

Shrub and dwarf shrub communities of Sangilen Plateau

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Abstract. The paper presents a detailed ecological and caenotic characteristic of dwarf shrub and shrub communities growing in the high-mountain belt of the Sangilen Plateau. The communities investigated were referred to the class of *Loiseleurio-Vaccinietea* Egger 1952. The dwarf birch thickets with prevalence of *Betula rotundifolia* and the high incidence of *Caragana jubata*, *Juniperus pseudosabina*, *J. sibirica*, *Pentaphylloides fruticosa*, *Salix glauca*, *Spiraea alpina* were referred to the union of *Carici tristis-Betulion rotundifoliae* Zibzeev et al. 2018 of the order of *Betuletalia rotundifoliae* Mirkin et al. ex Chytrý Pešout et Anenkhonov 1993. Communities with dominant calciphilous shrubs and dwarf shrubs, such as *Rhododendron adamsii*, *Caragana jubata*, *Salix berberifolia*, *S. reticulata*, were referred to the union of *Saxifrago oppositifoliae-Rhododendron adamsii* Zibzeev et al. 2018 of the order of *Rhododendro-Vaccinietalia* Br.-Bl. ex Daniels 1994.

1 Introduction

Shrub communities are the most common type of vegetation growing on the Sangilen Plateau. Prevalent are the communities formed by *Betula rotundifolia*, also common are communities with dominant *Caragana jubata* and *Rhododendron adamsii*.

Caragana jubata (Pall.) Poir. Is the Asian montane calciphilous shrub species, the habitat of which is related to the mountain systems of Central Asia, western Mongolia, China, Tibet, and the Himalayas. In the territory of Russia, the species covers the mountainous regions of Eastern Siberia and the Far East; the north-western boundary of its habitat goes along the Sangilen Plateau and certain ridges of south-eastern Altai (the Kurai and Chikhachev Ridges).

In the territory in question, *Caragana jubata* is found in the range of altitudes from 1900 m to 2550 meters. In deciduous forests consisting of *Larix sibirica*, it participates in the formation of the shrub tier. In river valleys and surrounded by cryophyte steppe, the species forms communities with co-dominance with *Pentaphylloides fruticosa*. In the

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mountain tundra belt, *Caragana jubata* forms vegetation communities with co-dominant *Rhododendron adamsii* and *Betula rotundifolia*.

Rhododendron adamsii Rehder is the north-Asian high-mountain calciphilous shrub species. In the territory of Russia, the western boundary of the habitat of *Rhododendron adamsii* goes along the Yenissei River, in the south, in western and eastern Tannu-Ola Range, the Sangilen Plateau, to go further to the mountain ridges of Eastern Sayan mountains, Khamar-Daban, Barguzin ridges, and in the north, it reaches the Aldan Highlands. In the Russian Far East, the habitat of *Rhododendron adamsii* stretches as far as the shore of the Sea of Okhotsk. Outside Russia, the species is commonly found in the mountain systems of Mongolia, and its southern boundary is in Tibet. In the territory of the Sangilen Plateau, *Rhododendron adamsii* grows in the high-mountain belt, where it forms communities on the carbonate rocky slopes of different exposure and steepness.

2 Materials and Methods

The study is based on 94 releves of high-mountain shrub communities performed by the authors in the upper reaches of the Naryn and Balyktyg-Hem Rivers in July 2014. The descriptions were made on the sample plots 100 m² in area. The classification of the vegetation communities was made using the Braun-Blanquet method [1]. In this work, we used the concept of a differentiating species proposed by German geobotanists [2, 3]. The names of the syntaxa are provided in accordance with the International Code of Phytosociological Nomenclature [4].

3 Results and discussion

Syntaxa prodromus

Cl. *Loiseleurio-Vaccinieta* Egger 1952

Ord. *Betuletalia rotundifoliae* Mirkin et al. ex Chytrý Pešout et Anenkhonov 1993

All. *Carici tristis-Betulion rotundifoliae* Zibzeev et al. 2018

Ass. *Carici tristis-Betuletum rotundifoliae* Zibzeev et al. 2018

Subass. *Carici tristis-Betuletum rotundifoliae typicum* Zibzeev et al. 2018

Subass. *Carici tristis-Betuletum rotundifoliae caraganetosum jubatae* Zibzeev et al. 2018

Ord. *Rhododendro-Vaccinietalia* Br.-Bl. ex Daniels 1994

All. *Saxifrago oppositifoliae-Rhododendron adamsii* Zibzeev et al. 2018

Resulting from the conducted classification of the shrub communities with dominant *Betula rotundifolia*, Ass. *Saussureo schanginiana-Caraganetum jubatae* Zibzeev et al. 2018

were referred to the union of *Carici tristis-Betulion rotundifoliae*, whereas the communities with *Rhododendron adamsii* and *Caragana jubata* were referred to the union of *Saxifrago oppositifoliae-Rhododendron adamsii* of the order of *Betuletalia rotundifoliae* of the class of *Loiseleurio-Vaccinieta*.

The class of *Loiseleurio-Vaccinieta* unites alpine and arctoalpine dwarf shrub and shrub communities of Eurasia and North America. The communities of the Altai-Sayan mountain region and of Northern Mongolia were referred to the order of *Betuletalia rotundifoliae*.

In the southern part of the Altai-Sayan mountain region, situated in the rain shadow zone, grass-shrub communities are most common. Their geographic isolation, the physiognomic image and the high species saturation and specifics allowed us to refer them to a separate union of *Carici tristis-Betulion rotundifoliae* [5].

The union of *Carici tristis–Betulion rotundifoliae* unites grass-shrub communities of the semi-arid highlands of the of the Altai-Sayan mountain region and of northern Mongolia. Its diagnostic group is represented by high-mountain and arctic high-mountain species (*Aconogonon alpinum*, *Betula rotundifolia*, *Carex tristis*, *Cetraria laevigata*, *Gentiana algida*, *Hedysarum consanguineum*, *Kobresia simpliciuscula*, *Pachypleurum alpinum*, *Ptilagrostis mongholica*, *Saussurea controversa*, *Swertia marginata*, *Vulpicidia tilesii*). These communities are widespread in the altitude range of 2200–2500 m. They form their own sub-belt on the Sangilen Plateau.

Apart from *Betula rotundifolia*, *Caragana jubata*, *Juniperus pseudosabina*, *J. sibirica*, *Pentaphylloides fruticosa*, *Salix glauca*, and *Spiraea alpina* communities participate in the formation of the shrub tier. One of the peculiar features of the said communities is a large number of prostrate and hemi-prostrate dwarf shrubs. Besides *Empetrum nigrum*, *Vaccinium uliginosum* and *V. vitis-idaea*, widespread in all the communities of the class of *Loiseleurio–Vaccinietaea*, *Arctous erythrocarpa*, *Dryas oxyodonta*, *Salix berberifolia*, *S. reticulata*, and *S. turczaninowii* are highly persistent and often abundant. Highly persistent in the communities under study are those species the habitat of which covers high-mountain regions of the mountains of southern Siberia, northern Mongolia, eastern Kazakhstan and the species sometimes found in the mountains of Central Asia: *Callianthemum sajanense*, *Campanula turczaninowii*, *Claytonia joanneana*, etc.

The association of *Carici tristis–Betuletum rotundifoliae* unites dwarf birch and shrub tundras of the Sangilen Plateau. These are dominant communities, widespread in the altitudinal range from 2200 to 2450 m.

Diagnostic species: *Aconogonon alpinum*, *Betula rotundifolia* (dom.), *Campanula turczaninowii*, *Cladonia coccifera*, *Cladonia uncialis*, *Gentiana algida*, *Peltigera aphthosa*, *Potentilla gelida*, *Sajanella monstrosa*, *Spiraea alpina*.

The grass-dwarf-shrub tier is represented by one or two sub-tiers. The upper sub-tier (20–35 cm tall) is scarce, formed by *Aconogonon alpinum*, *Hedysarum consanguineum*, *Gentiana algida*, *Ptilagrostis mongholica*, *Sajanella monstrosa*, *Trollius asiaticus*, etc. The lower sub-tier (10–15 cm tall) is formed by *Bistorta vivipara*, *Callianthemum sajanense*, *Campanula turczaninowii*, *Dracocephalum grandiflorum*, *Kobresia simpliciuscula*, *Pachypleurum alpinum*, and *Potentilla gelida*.

In all the above communities, the moss-lichen tier is distinct (*Cladonia arbuscula*, *C. coccifera*, *C. stellaris*, *Cetraria islandica*, *Flavocetraria cucullata*, *Hylocomium splendens*, *Polytrichum piliferum*, *Thamnolia vermicularis*, *Vulpicidia tilesii*, etc.).

In the territory in question, the association is represented by two subassociations (*C.t.–B.r. typicum* and *C.t.–B.r. caraganoetosum jubatae*). They differ by the character and degree of moisture content and the altitudinal and expositional characteristics.

The subassociation of *C.t.–B.r. typicum* unites moss-lichen-dwarf-birch tundras with domination of *Betula rotundifolia* in the shrub tier. These communities occupy relatively flat slopes (1–7° steep), with well-expressed soil cover, in the altitudinal range of 2250–2450 m.

The shrub tier (40–50 cm tall) is formed by *Betula rotundifolia*. Besides the highly persistent round-leaved birch having insignificant projective coverage (1–3 %), *Spiraea alpina* and *Salix glauca* also occur. The grass-dwarf-shrub tier is represented by *Aconogonon alpinum*, *Aster alpinus*, *Bistorta vivipara*, *Campanula turczaninowii*, *Festuca sphagnicola*, *Gentiana algida*, *Hedysarum consanguineum*, *Kobresia simpliciuscula*, *Potentilla gelida*, *Ptilagrostis mongholica*, *Sajanella monstrosa*, *Salix reticulata*, *Thalictrum alpinum*, *Trollius asiaticus*, and *Vaccinium vitis-idaea*.

The moss-lichen tier occupies from 10 to 55 % of the caenotic area.

The subassociation of **C.t.–B.r. caraganoetosum jubatae** unites dwarf-birch tundras, formed on well-warmed slopes of southern exposure, 4–25° steep. The altitudinal range of its habitat is 2000–2420 m.

Diagnostic species: *Callianthemum sajanense*, *Caragana jubata*, *Dracocephalum grandiflorum*, *Gentiana pseudoaquatica*, *Juniperus pseudosabina*, *Leontopodium ochroleucum*, *Pentaphylloides fruticosa*.

Unlike a typical subassociation, the communities of the subassociation of **C.t.–B.r. caraganoetosum jubatae** are highly persistent, and *Caragana jubata*, *Pentaphylloides fruticosa*, *Juniperus pseudosabina* often have projective coverage. The grass-dwarf-shrub tier is scarce, except for the species characteristic for a typical subassociation: *Callianthemum sajanense*, *Dracocephalum grandiflorum*, *Leontopodium ochroleucum*, *Potentilla nivea*, *Saussurea controversa*, and *Swertia marginata*.

The union **Saxifrago oppositifoliae–Rhododendron adamsii** contains calciphilous shrub communities with dominant *Rhododendron adamsii*, *Caragana jubata* and *Salix berberifolia*.

The obligate and facultative calciphilous species form the diagnostic group of the union: *Androsace lehmanniana*, *Arctous erythrocarpa*, *Dactylina madreporiformis*, *Pachypleurum alpinum*, *Rhododendron adamsii*, *Salix berberifolia*, *S. reticulata*, *Saussurea schanginiana*, *Saxifraga oppositifolia*.

The union is represented by two associations **Saxifrago oppositifoliae–Rhododendretum adamsii** and **Saussureo schanginianae–Caraganetum jubatae**.

The association of **Saxifrago oppositifoliae–Rhododendretum adamsii** unites shrub communities, with dominant *Rhododendron adamsii*. In the territory in question, these communities are formed on steep slopes 15–25° steep in the altitudinal range of 2400–2550 m.

The diagnostic species are: *Larix sibirica*, *Lloydia serotina*, *Oxytropis alpina*, *Rhododendron adamsii*, *Saxifraga oppositifolia*.

The vertical structure consists of three tiers. The shrub tier is formed by *Rhododendron adamsii*, *Betula rotundifolia*, *Salix glauca* and *Vaccinium uliginosum* also occur. The grass-shrub tier occupies up to 40 % of the caenotic area. It is formed by *Aster alpinus*, *Dryas oxyodonta*, *Gentiana algida*, *Hedysarum consanguineum*, *Kobresia myosuroides*, *Pachypleurum alpinum*, *Potentilla nivea*, *Saxifraga oppositifolia*, *Swertia marginata*, et al. The moss-lichen tier occupies from 5 to 30 % of the area, formed by *Cetraria ericetorum*, *Cladonia arbuscula*, *Flavocetraria cucullata*, *Thamnia vermicularis*, *Vulpicidia tilesii*, *Dicranum scoparium*, *Hylocomium splendens*, *Polytrichum commune*, *P. piliferum*, and *P. juniperinum*.

The association of **Saussureo schanginianae–Caraganetum jubatae** unites shrub tundras with co-dominant *Betula rotundifolia*, *Caragana jubata* and *Rhododendron adamsii*

The diagnostic species: *Arctous erythrocarpa*, *Caragana jubata*, *Lagotis integrifolia*, *Pedicularis tristis*, *Salix berberifolia*, and *Tephroses heterophylla*.

Unlike the above-described tundras, the associations of **Saxifrago oppositifoliae–Rhododendretum adamsii** are commonly occurring communities of the lower third (2220–2400 m) of the high-mountain belt of the Sangilen Plateau. They are found on the northern slopes 7–40° steep.

The shrub tier (50–70 cm tall) is formed by *Betula rotundifolia* and *Caragana jubata*, with *Juniperus pseudosabina*, *Pentaphylloides fruticosa* and *Salix glauca* also present. In some above-described communities, *Rhododendron adamsii* and *Vaccinium uliginosum* form their own sub-tier (25–40 cm tall). The grass-dwarf-shrub tier is represented by *Arctous erythrocarpa*, *Carex atterima*, *Dryas oxyodonta*, *Empetrum nigrum*, *Hedysarum consanguineum*, *H. sangilense*, *Lagotis integrifolia*, *Pedicularis tristis*, *Ptilagrostis mongholica*, *Salix berberifolia*, *Saxifraga oppositifolia*, *Swertia marginata*, and *Trollius*

asiaticus. The moss-lichen tier occupies from 5 to 60 %. In the lichen synusia, *Cetraria islandica*, *C. laevigata*, *Cladonia arbuscula* and *Flavocetraria cucullata* dominate. In the moss synusia, *Hylocomium splendens*, *Polytrichum piliferum*, and *P. juniperinum* prevail.

4 Conclusion

The characteristic features of caenotic variability and spatial organization of the vegetation cover of the Sangilen Plateau are determined by the conditions of the semiarid climate and the characteristics of the geological and geomorphological structure of the area, edaphic factors, in particular, a high degree of soil mosaicism, related to outcrops of marmorized limestone and granite.

Resulting from the performed classification of the shrub and dwarf-shrub communities of the high-mountain belt of the Sangilen Plateau, three associations have been described. The shrub tundras of the class of *Loiseleurio-Vaccinietea* are the landscape-forming type of vegetation; in the lower part of the high-mountain belt, they form their own sub-belt, which occupies up to 2/3 of the area of the highlands.

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