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Salicetum shugnanicae – a new plant association from alpine mires in the Pamir Alai Mts in Tajikistan (Middle Asia)

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Abstract: The paper discusses the floristic structure, distribution and habitat requirements of a shrubby community of *Salicetum schugnanicae* ass. nova. The potential range of the association is described within the Pamir Alai Mts in Middle Asia. The biotope of this community comprises alpine, humid tall-herbs with shrubby physiognomy on relatively flat slopes of mountain valleys. Th plots of the association were found at elevations between 2,500 and 3,500 m above sea level. Phytocoenoses of the *Salicetum schugnanicae* are characterised by an apparent domination of a characteristic species *Salix schugnanicae* in shrub layer. The density of the willow thicket is moderate, from 35 to 90%. The herb layer of the community is moderately rich in species and consists mainly of taxa typical for *Mulgedio-Aconitetea* class (*Angelica komarovii*, *Codonopsis clematoides*, *Geranium collinum*, *G. regelii*, *Heracleum lehmannianum* and *Polygonum coriarium*) and *Nardion alliance* (e.g. *Blysmus compressus*, *Carex orbicularis* subsp. *hissaro-darvasica*, *Dactylorhiza umbrosa*, *Heleocharis meridionalis*, *Pedicularis peduncularis*, *Primula iljinii*, *Swertia juzepczukii*). Also the moss layer is abundant as it is typically for peaty or boggy habitats similar to alpine mires. The most frequent bryophytes noted in the plots are: *Brachythecium mildeanum*, *Calliergonella cuspidata* or *Cratoneuron commutatum*. The described willow association is one of the rarest and most rapidly disappearing plant communit in Tajikistan. This makes the association of highest conservation priority and special management attention.

Key words: *Mulgedio-Aconitetea*, alpine vegetation, Hissar Mts, Zeravshan Mts, syntaxonomy, Tadzhikistan

Introduction

As one of the Middle Asian countries, Tajikistan is almost entirely located within the two extensive mountain ranges of Pamir Alai and Tian-Shan stretching generally from north-east to south-west. According to the literature and herbarium data ca. 4,500-5,000 vascular plant species is known from this country (Nowak et al. 2011). This number is still increasing due to recent floristic studies with records of plant species new to the Tajikistan (e.g. Lazkov 2008, Nobis et al. 2010, 2011; Nobis 2011a, 2013a; Nobis & Nowak 2011a,b; Nobis et al. 2013a). Also, some endemic species new to science have been described recently from this country (e.g. Fritsch et al. 2002, Khassanov et al. 2007, Fritsch & Friesen 2009, Ranjibar et al. 2010, Nobis 2011b, 2013b; Nobis et al. 2013b; Nobis et al. 2014). Exceptional richness and uniqueness of the Tajik vascular flora is mainly a result of the very variable habitat conditions and is reflected by the rate of endemism. More than 30% of vascular plants species have stenochoric distribution and are defined as endemics (Nowak & Nobis 2010; Nowak et al. 2011). This is one of the reasons for recognizing the mountains of Middle Asia as one of the thirty-four hotspots of world biodiversity (Mittermeier et. al. 2006) which needs special attention of botanists and conservationists (Giam et al. 2010).

The vegetation studies with use of modern methods are however still at the begining stage in Tajikistan. Just recently, several papers concerning Tajik phytocoenological classification have been published concerning forests (Nowak & Nobis 2013), aquatic vegetation (Nowak & Nobis 2012), segetal vegetation (e.g. Nowak et al. 2013a,b,c,d) and rock vegetation (Nobis et al. 2013b, Nowak et al. 2014 a,b). There is still no available data regarding the alpine acidophilous swards, peat-bog or shrub vegetation.

Some works concerning alpine swards and shrubs vegetation have been published in XX century by Russian botanists. Important ecological and phenological data on forest phytocoenoses provide works of Zakirov (1955), Ovczinnikov et al. (1973) and Stanjukovich (1982). However, these works present some basic formations of vegetation determined on the basis of so-called edificators, i.e. indicator species predominating in biotope, without distinction of separate syntaxa. The vegetation of alpine swards, tall-herbs, tall-forbes, mires and grasslands havn't been diversified till now for the area of Tajikistan. It is generally described without any hierarchical arrangement. There is no evidence in vagetation samples (or relevés) allowing to classify a given plot of vegetation to syntaxa known from Europe or Asia (e.g. Chytrý 2010; Petrík et al. 2005; Dúbravcová 2005; Matuszkiewicz 2007; Pott 1995; Mirkin, Naumova 2012; Lancioni et al. 2011). Throughout almost all mountain ranges of Pamir Alai, in alpine as well as subalpine zone, several types of wet grasslands, mires, tall-herb and tall-forb vegetation occur. These phytocoenoses surelly are related to European and Asiatic synataxa of alpine distribution: wind edge naked-rush and dwarf-shrub heath communities *Carici rupestris-Kobresietea bellardii*, alpine grasslands on base-rich soils *Elyno myosuroidis-Seslerietea caeruleae,* alpine and subalpine tall-herbs *Mulgedio-Aconitetea*), alpine acidophilous grasslands *Juncetea trifidi* and alpine and subalpine grasslands *Nardion*. Because of the apparent similarities of habitat conditions and the phytocoenosis physiognomy, the plots with *Salix shugnanica* seems to correspond to the wet variant of *Salicetum lapponae* shrubs known from European mountains.

The main aim of the presented work is to provide a detailed phytosociological study of the community of shrubby willow *Salix schugnanica* and the position of that phytocoenosis in syntaxonomic classification. The present paper includes the current chorology of the community in the area of Tajikistan and its composition of species as well as habitat conditions of its occurrence.

Material and methods

Study area: The area of Tajikistan is ca. 143,000 km^2 and extends between E 36 º40' – 41º05' and N 67º31' – 75º14' in Middle Asia (Figs 1,3). The alpine landscape of high mountains is dominating within the country. More than 50% of the area is elevated above 3,000 m above sea level. According to recently published bioclimatic classification of the World, which considers mainly precipitation and temperature values, the study area has to be classified within the Mediterrenean type of macrobioclimate (Rivaz-Martínez et al. 2011). As it is typical for the Mediterranean climate, the area has generally high solar radiation, as well as a low percentage of cloud cover, high-amplitude annual temperatures, low humidity and precipitation, with the exception of the spring period, when there is a considerable amount of rainfall (Fig. 2). In south-western regions of Tajikistan, the average June temperatures raised to around 30˚C. In the temperate zone and alpine elevations the average temperatures in mid summer are between 9.7˚C and 13.5˚C. Annual precipitation ranges in Tajikistan from ca. 70 mm (in mountainous deserts of eastern Pamir and south-western lowlands of the country) to ca. 600 mm (in southern slopes of the Hissar Range). The limit of perpetual snow is at an altitude of 3,500-3,600 m in the western Pamir Alai Mts, raising up to about 5,800 m a.s.l. in the highest elevations of eastern Pamir (Narzikulov, Stanjukovich 1968; Latipova 1968).

The study was conducted in whole area of Tajikistan, mainly in Zeravshan, Hissar, Turkestan, West Pamirian and East Pamirian geobotanical subregions (Fig. 3). The studied vegetation patches were located between 2,500 and 3,500 m a.s.l. (mean 2,700). They are developed on different types of soil substrate, with range of pH reaction between 7.1 to 8.5.

Data and analyses: The field researches were conducted in 2009 and 2011-2013. The vegetation plot size was delimited in such a way as to represent full floristic composition of the phytocoenosis. It varied from 20 to 30 m^2 depending on plant density and homogeneity of vegetation cover. For each vegetation plot all vascular plants and bryophytes were recorded. Plant species were recorded according to the Braun-Blanquet method as the most relevant in analysis the vegetation variability (Braun-Blanquet 1964). The 7-degree cover-abundance scale was used. Geographical coordinates, elevation above sea level, aspect and slope inclination were noted for each relevé. Hydrogen ion concentrations was measured in aqueous rock solution using the ELMETRON CP-105 pH meter.

Vegetation classification follows the sorted table approach of Braun-Blanquet (1964). In the analytic table (Table 1), species constancies are given in classes I-V (Dierschke 1994). Newly presented syntaxon was defined

according to the International Code of Phytosociological Nomenclature (Weber et al. 2000). While distinguishing and ranking the association the works of Petrík et al. (2005), Dubrovcova (2005), Matuszkiewicz (2007), Pott (1995), Mirkin, Naumova (2012), Chytrý (2010), Lancioni et al. (2011) were taken into account. The association concept follows Willner (2006).

Species nomenclature followed mainly Czerepanov (1995). Plant material collected during field studies was deposited in the Herbarium of Middle Asia Mountains, hosted in OPUN (Opole University, Poland) and KRA (Jagiellonian University, Poland).

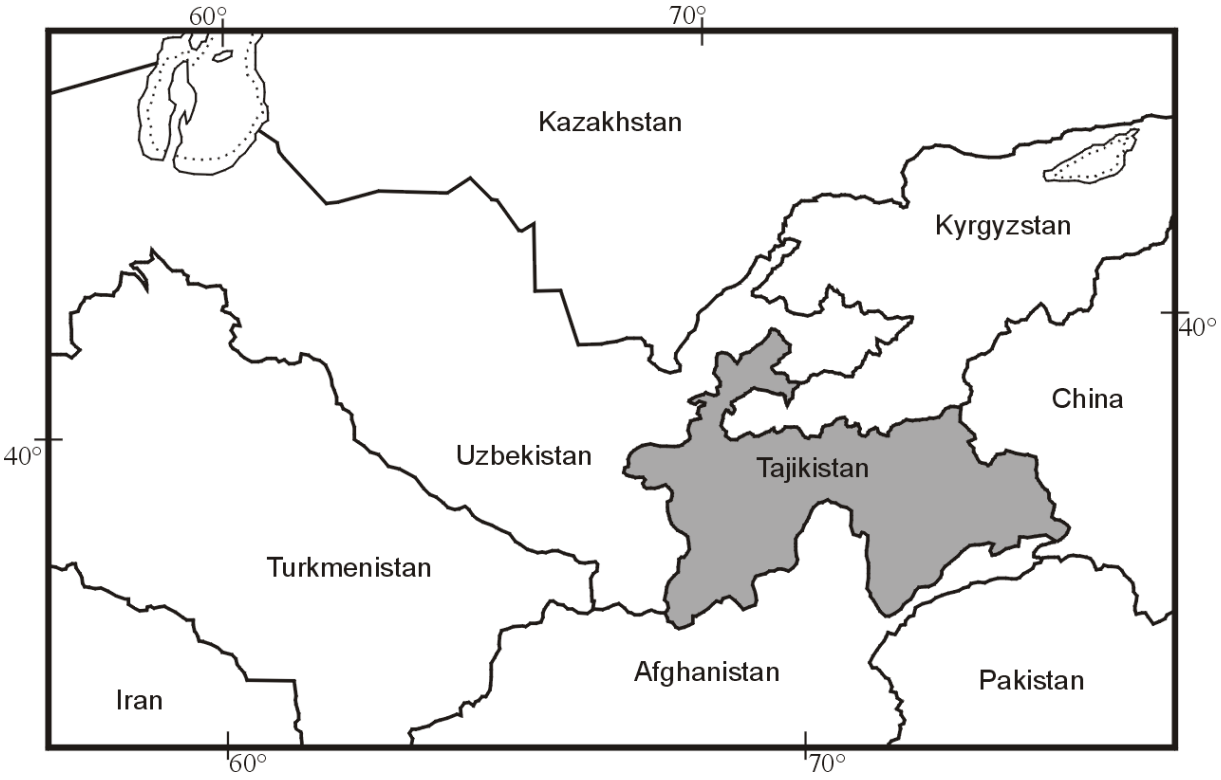

Fig 1: The location of Tajikistan in Middle Asia

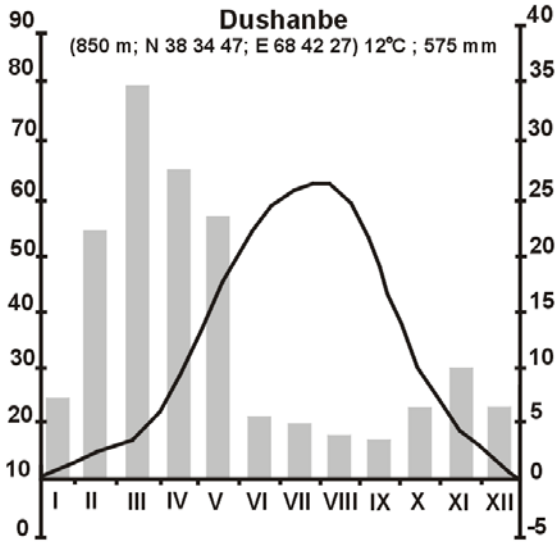

Fig 2: Climatic characterisation of the study area according to the Dushanbe weather station

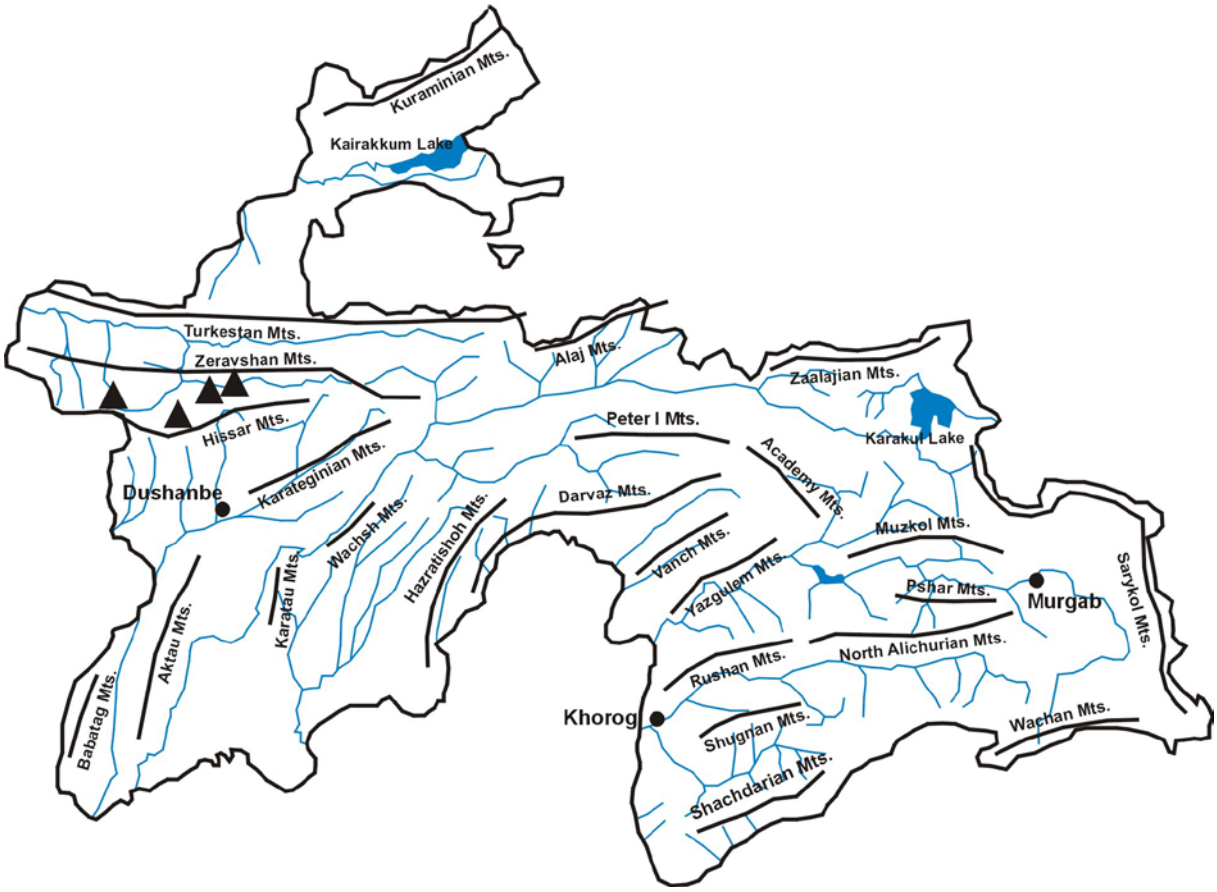

Fig 3: The location of *Salicetum schugnanicae* plots in Tajikistan (black triangles).

Results

Syntaxonomic position of the association

In Tajikistan the community of *Salicetum shugnanicae* occurs on slopes in alpine zone, in wet places with peaty soils. Its syntaxonomic position is as follow:

Cl. *Mulgedio-Aconitetea* Hadač et Klika in Klika et Hadač 1944
O. *Calamagrostietalia villosae* Pawłowski et al. 1928
All. *Adenostylion alliariae* Br.-Bl. 1926
Ass. *Salicetum schugnanicae* Nowak A. & M. Nobis 2013 (holotypus hoc loco, Tab. 1., rel. 6)

Floristic structure, distribution and habitat preferences of Salicetum schugnanicae

The phytocoenoses of *Salicetum shugnanicae* are apparently dominated by the main diagnostic species - *Salix shugnanica*. This willow reaches a total cover from around 30 to 90%, with an average of around 55%. Only in one plot in a shrub layer *Salix shugnanica* is accompanied by *Rosa ovczinnikovii*, however with insignificant share. Plots of the community are relatively diverse in terms of floristic richness. In phytosociological relevés from 7 to 23 species, around 18 taxa, were noted. The total number of taxa noted in the plots of studied community reached 51 species (Tab. 1). Most of them constitutes the herb layer. A highest frequency in researched plots have species typical for wet, boggy and nutrient poor habitats.

Tab 1: *Salicetum schugnanicae* ass. nova in Pamir Alai Mts.

Number of releve	1	2	3	4	5	6	7	8	9	10	11	12	CONSTANCY
day	15	15	15	3	18	8	15	16	16	16	15	15	
Date: month	6	6	6	7	8	6	6	6	6	6	6	6	
year	11	11	11	9	13	12	11	12	12	12	11	11	
Longitude	391131.3	391143.9	391143.9	385955.6	390749.8	390231.6	391143.9	390745	390745	390745	391131.3	391143.9	
Latitude	610646.0	690553	690553	681453.3	684036.1	690114.9	690553	684036	684036	684036	610646.0	690553	
Aspect	N	N	N	NE	E	NW	N	E	E	E	N	N	
Inclination (degrees)	20	20	10	3	15	15	30	10	5	10	15	10	
Altitude (m.a.s.l.)	2477	2529	2529	2886	2502	3424	2529	2530	2530	2530	2477	2529	
cover of b layer [%]	95	80	60	35	40	70	70	60	40	70	80	70	
cover of c layer [%]	85	65	85	85	90	95	70	90	90	65	90	90	
cover of d layer [%]	20	30	25	50	30	30	20	5	5	15	30	30	
releve area [m²]	25	25	25	20	25	25	30	25	30	25	25	30	
locality	J	J	J	K	D	M	J	D	D	D	J	J	
pH	7.3	8.2	7.5	7.1	8.52	8.2	7.1	8.2	8.2	8.2	7.17	8.02	
Number of species	17	13	14	21	20	23	19	14	17	14	16	8	
Ch. Ass. *Salicetum schugnanicae*													
Salix shugnanica b	5	5	4	3	3	4	4	4	3	4	4	4	V
Salix shugnanica c	+	.	.	+	.	.	.	.	.	.	.	.	I
Ch.Cl. *Mulgedio-Aconitetea*	.	.	.	.	.	.	.	.	.	.	.	.	
Geranium collinum	1	1	1	2	2	1	.	.	1	+	+	+	IV
Angelica komarovii	.	.	.	.	.	.	.	+	+	1	.	.	II
Heracleum lehmannianum	.	.	.	.	+	+	.	.	.	.	.	.	I
Sporadic species: *Codonopsis clematidea* 6(1); *Geranium regelii* 7(1); *Polygonum coriarium* 6.													
Others	.	.	.	.	.	.	.	.	.	.	.	.	
Carex orbicularis subsp. hissaro-darvasica	4	3	3	3	2	1	2	4	4	3	4	4	V
Calliergonella cuspidata d	2	2	2	3	2	2	2	1	1	2	3	2	V
Dactylorhiza umbrosa	1	1	1	2	1	2	1	+	1	1	1	1	V
Equisetum arvensis	3	1	1	2	3	.	2	2	2	2	1	.	V
Swertia juzepczukii	.	1	2	+	1	2	.	+	+	1	.	.	IV
Brachythecium mildeanum d	1	.	1	1	1	2	.	+	1	+	.	.	IV
Carum carvi	+	.	+	1	1	+	+	+	+	.	.	.	IV
Galium turkestanicum	.	1	1	+	.	1	+	.	+	+	.	.	III
Euphrasia pectinata	+	.	.	+	+	.	.	+	+	1	+	.	III
Cratoneuron commutatum d	.	2	1	2	1	.	2	.	.	.	.	1	III
Heleocharis meridionalis	.	.	1	1	.	1	2	.	.	.	+	.	III
Lathyrus pratensis	.	.	.	.	1	.	1	1	1	1	.	.	III
Taraxacum agg.	+	+	.	+	.	.	+	+	.	.	.	.	III
Cortusa turkestanica	.	.	.	1	1	2	.	.	+	.	.	.	II
Astragalus sp.	+	+	2	.	.	.	1	.	.	.	.	.	II
Festuca sp.	.	.	+	.	.	+	2	.	.	.	+	.	II
Alchemilla hissarica	+	.	.	.	.	.	.	1	1	.	.	+	II
Bryum pseudotriquetrum d	.	+	.	.	.	.	+	.	+	.	1	.	II
Carex karoi	+	.	.	+	.	.	.	.	.	.	+	+	II
Primula iljinii	+	.	.	+	.	+	.	.	.	.	+	.	II
Blysmus compressus	1	.	.	1	.	.	.	.	.	.	1	.	II
Trifolium repens	.	.	.	+	.	.	.	+	.	1	.	.	II
Poa pratensis	.	.	.	+	1	.	+	.	.	.	.	.	II
Gentiana leucomelaena	+	.	.	+	.	.	.	.	.	.	+	.	II
Pedicularis dolichorhiza	.	+	.	.	+	.	.	.	.	+	.	.	II
Trifolium pratense	.	.	.	.	1	+	.	.	.	.	.	.	I
Carex pachystylis	.	.	.	.	+	.	+	.	.	.	.	.	I
Sporadic species: *Aquilegia vicaria* 6; *Artemisia dracunculus* 7(1); *Cirsium* sp. 11; *Cobresia capillifolia* 6(1); *Glaux maritima* 11; *Ligularia thompsonii* 6; *Pedicularis peduncularis* 5(1); *Plantago lanceolata* 6(1); *Poa palustris* 5; *Ranunculus laetus* 6; *Rosa ovczinnikovii* b 6; *Schtschurovskia meifolia* 6(1); *Stellaria fontana* 9; *Tussilago farfara* 1; *Vicia tenuifolia* 7.													
Explanations: J - Jagnob; D - Dzidzhikrut; M - Margeb; K - Kashkuytal-Zanbar													

The most abundant were *Blysmus compressus*, *Carex orbicularis* subsp. *hissaro-darvasica*, *Dactylorhiza umbrosa*, *Heleocharis meridionalis*, *Pedicularis peduncularis*, *Primula iljinii*, *Swertia juzepczukii*. Generally these species contribute in Pamir Alai Mountains to alpine grasslands (comparable to European *Nardion* communities) or mire vegetation (camparable to *Montio-Cardaminetea*) communities. Also in moss layer there is an apparent and abundant contribution of species of very humid substrates related to alpine mire vegetation like

Brachythecium mildeanum, *Calliergonella cuspidata* or *Cratoneuron commutatum*. In comparison to other Asiatic or European phytocoenoses from *Mulgedio-Aconitetea* class, the share of species preferring fertile, deep and well drained soils is considerably lower. Only *Angelica komarovii*, *Codonopsis clematoides*, *Geranium collinum*, *G. regelii*, *Heracleum lehmannianum* and *Polygonum coriarium* could be mentioned in this group (Tab. 1).

Salicetum shugnanicae inhabits relatively flat slopes or depression bottoms alongside small brooks, often of ephemeric flow. Because of the shrubby physiognomy the plots of the community could be easily reconized and distinguished from neighbouring phytocoenoses of mires or wet grasslands. *Salix shugnanica* is not a common species in Pamir Alai. The association inhabits rather small occupancy areas. We didn't spot a plot larger than approx. 1 ha.

The *Salicetum shugnanicae* is a typical alpine shrubby community occurring at an altitude of 2,500-3,500 m above sea level. It inhabits mainly the wet slopes with seeping ground water and peaty soils in alpine landscape. The humus layer in soil profile is relatively deep. Only on northern expositions in Jagnob River Valley the ranker soils have been observed as a ground substrate of the association. In all cases, the soil environment has an neutral or alkaline reaction, from 7.1 to pH 8.5.

The potential range of the *Salicetum schugnanicae* has to be fully congruent with the range of its main diagnostic species, i.e. *Salix schugnanica.* It is limited to central and eastern Pamir Alai Mts. (Tajikistan) and Tian Shan Mts. (Kyrgyzstan, China). In Tajikistan, the species have been noted in alpine and subnival altitudinal zone (2,300 - 4,300 m a.s.l.) in Zeravshan, Hissar, Peter 1st, Darvaz, Shugnan, Alichur, Muzkol and Sarykol ranges (Ovchinnikov 1968). However due to intensive grazing in last decades, in many places were formerly or at present *Salix schugnanica* does occur, the association of that species disappeared. Despite extensive surveys of eastern and western Pamirian regions, we failed to find a plots of that association. The only, relatively small patches of *Salicetum schuganicae* have been found in Hissar Mts (Dzhidzhikrut valley) and Zeravshan Mts (Margeb, Jagnob, Kaskuytal-Zanbar).

Discussion

The present centre of occurrence of *Salicetum schugnanicae* seems to be in alpine zone of Zeravshan and Hissar Mts. Despite special explorations in Rushan, Vanch, Murgab, Shakhdara and Pyandzh River valleys in western and eastern Pamir we didn't found other plots of this phytocoenosis. Our preliminary studies in western and central Tian Shan mountains in Kyrgyzstan (Kyrgyz, Kakshaal, Alai and Zaalai ranges) also did not confirmed presence of *Salicetum schugnanicae*. Considering the dynamic situation of that community it is worth to mention that even in central Pamir Alay ranges (Zeravshan and Hissar), the extent of occurrence of *Salicetum schugnanicae* is not continuous. There are many small side valleys and slopes of main valleys with optimal habitat conditions for these phytocoenoses, however without plots of *Salicetum schugnanicae*. This is caused probably by intensive grazing and using the main diagnostic taxon as a fuel for local peaple. Also within the found plots of vegetation we found several sites with significantly degraded floristic structure due to cattle grazing.

The association of *Salicetum schugnanicae* was proposed to be included in the *Mulgedio-Aconitetea* class because of habitat similarities, i.e. wet, peaty and nutrient rich soil substrate in alpine zone on relatively flat slopes with pronounced snow cover. Also very distinct is the shrubby physiognomy of the community what allows to easily distinguish the plots of *Salicetum schugnanicae* from other tall herb or mire vegetation types. This is similar to European alpine broad-leaved shrubs. Many associations dominated by the oligothermal

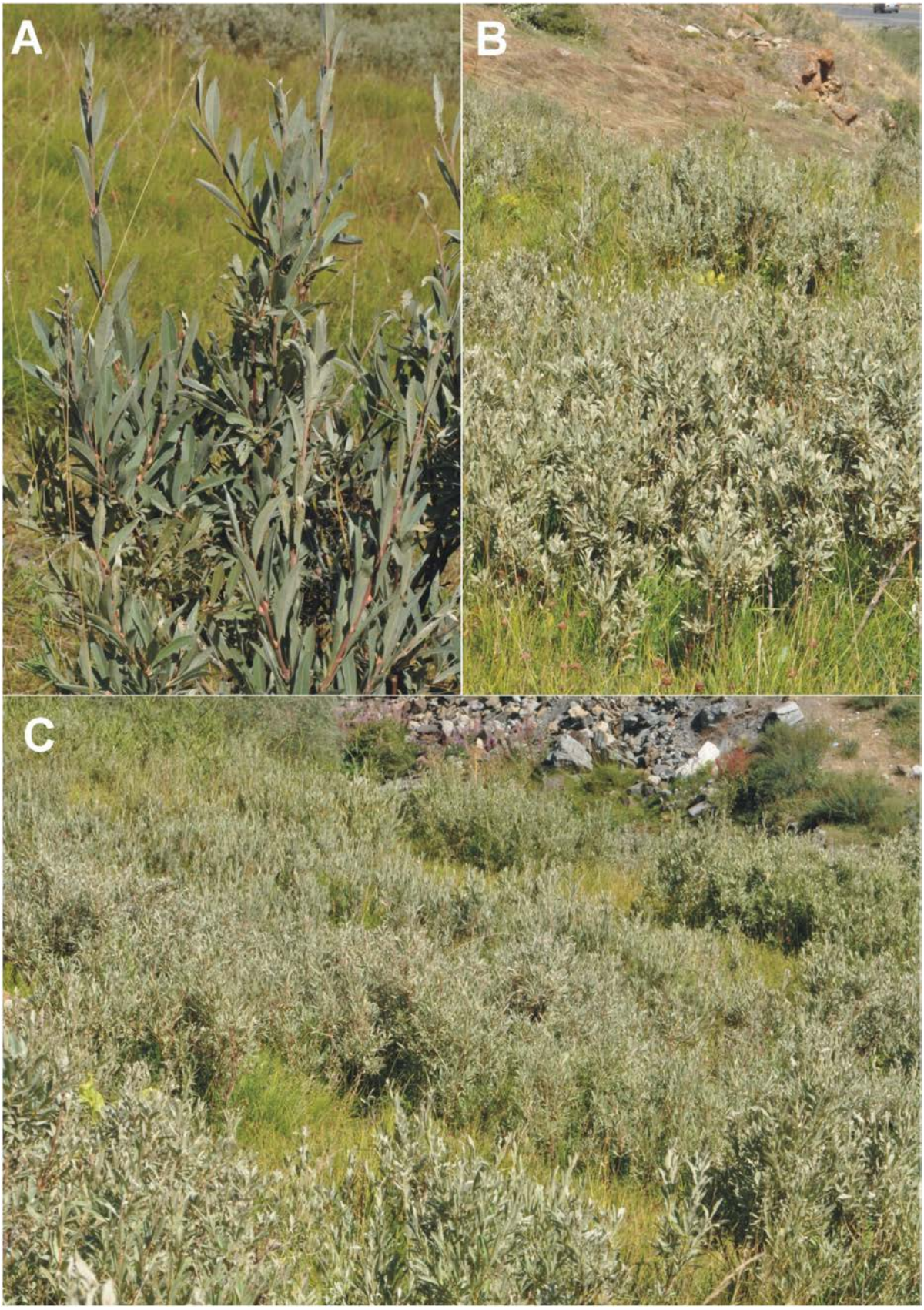

Fig 4: *Salix schugnanica* (A) and *Salicetum schugnanicae* in Pamir Alai Mts: Dzhidzhikrut valley (B) and Jagnob valley (C).

willows like *Salix appendiculata*, *S. hastata*, *S. lapponum*, *S. silesiaca* and *S. waldsteiniana*, that grow in peat-bogs, marshes, along streams and rivers are known from mountains of Central and Southern Europe (e.g. Pott 1995; Chytrý 2010). However, if compared to European alpine willow shrubs, the difference in herb layer composition is quite apparent. In *Salicetum schugnanicae* a large share of mire species, like *Blysmus compressus*, *Carex orbicularis* subsp. *hissaro-darvasica*, *Heleocharis meridionalis*, *Pedicularis peduncularis*, *Primula iljinii* or *Swertia juzepczukii* is observed. These species came over from the surrounding areas. In most cases, the closest neighbourhood of *Salicetum schuganicae* is dominated by mire vegetation. Probably species constituing the *Montio-Cardaminetea* or *Nardion* communities are preferred during the grazing of the valley slopes and bottoms. Also the significant share of meadow and pastures plants (e.g. *Artemisia dracunculus*, *Carum carvi*, *Galium turkestanicum*, *Lathyrus pratensis*, *Ligularia thompsoni*) is probably caused by the still persistent grazing and mowing.

This considerable share of graminoid species and plants typical for mires show, that the *Salicetum schugnanicae* is closely related to other types of mountain vegetation. However it clearly differs from *Carici-Kobresietea* vegetation because of microhabitat conditions and much higher soil humidity. The substrate reaction distincts *Salicetum schugnanicae* from *Elyno-Seslerietea* vegetation. Despite the high contribution of *Nardion* and *Juncetea trifidi* species, the shrubby physiognomy and presence of tall herb species like *Angelica komarovii*, *Geranium collinum*, *Heracleum lehmannianum* or *Polygonum coriarium* could be very helpful in association definition (Tab. 2). So, despite the floristic differences, the phytocoenosis of *Salicetum schugnanicae* in our opinion could be assigned to *Mulgedio-Aconitetea* class as an geographical vicariant of e.g. *Salicetum lapponum* or associations from *Alnion viridis* alliance known from the Alps and Sudety Mts. (e.g. Matuszkiewicz 2007; Chytrý 2010; Boscutti et al. 2013).

Further phytosociological surveys have to be conducted to set up a hierarchical system of shrubby alpine vegetation on humid, peaty soils in Middle Asia. Our preliminary studies in Tian Shan Mts in Kyrgyzstan give some results also in relation to the *Mulgedio-Aconitetea* and *Nardion* vegetation. For example in Kyrgyz range very extensive areas on peaty soils along alpine streams are covered by the *Caragana aurantiaca* thickets. This phytocoenoses have considerable share of tall-herb species like *Aconitum* sp. or *Seseli* sp. It is probable, that separate alliance for shrubby vegetation in alpine zone in Middle Asia should be established. However to solve that problem, the more comprehensive and larger data set have to be completed especially for *Caragana* sp., *Restella* sp., *Exochorda alberti* dominated communities.

The association of *Salicetum schugnanicae* develops in locations with less dynamic processes of land slides or gravel deposits, where the conditions for development of deep, fertile soils occurr. There were no river inundations or anthropogenic drainages observed which could influence the habitat of *Salicetum schugnanicae*. The Shugnan willow association is a plant community of typical alpine landscape, which is reflected, among others, in the fast development during the growing season, shortened to May-August generally. The community of *Salicetum schugnanicae* is an unique type of shrub vegetation having the highest limits in alpine and even subnival altitudinal belt. Higher, the harsh habitat conditions, in particular the very short growing season, almost exclude the development of broad-leaved shrub communities. Therefore, the community is essential in the researches of an altitudinal range of communities, including the relations to climate change (Dirnböck et al. 2003; Thuiller et al. 2005).

Tab 2: The comparison of alpine swards and tall herbs characters

	Vegetation type				
	Wind edge naked-rush and dwarf-shrub heath communities *Carici rupestris-Kobresietea bellardii*	**Alpine grasslands on base-rich soils *Elyno myosuroidis-Seslerietea caeruleae***	**Alpine and subalpine tall-herbs *Mulgedio-Aconitetea* (*Calamagrostietalia villosae*)**	**Alpine acidophilous grasslands *Juncetea trifidi***	**Alpine and subalpine grasslands *Nardion***
Range	Holarctic, highest summits in Europe from Pyrenees to Balkans	Central & Southern Europe	Euro-Siberian, Boreal, Alpine	Boreal, Alpine-Caucasian	Central European, montane
Taxa origin	80% Arctic-Alpine and Circumboreal, glacial relicts	Mediterranean, Montane (orophytes)	Euro-Siberian, Alpine	Euro-Siberian, Alpine	Euro-Siberian, Alpine, Central European
pH	from acidic to alkaline	alkaline	acidic, neutral	acidic	acidic
Soil	More xeric, initial	More humid, well developed	Rankers, peaty soils, nutrient rich, humid	Alpine ranker	Alpine rankers, moderately wet, moderately fertile
Slopes	Steep, moderate	Flat, moderate	Flat, moderate	Flat, moderate	Flat, moderate
Structure	Species rich, chionophobous, cryotemperate dwarf scrubs, cushion-sheped chamaephytes and graminoids on wind-exposed ridges	Grasslands with domination of graminoids like e.g: *Calamagrostis varia*, *Carex ferruginea*, *C. firma*, *C. sempervirens*, *C. atrata*, *Swertia perennis*, *Festuca versicolor*, *Sesleria caerulea*.	Tall-forb, tall-grass, tall-fern and deciduous shrubs, e.g.: *Salix lapponum*, *Veratrum album*, *Viola biflora*, *Philonotis seriata*, *Aconitum firmum*, *Brachythecium reflexum*, *Adenostyles alliariae*, *Cicerbita alpina*, *Solidago alpestris*, *Homogyne alpina*	Alpine grassland-like communities on windy slopes with lower snow cover	Alpine and subalpine grasslands with *Campanula bohemica*, *Potentilla aurea*, *Nardus stricta*, *Anthoxanthum alpinum*, *Hypochoeris uniflora*, *Thesium alpinum*
Endemism	various	high	moderate	low	low
Snow cover	low	low	pronounced		moderate
Share of mire species (*Montio-Cardaminetea*)	low	low	high	low	moderate

* prepared according to: Chytrý 2010; Petrík et al. 2005; Dúbravcová et al. 2005; Matuszkiewicz 2007; Pott 1995; Mirkin, Naumova 2012; Lancioni et al. 2011.

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