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Main Habitats and Floristic Diversity in the Tarvagatai Nuruu National Park – General View

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Abstract

This research was conducted as part of an overall assessment of biological diversity of the Tarvagatai Nuruu National Park in summer 2007. One objective of our research was to assess main habitats, floristic diversity and specific floristic conservation value of the area within the Mongolian network of protected areas. A total of 335 vascular plant species were recorded in the study area, also the main habitats and their species richness were characterized. The observed floristic characteristics, reasons for the observed relatively high species richness in the area as well as the combination of the flora from Tarvagatai mountain range on basis of eco-geographical elements and the conservation value of this area are discussed in this paper.

Key words: Tarvagatai Nuruu National Park, flora, vascular plant species, conservation value

Introduction

Mongolia is considered as a nation with a long history and tradition to conserve nature and a nation that established the first protected area in the world some 230 years ago. As of 2007, Mongolia has 60 protected areas under different conservation regimes (Myagmarsuren & Batsukh, 2007).

Tarvagatai Nuruu National Park is one of the latest established protected areas in Mongolia and the unique pattern of nature and landscape of the mountain range allowed its conservation status to become a national park, one of four classes of state protected areas in the country. In 2000, 525,440 hectare area of Tarvagatai mountain range was taken under state protection by the Resolution No. 29 of the Ikh Khural (Parliament of Mongolia). As a whole, this national park is located in Tsakhir soum of Arkhangai Aimag and Aldarkhaan, Ider, Tosontsengel and Ikh-Uul sums (districts) of Zavkhan Aimag (province), in the west-central Mongolia (Fig. 1).

Tarvagatai mountain range branches off perpendicularly from central part of Khangai mountain range and it is a home to many rare and very rare species of plants and wildlife. There are many sources of mineral waters and springs, which are mainly hot and flow almost parallel to one another along tectonic faults of northern slope of the range. The area is part of the watershed region of the Selenge, the biggest river in Mongolia and the largest inlet into the Lake Baikal, the deepest ancient tectonic lake in the world. It is also a composition of historical, cultural and natural heritages, and is increasingly becoming a tourist destination. Since ancient time, there has been a historical tradition to worship parts of this area (Oyungerel, 2004). However, adverse human activities such as logging and fire unintentionally set by people, and their worst impacts have been increasing in the area.

Goals to establish a protected area or nature reserve are usually threefold: a protection of particular species of interest such as endangered or endemic species, preservation of entire functioning community (this has become an increasingly attractive goal as science of ecology matures) and finally, preservation of biological diversity or the maximum number of species (Soule & Simberloff, 1986). Although the establishment of the Tarvagatai Nuruu National Park arguably appears to conform to these goals, there has not been any detailed inventory of biodiversity for the national park area before and after it was established. Therefore, the Khangai Component of the GTZ "Conservation and Sustainable Management of Natural Resources" Program

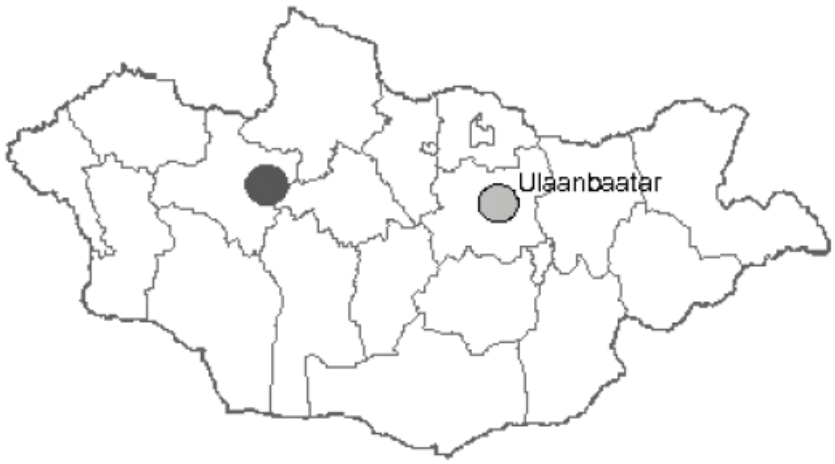

Figure 1. Tarvagatai Nuruu National Park is located in Tsakhir soum of Arkhangai Aimag and Aldarkhaan, Ider, Tososntsengel and Ikh-Uul soums of Zavkhan Aimag, in west-central Mongolia.

(CSMNR) organized a team of biologists from the National University of Mongolia (NUM) to perform a preliminary assessment of biological diversity of the national park. Our research area was a representative part of the national park in Ider soum, Zavkhan aimag. The comprehensive field research focused on different groups of vertebrates and invertebrates, vascular plants, habitats and their structure, forests, soil types and more. One objective of this research was to assess the main habitats, floristic diversity and specific floristic conservation value of the area within the Mongolian network of protected areas. After a short view in Ariuntsetseg *et al.* 2008 some results of this research are presented in this paper, for the complete results see (Bayartogtokh *et al.*, 2007).

Biogeography significance and landscape pattern of Tarvagatai Mountain Range

Tarvagatai mountain range belongs to the Mongolian Province, Iran-Turanian Region, Tethyan (Ancient Mediterranean) subkingdom, Holarctic kingdom according to the phytogeographical classification of the world developed by Takhtajan (1978). Yunatov (1946) divided Mongolia into the three regions, six provinces and 23 subprovinces. According to this phytogeographical classification, Tarvagatai mountain range is included in the Northern Khangai mountain-forest steppe subprovince of Khangai mountain-forest steppe province, Euro-Asian steppe region (Bumjaa, 2002).

The most specific characteristic of this subregion is that the last glaciation affected most places of this area and its traces, such as glacial lakes are very common in the region. For this reason, the subregion is considered as a "Pleistocene Park" where flora before and after glaciation can be observed (Olziikhutag, 1985; Cox & Moore, 2005). Therefore, the mountain range is a refuge for glaciation relicts (climatic relicts).

The flora of Khangai region is comprised of elements from many other phytogeographical regions because it is located in the intersection of arid steppe of Central Asia, the boreal ecosystem of Northern Asia and the high mountain ecosystem of Southern Siberia, and the elements of Altay-Sayan are distributed in summits of high mountains of Mt. Khangai. Moreover, some "descendents" of Himalaya grow in high elevated parts of mountain range (Olziikhutag, 1985). Such a borderline situation makes the mountain range a unique place for flora.

Flora, vegetation and soil of steppe zone and some ecological aspects of Khangai region were studied by Bannikova *et al*. (1986), who recorded 860 species of vascular plants in this region, but the endemic species are very few in the flora, about less than 2% (22 true endemic and sub-endemic species) of the flora is constituted by endemic species (Bannikova *et al.*, 1986; Bumjaa, 2002).

The summits of the Tarvagatai mountain range reach 3100-3200 m a.s.l. in the surroundings of our research area. Most ridge tops of the mountains are flat and valley between mountains is relatively wide. The valleys in our research area have a steep south-facing slope and a more gradual north-facing slope. North-facing slopes

and parts of south-facing slope at the elevation about 2200 to 2600 m a.s.l are forested, and alpine tundra occurs above nearly 2600 m a.s.l. Most of the south-facing slopes are steppe, dominated by grasses and sedges and often contain more moisture in lower parts near the valley bottom. Large boulders spread out in parts of the south-facing slopes. South- and north-facing slopes are very distinct because of significant effects of sun radiation, evaporation and predominant wind direction.

Valley terraces below ~2200 m a.s.l, formed from moraines during ice age, are open grasslands, dominated by grasses, sedges, forbs and shrubs. Small depressions, mounds and groups of small lakes formed by activities of glaciations and volcanoes are abundant in this mountain range. These elevations of the landscape patterns are very similar with the altitudinal distribution of vegetation of the Khangai mountain range described by Hilbig (1995) and the high heterogeneity of landscape renders a high diversity of habitats.

A remarkable change in vegetation of the mountain range occurred in 2002 due to a wildfire with high intensity. Nearly 80,000 hectares of the forests within the national park composed almost exclusively of larch trees (*Larix sibirica* Ldb.), some mixed of Siberian pine (*Pinus sibirica* Du Tour) were burned by the fire along with large areas of mountain steppe. Only very small island-like patches of forest were not affected by the fire in our research area. Moreover, most of the dry steppe on south-facing slopes was affected by the fire, which induced remarkable changes in the vegetation. Non-carbonated, sandier textured alpine soil type is dominated in research area and its various types are found in different landscape positions of the mountain range (Dorjgotov, 1976; Bayartogtokh *et al.*, 2007).

Materials and Methods

Field surveys and collection of materials were implemented in late July 2007 for two weeks. At first the main habitats were determined and chosen within the research area. To characterize the floristic diversity and the absolute species richness of the main habitats, we compiled a comprehensive species list and the frequency of the species for each habitat during field research.

Research activities took place near Alag Khad of upper Yamaat River in Ider Soum, Zavkhan Aimag. This area was predetermined as suitable study sites by CSMNR specialists and is situated in the special (core) zone of the national park. There are no settlements or lands used for pasture. During the field research, our team analyzed an area of approximately 40 sq km which is elevated between nearly 2100 and 2964 m a.s.l. (Table 1).

Identification keys to Mongolian flora were used to identify plants to the species level and to gather information of the species range (Grubov, 1982; Gubanov, 1996), with the nomenclature following Grubov (1982). The species identification was done in the field directly or in some cases in the Plant Taxonomy Laboratory of

Table 1. Locations of some study habitat types.

#	Landscape positions	Coordinates	Elevation
1	Alpine tundra (Songinot Ereg and Zost Shombon)	N 48^{0}06’ 23.0” E 098^{0}00’15.2”	2964m
		N 48^{0}05’37.9” E 097^{0}57’57.5”	2552m
2	Stream meadow (Yamaat river)	N 48^{0}07’56.5” E 097^{0}58’17.9”	2098m
3	Unburned larch forest (Khavkhaast)	N 48^{0}05’46.7” E 098^{0}01’50.3”	2183m
4	Burned larch forest (Khavkhaast)	N 48^{0}06’16.3” E 098^{0}00’04.0”	2192m
5	Unburned steppe	N 48^{0}08’08.4” E 097^{0}58’22.7”	2104m
6	Burned steppe (Saihan Denj)	N 48^{0}07’19.4” E 097^{0}58’51.0”	2135m
7	Rocky area (Lower part of Songinot Ereg)	N 48°07’33.1” E 097°59’13.6”	2204m

NUM after collecting for herbarium. Information for useful, medicinal, endemic species, as well as for the status recorded in the Red Data Book of Mongolia on individual species was obtained from available literature on Mongolian vegetation (Olziikhutag, 1985; Hilbig, 1995; Shiirevdamba, 1997; Bumjaa, 2002; Batkhuu *et al.*, 2003, 2005; Jigjidsuren & Johnson, 2003). Consequently, one of results of the field survey was a species list, differentiated by the main habitats and basis for further evaluations (for the complete species list recorded see the appendix in Bayartogtokh *et al.*, 2007, and it can also be made available by the authors upon request). It was possible to describe the habitats by typical species and to characterize their species richness.

Moreover, this list and some other data about the research area were the basis to compute the plant species richness of Tarvagatai Nuruu. Different formulae developed for this purpose by Arrhenius (1921) and Evans *et al*. (1955) were used.

In recent time the plant-geographical position of different Mongolian landscapes were described on the basis of floristic field surveys and the distribution-types of the plant species by some authors, e.g. Hilbig *et al*. (2004) for Mt. Bogd Khan and for the Mt. Western Khentei Dulamsuren (2004). Similarly, on the basis of the species list from Tarvagatai Nuruu it was possible to give a statement for the plant-geographical position of this area. For this we considered the eco-geographically defined distribution-types used also by Hilbig *et al*. (2004) and Dulamsuren (2004).

Results

Main habitats

In relation with the above-mentioned landscape patterns the following ten representative main habitats were chosen and their corresponding vegetation structure in the research area is characterized as described hereunder.

1. Unburned south-facing steppe: In this habitat grasses, such as *Helictotrichon* spp., *Schellianum* spp., *Festuca lenensis* and *Elymus chinensis*, and sedges as *Carex pediformis* are dominants and forbs are co-dominants. Canopy cover of green plants is about 70% with no bare ground. Spaces among plants are covered by litter.

2. Unburned larch forest: Forbs, *Aconitum septentrionale*, *Aquilegia sibirica*, *Cerastium pauciflorum*, *Doronicum turkestanicum*, *Hedysarum inundatum*, *Lilium martagon*, *Paeonia anomala*, *Polemonium racemosum*, and *Senecio nemorensis* are dominants in the under-story of larch forest. Moreover, shrubs such as *Spiraea alpina*, *Betula rotundifolia* occur here abundantly. Canopy cover of the community is about 60-70% and others are covered by moss.

3. Lake shore: There are five small lakes in the upper part of the Valley of Yamaat River within our research area. Along the shore of the lakes *Polygonum amphibum* grows abundantly. A large number of herbaceous plant species are found in this habitat because the small lakes are separated and distinct from each other in different abiotic factors, e.g. nutrients, depth, clearness, water-level fluctuation during the vegetation period and morphology of their shores.

4. Alpine tundra: Above nearly 2800 m a.s.l., a complex of alpine tundra vegetation and boulder fields is distributed, included are also small swamps and mossy bogs. Some characteristic elements of the flora in this elevation are *Kobresia Bellardii*, *Dryas punctata*, *Lagotis integrifolia* and *Salix berberifolia*.

5. Stream meadow (valley bottom): The stream meadows are dominated by sedge, e.g. *Carex melanantha*, *C. melananthiformis* and *C. stenocarpa*, which are characteristic for peat meadow influenced by permafrost and forbs. Also *Dasiphora fruticosa* and *Salix* spp. are common along river banks. The canopy cover in this habitat is high, about 90-95%. Also another specific feature of the community is moss cover with *Sphagnum* spp. and *Aulacomnium palustre*.

6. Burned south-facing steppe: Dominants of this habitat are forbs such as *Draba nemorosa*, *D. hirta*, *Bupleurum scorzonerifolium*, and *Chamaenerion angustifolium*, which are considered as weed species. Canopy cover of this habitat is about 10-15%, but plant height is often considerably high. There are also relatively big burned clumps and bunches of wormwoods and grasses as well as big gaps with 5-6 m radius, filled by moss-covered ash.

7. Burned larch forest: The dominant species of this community is *Chamaenerion angustifolium*. Fallen wood, old roots and stones are important structures and protection for the young trees, growing after fire, but the seed bank of the forests is very low and conditions required for

seed germination and seedling survival are not favorable in most places. Therefore, the estimated natural regeneration is occurring slowly in many places.

8. Rocky area: Shrubby community dominated by *Ribes altissimum*, *R. nigrum*, *Lonicera altaica*, *L. hispida*, *Berberis sibirica*, *Betula microphylla* and *B. rotundifolia* occurred in steep, rocky areas. Fruits of the most shrubs are used for supplemental food for local people.

9. Alpine meadow (upper part of valley): *Carex pediformis* (sedge) and grasses, e.g. *Alopecurus arundinaceus*, *Elymus chinensis* and *Poa angustifolia* are distributed commonly here. Also forbs, *Achillea asiatica*, *Chamaenerion angustifolium*, *Delphinium cheilanthum*, *Euphorbia discolor*, *Lappula myosotis* and *Hesperis sibirica* are abundant. As for shrubs, *Dasiphora fruiticosa*, *Betula rotundifolia*, *B. fusca* and *Cotoneaster uniflora* occur along little streams.

10. Freshwater habitats: Different plant communities are developed in the lakes and ponds, depending on water depth, nutrition and morphometry. The dominant genus is *Potamogeton* with different species, such as *P. perfoliatus*, *P. vaginatus* and *P. praelongus*. In deep, clear water *Characeae* species are found to be growing.

Floristic diversity

Species number (absolute). A total of 335 vascular plant species belonging to 170 genera, 55 families, 7 classes and 3 phyla were recorded in the study area during the field research (Table 2). The following ten families are richest in genera, and they constitute 58% (96 genera) of all the recorded genera during our research. Species of these families also make up 48% (194 species) of all species recorded. With more than 30 species, the families of Gramineae Juss., Compositae Giseke, Ranunculaceae Juss., Rosaceae Juss., Cruciferae Juss, Caryophyllaceae Juss., Leguminosae Juss., Scrophulariaceae Juss., Polygonaceae Juss. and Umbelliferae Juss. are most species-rich.

Species richness and species spectrum of the different habitats.

The highest species number was found in the unburned steppe and forest areas. In each of these habitats at least 100 species were found (Fig. 2). In the steppe and forests, the wildfire occurred in 2002 decreased the species number dramatically. Compared with the unburned habitats, species number of burned steppe and forest reaches values only between 33 and 50%, also the species spectrum changed almost completely. In burned areas the present dominant species are annuals and perennials with typical *r*-strategies whereas *Chamaenerion angustifolium* (L.) Scop., which is the main dominant species of the first stage of forest succession induced by fire, dominates in burned forests. Also codominants of the burned forest are often steppe species, while typical forest species have nearly disappeared. The occurrence of steppe species in the burned forests is also expression of changed micro- and mesoclimatic conditions after the fire. Due to the burned seed bank, the regeneration of the forest vegetation will likely

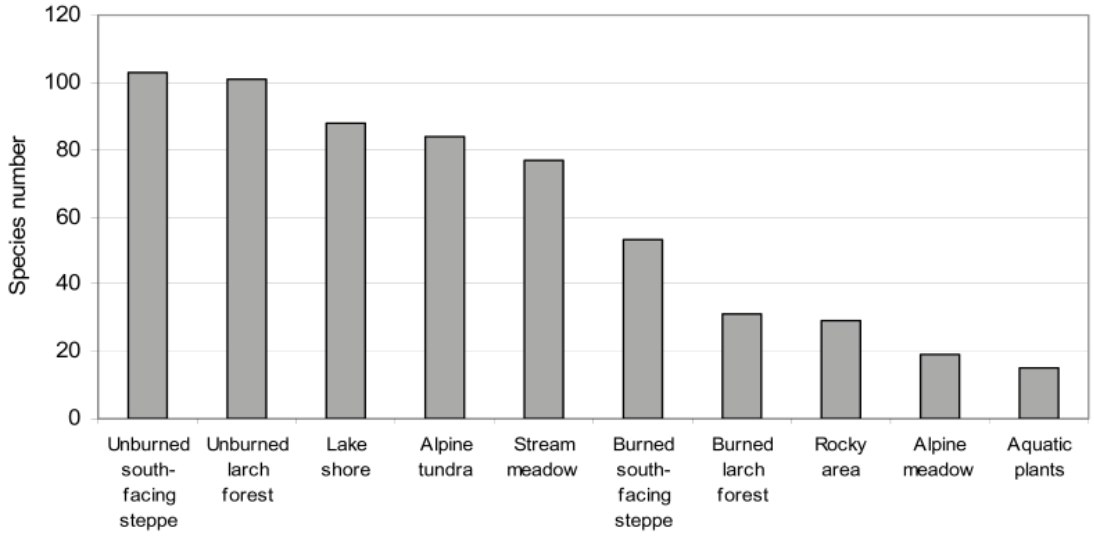

Figure 2. Plant species richness in main habitats of Tarvagatai mountain range.

Table 2. Higher taxa of the recorded plant species. Detailed species list can be obtained by contacting the authors.

Phylum	**Classes**	**Families**	**Genera**	**Species**
Pteridophyta	Equisetopsida	Equisetaceae Rich	1	4
	Polypodiopsida	Polypodiaceae R. Br	3	3
Pinophyta	Pinopsida	Cypressaceae Bartl.	1	2
	Gnetopsida	Ephedraceae Dum.	1	1
	Pinopsida	Pinaceae Lindl.	1	1
Angiospermae	Dicotyledoneae	Adoxaceae Trautv.	1	1
		Balsaminaceae A.Rich	1	1
		Berberidaceae Juss.	1	1
		Betulaceae S. F. Gray	1	4
		Boraginaceae Juss.	2	2
		Callitrichaceae Link.	1	2
		Campanulaceae Juss.	1	2
		Caprifoliaceae Juss.	2	3
		Caryophyllaceae Juss.	7	18
		Chenopodiaceae Vent.	2	2
		Compositae Giseke.	17	33
		Crassulaceae DC.	2	5
		Cruciferae	8	9
		Empetraceae S.F.Gray.	1	1
		Ericaceae Juss.	2	2
		Euphorbiaceae Juss.	1	1
		Gentianaceae Juss.	3	12
		Geraniaceae Juss.	2	3
		Grassulaceae	1	3
		Haloragaceae R.Br.	1	1
		Hippuridaceae Link.	1	1
		Labiatae Juss.	4	5
		Leguminosae Juss.	6	9
		Lentibulariaceae Rich.	1	1
		Onagraceae Juss.	2	4
		Papaveraceae Juss.	2	2
		Polemoniaceae Juss.	1	1
		Polygalaceae R.Br.	1	2
		Polygonaceae Juss.	6	11
		Primulaceae Vent.	2	6
		Pyrolaceae Dum.	1	1
		Ranunculaceae Juss.	15	32
		Rosaceae Juss.	9	24
		Rubiaceae Juss.	1	4
		Salinaceae Mirb.	1	6
		Santalaceae R. Br.	1	1
		Saxifragaceae Juss.	4	10
		Scrophulariaceae Juss.	6	11
		Umbelliferae Juss.	5	6
		Urticaceae Juss.	1	1
		Valerianaceae Batsch.	2	2
		Violaceae Batsch.	1	1
	Monocotyledoneae	Cyperaceae Juss.	4	15
		Gramineae Juss.	18	38
		Iridaceae Juss.	1	1
		Juncaceae Juss.	2	6
		Lemnaceae S. F. Gray	1	1
		Liliaceae Juss.	4	7
		Orchidaceae Juss.	2	3
		Potamogetonaceae Dum.	1	6

be delayed and it needs time as all species must immigrate from outside, from unburned areas.

We also found very high species numbers in lake shore, alpine tundra und stream meadow habitats. These habitats have a better water supplement and show a mosaic of different micro-habitats.

Particularities of the Flora.

During the short time of the assessment we recorded five species, new for Khangai region, namely: *Dianthus Hoeltzeri* Winkl. in alpine tundra and steppe, *Potentilla Regeliana* Th. Wolf in rocky area and steppe, *Sedum Ewersii* Ldb. in rocky areas above tree line, *Ranunculus reptans* L. in lake shores and *Potamogeton natans* L. in lakes. Most of them are known only from western Mongolian mountains up until now. Some montane-subalpine species from Altai-Sayan region reach the Khangai region in the western part, the Tarvagatai mountain range consequently, but in more eastern regions of Khangai region and the adjacent Hövsgöl area they are usually absent.

Additionally we found seven species listed in the Red Data Book of Mongolia. Some of these, e.g. *Gentiana algida* and *Saxifraga hirculus* are very common and distributed in different various habitats in the research area.

From the Khangai region, the only endemic species we found is *Ptilagrostis junatovii* in alpine meadows and tundra above the tree line. *Alchemilla pavlovii*, by many authors (e.g. Grubov 1982, Gubanov 1996) esteemed endemic only in Khangai region, is recorded also in Mt. Khentei recently (Dulamsuren & Muehlenberg 2003), and therefore it can be considered as endemic only for the territory of Mongolia.

Many species reach their distribution border in Khangai region, especially different species of the Eurasian taiga. However, the exact border of their range is unknown for most species until now. So, we were surprised to find some of these species, e.g. *Linnaea borealis*, *Paeonia anomala*, *Rosa oxyacantha* and *Empetrum sibiricum* in our research area. Most of them were found only in more eastern and north-eastern parts of the Khangai region up to date.

Discussion

Species richness. The recorded species number of 335 per 40 sq km was basis for the computation of the species richness of Tarvagatai Nuruu. We used the formulas developed by Arrhenius (1921) and Evans *et al*. (1955) for this purpose. In both cases the computed number is more than 800 species per 10,000 sq km. With the consideration, that real species number is higher than the number recorded during our short-time investigation and not all species were found within the 40 sq km area. The real species number per 10,000 sq km even may be higher, up to 900 spp. seems to be realistic. Thus, for the central Asiatic region, a conspicuously high species number per defined area is found in the mosaic of different habitats in Tarvagatai mountain range. In comparison with this, Hilbig *et al*. (2004) computed the species richness as about 920 species per 10,000 sq km for Mt. Bogd Khan in the vicinity of Ulaanbaatar city. But, it should be noted that the latter area was intensively investigated by many florists for some decades. This suggests that at least many more new records of plants are possible for Tarvagatai mountain range with further sampling. Within Mongolia the species richest areas are the northern mountains, while the steppe and desert belts are comparatively poor in species. So, Ganbold (2000) computed 1229 species per 60,000 sq km for the Mt. Khentei in north Mongolia, while Jaeger *et al*. (1985) presume only approx. 500 species per approx. 30,000 sq km for the Dzungarian gobi.

Combination of the flora from Tarvagatai mountain range on the basis of the analysis of eco-geographically defined distribution-types. When we consider the *distribution-types* (floral elements) of the recorded species, Tarvagatai mountain range belongs to the temperate flora zone. Nearly 25% of all recorded species are distributed in temperate zones. When we include the East-Asian species, this amount increases up to almost 50%. But the quota of temperate-boreal and strong boreal species is very high, with almost 20% of all species being boreal species (Fig. 3). This underlines the specific role of Tarvagatai mountain range within the temperate zone and its close contact with the northern taiga-belt.

Also the number of mountain – high mountain and arctic-alpine species, comprising more than 15% of all species is remarkable. In comparison, typical Central Asian species (most of them characteristic for steppe and semi-desert habitats) are not very diverse, with only 10% of the flora of Tarvagatai mountain range. An overview over the distribution-types and some characteristic species

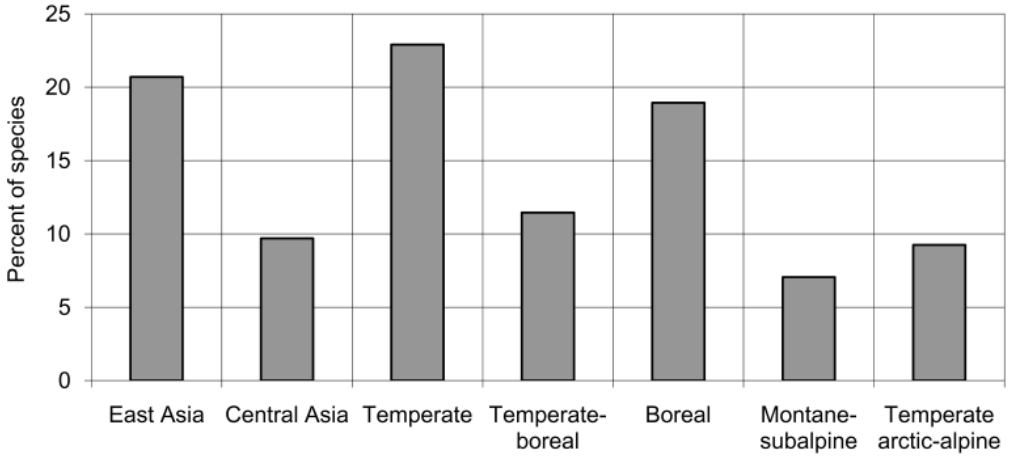

Figure 3. Percentage of plant species recorded in the Tarvagatai Nuruu National Park representing different distribution-types.

recorded in Tarvagatai Nuruu National Park gives table 3.

It shows that the area is generally belongs to the temperate flora zone in Central Asia. But the relatively high quota of boreal taiga species supports the statement that the forest of Tarvagatai mountain range holds an exceptional position. Especially, predominantly boreal-distributed species, e.g. *Linnaea borealis*, *Equisetum scirpoides* and *Calamagrostis neglecta* reach their distributional range border in the Khangai region and Tarvagatai mountain range.

Conservation value of Tarvagatai Nuruu National Park. In the light of these evaluations it could be concluded that Tarvagatai mountain range is an important center of floristic biodiversity in Mongolia. Even the mosaic of different habitats in Tarvagatai mountain range and the low human

Table 3. Distribution-types and some of their representative plant species recorded in Tarvagatai Nuruu National Park.

Distribution-type	**representative species**
East Asia	*Aconitum barbatum* Pers., *Beckmannia syzigachne* (Steud.) Fern., *Gentiana macrophylla* Pall., *Euphorbia discolor* Ldb., *Orostachys spinosa* (L.) C. A. Mey., *Spodiopogon sibiricus* Trin., *Thalictrum petaloideum* L.
Central Asia	*Arenaria capillaris* Poir., *Betula fruticosa* Pall., *Gentiana pseudoaquatica* Kusn., *Potentilla acaulis* L., *Ranunculus natans* C. A. Mey., *Thymus gobicus* Tschern.
Temperate	*Calamagrostis macilenta* (Griseb.) Litv., *Carex pediformis* C. A. Mey., *Cirsium serratuloides* (L.) Hill, *Dianthus superbus* L., *Iris flavissima* Pall., *Ligularia sibirica* (L.) Cass., *Lonicera altaica* Pall., *Potentilla anserina* L., *Spiraea alpina* Pall., *Veronica longifolia* L.
Temperate-boreal	*Antennaria dioica* (L.) Gaertn., *Carex rostrata* Stokes, *Cystopteris fragilis* (L.) Bernh., *Galium boreale* L., *Parnassia palustris* L., *Ribes rubrum* L., *Sanguisorba officinalis* L., *Tanacetum vulgare* L.
Boreal	*Aconitum septentrionale* Koelle, *Atragene sibirica* L., *Empetrum sibiricum* V. Vassil., *Equisetum scirpoides* Michx., *Linnaea borealis* L., *Paeonia anomala* L., *Stellaria crassifolia* Ehrh., *Trollius asiaticus* L.
Montane-subalpine	*Androsace septentrionalis* L., *Dryopteris fragrans* (L.) Schott. *Juniperus sibirica* Burgsd., *Linaria acutiloba* Fisch. ex Reichb., *Potentilla nivea* L., *Saxifraga spinulosa* Adams, *Woodsia ilvensis* (L.) R. Br.
Temperate arctic-alpine	*Betula rotundifolia* Spach, *Dracocephalum grandiflorum* L., *Eriophorum scheuchzeri* Hoppe, *Juncus triglumis* L., *Kobresia bellardii* (All.) Degl., *Lomatogonium rotatum* (L.) Fries, *Rhodiola rosea* L., *Viola biflora* L.

impact are the basis for a conspicuously high species number. Also the coincidence of species from forest, meadow-steppe, taiga, steppe and mountain areas on a relatively small area is one of the particularities of Tarvagatai Nuruu National Park. So the area has a specific role in the Mongolian protected area network. Some species, especially boreal species reach their range border in the Khangai region and Tarvagatai mountain range. For the protection of these species the National Park holds a high importance.

Also the recorded species, listed in the Red Data Book of Mongolia, support the high conservation value of the Tarvagatai Nuruu National Park. Some of these species are very common in the research area and the national park has also a high significance for conservation of these species and their intraspecific genetic diversity. Some species, which we newly found for the Khangai region express the high diversity of the flora and its insufficiently investigated situation. Since the floristic diversity of this national park is incompletely known, further species to be explored in the future.

Conclusions

The mosaic of different habitats in Tarvagatai mountain range and the low human impact are the basis for a conspicuously high species number of plants. With more than 800 species of vascular plants per 10,000 sq km, the estimated species number is very high for the central Asiatic region.

The most species-rich habitats are the unburned steppe and forests. The assessment showed that the fire occurred five years ago had a significant influence on plant communities and species richness within the different habitats.

In the flora of Tarvagatai mountain range the temperate species of forest and meadow-steppe are dominated. It shows that the area generally belongs to the temperate flora zone in Central Asia, but the relatively high quota of boreal species is remarkable and expression for the exceptional position of this area. Most of the boreal species reach their southern distribution border here, so the Khangai region is an interesting area from floristic-geographical viewpoints.

Generally, the coincidence of species from forest, meadow-steppe, taiga, steppe and mountain areas on a relatively small area is one of the particularities of Tarvagatai Nuruu National Park. Moreover, some species listed in the Red Data Book of Mongolia are very common in this area. There is also a high potential to record species newly for Khangai region because the biodiversity is not exactly known yet and further assessments are necessary. Based on these finding, we conclude that the Tarvagatai Nuruu National Park has an important and specific role within the Mongolian protected area network.

References

Ariuntsetseg, L., B. Boldgiv & A. Golde (2008): Assessment of biological diversity in the Tarvagatai Nuruu National Park – main habitats and floristic diversity. – Proceedings of International Conference "*Fundamental and Applied Issues of Ecology and Evolutionary Biology*" Ulaanbaatar: 13-19

Arrhenius, O. 1921. Species and area. *Journal of Ecology* 9: 95-99.

Bannikova, I. A., Bayasgalan, D., Beresneva, I. A., Buevich, Z. G., Guricheva, N. P. & Dmitriev, P. P. 1986. *Biological Resources and Natural Conditions of Mongolia*. Nauka, Moscow.

Batkhuu, J., Sanchir, C., Ligaa, U., Jamsran, T., Suzuki, T., Ota, M., Tsuruoka, T. & Hamasaki, C. 2003. *Mongolian Useful Plants, I*. Admon Printing, Ulaanbaatar.

Batkhuu, J., Sanchir, C., Ligaa, U., Jamsran, T., Suzuki, T., Ota, M., Tsuruoka, T. & Hamasaki, C. 2005. *Mongolian Useful Plants, II*. Admon Publishing, Ulaanbaatar.

Bayartogtokh, B., Batsaikhan, N., Ariuntsetseg, L. & Boldgiv, B. 2007. *Assessment of Biological Diversity in the Tarvagatai National Park*. Report. pp. 69. Ulaanbaatar: German Technical Advisory Group (GTZ) and National University of Mongolia.

Bumjaa, D. 2002. *Flora and Vegetation of Mongolia*. National University Press, Ulaanbaatar. [in Mongolian]

Cox, C. B. & Moore, P. D. 2005. *Biogeography: An Ecological and Evolutionary Approach*. 7th edition, Blackwell Publishing.

Dorjgotov, D. 1976. *Geographical and Soil Zonation of Mongolia*. National Press, Ulaanbaatar. [in Mongolian]

Dulamsuren, Ch. 2004. Floristische Diversitaet, Vegetation und Standortbedingungen in der Gebirgstaiga des Westkhentej, Nordmongolei.

Berichte des Forschungszentrums Waldoekosysteme, Reihe A, Band 191, Goettingen.

Dulamsuren, Ch. & Muehlenberg, M. 2003. Additions to the flora of the Khentei, Mongolia. *Willdenowia* 33: 149-158

Evans, F. C., P. J. Clark, & Brand, R. H. 1955. Estimation of the number of species present in a given area. *Ecology* 36: 342-343.

Ganbold, E. 2000. *Flora severnoj Mongolii*. Avtoreferat dissertacii. Sankt Peterburg[in Russian]

Grubov, V. I. 1982. *Key to Vascular Plant of Mongolia*. Nauka, Leningrad. [in Russian]

Gubanov, I. A. 1996. *Conspectus of Flora of Outer Mongolia (Vascular Plants)*. Nauka., Moskow. [in Russian]

Hilbig, W. 1995. *The Vegetation of Mongolia*. SPB Academic Publishing.

Hilbig, W., Jaeger, E. J. & Knapp, H. D. 2004. Die Vegetation des Bogd-uul bei Ulaanbaatar (Mongolei) – Standortbindung und pflanzengeographische Stellung. *Feddes Repertorium* 115: 265-342 [in German]

Jaeger, E. J., Hanelt, P. & Davajamz, C. 1985. Zur Flora der Dsungarischen Gobi (Mongolische Volksrepublik). *Flora* 177: 45-89 [in German]

Jigjidsuren, S. & Johnson, D. A. 2003. *Forage Plants in Mongolia*. Admon, Ulaanbaatar. [in Mongolian]

Myagmarsuren, D. & Batsukh, D. 2007. *Protected Areas of Mongolia*. 2nd edition, Munkhiin Useg, Ulaanbaatar. [in Mongolian]

Olziikhutag, N. 1985. *The Key to Forage Plants of Mongolia*. National Press, Ulaanbaatar. [in Mongolian]

Oyungerel, B. 2004. *Protected Areas of Mongolia*. Admon, Ulaanbaatar. [in Mongolian]

Shiirevdamba, T. 1997. *Mongolian Red Data Book*. Admon, Ulaanbaatar. [in Mongolian]

Soule, M. E. & Simberloff, D. 1986. What do genetics and ecology tell us about the design of nature reserves? *Biological Conservation*. 35: 19-40.

Takhtajan, A. L. 1978. Floristicheskie oblasti zemli (Floristic regions of the earth). Nauka, Leningrad. [in Russian]

Yunatov, A. A. 1946. Materialy po geografii i ekologii glavneishikh drevesnykh porod Mongolii (Contributions to the geography and ecology of the main arboreal species of Mongolia). *Scientific Transactions of the Mongolian State University,* 2:1-38. [in Russian]

Хураангуй

Энэхүү өгүүлэлд 2007 оны зун хийгдсэн Тарвагатайн Нурууны Байгалийн Цогцолборт Газрын биологийн олон янз байдлын ерөнхий үнэлгээний нэг хэсгийг тусгав. Бидний судалгааны гол зорилго бол тус байгалийн цогцолборт газрын үндсэн амьдрах орчин, ургамлын аймгийн бүтэц, олон янз байдлыг тодорхойлох, түүнчлэн Монгол улсын тусгай хамгаалалттай газар нутгуудын сүлжээн дэх ургамлын аймгийн хамгааллын ач холбогдлыг үнэлэхэд оршиж байв. Судалгаанд хамрагдсан нутагт тохиолдох үндсэн амьдрах орчин, тэдгээрийн ургамлын зүйлийн баялгийг үнэлсэн ба нийт 335 зүйлийн гуурст ургамал бүртгэгдлээ. Энэ өгүүлэлд Тарвагатайн нурууны ургамлын аймгийн бүрдэл онцлог, гуурст ургамлын зүйлийн баялаг харьцангуй өндөр байгаагийн шалтгаан зэргийг экогеографийн үүднээс тайлбарлаж, уг тусгай хамгаалалттай газар нутгийн байгаль хамгааллын ач холбогдлын тухай өгүүлэв.

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