TALL-FORB COMMUNITIES OF THE NORTH ALTAI

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ABSTRACT - Classification of tall-forb vegetation of the Altai using the Braun-Blanquet approach was carried out on the basis of a wide ranging set of data from different altitudinal belts. Three main phytosociological types of the tall-forb communities were distinguished within the class *Mulgedio - Aconitetea*, order *Trollio - Crepidetalia* due to performed syntaxonomic analysis. The thermophilous tall-forb communities occurring in the subnemoral belt at altitudes of 259-700 m were included in the alliance *Cacalio hastatae - Aconition septentrionalis* all. nova. The montain tall-forb meadows of the dark-coniferous taiga belt (altitudes of 800-1700 m) were included in the alliance *Triseto sibiricae-Aconition septentrionalis* all. prov. The moderately cryophilous subalpine tall-forb communities widespread at the upper boundary of the forest belt at altitudes of 1000-1900 m were included in the alliance *Rhaponticion carthamoidis*. Altaian tall-forb vegetation shows a distinct phytosociological and plant geographical unity with European subalpine communities but the closeness of the floristic relations varies in certain altitudinal groups. Most thermophilous tall-forb Siberian meadows of the alliance *Cacalio-Aconition* which occur at lower altitudes demonstrate strong plant geographical relations with North and Central European meadows of the *Adenostyletalia*. Gradual decrease of the European floristic relations in the Altaian tall-forb meadows at higher altitudes is shown.

KEY WORDS - Syntaxonomy, Vegetation survey, *Mulgedio - Aconitetea*, Russia.

INTRODUCTION

This paper is a study of phytosociological and syntaxonomic peculiarities of tall-forb communities and open forests of the Altai mountain system located in the center of Eurasia between 49°-53°N and 85°-90°E. The Siberian tall-forb vegetation represents a phytosociological and plant-geographical unity with European *Mulgedio-Aconitetea* communities, due to high phytosociological role of European-Siberian species and presence of numerous pairs of vicarious species. They contain some ecological and phytosociological distinctions from their European analogs, in consequence of an increase of climatic continentality eastward the Urals mountains.

There is only one study on syntaxonomy of subalpine vegetation of the Altai which was performed with the use of the Braun-Blanquet approach in the restricted area of the Altai Nature Reserve (Zhitlukhina, 1988). In that study, the subalpine tall-forb communities were included in one association of the class *Aconito-Geranietea albiflori* Zhitlukhina et Onishchenko 1987. The present study based on comprehensive phytosociological data collected from various altitudinal belts of the Altai mountain system represent a new concept of the classification of the tall-forb vegetation.

The hygro-mesophilous tall-forb plant communities are spread in the western and northern parts of the Altai which are characterized by the highest precipitation and warmth indices in Siberia (annual precipitation is 1000-1600 mm, average annual temperature is −1-+2°C). The most important factor for the survival of the moderately thermophilous tall-forb vegetation is abundant winter precipitation which forms a snow cover of up to 1.5m and protects soil from the strong frost. These meso-climatic conditions are characteristic of the various altitudinal zones and are favorable for spreading the tall-forb communities both in the subalpine and in the lower belts.

Material and methods

The basis for the present study was 117 relevés of tall-forb communities from the northern ridges and foothills of the Altai mountain system. The classification of the vegetation has been carried out using the Braun-Blanquet approach (Westhoff & van der Maarel, 1973).

The TURBOVEG, MegaTab (Hennekens, 1996) and TWINSPAN (Hill, 1979) software was used for database management and for quantitative treatment of relevés. Syntaxonomic comparisons have been carried out using the available phytosociological literature (Kielland-Lund, 1981; Guinochet, 1982; Oberdorfer, 1983; Ellenberg, 1988; Korotkov *et al.*, 1991; Chytry *et al.*, 1993, 1995; Mucina, 1997).

The dendrogram for lower units of tall-forb vegetation has been produced for demonstration of the floristic integrity of the higher units and floristic relations between them.

For characterization of the relevés and syntaxa the Braun-Blanquet scale (r, +, 1, 2, 3, 4, 5) and constancy scale: I (1-20%), II (21-40%), III (41-60%), 1V (61-80%), V (81-100%) were used. The abbreviations in the tables appended to the species names refer to the structural role of the plants: t1=tree layer, t2=second tree layer, s1=first shrub layer, s2=second shrub layer, hl=herb layer, ml=ground layer.

Species names follow the list of vascular plants of former USSR (Cherepanov, 1995).

Results

When syntaxonomic analyses were performed, all Altaian tall-forb communities were included in the European-Siberian class *Mulgedio - Aconitetea*. The main basis for the decision was a high constancy of differential species of this class which are widespread in Europe and Western Siberia: *Veratrum lobelianum, Rumex alpestris, Delphinium elatum, Viola biflora, Milium effusum, Athyrium distentifolium, Aconitum*

septentrionalis, Bistorta major. Besides, there are numerous pairs of close vicarious European and Siberian subalpine and subalpine-forest species: *Aconitum baicalense – A. napellus, Lathyrus gmelinii – L. laevigatus, Lilium pilosiusculum – L. martagon, Anemonoides altaica – A. nemorosa, Primula pallasii – P. elatior, Erythronium sibiricum – E. dens-canis, Solidago dahurica – S. virgaurea, Pleurospermum uralense – P. austriacum, Doronicum altaicum – D. austriacum, Bupleurum aureum – B. longifolium, Heracleum dissectum – H. sphondylium, Stellaria bungeana – S. nemorum.*

In the Altai mountain system, the class *Mulgedio-Aconitetea* is represented by tall-forb communities, (sometimes with participation of single trees: *Pinus sibirica, Abies sibirica*) and krummholz (*Betula tortuosa*). They have well-developed herb layer (cover – 90-100%, height – 110-180cm (up to 250 cm), species richness – 32-49 per 100 m^2), which is subdivided into several sublayers. The ground-moss layer is sparse in majority of the communities. Development of spring synusia of geophytes (*Erythronium sibiricum, Anemonoides altaica, A. coerulea, Corydalis bracteata*) with cover of 30-80% is typical in Siberia only of the *Mulgedio-Aconitetea* and of the relic *Fagetalia* forests. At present, the Altaian tall-forb communities are included in one order, three alliances, 11 associations, subassociations and variants.

Syntaxonomic Synopsis:

Class ***Mulgedio-Aconitetea*** Hadac et Klika in Klika et Hadac 1944

Order ***Trollio-Crepidetalia sibiricae*** Guinochet ex Chytry *et al.* 1993

Species-rich tall-forb communities of humid and ultrahumid sectors of the Altai-Sayanian mountain system.

Alliance ***Cacalio hastatae - Aconition septentrionalis*** all. nov. *hoc loco* (tab. 1, columns 1-3). Nom. type is association *Calamagrostio obtusatae-Aconitetum septentrionalis.*

Altaian thermophilous tall-forb communities of the subnemoral belt of the relic small-leaved coniferous *Fagetalia* Pawlowski *et al.* 1928 forests. They are widespread in ultrahumid lower mountains at altitudes of 250-700 m. The groups of alpine and arctic-alpine species are absent in the floristic composition of the alliance communities, but an essential role of the European-Siberian relic nemoral species is shown there (*Stachys sylvatica, Festuca gigantea, Aegopodium podagraria, Lathyrus vernus*).

Association ***Calamagrostio obtusatae - Aconitetum septentrionalis*** ass. nova *hoc loco* (tab.1 column nr. 1).

Communities of this association are widespread in the lower part of the subnemoral forest belt. They occupy gentle slopes of foothills and low mountains at altitudes of 350-600 m. The warm and ultrahumid meso-climate of the region promotes the vigorous development of a dense tall-forb layer rich in species, containing several dominants and subdominants. Besides, there is a distinct lower sublayer (15-25 cm) of shade-tolerant boreal herbs: *Stellaria bungeana, Adoxa moschatellina, Viola uniflora, Ranunculus monophyllus, Myosotis krylovii.*

Nom. type: relevé 135, Russia, Kemerovskaya oblast, Barzaskii region, near Glukharinka, 2 km east, plot size – 100 m^2, altitude – 410 m, aspect - 260°, inclination - 5°, 1998.07.08, author: N. Ermakov.

Ribes atropurpureum - +, *Aconitum septentrionalis* - 2, *Adoxa moschatellina* - +, *Allium microdictyon* - +, *Anemonoides altaica* - 1, *Anthriscus sylvestris* - 1, *Athyrium filix-femina* - 1, *Cacalia hastata* - 1, *Calamagrostis langsdorffii* - 1, *C. obtusata* - +,

Cirsium heterophyllum - 2, *Crepis sibirica* - 1, *Delphinium elatum* - 2, *Dryopteris carthusiana* - 1, *Equisetum sylvaticum* - +, *Erythronium sibiricum* - 1, *Euphorbia pilosa* - 1, *Filipendula ulmaria* - +, *Heracleum dissectum* - 2, *Matteuccia struthiopteris* - 1, *Milium effusum* - 1, *Myosotis krylovii* - +, *Paris quadrifolia* - +, *Pleurospermum uralense* - 1, *Polemonium coeruleum* - 2, *Pteridium aquilinum* - +, *Ranunculus monophyllus* - +, *Saussurea latifolia* - 1, *Senecio nemorensis* - 1, *Solidago dahurica* - +, *Stachys sylvatica* - +, *Stellaria bungeana* - 1, *Tanacetum vulgare* - +, *Thalictrum minus* - +, *Urtica dioica* - 1, *Veratrum lobelianum* - 1, *Vicia sepium* - +.

Association ***Athyrio filix-feminae - Aconitetum septentrionalis*** ass. nova *hoc loco* (tab. 1, column nr. 3).

Communities of this association occur in the upper part of the coniferous subnemoral forest belt of the North-Eastern Altai. They occupy steep and gentle slopes with less developed soils at altitudes of 500-800 m. The association also includes secondary tall-forb communities formed in places where the primary subnemoral forests have been destroyed. The presence of the shrubs (*Padus avium, Ribes atropurpureum, Sorbus sibirica, Rubus idaeus*) and single trees (*Abies sibirica, Betula pendula* and *Pinus sibirica*) which do not generate special dense stands is a characteristic feature of the association communities. In the grass layer, the usual tall-forb species together with forest ferns (*Athyrium filix-femina, Dryopteris expansa, Matteuccia struthiopteris, Pteridium aquilinum, Phegopteris connectilis*) and nemoral plants (*Brachypodium sylvaticum, Brunnera sibirica*) play a leading role.

Nom. type: relevé 1297, Russia, Altai Republic, Turochakskii raion, near v. Kayashkan, 5 km west, altitude – 370 m, plot size – 100 m^2, aspect - 22.5°, inclination - 30°, 1989.06.13, author: N. Ermakov.

Abies sibirica - 2, *Aconitum septentrionalis* - 2, *A. volubile* - +, *Alfredia cernua* - +, *Anemonoides altaica* - 1, *Anthriscus sylvestris* - +, *Asarum europaeum* - +, *Athyrium filix-femina* - 2, *Betula pendula*-s1 - 1, *Brachypodium sylvaticum* - 1, *Cacalia hastata* - +, *Calamagrostis langsdorffii* - 1, *Calamagrostis obtusata* - 1, *Caltha palustris* - 1, *Chamaenerion angustifolium* - +, *Cirsium heterophyllum* - +, *Corydalis bracteata* - 1, *Crepis sibirica* - 1, *Delphinium elatum* - +, *Diplazium sibiricum* - +, *Erythronium sibiricum* - 1, *Euphorbia pilosa* - 1, *Galium odoratum* - 1, *Geranium albiflorum* - 1, *Heracleum dissectum* - 1, *Humulus lupulus* - +, *Matteuccia struthiopteris* - 2, *Milium effusum* - 1, *Myosotis krylovii* - 1, *Oxalis acetosella* - 1, *Padus avium* - 2, *Paeonia anomala* - +, *Paris quadrifolia* - +, *Polemonium coeruleum* - 1, *Populus tremula* - +, *Pteridium aquilinum* - 1, *Ribes atropurpureum* - +, *Saussurea latifolia* - 2, *Senecio nemorensis* - 1, *Sorbus sibirica* - 2, *Stachys sylvatica* - +, *Stellaria bungeana* - 2, *Urtica dioica* - +, *Veratrum lobelianum* - 1, *Viola biflora* - 2.

Association ***Aegopodio podagrariae - Cirsietum heterophylli*** ass. nova *hoc loco* (tab. 1, column nr. 2).

These tall-forb communities are spread in the warm humid foothills of the Altai where they occur in combination with small-leaved (*Populus tremula, Betula pendula*) *Fagetalia* forests on gentle slopes of hills and mountains at altitudes of 180-350 m. They also occur in the elevated plains of the south-eastern part of West Siberia where they occupy only moist well-drained bottoms of ravines. The diagnostic species of the association are European-West-Siberian thermophilous nemoral and south-boreal species (*Aegopodium podagraria, Vicia sylvatica, Geranium sylvaticum, Humulus lupulus, Lathyrus vernus*) growing only at lower altitudes.

Nom. type: relevé 267, Russia, Novosibirskaya oblast, Novosibirsk, near Central Siberian Botanical Garden, plot size – 100 m^2, bottom of ravine, altitude – 200 m, 1996.08.09, author: N. Ermakov.

Aconitum septentrionalis - 1, *Adoxa moschatellina* - +, *Aegopodium podagraria* - 3, *Angelica sylvestris* - +, *Anthriscus sylvestris* - 1, *Athyrium filix-femina* - 3, *Cacalia hastata* - +, *Calamagrostis arundinacea* - +, *Circaea alpina* - +, *Cirsium heterophyllum* - +, *Crepis sibirica* - 1, *Delphinium elatum* - 1, *Equisetum pratense* - +, *Equisetum sylvaticum* - 1, *Filipendula ulmaria* - +, *Geranium sylvaticum* - +, *Heracleum dissectum* - +, *Lathyrus gmelinii* - +, *Lathyrus vernus* - 1, *Lysimachia vulgaris* - r, *Matteuccia struthiopteris* - 2, *Milium effusum* - 1, *Mnium* sp. - r, *Poa remota* - +, *Pulmonaria mollis* - +, *Ranunculus monophyllus* - +, *Ranunculus repens* - +, *Rosa majalis* - +, *Senecio nemorensis* - +, *Stachys sylvatica* - 1, *Stellaria bungeana* - 1, *Thalictrum minus* - +, *Trollius asiaticus* - 1, *Veratrum lobelianum* - 1, *Vicia sylvatica* - +, *Viola selkirkii* - +, *Urtica dioica* - +.

Alliance ***Triseto sibiricae - Aconition septentrionalis*** all. prov.

South-Siberian mountain tall-forb communities with participation of herbs of south-boreal and hemiboreal forests. They occur in the forest (dark-coniferous taiga) belt of the humid and ultrahumid regions at altitudes of 800 - 1700 m. These are natural stages of the coniferous forests (*Vaccinio - Piceetea* Br.-Bl. in Br.-Bl., Siss. et Vlieger 1939) successions. Communities of the alliance are replaced by *Molinio - Arrhenatheretea* R. Tx. 1937 meadows (*Crepidion sibiricae* Mirkin 1983) because of heavy grazing and haying.

Association ***Triseto sibiricae - Aconitetum septentrionalis*** ass. prov. (tab. 1, columns nr. 4-7).

This association keeps all characteristic features of the alliance.

Subassociation ***T.s.-A.s. typicum*** subass. prov. (tab. 1, column nr. 4).

These are typical communities of the association.

Subassociation ***T.s-A.s. deschampsietosum cespitosae*** subass. prov. (tab. 1, column nr. 5).

Moist tall-forb communities used irregularly as pastures occur in the middle and upper parts of the forest belt. They are characterized by essential role of some true meadow species: *Trifolium pratense, Deschampsia cespitosa, Amoria repens.*

Subassociation ***T.s-A.s. calamagrostietosum arundinaceae*** subass. prov. (tab. 1, column nr. 6).

Moderately moist tall-forb communities used irregularly as pastures and hay meadows occur in the lower part of the forest belt. The increase of the role of more thermophilous mesophytes (*Calamagrostis arundinacea, Vicia sepium, Dactylis glomerata*) is shown here.

Subassociation ***T.s.-A.s. rhytidiadelphetosum*** subass. prov. (tab. 1, column nr. 7).

These tall-forb communities are stages of natural and antropogenic successions of the *Vaccinio-Piceetea* coniferous forests. They occur on the northern slopes of the taiga belt of the Altai at altitudes of 1100-1500 m.

Alliance ***Rhaponticion carthamoidis*** Zhitlukhina et Onishchenko 1987 (tab. 1, columns nr. 8-11).

South-Siberian subalpine communities widespread at the upper boundary of the forest belt at altitudes of 1000 - 1900 m. Combination of subalpine, subalpine-forest and some alpine species is a characteristic feature of the alliance.

Association ***Cirsio heterophylli-Rhaponticetum carthamoidis*** Zhitlukhina 1988 (tab. 1, column nr. 8).

Typical tall-forb subalpine communities widespread in the higher mountain ridges of humid regions of the Altai. They occupy the moist warm parts of southern, south-western and south-eastern steep and gentle slopes with stony soils at altitudes of 1750-1850 m. The main dominant of the first sublayer of grass layer is *Stemmacantha carthamoides* – a characteristic species of the alliance. The lower sublayer is weakly developed and is predominantly represented by alpine and arctic-alpine species.

Association ***Abieteto sibiricae - Athyrietum distentifolii*** ass. nova *hoc loco* (tab. 1, columns nr. 9-11).

This association includes tall-forb communities with participation of fir (*Abies sibirica*) and birch (*Betula tortuosa*) which form a sparse layer with cover of 5-30%. They are widespread in the subalpine belt of moderately warm ultrahumid mesoclimate of the North-Eastern Altai and Kuznetskii Alatau at altitudes of 800-1100 m. The characteristic feature of the association is a high phytosociological role of the group of moderately thermophilous forest mesophytes (*Adenophora lamarckii, Sorbus sibirica, Rubus idaeus, Phegopteris connectilis, Dryopteris expansa, Cerastium davuricum*) as well as of the group of spring geophytes (*Erythronium sibiricum, Anemonoides altaica, Corydalis bracteata*), forming a temporal sublayer with cover of 60-80%.

Subassociation ***A.s. - A.d. sorbetosum sibiricae*** subass. nova *hoc loco* (tab. 1, column nr. 10).

Nom. type: relevé 38, Russia, Kemerovskaya oblast, Kuznetskii Alatau ridge, the Ivanovka river basin, the Pravii Filippova stream, plot size – 100 m^2, altitude - 1050 m, aspect - 150°, inclination - 5°, 1998.06.26, author: N. Ermakov.

Abies sibirica - 2, *Aconitum septentrionalis* - 1, *Adenophora lamarckii* - +, *Allium microdictyon* - 2, *Anemonoides altaica* - 2, *Anthoxanthum alpinum* - 1, *Athyrium distentifolium* - 2, *Bistorta major* - 2, *Bupleurum aureum* - 1, *Calamagrostis obtusata* - +, *Chamaenerion angustifolium* - +, *Dicranum polysetum* - +, *Doronicum altaicum* - 1, *Dryopteris carthusiana* - +, *D. expansa* - +, *Euphorbia pilosa* - 2, *Geranium albiflorum* - 2, *Lathyrus gmelinii* - +, *Lilium pilosiusculum* - +, *Lonicera altaica* - +, *Milium effusum* - +, *Pedicularis incarnata* - +, *Pleurozium schreberi* - +, *Poa sibirica* - 2, *Polemonium coeruleum* - +, *Primula pallasii* - 1, *Ranunculus grandifolius* - 1, *Ribes hispidulum* - +, *Rubus idaeus* - +, *Rumex alpestris* - 1, *Saussurea latifolia* - 1, *Senecio nemorensis* - 1, *Sorbus sibirica* - 1, *Solidago dahurica* - 1, *Stemmacantha carthamoides* - 1, *Trollius asiaticus* - 1, *Vaccinium myrtillus* - 1, *Veratrum lobelianum* - 1, *Viola biflora* – 1.

Var. *Betula tortuosa* (tab. 1, column nr. 9) includes communities with participation of *Betula tortuosa* forming a sparse layer.

Subassociation ***T.s-A.s. euphorbietosum pilosae*** subass. nova *hoc loco* (tab. 1, column 11).

Communities with predominance of tall-forb species: *Euphorbia pilosa* – the main dominant, *Saussurea latifolia, Heracleum dissectum, Bupleurum aureum, Lathyrus gmelinii*. They are widespread in the subalpine belt of the Kuznetskii Alatau ridge where they form the typical combination with communities of the previous subassociation.

Nom. type: relevé N27. Locality: Russia, Khakasia, Ordzhonikidzevskii region, the Sarala river basin, near Ivanovskoye Lake, plot size – 100 m^2, altitude - 1080 m, aspect - 260°, inclination - 30°, 1998.06.25, author: N. Ermakov

Aconitum septentrionalis - 1, *Adenophora lamarckii* - 1, *Anemonoides altaica* - 1, *Angelica decurrens* - r, *Anthriscus sylvestris* - +, *Aquilegia glandulosa* - 2, *Athyrium distentifolium* - 2, *Bistorta major* - 2, *Bupleurum aureum* - 1, *Cerastium davuricum* - +, *Chamaenerion angustifolium* - 1, *Corydalis bracteata* - +, *Crepis lyrata* - 1, *Erythronium sibiricum* - 2, *Euphorbia pilosa* - 2, *Geranium albiflorum* - 1, *Heracleum dissectum* - +, *Lamium album* - +, *Lathyrus gmelinii* - +, *Lilium pilosiusculum* - +, *Paeonia anomala* - +, *Pedicularis incarnata* - 1, *Pleurospermum uralense* - +, *Poa sibirica* - +, *Polemonium coeruleum* - 1, *Primula pallasii* - 1, *Ranunculus grandifolius* - +, *R. propinquus* - +, *Rumex alpestris* - 1, *Saussurea latifolia* - 1, *Senecio nemorensis* - +, *Solidago dahurica* - +, *Stemmacantha carthamoides* - 2, *Thalictrum minus* - +, *Trollius asiaticus* - +, *Veratrum lobelianum* - +, *Viola biflora* - +.

The dendrogram for 11 associations and subassociations (fig. 1) demonstrates the floristic relations between the alliances of tall-forb communities of the North Altai. Three distinct altitudinal syntaxa groups characterized by the largest linkage distances are shown and these represent the alliances. The alliance *Rhaponticion carthamoidis* (subalpine tall-forb communities) which occupies the central part of the dendrogram (fig. 1, Var 8-11) demonstrates greater similarity with the alliance *Cacalio - Aconition septentrionalis* (tall-forb communities of the lower part of the forest belt; fig. 1, Var 1 - 3) despite the fact that the communities of these alliances occur at different altitudes and they are separated by tall-forb vegetation of the alliance *Triseto - Aconition septentrionalis* (fig.1, Var 4 - 7) which form a discrete branch of the diagram. The dendrogram demonstrates the asymmetry of the floristic relationships and regional peculiarities of the flora genesis of altitudinal groups of the Altaian tall-forb vegetation.

Discussion

The Altaian tall-forb vegetation represents a phytosociological and plant geographical unity with European subalpine class *Mulgedio - Aconitetea*. Besides, the closeness of floristic relations of the Siberian tall-forb communities to the European analogs varies in certain altitudinal groups. Most thermophilous tall-forb Siberian vegetation of the alliance *Cacalio-Aconition septentrionalis* demonstrate strong plant geographical relations with North European communities of the *Adenostyletalia alliariae* (the alliance *Lactucion alpinae*) in Scandinavia (Kielland-Lund, 1981). The thermophilous and moderately thermophilous subalpine-forest, south-boreal and nemoral species (*Aconitum septentrionalis, Stellaria nemorum, Anemone nemorosa, Paris quadrifolia, Milium effusum, Oxalis acetosella, Phegopteris connectilis, Geranium sylvaticum, Athyrium filix-femina*) predominate in the communities. At the same time, cryophilous alpine and arctic-alpine species occur occasionally or are absent there. There are also numerous plant-geographical relations between Altaian communities of the *Cacalio–Aconition septentrionalis* and subalpine vegetation of the Central European alliance *Calamagrostion arundinaceae* (Oberdorfer, 1983; Ellenberg, 1988). The relations are indicated by common species of the European-Siberian and West Palaearctic chorologic groups (*Cirsium heterophyllum, Delphinium elatum, Geranium sylvaticum, Angelica sylvestris, Paris quadrifolia, Milium effusum, Athyrium filix-femina, Senecio nemorensis*) and by numerous close vicarious species.

The change in relationships among the chorologic groups is observed in the subalpine tall-forb communities of the alliance *Rhaponticion carthamoidis*. There, the eastern chorologic groups dominate over the western ones. Besides, the increase of the role of endemic groups (South-Siberian-Mongolian, Altai-Sayanian-Jungarian) is shown there. These are dominantly cryophilous alpine and arctic-alpine species.

Low values of the South-Siberian-East-Asian chorologic group in all alliances demonstrate weak plant geographical relations of the Siberian tall-forb communities with the East Asian analogues included in the special class *Thalictretea kemensis* Akhtyamov 1990.

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Attributes of syntaxa (Var 1 - Var 11) correspond to syntaxa numbers (columns N 1 - 11) in Tab. 1

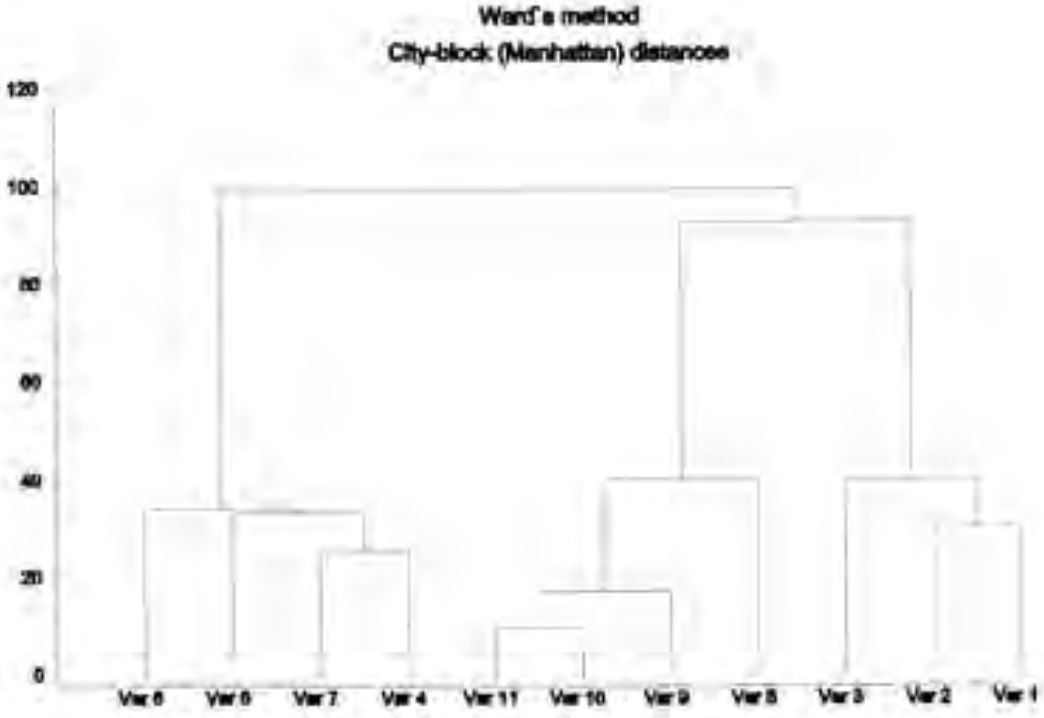

Figure 1 - Dendrogram of lower syntaxa (association, subassociations and variant) of the Altaian tall-forb communities

TABLE 1 - Synoptic table of sintaxa of the Altain tall-forb vegetation

Syntaxa nr. (column nr.)	1	2	3	4	5	6	7	8	9	10	11
Mean altitude (m)	400	270	550	1200	1250	1100	1450	1800	900	950	950
Mean number of species	32	35	40	43	46	44	49	35	45	41	33
Size of plot	everywhere 100 m^2										
Number of relevés	17	12	7	9	13	8	12	11	15	6	7
Tree species											
Abies sibirica	.	.	IV	.	.	.	.	I	V	V	I
Betula tortuosa	.	.	.	.	.	.	.	.	V	II	.
Pinus sibirica	.	.	II	.	I	.	V	II	.	I	.
Larix sibirica	.	.	.	.	.	.	IV	.	.	.	.
Betula pendula	.	.	V	.	.	.	.	.	.	.	.
Diagnostic species (D.S.) Ass. *Calamagrostio obtusatae - Aconitetum septentrionalis* = D.S. All. *Cacalio hastatae-Aconition septentrionalis*											
Urtica dioica	V	V	I	III	.	I	.	.	.	.	.
Cacalia hastata	V	III	III	III	.	II	.	.	.	.	.
Matteuccia struthiopteris	III	III	V	.	.	.	.	.	.	.	.
Athyrium filix-femina	IV	III	V	I	.	I	.	.	.	.	.
Padus avium	II	III	V	.	.	.	.	.	.	.	.
Filipendula ulmaria	IV	V	II	I	.	.	.	.	.	.	.
Equisetum sylvaticum	I	III	III	.	.	.	.	.	I	.	.
Stachys sylvatica	III	III	I	.	.	.	.	.	.	.	.
Paris quadrifolia	IV	II	III	.	.	IV	.	.	I	II	.
Dryopteris expansa	III	.	III	.	.	.	.	.	I	V	.
D.S. Ass. *Aegopodio podagrariae - Cirsietum heterophylli*											
Aegopodium podagraria	I	V	.	.	.	.	.	.	.	.	.
Vicia sylvatica	I	IV	.	I	.	.	.	.	.	.	.
Geranium sylvaticum	I	IV	.	I	.	.	.	.	.	.	.
Humulus lupulus	I	III	I	.	.	.	.	.	.	.	.
Lathyrus vernus	.	III	.	.	.	.	.	.	.	.	.
D.S. Ass. *Athyrio filix-feminae - Aconitetum septentrionalis*											
Brunnera sibirica	.	I	IV	.	.	.	.	.	.	.	.
Ribes atropurpureum	II	.	IV	.	.	.	.	.	.	.	.
Pteridium aquilinum	II	II	IV	.	.	.	.	.	.	.	.
Circaea alpina	.	I	III	.	.	.	.	.	.	.	.
Melica nutans	.	I	III	.	.	.	.	.	.	.	.
Oxalis acetosella	I	.	III	.	.	.	.	.	I	.	.
Phegopteris connectilis	.	.	III	.	.	.	.	.	II	II	.
Brachypodium sylvaticum	.	I	III	.	.	.	.	.	.	.	.
D.S. Ass. *Triseto - Aconitetum septentrionalis* = D.S. All. *Triseto - Aconition septentrionalis*											
Aegopodium alpestre	.	.	.	IV	V	IV	V	.	.	.	.
Cruciata krylovii	.	.	III	V	V	IV	V	III	.	.	.
Ptarmica impatiens	.	.	.	IV	V	III	V	.	.	.	.
Trisetum sibiricum	.	.	.	V	IV	II	V	.	.	.	.
Lathyrus frolovii	.	.	.	V	V	IV	III	.	.	.	.
Viola uniflora	III	III	I	V	III	IV	III	.	.	.	.
Spiraea chamaedrifolia	.	.	II	V	II	I	III	.	I	.	.

Elymus mutabilis	.	.	.	II	IV	II	I	.	.	.	.
Campanula altaica	.	.	.	I	IV	I	V	.	.	.	.
Galium boreale	.	I	I	V	II	IV	II	.	.	.	.
Helictotrichon pubescens	.	.	.	III	V	IV	II	.	.	.	.
Vicia megalotropis	I	.	.	III	IV	II	I	.	I	.	.
Carex macroura	.	.	I	III	IV	IV	I	I	.	.	.
Angelica sylvestris	II	III	IV	III	II	IV	III	.	.	.	.

D.S. Subass. *T.s. - A.s. deschampsietosum cespitosae*

Achillea asiatica	.	.	.	I	V	II	III	.	.	.	.
Deschampsia cespitosa	I	.	.	II	V	I	.	I	I	.	.
Rumex thyrsiflorus	.	.	.	.	IV	.	.	.	.	.	.
Trifolium pratense	.	.	.	.	III	I	.	.	.	.	.
Amoria repens	I	.	.	.	III	I	.	.	.	.	.
Bromopsis inermis	.	.	.	I	III	.	.	.	.	.	.

D.S. Subass. *T.s. - A.s. calamagrostietosum arundinaceae*

Calamagrostis arundinacea	.	I	.	II	.	V	.	.	.	.	.
Vicia sepium	I	III	.	I	III	V	I	.	.	.	.
Dactylis glomerata	I	III	.	II	II	V	.	.	.	.	.
Primula macrocalyx	.	.	.	.	.	V	.	.	.	.	.
Brachypodium pinnatum	.	.	.	.	.	V	.	.	.	.	.
Rubus saxatilis	.	I	.	.	.	III	.	.	I	.	.

D.S. Subass. *T.s. - A.s. rhytidiadelphetosum*

Lonicera altaica	.	.	II	IV	III	.	V	II	V	IV	.
Atragene sibirica	.	.	.	II	I	II	III	.	I	.	.
Rhytidiadelphus triquetrus	.	.	.	I	.	I	V	.	.	.	.
Aconitum krylovii	.	.	.	III	I	II	V	.	.	.	.
Carex kirilowii	.	.	.	.	.	I	IV	.	.	.	.
Cirriphyllum piliferum	.	.	.	I	.	.	IV	.	.	.	.
Picea obovata	.	.	.	II	I	I	III	.	.	.	.
Hylocomium splendens	.	.	.	I	.	.	III	.	.	.	.

D.S. Ass. *Cirsio heterophylli - Rhaponticetum carthamoidis* = D.S. All. *Rhaponticion carthamoidis*

Stemmacantha carthamoides	.	.	.	.	I	.	II	V	V	III	V
Primula pallasii	.	.	.	.	.	.	III	III	IV	IV	V
Aquilegia glandulosa	.	.	.	.	.	.	.	III	V	IV	V
Athyrium distentifolium	.	.	.	.	.	.	.	.	V	V	IV
Anthoxanthum odoratum	.	.	.	I	III	I	II	III	IV	V	III
Vaccinium myrtillus	.	.	.	.	.	.	.	II	IV	V	.
Carex aterrima	.	.	.	.	.	.	.	III	II	I	II

D.S. Ass. *Abieteto sibiricae - Athyrietum distentifolii*

Adenophora lamarckii	.	.	.	.	.	II	.	.	IV	V	V
Allium microdictyon	III	.	II	.	.	.	.	.	IV	V	III
Anemonoides altaica	III	IV	I	.	.	.	I	.	V	V	V
Corydalis bracteata	III	I	I	.	.	.	I	.	III	III	III
Cerastium davuricum	I	II	.	I	.	II	I	.	III	II	III
Dianthus superbus	.	.	.	.	.	.	.	I	III	II	III

D.S. Subass. *A.s. - A.d. sorbetosum sibiricae*

Sorbus sibirica	.	I	III	.	.	.	.	.	V	V	.
Rubus idaeus	II	II	III	.	.	.	.	.	IV	V	I

D.S. Ord. *Trollio - Crepidetalia sibiricae*

Lathyrus gmelinii	I	IV	III	V	V	IV	V	V	V	V	V
Euphorbia pilosa	V	IV	III	IV	V	IV	III	V	V	V	V
Anthriscus sylvestris	V	V	II	II	I	IV	III	IV	IV	.	V
Myosotis krylovii	III	II	III	IV	V	II	V	.	II	I	I
Ranunculus grandifolius	.	.	III	V	V	II	V	V	III	V	III
Paeonia anomala	II	III	III	V	V	III	IV	I	IV	.	IV
Crepis sibirica	V	V	IV	V	V	V	IV	.	III	I	III
Lilium pilosiusculum	.	II	I	I	I	IV	II	I	V	V	III
Senecio nemorensis	II	II	IV	V	III	II	IV	I	V	V	V
Thalictrum minus	V	IV	III	IV	IV	V	III	.	I	II	V
Polemonium coeruleum	V	III	V	IV	V	V	II	I	IV	V	V
Calamagrostis obtusata	V	II	V	V	V	I	V	II	I	IV	I
Heracleum dissectum	V	V	III	IV	III	V	V	IV	IV	II	V
Geranium albiflorum	.	.	III	V	V	IV	V	V	V	V	V
Ranunculus monophyllus	IV	V	I	II	.	V	II	.	.	.	.
Pulmonaria mollis	IV	III	III	V	IV	V	III	.	II	II	III
Aconitum volubile	I	II	III	III	V	III	IV	.	.	.	.
Crepis lyrata	I	I	.	III	V	II	III	II	II	.	III
Cirsium heterophyllum	V	V	V	III	V	IV	IV	V	II	I	I

D.S. Class *Mulgedio - Aconitetea*

Veratrum lobelianum	III	V	II	V	V	I	V	V	III	V	IV
Rumex alpestris incl. R. acetosa	.	.	.	I	.	.	IV	V	V	V	V
Solidago dahurica	I	.	II	I	II	III	III	I	V	V	IV
Viola biflora	.	.	III	.	.	.	III	V	V	V	IV
Pedicularis incarnata	I	.	I	III	IV	I	III	V	V	V	V
Saussurea latifolia	III	I	IV	I	I	.	IV	V	V	V	V
Bistorta major	.	.	.	I	I	II	IV	V	V	V	V
Aconitum septentrionalis	V	V	V	V	V	V	V	V	V	V	III
Cerastium pauciflorum	.	.	III	IV	V	V	V	V	V	IV	.
Delphinium elatum	V	IV	III	IV	II	.	III	II	.	.	.
Bupleurum aureum	I	V	I	II	V	V	V	V	V	V	V
Milium effusum	V	V	IV	III	I	IV	IV	II	II	IV	I

Other species with high constancy values:

Trollius asiaticus	II	III	III	V	V	V	V	V	IV	V	III
Poa sibirica	I	I	I	V	V	V	V	V	V	V	V
Pleurospermum uralense	II	II	I	IV	IV	IV	V	I	III	IV	III
Erythronium sibiricum	IV	I	II	II	.	IV	III	.	V	III	V
Lamium album	IV	III	III	IV	II	III	IV	.	III	II	III
Chamaenerion angustifolium	II	II	III	I	.	II	I	IV	IV	V	IV
Adoxa moschatellina	III	IV	III	I	.	I	IV	II	I	.	.

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