseudodanthoniae* 4 (r), 12 (r); *Carex pachystylis* 11 (1); *Crucianella filifolia* 4 (r); *Descurainia sophia* 4 (+); *Diarthron vesiculosum* 12 (r); *Elaeosticta transcaspica* 14 (+); *Ephedra intermedia* 14 (2); *Erodium ciconium* 7 (r); *Erophila verna* 16 (1); *Euphorbia densa* 4 (r); *Goldbachia torulosa* 13 (+); *Halothamnus auriculus* 2 (r); *Heliotropium arguzioides* 12 (+); *Henrardia persica* 12 (r); *Hypecoum pendulum* 8 (r); *Koelpinia linearis* 10 (r), 15 (r); *Krascheninnikovia ceratoides* 4 (r), 12 (1); *Lachnophyllum gossypinum* 12 (r); *Meniocus linifolius* 12 (r); *Onobrychis micrantha* 12 (+); *Rheum turkestanicum* 15 (r); *Salsola richteri* 12 (r); *S. turkestanica* 4 (r); *Scabiosa olivieri* 17 (+); *Ziziphora persica* 12 (r).

Localities of relevés. 1 – 750 m S of the Stolbavaya trig point, 06.05.1991, 35.723644ºN 61.836014ºE; **2** – 300 m E of the Lysaya trig point, 17.04.1991, 35.736872ºN 61.883994ºE; **3** – 1.7 km W of the Lysaya trig point, 18.04.1991, 35.736102ºN 61.861592ºE; **4** – 1 km N of the cliffs on 8 km of road, 10.05.1991, 35.729523ºN 61.805802ºE; **5, 6** – 1 km E of the Stolbavaya trig point, 06.05.1991, 35.730923ºN 61.857944ºE; **7** – 750 m of the Peschanaya trig point, 17.05.1991, 35.773322ºN 61.904765ºE; **8** – S of the Uglovaya trig point, 12.04.1991,

Table 4. Continued.

35.738691°N 61.938668°E; **9** – S of the Uglovaya trig point, 12.04.1991, 35.738691°N 61.938668°E; **10** – 250 m S of the 3 km of the Morgunovskaya road, 16.04.1991, 35.834502°N 61.882706°E; **11** – Namaksar, 4 km N of the natural reserve border, 11.04.1990, 35.714767°N 61.725181°E; **12** – E of the Peschanaya trig point, 23.05.1990, 35.775490°N 61.931973°E; **13** – 1 km E of the Uglovaya trig point, 08.05.1991, 35.748117°N 61.949090°E; **14** – cliffs S of the Uglovaya trig point, 12.04.1991, 35.739601°N 61.937981°E; **15** – 2 km E of the Uglovaya trig point, 12.04.1991, 35.748076°N 61.959997°E; **16** – 1 km W of the Uglovaya trig point, 12.04.1991, 35.748557°N 61.926652°E; **17, 18** – 1.6 km E of the Peschanaya trig point, 16.04.1991, 35.772693°N 61.916953°E.

***** – **holotypus** of the association ***Alysso turkestanici–Artemisietum badhysi***. Turkmenistan, Mariysky Velayat, Badhyz Reserve, cliff faces S of the Uglovaya trig point, 100 m from cliffs, 12.04.1991, 35.739601°N 61.937981°E. Author – N. Polyakova.

****** – **holotypus** of the subassociation ***At.–Ab. zygophylletosum eurypterum***. Turkmenistan, Mariysky Velayat, Badhyz Reserve, 1 km E of the Stolbavaya trig point, 06.05.1991, 35.730923°N 61.857944°E. Author – N. Polyakova.

******* – **holotypus** of the subassociation ***At.–Ab. stachyetosum trinervis.*** Turkmenistan, Mariysky Velayat, Badhyz Reserve, S of the Uglovaya trig point, 12.04.1991, 35.738691°N 61.938668°E. Author – N. Polyakova.

Ziziphora tenuior play a significant role. The number of species per site ranges from 20 to 32 (24 on average). The TC varies widely from 15 to 85 %. The average height of the grass stand is low 10–30 cm.

The diversity of the communities within the association manifests itself in 4 subassociations: *typicum*, *At.–Ab. zygophylletosum eurypterum*, *At.–Ab. stachyetosum trinervis* and *At.–Ab. artemisietosum turanicae.*

Subassociation *typicum* (table 4, col. 11–18).

Diagnostic species of the subassociation are equal to diagnostic species of the association.

The number of species per site ranges from 21 to 32 (26 on average). TC varies widely from 15 to 75 %. The average height of the grass stand is low 10-30 cm. The communities are characterized by the predominance of *Artemisia badhysi.*

Subassociation *At.–Ab. zygophylletosum eurypterum* Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **subass. nov.** (table 4, col. 1–6, **holotypus** hoc loco – Table 4, rel. 5: 1 km E of the Stolbavaya trig point, 06.05.1991, 35.730923°N 61.857944°E. Author – N. Polyakova)

Diagnostic species: *Alyssum dasycarpum*, *Astragalus campylorhynchus*, *Cousinia congesta*, *Zygophyllum eurypterum* (dominant, codominant).

The communities of the subassociation are characterized by the dominance and co-dominance of *Zygophyllum eurypterum*, which is the species typical of rocky, rubble and skeletonless slopes. Among the species characteristic of silt rocks is *Cousinia congesta*. The number of species per site ranges from 21 to 25 (22 on average). The TC varies from 55 to 70 %. The average height of the grass stand is low 10–20 cm.

Subassociation *At.–Ab. stachyetosum trinervis* Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **subass. nov.** (table 4, col. 7–10; Fig. 2C, **holotypus** hoc loco – Table 4, rel. 9: S of the Uglovaya trig point, 12.04.1991, 35.738691°N 61.938668°E. Author – N. Polyakova)

Diagnostic species: *Astragalus rubrifolius*, *A. xiphidioides*, *Cousinia badhysi* (dominant, codominant), *Holosteum polygamum*, *Isatis bullata*, *I. emarginata*, *Moraea sisyrinchium*, *Stachys trinervis* (dominant, codominant), *Streptoloma desertorum*, *Trigonella geminiflora*, *Tulipa lehmanniana*.

The communities of the subassociation are characterized by the predominance of *Cousinia badhysi* and *Stachys trinervis*, which are the species typical of skeletonless and rubble slopes. *Cousinia badhysi* and *Tulipa lehmanniana* are listed in the Red Book of Turkmenistan (Annabayramov 2011). The number of species per site ranges from 21 to 26 (24 on average). The TC varies from 55 to 70 %. The average height of the grass stand is low 15–20 cm.

Subassociation *At.–Ab. artemisietosum turanicae* Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **subass. nov.** (table 5, **holotypus** hoc loco – Table 5, rel. 5: Namaksar, 5 km N of the natural reserve border, 24.05.1992, 35.755414°N 61.703148°E. Author – N. Polyakova)

Diagnostic species: *Artemisia turanica* (dominant, codominant), *Diarthron vesiculosum*.

Artemisia turanica is found in deserts on clay, sandy loam and rubble soils in the low foothills of the Eastern Kopet Dag and Badhyz. The communities of the variant are related to the cliff faces of the Kyzyljar and reflect weak soil crushing, as well as to the verge of the cliffs of Eroylanduz and partly of Namaksaar – the areas where bedrocks come to the surface. They correspond to "relic Badhyz phryganoid vegetation" (herb-rich steppe) according to Kamelin (1989). The number of species per site ranges from 20 to 30 (23 on average). The TC varies from 40 to 85 %. The average height of the grass stand is low 10–30 cm.

Association *Astragalo agametici–Caricetum pachystylidis* Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.** (Table 1, col. 6–7; Tables 6, 7, **holotypus** hoc loco – Table 6, rel. 9: 3.5 km S of the Kepelinskaya road, 13 km from the Kyzyljar lodge, 05.30.1990. Author – N. Polyakova)

Diagnostic species: *Astragalus agameticus*, *Erysimum badghysi*, *Delphinium semibarbatum*, *Hyalolaena lipskyi*, *Pseudohandelia umbellifera*, *Phlomoides labiosa.*

The communities are most often dominated by *Carex pachystylis* and *Poa bulbosa*. They are the richest in species of the plateau territory, confined to deep high-humic grey soils (more rarely sandy) and extend in a wide area in the northern and northwestern parts of the plateau, occupying the macroslope of the southern and southeastern exposure of the Duzenkyr and Ellibir Ridges.

The communities are characterized by a significant occurrence of the hemicryptophyte species (*Carex pachystylis*, *Delphinium semibarbatum*, *Haplophyllum pedicellatum*, *Heteropappus canescens*, *Onobrychis chorassanica*, *Pseudohandelia umbellifera*). The number of species per site ranges from 15 to 30 (21 on average). The TC varies from 40 to 95%. The average height of the grass stand varies from 20 to 45 cm.

The diversity of the association communities manifests itself in two subassociations: *typicum* and *Aa.–Cp. psoraleae drupaceae.*

Subassociation *typicum* (table 6)

Diagnostic species of the subassociation are equal to diagnostic species of the association.

The number of species per site ranges from 19 to 30 (22 on average). The TC varies widely from 45 to 90 %. The average height of the grass stand is low 20–45 cm.

Subassociation *Aa.–Cp. psoraleae drupaceae* Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **subass. nov.** (table 7, **holotypus** hoc loco – Table 7, rel. 10: 1.5 km N of the Kepelinskaya road, 12 km from the Kyzyljar lodge, 05.06.1990, 35.834991°N 61.702633°E. Author – N. Polyakova)

Table 5. Association ***Alysso turkestanici–Artemisietum badhysi*** and subassociation ***At.–Ab. artemisietosum turanicae***

Reléve area, m²	100	100	100	100	100	100	100	100	%
Total cover, %	70	70	40	85	80	85	85	80	
Average height herbs, sm	20	10	10	20	30	25	20	20	
Number of species	24	22	22	24	30	26	20	20	
TURBOVEG number	18	92	17	22	23	21	19	20	
Sequence number	1	2	3	4	**5***	6	7	8	
Diagnostic species of the association *Alysso turkestanici–Artemisietum badhysi*									
Artemisia badhysi	2	2	r	3	2	3	3	4	100
Alyssum turkestanicum	r	·	r	r	r	r	r	r	88
Diagnostic species of the subassociation A.t.–A.b. *artemisietosum turanicae*									
Artemisia turanica	2	3	3	3	4	4	3	2	100
Diarthron vesiculosum	·	·	·	r	r	+	+	r	63
Diagnostic species of the suballiance *Poo bulbosae–Ferulenion badrakemii* and the alliance *Vulpio persicae–Caricion pachystylidis*									
Poa bulbosa	2	2	1	3	2	3	2	2	100
Ferula badrakema	·	r	+	r	1	2	1	2	88
Astragalus barrowianus	+	r	r	1	+	+	r	·	88
Papaver pavoninum	r	r	1	·	r	r	+	·	75
Astragalus filicaulis	1	2	·	·	1	1	r	r	75
Cousinia schistoptera	+	·	+	·	r	r	+	+	75
Iris songarica	+	+	·	r	r	+	r	·	75
Ranunculus sewerzowii	·	1	1	r	r	+	·	·	63
Carex pachystylis	·	·	·	2	2	2	1	1	63
Haplophyllum pedicellatum	·	·	+	r	r	r	r	·	63
Phlomoides regeliana	·	r	·	+	+	+	·	·	50
Arnebia decumbens	r	r	·	·	·	+	·	r	50
Gagea afghanica	r	1	r	·	·	·	·	·	38
Bongardia chrysogonum	r	·	r	r	·	·	·	·	38
Other species									
Aphanopleura leptoclada	1	r	·	1	1	1	r	1	88
Stipa hohenackeriana	·	·	·	+	r	r	r	r	63
Bromus oxyodon	1	·	·	+	+	·	r	+	63
Allium leucosphaerum	·	·	·	r	r	1	r	r	63
Scorzonera litwinowii	·	r	·	r	r	r	·	+	63
Lachnophyllum gossypinum	·	·	·	r	r	r	·	r	50
Pseudohandelia umbellifera	+	·	·	·	+	+	·	+	50
Erysimum badghysi	·	·	·	+	·	+	·	+	38
Holosteum polygamum	1	·	+	·	·	r	·	·	38
Koelpinia linearis	·	·	·	·	+	+	+	·	38
Lallemantia royleana	r	r	1	·	·	·	·	·	38
Astragalus xiphidioides	·	·	·	+	+	+	·	·	38
Scabiosa olivieri	r	·	·	r	r	·	·	·	38
Hypecoum parviflorum	1	·	+	·	·	·	·	·	25
Centaurea belangeriana	r	·	1	·	·	·	·	·	25
Anisantha tectorum	r	·	·	·	·	·	1	·	25
Carex subphysodes	·	1	·	·	r	·	·	·	25
Senecio subdentatus	·	·	·	+	·	·	·	r	25

Taxa in one relevé: *Allium fibrosum* 2 (r); *Ammothamnus lehmannii* 3 (+); *Arnebia transcaspica* 3 (r); *Bromus lanceolatus* 3 (2); *B. pseudodanthoniae* 4 (r); *Dorema aitchisonii* 2 (+); *Ephedra intermedia* 3 (r); *Eremopyrum bonaepartis* 5 (r); *Erodium cicutarium* 1 (1); *Erophila verna* 2 (1); *Heteropappus canescens* 5 (r); *Holosteum glutinosum* 2 (1); *Hyalolaena lipskyi* 8 (r); *Koelpinia tenuissima* 5 (+); *Leontice armeniaca* 2 (+); *Phlomoides labiosa* 2 (r); *Psylliostachys suworowii* 3 (1); *Salsola turkestanica* 5 (r); *Streptoloma desertorum* 3 (r); *Tulipa lehmanniana* 1 (+); *Ziziphora persica* 7 (r); *Zygophyllum eurypterum* 1 (+).

Localities of relevés. 1 – 1 km W of the Uglovaya trig point, 13.04.1991, 35.747438ºN 61.925867ºE; **2** – 3 km W of the Uglovaya trig point, 13.04.1991, 35.748067ºN 61.903220ºE; **3** – 1 km N of the Uglovaya trig point, 12.04.1991, 35.757932ºN 61.935320ºE; **4** – Namaksar, 4 km N of the natural reserve border, 23.05.1992, 35.745998ºN 61.709929ºE; **5** – Namaksar, 5 km N of the natural reserve border, 24.05.1992, 35.755414ºN 61.703148ºE; **6** – Namaksar, 3 km N of the natural reserve border, 22.05.1992, 35.737221ºN 61.717568ºE; **7, 8** – Namaksar, 2 km N of the natural reserve border, 22.05.1992, 35.727284ºN 61.721688ºE.

***** – **holotypus**. Turkmenistan, Mariysky Velayat, Badhyz Reserve, Namaksar, 5 km N of the natural reserve border, 24.05.1992, 35.755414ºN 61.703148ºE. Author – N. Polyakova.

Table 6. Association ***Astragalo agametici–Caricetum pachystylidis*** and subassociation ***typicum***

Reléve area, m²	100	100	100	100	100	100	100	100	100	100	100	100	%
Total cover, %	55	40	85	45	70	80	90	50	45	85	65	65	
Average height herbs, sm	30	25	30	45	25	20	20	25	30	20	20	20	
Number of species	20	24	22	21	30	21	19	22	24	20	19	19	
TURBOVEG number	110	53	43	54	42	24	28	113	118	139	132	131	
Sequence number	1	2	3	4	5	6	7	8	**9***	10	11	12	
Diagnostic species of the association *Astragalo agametici–Caricetum pachystylidis*													
Pseudohandelia umbellifera	+	+	1	1	1	+	+	+	+	+	+	+	100
Erysimum badghysi	+	1	+	+	+	+	+	+	+	·	+	+	92
Astragalus agameticus	+	+	+	+	r	·	+	·	+	2	2	+	83
Hyalolaena lipskyi	·	1	+	1	+	·	+	+	+	+	+	1	83
Delphinium semibarbatum	1	1	1	1	2	·	·	1	2	1	2	2	83
Phlomoides labiosa	·	·	·	·	·	1	2	1	+	1	1	1	58
Diagnostic species of the suballiance *Poo bulbosae–Ferulenion badrakemii* and the alliance *Vulpio persicae–Caricion pachystylidis*													
Carex pachystylis	2	2	2	2	2	2	2	2	3	3	1	2	100
Poa bulbosa	3	3	4	3	3	2	2	3	2	2	2	2	100
Ranunculus sewerzowii	1	+	1	1	1	1	1	·	+	1	1	1	92
Cousinia schistoptera	2	2	2	1	1	r	r	2	2	+	+	·	92
Arnebia decumbens	1	1	1	1	2	·	2	1	+	+	·	·	75
Ferula badrakema	2	r	·	r	1	r	r	+	·	·	+	+	75
Astragalus barrowianus	+	r	+	1	+	r	·	+	·	1	·	1	67
Iris songarica	·	+	r	1	+	+	·	+	1	·	·	·	58
Aphanopleura leptoclada	1	+	1	·	1	1	·	1	+	·	·	·	58
Salsola turkestanica	+	+	·	·	+	1	2	·	+	·	·	·	58
Bongardia chrysogonum	·	·	+	·	+	·	·	·	+	·	1	+	50
Haplophyllum pedicellatum	+	·	·	·	·	r	r	+	·	·	+	·	42
Gagea afghanica	·	r	1	·	·	·	·	·	·	1	·	1	33
Papaver pavoninum	·	·	·	·	·	·	r	·	+	+	+	·	33
Other species													
Allium leucosphaerum	+	+	+	+	+	·	+	+	+	+	1	+	92
Scorzonera litwinowii	+	+	·	+	r	r	r	+	+	+	·	·	67
Artemisia scoparia	+	·	1	+	+	2	r	·	·	+	·	2	67
Stipa hohenackeriana	+	+	·	+	+	r	·	·	·	·	·	·	42
Lachnophyllum gossypinum	·	·	·	1	·	r	r	1	+	·	·	·	42
Onobrychis chorassanica	·	·	+	·	1	·	·	+	+	+	·	·	42
Psoralea drupacea	·	·	·	+	+	·	+	+	·	·	·	·	33
Juno drepanophylla	·	+	+	·	·	·	·	·	·	·	+	+	33
Scabiosa olivieri	+	1	·	·	1	·	·	1	·	·	·	·	33
Heteropappus canescens	·	+	+	+	·	·	·	+	·	·	·	·	33
Erodium cicutarium	·	·	·	·	+	·	·	·	·	2	+	·	25
Allium caspium	·	+	·	·	+	·	·	·	+	·	·	·	25

Taxa in one relevé: *Alyssum turkestanicum* 5 (+); *Anisantha tectorum* 5 (+); *Bromus oxyodon* 5 (+), 6 (+); *Consolida camptocarpa* 9 (+); *Cousinia congesta* 6 (+); *Cuminum setifolium* 2 (+), 3 (+); *Gagea olgae* 12 (1); *G. stipitata* 10 (1); *Galagania platypoda* 11 (1); *Goldbachia torulosa* 9 (+); *Erodium ciconium* 3 (+), 9 (+); *Eremopyrum bonaepartis* 5 (+); *Holosteum umbellatum* 11 (+); *Ixiolirion tataricum* 10 (+); *Leontice armeniaca* 4 (+), 5 (+); *Leptaleum filifolium* 12 (+); *Onobrychis micrantha* 6 (+); *Phlomoides regeliana* 1 (1), 12 (1); *Scabiosa rhodantha* 6 (+); *Stipa arabica* 8 (1).

Localities of relevés. 1 – 2.5 km S of the Kepelinskaya road, 29.05.1990, 35.797562ºN 61.771161ºE; **2** – 1.5 km S of the Kepelinskaya road, 05.06.1990, 35.806190ºN 61.693364ºE; **3** – 0.5 km S of the Kepelinskaya road, 05.06.1990, 35.815279ºN 61.759968ºE; **4** – 0.5 km S of the Kepelinskaya road, 08.06.1990, 35.817229ºN 61.682369ºE; **5** – 500 m S of the Kepelinskaya road, 27.05.1990, 35.817935ºN 61.793442ºE; **6** – Namaksar, 5 km N of the natural reserve border, 24.05.1992, 35.741140ºN 61.714821ºE; **7** – Namaksar, 8 km N of the natural reserve border, 19.06.1992, 35.765628ºN 61.697484ºE; **8** – 3.5 km S of the Kepelinskaya road, 30.05.1990, 35.786751ºN 61.749154ºE; **9** – 3.5 km S of the Kepelinskaya road, 30.05.1990, 35.789268ºN 61.704522ºE; **10** – 2.5 km N of the 3 km of the Morgunovskaya road, 18.04.1990, 35.858414ºN 61.873302ºE; **11** – 2 km N of the Kyzyljar lodge, 06.04.1990, 35.843098ºN 61.848631ºE; **12** – 100 m N of the 2 km of the Morgunovskaya road, 11.04.1990, 35.834959ºN 61.864158ºE.

***** – **holotypus**. Turkmenistan, Mariysky Velayat, Badhyz Reserve, 5 km S of the Kepelinskaya road, 13 km from the Kyzyljar lodge, 30.05.1990, 35.789268ºN 61.704522ºE. Author – N. Polyakova.

Diagnostic species: *Gagea stipitata*, *Heteropappus canescens*, *Psoralea drupacea*, *Onobrychis chorassanica*.

The number of species per site ranges from 15 to 27 (21 on average). The TC varies widely from 55 to 95 %. The average height of the grass stand is low 35–45 cm. The communities of the variant are characterized by a smaller role of the species of the suballiance *Ferulo badrakemii–Poenion bulbosae*. The diagnostic species of the subassociation is confined to skeletonless and skeletonless-rubble slopes.

Association *Salsolo turkestanici–Caricetum pachystylidis* Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.** (Table 1, Col. 8, Table 8, **holotypus** hoc loco – Table 8, rel. 6: 600 m W of the Kustarnikovaya trig point, 05.11.1991. Author – N. Polyakova)

Diagnostic species: *Astragalus filicaulis* (dominant, codominant), *Erodium ciconium*, *Salsola turkestanica*.

The association communities are widespread on light calcareous grey soils in the central and southern parts of the plateau; located in a fuzzy strip stretching from the northwest to the southeast, the southern boundary of the association approaches the zone adjacent to the cliff faces of the Eroylanduz Depression. The communities occupy predominantly upland and hilly lands.

They are characterized by the participation of the species of the alliance *Vulpio persicae–Caricion pachystylidis* (*Carex pachystylis*, *Poa bulbosa*, *Ranunculus severzowii*), and of the suballiance *Poo bulbosae–Ferulonion badrakemii* (*Arnebia decumbens*, *Astragalus barrowianus*, *Cousinia schistoptera*, *Ferula badrakema*, *Iris songarica*).

The number of species per site ranges from 15 to 23 (19 on average). The TC varies from 55 to 90 %. The average height of the grass stand fluctuates from 10 to 30 cm. A characteristic feature of the association communities is almost complete absence of the species from the upper sublayer, the so-called tall herbs.

Salsola turkestanica, which is a diagnostic species of the association, indicates a high content of various carbonates in the upper soil layers. This is evidenced by the fact that large groups of this species of saltwort were noted on rodent colonies in other parts of the plateau and on other soils, where resulting from the burrowing activity of rodents, carbonates were brought to the surface from deeper soil layers. Related species in this association are *Astragalus filicaulis*, *Erodium ciconium*, *Lallemantia royleana*.

DISCUSSION

Acording to the results of syntaxonomic analysis, 2 alliance, 1 suballiances, 5 associations and 6 subassociations were identified.

The researchers indicate that the syntaxonomic position of the tall herb vegetation of the arid and semiarid zones dominated by the species of the genera *Ferula*, *Prangos* or *Tetrataenium* is not clear (Nowak et al. 2020a). However, a lot of tall herb communities of Central Asia (Tajikistan, Kyrgyzstan), including those dominated by the species of the genus *Ferula*, are referred to the class *Prangetea ulopterae* (Nowak et al. 2020b). The class comprises the species rich communities with the predominance of tall herbs from the families Apiaceae and Polygonaceae of the alpine, subalpine and subniveal vegetation of the Central Elburz (Iran) (Klein 1987). Nowak et al. (2020b) note that the vegetation similar to the class *Prangetea ulopterae* in Central Asia is quite frequent. Thus, it refers to subtropical steppes and semi-savannahs (Ovchinnikov 1957), the communities dominated by the species of the genera *Ferula* and *Prangos* (Golovkova 1959), or ephemeroid vegetation (Agakhanyanz & Yusufbekov 1975).

Thus, the syntaxa of the class *Prangetea ulopterae* noted in Central Asia are widespread at much higher altitudes up to 3500 m a.s.l. in the alpine and low-mountain belts (Nowak et al. 2020b, 2021). In our case, however, the communities are noted at much lower altitudes up to 700 a.s.l. in the foothills of Badhyz. Some of the communities we described are close to the communities of the alliance *Vulpio persicae–Caricion pachystylidis* in the class *Lygeo sparti–Stipetea tenacissimae*. The following species are among the ones common for the communities of the Badhyz foothills and the tall herb communities of the Tien Shan and the Pamir-Altai: *Aegilops triuncialis*, *Anisantha tectorum*, *Astragalus filicaulis*, *Bromus oxyodon*, *Carex pachystylis*, *Papaver pavoninum*, *Poa bulbosa*, *Taeniatherum crinitum*. Specificity of communities described from the territory of Turkmenistan adjacent to

Table 7. Association ***Astragalo agametici–Caricetum pachystylidis*** and subassociation ***Aa.–Cp. psoraleae drupaceae***

Relévе area, m²	100	100	100	100	100	100	100	100	100	100	%
Total cover, %	75	80	90	85	85	90	60	55	95	90	
Average height herbs, sm	45	45	45	45	40	35	40	35	45	45	
Number of species	20	22	21	21	22	20	16	19	23	27	
TURBOVEG number	48	47	46	51	50	44	114	119	45	52	
Sequence number	1	2	3	4	5	6	7	8	9	**10***	
Diagnostic species of the association *Astragalo agametici–Caricetum pachystylidis*											
Hyalolaena lipskyi	1	1	1	1	1	1	2	1	1	1	100
Delphinium semibarbatum	1	1	2	1	1	1	2	1	2	2	100
Pseudohandelia umbellifera	1	1	+	1	1	+	2	+	2	1	100
Erysimum badghysi	1	+	+	1	+	+	+	+	1	+	100
Astragalus agameticus	r	+	r	+	1	+	+	·	r	r	90
Phlomoides labiosa	·	·	·	·	·	·	2	2	·	·	20
Diagnostic species of the subassociation *Aa.–Cp. psoraleae drupaceae*											
Psoralea drupacea	2	2	+	+	2	+	+	+	+	2	100
Onobrychis chorassanica	r	+	r	r	+	+	·	+	+	+	90
Heteropappus canescens	+	+	+	+	+	1	+	·	+	+	90
Gagea stipitata	·	·	·	·	r	·	·	·	+	+	30
Diagnostic species of the suballiance *Poo bulbosae–Ferulenion badrakemii* and the alliance *Vulpio persicae–Caricion pachystylidis*											
Carex pachystylis	3	3	3	3	3	3	2	2	2	3	100
Poa bulbosa	3	3	3	4	4	4	4	4	4	4	100
Cousinia schistoptera	2	2	2	2	2	1	2	1	2	1	100
Arnebia decumbens	1	1	1	1	1	1	1	1	1	1	100
Ranunculus severzowii	1	1	1	1	·	2	+	+	1	+	90
Bongardia chrysogonum	·	+	·	+	r	·	+	+	r	+	70
Astragalus barrowianus	r	+	r	r	·	+	·	·	·	+	60
Salsola turkestanica	1	·	+	+	·	·	·	+	1	·	50
Gagea afghanica	·	·	·	·	r	·	·	·	r	r	30
Ferula badrakema	r	r	·	·	·	·	·	·	·	r	30
Iris songarica	r	+	·	·	·	·	·	·	·	·	30
Other species											
Allium leucosphaerum	+	r	+	+	r	·	+	+	1	r	90
Juno drepanophylla	+	·	+	+	·	+	·	+	+	+	70
Scorzonera litwinowii	·	·	r	·	+	+	·	+	+	r	60
Aphanopleura leptoclada	·	1	+	·	+	1	·	·	·	·	40
Diptychocarpus strictus	·	·	·	+	·	·	·	·	+	+	30
Lachnophyllum gossypinum	·	·	·	+	+	·	·	+	·	·	30
Cuminum setifolium	·	r	·	·	·	r	·	+	·	·	30
Centaurea belangeriana	·	·	+	+	·	·	·	·	·	·	20
Artemisia scoparia	·	+	·	·	·	+	·	·	·	·	20
Gagea olgae	·	·	·	·	r	·	·	·	+	·	20

Taxa in one relevé: *Allium caspium* 10 (+); *Alyssum turkestanicum* 5 (+); *Anisantha tectorum* 5 (+); *Bromus oxyodon* 3 (+); *Cousinia raddeana* 6 (+); *Erodium cicutarium* 10 (+); *Goebelia pachycarpa* 2 (+); *Haplophyllum pedicellatum* 7 (+); *Lagonychium farctum* 10 (+); *Onobrychis micrantha* 10 (+); *Scabiosa olivieri* 10 (1); *Stipa hohenackeriana* 1 (+); *Strigosella hispida* 9 (+).

Localities of relevés. 1 – 0.5 km N of the Kepelinskaya road, 31.05.1990, 35.822829°N 61.781769°E; **2** – 1.5 km N of the Kepelinskaya road, 31.05.1990, 35.833663°N 61.771727°E; **3** – 1.5 km S of the Kepelinskaya road, 31.05.1990, 35.805910°N 61.759110°E; **4** – 1.5 km N of the Kepelinskaya road, 11 km from the Kyzyljar lodge, 31.05.1990, 35.832195°N 61.725464°E; **5** – 1.5 km N of the Kepelinskaya road, 5 km from the Kyzyljar lodge, 31.05.1990, 35.835899°N 61.791812°E; **6** – 0.5 km S of the Kepelinskaya road, 10 km from the Kyzyljar lodge, 30.05.1990, 35.812482°N 61.733618°E; **7** – 1.5 km S of the Kepelinskaya road, 10 km from the Kyzyljar lodge, 30.05.1990, 35.803323°N 61.733618°E; **8** – 0.5 km S of the Kepelinskaya road, 10 km from the Kyzyljar lodge, 06.06.1990, 35.815088°N 61.679988°E; **9** – 1.5 km S of the Kepelinskaya road, 9 km from the Kyzyljar lodge, 30.05.1990, 35.805211°N 61.748467°E; **10** – 1.5 km N of the Kepelinskaya road, 12 km from the Kyzyljar lodge, 05.06.1990, 35.834991°N 61.702633°E.

***** – **holotypus**. Turkmenistan, Mariysky Velayat, Badhyz Reserve, 1.5 km N of the Kepelinskaya road, 12 km from the Kyzyljar lodge, 05.06.1990, 35.834991°N 61.702633°E. Author – N. Polyakova.

Table 8. Association ***Salsolo turkestanici–Caricetum pachystylidis***

Relévе area, m^2	100	100	100	100	100	100	100	100	%
Total cover, %	60	60	55	65	80	75	60	90	
Average height herbs, sm	10	10	15	15	15	15	15	30	
Number of species	23	19	22	15	16	21	15	21	
TURBOVEG number	32	29	31	63	67	36	65	27	
Sequence number	1	2	3	4	5	**6***	7	8	
Diagnostic species of the association *Salsolo turkestanici–Caricetum pachystylidis*									
Astragalus filicaulis	1	2	1	2	2	2	2	3	100
Salsola turkestanica	1	r	1	r	r	r	1	2	100
Erodium ciconium	r	r	+	r	·	r	r	·	75
Lallemantia royleana	+	·	r	·	·	+	r	·	50
Diagnostic species of the suballiance *Poo bulbosae–Ferulenion badrakemii* and the alliance *Vulpio persicae–Caricion pachystylidis*									
Carex pachystylis	1	1	1	2	2	2	1	2	100
Ranunculus sewerzowii	1	1	1	r	1	r	r	1	100
Poa bulbosa	2	2	2	3	3	4	3	3	100
Ferula badrakema	+	1	r	r	1	r	r	r	100
Arnebia decumbens	1	2	r	·	·	1	r	r	75
Papaver pavoninum	r	1	r	·	+	r	r	·	75
Haplophyllum pedicellatum	r	·	r	r	+	·	·	+	63
Pseudohandelia umbellifera	+	·	·	r	+	+	·	r	63
Cousinia schistoptera	+	·	1	·	+	r	·	+	63
Delphinium semibarbatum	+	r	·	r	·	1	·	·	50
Gagea afghanica	r	r	·	·	·	r	·	·	38
Phlomoides regeliana	·	+	·	·	+	+	·	·	38
Iris songarica	·	+	·	·	·	·	r	·	25
Astragalus barrowianus	·	·	r	·	·	+	·	·	25
Other species									
Allium leucosphaerum	+	r	r	r	1	+	·	+	88
Scorzonera litwinowii	+	r	·	r	r	r	r	r	88
Aphanopleura leptoclada	r	1	1	·	r	r	r	·	75
Juno drepanophylla	+	+	·	r	+	+	·	·	63
Lachnophyllum gossypinum	·	1	·	1	·	+	·	1	50
Eremopyrum bonaepartis	+	·	·	·	·	·	r	·	25
Phlomoides labiosa	·	·	·	r	·	·	·	r	25

Taxa in one relevé:*Aegilops triuncialis* 1 (r); *Allium caspium* 8 (r); *Artemisia scoparia* 8 (+); *Astragalus agameticus* 8 (+); *Bromus oxyodon* 3 (r); *Centaurea belangeriana* 3 (2); *Gagea olgae* 1 (+); *Garhadiolus papposus* 3 (+); *Heterocaryum rigidum* 5 (+); *Hordeum leporinum* 3 (+); *Ixiolirion tataricum* 8 (r); *Nigella integrifolia* 3 (r); *Onobrychis micrantha* 8 (r); *Psoralea drupacea* 8 (+); *Psylliostachys suworowii* 3 (r); *Scabiosa olivieri* 2 (+); *Stipa hohenackeriana* 8 (+); *Taeniatherum crinitum* 7 (r); *Veronica campylopoda* 1 (+); *Ziziphora persica* 3 (+).

Localities of relevés. 1 – 1 km N of the Stolbovaya trig point, 06.05.1991, 35.737797°N 61.829796°E; 2 – 2 km W of the Stolbovaya trig point, 08.05.1991, 35.728194°N 61.808720°E; 3 – 1 km E of the Stolbovaya trig point, 06.05.1991, 35.728544°N 61.841593°E; 4 – 3 km N of the cliffs, 13.05.1991, 35.749257°N 61.703492°E; 5 – 1 km N of the cliffs, 10.05.1991, 35.731343°N 61.703320°E; 6 – 600 m W of the Kustarnikovaya trig point, 11.05.1991, 35.721090°N 61.793743°E; 7 – 2 km N of the cliffs, 13.05.1991, 35.743624 N, 61.700874 E; 8 – Namaksar, 8 km N of the natural reserve border, 19.06.1992, 35.777239°N 61.690409°E.

*** – holotypus**. Turkmenistan, Mariysky Velayat, Badhyz Reserve, Namaksar, 35.721090°N 61.793743°E, 600 m W of the Kustarnikovaya trig point, 05.11.1991. Author – N. Polyakova.

areas of the southeastern Karakum ensures the occurance of desert species not associated with the mountain habitats. High presence of endemic species, *Ferula badrakema*, in cenoses is characteristic. It is the base of allocation of the suballiance *Poo bulbosae–Ferulenion badrakemii* encompasses the ephemeral vegetation of the Badhyz foothills. Apparently, in the future they will be described outside the reserve on the territory of the southeastern Turkmenistan and Afghanistan, within the Parapameisos and the Kopet Dag Mountain Ranges. Physiognomically, the communities are distinguished by a specific combination of *Ranunculus sewerzowii*, *Pseudohandelia umbellifera*, *Aphanopleura leptoclada*, *Delphinium semibarbatum*, against the background of a dense cover of *Poa bulbosa* and *Carex pachystylis*. These communities were formed partially as a result of intensive overgrazing at the beginning and in the middle of the last century, and some of them undoubtedly represent perennial idle lands after plowing in the 1930–1950s.

Pioneer sparse communities of herbs formed by perennial turf herbs with creeping underground shoots – *Sipagrostis pennata* on slight turf sand soils are assigned to the new preliminary alliance *Stipagrostion pennati*. The coenoses of the alliance widespread on send soils are characterized by annual plant species – therophytes, typical of the desert zone (*Anisantha tectorum*, *Bromus oxyodon*, *Ceratocephala falcata*, *Erodium cicutarium*, *Senecio subdentatus*, *Holosteum glutinosum*). Dwarf shrubs, chamaephytes, hemicryptophytes and nanophanerophytes, are often dominants and codominants (*Ammothamnus lehmannii*, *Artemisia badhysi*, *Artemisia turanica*, *Cousinia badhysi*, *Stipagrostis pennata*, *Zygophyllum eurypterum*). Position of the alliance in the system of Asian vegetation has not determined yet.

Five new associations and 6 subassociation, which are clearly differentiated by diagnostic species, were allocated.

The DCA – ordination results illustrate the ecological differentiation of the syntaxa (Fig. 4). The communities of the alliance *Stipagrostion pennati* replace each other along the first axis of ordination from left to right: associations *Atraphaxio badghysi–Stipagrostietum pennati* confined to flat habitats with sandy soils, as well as on blown sands (sand dunes) and the association *Eremopyro bonaeparti–Ammothamnetum lehmannii*, which grows on sandy and rubble grey soils.

The right part of the diagram features the communities of the associations *Astragalo agametici–Caricetum pachystylidis* and *Salsolo turkestanici–Caricetum pachystylidis*, mainly confined to typical grey soils on smooth slopes of various exposures. Thus, the first axis can be interpreted as a gradient of edaphic habitat conditions, which is confirmed by the correlation coefficient value of the vector of the corresponding environmental variables with the axis: soil type (r = 0.45). To a lesser extent, the differentiation is determined by the relief type, which is reflected in the change of communities along the second ordination axis and the revealed correlation with the axis of the vector of the ecological variable "Typical relief" (r = 0.34).

The identified syntaxa have a certain spatial differentiation on the territory of the Kulan Plateau (Fig. 1). Thus, the communities of the association *Astragalo agametici–Caricetum pachystylidis* are widespread in the northern part of

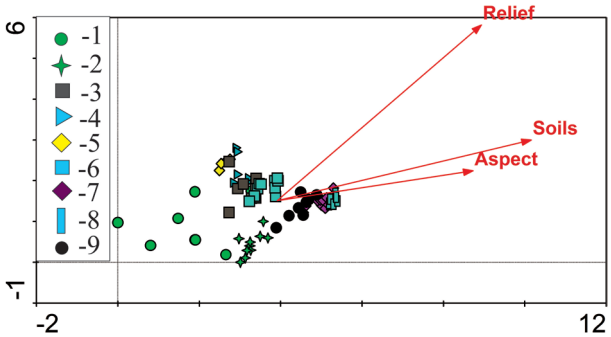

Figure 4 DCA ordination of the ephemeroid vegetation of the Kulan Plateau in the Badhyz Reserve (syntaxa numbers are given in accordance with the table 1). Eigenvalues: Axis 1 – 0.562; Axis 2 – 0.270

the plateau adjacent to the Duzenkyr ridge. This territory is characterized by a flattened surface and large areas occupied by typical grey soils. The communities of the associations *Salsolo turkestanici–pachystylidis* and *Atraphaxio badghysi–Stipagrostietum pennati* are found sporadically throughout the plateau. The territory of the plateau adjacent to the cliff faces of the Kyzyljar canyon is occupied by the coenoses of the associations related to sandy and sandy-rubble soils: *Alysso turkestanici–Artemisietum badhysi* and *Salsolo turkestanici–Caricetum pachystylidis*.

The prodromus of vegetation includes 2 alliances, 1 suballiance, 5 associations and 6 subassociations. An overview table of syntaxa is provided below (Table 1). The position of the communities of the alliance in the system of vegetation classes in Central Asia still remains an unresolved issue.

Lowland warm desert steppes and semi-deserts of Middle Asia

Cl. ?

Ord. ?

All. *Stipagrostion pennati* all. prov.

Ass. ***Atraphaxio badghysi–Stipagrostietum pennati*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.**

Ass. ***Eremopyro bonaeparti–Ammothamnetum lehmannii*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.**

Thermo-mesomediterranean secondary perennial pseudosteppes on calcareous soils of colline and montane belts with long dry summer period

Cl. ***Lygeo sparti–Stipetea tenacissimae*** Rivas-Mart. 1978 nom. conserv. propos.

Ord. ***Cymbopogono–Brachypodietalia ramosi*** Horvatič 1963

All. ***Vulpio persicae–Caricion pachystylidis*** Swierszcz et al. 2020

Suball. ***Poo bulbosae–Ferulenion badrakemii*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **suball. nov.**

Ass. ***Alysso turkestanici–Artemisietum badhysi*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.**

Subass. ***At.–Ab. typicum*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov

Subass. ***At.–Ab. zygophylletosum eurypterum*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **subass. nov.**

Subass ***At.–Ab. stachyetosum trinervis*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **subass. nov.**

Subass ***At.–Ab. artemisietosum turanicae*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **subass. nov.**

Ass. ***Astragalo agametici–Caricetum pachystylidis*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.**

Subass. ***Aa.–Cp. typicum*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov

Subass. ***Aa.–Cp. psoraleae drupaceae*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **subass. nov.**

Ass. ***Salsolo turkestanici–Caricetum pachystylidis*** Polyakova, Golovanov, Yamalov, Lebedeva et Shigapov **ass. nov.**

CONCLUSION

These studies expand and supplement the knowledge on the ephemeral vegetation of the foothills of South-Eastern Turkmenistan and make a significant contribution to the study of the vegetation in the entire Central Asia. For the first time in terms of science, the alliance *Stipagrostion pennati* and suballiance *Poo bulbosae–Ferulenion badrakemii* were desctibed. It encompasses the specific communities of ephemeral vegetation dominated by *Poa bulbosa* and *Carex pachystylis* in the lower layer in combination with Mediterranean, Iranian, Turanian, and Central Asian species. The upper layer is formed by Ferula badrakema, an endemic of Badhyz. The preliminary alliance *Stipagrostion pennati* unites pioneer sparse grass communities formed by perennial turfgrasses with creeping underground shoots. They are characteristic of weakly sodded sands and barchans. Five associations and 6 subassociations are identified.

The leading factors in the differentiation of the syntaxa are the soil type and the position in the landscape.

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