



Validation and description of some syntaxa of Siberian subalpine herb-rich alder scrub (the class *Betulo carpaticae–Alnetea viridis*)

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ABSTRACT

As a result of the syntaxonomic analysis of the subalpine alder *Alnus alnobetula* subsp. *fruticosa* (Rurp.) Raus scrub communities, it was determined that the associations names ‘*Calamagrostio obtusatae–Alnetum alnobetulae*’, ‘*Poa irkuticae–Alnetum fruticosae*’ and ‘*Calamagrostio langsdorffii–Alnetum fruticosae*’ are later synonyms of the association name ‘*Athyrio distentifoliae–Alnetum fruticosae*’. The validations and descriptions of the alliance *Aquilegio glandulosae–Alnion alnobetulae* Ermakov **all. nov.** and the order *Aquilegio glandulosae–Alnetalia alnobetulae* Ermakov **ord. nov.** were carried out in accordance with the 4th edition of the International Code of Phytosociological Nomenclature. The diagnostic species, peculiarities of ecology and geographical area are indicated for these higher units. Prodrum of South Siberian syntaxa of the class *Betulo carpaticae–Alnetea viridis* Rejmanek ex Boeuf, Theurillat, Willner, Mucina et Simler in Boeuf et al. 2014 is represented.

Keywords: syntaxonomy, subalpine vegetation, alder scrub, validation, *Betulo–Alnetea viridis*, Siberia

РЕЗЮМЕ

Ермаков Н.Б. Валидизация и описание некоторых синтаксонов субальпийских богато-разнотравных ольховниковых сообществ Сибири (класс *Betulo carpaticae–Alnetea viridis*). В результате выполненного синтаксономического анализа единиц субальпийских сообществ высоких ольховниковых (*Alnus alnobetula* subsp. *fruticosa* (Rurp.) Raus) кустарников определено, что названия ассоциаций ‘*Calamagrostio obtusatae–Alnetum alnobetulae*’, ‘*Poa irkuticae–Alnetum fruticosae*’ и ‘*Calamagrostio langsdorffii–Alnetum fruticosae*’ являются более поздними синонимами названия ‘*Athyrio distentifoliae–Alnetum fruticosae*’. Осуществлена валидизация и описание союза *Aquilegio glandulosae–Alnion alnobetulae* Ermakov **all. nov.** и порядка *Aquilegio glandulosae–Alnetalia alnobetulae* Ermakov **ord. nov.** в соответствии с 4-м изданием Международного Кодекса Фитосоциологической номенклатуры. Для новых высших единиц приведены диагностические виды, особенности экологии и географии. Представлен продромус южносибирских сообществ класса *Betulo carpaticae–Alnetea viridis* Rejmanek ex Boeuf, Theurillat, Willner, Mucina et Simler in Boeuf et al. 2014.

Ключевые слова: синтаксономия, субальпийская растительность, ольховники, валидизация, *Betulo–Alnetea viridis*, Сибирь

Communities of subalpine herb-rich alder (*Alnus alnobetula* subsp. *fruticosa* (Rurp.) Raus) scrub occur in the high mountain belt of Southern Siberian mountains. Until recently, they were represented in the literature (Ermakov et al. 2000, Lashchinskiy et al. 2015, Zibzeev & Nedovesova 2017) by several associations – *Athyrio distentifoliae–Duschekietum fruticosae* Ermakov et al. 2000, *Doronico altaici–Duschekietum fruticosae* Lashchinsky 2015 nom. inval. (Art. 5a), *Bergenio crassifoli–Alnetum fruticosae* Zibzeev et Nedovesova 2017, *Carici iljinii–Duschekietum fruticosae* Zibzeev et Nedovesova 2017 included together with syntaxa of tall-forb subalpine meadows in the class *Mulgedio–Aconitetea*. Recently, two papers on the classification of this vegetation type in the Altai–Sayan mountain system were independently published in 2024 (Ermakov 2024, La-

shchinsky et al. 2024). Authors of these publications proposed to classify the South Siberian subalpine communities dominated by *Alnus alnobetula* subsp. *fruticosa* within the class *Betulo carpaticae–Alnetea viridis* in the rank of orders – *Doronico altaicae–Alnetalia alnobetulae* Ermakov 2024 and *Veratro lobeliani–Alnetalia viridis* Lashchinskiy et al. 2024 that are actually synonyms. Each of these orders includes one alliance, respectively *Aquilegio glandulosae–Alnion alnobetulae* Ermakov 2024 and *Veratro lobeliani–Alnion fruticosae* Lashchinsky, Chepinoga et Zibzeev 2024 being also synonyms. The issue of name priority could be resolved in accordance with art. 23 of the International Code of Phytosociological Nomenclature (ICPN) (Theurillat et al. 2021). However, both publications lack the results of a comparative syntaxonomic analysis of the new associations

and the previously described association *Athyrio distentifoliae*–*Alnetum fruticosae* Ermakov et al. 2000 nom. corr. et mut. (recte: *Athyrio distentifoliae*–*Duschekietum fruticosae* Ermakov et al. 2000). It resulted in the emergence of synonyms among the proposed new associations, including those that were chosen as nomenclatural types of new higher rank syntaxa (alliances mentioned above). Therefore, the aim of the study is to identify synonyms among the described South Siberian associations of the class *Betulo carpaticae*–*Alnetea viridis* and to validate the higher rank units according to the ICPN (Theurillat et al. 2021).

A quantitative analysis of the floristic similarity of the associations was performed based on the results of processing the constancy table (species constancy values 1–100 %) of 10 syntaxa using program Statistica 6.0 (Euclidian Distance, Ward's method). Constancy scale used in the synoptic table: I – 1–20 %, II – 21–40 %, III – 41–60 %, IV – 61–80 %, V – 81–100 %. Taxonomic reference: POWO (2025).

The results of the quantitative analysis (Euclidian distance, Ward's method) of 10 subalpine alder scrub syntaxa (Fig. 1) showed the high level of floristic similarity between associations *Athyrio distentifolii*–*Alnetum viridis* Ermakov et al. 2000 (10), *Athyrio distentifolii*–*Alnetum viridis* Ermakov et al. 2000 (in Zibzeev & Nedovesova, 2017) (7), *Calamagrostio obtusatae*–*Alnetum alnobetulae* Ermakov 2024 (8), *Poo irkuticae*–*Alnetum fruticosae* Lashchinskiy et Chepinoga in Lashchinskiy et al. 2024 (6) and *Calamagrostio langsdorffii*–*Alnetum fruticosae* Lashchinskiy in Lashchinskiy et al. 2024 (9) united in one cluster A (Fig. 1). The association *Bergenia crassifolia*–*Duschekietum fruticosae* Zibzeev et Nedovesova 2017 and non-rank community *Duschekia fruticosa* (Zibzeev & Chernikova 2006) were also united in one cluster B. Other associations were represented in cluster C (Fig. 1).

Synoptic table based on the results of cluster analyses (Table 1) demonstrates the floristic diagnostic features of all South Siberian units of subalpine alder (*Alnus alnobetula* subsp. *fruticosa*) scrub. Four floristically similar associations (*Athyrio distentifolii*–*Alnetum viridis*, *Calamagrostio langsdorffii*–*Alnetum fruticosae*, *Poo irkuticae*–*Alnetum fruticosae* and *Calamagrostio obtusatae*–*Alnetum alnobetulae*) described from the North-Eastern Altai, Western Sayan and the Khamar-Daban mountain ridge have a common group of diagnostic species (*Athyrium distentifolium*, *Calamagrostis obtusata*, *Dryopteris expansa*, *Gymnocarpium dryopteris*, *Lysimachia europaea*, *Micranthes nelsoniana* subsp. *aestivalis*, *Phegopteris connectilis*, *Thelypteris limbosperma*) distinguishing them from other associations of the class *Betulo carpaticae*–*Alnetea viridis* (Table 1). These predominantly mesophilous forest plants indicate specific ecological and geographical features of these four associations related to their occurrence in the ultra-humid climatic sector of in South Siberian mountains. The cyclonic climate regime providing a large amount of winter precipitation, results in the formation of deep (up to 2 m) snow cover, which protects the soil from strong freezing (Polikarpov et al. 1986). This

promote to the penetration of moderately thermophilous forest plants into the subalpine belt, which have high values of constancy and abundance in all four above-mentioned associations. There are no significant differences in the floristic compositions and ecology of these syntaxa. Consequently, the associations *Calamagrostio langsdorffii*–*Alnetum fruticosae* Lashchinskiy in Lashchinskiy et al. 2024 *Calamagrostio obtusatae*–*Alnetum alnobetulae* Ermakov 2024 and *Poo irkuticae*–*Alnetum fruticosae* Lashchinskiy et Chepinoga in Lashchinskiy et al. 2024 are considered as later synonyms of the association *Athyrio distentifolii*–*Alnetum viridis* Ermakov 2000. The subalpine alder scrub community included by Lashchinskiy et al. (2024) in the *Calamagrostio langsdorffii*–*Alnetum fruticosae* is characterized by the high constancy a local endemic species *Aconitum sajanense* which replaces the more widespread species *A. septentrionale* in the central part of the Western Sayan. Therefore it may be considered as a geographically local variant of the association *Athyrio distentifolii*–*Alnetum viridis*. The association *Poo irkuticae*–*Alnetum viridis* shows essential similar ecological and floristic features to the *Athyrio distentifoliae*–*Alnetum viridis* as well. It is found in the ultra-humid climatic sector in in the Khamar-Daban ridge (the Baikal region) and some moderately thermophilous mesophilous forest species (*Athyrium distentifolium*, *Dryopteris expansa*, *Lysimachia europaea*, *Phegopteris connectilis*) being diagnostic for the *Athyrio distentifoliae*–*Alnetum viridis* have high constancy values here. This association may be

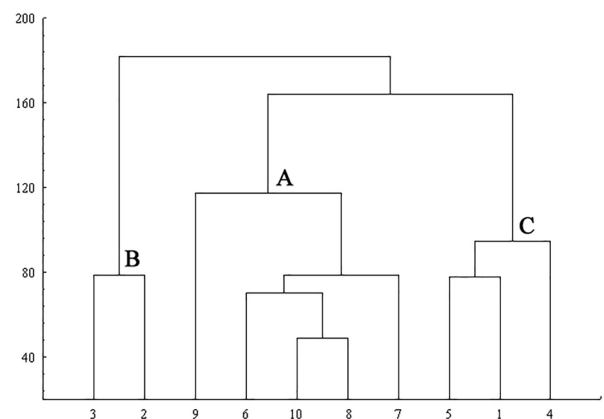


Figure 1 Results of cluster analysis (Euclidian distance, Ward's method) of 10 subalpine alder scrub syntaxa from the South-Siberian mountains. Syntaxa: 1 – ass. *Carici iljinii*–*Duschekietum fruticosae* Zibzeev et Nedovesova 2017, 2 – ass. *Bergenia crassifolia*–*Alnetum fruticosae* Zibzeev et Nedovesova 2017, 3 – comm. *Duschekia fruticosa* (Zibzeev & Chernikova 2006), 4 – ass. *Doronico altaici*–*Alnetum fruticosae* Lashchinskiy in Lashchinskiy et al. 2024, 5 – ass. *Swertio obtusae*–*Alnetum fruticosae* Zibzeev in Lashchinskiy, Chepinoga et Zibzeev 2024, 6 – ass. *Poo irkuticae*–*Alnetum fruticosae* Lashchinskiy et Chepinoga in Lashchinskiy et al. 2024, 7 – ass. *Athyrio distentifoliae*–*Duschekietum fruticosae* Ermakov et al. 2000 (in Zibzeev & Nedovesova 2017), 8 – ass. *Calamagrostio obtusatae*–*Alnetum alnobetulae* Ermakov 2024, 9 – ass. *Calamagrostio langsdorffii*–*Alnetum fruticosae* Lashchinskiy in Lashchinskiy et al. 2024, 10 – ass. *Athyrio distentifoliae*–*Alnetum fruticosae* Ermakov et al. 2000.

Table 1. Synoptic table of the class *Betulo carpaticae*–*Alnetea viridis* in Southern Siberia.

Syntaxon Nr.	1	2	3	4	5	6	7	8	9	10
Ass. Carici iljinii–Duschekietum fruticosae (1)										
<i>Rhododendron aureum</i>	V	III	III	.	.	.	I	.	I	.
<i>Cladonia rangiferina</i>	V	II	.	.	.	.	I	.	.	.
<i>Vaccinium uliginosum</i>	V	.	.	.	.	.	.	.	.	.
<i>Anulacommium palustre</i>	V	.	.	.	.	.	I	.	.	.
<i>Polytrichum juniperinum</i>	IV	IV	.	.	.	.	.	.	.	.
<i>Carex iljinii</i>	IV	.	.	.	.	.	.	.	.	.
<i>Cladonia arbuscula</i>	III	.	.	.	.	.	I	.	.	.
<i>Cladonia stellaris</i>	III	I	.	.	.	.	.	.	.	.
<i>Cladonia coccifera</i>	III	.	.	.	.	.	.	.	.	.
Ass. Bergenio crassifolii–Duschekietum fruticosae (2) and comm. <i>Duschekia fruticosa</i> (3)										
<i>Aconitum sajanense</i>	I	V	IV	.	.	.	.	.	III	.
<i>Caltha palustris</i>	.	V	V	II	III	I	III	I	I	II
<i>Valeriana capitata</i>	.	V	V	.	.	.	.	I	.	I
<i>Anemone altaica</i>	.	IV	V	.	.	III	.	.	.	.
<i>Dryopteris filix-mas</i>	.	IV	V	.	I	.	.	.	.	.
<i>Rumex arifolius</i>	.	IV	V	.	I	I	.	I	I	.
<i>Primula matthioli</i> subsp. <i>altaica</i>	.	IV	IV	.	.	.	.	I	.	.
<i>Macropodium nivale</i>	.	III	II	.	.	.	.	.	.	.
Ass. Doronico altaici–Alnetum fruticosae (4)										
<i>Heracleum dissectum</i>	.	.	.	V	.	.	.	I	I	I
<i>Dryopteris dilatata</i>	.	.	.	V	.	.	.	.	.	.
<i>Aconitum septentrionale</i>	.	.	.	V	II	.	II	I	.	I
<i>Athyrium filix-femina</i>	.	.	.	IV	.	.	.	.	.	.
<i>Ribes atropurpureum</i>	.	.	.	IV	II	.	.	.	.	.
Ass. Swertio obtusae–Alnetum alnobetulae (5)										
<i>Swertia obtusa</i>	.	.	.	V	.	.	.	II	.	I
<i>Cerastium pauciflorum</i>	.	III	II	V	.	.	.	I	.	.
<i>Senecio nemorensis</i>	.	.	III	V	I	.	.	III	.	II
<i>Aconitum baicalense</i>	.	.	.	III	.	.	.	.	.	.
Ass. Athyrio distentifoliae–Alnetum viridis (6–10)										
<i>Athyrium distentifolium</i>	I	II	II	III	II	V	V	V	V	V
<i>Dryopteris expansa</i>	II	I	.	.	II	IV	.	III	V	III
<i>Phegopteris connectilis</i>	.	.	.	.	.	III	II	IV	V	V
<i>Lysimachia europaea</i>	IV	I	.	.	II	III	II	III	IV	III
<i>Thelypteris limbosperma</i>	.	.	.	.	.	.	.	III	I	III
<i>Calamagrostis obtusata</i>	.	.	.	I	.	I	.	V	I	IV
<i>Gymnocarpium dryopteris</i>	.	.	.	.	.	.	.	I	III	II
<i>Miranthes nelsoniana</i> subsp. <i>aestivalis</i>	.	.	V	.	.	I	.	III	.	III
Subass. Athyrio distentifoliae–Alnetum viridis poetosum irkuticae										
<i>Poa irutica</i>	.	.	.	.	.	V	.	.	.	.
<i>Maianthemum bifolium</i>	.	.	.	.	.	IV	.	.	I	.
<i>Anemone reflexa</i>	.	.	.	.	.	III	.	.	.	.
<i>Eranthis sibirica</i>	.	.	.	.	.	III	.	.	.	.
<i>Anemonastrum baicalense</i>	.	.	.	.	.	III	.	.	.	.
Variant <i>Sorbus aucuparia</i>										
<i>Sorbus aucuparia</i> subsp. <i>glabrata</i>	I	.	.	II	II	.	II	I	V	.
All. Aquilegio glandulosae–Alnion alnobetulae and Ord. Aquilegio glandulosae–Alnetalia alnobetulae										
<i>Saussurea latifolia</i>	II	III	II	V	V	I	III	IV	II	III
<i>Solidago daburica</i>	IV	V	V	II	IV	IV	V	IV	V	IV
<i>Doronicum altaicum</i>	.	III	IV	V	III	II	V	III	.	III
<i>Bistorta officinalis</i> subsp. <i>officinalis</i>	IV	IV	V	.	IV	I	I	III	III	I
<i>Aquilegia glandulosa</i>	III	V	V	.	V	.	IV	V	III	IV
<i>Allium microdictyon</i>	I	V	V	I	IV	II	V	.	III	.
<i>Bergenia crassifolia</i>	I	V	V	.	I	II	V	V	V	V
<i>Poa sibirica</i>	IV	V	V	V	V	.	IV	.	III	.
<i>Anthoxanthum nipponicum</i>	IV	I	.	.	I	I	III	V	.	V
<i>Trollius asiaticus</i>	I	V	V	II	V	.	III	I	I	I
<i>Carex aterrima</i>	I	I	V	.	IV	.	II	II	.	I
<i>Geranium albiflorum</i>	I	V	II	V	III	IV	III	IV	II	III
Cl. Betulo carpaticae–Alnetea viridis										
<i>Alnus alnobetula</i> subsp. <i>fruticosa</i>	V	V	V	V	V	V	V	V	V	V
<i>Veratrum lobelianum</i>	I	V	II	V	IV	IV	V	III	V	III
<i>Viola biflora</i>	II	IV	IV	I	IV	III	V	IV	II	III
<i>Calamagrostis purpurea</i>	II	.	.	IV	II	V	III	IV	V	IV
<i>Lonicera caerulea</i> subsp. <i>altaica</i>	V	V	V	II	V	.	II	III	V	IV
<i>Salix glauca</i>	II	III	IV	.	II	.	.	IV	.	III
<i>Milium effusum</i>	.	III	IV	III	.	.	.	.	.	.
Other species										
<i>Abies sibirica</i>	I	IV	IV	III	III	II	II	I	V	I
<i>Vaccinium myrtillus</i>	III	V	V	.	IV	II	V	V	IV	IV
<i>Betula glandulosa</i>	IV	V	V	.	.	.	.	I	.	I
<i>Dicranum scoparium</i>	III	.	.	.	.	.	V	.	.	.
<i>Polytrichum longisetum</i>	.	.	.	.	.	I	V	.	.	.
<i>Paraleucobryum longifolium</i>	.	.	.	.	.	.	V	.	.	.
<i>Viola altaica</i>	.	II	III	.	I	.	IV	.	.	.
<i>Cirsium helenioides</i>	II	I	.	V	.	II	IV	.	II	.
<i>Cardamine macrophylla</i>	.	IV	V	III	.	.	.	.	I	.
<i>Oxalis acetosella</i>	.	.	.	II	III	.	.	.	.	.
<i>Plagiothecium denticulatum</i>	.	.	.	.	.	.	IV	.	.	.
<i>Pedicularis incarnata</i>	I	II	V	.	II	.	II	II	I	I
<i>Cladonia chlorophaea</i>	I	.	.	.	.	.	III	.	.	.
<i>Ranunculus grandifolius</i>	.	I	I	I	II	.	.	III	.	I

considered as geographical subassociation *Athyrio distentifoliae*–*Alnetum viridis poetosum irkuticae* prov. indicated by specific regional species group (*Anemonastrum baicalense*, *Anemone altaica*, *A. reflexa*, *Eranthis sibirica*, *Poa irutica*). The non-rank community *Duschekia fruticosa* (Zibzeev & Chernikova 2006) should be included into the association *Bergenio crassifolii*–*Duschekietum fruticosae* Zibzeev et Nedovesova 2017 after results of cluster analysis (Fig. 1). Diagnostic species group of this association is *Aconitum sajanense*, *Anemone altaica*, *Caltha palustris*, *Dryopteris filix-mas*, *Macropodium nivale*, *Primula matthioli* subsp. *altaica*, *Rumex arifolius*, *Valeriana capitata* (Table 1).

Validation of syntaxa

The alliance name ‘*Veratro lobeliani*–*Alnion fruticosae* Lashchinskiy’ proposed by Lashchinskiy et al. (2024) is invalidly published (Art. 5a) because the association *Calamagrostio langsdorffii*–*Alnetum viridis* Lashchinskiy in Lashchinskiy et al. 2024 designated as its holotype is a latter synonym of the association *Athyrio distentifoliae*–*Alnetum viridis* Ermakov et al. 2000 nom. corr. et mut.

The order name ‘*Veratro lobeliani*–*Alnetalia fruticosae*’ is also invalidly published in Lashchinskiy et al. (2024) because its original diagnosis contains only one invalidly published alliance *Veratro lobeliani*–*Alnion fruticosae* Lashchinskiy et al. 2024 nom. inval., which was designated as the type (Art. 5a).

The alliance name ‘*Aquilegio glandulosae*–*Alnion alnobetulae*’ is invalidly published by Ermakov (2024) (Art. 5a) because the name ‘*Calamagrostio obtusatae*–*Alnetum alnobetulae*’ which was designated as its type association is a latter synonym of the association name *Athyrio distentifoliae*–*Alnetum viridis* Ermakov, Shaulo et Maltseva 2000 nom. corr. et mut.

The order name ‘*Doronicum altaicae*–*Alnetalia alnobetulae*’ is also invalidly published in Ermakov (2024) because its original diagnosis contains only one invalidly published alliance *Aquilegio glandulosae*–*Alnion alnobetulae* Ermakov 2024 nom. inval., which was designated as the type (Art. 5a).

Description of new syntaxa

All. Aquilegio glandulosae–Alnion alnobetulae Ermakov all. nov.

Diagnostic species: *Allium microdictyon*, *Aquilegia glandulosa*, *Anthoxanthum nipponicum*, *Bergenia crassifolia*, *Bistorta officinalis* subsp. *officinalis*, *Carex aterrima*, *Doronicum altaicum*, *Geranium albiflorum*, *Poa sibirica*, *Saussurea latifolia*, *Solidago daburica*, *Trollius asiaticus*.

Lectotypus hoc loco: ass. *Athyrio distentifoliae*–*Alnetum viridis* Ermakov, Shaulo et Maltseva 2000 nom. corr. (recte: *Athyrio distentifoliae*–*Duschekietum fruticosae* Ermakov, Shaulo et Maltseva 2000 (Ermakov et al. 2000, p. 165).

Subalpine herb-rich alder (*Alnus alnobetula* subsp. *fruticosa*) shrub occurring on well-drained moist slopes at altitudes of 1500–2100 m in the mountains of Southern Siberia.

**Ord. Aquilegio glandulosae–Alnetalia
alnobetulae Ermakov ord. nov.**

Diagnostic species are the same as for the alliance Aquilegio glandulosae–Alnion alnobetulae Ermakov **all. nov.**

Holotypus is the alliance Aquilegio glandulosae–Alnion alnobetulae Ermakov **all. nov.** (described in this paper).

Subalpine herb-rich alder (*Alnus alnobetula* subsp. *fruticosa*) scrub occurring in the subalpine and upper part of forest belts in the humid and ultra-humid climatic sector of the South Siberian mountains.

**Prodromus of syntaxa of the class
Betulo carpaticae–Alnetea viridis
in the mountains of Southern Siberia**

Class

Order

Alliance

Association

Betulo carpaticae–Alnetea viridis Rejmanek ex Boeuf, Theurillat, Willner, Mucina et Simler in Boeuf et al. 2014

Aquilegio glandulosae–Alnetalia

alnobetulae Ermakov **ord. nov.** (Synonyms: *Doronico altaicae–Alnetalia alnobetulae* Ermakov 2024 nom. inval. (Art. 5a), *Veratro lobeliani–Alnetalia fruticosae* Lashchinskiy, Chepinoga et Zibzeev 2024 nom. inval. (Art. 5a))

Aquilegio glandulosae–Alnion

alnobetulae Ermakov **all. nov.** (Synonyms: *Aquilegio glandulosae–Alnion alnobetulae* Ermakov 2024 nom. inval. (Art. 5a), *Veratro lobeliani–Alnion fruticosae* Lashchinskiy, Chepinoga et Zibzeev 2024 nom. inval. (Art. 5a))

Athyrio distentifoliae–Alnetum

fruticosae Ermakov et al. 2000 nom. corr. (Lashchinskiy et al. 2024) (Synonyms: *Calamagrostio obtusatae–Alnetum alnobetulae* Ermakov 2024 syntax. syn., *Calamagrostio langsdorffii–Alnetum fruticosae* Lashchinskiy in Lashchinskiy, Chepinoga et Zibzeev 2024 syntax. syn.), *Poo irkuticae–Alnetum fruticosae* Lashchinskiy et Chepinoga in Lashchinskiy, Chepinoga et Zibzeev 2024 syntax. syn.). Subass. *A. d.–A. f. typicum*, variant *Sorbus aucuparia*, subass. *A. d.–A. f. poetosum irkuticae* prov.

Bergenio crassifoli–Alnetum fruticosae

Zibzeev et Nedovesova 2017 (incl. comm. *Duschekia fruticosa* (Zibzeev & Tchernikova 2006))

Carici iljinii–Duschekietum fruticosae

Zibzeev et Nedovesova 2017

Doronico altaici–Alnetum fruticosae

Lashchinsky in Lashchinskiy, Chepinoga et Zibzeev 2024

Swertio obtusae–Alnetum fruticosae

Zibzeev in Lashchinskiy, Chepinoga et Zibzeev 2024

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