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Plant communities of the Great Gobi B Strictly Protected Area, Mongolia

Henrik von Wehrden[1,2], Karsten Wesche[2] and Radnaakhand Tungalag[3]

[1] *Research Institute of Wildlife Ecology, Savoyen Strasse 1,Vienna, 1160 Austria*
[2]*Institute of Biology - Geobotany and Botanical Garden, Martin-Luther-University Halle-Wittenberg, 06099 Halle, Germany, E-mail: HenrikvonWehrden@web.de*
[3]*Faculty of Biology, National University of Mongolia, P.O. Box 377, Ulaanbaatar, Mongolia*

Abstract

This paper presents the first syntaxonomical overview of plant communities of the Great Gobi B Strictly Protected Area. Within Mongolia this region represents the south-westernmost protected area and preserves several species listed in the IUCN Red List. Therefore the region is of high importance to the country and moreover for the whole Central Asian eco-zone. Knowledge of the main habitat types is a precondition for nature conservation. Based on 211 vegetation samples collected during the summer of 2003 we derived 16 vegetation units. There are two mountainous communities; eight zonal semi-desert units, and the extra-zonal vegetation is assigned to six communities. The described vegetation units are compared with available descriptions from other Gobi regions.

Key words: conservation, Dzungaria, Gobi, habitat, Mongolia, phytosociology, plant communities

Introduction

The Great Gobi Strictly Protected Area is located in the south-western part of Mongolia (see Figure 1). It covers some 44,000 km^2 and hence represents one of the largest protected areas worldwide. With respect to size, it ranks 33 within the 26,000 protected areas in the world listed by the IUCN in 2005 (http://glcf.umiacs.umd.edu/data/wdpa). It is divided into two regions; the larger one represents much of the Mongolian Trans-Altay Gobi, the smaller one represents large parts of the Mongolian Dzungarian Gobi. The latter region is mainly covered by semi-desert vegetation, yet several oases as well as high mountain desert-steppes are also found there. The main focus of this reserve is the conservation of equids (Equus ferus przewalskii, E. hemionus hemionus; Kaczensky et al., submitted), although several other endangered species occur as well. The region's flora is reasonably well known (Jäger et al., 1985; Gubanov, 1996; Grubov, 2000, 2001), but knowledge on the vegetation of the Gobi is only available on a rough nation-wide scale (Yunatov, 1954; Hilbig, 1990; Lavrenko & Karamysheva, 1993; Gunin & Vostokova, 1995; Hilbig, 1995, 2000). Attaining detailed knowledge on the vegetation, therefore, represents the first step towards creating a comprehensive ecological protection framework for the reserve (von Wehrden, 2005; von Wehrden & Wesche, 2006). Vegetation samples also serve as useful ground-truth data for satellite-based vegetation mapping (von Wehrden and Wesche, 2007). The results presented here are part of a larger survey, which covers all protected areas in the whole southern Mongolian Gobi.

Working area

Climate. The Great Gobi B Strictly Protected Area (henceforth abbreviated as "SPA") is part of the Mongolian Dzungarian Gobi. This eco-region extends westwards well into China and Kazakhstan. It is the only region in southern Mongolia that is not screened by high mountain ranges against rainfalls originating westwards over the Mediterranean, the Black Sea and the Caspian Sea. Therefore, both the flora and vegetation of the Dzungarian Gobi show certain linkages to the Aralo-Caspian region (Meusel et al., 1965). There are presently no climate stations situated in the working area, but an extrapolation model (Hijmans et al., 2005) indicates a mean annual rainfall of below 100 mm/yr for most sites; however the highest peaks in the south (2850 metres asl.) may gain as much as 180 mm/yr in an average year. Winter temperatures are low, ranging between -20°C and -30°C. In contrast, the summers are hot, with a maximum average July temperature of around 28°C. Due to the influence of western disturbances in winter; snowfall seems to

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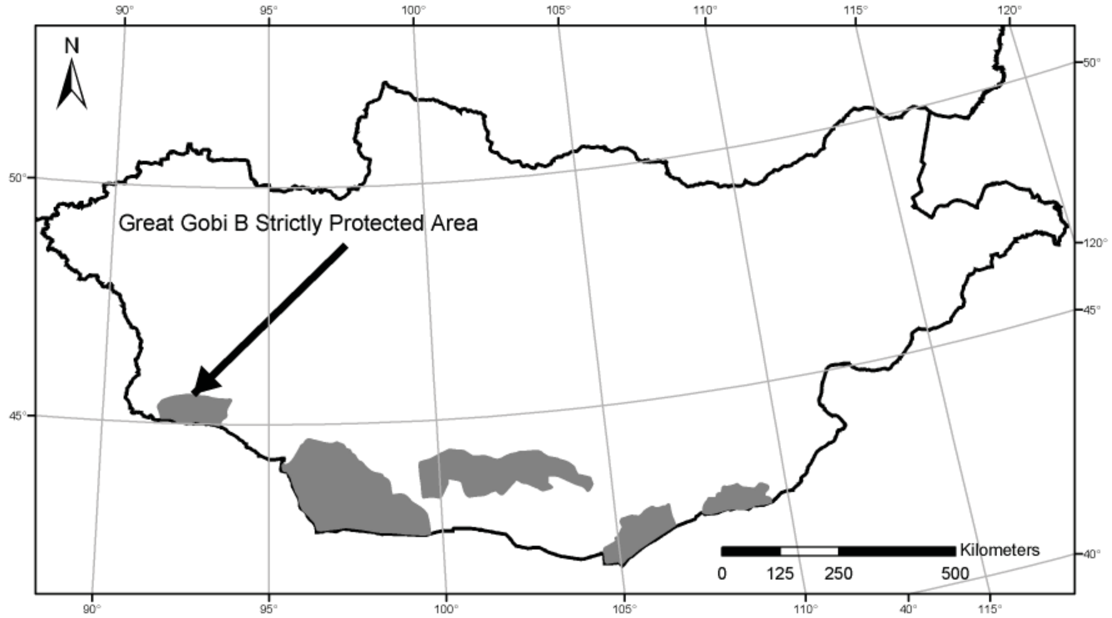

Figure 1. Location of the working area within the Mongolian Republic

be more intense compared to the rest of the southern Mongolian Gobi.

Geomorphology, landforms and soils. The Dzungarian Gobi is situated just south of the Altay mountain range, which represents a clear natural border with altitudes above 3000 metres. The protected area covers only forelands of the Altay, yet the rivers originating in its ranges flow deep into the reserve forming several oases until they eventually evaporate in the endorheic depth-line. The largest river forms a wide fan fringed with a broad belt of oases, which extend somewhat to the north-west of the protected area. The southern park boundary is formed by some island-like mountain ranges which fall steeply towards the Dzungarian depression in China. The highest range is situated in the south-west of the Great Gobi B SPA with summits at around 2900 m. An outcrop of the Altay, some 20 km away from the reserve's boundary, buffers the Mongolian Dzungarian Gobi to the east. Most hills and mountains are built of metamorphic deep-sea sediments, which have undergone severe physical erosion resulting in steep slopes. Parts of the highest mountains and some few hills are built of granite rocks and hence show more gentle erosion forms. Sand is a prominent phenomenon in the northern part of the area. It covers large parts of the northern hilly regions, which are therefore protected from further erosion.

The soils are shallow and often poorly developed. Kastanosems and Burosems dominate in the semi-deserts, while soils with better developed upper horizons are found only in high mountain sites.

The regional floristic context. Due to the western climatic and biogeographical context, the flora of the Dzungarian Gobi is unique within Mongolia. According to Gubanov (1996), at least 44 species found there occur in no other floristic region in Mongolia; many of these elements are Turanic. However, the vegetation is still dominated by Central Asian elements, which form most of the vegetation. Some taxa are northern, often montane elements. The region connects the Central Asian region with the Aralo-Caspian province, leading Meusel et al., (1965) to consider the region as a part of the submeridional zone.

Human impact and grazing. The area is almost uninhabited apart from military border stations to the south and a few herdsmen, who maintain their wintering camps in the south-western hills and north-eastern oases. Hence, livestock grazing plays a minor role, compared to other protected areas situated in the southern Mongolian Gobi (e.g. the Gobi Gurvan Saykhan National Park, see Bedunah & Schmidt, 2000; Wesche et al., 2005). However, grazing by wild ungulates is common and several species have found their last retreats in these protected areas (Zevegmid & Dawaa, 1973). The area hosts a large proportion of the Mongolian Khulan population (Kaczensky et al., 2002), as well as gazelle.

Methods

The so called dominance-based approach has a long tradition in Mongolian and Russian vegetation science, and most of the earlier publications are based on this method (Anonymous, 1990; Gunin & Vostokova, 1995). However, we think that dominance relations are subject to pronounced changes in a non-equilibrium system such as the Mongolian Gobi (Fernandez-Gimenez & Allen-Diaz, 1999). This renders communities devised on a dominance approach rather unstable. Consequently, most of the more recent overviews on the Mongolian vegetation have employed phytosociological methods (Hilbig, 1995, 2000). By such methods plant communities are identified based on diagnostic species that are restricted to the given community, but which are not necessarily dominant there (Mueller-Dombois & Ellenberg, 1974; Dierschke, 1994).

We used sample plots (relevés) 10 x 10 metres in size; species cover was estimated with percentage accuracy. Since the year of our survey had extraordinarily high rainfall, the high cover of certain species – especially annuals – might be untypical; however the presence/absence of diagnostic species can be assumed to be representative. Along with the vegetation data, several environmental parameters were recorded including simple soil data and topological information (see Table 1).

Table 1. Supplementary data available for interpretation of plant community composition in a given relevé

Parameter	**Method**
Geographical position	GPS (in decimal degrees)
Elevation	altimeter, GPS (m asl.)
Aspect	compass (degrees)
Inclination	clinometer (degrees)
Carbonate	estimated with HCl addition (%)
Grazing influence	estimated (ordinal scale with 4 divisions)
Cover of vegetation strata (tree, shrub, herb layer)	visually estimated (percentage scale)
Climate: mean annual temperature	data from Hijmans et al. 2005, in °C
Climate: mean annual precipitation	data from Hijmans et al. 2005, in mm

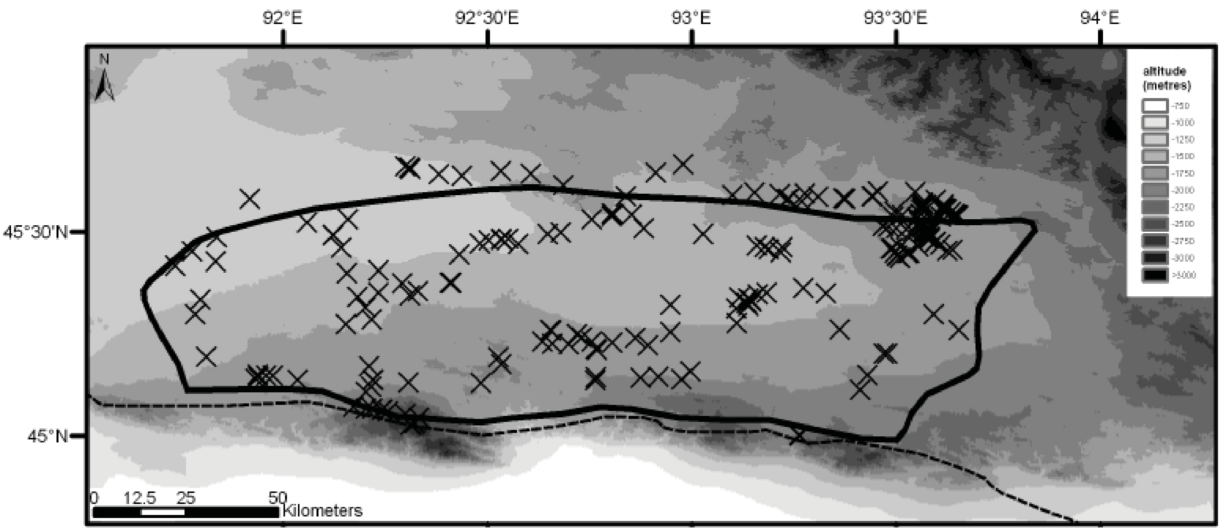

Figure 2. Topographical map of the working area. Each cross represents one relevé, the dotted line indicates the interstate boundary of Mongolia and China, the continuous line the boundary of the Great Gobi B SPA.

Sampling locations were deliberately chosen based on topographical maps and printouts of Landsat 7 data. Within all land-units, visually discernible vegetation units were sampled.

Plots were georeferenced with an ordinary hand-held GPS (see Figure 2). Additional supplementary information was taken from an open source-climate extrapolation model (Hijmans et al., 2005); topological parameters were added from SRTM-datasets (http://glcf.umiacs.umd.edu/index.shtml). All GIS analyses were made using Arc Map 8.2, Diva-GIS (www.diva-gis.org) and BLACKART-software (www.terrainmap.com).

Plants were preliminarily identified in the field using standard keys and floristic compendiums (Friesen, 1995; Gubanov, 1996; Grubov, 2001). All uncertain specimens were collected as doublets and checked in the herbariums of Halle/Germany and Ulaanbatar/Mongolia, where we also consulted additional literature (Hanelt & Davažamc, 1965; Jäger et al., 1985; Grubov, 2000). Several specimens were crosschecked by specialists (see Acknowledgements).

The vegetation data were manually classified using TABWIN and JUICE (Tichý 2002). We followed the phytosociological approach, i.e. groups of samples were manually classified based on the shared presence of diagnostic species (Mueller-Dombois & Ellenberg, 1974). Ordination methods (DCA) were used to compare manual classification and position of samples in a multivariate space, and DCA also helped to elucidate the environmental background. Ordination plots are, however, not given here as they reveal little additional information. Descriptive Boxplots of environmental data were created using the open source software "R" (www.r-project.org, version 2.1.1).

The phytosociological results are presented in three overview tables (Tables 2-4). Two distinct groups of extra-zonal communities were sampled: Mountain communities and riparian vegetation comprised two tables, and zonal stands were arranged in one table; the syntaxonomic status of each species was included in each table where known. In the Appendix, a list of the communities/associations and their syntaxomonical context is given.

Description of plant communities

1. *Hedysaro pumili-Stipetum krylovii, Festuca valesiaca* variety (see Table 2).

The highest slopes in the south western mountain range of the area are moist enough to support relatively dense mountain steppes. Extrapolated data suggests a level of precipitation higher than 180 mm/yr in an average year for the summit region (see Fig. 3b). Vegetation covers around 20% and has low shrub content. Agropyron cristatum is the character species of the phytosociological class; Festuca kryloviana and Sibbaldianthe adpressa are typical alpine or montane elements, the latter characterising the alliance (Hilbig, 2000). Most of the occurring species are also found in the comparable Gobi Gurvan Saykhan ranges in southern central

Table 2. Constancy table of the mountain communities in the Great Gobi B Strictly Protected Area including mountain steppe, a juniper community and their phytosociological relations (after HILBIG, 2000, C = class; O = order, L = alliance; A = association, communities and associations in bold letters). Diagnostic species are indicated: CC = class-level character species; OC = order-level character species; LC = alliance-level character species; AC = association-level character species, rC = regional character species, (after Hilbig, 2000). If more than 5 relevés were present in a given community, frequency is given as constancy classes ("r" = present in <5% of all relevés of that community; "+" = 5-10%; "I" = 11-20%; "II" = 21-40%; "III" = 41 – 60%; "IV" = 61-80%; "V" = 81-100%)

COMMUNITY NUMBER		1	2
No. of relevés		6	3
SPECIES OF THE AGROPYRETREA CRISTATI			
CC	*Agropyron cristatum*	V	1
CC	*Heteropappus altaicus*	I	.
SPECIES OF THE STIPION KRYLOVII			
LC	*Kochia prostrata*	II	.
LC	*Sibbaldianthe adpressa*	IV	.
SPECIES OF THE THYMION GOBICI OROSTACHYETUM SPINOSA			
LC	*Orostachys spinosa*	II	.
rC	*Potentilla sericea*	I	.
SPECIES OF THE *FESTUCA VALESIACA* SUB-VARIANT			
	Pedicularis flava	IV	.
	Festuca kryloviana	IV	.
	Potentilla stricta	IV	.
AC	*Ranunculus pedatifidus*	III	.
rC	*Festuca valesiaca*	II	2
SPECIES OF THE JUNIPERION PSEUDOSABINAE			
AC	*Juniperus sabina*	.	3
	Lophanthus chinensis	.	3
	Lonicera hispida	.	3
	Melica virgata	.	2
	Silene repens	.	2
COMPANIONS			
	Artemisia caespitosa	I	2
	Scorzonera pseudodivaricata	II	.
	Arabis rupicola	II	.
	Oxytropis tragacanthoides	II	.
	Stipa gobica	II	.
	Ephedra monosperma	II	.
	Scorzonera divaricata	II	.

ADDITIONAL:
ad 1: *Gentiana barbata* (I), *Cerastium bungeanum* (I), *Androsace dasyphylla* (I), *Pulsatilla bungeana* (I), *Galium verum* (I), *Allium polyrrhizum* (I), *Hackelia thymiflora* (I), *Rheum nanum* (I), *Taraxacum dealbatum* (I), *Rumex thyrsiflorus* (I), *Smelovskia alba* (I), *Scorzonera ikonnikovii* (I), *Arenaria meyeri* (I), *Astragalus monophyllus* (I), *Goniolimon speciosum* (I), *Artemisia phaeolepis* (I), *Saussurea saichanensis* (I), *Gentiana riparia* (I), *Allium tenuissimum* (I), *Astragalus brevifolius* (I), *Artemisia santolinifolia* (I), *Ephedra intermedia* (I), *Polygonum argyroleucum* (I), *Gypsophila dshungarica* (I), *Melandrium viscosum* (I), *Dracocephalum foetidum* (I), *Dracocephalum origanoides* (I); ad 2: *Artemisia freyniana* (1), *Rosa platycantha* (1), *Elymus chinensis* (1), *Chenopodium hybridum* (1), *Urtica cannabina* (1).

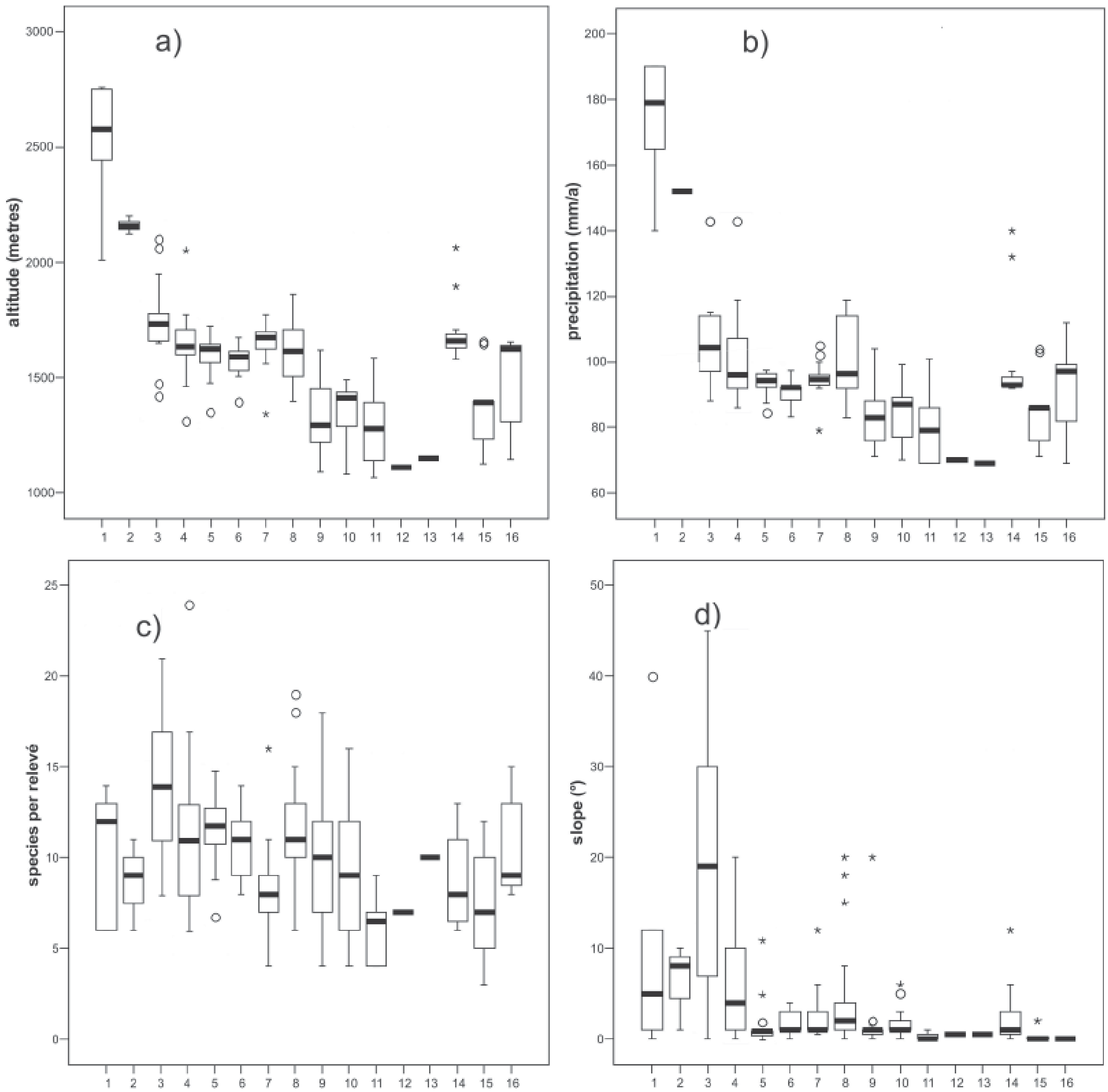

Figure 3. Boxplots summarising important environmental characteristics of the 16 vegetation units described in the text (boxes give the interquartile range, medians are indicated by a horizontal line). For community numbers refer to the text and the overview tables.

a) Altitudinal range of the vegetation units
b) Estimated mean annual precipitation, based on a model by Hijmans *et al.* (2005)
c) Species richness
d) Inclination of sites

Mongolia (Wesche et al., 2005).

Sibbaldianthe adpressa and Pedicularis flava exemplify the connection to mountain steppes of the Gobi Altay (Wesche et al., 2005). Since the mountains of the Dzungarian Gobi mark the border towards China, knowledge on the ecology and biogeographical affinities of these habitats is poor. We have therefore incorporated all relevés into one tentative community, because the number of samples is too low to allow for a description of subcommunities.

2. *Juniperus sabina*-community (Table 2).

Juniperus sabina was found on the upper slopes of the southern mountains north of the Chinese-Mongolian border (Khavtag mountains). The juniper forms dense patches that provide refuge from grazing for other shrubs such as Lonicera hispida.

Table 3. Semi-deserts of the Great-Gobi B Strictly Protected Area (for explanation of constancy classes see table 2)

COMMUNITY NUMBER		3	4	5	6	7	8	9	10
No. of relevés		18	26	20	7	22	26	21	22
SPECIES OF THE ALLION-POLYRRHIZI									
C	*Stipa glareosa*	V	V	IV	III	IV	V	II	II
C	*Allium mongolicum*	IV	IV	IV	III	IV	V	II	II
V	*Dontostemon senilis*	V	IV	I	I	II	II	.	.
C	*Ajania fruticulosa*	V	III	II	III	IV	III	II	r
SPECIES OF THE STIPO GLAREOSAE - ANABASIETUM BREVIFLORAE									
A	*Anabasis brevifolia*	V	V	.	.	III	IV	+	II
rC	*Artemisia sublessingiana*	II	III	IV	III	V	IV	I	II
A	*Bassia dasyphylla*	II	II	III	III	+	I	r	II
A	*Eurotia ceratoides*	IV	III	II	I	III	III	II	III
STIPA GOBICA VARIETY									
rC	*Stipa gobica*	V	.	.	.	.	+	.	.
rC	*Ptilagrostris pelliotii*	IV	+	.	.	.	.	.	.
SPECIES OF THE CARAGANION LEUCOPHLOEAE									
rC	*Corispermum mongolicum*	.	I	IV	III	.	.	.	r
rC	*Iris tenuifolia*	.	r	III	.	.	.	.	.
A	*Oxytropis aciphylla*	.	+	III	I	.	.	.	.
V	*Caragana leucophloea*	IV	I	V	II	+	r	I	.
CONVOLVULUS GORTSCHAKOVII COMMUNITY									
	Convolvulus gortschakovii	II	II	I	V	II	II	I	I
NANOPHYTON ERINACEUM COMMUNITY									
A	*Nanophyton erinaceum*	.	.	.	.	V	.	.	.
SPECIES OF THE HALOXYLETUM AMMODENDRONIS									
A	*Haloxylon ammodendron*	.	.	.	.	r	.	V	IV
	Reaumuria songarica	.	.	.	.	I	V	V	V
rC	*Salsola arbuscula*	.	r	+	I	I	II	.	V
	Micropeplis arachnoidea	I	II	.	.	.	I	V	IV
COMPANIONS									
	Scorzonera pseudodivaricata	III	I	r	II	.	+	+	+
	Zygophyllum neglectum	IV	III	I	I	II	IV	I	III
	Lappula stricta	III	III	V	III	II	III	II	III
	Salsola paulsenii	III	II	IV	V	I	+	II	II
	Ephedra przewalskii	III	III	III	III	III	II	III	II
	Cancrinia discoidea	II	I	r	.	.	II	II	II
	Goniolimon speciosum	II	II	.	I	I	I	r	r
	Orostachys spinosa	II	II	.	.	r	II	r	.
	Cousinia affinis	+	.	II	I	.	.	.	.
	Agropyron michnoi	+	.	II	I	.	.	.	.
	Astragalus monophyllus	+	I	I	II	II	II	+	.
	Convolvulus ammanii	+	r	r	.	II	.	.	.
	Halogeton glomeratus	.	I	r	I	II	II	II	II
	Artemisia sphaerocephala	.	r	II	I	.	.	.	.
	Artemisia xanthochroa	+	r	I	I	.	.	.	.
	Panzerina lanata	+	+	I	I	.	.	.	.
	Arnebia fimbriata	I	II	r	I	.	I	r	+
	Sympegma regelii	II	r	.	.	.	+	+	r
	Chenopodium hybridum	II	.	.	.	.	.	.	.
	Ephedra intermedia	II	r	.	.	.	.	.	.
	Ceratocarpus arenarius	I	+	I	I	I	r	.	r
	Calligonum junceum	.	.	r	I	.	.	.	r
	Ptilotrichum canescens	.	.	r	I	.	r	.	.
	Chenopodium acuminatum	.	r	.	I	.	.	.	.
	Atriplex sibirica	+	.	.	I	.	.	.	.
	Elymus chinensis	+	r	r	.	.	.	.	.
	Erodium tibetanum	I	+	r	.	.	+	I	r
	Zygophyllum kaschgaricum	+	r	.	.	.	r	.	.
	Atraphaxis frutescens	.	r	I	.	r	r	.	.
	Kochia melanoptera	I	+	.	.	.	I	+	I
	Chenopodium album	I	+	.	I	.	.	.	.
	Astragalus brevifolius	.	r	r	.	.	r	r	.
	Dontostemon crassifolius	+	+	I	.	+	I	r	r
	Artemisia caespitosa	+	I	.	.	.	+	.	.
	Allium tenuissimum	I	+	.	.	.	.	.	.
	Zygophyllum rosovii	+	I	.	.	r	+	I	II

Salsola pestifera	.	+	+	.	r	I	.	.
Anabasis aphylla	.	.	.	.	.	r	+	I
Zygophyllum xanthoxylon	.	.	.	+	.	r	.	r
Zygophyllum pterocarpum	.	.	.	.	r	.	r	r
Astragalus baytagensis	.	.	.	.	.	I	+	+

ADDITIONAL:
ad 3: *Astragalus ammodytes* (r), *Cistanche salsa* (r), *Kalidium foliatum* (r), *Euphorbia humifusa* (r), *Anabasis elatior* (r), *Plantago minuta* (r), *Senecio dubitabilis* (+), *Gypsophila dshungarica* (+), *Astragalus stenophyllus* (+), *Elymus angustus* (+)
ad 4: *Panicum sp*. (I), *Chenopodium foliosum* (I), *Kaschgaria komarovii* (I) *Dracocephalum bungeanum* (I), *Salsola collina* (I), *Orobanche cumana* (+), *Atraphaxis pungens* (I), *Astragalus rudolvii* (+), *Lepidium latifolium* (+), *Elymus paboanus* (+), *Kochia prostrata* (+), *Agropyron fragile* (+), *Artemisia frigida* (+), *Schizonepeta annua* (+), *Thymus gobicus* (+), *Geranium collinum* (+), *Galitzkya potaninii* (+), *Senecio dubitabilis* (r), *Gypsophila dshungarica* (r), *Astragalus stenophyllus* (+)
ad 5: *Rheum nanum* (r), *Cleistogenes squarrosa* (r), *Astragalus baytagensis* (r), *Cleistogenes soongarica* (r), *Saussurea pricei* (r), *Stellaria amblyosepala* (r), *Climacoptera affinis* (r), *Lappula intermedia* (r), *Astragalus stenophyllus* (r), *Elymus angustus* (+)
ad 6: *Astragalus pavlovii* (I), *Peganum nigellastrum* (I), *Allium polyrrhizum* (I)
ad 7: *Anabasis aphylla* (r), *Achnatherum splendens* (r), *Astragalus stenophyllus* (r)
ad 8: *Cleistogenes squarrosa* (r), *Peganum harmala* (r), *Lappula intermedia* (r), *Chamaerhodos sabulosa* (r), *Ajania achilleoides* (r) *Dontostemon elegans* (r), *Asparagus gobicus* (r), *Astragalus junatovii* (r), *Lagochilus illicifolius* (+), *Rheum nanum* (r)
ad 9: *Lepidium latifolium* (r), *Kochia prostrata* (r), *Anabasis elatior* (+), *Halerpestes salsuginosa* (r), *Suaeda corniculata* (+), *Kalidium cuspidatum* (r), *Kochia iranica* (+), *Kochia kryloviana* (r), *Lagochilus illicifolius* (r), *Anabasis truncata* (r)
ad 10: *Atraphaxis pungens* (r), *Kochia iranica* (r), *Kochia kryloviana* (r), *Anabasis truncata* (+), *Rheum nanum* (r)

Other typical associates include Lophanthus chinensis and Silene repens, which are also typical for juniper stands in the Gobi Altay (see Wesche et al., 2005). The vegetation structure and distribution exhibit certain similarities between both regions.

The morphological differences between Juniperus sabina and *J. pseudosabina* are not clear (K. Ronnenberg pers. comm.). The standard flora regards the number of seeds as the main differentiating characteristic (Grubov, 2001), by which method we found both species. However, the number of seeds is quite variable, and a comparison with true *Juniperus pseudosabina* from other regions of Central Asia clearly revealed that specimens from the Dzungarian Gobi belong to *J. sabina* (S. Miehe, pers. comm.).

The stands grow as large patches, which may regenerate clonally (Wesche et al., 2005). In contrast to the stands in the Gobi Altay, most patches in the Dzungarian Gobi occurred on flat or weakly inclined slopes (see Fig. 1d) that experienced only limited substrate movement and erosion along with a high accumulation of both litter and fine soil. However, in both regions juniper stands avoided the uppermost 200 metres below the summit regions - but whether this is related to strong winds remains unclear.

Stipo glareosae-Anabasietum brevifoliae (Table 3).

Desert steppes with Stipa glareosa and Anabasis brevifolia are very widespread in the Mongolian drylands including the Dzungarian Gobi (Hilbig, 1995). Many of the typical elements occur in our study area as well (e.g. *Dontostemon senilis, Ajania achilleoides, Allium mongolicum*), while regional character species include *Zygophyllum neglectum, Lappula stricta* and *Eurotia ceratoides*. We have consequently distinguished three sub-units:

3. *Stipo glareosae-Anabasietum brevifoliae, Stipa gobica* variety (Table 3).

Summer precipitation levels in our survey were comparatively high, which allowed us to distinguish between Stipa gobica and S. glareosa based on the caryopses structure, while species are otherwise similar. This yielded a reasonably clear impression of the regional distribution of both species and allowed us to devise a regional variety for Hilbig's (2000) *Stipo glareosae-Anabasietum brevifoliae*. Relatively steep slopes with strong erosion and undeveloped soils are typical for *Stipa gobica*. The sub-association contains *Ptilagrostris pelliotii* as another differential species, and a higher abundance of Eurotia ceratoides and *Ajania fruticulosa* along with a high species richness underlines the distinct character of these stands. *Caragana leucophloea* can serve as a differential species to the typical stands of the *Stipo glareosae-Anabasietum brevifoliae* without *Stipa gobica*. Some relevés resemble the *Convolvulus gortschakovii* sub-association listed by Hilbig (1995).

The stands described here neither fit into his *Convolvulus ammani* sub-association, nor into the *Reaumuria soongorica* sub-association of the *Stipo glareosae-Anabasietum brevifoliae* described by Wesche et al. (2005) for the Gobi Altay. There, *Stipa gobica* is a character species of the piedmont regions (von Wehrden *et al*., 2006a). In the Gobi Altay it is hardly found in the *Stipo glareosae-Anabasietum brevifoliae* at all (Wesche et al., 2005). We therefore suggest that our stands form a regional variety, which could be ranked as a sub-association in the future when more data becomes available.

4. *Stipo glareosae-Anabasietum brevifoliae*, typical stands (see Table 3).

On more gently inclined slopes (see Fig.1d) and pediments, *Stipa gobica* is missing and the species set shows a higher proportion of desert elements. *Sympegma regelii* exemplifies this pattern, indicating the overall higher dryness of the sites (see von Wehrden *et al*., 2006b). A higher proportion of annuals more commonly found in semi-deserts and underlines the shift in the species set. With an average of 8, the number of species is much lower than in the previous communities (see Fig. 1c). This community grows mainly on deflated pediments and more gently sloping hills; the soils are mainly composed of silt and fine sand. Deflation pavements are common and preserve the soils from wind erosion; *A. brevifolia* is a typical species of these pediments with their sealed surfaces. The community covers large areas along the slopes south of the Altay or north of the southern border mountains (see Fig. 2).

5. *Oxytropidi aciphyllae-Caraganetum leucophloae* (Table 3).

This association is found in the northern part of the Dzungarian Gobi, where sand is a common environmental feature. Although the name-giving spiny Leguminosae *Caragana leucophloae* is frequently found in other communities, it reaches its highest cover values at sites where the other diagnostic species *Corispermum mongolicum, Iris tenuifolia, Agropyron michnoi* and *Oxytropis aciphylla* are found, all of which are widely restricted to flat sand dunes. With an average of 12 (see Fig. 1c), the species richness is comparatively high, yet the overall number of species in all samples of that association is lower than in other semi-desert steppe communities, since almost all elements typical for stony or clayey sites are absent (e.g. *Stipa gobica, Orostachys spinosa, Goniolimon speciosum, Anabasis brevifolia, Halogeton glomeratus* etc.).

6. *Convolvulus gortschakovii*-community (Table 3).

This community shares its sandy habitats with the previous one. However, the set of characteristic species typical for the Caraganion is absent and stands are species-poor (see Fig. 1c). *Convolvulus gortschakovii* occurs in almost all zonal communities, and has only low diagnostic values. However, we assigned stands to Hilbig's (2000) community, whenever the name-giving spiny shrub dominates with higher cover values within the stands. More data might clarify whether or not stands should be regarded as really distinct.

7. *Reaumuria soongoricae-Nanophytetum erinacei* (Table 3).

The low dwarf-shrub Nanophyton erinaceum (Chenopodiaceae) characterises a community that is found on the deflated pediments in the forelands of the Altay main thrust (Jäger *et al*., 1985). This species is a Turanian element, which is absent from eastern and central Mongolia and thus once again underlines the distinct nature of the Dzungarian Gobi. Its occurrence in the Uvs Nuur (Hilbig, 1995, 2003) highlights the linkages between these two western Mongolian regions. On sites with a micro-mosaic of sandy spots *Convolvulus gortschakovii* might also occur, while the presence of *Anabasis brevifolia* indicates windblown habitats with a closed deflation pavement. The presence of small mammal burrows on these plots is indicated by the presence of *Convolvulus ammani*. Instead of the short-lived *Artemisia pectinata*, which is a widespread annual in the pediments of the Gobi Altay (Wesche *et al*., 2005), the perennial A. sublessingiana is found. This species again exemplifies the Middle-Asian influence.

The syntaxonomical position is again unclear. The rareness of *Reaumuria songarica* clearly indicates that these stands do not belong to the *Reaumurio songoricae-Salsolion passerinae* (Hilbig, 2000). The proposal of Hilbig (1990) to put Nanophyton stands in this syntaxonomical context is therefore not supported. Instead we have included them in the *Allion polyrrhizi*, although the name-giving onion is widely replaced by *A. mongolicum* in the Dzungarian Gobi (Friesen, 1995).

8. *Stipo glareosae-Anabasietum brevifoliae, Reaumuria songorica* sub-association (see Table 3).

At lower altitudes, the *Stipo glareosae-Anabasietum brevifoliae* forms a sub-association which is mainly characterised by the presence of *Reaumuria songarica*. These stands are common throughout

Table 4. Vegetation on saline sites (for explanation of constancy classes see table 2)

	COMMUNITY NUMBER	11	12	13	14_1	14_2	15	16
	No. of relevés	6	1	1	9	2	9	7
	DIAGNOSTIC SPECIES OF THE *TAMARIX RAMOSISSIMA* COMMUNITY							
	Tamarix ramosissima	V	1	.	.	.	.	.
	Glycyrrhiza uralensis	II	.	.	.	.	.	.
	DIAGNOSTIC SPECIES OF THE *SALIX TURRANICA* COMMUNITY							
	Salix turranica	.	1	.	.	.	.	.
	DIAGNOSTIC SPECIES OF THE POPULETUM							
	Populus diversifolia	.	.	1	.	.	.	.
	DIAGNOSTIC SPECIES OF THE *ACHNATHERUM* COMMUNITY							
	Achnatherum inebrians	.	.	.	III	.	.	.
	Achnatherum splendens	II	.	1	III	1	II	.
	Peganum nigellastrum	.	.	.	II	1	.	.
	Chenopodium album	.	.	.	III	2	.	.
	DIAGNOSTIC SPECIES OF THE NITRARIO -KALIDIETUM							
AC	*Nitraria sibirica*	III	.	.	II	.	V	.
AC	*Kalidium foliatum*	III	.	.	.	.	III	I
	Kalidium cuspidatum	I	.	.	.	.	II	.
	Halimodendron halodendron	I	.	.	.	.	II	.
AC	*Phragmites communis*	III	.	1	.	.	IV	II
	Lactuca tatarica	II	.	.	.	.	II	.
	Poa tibetica	I	.	.	.	.	.	III
	DIAGNOSTIC SPECIES OF THE BLYSMETUM RUFI							
LC	*Triglochin maritimum*	.	.	.	.	.	I	V
CC	*Glaux maritima*	.	.	.	.	.	.	IV
OC	*Halerpestes salsuginosa*	.	.	.	.	.	.	IV
CC	*Juncus gerardii*	.	.	.	I	.	.	III
	Eleocharis intermedia	.	.	.	.	.	.	IV
	Blysmus popovii	.	.	.	.	.	.	III
	INTROGRESSIVE SPECIESS OF THE ZONAL VEGETATION							
	Artemisia sublessingiana	.	.	.	II	.	.	.
	Eurotia ceratoides	.	.	.	II	.	.	.
	Artemisia macrocephala	.	.	.	II	.	.	.
	Lappula stricta	.	.	.	II	.	.	.
	Anabasis brevifolia	.	.	.	II	.	.	.
	Salsola paulsenii	I	.	1	II	1	I	.
	Bassia dasyphylla	I	.	1	III	1	II	I
	Reaumuria soongorica	III	.	.	.	.	II	.
	Haloxylon ammodendron	II	.	.	.	.	I	.
	Micropeplis arachnoidea	III	1	1	.	.	II	.
	Ceratocarpus arenarius	.	.	.	II	.	.	I
	Elymus angustus	II	.	.	I	.	I	I
	Asparagus gobicus	II	.	.	.	.	II	.
	Halogeton glomeratus	II	.	.	II	1	II	.
	Elymus chinensis	I	.	.	III	1	III	II
	Sympegma regelii	.	.	.	I	.	I	.
	Artemisia dracunculus	.	1	.	II	.	.	.
	Atraphaxis pungens	.	.	.	I	.	.	I
	Atriplex sibirica	I	.	1	II	.	.	.
	OTHER SALT-TOLERANT SPECIES							
	Saussurea salsa	.	.	.	.	.	I	III
	Potentilla dealbata	.	.	.	I	.	.	II
	Salicornia europaea	.	.	.	.	.	I	II
	Suaeda heterophylla	I	.	.	.	.	I	II
	Polygonum aviculare	.	.	.	II	.	.	.
	Kochia melanoptera	.	.	.	II	.	.	.
	Plantago minuta	.	.	.	II	.	.	.
	Chenopodium hybridum	.	.	.	II	1	.	.
	Orobanche cumana	I	.	.	.	.	II	.
	Polygonum argyroleucum	I	.	.	.	.	.	I

ADDITIONAL:

ad 11: *Apocynum hendersonii* (I), *Suaeda acuminata* (I), *Anabasis truncata* (I), *Agriophyllum pungens* (I)

ad 13: *Polygonum sibiricum* (1)

ad 14_1: *Heteropappus altaicus* (I), *Kochia iranica* (I), *Eragrostis minor* (I), *Lepidium amplexicaule* (I), *Trigonella cancellata* (I), *Allium mongolicum* (I), *Zygophyllum neglectum* (I), *Convolvulus gortschakovii* (I), *Elymus ovatus* (I), *Linum pallescens* (I), *Astragalus inopinatus* (I), *Peganum harmala* (I), *Alyssum desertorum* (I), *Clematis songarica* (I)

ad 14_2: *Urtica canescens* (I), *Lappula intermedia* (I), *Axyris hybrida* (I)

ad 15: *Elymus secalinus* (I), *Limonium suffruticosum* (I), *Scorzonera pseudodivaricata* (I)

ad 16: *Carex stenophylla* (III), *Potentilla anserina* (III), *Hordeum brevisubulatum* (III), *Puccinellia altaica* (II), *Primula longiscapa* (II), *Crepis flexuosum* (II), *Peucedanum falcatum* (I), *Blysmus rufus* (I), *Puccinellia hauptiana* (I), *Carex enervis* (I), *Puccinellia schischkinii* (I), *Gentiana decumbens* (I), *Odontites vulgaris* (I), *Scirpus hippolyti* (I), *Pedicularis flava* (I) the whole of southern Mongolian Gobi (e.g. Hilbig, 1990, 2000) and indicate higher salt content in the soil (Wesche *et al.*, 2005; von Wehrden *et al.*, 2006b). Most of the constituent species are found at similar sites all over southern Mongolia (e.g. *Ajania fruticulosa, Eurotia ceratoides*), but the eastern elements *Cleistogenes songarica* (Zemmrich, 2005) and *Salsola passerina* (which is hardly found in Middle-Asia, see a distribution map in Grubov, 2000) are absent from the Dzungarian Gobi.

Stands receive lower precipitation than all other sub-associations of the *Stipo glareosae-Anabasietum brevifoliae*, and are transitory to drier semi-desert communities (see Fig. 3b).

9. *Calligono mongolici-Haloxyletum ammodendronis: Reaumuria songarica* sub-association (see Table 3).

Haloxylon ammodendron is one of the most conspicuous species in the semi-deserts of southern Mongolia (Hilbig, 1995). Although it can grow as a tree, it normally forms corkscrew-shaped shrubs. Grazing and other forms of land use influence the growth form (Helmecke & Schamsran, 1979a), but the main determinant for the height of the stands is the availability of groundwater. The present sub-association is described from all southern Mongolia and northern Chinese semi-deserts (Helmecke & Schamsran, 1979b; Hilbig, 1990, 1995; Kürschner, 2004; Wesche *et al.*, 2005; von Wehrden *et al.*, 2006b). Contrary to Hilbig's description (Hilbig, 1990, 2000), we did not find any *Calligonum mongolicum* in these *Saxaul* stands. *Nitraria sphaerocarpa* which characterises a distinct sub-association as found by Wesche *et al*. (2005) and von Wehrden *et al*. (2006b) is also absent. Instead, *Reaumuria songarica* was found on almost all plots, indicating the high salt content of the soils (von Wehrden *et al*., 2006b). The constant presence of the annual *Micropeplis arachnoidea* indicates the comparatively high level of rainfall throughout the year of our survey; this species may be far less common in years of average precipitation. However, the mean species richness seems to be higher than in stands described from the more eastern and southern Mongolian regions (see Fig. 1) by von Wehrden *et al*. (2006b) and Wesche *et al*. (2005).

10. *Calligono mongolici-Haloxyletum ammodendronis, Salsola arbuscula* variety (see Table 3).

At slightly higher altitudes than the previous stands, a variety characterised by the shrubby Salsola arbuscula is found. As with altitude, average precipitation is slightly higher when compared to other *H. ammodendron* stands (see Fig. 1b). The community is found on deflated pediments. The occurrence of *Anabasis brevifolia, Zygophyllum neglectum* and *Eurotia ceratoides* shows the relationships to other vegetation types typical of deflated pediments. The characteristic species S. arbuscula was also described from stands of the *Calligono mongolici-Haloxyletum ammodendronis* in the Gobi Gurvan Saykhan (Wesche *et al*., 2005). The species is widely absent in other drier areas of the Gobi, e.g. the Trans-Altay (von Wehrden *et al*., 2006b) and the Alashan Gobi (unpublished data by the author; Kürschner, 2004), but we have refrained from describing a new sub-association until more relevés become available.

11. *Tamarix ramosissima*-community (Table 4).

Tamarix ramosissima forms characteristic stands in Central Asian oases. Stands often grow on sandy soils, and the shrubs sometimes trap fine material and form dunes. All associated species have high salt tolerance; and most companions are also found in other associations typical for extrazonal sites such as the *Phragmitetum communis* and the *Nitrario sibiricae-Kalidietum gracilis*. This renders a placement of Tamarix stands in the syntaxomonical system difficult, although similar stands occur in the Gobi Altay region (Wesche *et al*., 2005), in the Alashan Gobi (Kürschner, 2004) and in the Trans-Altay Gobi (von Wehrden *et al*., 2006b). Hilbig (2000) assigned it to a separate community, but one which lacks characterising species other than the (various) *Tamarix* species themselves.

12. *Salix turranica*-community (Table 4).

One willow stand on a large fan south of the Altay just outside the protected area exemplifies how strong these episodic stands are flooded in wet years and thus support these luxurious stands. The plants grew up to three metres high, and were heavily grazed; the high abundance of ticks hints at the high livestock density in winter. Hilbig (1990) likewise describes these stands from the Dzungarian Gobi.

13. *Populetum euphraticae* (Table 4).

Populus diversifolia (= *P. euphratica*) is the characteristic riparian tree in Middle and Central

Asia (Hilbig, 1990). It is found in the western parts of the Mongolian Gobi (Wesche *et al*., 2005; von Wehrden *et al*., 2006b) and reaches its easternmost distributional limit in the Mongolian part of the Alashan Gobi (von Wehrden, pers. obs. 2005). Its eastern distribution limit is a rather gradual border, which is nowadays blurred due to plantations in the Alashan Gobi. The poplar is also found in the Chinese part of central Asia, but stands are threatened by increasing human land use (Bruelheide *et al*., 2003; Kürschner, 2004). In our working area only one stand was found; it comprised dozens of trees growing along a temporary river in an oasis at the north-western border of the Great Gobi B SPA.

14.1. *Achnatherum*-communities (Table 4).

On disturbed and grazed sites, *Achnaterum inebrians* forms typical stands found in other Gobi regions as well. It forms characteristic stands in northern and central Mongolia (Hilbig, 1995), is only found on mountain sites and pediments within the Gobi Altay (Wesche *et al*., 2005); within the Dzungarian Gobi it seems to follow a comparable ecological pattern (see the two outliers in Fig. 1a).

At lower elevations it is widely replaced by *Achnatherum splendens*, which is abundant in other Mongolian regions as well (Kürschner, 2004; von Wehrden *et al*., 2006b; Wesche *et al*., 2005).

14.2. *Chenopodio prostrati-Lepidietum densiflori* (Table 4).

In the northern part of the Great Gobi B SPA, several wintering sites were found which had been abandoned. However, the vegetation of these sites still indicates the former high levels of disturbance and nutrient input. The cover of herbaceous plants is comparatively high. *Chenopodium album* characterises these stands, with other disturbance-indicators being present such as *Peganum nigellastrum, P. harmala, Atriplex sibirica* and *Chenopodium hybridum*. Stands belong to the *Chenopodio prostrati-Lepidietum densiflori* designated by Hilbig (1990).

15. *Nitrario sibiricae-Kalidietum gracilis* (Table 4).

This community is a typical feature of oases and saline pans in the Mongolian Gobi. Stands often grow along the outer belts of oases, where almost all species have to tolerate high salt contents in the soils (Wesche *et al*., 2005; von Wehrden *et al*., 2006b). *Nitraria sibirica* plants trap fine soil material and form characteristic dunes, even on clayey soils. *Lactuca tatarica* accompanies these stands. The overall species richness is low with a median around seven (see Fig. 3c). The high presence of *Phragmites australis* is not concordant with descriptions from Hilbig (2000). Extensive reed beds dominated by *P. australis* were hardly found in the study area; there is only one large oasis which contains extensive reed stands in the northwest of the area. Comparable stands were mentioned from the Gobi Altay region (*Phragmitetum australis*, Wesche *et al*., 2005) and the Trans-Altay (von Wehrden *et al*., 2006b).

Included in this community are several stands containing *Halimodendron halodendron*. This characteristic Fabaceae shrub reaches its easternmost distribution limit in the Trans-Altay Gobi (von Wehrden *et al*., 2006b). However, its syntaxomonical status is undefinable. Based on our data, however, we would include stands here; which is contrary to Hilbig (2000), who classified stands of *Halimodendron halodendron* as an unranked community. Until more data become available, the syntaxonomic status remains unclear.

16. *Blysmetum rufi*-community (Table 4).

In the centre of oases, sites gain permanent water surplus and support dense green meadows. The high salinisation is also reflected in the species composition; almost all species are halophytes. The composition of the vegetation varies across fine mosaics defined by the microcrelief of the sites; but the general species composition is remarkably constant over the whole southern Mongolian Gobi (Hilbig, 1990, 2000; Wesche *et al*., 2005; von Wehrden *et al*., 2006b). Many elements are widely distributed in the Holarctic region, e.g. *Triglochin maritimum, Triglochin palustre, Glaux maritimum* and *Potentilla anserina* (Meusel & Jäger, 1992)

Seven sites with saline meadows were found in the Dzungarian Gobi; they are mainly restricted to the depressions where the rivers originating from the Altay disappear. Thus, we did not distinguish among the several associations described in the literature (Hilbig 2000) and included all relevés into the Blysmetum rufi.

Nature conservation in the Dzungarian Gobi.

The Great Gobi B SPA was established in 1975. At a size of approximately 9,000 km^2 it is very large; though some animals have even larger annual home ranges and are capable of long-distance movements (Kaczensky *et al*., 2007). These include the large steppe herbivores; the Khulan, and the Black-tailed gazelle (*Gazella subgutturosa*). However, the park is apparently large enough to support several herds of the reintroduced Przewalski horses (Kaczensky *et al*., 2007). Many small mammal species are found as well, including the endangered Allactaga bullata (Kaczensky *et al*., 2002). Endangered carnivores are the Corsac Fox and the Snow Leopard. Some 130 bird species also are found in the park.

Poaching endangers a number of species in the southern Mongolian Gobi (Zevegmid & Dawaa, 1973; Reading *et al*., 1999; Schaller, 2000, Wingard & Zahler 2006). Protected areas are therefore a precondition for preservation of the remaining populations, but the respective administrations presently suffer from a lack of funding, personnel and equipment, and are thus often unable to enforce the law. Although conservation efforts are substantial in the region (see http://www.takhi.org), thorough monitoring of such a spatially extensive ecosystem will always be difficult.

The composition of the vegetation of southern Mongolia indicates a long grazing history (Fernandez-Gimenez, 1999). The number of families using the park has remained fairly stable since the 1970s. At present about 100 families with 60,000 livestock use the park, predominantly in the winter (Kaczensky *et al*., 2007).

The Dzungarian Gobi undoubtedly hosts a high biodiversity, regarding both flora and fauna, compared to other regions in Central Asia. This is related to the sheltering topography, but also to the closeness to the boundary of China; the border region is normally prohibited to civilians, but military personnel are known to graze livestock there and poach unobserved. Nevertheless, within a Central Asian context the region represents one of the best protected areas.

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References

Anonymous. 1990. Atlas of Mongolia. Ulaanbaa tar.

Bedunah D. & Schmidt S.M. 2000. Rangelands of Gobi Gurvan Saikhan National Conservation Park, Mongolia. Rangelands 22: 18-24.

Bruelheide H., Jandt U., Gries D., Thomas F. M., Foetzki A., Buerkert A., Gang W., Ximing, Z. & Runge, M. 2003. Vegetation changes in a river oasis on the southern rim of the Taklamakan Desert in China between 1956 and 2000. Phytocoenologia 33: 801-818.

Dierschke H. 1994. Pflanzensoziologie: Grundlagen und Methoden. Ulmer, Stuttgart.

Fernandez-Gimenez M.E. 1999. Sustaining the steppes: a geographical history of pastoral land use in Mongolia. Geogr. Rev. 89: 315-342.

Fernandez-Gimenez M.E. & Allen-Diaz B. 1999. Testing a non-equilibrium model of rangeland vegetation dynamics in Mongolia. J. Appl. Ecol. 36: 871-885.

Friesen N. 1995. The genus Allium L. in the flora of Mongolia. Feddes Repertorium 106: 59-81.

Grubov V.I. 2000. Plants of Central Asia Vol. 2. Chenopodiaceae. Science Publishers Inc., Enfield.

Grubov V.I. 2001. Key to the vascular plants of Mongolia. Volume I & II. Science Publishers Envield, Plymouth.

Gubanov I.A. 1996. Konspekt flory vneskney Mongolii (sosudistye rasteniya). Moskva.

Gunin P.D. & Vostokova E.A. 1995. Ecosystems of Mongolia. Moscow.

Hanelt P. & Davažamc S. 1965. Beitrag zur Kenntnis der Flora der Mongolischen Volksrepublik, insbesondere des Gobi-Altai, des Transaltai- und Alašan-Gobi-Bezirks. *Feddes Repertorium* 70: 7-68.

Helmecke K. & Schamsran Z. 1979a. Ergebnisse ökologischer Untersuchungen in der Gobi der Mongolischen Volksrepublik. 1. Untersuchungsgebiet, Vegetationseinheiten und Ergebnisse der mikroklimatischen Untersuchungen. *Archiv für Naturschutz und Landschaftsforschung* 19: 1-22.

Helmecke K. & Schamsran Z. 1979b. Ergebnisse ökologischer Untersuchungen in der Gobi der Mongolischen Volksrepublik. 2. Untersuchungen über die osmotischen Verhältnisse ausgewählter Pflanzenarten. *Archiv für Naturschutz und Landschaftsforschung* 19: 81-95.

Hijmans R.J., Cameron S.E., Parra J.L., Jones P.G. & Jarvis A. 2005. Very high resolution interpolated climate surfaces for global land areas. *Int. J. Climatol*. 25: 1965-1978.

Hilbig W. 1990. Pflanzengesellschaften der Mongolei. *Erforschung Biologischer Ressourcen der Mongolischen Volksrepublik* 8: 5-146.

Hilbig W. 1995. The vegetation of Mongolia. *SBC Academic Publishing,* Amsterdam.

Hilbig W. 2000. Kommentierte Übersicht über die Pflanzengesellschaften und ihre höheren Syntaxa in der Mongolei. *Feddes Repertorium* 111: 75-120.

Hilbig W. 2003. The distribution of the vegetation in the Uvs-nuur basin and its surrounding mountain ranges. *Feddes Repertorium* 114: 540-558.

Jäger E.J., Hanelt P. & Davažamc C. 1985. Zur Flora der Dsungarischen Gobi (Mongolische Volksrepublik). *Flora* 177: 45-89.

Kaczensky P., Walzer C. & Steinhauer-Burkart B. 2002. Great Gobi B Strictly Protected Area - a wild horse refuge. Ulanbaatar.

Kaczensky P., Enkhsaihan N., Ganbaatar O. & Walzer C. 2007. Identification of herder-wild equid conflicts in the Great Gobi B Strictly Protected Area in SW Mongolia. *Exploration into the Biological Resources of Mongolia* 10.

Kaczensky P., Walzer C. & Ganbaatar O. submitted. Niche separation of the two native Asian equids: the Przewalski's horse and the Asiatic wild ass in the Gobi areas of SW Mongolia.

Kürschner H. 2004. Phytosociological studies in the Alashan Gobi - a contribution to the flora and vegetation of Inner Mongolia (NW China). *Phytocoenologia* 34: 169-224.

Lavrenko E.M. & Karamysheva Z.V. 1993. Steppes of the former Soviet Union and Mongolia. In: Coupland R. T. (ed.): *Natural Grasslands. Ecosystems of the world 8b*. Amsterdam, London, New York, Tokyo.

Meusel H. & Jäger E. 1992. Vergleichende Chorologie der zentraleuropäischen Flora. Bd. III Text und Kartenband. *Gustav Fischer Verlag*, Jena, Stuttgart.

Meusel H., Jäger E. & Weinert E. 1965. Vergleichende Chorologie der zentraleuropäischen Flora. Teil 1. Text und Kartenband. *Gustav Fischer Verlag*, Jena.

Mueller-Dombois D. & Ellenberg H. 1974. Aims and methods of vegetation ecology. New York, London, Sydney, Toronto.

Reading R.P., Amgalanbaatar S. & Lhagvasuren L. 1999. Biological Assessment of Three Beauties of the Gobi National Conservation Park, Mongolia. *Biodivers. Conserv*. 8: 1115-1137.

Schaller G. B. 2000: Wildlife of the Tibetan Steppe. *University of Chicago Press*, Chicago.

Tichý L. 2002. JUICE, software for vegetation classification. *J. Veg. Sci.* 13: 451-453.

von Wehrden H. 2005. Vegetation mapping in the Gobi Gurvan Saikhan national park and the Great Gobi B special protected area - a comparison of first results. *Exploration into the Biological Resources of Mongolia* 9: 225-236.

von Wehrden H., Wesche K., Reudenbach C. & Miehe G. 2006a. Mapping of large-scale vegetation pattern in southern Mongolian semi-deserts - an application of LANDSAT 7 data. *Erdkunde* 60:261-272.

von Wehrden H., Hilbig W. & Wesche K. 2006b. Plant communities of the Mongolian Transaltay. *Feddes Repertorium* 7-8: 526-570.

von Wehrden H. & Wesche K. 2007. Conservation of Equus hemionus in southern Mongolia: a GIS approach. *Exploration into the Biological Resources of Mongolia* 10.

Wesche K., Miehe S. & Miehe G. 2005. Plant communities of the Gobi Gurvan Sayhan National Park (South Gobi Aymak, Mongolia). *Candollea* 60: 149-205.

Wingard J.R. & Zahler P. 2006. Silent Steppe: The Illegal Wildlife Trade Crisis in Mongolia. Mongolia Discussion Papers, East Asia and Pacific Environment and Social Development Department. Washington, D.C.: World Bank. [Available at: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/MONGOLIAEXTN/ K:21021328~pagePK:141

137~piPK:141127~theSitePK:327708,00.html; last accessed September 2006]

Yunatov A.A. 1954. Kormovye rasteniya pastbishch i senokosov Mongolskoy Narodnoy Respubliki. Moskva-Leningrad.

Zemmrich A. 2005. Die Steppengliederung der Mongolei aus Sicht der russischen und mongolischen Geobotanik. *Archiv für Naturschutz und Landschaftsforschung* 44: 17-35.

Zevegmid D. & Dawaa N. 1973. Die seltenen Großsäuger der Mongolischen Volksrepublik und ihr Schutz. *Archiv für Naturschutz und Landschaftsforschung* 2: 87-106.

Хураангуй

Энэхүү өгүүлэлд Их говийн дархан цаазат газрын Б хэсгийн ургамлын бүлгэмлийн бүтцийн судалгааны дүнг нэгтгэн оруулав. Судалгаанд хамрагдсан бүс нутаг нь Монгол орны тусгай хамгаалалттай газрын баруун өмнөд хэсэгт байрлах бөгөөд Олон Улсын Байгаль Хамгаалах Холбооноос эрхлэн гаргадаг Улаан Жагсаалтанд бүртгэгдсэн хэд хэдэн зүйлийг өөртөө агуулдаг. Иймд тус бүс нутаг нь зөвхөн тус орны төдийгүй Төв Азийн эко бүс нутгийн хувьд ихээхэн ач холбогдолтой юм. Тус бүс нутгийн амьдрах орчны талаархи мэдээ мэдээлэл байгаль хамгааллын үйл ажиллагаанд шаардагдах хэмжээнд хүртэл хараахан бүрдээгүй байгаа билээ. Бид 2003 оны зун хийсэн ургамалжилтын судалгааны явцад цуглуулсан 211 дээж материал дээр үндэслэн тус бүс нутагт 16 ургамалжилтын нэгж бүлгэмдлийг ялган тодорхойлов. Үүнд: уулын ургамалжилтын 2 бүлгэмдэл, заримдаг цөлийн 8 бүлгэмдэл, бүсийн бус шинжтэй 6 бүлгэмдэл орж байгаа бөгөөд тэдгээрийг говийн бусад бүс нутгийн ургамалжилтын бүлгэмдэлтэй харьцуулав.

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Appendix: syntaxonomical overview

C *Achnatheretea splendentis* (Mirkin in Kasapov *et al*. 1987) Mirkin *et al*. 1988
O *Achnatheretalia splendentis* (Mirkin in Kasapov *et al*. 1987) Mirkin *et al*. 1988
L *Achnatherion splendentis* Mirkin *et al*. ex Hilbig 2000
Achnatherum inebrians community (including stands with *A. splendens)*
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 Blysmetum rufi Du Rietz 1925
C *Agropyretea cristati* Hilbig et Koroljuk 2000
O *Stipetalia krylovii* Kononov, Gogoleva et Mironova 1985
L *Stipion krylovii* Kononov, Gogoleva et Mironova 1985
A Hedysaro pumili-Stipetum krylovii Hilbig (1987) 1990 corr. 1995
Stellaria petraea subassociation Hilbig 1990
Festuca valesiaca variety
C *Stipetea glareosae*-gobicae Hilbig 2000
O *Allietalia polyrrhizi* Hilbig 2000
L *Allion polyrrhizi* Hilbig 2000
?A *Reaumuria soongoricae-Nanophytetum erinacei* Hilbig (1987) 1990
A *Stipo glareosae-Anabasietum brevifoliae* Hilbig (1987) 1990
typical sub-association
Stipa gobica-regional variety
Reaumuria soongorica subassociation
O *Reaumurio soongoricae-Salsoletalia passerinae* (Mirkin in Kasapov *et al*. 1988) Mirkin *et al*. 1988 em. Hilbig 2000
L *Reaumurio soongoricae-Salsolion passerinae* (Kasapov *et al*. 1988) Mirkin *et al*. 1988 em. Hilbig 2000
A *Nitrario sibiricae-Kalidietum gracilis* Hilbig 2000
O *Zygophyllo xanthoxyli-Brachanthemetalia gobici* (Mirkin in Kasapov *et al*. 1988) Mirkin *et al*. 1988
L *Zygophyllo xanthoxyli-Brachanthemion gobici* (Mirkin in Kasapov *et al*. 1988) Mirkin *et al*. 1988
A *Calligono mongolici-Haloxyletum ammodendronis* Hilbig (1987) 1990
typical subassociation
Salsola arbuscula variety
L *Caraganion leucophloeae* Hilbig 2000
A *Artemisio xerophyticae-Caraganetum leucophloeae* Hilbig (1987) 1990
Caragana leucophloea-regional variety
A *Amygdalo pedunculatae-Caraganetum leucophloeae* Hilbig (1987) 1990
Convolvulus gortschakovii community (Hilbig 2000)
C ? *Populetea euphraticae* Zohary 1962
Populus diversifolia community (position unclear)
K *Juniperetea pseudosabinae* Mirkin *et al*. 1986
O *Juniperetalia pseudosabinae* Mirkin *et al*. 1986
L *Juniperion pseudosabinae* Mirkin *et al*. 1986
Juniperus sabina community
typical subcommunity
C ?*Salicetea purpureae* Moor 1958
O *Salicetalia miyabeanae* Hilbig 2000
L *Salicion viminalis* Hilbig 2000
Tamarix ramosissima community (position unclear, see Hilbig 2000)
Salix turranica community (position unclear)