PHYTOSOCIOLOGICAL PECULIARITIES OF SOUTH SIBERIAN FOREST MEADOWS

N. ERMAKOV and T. MALTSEVA

Cenral Siberian Botanical Garden, Russian Academy of Sciences, Zolotodolinskaya, 101, Novosibirsk 630090-Russia; tel. 7 3832 354102, fax 7 3832 354986, E-mail root@botgard.nsk.su

ABSTRACT – The problem of classification and ordination of forest meadows in Southern Siberia are discussed on the basis of geographically wide ranging set of data. The classification of the meadows has been carried out using Braun-Blanquet approach. DCA ordination using DECORANA was carried out for elucidation of various macro-ecological and phytosociological regularities of the meadows. Siberian forest meadows were included in the order *Carici macrourae-Crepidetalia sibiricae* prov. of the class *Molinio-Arrhenatheretea*. They are both a stage of the natural succession and the first stage of the anthropogenic replacement of zonal hemiboreal forests caused by clearing of later stages as well as subsequent moderate grazing and mowing. The strong disturbance of the forest meadows over a long period results in their replacement by widespread anthropogenic types of the Arrhenatheretalia meadows.

KEY WORDS – Braun-Blanquet system, Southern Siberia, forest meadows, ordination.

INTRODUCTION

South Siberian forest meadows are a unique phytosociological type of the European-Siberian class *Molinio-Arrhenatheretea* R.Tx. 1937 em. R.Tx. 1970. They represent an example of natural zonal vegetation of the temperate continental sector of the transcontinental forest-steppe zones. There are still few available data concerning the diversity of these meadows as well as current conditions. At the same time, these are vulnerable communities because they are closely related with peculiarities of the zonal habitats. The strong disturbance of their sites over a long period has resulted in changes of floristic composition and phytocoenotic structure of forest meadows and their replacement by widespread anthropogenic types of meadows. Analysis of the phytosociological peculiarities and floristic relations of these Siberian forest meadows have been carried out on the basis of a geographically wide ranging set of data from the West Siberian Plain and Altai-Sayanian mountain system.

Data and methods

The basis for the present study was 480 relevés of meadows from the southern part of the West-Siberian Plain and northern part of the Altai-Sayanian mountain system (fig. 1). 110 relevés of zonal hemiboreal forests of the same regions were used for elucidating the phytosociological relations between the meadows and the grass forests. The classification of the meadows has been carried out using Braun-Blanquet approach (Ermakov *et al*. in press).

The TURBOVEG, MegaTab (Hennekens, 1996) and TWINSPAN (Hill, 1979) software was used for database management and for quantitative treatment of a large number of relevés. Syntaxonomic comparisons have been carried out using the available phytosociological literature (Matuszkiewicz, 1981; Oberdorfer, 1983; Ellenberg, 1986; Mirkin *et al*. 1989; Korotkov *et al*. 1991; Mucina *et al*, 1993 and Dierschke, 1995). DCA ordination using DECORANA (Hill, 1979) was carried out for elucidation of various macro-ecological and phytosociological regularities of meadows.

Species names follow the list of vascular plants of the former USSR (Cherepanov, 1995; electronic version prepared by D. Geltman).

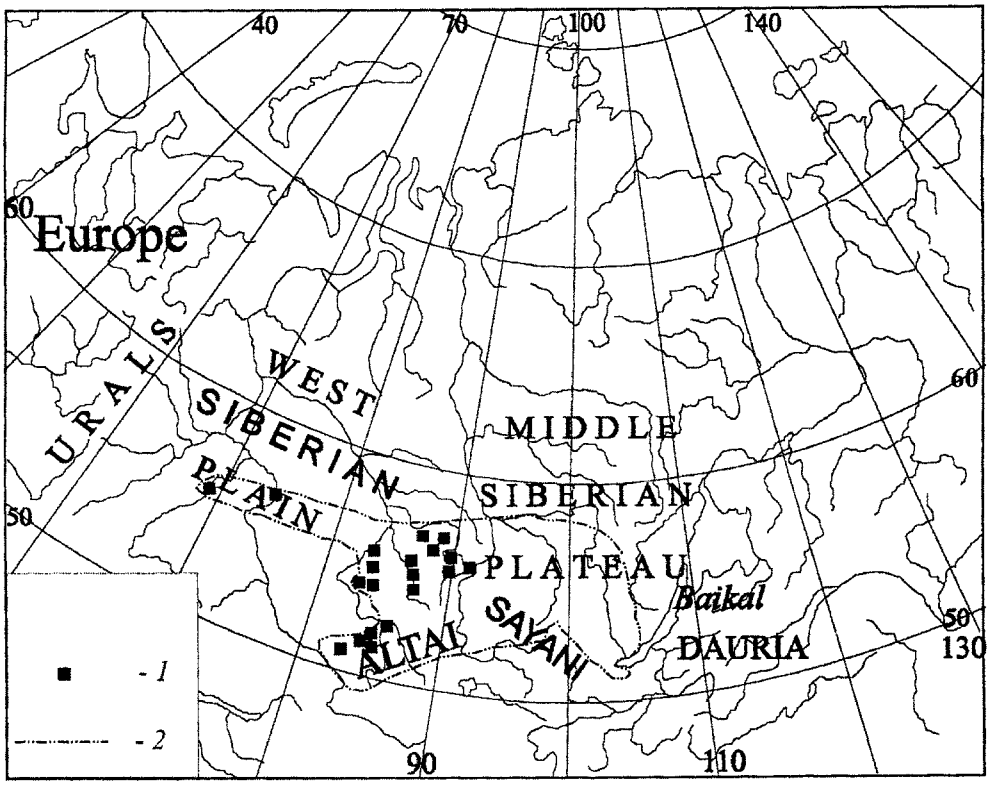

Fig. 1 - Locations of the relevés (*1*) and extent of forest meadows (*2*) in Southern Siberia

Results of the classification and ordination

Siberian forest meadows were included in the special order *Carici macrourae-Crepidetalia sibiricae* prov. of the class *Molinio-Arrhenatheretea*. They are characterized by a rich flora (547 species in 282 relevés) and rich assemblages of 45-75 species (even up to 98 species) per 100m^2 in the plains. Non-graminoid species play the leading phytocoenotic role in these meadows. The large group of differential species separates communities of the *Carici macrourae-Crepidetalia* order from those of existing orders (*Molinietalia, Arrhenatheretalia, Galietalia veri*). These are North Asian and European-Siberian photophilous high-demanding, nutrient-requiring herbs - *Trollius asiaticus, Heracleum dissectum, Vicia unjuga, Lilium pilosiusculum, Carex macroura, Pleurospermum uralense, Aconitum volubile, Geranium pseudosibiricum, Serratula coronata, Ptarmica impatiens, Ligularia glauca, Pulmonaria mollis, Crepis sibirica, Rubus saxatilis, Brachypodium pinnatum, Calamagrostis arundinacea*. These species are not true meadows plants. They have a great phytosociological role both in the Asian zonal hemiboreal forests and forest meadows. There are differential species of the order *Arrhenatheretalia* in the floristic composition of some communities of the *Carici macrourae-Crepidetalia sibiricae*. However, their presence is conditioned only by strong human influence and degradation of the meadows.

The *Carici macrourae-Crepidetalia sibiricae* communities have developed in the temperate continental climate of the southern part of Western and Middle Siberia as well as in the northern part of the Altai-Sayanian mountain system (fig. 1). Geographically, they represent the eastern part of the class *Molinio-Arrhenatheretea* in Eurasia with an eastern limit at the Transbaical Mountains.

Floristic relations of the Forest Meadows

The forest meadows occupy a distinct position in the natural ecological and anthropogenic series of actual Siberian vegetation. Some important phytocoenotic and floristic relations of these meadows are demonstrated in the scatterplot of syntaxa (fig. 2).

The main axis 1 of the DCA ordination of syntaxa represents a series of anthropogenic transformation of the primary zonal vegetation of the forest-steppe zone - belt in the mountains of Southern Siberia: ***primary hemiboreal forests => forest meadows => degraded true meadows***.

The syntaxa of forest meadows (groups 1, 2) fall in set of values of 0.7 - 1.7 of the axis 1 DCA ordination (fig. 2) between the *Arrhenatheretalia* meadows (group 3) and hemiboreal forests of the class *Brachypodio-Betuletea* Ermakov *et al*. 1991 (groups 4, 5). This regularity corresponds to the ecological position of the forest meadows in the actual vegetation of Southern Siberia.

Relations of the forest meadows with primary hemiboreal forests

The forest meadows are close ecologically and floristically to zonal Siberian small-leaved and light-coniferous hemiboreal forests. In the continental climate of Southern Siberia, the grasses compete more successfully with species of tree layers

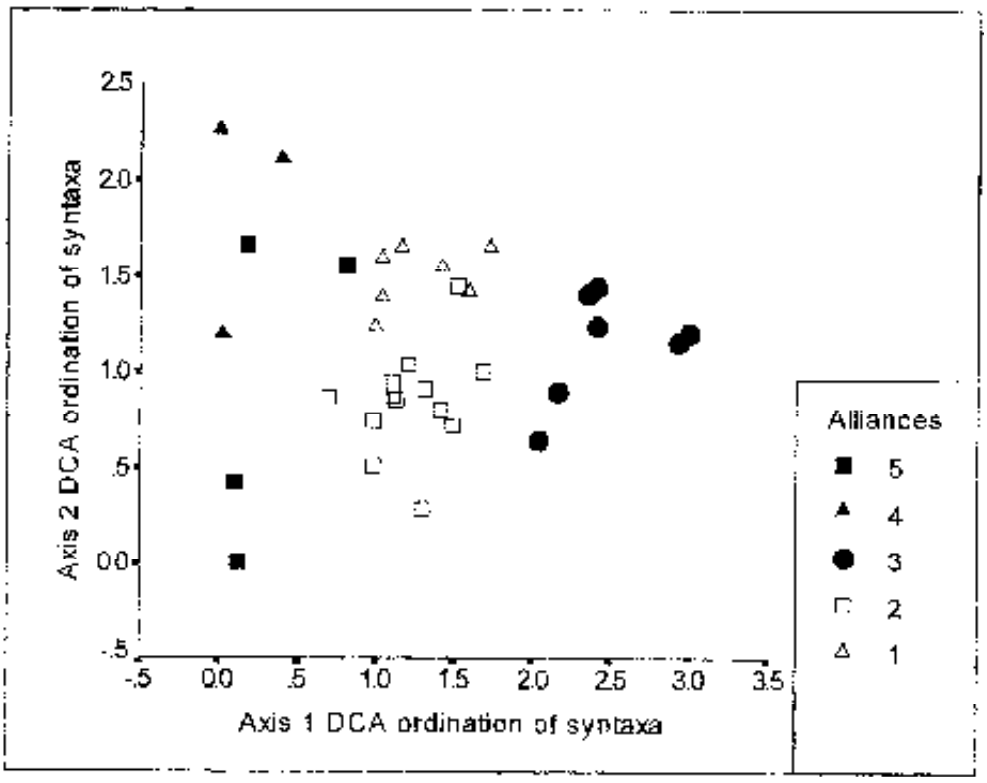

Fig. 2 - DCA ordination of syntaxa of Siberian meadows and hemiboreal forests: 1 - Crepidion sibiricae; 2 - Aconito barbati-Vicion unijugae; 3 - Festucion pratensis (Arrhenatheretalia); 4 - Lathyro gmelinii-Pinion sylvestris (Brachypodio-Betuletea); 5 - Vicio unijugae-Pinion sylvestris (Brachypodio-Betuletea).

than in the case in oceanic and suboceanic climates because the main dominants of the hemiboreal forests (*Betula pendula, Pinus sylvestris, Larix sibirica, Populus tremula*) do not form the dense shady canopy like broad-leaved and dark coniferous trees. As result, zonal communities of the class *Brachypodio-Betuletea* themselves have distinct "meadow features" in their field layer while there is a great phytocoenotic role of the forest species in the forest meadows. In the zonal habitats, the *Carici macrourae-Crepidetalia sibiricae* communities comprise a natural succession after different types of disturbances of climax forests (fire, winter frost, insects and etc). These meadows have a well-developed herb layer hindering the establishment of a new generation of trees. Therefore, forest meadows are able to exist for a long time before being replaced by the climax forests. These types of meadows grow in similar display conditions and show similarity of floristic composition with primary forests. Differential species of the *Carici macrourae-Crepidetalia sibiricae* are very important diagnostic species of higher syntaxa of the class *Brachypodio-Betuletea* and they indicate the phytosociological peculiarities of both Siberian hemiboreal forests and

TABLE 1 - FLORISTIC RELATIONS OF THE FOREST MEADOWS WITH TRUE MEADOWS AND ZONAL HEMIBOREAL FORESTS

Vegetation type	Hemiboreal forests							Forest meadows																			True meadows						
Syntaxon N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Hygro-mesophilous species of the alliance Lathyro gmelinii-Pirion sylvestris and Crepidion sibiricae																																	
Euphorbia pilosa	5	3	5	3	.	2	3	4	5	5	5	4	4	1	2	2	2	3	2	2	1	1	1	4	.	.	.	.	.	1	.	.	.
Bupleurum longifolium	5	2	5	5	.	1	5	3	5	5	4	4	5	.	1	1	3	2	1	2	1	3	3	5	.	.	.	.	.	.	1	1	.
Angelica sylvestris	5	5	4	4	.	1	4	2	4	4	3	2	3	.	1	3	2	2	2	1	1	1	3	1	2	.	.	.	2	1	.	1	
Polemonium caeruleum	4	5	5	2	1	2	1	.	2	4	5	5	4	1	3	5	3	.	1	1	1	2	.	.	.	.	.	.	1	.	.		
Crepis lyratha	3	.	1	1	.	.	1	4	1	1	1	4	5	.	.	.	1	1	1	.	1	1	.	2	.	.	.	.	2	.	.		
Lathyrus gmelinii	5	5	5	3	.	1	3	3	5	4	3	4	3	.	1	2	1	1	1	2	1	1	.	1	.	.	.	.	.	.	.	.	.
Veratrum lobelianum	1	.	3	1	.	.	.	3	1	2	2	2	5	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.	.	3	1	.	1
Aconitum septentrionale	5	5	5	2	.	1	2	.	4	2	2	4	2	.	.	4	1	1	1	.	1	1	1	1	.	.	.	.	2	.	.		
Cirsium heterophyllum	3	.	2	1	.	.	1	2	2	3	1	3	5	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	1	.	.		
Xero-mesophilous species of the alliances Vicio unijugae-Pirion sylvestris and Aconito-Vicion unijugae																																	
Fragaria viridis	.	.	.	2	1	2	1	1	1	1	1	1	1	4	2	.	1	2	3	4	4	2	5	2	3	3	1	.	4	2	.	5	1
Seseli libanotis	.	.	.	.	4	3	2	.	1	1	1	1	.	5	5	4	3	4	3	4	3	2	3	1	5	5	1	.	1	.	.	4	2
Aconitum barbatum	.	2	.	.	5	5	2	.	.	1	1	2	.	5	5	5	5	3	3	4	1	2	1	.	.	.	.	.	.	.	.	2	.
Lathyrus pisiformis	2	2	1	3	3	3	4	2	1	3	1	1	1	2	3	5	4	4	3	4	4	2	3	.	5	1	.	.	.	.	.	3	1
Galium verum	.	.	1	2	3	1	2	.	1	1	1	1	.	5	5	3	3	3	1	5	3	4	5	.	3	5	1	.	.	1	1	4	5
Trommsdorfia maculata	.	.	.	.	2	2	1	3	2	2	1	1	1	3	2	3	3	3	4	4	3	2	3	3	2	2	.	1	1	1	.	2	1
Dracocephalum ruyschiana	.	.	.	2	3	4	1	.	1	.	1	1	.	3	5	4	4	3	2	3	2	3	4	1	3	1	.	.	1	.	.	1	
Tragopogon orientalis	.	.	.	.	1	1	.	.	1	1	1	3	3	5	4	2	3	3	2	4	4	3	4	4	.	.	.	.	.	.	4	3	
Polygonatum odoratum	3	1	3	5	2	1	4	.	1	1	1	1	1	2	3	2	3	4	1	4	3	2	4	5	5	.	.	.	.	.	3	1	
Phleum phleoides	.	.	.	.	1	.	1	.	.	1	1	2	1	5	4	3	3	2	2	2	2	2	5	.	.	2	.	.	.	.	.	4	2
Vicia amoena	.	.	.	.	1	1	1	.	1	1	1	1	1	3	1	3	1	3	3	3	3	2	3	.	.	.	.	.	.	.	.	5	1
Potentilla chrysantha	.	.	.	3	.	1	1	1	.	.	1	1	1	2	3	1	2	.	2	1	3	4	5	2	.	.	1	1	1	2	.	1	.
Hemerocallis minor	.	.	.	.	2	3	.	.	1	1	1	1	1	3	3	3	2	4	2	3	1	2	3	.	.	.	.	.	.	.	.	1	1
Veronica krylovii	.	.	.	.	1	1	1	.	1	1	1	1	1	3	4	2	3	2	2	3	3	2	2	2	3	.	1	.	.	.	.	.	3	.
Crepis praemorsa	.	1	.	.	3	4	1	1	1	1	.	.	1	3	3	1	3	3	2	2	2	2	3	2	4	2	.	.	.	.	.	1	.
Mesophytes of the Cariacim acrourae-Pinetalia sylvestris, Caricim acrourae- Crepidetalia sibiricae																																	
Trollius asiaticus	5	5	5	2	3	4	3	3	4	5	5	5	5	3	4	5	5	4	3	3	3	4	.	3	.	.	.	1	1	4	1	.	2
Pulmonaria mollis	5	5	5	5	4	5	5	4	3	5	4	4	5	3	4	5	3	4	5	5	4	2	5	4	5	3	1	.	3	1	.	.	1
Rubus saxatilis	5	5	5	5	4	5	5	4	4	5	3	4	4	4	5	5	5	5	5	5	4	5	5	4	5	4	.	.	.	1	.	3	1
Crepis sibirica	5	5	5	3	1	5	4	3	5	5	4	5	3	2	3	5	4	4	4	5	4	4	4	4	5	4	.	.	.	.	.	1	.
Heracleum dissectum	5	5	4	4	4	4	4	5	5	4	4	4	3	2	3	5	4	4	4	3	4	2	2	4	.	.	.	.	1	.	2	1	2
Vicia unijuga	2	2	2	5	5	5	5	1	3	4	2	4	2	4	5	5	5	5	5	4	4	4	5	4	.	.	.	.	1	.	4	1	
Lilium pilosiusculum	5	4	4	4	5	5	5	3	3	2	2	1	.	3	3	5	5	3	4	3	3	2	3	5	2	2	.	.	.	.	.	1	.
Carex macroura	5	5	5	5	4	5	5	1	2	5	5	5	5	4	5	5	5	4	3	5	2	5	5	5	.	.	.	2	1	1	.	1	1
Pleurospermum uralense	5	5	5	4	4	5	4	2	2	5	4	3	1	2	4	4	4	2	4	2	1	1	.	1	3	2	.	.	.	.	.	.	.
Aconitum volubile	4	5	3	2	.	4	3	2	2	3	4	4	3	.	3	3	4	3	3	3	1	1	2	3	1	.	.	.	.	1	.	.	1
Geranium pseudosibiricum	2	5	.	4	5	5	.	1	.	4	5	2	3	5	5	5	4	4	3	4	4	5	5	3	5	.	.	.	.	.	.	1	1
Brachypodium pinnatum	5	5	4	5	2	5	5	3	3	4	3	4	3	1	3	3	3	4	1	5	1	4	5	4	5	5	.	.	1	.	.	.	
Calamagrostis arundinacea	5	4	3	5	3	5	5	.	3	5	4	5	5	.	3	5	4	5	3	2	4	1	5	3	2	5	.	.	2	.	.	.	
Iris ruthenica	1	5	3	4	5	5	4	1	2	4	4	3	3	4	5	5	4	3	3	3	4	2	4	3	3	.	3	.	.	.	.	1	.
Ligularia glauca	.	1	.	.	4	3	1	.	1	1	2	3	2	2	5	3	4	2	1	2	1	4	4	.	.	.	.	.	.	.	1	.	
Ptarmica impatiens	1	2	1	1	.	4	3	2	4	5	4	4	5	1	4	5	4	4	3	3	1	4	.	3	.	.	.	.	.	1	.	1	
Serratula coronata	2	.	2	3	1	2	4	3	2	3	3	5	1	2	2	3	3	2	4	2	4	2	2	3	.	4	2	.	.	.	.	.	.

Mesophytes of Arrhenatheretalia

Ranunculus polyanthemos	. . 1 1 5 4 5	3 3 3 3 1 1 5 4 3 4 4 5 4 5 1 3 5 4 3	3 3 3 4 3 5 5
Phleum pratense	 2	5 3 3 2 2 5 1 1 . 1 3 4 4 5 3 2 5 . .	5 5 4 5 4 5 3
Amoria repens	. . 1 . . . 1	3 1 1 1 . 3 3 2 1 1 . 5 1 3 1 . 2 . .	5 5 2 5 5 3 4
Carum carvi	 1	1 . . 1 1 4 2 1 . 1 . 4 1 4 2	5 5 3 5 2 5 4
Leucanthemum vulgare	 1	4 1 2 1 1 3 1 . . . 2 2 2 4 1 1 5 . .	2 3 3 5 5 4 1
Rhinantus vernalis	. . . .	4 1 1 . 2 4 2 3 2 2 . 3 2 3 2 2 4 1 .	. 1 1 4 4 4 2
Veronica chamaedrys	3 . 2 . . . 2	3 1 . . . 2 . . . . 1 . 1 1 1 2 3 . .	. 1 2 3 . . .

Mesophytes of Molinio-Arrheratheretea

Poa pratensis	. . 1 . . . 4	4 2 5 2 2 3 5 3 4 3 4 4 5 5 3 1 4 3 4	5 5 5 5 4 5 5
Vicia cracca	1 . 1 2 . . 3	4 5 5 4 5 5 5 5 5 5 5 5 5 5 5 5 4 5 5	2 3 3 4 4 5 5
Festuca pratensis	. . 1 . . . 2	5 3 3 2 4 5 2 1 1 1 2 5 4 5 4 2 5 . 1	5 5 5 5 5 5 5
Sanguisorba officinalis	3 4 3 4 5 5 5	2 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 4 4	. . 2 1 2 5 5
Galium boreale	5 4 4 5 5 5 5	4 5 5 5 5 5 5 5 5 5 5 5 5 5 4 5 5 5 4	1 . 2 2 1 5 5
Trifolium pratense	. . 1 . 1 1 3	5 3 3 3 1 5 4 4 . 2 3 5 4 5 3 1 5 2 1	5 5 1 5 5 5 5
Taraxacum officinale	. . 1 . . . 2	3 3 3 3 2 3 4 1 . 1 2 4 4 5 3 3 3 . 2	4 5 5 3 4 5 5
Filipendula ulmaria	4 1 3 1 . . 3	5 5 4 3 4 5 5 4 3 4 4 4 5 5 4 . 1 5 5	3 1 1 4 1 4 5
Achillea millefolium	1 1 . 2 5 5 2	4 3 3 3 4 5 5 5 5 5 4 5 5 5 5 5 4 5 4	5 5 5 4 5 5 5
Dactylis glomerata	5 . 4 5 . . 5	5 5 5 . 5 5 . . . . 5 4 5 5 5 5 5 . .	2 1 5 4 5 2 1
Stellaria graminea	. . 1 . . . 2	4 2 3 3 . 2 3 3 1 3 2 4 4 5 1 1 5 . 1	5 4 4 5 5 4 4
Lathyrus pratensis	1 . 1 1 1 . 3	5 4 4 2 5 5 1 3 3 3 4 3 4 4 3 1 5 4 5	. 2 3 2 3 2 4
Agrostis gigantea	1 1	4 3 1 1 2 3 1 1 . 1 2 3 2 3 1 2 3 . 2	4 5 3 5 4 3 4
Plantago media	. . 1 . . . 1	3 . . . . 1 . 1 . 2 . 3 1 2 1	5 4 4 4 5 5 5
Prunella vulgaris	1 . 1 . . . 1	2 1 . . . 2 . . . . . 1 1 1 1 . 3 . .	2 1 3 5 3 1 .
Alopecurus pratensis	1 . 1	1 . 1 2 2 2 . 2 1 2 2 . 1 1 1	. 1 . . 1 1 5
Festuca rubra	1	1 . . 1 3 1 2 . . 1 1 1 . 1 2 . 1 . .	3 2 . 1 . 1 5
Alchemilla xanthochlora	. . . .	1 . 1 4 2 5 1 2 1 2 1 3 1 2 1 . 2 . .	1 1 2 5 3 2 1

Mesophytes of the hemiboreal forests

Betula pendula	5 5 5 5 5 5 5	. . 1 1 . 1 1 2 2 2 2 1 1 1 1	 1
Pinus sylvestris	5 . 1 5 . . 1	. . . . 1	. . . 1 . . .
Populus tremula	3 3 4 1 1 3 2	. 1 . . . . 1 . . . . . 1 1	. . . .
Cimicifuga foetida	4 5 1 4 4 5 2	. . 1 2 1 . 2 3 5 3 2 2 3 1 2	. . . .
Viola mirabilis	3 4 1 3 4 5 3	1 1 1 1 1 . 1 3 2 2 1 1 2 1 1 2 . 1 .	. . . . . 1 .
Erythronium sibiricum	5 5 1 5 5 4 .	. . . . 1 1 . . . . . . 1 . 1	. . . .
Fragaria vesca	4 3 4 3 . 1 4	. . . . 1 . . . . . 1 1 1 1 . . 1 . .	. 1 . 1 . . .
Padus avium	5 2 3 3 . 1 3	. 1 . . . . 1	. . . .
Rosa majalis	1 2 2 1 2 4 2	. . . .	. . . .
Pleurozium schreberi	3 4 1 3 5 2 .	. . . .	. . . .
Rhytidiadelphus triquetrus	4 . . 1 2 1 .	. . . .	. . . .
Viola uniflora	5 5 4 3 4 5 4	. 1 3 4 2 3 2 4 5 4 3 3 1 1 3 . 4 . .	. . . .
Maianthemum bifolium	3 5 3 1 2 4 1	. 1 2 1 . . . 1 4 1 1 1 1	. 1 . . . . .
Pteridium aquilinum	5 1 4 3 . . 3	. 3 1 . 1 . . . . . 1 1 1 1 2 . 3 5 .	. . . .
Cacalia hastata	4 4 4 2 2 1 1	1 1 1 . 1 . . 1 3 1 1 1 . 1 . . . 3 .	. . . .
Cypripedium macranthon	1 4 . . 4 3 1	. . . 1 1 . . 1 2 . . . . . 1	. . . .
Viola hirta	3 4 2 3 1 2 5	2 2 1 1 . . . 1 . 2 3 1 2 2 3 5 5 . .	. 1 4 1 1 1 .
Spiraea chamaedrifolia	3 1 . 2 3 2 .	. . . .	. . . .
Rubus idaeus	3 . 2 3 . . 1	. . . .	. . . .
Rosa acicularis	. 4 1 3 . . 2	. . . .	. . . .

Other constant mesophytes of meadows and hemiboreal forests

Phlomoides tuberosa	1	4	3	4	5	5	5	2	3	4	4	1	.	5	5	4	5	5	5	5	4	4	3	4	5	4	1	1	3	2	1	3	2
Thalictrum minus	5	5	5	5	5	5	5	5	5	5	4	4	3	4	5	5	5	5	3	5	3	4	4	4	.	1	.	.	3	1	2	2	2
Lupinaster pentaphyllus	.	1	1	4	5	5	4	1	2	4	4	4	5	5	5	5	5	4	5	5	4	5	5	2	5	4	.	2	.	.	4	4	3
Hieracium umbellatum	1	1	.	2	5	5	3	5	3	4	2	2	4	4	4	3	4	5	4	4	3	3	5	5	5	4	.	.	1	1	2	3	4
Elytrigia repens	.	1	1	.	.	.	3	4	2	1	1	1	1	5	4	2	3	3	3	4	5	3	.	3	1	4	5	5	5	3	2	5	4
Thalictrum simplex	.	.	.	.	.	.	2	.	1	3	4	4	2	4	3	5	2	4	4	5	4	4	3	3	5	5	.	1	.	.	1	5	5
Helictotrichon pubescens	1	1	1	2	2	1	1	1	1	5	5	4	5	5	5	3	5	3	3	2	3	4	5	3	.	.	.	.	.	1	.	1	1
Vicia sepium	5	3	5	2	1	1	4	5	3	3	3	4	4	1	1	2	2	2	3	3	3	2	2	4	5	4	1	1	3	4	2	1	4
Agrimonia pilosa	3	4	4	2	3	2	5	1	1	1	1	3	3	2	1	3	1	3	4	3	4	4	3	4	.	.	2	1	5	.	.	3	2
Campanula glomerata	.	5	.	1	5	5	2	1	3	3	4	2	3	5	5	3	4	4	4	4	4	4	4	1	.	.	.	.	1	.	2	2	5
Gentiana macrophylla	.	1	.	.	5	2	.	.	.	1	1	2	2	4	5	3	4	.	4	2	1	3	.	.	.	.	.	1	.	2	1	4	2
Solidago virgaurea	2	4	1	3	1	4	3	2	1	1	1	3	1	2	2	3	3	3	3	2	3	3	3	.	4	2	.	.	1	1	.	3	.
Cirsium setosum	.	.	1	.	.	.	2	5	4	1	1	1	1	1	1	1	.	1	1	2	3	1	2	3	.	2	1	.	3	2	1	1	1

List of syntaxa

Class Brachypodio pinnati-Betuletea

1.Dentario sibiricae-Pinetum sylvestris Ermakov 1991

2. Polygonato humiles - Betuletum prov.

3. Trollio asiaticae-Populetum tremulae Dymina 1989

4. Filipendulo vulgaris-Pinetum sylvestris Ermakov 1991

5. Adenophoro-Laricetum ligularietosum prov. var. Filipedula vulgaris

6. Adenophoro-Laricetum ligularietosum glaucae prov.

7. Calamagrostio arundinaceae-Betuletum Dymina 1989

Ord. Caricimacrourae-Crepidetalia sibiricae

All. Crepidion sibiricae (8-14)

Crepidetum sibiricae (8-10)

8. C.s. crepidetosum lyrathae

9. C.s. typicum

10. C.s. vicietosum megalotropis

11. Violo uniflorae-Caricetum macrourae

Aegopodio alpestris calamagrostietum (12,13)

12. A.a.-C.a. typicum

13. A.a.-C.a. phleumetosum pratensis

All. Aconito barbati-Vicion unijugae (14-26)

Artemisio tanacetifoliae-Trisetetum (14-19)

14-15. A.t.-T.s. elymetosum gmelinii

15. Var. Taraxacum officinale

16. A.t.-T.s. paeoretosum anomalae

17. A.t.-T.s. typicum

18-19. A.t.-T.s. inuletosum salicinae

19. Var. Festuca pratensis

Pulmonario-Dactyletum glomeratae (20,21)

20. P.m.-D.g. typicum

21. P.m.-D.g. carumetosum carvi

Cruciato-Dactyletum glomeratae (22-24)

22. C.k.-D.g. typicum

23. C.k.-D.g. artemisietosum sericeae

24. C.k.-D.g. aegopodietosum

Galatello-Brachypodietum pinnati (25, 26)

25. G.b.-B.p. pteridetosum

26. G.b.-B.p. typicum

Ord. Arrheratheretalia

All. Festucion pratensis (27, 33)

Potentillo anserinae-Festucetum

27. P.a.-F.p. typicum

28. P.a.-F.p. deschampsietosum

29. Filipendulo vulgaris-Dactyletum

Leucanthemo-Festucetum (30-32)

30. L.v.-F.p. trollietosum asiaticae

31-32. L.v.-F.p. centaurretosum scabiosae

32. Var. Seseli libanotis

33. Community Hordeum brevisubulatum

forest meadows (table 1).

The ecologically corresponding alliances of the meadows and forests are observed on the axis 2 of the DCA ordination of syntaxa which have ecological meaning in terms of moisture requirement (fig. 2). Meadows of the *Crepidion sibiricae* are secondary communities replacing forests of *Lathyro gmelinii-Pinion sylvestris*. These alliances are represented by groups of syntaxa which have a similar distribution on the axis 2 of the DCA ordination (group 1 and 4) between values of 1.3 and 2.4. The corresponding groups of diagnostic species of these alliances are represented by subalpine-forest hygro-mesophytes - *Aconitum septentrionale, Cirsium heterophyllum, Lathyrus gmelinii* and *Veratrum lobelianum*.

Meadows of the *Aconito barbati-Vicion unijugae* are secondary communities replacing forests of the *Vicio unijugae-Pinion sylvestris*. The syntaxa of these alliances have a similar distribution on axis 2 (groups 2 and 5) between values 0 and 1.7. The correspond groups of diagnostic species of the alliances are represented by xero-mesophytes - *Seseli libanotis, Aconitum barbatum, Lathyrus pisiformis, Galium verum, Trommsdorfia maculata, Dracocephalum ruyschiana* and *Crepis praemorsa*.

Anthropogenic relations of Siberian meadows

The forest meadows are both a stage of the natural succession and the first stage of the anthropogenic replacement of zonal hemiboreal forests caused by clearing of later stages as well as subsequent moderate grazing and mowing. At present, they have replaced the primary forests over large areas, especially in the foothills and lower mountain regions. On axis 1 of the DCA ordination (fig. 2), the synaxa of the *Carici macrourae-Crepidetalia* occupy an intermediate position between syntaxa of the *Brachypodio-Betuletea* primary forests (values of 0-0.8) and the *Arrhenatheretalia* degraded true meadows (values of 2 - 3). The last communities replace the *Carici-Crepidetalia* meadows because of heavy grazing or intensive mixed use (grazing and mowing). These degraded meadows are widespread in the river valleys and adjacent mountain slopes. They are characterized by an absence of the forest-meadow species, which are differential plants of the *Carici macrourae-Crepidetalia sibiricae*, and by lower species numbers. Differential species of the order *Arrhenatheretalia* (*Amoria repens, Carum carvi, Leucanthemum vulgare, Rhinanthus vernalis*) are of great importance for definitions of this degree of anthropogenic transformation of the forest meadows. The strong disturbance of the forest meadows over a long period results in the changes in the floristic composition and phytocoenotic structure of the vegetation and their replacement by widespread anthropogenic types of the *Arrhenatheretalia* meadows.

Prodromus of South-Siberian Forest Meadows

MOLINIO-ARRHENATHERETEA R.Tx. 1937 em. R.Tx. 1970
Carici macrourae-Crepidetalia sibiricae prov.

Crepidion sibiricae Mirkin in Mirkin *et al*. 1988.
Differential species: *Aconitum septentronale, Bupleurum aureum, Lathyrus*

gmelinii, Veratrum lobelianum, Euphorbia pilosa, Crepis lyratha, Angelica sylvestris, Cirsium heterophyllum, Polemonium caeruleum.

Crepidetum sibiricum Dymia 1986.

Differential species: *Aegopodium podagraria, Geranium sylvaticum, Lathyrus vernus, Calamagrostis epigeios, Equisetum sylvaticum*.

C.s typicum Dymina 1986

C.s crepidetosum lyrathae prov.

Differential species: *Amoria repens, Leucanthemum vulgare, Rhinantus vernalis, Ranunculus acris, Elytrigia repens, Cirsium setosum, Agrostis gigantea*.

C.s. vicietosum megalotropis prov.

Differential species: *Elymus mutabilis, Vicia megalotropis*.

Violo uniflorae-Caricetum macrourae prov.

Differential species: *Bistorta major, Viola uniflora*.

Aegopodio alpestris-Calamagrostietum arundinaceae prov.

Differential species: *Aegopodium alpestre, Cerastium pauciflorum, Cruciata krylovii, Dianthus superbus, Melilotoides platycarpos, Primula macrocalyx*.

A.a.-C.a. typicum prov.

A.a.-C.a. phleumetosum pratensis prov.

Differential species: *Deschampsia cespitosa, Galium uliginosum, Geum allepicum, G. rivale, Carum carvi, Amoria repens, Leucanthemum vulgare*.

Aconito barbati-Vicion unijugae prov.

Differential species: *Seseli libanotis, Fragaria viridis, Galium verum, Polygonatum odoratum, Trommsdorfia maculata, Dracocephalum ruyschiana, Aconitum barbatum, Tragopogon orientalis, Lathyrus pisiformis, Phleum phleoides, Vicia amoena, Potentilla chrysantha, Hemerocallis minor, Veronica krylovii, Crepis praemorsa*.

Artemisio tanacetifoliae-Trisetetum sibiricae prov.

Differential species: *Adenophora lamarckii, Artemisia tanacetifolia, Lathyrus humilis, Poa sibirica, Pulsatilla patens, Saussurea controversa, Trisetum sibiricum, Thalictrum foetidum*.

A.t.-T.s. typicum prov.

A.t.-T.s. elymetosum gmelinii prov.

Differential species: *Onobrychis sibirica, Elymus gmelinii, Aster alpinus, Allium strictum*.

A.t.-T.s. paeonetosum anomalae prov.

Differential species: *Paeonia anomala, Maianthemum bifolium, Cacalia hastata*.

A.t.-T.s. inuletosum salicinae prov.

Differential species: *Inula salicina, Origanum vulgare*.

Pulmonario-Dactyletum glomeratae prov.

Differential species: *Calamagrostis epigeios, Inula salicina, Origanum vulgare*.

P.d.-D.g. typicum prov.

P.d.-D.g. carumetosum carvi prov.

Differential species: *Amoria repens, Carum carvi, Leucanthemum vulgare, Rhinantus vernalis*.

Cruciato krylovii-Dactyletum glomeratae prov.

Differential species: *Viola hirta, Filipendula vulgaris, Peucedanum morisonii,*

Potentilla fragarioides, Cruciata krylovii.

C.k.-D.g. typicum prov.

C.k.-D.g. artemisietosum sericeae prov.

Differential species: *Senecio erucifolius, Artemisia sericea, Artemisia gmelinii, Hypericum attenuatum, Aulacospermum anomalum*.

C.k.-D.g. aegopodietosum podagrariae prov.

Differential species: *Aegopodium podagraria, Geranium sylvaticum, Centaurea scabiosa, Amoria hybrda*.

Galatello biflorae-Brachypodietum pinnati Korolyuk 1993.

Differential species: *Heracleum dissectum, Galatella biflora, Melampyrum cristatum, Artemisia macrantha*.

G.b.-B.p. typicum Korolyuk 1993.

G.b.-B.p. pteridetosum prov.

Differential species: *Artemisia latifolia, Cacalia hastata, Pteridium aquilinum, Silene nutans, Rosa majalis, Veronica spuria*.

ACKNOWNLEDGEMENTS

I am very grateful to Professor Sandro Pignatti for the opportunity to discuss the problems of classification of the Siberian forests meadows during the 7th Workshop of European Vegetation Survey (Rome, 27-30 March 1998).

REFERENCES

CHEREPANOV S.K., 1995 - Vascular plants of Russia and neighbor countries. Saint -Petersburg, 990 p. (in Russian).

DIERSCHKE H., 1995 - Syntaxonomical survey of Molinio-Arrhenatheretea in Central Europe. Colloques Phytosociologiques, XXIII, Large area vegetation surveys, Bailleul, 1994. Berlin, Stutgart, 387-399.

ELLENBERG H., 1986 - Vegetation Ecology of Central Europe. Cambridge University Press. Cambridge, New York, New Rochlle, Melbourne, Sydney, 731 p.

ERMAKOV N., MALTSEVA T. and MAKUNINA N., in press - *Classification of meadows of South Siberian uplands and mountains*. Folia Geobotanica.

HENNEKENS S.M., 1996 - TURBO(VEG). Software package for input, processing and presentation of phytosociological data. User's guide. IBN-DLO, University of Lancaster, Lancaster, 59 p.

HILL M.O., 1979 - DECORANA and TWINSPAN for ordination and classification of multivariate species data: a new edition, together with supporting programs, in FORTRAN 77. Huntingdon: Institute of Terrestrial Ecology, 58 p.

KOROTKOV K., MOROZOVA O. and BELONOVSKAYA E., 1991 - The USSR Vegetation Syntaxa Prodromus. Published by Dr Gregory E. Vilchek, Moscow, 346 p.

MATUSZKIEWICZ W., 1981 - Przewodnik do oznaczania zbiorowisk roslinnych Polski. Warszawa: Panstwowe Wydawnictwo Naukowe, 298 p.

MIRKIN B.M., SOLOMESHCH A.I., ISHBIRDIN A.R. and ALIMBEKOWA L.M., 1989 - List and diagnostic criteria of the high units of ecological-floristical classification of vegetation of the USSR. Moscow: Preprint of the Institute of Evolution, Morphology and Ecology of Animals (in Russian).

MUCINA L., GRABHERR G. and ELLMAUER TH., 1993 - Die Pflanzengesellschaften Österreichs. Teil I. Antropogene Vegetation. Jena; Stuttgard; New York: G. Fischer, 578 p.

OBERDORFER E., 1983 - Süddeutsche Pflanzengesellschaften. Teil III. Gustav Fischer Verlag. Stuttgart New York, 455 p.