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Plant Communities in Eastern Mongolia

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Abstract

In this contribution is presented a phytosociological description of plant communities, recorded in the phytogeographical district of Eastern Mongolia, including parts of the Dornod (Eastern) and the Choybalsan aymags. The whole district is characterized by steppe vegetation. Other vegetation types, like elm (*Ulmus pumila*) bush vegetation, shrubbery on sandy and rocky sites, *Salix miyabeana* bushes, meadow and reed vegetation in the river plains and lake basins, salt vegetation and ruderal plant communities were also recorded, documented by synoptic vegetation tables or single relevés and characterized by information on the ecological conditions of their habitats. Some of the observed plant communities could only be noticed without collecting proper vegetation samples. Summarizing the data, we give a short synopsis of the plant associations and communities with respect to the available phytosociological system.

Key words: Eastern Mongolia, Dornod Aymag, Suhbaatar Aymag, phytosociology, plant communities

Introduction

The knowledge on the plant communities of Mongolia increased considerably in the last decades. HILBIG (1995) summarized the hitherto existing knowledge and elaborated a first outline of the plant communities and their higher syntaxa (HILBIG 2000). Especially in the southern plant-geographical districts of Mongolia (v. WEHRDEN et al. 2006a, 2006b, 2009; WESCHE et al. 2005), but also in the northern (DULAMSUREN et al. 2005) and central areas of the country (CHENG et al. 2008, NAKAMURA & SUZUKI 2009, van STAALDUINEN et al. 2005) geobotanical investigations brought new material on the vegetation of Mongolia.

In contrast, the vast areas of Eastern Mongolia with their phytogeographical districts Eastern Mongolia and Hingan foothills (GRUBOV 1982, GUBANOV 1996), and the eastern part of the Middle Halha district are still much less covered by geobotanical research. We refer to the classical publication on the vegetation of Mongolia by YUNATOV (1950), to the publications of DASHNYAM (1974) on the steppes in Eastern Mongolia, to GUBANOV et al. (1996) on the flora and vegetation of Hingan foothills, and also to the research of the Institute of Botany of the MAS (NARANTUYA 2012, TUVSHINTOGTOKH et al. 2009, 2010). Unfortunately, these publications do not give complete plant-sociological tables.

First investigations, employing the Braun-Blanquet method in the Dornod Aymag (east of Choybalsan to the Nömrög-gol in the Hingan foothills) brought new impressions of the vegetation in Eastern Mongolia (HILBIG 2003). The complex biological expedition 2010 of idbio ("interdisciplinary biological research, exploration, consulting, Göttingen") in cooperation with Mongolian authorities and scientific research institutions of the MAS gave the opportunity for collecting additional vegetation relevés in the plant-geographical district Eastern Mongolia. We include also some material from the region west of Baruun-Urt, the center of the Suhbaatar Aymag, already belonging to the easternmost part of the Middle Halha district. Material from the Hingan foothills, where we could work only in their western marginal areas, was included in our paper only for some overlapping and especially remarkable vegetation units. Naturally, we cannot give a complete treatment of all plant communities occurring in East Mongolia, and instead provide a contribution to improving the knowledge on an important part of them.

[1] Ergebnisse der Mongolisch-Deutschen Biologischen Expeditioen seit 1962, Nr. 327.

Study area

The eastern part of Mongolia (fig. 1) contrasts with the western and central parts of the country, and is characterized by a plain or gently undulate landscape, being uniform over hundreds of kilometres (fig. 2). Unlike the Mongolian Barga in the east of the Halha plain with elevations more than 1000 m above sea level, the elevation reaches only from 500 to 1000 m. The phytogeographical district of Eastern Mongolia is approximately delimited in the North by spurs of the eastern Hentey and the Onon highlands, in the East by the Hingan foothills. In the South, the study area borders to the East Mongolian Basin and the highlands of Dariganga with the border ranges to China reaching elevations of more than 1500 m. In the West, the transition to the Halha plain (Middle Halha district) is gradual. Here and there isolated mountain massifs (e.g. Zuun Matad-uul, Baruun Matad-uul, Ih Chuluut, Tsagaan-uul), and little rocky outcrops break the monotony of the area. In vast areas of the Dornod and Sühbaatar Aymag, which represent parts of the Eastern Mongolia district, we find neither rivers and nor freshwater lakes over hundreds of kilometers. The most important river is the Herlen river (Kerulen), which drains the SW-Hentey, running through the aymag center Choybalsan and falling on Chinese territory into the Dalay-nuur. The Halhyn-gol in the very East drains the Hingan foothills into the Buyr-nuur (583 m asl.) and falls into the Dalay-nuur, which feeds the Amur irregularly. In the flat basins of the study area, we often find salt lakes and small salt pans. Examples with salt vegetation are the Shavar-nuur lakes, the Bayan-nuur south of Buyr-nuur, the Sangiyn Dalay-nuur and saltpans near Tamsag-bulag. Sand areas with dune ridges and hills occur in the border region to the Hingan foothill district.

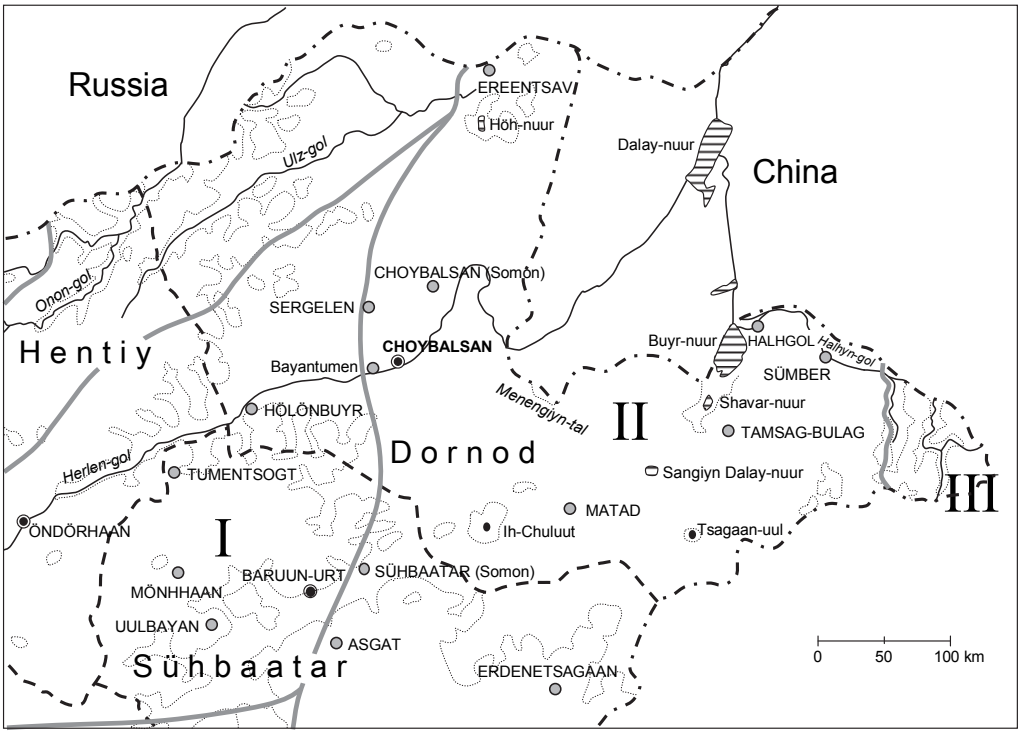

Fig. 1: Sketch map of East Mongolia with the boundaries of the phytogeographical districts Middle Halha (I), Eastern Mongolia (II) and Hingan foothill (III) (draft Pistrick & Hilbig, further modifications by Hilbig & Wesche).

Because of the missing freshwater supply, vast steppe areas have still well developed steppe vegetation, where despite of the severe decreases elsewhere big herds of the Mongolian Gazelle

(Dzeren, *Procapra gutturosa*) survived (fig. 3). Surrounding settlements, we can, however find extensive areas with strong degraded steppe vegetation even in eastern Mongolia.

The mean annual precipitation is less than 300 mm. The region between Choybalsan and Halhgol has 250-300 mm, while the area between Baruun-Urt and Matad receives 200-250 mm.

Fig. 2: Steppe plain in the Dornod Aymag, August 2002.

Fig. 3: Herd of Mongolian Gazelle (*Procapra gutturosa*) in the steppe north of Sangiyn Dalay-nuur, August 2002.

Methods

The field study was conducted in July 2010. Some relevés, made by Hilbig in August 2002 in the Dornod Aymag (HILBIG 2003) were additionally included in the tables of the present paper. Notes on rare vegetation units recorded earlier were likewise included.

Size and extend of the sample plots depended on the vegetation type. It varied from less than 10 m² in short growing mud bank vegetation to about 200 m² in forest and bush vegetation.

The cover/abundance for every species in a relevé (vegetation sample, vegetation record) was estimated following the scale of Braun-Blanquet (1964), which is in general use in geobotany in central and western Europe, and is now increasingly been used by Russian geobotanists as well.

r	solitary, with very low cover
+	few plants, with low cover (< 5 %)
1	numerous, but low cover (< 5 %)
2	5-25% cover
3	26-50% cover
4	51-75% cover
5	76-100% cover.

In the synoptic tables the species frequency (constancy) is given in columns, normally by Roman numbers:

s	the species could be found in 1 to 1 % of the relevés of the column		
I	in 11 to 20 %		
II	in 21 to 40 %	IV	in 61 to 80 %
III	in 41 to 60 %	V	in 81 to 100 %.

If fewer than 5 relevés where available for a given column, the absolute number of relevés, in which a species was recorded, is given. Behind the frequency number in the synoptic tables we indicate the range of cover/abundance values, e. g. III+-2. If in most relevés of a given unit a certain cover value is especially common for a given species, it is underlined, e. g. IV+-3, II+-1-2. For some plant communities with only less than 5 sample plots the single relevés are given.

For plant identification, we used GRUBOV (1982). The scientific plant names in the present paper mainly follow GUBANOV (1996). The placement of the plant communities in the syntaxonomic system is according to HILBIG (2000). In names of phytosociological units (e. g. associations, alliances) the scientific plant names may differ from the names given by GUBANOV (1996). This is because phytosociological units have to be given in the form they were first validly described and published. They may thus be formed with names now considered synonyms in comparison with the plant names after GUBANOV (1996). For instance *Phragmites australis* is a diagnostic species of the Phragmitetum communis and *Persicaria hydropiper* of the Bidenti tripartitae-Polygonetum hydropiperis.

The Mongolian names of settlements, rivers, lakes, mountains and other geographic locations follow as far as possible the English edition of the Geographic Atlas of Mongolia (2004).

The plant communities

Steppe vegetation (table 1)

Vast areas in the central and eastern parts of Mongolia are covered with steppes (Lavrenko et al. 1979). Karamysheva & Khramtsov (1995) unite them within the grass steppes as “mixed grass *Stipa krylovii-Leymus chinensis-Koeleria macrantha-Cleistogenes squarrosa-Poa botryoides* communities with xeophilous forbs”, and “bunch grass *Stipa krylovii-Cleistogenes squarrosa-Koeleria macrantha* communities with xerophilous forbs”, respectively. They distinguish them from the meadow steppes in the Hingan foothills with species as *Helictotrichon schellianum*, *Carex pediformis*, *Stipa baicalensis*, *Stipa sibirica* and *Filifolium sibiricum* (see HILBIG 2003).

Table 1: Steppe vegetation

Column No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
number of relevés	13	6	9	7	9	23	4
year (2002, 2010)	02,10	10	10	10	02,10	02	10
mean cover (%)	35	45	20	25	35	50	10
Species with main distribution in steppes and meadow steppes							
*Agropyron cristatum**	IV+-1	IV1	III+-1	.	IV+-2	I	1, +
*Serratula centauroides**	II1-2	.	I+	.	IV+-2	III	.
Bupleurum bicaule	II+	I+	II+	.	III+	II	4, +
Potentilla bifurca	I+	I+	.	I+	II+	II	3, +
Haplophyllum davuricum	IV1-2	I+	IV+-2	III+	II+	III	4, +
Heteropappus altaicus	II+-1	IV+	I+	I+	II+-1	IV	2, +
Ephedra dahurica	II+-1	IV +-2	.	.	.	I	.
Species with main distribution in steppes							
Cymbaria daurica	III+-2	II+	.	.	II+-2	IV	.
Stipa krylovii	V2-3	V2-3	V+-1	.	II1-2	s	4, +-1
Cleistogenes squarrosa	V+-2-3	V1-2	IV+-1	.	V1-2	V	.
Allium anisopodium/bidentatum	III+-2	III+	I+	I+	IV+-1	V	.
Artemisia frigida	V+-2	V+-2	II+	.	IV+-2	V	2, +-1
Leymus chinensis	II1	I1	V+-2	V+-1	III+-2	III	1, +
Euphorbia discolor	II+-1	.	I+	.	II+-1	I	.
Ptilotrichum tenuifolium	s+	I+	II+	.	.	I	4, +
Kochia prostrata	s+	.	.	.	III+-1	II	.
Caragana pygmaea/stenophylla	IV+-1	V+-1	V+-2	V+-2	.	IV	4, +-1
*Caragana microphylla**	III+-1	V1-2	I+	II+	IV+-2	III	2, +
*Asparagus dahuricus**	III+	II+	V+	III+-1	IV+-2	IV	1, +
Iris tenuifolia	s+	.	V+-1	IV+	III+-1	.	.
Convolvulus ammanii	II+	I1	.	.	.	s	.
Artemisia adamsii	II2	.	.	.	.	I	.
Differential species of *Carex duriuscula facies*							
Carex duriuscula	.	V1-2	II+-1	.	II1	II	3, +-1
Diagnostic species of Poo attenuatae-Stipetum grandis							
Stipa grandis	.	.	.	.	.	V3	.
Differential species of *Hedysarum fruticosum-Carex korshinskyi* community							
Carex korshinskyi	.	.	III+-1	II1-2	V1-2	.	2, +
Koeleria cristata	.	.	II+	.	IV2	.	1, +
Saposhnikovia divaricata	II+	I+	.	.	IV+	II	.
Allium senescens	.	I+	.	.	III+	II	.
Artemisia scoparia	I+-1	.	I+	.	V+-2	III	.
Hedysarum fruticosum	.	.	.	.	IV+-2	.	.
Thymus dahuricus	.	.	.	.	IV+-2	.	.
Rumex acetosella	.	.	.	.	II+-1	.	.
Festuca ovina	.	.	.	.	II2-3	.	.
Aconogonon divaricatum	.	.	.	.	II+	.	.
Thesium refractum	.	.	.	.	I+	.	.
Orostachys fimbriata	s+	.	.	.	III+-1	I	.
Orostachs thyrsiflora	.	.	.	.	II+	.	.
Poa botryoides	.	.	.	.	III1-2	s	.
Astragalus adsurgens	.	.	.	.	II+	I	.
Potentilla acaulis	.	.	.	.	II1	II	.
Thalictrum squarrosum	.	.	.	.	III+-2	I	.
Astragalus tenuis	.	.	.	.	II+	III	.

Column No.	1	2	3	4	5	6	7
Allium polyrrhizum	.	.	I2	II+	II+-1	s	2, +
Silene repens	.	.	.	.	I+	s	1, +
Differential species of the *Caryopteris mongholica* community							
Caryopteris mongholica	.	.	.	.	.	.	4, 2
Atraphaxis pungens	.	.	.	III+	.	.	2, +
Stellaria dichotoma	.	.	III+	.	.	.	4,+-1-2
Arctogeron gramineum	.	.	.	.	.	.	2, +
Oxytropis oxyphylla	.	.	.	II+	.	.	1, +
Species with main distribution on overgrazed places							
Chenopodium acuminatum	III1-2	III+-2	V2	V+-3	.	II	3, +
Setaria viridis	.	.	V+-1	IV+-1	.	II	3, +
Eragrostis minor	.	.	II+	V+-1	.	s	1, +
Bassia dasyphylla	.	.	IV±-2	IV+	.	s	2, +
Tribulus terrestris	.	.	I+	IV+-2	.	.	.
Salsola pestifera s. l.	s+	I+	I1	II+	I2	IV	.
Axyris amaranthoides	.	.	II+-1	.	.	.	.
cf. *Corispermum* sp.	.	.	III+-2	V+-3	.	.	.
Chenopodium album	s+	.	I+	.	.	II	.
Chenopodium aristatum	.	.	.	.	I2	II	.
Species with main distribution in meadow steppes							
Galium verum	.	.	.	.	III+	.	.
Scabiosa comosa	.	.	.	.	II+	.	.
Pulsatilla bungeana	.	.	.	.	II+	.	.
Medicago ruthenica	.	.	.	.	IV±-1	.	.
Potentilla tanacetifolia	s+	.	.	.	IV±-2	II	.
Lespedeza davurica	II1	.	.	.	II2	II	.

Furthermore in **column 1**: *Artemisia* sp., *Glycyrrhiza uralensis*, *Stipa klemenzii*, *Thermopsis lanceolata* s+, *Sibbaldianthe adpressa* I+;
2: *Limonium bicolor* II+, *Artemisia* sp. V±-1;
3: *Allium mongolicum*, *Elytrigium repens*, *Saussurea salicifolia*, *Vincetoxicum sibiricum* I+, *Astragalus galactites* II+;
4: *Saussurea salicifolia* I3, *Allium mongolicum*, *Astragalus galactites*, *Enneapogon borealis*, *Erodium stephanianum* I+, *Vincetoxicum sibiricum* II+, *Scorzonera divaricata* III+;
5: *Alyssum lenense*, *Chamaerhodos erecta*, *Linum sibiricum*, *Orobanche coerulescens*, *Oxytropis hailarensis* (*O. arenaria* auct. Fl. Mong.), *Pulsatilla turczaninovii*, *Rhaponticum uniflorum* I+, *Alyssum obovatum* I1, *Silene jenisseensis* II+;
6: *Allium leucocephalum*, *Allium mongolicum*, *Artemisia dracunculus*, *Glycyrrhiza uralensis*, *Goniolimon speciosum*, *Iris dichotoma*, *Lespedeza juncea*, *Nonea pulla*, *Saussurea salicifolia*, *Sibbaldianthe adpressa* s, *Limonium bicolor*, *Stipa baicalensis*, *Stipa sibirica**, *Vincetoxicum sibiricum* I, *Allium ramosum*, *Chamaerhodos erecta*, *Linaria buriatica* II;
7: *Carex pediformis* 1, +;
***** also with high constancy in elm bush vegetation;

column 1-4: Cymbario-Stipetum krylovii, Choybalsan, Menengiyn-tal between Choybalsan and Buyr-nuur, Matad, Baruun-Urt;
1: typical form, 2: *Carex duriuscula* degradation form, 3: Degradation form, rich in annuals, 4: strongly degradet form;
5: *Hedysarum fruticosum-Carex korshinskyi* community, S and SE Sümber;
6: Poo attenuatae-Stipetum grandis (after HILBIG 2003), Menengiyn-tal between Choybalsan and Buyr-nuur; the cover-abundance span is not transferred from the mentioned paper;
7: *Caryopteris mongholica* community, W Baruun-Urt.

The typical steppe association in Eastern Mongolia is the **Cymbario dauricae-Stipetum krylovii** with a wide distribution in the Mongolian-Daurian, Middle Halha and Eastern Mongolian districts. The stands are dominated by bunch grasses like *Stipa krylovii* and *Cleistogenes squarrosa*, and are much poorer in forbs than the meadow steppes of the Hingan foothills, which we do not include in our contribution. Stands dominated by different grass species can be recognized as grazing facies of this association (e. g. *Agropyron cristatum*, *Cleistogenes squarrosa*, *Leymus chinensis* in comparison with *Stipa krylovii*). PISTRICK et al. (1988) already gave a relevé with high cover values of *Leymus chinensis* and *Carex duriuscula* and very low abundance (r) of *Stipa krylovii*. In the different steps of grazing and overgrazing we can distinguish a *Carex duriuscula* facies, and a type with a decrease of well palatable forbs and grasses and high cover of annual grasses and *Chenopodiaceae*. Strongly overgrazed stands are completely dominated by these species, and also characterized by the lack of the typical steppe elements. That is clearly demonstrated by a comparison of frequencies for some species from well developed Cymbario-Stipetum krylovii stands to strongly overgrazed stands of the association (from table 1). Only *Caragana pygmaea*/*stenophylla* and *Iris tenuifolia* keep their conspicuously high values.

column (see table 1)	**1**	**2**	**3**	**4**
Stipa krylovii	V2-3	V2-3	V+-1	.
Cleistogenes squarrosa	V2-3	V1-2	IV+-1	.
Cymbaria daurica	III+-2	II+	.	.
Leymus chinensis	II1	I1	V+-2	V+-1
Chenopodium acuminatum	III1-2	III+-2	V2	V+-3
Eragrostis minor	.	.	II+	V+-1
Bassia dasyphylla	.	.	IV+-2	IV+
Tribulus terrestris	.	.	I+	IV+-2

The **Poo attenuatae-Stipetum grandis**, a tall growing steppe community, was recorded by Hilbig (2003) in the Menengiyn steppe between Choybalsan and the lake Buyr-nuur. *Stipa grandis* dominates the stands. Mongolian-Daurian and Mongolian-Mandzhurian elements, which dominate in the Veronico incanae-Stipetum baicalensis of the Hingan foothills, reach a higher proportion. In 2010 we did not record any samples of the association. Therefore we give in table 1 the species frequency values of the association after HILBIG (2003). The soils under both steppe communities are Kastanozems and Dark Kastanozems.

The ***Hedysarum fruticosum-Cleistogenes squarrosa* community** of sand areas in the eastern part of the Eastern Mongolia district has a high number of species with their main distribution on sandy habitats, including *Carex korshinskyi*, *Festuca ovina*, *Hedysarum fruticosum*, *Orostachys fimbriata*, *Orostachys thyrsiflora*, *Rumex acetosella*, *Thesium refractum*, and *Thymus dahuricus*, some of them also growing on stony-gravelly sites. *Koeleria macrantha* and *Poa botryoides* reach high cover values here. In the vicinity of the Hingan foothills also meadow steppe species belong to the stands. For this type of sand steppe occurring in Eastern Mongolia, the available material is, however, not sufficient to describe a distinct association.

On the top of stony-rocky hills in the overgrazed *Stipa krylovii* steppe west of Baruun-Urt we recorded small stands (about 20-25 m²), characterized by some shrubs, especially by *Caryopteris mongholica* accompanied by *Atraphaxis pungens*. Differential species of the *Arctogeron gramineum* subass. of the Cymbario dahuricae-Stipetum krylovii like *Arctogeron gramineum* and *Oxytropis oxyphylla* were only found here, as was *Stellaria dichotoma*. The plants in the stands are completely overgrazed. The steppe grasses and forbs have only a very low cover and abundance (table 1). The shrubs are browsed nearly to the ground. The position of the community in the phytosociological system is not clear.

Bush forests and shrubbery on sand and rock habitats (tables 2 and 3)

Ulmus pumila woodland (table 2)

In the districts of Eastern Mongolia and Hingan foothills *Ulmus pumila* builds isolated woodland patches on sandy and rocky underground. Here the elm (Mongol.: haylas) can be met in loose tree groves (fig. 4) or dense bush groups (fig. 5) within steppe and meadow steppe vegetation. The **Spiraeo aquilegifoliae-Ulmetum pumilae** with a main distribution in the central and northern Mongolian territory was also found in Eastern Mongolia, though only rarely. We provide the frequency list with the diagnostic species of the association according to Hilbig (1995) for comparison. In the easternmost areas of Mongolia, we find the **Paeonio lactiflorae-Ulmetum pumilae** (HILBIG 2003), which we could investigate also in 2010, not only in the Hingan foothills, but also in the eastern parts of the Eastern Mongolia district. *Ulmus pumila* occurs in the tree and shrub layer. Other shrub species include *Armeniaca sibirica*, *Padus avium*, *Ribes diacantha* and *Rosa davurica*. Diagnostic species in the herb layer are *Paeonia lactiflora*, *Clematis hexapetala* and *Aconogonon divaricatum*. The typical species of elm forests and scrub, *Rubia cordifolia*, *Stipa sibirica*, *Thalictrum squarrosum* and *Asparagus dahuricus* are also important elements. Many of these species are strictly linked to steppe and meadow steppe vegetation. Tree stands of *Ulmus* are often used by cattle as shadow places. Therefore they have a lot of ruderal elements and can be distinguished as an *Urtica cannabina* variant. We recorded a typical example of such a degraded bush forest of the Spiraeo aquilegifoliae-Ulmetum pumilae between Choybalsan and the salt lake Sangiyn-dalay-nuur at the locality Engonchiyn-hudag (Haylasny-ovoljöö). Relevé 83/02, bottom of a rock valley, 21.08.2002:

cover tree layer 40 %;	*Ulmus pumila* 3
shrub layer 1 %;	*Ulmus pumila* +, *Spiraea aquilegifolia* +
herb layer 70 %;	*Urtica cannabina* 1, *Cannabis ruderalis* +, *Stipa sibirica* +, *Asparagus dahuricus* +, *Rumex gmelinii* +.

Fig. 4: Elm groves and single elm trees within the steppe south of Sümber, July 2010.

Fig. 5: Dense elm bush south of Sümber, in the foreground *Aconogonon divaricatum*, July 2010.

Fig. 6: Fruit-bearing Armeniaca sibirica; Dornod Aymag, August 2002.

The alliance Ulmion pumilae MIRKIN et al. ex HILBIG 2000 was already described by HILBIG (2000). We unite the *Ulmus pumila* bush forests and related shrub communities in the new class Ulmetea pumilae cl. nov. hoc loco with the Ulmetalia pumilae ord. nov. hoc loco. The nomenclatorical type of the Ulmetalia pumilae is the Ulmion pumilae. The diagnostic species are *Ulmus pumila*, *Padus asiatica*, *Malus baccata*, *Ribes diacantha*, *Rhamnus erythroxylon*, *Rubia cordifolia*, *Thalictrum squarrosum*, *Stipa sibirica*, *Asparagus dahuricus*.

Single elm trees and tree groups, elm shrubs and elm bush patches in the steppe vegetation document the formerly much wider distribution of elm bush forests and bushes in the Mongolian-Daurian region.

Armeniaca sibirica (fig. 6) does not only grow in the shrub layer of the elm bush vegetation. YUNATOV (1950) already mentioned an ***Armeniaca sibirica* community**, a shrubbery from south-facing stony slopes in the Hingan foothills. KAMELIN (1994) described dense stands of this species from the mountain massif of Tsagaan-uul south of Tamsag-bulag in the Eastern Mongolia district. Stands there comprise dozens of square kilometers. We give material of both dense and sparse stands from the area south and south-east of Sümber, towards the Degee-gol (tab. 2).

We did not yet raise the community to the rank of an association. The herb layer is dominated by species with a main distribution in elm forests and meadow steppes, like those from the Paeonio lactiflorae-Ulmetum in the Dornod Aymag.

Table 2: *Ulmus pumila* bush vegetation and *Armeniaca sibirica* shrubbery

Column No.	**1**	**2**	**3**
number of relevés	12	16	6
year (2002, 2010)	02,10	1981, 1983	02, 10
mean cover (%)			
tree layer in relevés with tree layer	(40)	15	.
shrub layer	70	25	60
herb layer	25	45	25
TREE LAYER			
Ulmus pumila	II2-4	V	.
Padus asiatica	.	II	.
SHRUB LAYER			
Ulmus pumila	V2-4-5	IV	.
Armeniaca sibirica	III1-2	.	V1-5
Rosa davurica	III1-2	.	.
Rosa acicularis	.	.	I1
Padus avium	II3	.	.
Ribes diacantha	III1-2-3	III	.
Spiraea aquilegifolia	.	IV	I+
Cotoneaster melanocarpa	.	II	.
Rhamnus erythroxylon	.	II	.
HERB LAYER			
Diagnostistic species of Paeonio lactiflorae – Ulmetum pumilae			
Paeonia lactiflora	IV+-1-2	.	I+
Clematis hexapetala	IV +-2	.	II1
Aconogonon divaricatum	V+-1-2	.	V+
Euphorbia fischeriana	I+	.	.
Diagnostistic species of Spiraeo aquilegifoliae – Ulmetum pumilae			
Dictamnus dasycarpus	s2	.	.
Melica virgata	.	III	.
Chamaerhodos erecta	.	IV	.
Polygonatum odoratum	.	II	.
Patrinia rupestris	.	III	.
Stellaria dichotoma	.	IV	.
Artemisia santolinifolia	.	IV	.
Species with main distribution in Ulmus bush vegetation			
Rubia cordifolia	V+-1-2	V	II+
Stipa sibirica	III+-1	IV	IV+-2
Thalictrum squarrosum	V+-2	III	V+-2
Species of steppes and meadow steppes			
Agropyron cristatum	II+-1-2	V	.
Serratula centauroides	V+-1	III	V+-1
Potentilla tanacetifolia	V+-1-2	IV	V+-1
Adenophora stenanthina	IV+-1	I	.
Galium verum	III+-2	V	II+-1
Asparagus dahuricus	V+-1	II	V+-1
Caragana microphylla	III +-1	II	II+
Schizonepeta multifida	IV+	II	II+
Artemisia frigida	II+-1	II	III+-2
Bupleurum bicaule	I+	II	.

Column No.	1	2	3
Euphorbia discolor	III+-1	.	II+
Veronica spuria	I1	.	.
Artemisia dracunculus	IV+-1-2	III	II+-2
Artemisia scoparia	s+	II	III+
Cleistogenes squarrosa	.	II	II3
Elymus sibiricus	I+	.	III1-2
Silene repens	III+	IV	.
Lilium pumilum	I+	II	I+
Saposhnikovia divaricata	III+-2	.	V+
Carex cf. korshinskyi	I1-2	IV	.
Heteropappus altaicus	I+	.	.
Stipa grandis	.	.	III+-2
Medicago ruthenica	.	.	II+
Allium bidentatum	.	.	II1-2
Allium senescens	.	.	IV+-2
Lespedeza davurica	.	I	III+-2
Lespedeza juncea	.	I	II1-2
Further species			
Scutellaria baicalensis	III+-2	.	I1
Artemisia mongolica	II+-1	II	.
Bromopsis inermis	III1-2	.	I1
Chelidonium majus	I+	.	.
Urtica cannabina	III+-1	.	.
Cannabis sativa	I1	.	I+
Chenopodium album	III+	.	.
Chenopodium acuminatum	s+	II	II+-1
Fallopia convolvulus	II+-1	.	.
Poa pratensis	II1	.	.

Furthermore in **column 1**: *Astragalus adsurgens*, *Galatella dahurica*, *Pimpinella thellungiana*, *Potentilla bifurca*, *Rumex gmelinii*, *Scabiosa comosa* s+, *Herdysarum fruticosum*, *Vicia cracca* I+, *Artemisia* sp. I1, *Artemisia* cf. *laciniata* II+;

2: shrub layer: *Malus baccata, Spiraea media* s, *Caryopteris mongholica* I, *Caragana pygmaea* III; **herb layer:** *Agrimonia pilosa, Bidens parviflora, Chenopodium album, Chenopodium hybridum, Galium spurium, Melica turczaninovii, Poa pratensis, Potentilla bifurca* s, *Geranium sibiricum, Lophanthus chinensis, Salsola pestifera* s. l.*, Vincetoxicum sibiricum* I, *Allium leucocephalum, Artemisia frigida, Bromus inermis, Carum buriaticum, Dontostemon integrifolium, Echinops latifolius, Heteropappus sp., Kochia prostrata, Lappula* sp., *Leonurus deminutus, Leuzea uniflora, Medicago falcata, Papaver nudicaulis, Phlomopsis tuberosa, Physochlaina physaloides, Pulsatilla ambigua, Scabiosa comosa, Schizonepeta multifida, Sedum aizoon, Thymus baicalensis, Veronica incana* II, *Poa attenuata, Rheum undulatum, Thalictrum foetidum, Youngia tenuifolia* III;

3: *Adenophora crispata, Allium racemosum, Carex pediformis, Lilium martagon, Potentilla bifurca, Sanguisorba officinalis, Scutellaria scordifolia I+, Ephedra dahurica* I1;

column 1: Paeonio lactiflorae-Ulmetum pumilae, between Sümber and Nömrög, SE Choybalsan at the road to the Sangiyn-dalay-nuur;

2: Spiraeo aquilegifoliae-Ulmetum pumilae, typical subass., Orhon and Selenge valley, eastern Hangay, southern foothills of Hentey, Middle Halha district, SE Choybalsan;

3: *Armeniaca sibirica* community, SE Sümber, Degee-gol, area Sümber-Ih-tashgay-nuur.

Another community of rock shrubbery is the **Amygdalo pedunculatae-Spiraeetum aquilegifoliae** (tab. 3, fig. 7). It develops on southern exposures of rocky slopes in central, north and east Mongolia. In addition to the dominant *Spiraea aquilegifolia* also *Caragana* species and *Atraphaxis pungens* belong to the shrub layer. The second name-giving shrub species, *Amygdalus pedunculata* that occurs with high frequency in the stands of the association from other regions of Mongolia, was not recorded here. The composition of the other species, however, illustrates that the stands belong to the Amygdalo-Spiraeetum. Stands of the Spiraeo aquilegifoliae-Ulmetum pumilae at similar sites growing in the vicinity, and isolated *Ulmus* trees in the direct neighbourhood hint at the descent of the shrubbery from loose elm bush stands.

The **Spiraeo mediae-Cotoneastretum melanocarpi** (tab. 3) also grows on rocky and stony habitats, especially on north-facing slopes. We found shrub stands of the association in contact with stands of the *Spiraea aquilegifolia* association described above. Klaus Pistrick (Gatersleben) found *Cotoneaster melanocarpa* scrub in the Tsogunder mountains west of Matad and in the Tumencogt mountains near Tumentsogt (see HILBIG et al. 2013). In the forest steppe zone *Cotoneaster melanocarpa* shrubbery occurs often in contact with *Larix sibirica* forest, where the species can build a dense understory.

The ***Salix microstachya* community** (tab. 3) is a typical scrub on hills and ridges of sand dune areas. Commonly, single shrubs are found within the sand steppe vegetation, but they can also form dense groups. Sand steppe and meadow steppe species complete the species combination.

Fig. 7: Slope with *Spiraea aquilegifolia* shrubbery, Mergen-tolgoy NW Sangiyn Dalay-nuur, August 2002.

Table 3: Shrub communities on rock and sand habitats

Column No.	**1**	**2**	**3**	**4**	**5**
number of relevés/relevé	11	79	79a	36	54
year (2002, 2010)	02,10	02	02	02	10
mean cover resp. cover (%)					
shrub layer	50	60	70	80	80
herb layer	25	10	10	15	20
SHRUB LAYER					
Spiraea aquilegifolia	V3-4	1	.	.	.
Caragana pygm./stenophylla	V1-2	.	.	.	.
Caragana microphylla	s1	.	.	1	.
Atraphaxis pungens	V+-1	.	.	.	.
Armeniaca sibirica	.	.	.	1	.
Cotoneaster melanocarpa	.	4	4	.	.
Ribes diacantha	.	.	2	.	.
Salix microstachya	.	.	.	5	5
HERB LAYER					
Species with main distribution in Ulmus bush vegetation					
Asparagus dahuricus	IV+-2	.	.	+	+
Stipa sibirica	V2	1	.	.	.
Thalictrum squarrosum	I+	.	.	2	2
Aconogonon divaricatum	.	.	.	1	1
Species with main distribution in shrub vegetation on rock habitats					
Artemisia gmelinii	V1-2	2	1	.	.
Amethystea coerulea	V+-2	.	.	.	.
Scorzonera austriaca	IV+	+	.	.	.
Sedum aizoon	III+	.	.	.	.
Stipa baicalensis	II+-1	.	.	.	.
Species with main distribution on sand habitats					
Hedysarum fruticosum	.	.	.	+	+
Species with main distribution in steppes and meadow steppes					
Agropyron cristatum	I+-1	.	.	+	.
Serratula centauroides	s+	.	.	+	1
Potentilla tanacetifolia	.	.	.	1	+
Galium verum	s+	.	.	1	2
Bupleurum bicaule	s+	.	.	+	.
Artemisia frigida	s+	.	.	+	+
Leymus chinensis	.	.	.	.	2
Further species					
Phlomoides tuberosa	II+	.	.	.	.
Rheum undulatum	II+-1	.	.	.	.
Stellaria dichotoma	II+-1	+	2	.	.
Artemisia dracunculus	II+-2	.	.	.	1
Chenopodium album	IV+	+	+	.	.
Chenopodium acuminatum	IV+-1	.	.	.	.
Fallopia convolvulus	III+	.	.	.	.
Setaria viridis	IV+-1	+	.	.	.

Furthermore in **column 1***: Artemisia cf. commutata, Artemisia scoparia, Cannabis sativa, Haplophyllum davuricum, Iris potaninii, Kochia prostrata s+, Carex duriuscula, Koeleria macrantha* s1*, Cleistogenes squarrosa* I+-1*, Urtica cannabina* I+-2

3: *Rheum undulatum* 1
4: *Medicago ruthenica*, *Pimpinella thellungiana* +, *Carex* cf. *korshinskyi* 1
5: *Allium bidentatum*, *Euphorbia discolor* +, *Saposhnikovia divaricata* 1

column 1: Amygdalo pedunculatae-Spiraeetum aquilegifoliae, Mergen-tolgoy between Choybalsan and Sangiyn-dalay-nuur, SW Sümber
2 and **3**: Spiraeo mediae-Cotoneastretum melanocarpae, Mergen-tolgoy between Choybalsan and Sangiyn-dalay-nuur
4 and **5**: *Salix microstachya* community, sand area with dunes SW Sümber

Willow bushes in the flood plains (table 4)

Bush vegetation of willows (Mongol.: burgas) occurs very often in the river plains of Eastern Mongolia. Of course, these are mostly disturbed and thinned out due to wood cutting and pasturing, or even completely destroyed. Less disturbed dense stands of a ***Salix miyabeana*** **community**, also used as free pasture ground, were during our expedition routes only found near the mouth of the Halhyn-gol into the Buyr-nuur (fig. 8). The species-rich stands, more than 2 meters high, comprise phytogeographically interesting Mandshurian-Daurian elements like *Lycopus lucidus*, newly found by GUBANOV et al. (1996). Species of moist and eutrophic floodplain habitats, of meadows and tall forb vegetation dominate the herb layer. The sward is damaged to a certain degree due to cattle trampling, facilitating the appearance of ruderal species.

Fig. 8: Willow bush (*Salix miyabeana*) in the Halhyn-gol floodplain near Buyr-nuur, July 2010.

Meadows

In the broad river plains of Herlen river and Halhyn-gol on moist sites meadows are widespread. They are used intensively as pastures, and it is thus often difficult to recognize the complete species composition. Especially the determination of the grasses in this heavily grazed state is nearly impossible.

Saline meadows of the **Halerpesto salsuginosae**-**Hordeetum brevisubulati** occur in the basins with solonchak soils. In the zonation from the vegetation free center of a saltpan to the steppe environment, these meadows are situated between the “salt-reed” and the deris-belt. Also in the Buyr-nuur basin, pastures with *Puccinellia tenuiflora* and typical salt meadow species as *Glaux maritima*, *Triglochin* species, *Halerpestes salsuginosa* are common, though identification is often hampered due to overgrazing.

Table 4: *Salix miyabeana* shrubbery (river plain of the Halhyn-gol between Halhgol and the mouth into the Buyr-nuur)

relevé	**1**	**2**	**3**
number	28	23	23a
year (2002, 2010)	02	10	10
cover shrub layer (%)	60	70	70
cover herb layer (%)	70	40	60
SHRUB LAYER			
Salix miyabeana	4	4	4
Salix rhamnifolia	+	.	.
HERB LAYER			
Species of moist places			
Potentilla anserina	1	2	2
Equisetum arvense	1	+	2
Mentha arvensis	+	.	+
Lactuca tatarica	+	1	2
Geranium sibiricum	1	.	1
Achillea alpina	+	+	.
Phragmites australis	.	1	1
Calamagrostis purpurea	.	2	2
Angelica dahurica	.	+	1
Lathyrus palustris	.	+	+
Anemone dichotoma	.	+	+
Persicaria amphibia	.	+	1
Sanguisorba officinalis	+	.	.
Solanum kitagawae	+	.	.
Lycopus lucidus	.	+	.
Meadow species			
Medicago lupulina	2	1	1
Agrostis cf. mongholica	1	2	2
Hordeum brevisubulatum	.	1	1
Thalictrum simplex	.	2	2
Artemisia mongolica	2	2	2
Melilotus suaveolens	.	+	+
Poa pratensis	.	1	2
Inula britannica	.	1	1
Odontites vulgaris	.	+	+
Vicia cracca	.	.	+
Other species			
Plantago major	+	2	2
Galatella dahurica	1	+	.
Artemisia laciniata	+	+	.
Carex songorica	.	1	1
Cirsium arvense	.	1	1

Furthermore in **relevé 1**: *Adenophora tricuspidata*, *Artemisia macrocephala*, *Astragalus adsurgens*, *Axyris amaranthoides*, *Beckmannia syzigachne*, *Dianthus versicolor*, *Elymus dahuricus*, *Galium verum*, *Iris* sp., *Medicago falcata*, *Plantago depressa*, Potentilla tanacetifolia, *Rumex maritimus*, *Saposhnikovia divaricata*, *Saussurea* sp., *Silene repens*, *Sonchus arvensis*, *Taraxacum* sp., *Thalictrum petaloideum*, *Vicia pseudorobus*, *Xanthium strumarium* +, *Amaranthus retroflexus*, *Artemisia annua*, *Artemisia palustris* 1, *Artemisia scoparia*, C*henopodium album*, *Setaria viridis* 2.

2: *Halerpestes salsuginosa*, *Iris lactea*, *Rumex* cf. *crispus*, *Scutellaria baicalensis*, *Sphaerophysa salsula* +.

The **Medicagini falcatae**-**Brometum inermis** (table 5) has a much smaller distribution. It is developed in narrow depressions outside the salt influenced basins, with better and more regular water supply than in the steppe. In central and western Mongolia stands of the association, characterized by *Bromopsis inermis*, were found near ditches and irrigation channels in agricultural regions. In the transition to the Hingan foothills we also noticed some *Bromopsis inermis* meadows.

Table 5: Medicagini falcatae-Brometum inermis

number of relevés	**3**
year (2002, 2010)	02,10
mean cover (%)	80
Diagnostic species	
Bromopsis inermis	3, 3-4
Medicago falcata	3, 1-2
Species with main distribution in meadows and pasture ground	
Sanguisorba officinalis	3, 1-2
Vicia cracca	3, +-1
Poa pratensis	2, 1
Potentilla anserina	1, 3
Species with main distribution in meadow steppes and steppes	
Galium verum	3, +-2
Potentilla bifurca	3, +
Adenophora stenanthina	2, +
Aconogonon divaricatum	3, +
Medicago ruthenica	1, 1
Dianthus versicolor	1, +
Geranium pratense	1, 1
Artemisia dracunculus	2, +-1

Further species: *Achillea asiatica*, *Agrimonia pilosa*, *Artemisia mongolica*, *Campanula glomerata, Linum sibiricum, Potentilla tanacetifolia, Veronica longifolia* 1, +-1.

Achnatherum splendens vegetation (table 6)

Achnatherum splendens (Mongol.: deris) forms about one and a half meter high stands (fig. 9), often in broad belts at the transition between desert (with deep water tables), semi-desert or steppe vegetation to groundwater-dependent vegetation in floodplains and lake basins. *Achnatherum splendens* dominates with its tall and coarse tussocks. The species is poor in nutrients and is largely avoided by cattle. Other diagnostic species are *Knorringia sibirica* and *Atriplex sibirica*. We distinguish 3 deris associations. The **Caragano microphyllae**-**Achna-theretum splendentis** is typical for steppe regions. In broad deris belts, we find it commonly in contact with the adjacent steppe vegetation. The **Glycyrrhizo uralensis**-**Achnatheretum splendentis** is well developed in the semi desert zone. Steppe elements are lacking, being replaced by *Glycyrrhiza uralensis*,

Lactuca tatarica, *Saussurea salsa* and (due to the contact to *Nitraria sibirica* stands) with *Nitraria sibirica*. We found *Glycyrrhiza uralensis* in the mentioned deris association in the south of Buyrnuur, at the Shavar-nuur lakes and near Matad. Some mono-specific deris stands should be incorporated in this association here although they lack differential species. The **Suaedo corniculatae**-**Achnatheretum splendentis** is the deris association in contact with typical salt vegetation. *Nitraria sibirica*, *Kalidium cuspidatum* and the name-giving *Suaeda corniculata* are the differential species. Often the surface between the deris tussocks is more or less covered by salt crusts. Mechanical disturbance causes the *Achnatherum* tussocks to die. Halophilous annuals, the dominance of which indicates degradation forms of the Achnatherum communities, fill the gaps.

Table 6: *Achnatherum splendens* (deris) vegetation

Column No.	**1**	**2**	**3**	**4**
number of relevés	10	9	3	7
year (2002, 2010)	02,10	02,10	10	02,10
mean cover (%)	50	45	50	50
Species with main distribution in deris vegetation				
Achnatherum splendens	V2-3	V2-5	3, +-1	V2-4
Knorringia sibirica	II+-1	II+-1	2, 3-4	II+-1
Atriplex sibirica	I+-1	.	.	II+-2
Saussurea salsa	I+	II+	1, 2	.
Nitraria sibirica	II+-1	.	.	V+-2
Kalidium cuspidatum	.	.	.	III+-1
Reaumuria songarica	s+	.	.	I+
Limonium aureum	s1	.	.	III+
Suaeda cf. corniculata	s1	.	.	V+-1-2
Species with main distribution in steppes				
Leymus chinensis	IV1-2	.	.	II+
Allium anisopodium	III+-1	II+	.	.
Carex duriuscula	III+-3	.	.	II2
Artemisia adamsii	II+	.	.	I+
Convolvulus ammanii	II+-2	.	.	.
Carex korshinskyi	II+-1	.	.	.
Artemisia scoparia	II+-1	.	.	V+-2
Thermopsis lanceolata	II+-1	II+-1	.	.
Elytrigia repens	.	II1-2	.	.
Species with main distribution on disturbed places				
Chenopodium album	II+-2	III+	.	III+
Chenopodium acuminatum	II+-2	II2	3, 2-4	.
Salsola pestifera s. l.	II+-1	.	.	II+
Eragrostis minor	II+-2	III1-2	1, 1	I+
Setaria viridis	s+	III+-1	1, 1	.
Bassia dasyphylla	s1	II+	1, +	I+
Tribulus terrestris	.	II+-1	.	.
Chenopodium aristatum	.	II+	.	I+

Furthermore in **column 1**: *Artemisia cf. commutat*a, *Artemisia palustris*, *Artemisia sieversiana*, *Asparagus dahuricus*, *Astragalus adsurgens*, *Caragana microphylla*, *Chiazospermum erectum*, *Euphorbia discolo*r, *Haplophyllum davuricum*, *Iris lactea*, *Kochia densiflora*, *Potentilla anserina*, *Silene repens*, *Sphaerophysa salsula*, *Stipa krylovii*, *Tournefortia sibirica* s+, *Artemisia frigida*, *Bupleurum bicaule*, *Caragana stenophylla*, *Heteropappus altaicus*, *Limonium bicolor*, *Potentilla bifurca*, *Ptilotrichum canescens* I+, *Allium polyrrhizum*, *Artemisia dracunculus*, *Cleistogenes squarrosa*, *Cymbaria dahurica* I+-1;

2: *Artemisia sieversiana*, *Asparagus dahuricus*, *Axyris amaranthoides*, *Caragana microphylla*, *Silene repens*, *Vincetoxicum sibiricum* I+, *Calamagrostis epigeios*, *Caragana stenophylla*, *Iris lactea*, *Phragmites australis*, *Polygonum aviculare* s1, *Artemisia macrocephala*, *Artemisia palustris* II+, *Artemisia dracunculus* I+;
3: *Elymus sibiricus*, *Iris tenuifolia* 1, +, *Caragana stenophylla*, *Hordeum brevisubulatum* 1, 1;
4: *Artemisia frigida*, *Lepidium densiflorum*, E*uphorbia discolor*, *Orobanche coerulescens*, *Polygonum aviculare*, *Serratula centauroides* I+, *Artemisia dracunculus*, *Thellungiella salsuginosa* I1, *Kochia densiflora* I3;

column 1: Caragano microphyllae-Achnatheretum splendentis, E Choybalsan, Bayan-nuur;
2: Glycyrrhizo uralensis-Achnatheretum splendentis, W Matad;
3: Glycyrrhizo uralensis-Achnatheretum splendentis, degradation stage, W Matad;
4: Suaedo corniculatae-Achnatheretum splendentis, Bayan-nuur, Buyr-nuur, Shavar-nuur lakes, W Matad.

Fig. 9: Deris belt (*Achnatherum splendens* belt) near the southern shore of the lake Buyr-nuur, July 2010.

Table 7: *Tournefortia sibirica* sand dune community near the southern shore of Buyr-nuur in contact with saline lowland

Column No.	**1**	**2**	**3**	**4**	**5**
relevé	20	20a	24	14	14b
year: (2010)	10	10	10	10	10
vegetation cover (%)	15	20	10	3	1
Tournefortia sibirica	2	2	2	1	+
Silene repens	2	1	+	.	.
Hypecoum erectum	2	1	.	.	.
Linaria acutiloba	+	1	.	.	.
Xanthium strumarium	.	+	+	.	.
Saussurea salsa	.	+	.	+	.

Furthermore in relevé **1**: Salsola pestifera s. l. +; **2**: Astragalus adsurgens +;
3: Melilotus suaveolens, Phragmites australis +; **5**: Knorringia sibirica, Puccinellia tenuiflora +.

In contact with stands of *Achnatherum splendens* and the *Leymus chinensis*-*Calamagrostis epigeios* community, and growing on loose sand dunes at the outer border of the lake lowlands, an early successional vegetation is developed, in which *Tournefortia sibirica* plays an important role. At present, we cannot place the very species-poor ***Tournefortia sibirica* community** (tab. 7) in the phytosociological system, but it seems to be related to the deris vegetation.

Reed vegetation (table 8)

Tall reed vegetation is developed in the shallow shore zone of lakes, oxbow lakes and small backwaters of rivers. The dominant reed community is the **Phragmitetum communis**. Loose stands in the lakes, often mono-specific, grow in the shallow water, sometimes overlapping with water plants like *Potamogeton* and *Myriophyllum* species. Where groundwater merely reaches the soil surface in the depressions near the lakes, the Phragmitetum stands grow as terrestrial reed beds being much denser than the "water-reed". Here *Phragmites australis* is accompanied by other typical reed elements like *Epilobium palustre*, *Mentha arvensis*, *Persicaria amphibia*, *Stellaria palustris* and *Scutellaria galericulata*, forming a special ***Mentha arvensis*-subass.** (HILBIG 2009). Also meadow species find good habitat conditions. The "land-reed" is grazed, partly heavily grazed by cattle. Young reed stands are also mown. On places in the outer parts of salty depressions we find *Beckmannia syzigachne*, *Puccinellia tenuiflora*, *Glaux maritima* and other salt meadow species. In the overall zonation, the "salt reed" is situated between the deris (*Achnatherum*) belt and the annual salt vegetation.

Other tall marshland communities are characterized by *Scirpus hippolytii*, resp. by *Bolboschoenus planiculmis*, *Glyceria triflora*, *Scirpus radicans* and *Equisetum fluviatile*. These communities are species-poor, and the name-giving species have a high vegetation cover. *Scirpus hippoliti* (*Scirpus hippolytii*, *Scirpus tabernaemontani*) forms loose, often mono-specific stands in the shallow water of the lake shore, where we could find them in contact with the Phragmitetum communis in the Buyr-nuur (**Scirpetum tabernaemontani**). At the banks of the Halhyn-gol near the mouth into the Buyr-nuur with slowly floating water *Scirpus hippoliti* together with *Glyceria triflora* forms small stands of the **Scirpo hippolytii**-**Glycerietum triflorae**. Reeds of the ***Equisetum fluviatile* community** were only encountered at the river bank of the Nömrög-gol in the phytogeographical district of the Hingan foothills:

Relevé 43/2002 *Equisetum fluviatile* 4, *Butomus umbellatus* 2, *Agrostis mongholica* +, *Alisma plantago-aquatica* +.

Other communities in the study area are the ***Phalaris arundinacea* community** and the **Scirpetum radicantis**. The first grows in connection with the *Phragmites* reed on places with groundwater near the soil surface; the latter grows on eutrophic muddy river banks.

Near the Halhyn-gol we found low reed vegetation with *Butomus umbellatus* and *Alisma plantago-aquatica*, and the ***Eleocharis palustris* community**. The latter is more or less similar to the Eleocharitetum palustris. Stands of a ***Bolboschoenus planiculmis* community** can be found in connection with saline meadows and other vegetation types on solonchak soils. They are poor in species, but have high cover values of *Suaeda* cf. *corniculata*.

Phragmites australis also attains high constancy in the ***Leymus chinensis*-*Calamagrostis epigeios* community**, together with elements of saline meadows. The community grows in contact with the Phragmitetum communis in the lake lowland of the Buyr-nuur on sand sediments near the shore line. The phytosociological position is not yet clear, as it does not belong to the Phragmitetea communis. The *Tournefortia sibirica* stands on dune habitats are usually found in the vicinity.

Table 8: Reed vegetation

Column No.	**1**	**2**	**3**	**4**	**5**
number of relevés/relevé	8	8	3	69	69a
year (2002, 2010)	02, 10	10	02,10	02	02
mean cover resp. cover (%)	70	30	75	90	90
Reed species					
Phragmites australis	V3-4	IV+-1	3, 3-5	.	.
Bolboschoenus planiculmis	.	.	.	4	4
Scutellaria galericulata	IV+-1	.	.	.	.
Epilobium palustre	IV+	.	.	.	.
Persicaria amphibia	II+-1	I1	.	.	.
Meadow species, especially salt meadow species					
Saussurea salsa	V+-2	V+-2	.	.	.
Poa subfastigiata	V1-2	.	.	.	.
Melilotus suaveolens	III+-4	II+	.	.	.
Inula britannica	II+-2	.	.	.	.
Potentilla anserina	II+-2	.	.	.	.
Stellaria palustris	III+-1	.	.	.	.
Calamagrostis epigeios	IV1-3-4	III+-1	.	.	.
Puccinellia tenuiflora	V+-1-2	.	3, 1-3	.	.
Leymus chinensis	.	V2-3	1, 1	.	.
Astragalus adsurgens	.	IV+	.	.	.
Glaux maritima	II1	.	.	.	.
Iris lactea	.	V+-1	.	.	.
Carex duriuscula	.	II1-2	.	.	.
Suaeda corniculata	.	.	3, +-1	4	3
Further species					
Knorringia sibirica	III+	II+-1	2, 1	1	2
Lactuca sibirica	IV+-2	.	.	.	.
Artemisia mongolica	II+-1	I1	.	.	.
Artemisia scoparia	.	IV+-1	.	.	.
Cirsium arvense	IV1-2	.	.	.	.
Sphallerocarpus gracilis	IV+-1	.	.	.	.
Chenopodium album	II+	I+	1, +	.	.
Chenopodium rubrum	I+	.	.	.	
Tournefortia sibirica	.	II2	.	.	.

Furthermore in **column 1**: *Chenopodium ficifolium*, *Halerpestes salsuginosa*, *Hordeum brevisubulatum*, *Odontites vulgaris*, *Plantago major*, *Silene repens*, *Sphaerophysa salsula*, *Thalictrum squarrosum* I+, *Artemisia integrifolia*, *Carex* sp., *Poa pratensis* I1;

2: *Allium anisopodium*, *Lappula* sp., *Limonium bicolor*, *Medicago falcata*, *Taraxacum* sp., T*halictrum squarrosum* I+, *Hordeum roshevitzii* I1, *Artemisia dracunculus*, *Silene repens* I2, *Artemisia* cf. *commutata* II+;

column 1: Phragmitetum communis, *Mentha arvensis* subass., Buyr-nuur

2: *Leymus chinensis-Calamagrostis epigeios community*, Buyr-nuur

3: *Phragmitetum communis*, *Suaeda cf. corniculata form*, Buyr-nuur, SW Buyr-nuur, Tamsag-bulag

4 and **5**: *Bolboschoenus planiculmis* community, Tamsag-bulag.

Water vegetation

Decidedly well developed water plant communities are quite rare in Eastern Mongolia. We found them in the Buyr-nuur and in the oxbows and waterhollows of the rivers Cherlen and Halhyn-gol. Species-poor or mono-specific stands of the pondweeds ***Potamogeton filiformis*** (Buyr-nuur), *P. pectinatus*, *P. pusillus*, build typical communities of the Potamion. The ***Potamogeton pusillus*** **community** and the **Potametum pectinati** are already known water plant communities. ***Myriophyllum spicatum*** forms dense stands in the shallow water of lake Buyr-nuur and in water hollows and stillwater parts of rivers. *Nymphoides peltata*, especially widespread in the west-Mongolian Great Lakes Basin, is the typical species of the floating-leaf water plant association **Nymphoidetum peltatae** within the Nymphaeion albae. ***Batrachium divaricatum*** and *Potamogeton pusillus* grow in big swathes in the course of the Halhyn-gol. These stands belong to the Ranunculion fluitantis or a close unit of floating water vegetation. A relevé of this community is No. 27/2002 from there, downstream of Halhgol is typical:

cover 100%; *Batrachium divaricatum* 5, *Myriophyllum spicatum* +.2, *Persicaria amphibia* form. *natans* +.

Mono-specific stands of the free-floating duckweed *Lemna minor* (**Lemnetum minoris**) cover here and there the surface of small stagnant waters, well developed e. g. in Sümber. The **Ceratophylletum demersi** is a free-floating water plant community, which is not limited to the water surface. *Ceratophyllum demersum* grows in crowds in the whole water volume of small eutrophic stillwaters. Localities of the mentioned species are given in HILBIG et al. (2013).

Vegetation on mud banks (table 9)

On unshaded moist and nutrient-rich muddy soils, which are devoid of tall perennial plants, we can occasionally find dense stands of plants from the genera *Bidens*, *Chenopodium*, *Persicaria* and *Rumex*.

They build communities belonging to the class Bidentetea tripartitae. Riverbanks, shores of oxbow lakes and the borders of little watercourses with changing water level are typical habitats. We found more or less dense stands of species like *Bidens tripartita*, *B. cernua*, *Chenopodium album*, *Ch. ficifolium*, *Ch. glaucum*, *Ch. rubrum*, *Persicaria hydropiper*, *P. lapathifolia*, *Ranunculus sceleratus*, *Rorippa islandica*, *Rumex maritimus* on the banks of the Halhyn-gol between Halhgol and the mouth of the river into the Buyr-nuur and (often with an incomplete species set) on the lake shore. We give 2 relevés from the small water course near the spring in Sümber, belonging to the association of **Bidenti tripartitae**-**Polygonetum hydropiperis** (fig. 10), and one relevé of the ***Persicaria lapathifolia*** **community** from a water course in the south of the Buyr-nuur.

Fig. 10: *Bidens tripartitus* at a ditch, Sümber, July 2010.

The typical Bidentetea species are often mixed with the low growing and short-living species of the Isoeto-Nanojuncetea, like *Gnaphalium uliginosum*, *Juncus bufonius* and *Limosella aquatica*. These dwarf rush species form their own species combinations on little patches of such bare mud banks. Often these communities are fragmentary. The optimum of development of these species is in late summer, when the water has retreated.

Table 9. Bidenti-Polygonetum hydropiperis and *Polygonum lapathifolium* community

relevé	**1**	**2**	**3**
number	28	28a	21
year (2002, 2010)	10	10	02
cover (%)	40	60	80
Bidentetea species			
Bidens tripartita	4	3	.
Persicaria lapathifolia	2	1	3
Chenopodium glaucum	1	.	.
Bidens cernua	.	.	+
Rumex maritimus	.	.	1
Potentilla supina	+	+	+
Alopecurus aequalis	1	2	.
Species of trodden vegetation			
Polygonum aviculare s. l.	2	1	.

Furthermore in **relevé 1**: *Xanthium strumarium* 1; **2**: Puccinellia tenuiflora +;
3: *Tripolium vulgare*, *Chenopodium album*, *Erigeron lonchophyllus*, *Halerpestes salsuginosa*, *Plantago major*, *Sonchus arvensis* +, *Epilobium palustre* 1, *Conioselinum longifolium* 2, *Phragmites australis* 3 (very low by grazing);

relevé 1 and **2**: Bidenti-Polygonetum hydropiperis, Sümber;
3: *Persicaria lapathifolia* community, ditch S Buyr-nuur.

Salt vegetation (table 10)

In the south of Buyr-nuur, specially in the Bayan-nuur, in the regions of Tamsag-bulag (Tamsagiyn-hooloy), round the Shavar-nuur lakes, the Sangiyn-dalay-nuur and the Ölziyt-nuur (N Choybalsan) we found dense and extensive stands of *Suaeda* cf. *corniculata* (probably incl. *S. glauca* and *S. heteroptera*). We previously described them as a ***Suaeda corniculata* community** (HILBIG 2003). On many places there are only mono-specific stands of *Suaeda*. At other sites, few of halophilous companions join the *Suaeda* stands. They are also components of the contact communities, namely the ***Salicornia perennis* community** in the direction of the depression's center, and the *Kalidium cuspidatum* community and/or the *Achnatherum splendens* community towards the outer border of the salt lakes and pans. The loose *Salicornia perennis* stands settle between the *Suaeda* community and the vegetationless inner part of a saltpan, also growing on the white salt crust, which covers the center (fig. 11).

Kalidium cuspidatum, a succulent knee-high semishrub with (after GRUBOV 1982) emerald green colour, forms more or less dense **stands** between the deris-belt and the annual salt vegetation. The high portion of *Suaeda* cf. *corniculata* and of halophilous species with a main distribution in deris- and reed vegetation indicate the moist solonchak habitats. Another *Kalidium* community is the **Nitrario sibiricae-Kalidietum gracilis**, dominated by the succulent fresh-green semishrubs of *Kalidium gracile* (fig. 12). The species reaches 0.5 to 1 meter in height. Extensive stands of this association were recorded in the Galbyn-Gobi and Borzongiyn-Gobi (HILBIG & TUNGALAG 2006). In Eastern Mongolia stands of the association occur on less moist habitats, interspersed with deris and *Kalidium cuspidatum* stands.

Fig. 11: *Salicornia perennis*, Shavar-nuur, between Buyr-nuur and Tamsag-bulag, August 2002.

Table 10. Salt vegetation

Column No.	**1**	**2**	**3**	**4**
number of relevés	5	3	2	10
year (2002, 2010)	02, 10	10	10	02, 10
mean cover (%)	40	60	10 + 80	60
Kalidium cuspidatum	V2-3	1, 1	.	.
Kalidium gracile	.	3, 3-4	.	.
Nitraria sibirica	II+-2	3, 1-2	.	.
Reaumuria songarica	I2	1, 1	.	.
Achnatherum splendens	I+	1, +	.	.
Atriplex sibirica	I+	2, +	.	.
Knorringia sibirica	I+	2, 1	.	IIIr-1
Phragmites australis	I2	.	1, 1	s1
Suaeda cf. *corniculata*	V+-2	.	1, 1	V3-5
Salicornia perennis	.	.	2, 2+5	s+

Furthermore in **column 1**: *Artemisia scoparia*, *Chenopodium album*, Eragrostis minor, *Leymus chinensis*, *Salsola pestifera* s. l., *Setaria viridis* I+, *Chenopodium acuminatum* I1, *Bassia dasyphylla* I2, *Limonium* sp. II+, *Artemisia* cf. *commutata* III1-2,

2: *Artemisia* cf. *commutata* 1, +, *Bassia dasyphylla* 2, +;

3: *Triglochin palustre* 1, +, *Puccinellia tenuifolia* 1, 1;

4: *Chenopodium acuminatum* s+, *Saussurea salsa* I+, *Kochia densiflora* I+-1;

column 1: *Kalidium cuspidatum* community, Shavar-nuur lakes, area Matad – Öndör;

2: Nitrario sibiricae-Kalidietum gracilis, area Matad – Öndör;

3: *Salicornia perennis* community, Buyr-nuur, SW Buyr-nuur;

4: *Suaeda* cf. *corniculata* community, Buyr-nuur, Bayan-nuur, Tamsag-bulag, W Matad, Ölziyt-nuur, NE Choybalsan.

Fig. 12: *Kalidium gracile* stand, Shavar-nuur between Buyr-nuur and Tamsag bulag, August 2002.

Segetal vegetation

We could not record typical weed vegetation on arable fields, neither in 2002 nor in 2010. In the study area we saw only some fallows in different phases of succession towards natural steppe vegetation, and still with *Fagopyron tataricum*, *Panicum miliaceum* and *Setaria viridis* as remnants of the former segetal vegetation. Fenced gardens, in contrast, are more or less free of weeds. Only near Bayantumen we noticed in loose maize fields some weed stands of summer annuals (table 11) as *Amaranthus retroflexus*, *Amaranthus blitoides*, *Xanthium strumarium*, *Setaria viridis* and other species, which also dominate on other disturbed places.

Ruderal vegetation (table 11)

Ruderal vegetation is generally rare in Mongolia, and is rare in Eastern Mongolia as well, being concentrated in settlements and along roadsides. In yurt settlements and on garbage dumps we hardly found special ruderal plant communities. Degraded subunits of the original vegetation with a higher share of poisonous and unpalatable species occur instead. Annual *Chenopodiaceae*-species and grasses indicate the level of degradation.

The **Plantagini depressae-Polygonetum avicularis** is the characteristic shortgrowing ruderal community on strongly trampled sites. It can be found from the inner city of the capital Ulaanbaatar to yurt camps. In Eastern Mongolia, the species-poor association is also quite frequent in the aymag and sum centers. *Polygonum aviculare* s. l. dominates the stands, reaching high constancy and high cover, accompanied by *Plantago depressa* and some annuals, which increase in steppe vegetation due to overgrazing.

A special ***Amaranthus retroflexus* community** with *Amaranthus retroflexus*, *Amaranthus albus*/*blitoides* (both species were found, but not always identified with certainty) and *Xanthium strumarium* together with other summer annuals settles on open eutrophic dry habitats, on the border of dung and rubbish heaps, along fences in settlements, as in Choybalsan, Halhgol, Matad, at the salt-works near the Sangiyn-Dalay-nuur and in Bayantumen. *Polygonum aviculare* reaches high constancy, but only low cover. The species composition is more or less the same as on the above-mentioned sparse maize fields.

The ***Salsola pestifera*** s. l. **community** is the typical plant community of track verges and abandoned road tracks, which in high numbers pass through the vast steppe areas. Their bare compact soils are covered by stands of annual *Chenopodiaceae*, dominated by *Salsola pestifera* s. l. growing in long stripes. Because such tracks are depressed by traffic, the ruderal stands have a comparatively favourable water supply. We find the community also on rubbish places.

Table 11: Ruderal communities

Column no.	**1**	**2**	**3**	**4**	**5**
number of relevés	6	10	2	2a	8
year (2002, 2010)	10	02, 10	10	10	02, 10
mean cover (%)	20	65	30	40	80
Species with main distribution in annual vegetation					
Salsola pestifera s. l.	V1-2	IV+-1	.	.	II+
Eragrostis minor	IV+-1	V+-1-3	2	2	II+-1
Chenopodium acuminatum	V2	III+-2	+	1	.
Setaria viridis	V+-2	s+	2	1	.
Chenopodium album	.	IV+-2	.	+	II+-1
Lepidium densiflorum	.	s+	.	.	II+
Differential species of Amaranthus retroflexus community					
Amaranthus retroflexus	.	V+-3-5	1	2	II+
Amaranthus albus/blitoides	.	V+-5	1blit.	1blit.	I+
Xanthium strumarium	.	II+	+	+	Ir-+
Species with main distribution in trodden vegetation					
Polygonum aviculare s. l.	II+	IV+-1	.	+	V3-5
Plantago depressa	.	.	.	.	IV+
Convolvulus arvensis	.	s+	.	2	.
Further species					
Axyris amaranthoides	.	.	.	.	II+
Axyris hybrida	.	s1	+	+	.
Chloris virgata	.	I+-2	.	.	I+
Potentilla supina	.	.	.	.	II+
Tribulus terrestris	.	.	2	1	.
Erodium stephanianum	I1	.	1	1	.
Chiazospermum erectum	.	.	+	+	.
Tournefortia sibirica	.	.	1	+	.

Furthermore in **column 1**: *Artemisia sieversiana*, *Glycyrrhiza uralensis* I +, *Cleistogenes squarrosa* I 1;

2: *Bassia dasyphylla*, *Chenopodium aristatum*, *Kochia densiflora*, *Lappula* sp., *Potentilla bifurca* s+, *Neopallasia pectinata* s 1;

3: *Hyoscyamus niger*, *Persicaria amphibia*, *Thermopsis lanceolata*, *Vincetoxicum sibiricum* +

4: *Panicum miliaceum* +;

5: *Artemisia macrocephala*, *Artemisia mongolica*, *Atriplex sibirica*, Kochia prostrata, *Neopallasia pectinata*, *Plantago major*, *Puccinellia tenuiflora*, *Rumex crispus* I+, *Carex duriuscula* II+-2, *Elytrygia repens* II+-1, *Taraxacum* sp. III+;

column 1: *Salsola pestifera* s. l. community, steppe area between Öndör and Matad;

2: *Amaranthus retroflexus* community on ruderal sites, Choybalsan, Halhgol, Sümber, Sangiyn Dalay-nuur, Menengiyn-tal;

3 and **4**: *Amaranthus retroflexus* community on fields, Bayantumen in the west of Choybalsan

5: Plantagini depressae-Polygonetum avicularis, Choybalsan, Halhgol, Nömrög, Sümber.

Silverweed community (table 12)

The moist sector of the Plantaginetea majoris is represented by the Agrostietalia stoloniferae. A typical alliance is the Potentillion anserinae with the association **Puccinellio tenuiflorae-Potentilletum anserinae**, the silverweed turf.

Table 12: Puccinellio tenuiflorae-Potentilletum anserinae in saline lowland near the southern shore of Buyr-nuur

relevé	19	19a
year	2010	2010
vegetation cover (%)	80	80
Potentilla anserina	5	5
Glaux maritima	2	+
Saussurea amara	+	2
Lepidium densiflorum	r	r
Potentilla supina	+	.
Astragalus adsurgens	+	.
Salsola pestifera s. l.	+	.
Phragmites australis	.	+
Iris lactea	.	r

It is a species-poor, short and dense turf, dominated by *Potentilla anserina*. On moist eutrophic and slightly saline sites the name-giving species (in our relevés without the frequent *Puccinellia tenuiflora*) are accompanied by other halophilous species. From such habitats HILBIG (1995) already described a *Halerpestes sarmentosa* subass. (Puccinellio tenuiflorae-Potentilletum anserinae halerpestosum sarmentosae HILBIG (2009)). We found the stands near the southern shore of the Buyr-nuur in saline lowland in connection with the *Suaeda* cf. *corniculata* community, on a place used by waterfowl and grazed by cattle. In other parts of Mongolia, this association occurs also on ruderalized places, near ponds and along ditches in settlement areas.

Conclusion

Although the traveler has the impression that Eastern Mongolia is covered by the vast steppes reaching from horizon to horizon, we found also a high number of other vegetation types. Especially on rocky and sandy habitats, but also on moist and saline places, near rivers and lakes and around salt pans they find suitable habitat conditions. Some of these interesting plant communities were described above. We placed them in the available phytosociological system as far as possible. The phytosociological levels in the list of vegetation types from the highest rank to the lowest, the basic rank, are Class (C), Order (O), Alliance (L) and Association (A), in some case with Subassociation (SA), resp. plant community (comm.). The latter is (probably) similar in rank level to the association, but is not (yet) formerly described as an association. Not only the landscape characterizing steppe vegetation changes in response to pasture intensity; also bush forests, shrubbery and especially the reed vegetation are exposed to overgrazing and ruderalisation.

C Lemnetea minoris W. Koch et Tx. in Oberd. 1957
O Lemnetalia minoris W. Koch et Tx. in Oberd. 1957
L Lemnion minoris (Rübel 1912) Th. Müller et Görs 1960
A Lemnetum minoris (Rübel 1912) Th. Müller et Görs 1960
O Hydrocharitetalia morsus-ranae Rübel 1933
L Ceratophyllion demersi den Hartog et Segal 1964
A Ceratophylletum demersi (Soó 1927) Hild 1956

C Potametea pectinati Tx. et Prsg. 1942
O Potametalia pectinati W. Koch 1926
L Potamion pectinati W. Koch em. Oberd. 1957
A Potametum pectinati Carst. 1955
Potamogeton pusillus comm.
L ? Ranunculion fluitantis Neuhäusl 1959
Batrachium divaricatum comm. (1 relevé in text)
L Nymphaeion albae Oberd. 1957
A Nymphoidetum peltatae (Allorge 1922) Bellot 1951

C Phragmitetea communis Tx. et Prsg. 1942
O Phragmitetalia communis (W. Koch 1926) Tx. et Prsg. 1942
L Phragmition communis W. Koch 1926
A Phragmitetum communis (Gams 1927) Schmale 1939 (tab. 8)
SA Phragmitetum communis menthetosum arvensis Hilbig 2009 (tab. 8)
A Scirpetum tabernaemontani Soó (1927) 1947
Phalaris arundinacea comm. (? Phalaridetum arundinaceae Libbert 1931)
A Scirpo hippolytii-Glycerietum triflorae Mirkin et al. ex Hilbig 2000
Equisetum fluviatile comm. (? Equisetetum fluviatilis [Steffen 1931] Wilzek 1935)
Bolboschoenus planiculmis comm. (tab. 8)
L Eleocharito-Sagittarion sagittifoliae Pass. 1964
A Eleocharitetum palustris Ubrizsy 1948
Alisma plantago-aquatica comm.
O ? Magnocaricetalia Pign. 1953
V ?
A Scirpetum radicantis Hejný in Hejný et Husák 1978

C Bidentetea tripartitae Tx., Lohm. et Prsg. in Tx. 1950
O Bidentetalia tripartitae Br.-Bl. et Tx. ex Klika in Hadacč 1944
L Bidention tripartitae Nordh. 1940 em. Tx. in Poli et J. Tx. 1960
A Bidenti-Polygonetum hydropiperis Lohm. in Tx. 1950 (tab. 9)
L Chenopodion rubri Soó 1968
Persicaria lapathifolia comm. (tab. 9)

C Thero-Salicornietea Pignatti 1953 em. Tx. in Tx. et Oberd. 1958
O Thero-Suaedetalia Br.-Bl. et de Bolos 1957 em. Beeftink 1962
L Thero-Suaedion Br.-Bl. (1931) 1933 em. Tx. 1950
Salicornia perennis comm. (tab. 10)
Suaeda cf. *corniculata* comm. (tab. 10)

C ? Stipetea glareosae-gobicae Hilbig 2000 resp., Kalidietea (Mirkin in Kašapov et al. 1988) Mirkin et al. 1988, with O Kalidietalia (Mirkin in Kašapov et al. 1988) Mirkin et al. 1988 and L Kalidion (Mirkin in Kashapov et al. 1988) Mirkin et al. 1988; vgl. MIRKIN et al. 1988
O Reaumurio soongoricae-Salsoletalia passerinae (Mirkin in Kašapov et al. 1988) Mirkin et al. 1988 em. Hilbig 2000

(Incorporating stands of the Reaumurio-Salsoletalia passerinae with diagnostic species of the Stipetea glareosae-gobicae in the desert and semidesert regions in this phytosociological class is well possible. In the steppe zone, where these species do not belong to the typical species composition, the placement is doubtful. On the other hand, creating an own class Kalidietea without mentioning a species name and accepting the occurrence of diagnostic species of neighbouring classes is also unsatisfactory.)

L Reaumurio soongoricae-Salsolion passerinae (Mirkin in Kašapov et al. 1988) Mirkin et al. (1988) em. Hilbig 2000
A Nitrario sibiricae-Kalidietum gracilis Hilbig 2000 (tab.10)
Kalidium cuspidatum comm. (tab. 10)

C Achnatheretea splendentis (Mirkin in Kašapov et al. 1987) Mirkin et al. 1988
O Achnatheretalia splendentis (Mirkin in Kašapov et al. 1987) Mirkin et al. 1988
L Achnatherion splendentis Mirkin et al. ex Hilbig 2000
A Caragano microphyllae-Achnatheretum splendentis Kašapov et al. ex Hilbig 2000 (tab. 6)
A Glycyrrhizo-Achnatheretum splendentis Hilbig (1987) 1990 (tab. 6)
A Suaedo corniculatae-Achnatheretum splendentis Mirkin in Mirkin et al. ex Golub 1994 (tab. 6)

C Asteretea tripolium Westh. et Beeftink in Beeftink 1965
O Halerpestetalia salsuginosae Mirkin et al. ex Golub 1994
L Halerpestion salsuginosae Mirkin et al. ex Golub 1994

A Halerpesto salsuginosae-Hordeetum brevisubulati Hilbig (1987) 1990

C Hordeetea brevisubulati Mirkin et al. 1984 em. Golub 1994
O Elymetalia dahuricae Mirkin et al. (1984) 1986
L Elymion dahuricae Mirkin et al. (1984) 1986
A Medicagini falcatae-Brometum inermis Hilbig 2000 (tab. 5)

C Cleistogenetea squarrosae Mirkin et al. ex Korotkov et al. 1991
O Stipetalia krylovii Kononov, Gogoleva et Mironova 1985
L Stipion krylovii Kononov, Gogoleva et Mironova 1985
A Cymbario dauricae-Stipetum krylovii Hilbig (1987) 1990 (tab. 1)
A Poo attenuatae-Stipetum grandis Kašapov et al. 1987 em. Hilbig 1995 (tab. 1)
Hedysarum fruticosum-Carex korshinskyi comm. (tab. 1)

C Sisymbrietea officinalis Gutte et Hilbig 1975
O Sisymbrietalia officinalis J. Tx. in Lohm. et al. 1962
L Salsolion ruthenicae Phil. 1971
Salsola pestifera comm. (tab. 11)
Amaranthus retroflexus comm. (tab. 11)

C Plantaginetea majoris Tx. et Prsg. 1950
O Plantaginetalia majoris Tx. et Prsg. 1950
L Polygonion avicularis Br.-Bl. 1931
A Plantagini depressae-Polygonetum avicularis Hilbig (1987) 1990 (tab. 11)
O Agrostietalia stoloniferae Oberd. 1967
L Potentillion anserinae Tx. 1947
A Puccinellio tenuiflorae-Potentilletum anserinae Hilbig (1987) 1990 (tab. 12)
SA Puccinellio tenuiflorae-Potentilletum anserinae halerpestosum sarmentosae Hilbig 2009

C **Ulmetea pumilae cl**. **nov**. hoc loco (bush forests and shrub communities in the steppe and forest steppe zones)
O **Ulmetalia pumilae ord**. **nov**. hoc loco
L Ulmion pumilae Mirkin et al. ex Hilbig 2000
A Spiraeo aquilegifoliae-Ulmetum pumilae Hilbig (1987) 1990 (tab. 2, and 1 relevé in text)
A Paeonio lactiflorae-Ulmetum pumilae Hilbig 2003 (tab. 2)
Armeniaca sibirica comm. (tab. 2)
Salix microstachya comm. (tab. 3)
L Spiraeion aquilegifoliae Hilbig 2000
A Amygdalo pedunculatae-Spiraeetum aquilegifoliae Hilbig (1987) 1990 (tab. 3)
A Spiraeo mediae-Cotoneastretum melanocarpi Hilbig (1987) 1990 (tab. 3)

C ? Salicetea purpureae Moor 1958
O Salicetalia miyabeanae Mirkin et al. ex Hilbig 2000
L Salicion viminalis Mirkin et al. ex Hilbig 2000
Salix miyabeana comm. (tab. 4)

Plant communities with uncertain position

Caryopteris mongholica comm. (tab. 1)
Tournefortia sibirica comm. (tab. 7)
Leymus chinensis-Calamagrostis epigejos comm. (tab. 8)

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