http://mjbs.num.edu.mn
http://biotaxa.org./mjbs
Volume 15(1-2), 2017

Mongolian Journal of Biological Sciences

ISSN 1684-3908 (print edition)
MJBS
ISSN 2225-4994 (online edition)

http://dx.doi.org/10.22353/mjbs.2017.15.02

Original Article

The Vegetation of North-Western Mongolia: Floristic Checklist and Conservation Status of Mongolian Grassland Flora

Katharina Lapin*, Andreas Eipeldauer, Gerald Folly, Daniel Mank and Karl-Georg Bernhardt

Institute of Botany, University of Natural Resources and Life Sciences (BOKU), Gregor Mendel Strasse 33, A-1180 Vienna, Austria

Abstract

Key words: Eurasian grassland, Mongolia, land use change, plant species, steppe, Red List.

Article information:
Received: 04 May 2017
Accepted: 26 May 2017
Published online: 30 May 2017

***Correspondence:**
katharina.lapin@boku.ac.at

Mongolia´s grassland (steppe) is reported to be vulnerable to climate change, degradation, and densification. The traditional Mongolian pastoral herding system is currently transforming due to changes in market relations and economic developments, and this transformation has an impact on species composition and biodiversity. For this study, we observed the current situation of the flora in the north-western Mongolian territories to provide data on plant species occurrence in this remote area. A vegetation assessment was conducted for 15 locations in June and July 2016. Indicator plant species were determined to assess the level of grazing and degradation, as well as the respective steppe sub-type. The conservation status of all recorded plant species was assessed in accordance with the IUCN Red List. In total, 106 vascular plant species belonging to 73 genera and 26 families were recorded. Four endemic plant species were observed. All locations were classified into three steppe sub-types: Desert-steppe, dry-steppe and mountain-steppe. A large number of degradation indicator plant species were observed in almost all locations. No endangered species in the Mongolian IUCN Red List were observed. The observation indicates that the vegetation in the north-western area of Mongolia is partly showing tendencies towards overgrazing and degradation. The conservation status of the most recorded species is currently unknown, and more studies on Mongolian vegetation will need to be conducted to assess these species' status. We emphasize the urgent need for further studies on the vegetation and plant species composition, and indicators in north-western Mongolia, especially in context of the ongoing rapid economic, social, and ecological changes in the region.

Cite this paper as: Lapin, K., Eipeldauer, A., Folly, G., Mank, D. & Bernhardt, K. 2017. The vegetation of North-Western Mongolia: Floristic checklist and conservation status of Mongolian grassland flora. *Mong. J. Biol. Sci*., 15(1-2): 13-22.

Introduction

Eurasian grasslands (steppe) have a high importance for global biodiversity (Hoekstra *et al*., 2005; Liu *et al*., 2008; German *et al*., 2017). These ecosystems are also vulnerable to climate change and changes in grazing management (Christensen *et al*., 2004). 2.6% of the world´s grassland (12% of Eurasian grassland) is to be found in Mongolia. Almost 66% (1,034,737.38 km²) of the Mongolian territory (1,566,000 km²) is covered in grassland, of which almost 80% are used as pastures for livestock (Tuvshintogtokh, 2014): 225,000 nomadic households keep around 44 million head of livestock (19.6 million goats, 19.3 million sheep, 2.6 million cattle, 2.2 million

horses, and 0.3 million camels). The Mongolian pastoral herding system is traditionally based on the herding of these five kinds of livestock (Suttie, 2006; Mongolian Government, 2009). However, political transformations and developing market relations are causing changes to these traditional agricultural processes and the Mongolian economy as a whole.

Of the 3.1 million inhabitants of Mongolia today, 71.2% live in urban areas, mostly in the capital Ulaanbaatar (BTI., 2016). The establishment of permanent settlements and concentration of people around cultural and social centers has changed the traditional approaches to herd management (Suttie, 2006; BTI., 2016). The traditional semi-nomadic way of pasture management allowed the regeneration of plant species due to frequent and rapid changes in grazing frequency. Recent developments have resulted in an increase of permanent pastures close to urban areas, however, thereby causing local overgrazing (Rosales & Livinets, 2006). The global demand for cashmere has grown significantly over the last decades (Berger *et al*., 2013), and due to the increase in prices paid for cashmere wool, the number of goats has likewise grown. This is causing changes to the traditional mixed farming principle, with differing diet preferences among the domestic animals. The increasing goat population in remote areas is promoting grassland degradation and deforestation and impeding forest recovery (Rosales & Livinets, 2006).

The 5th National Report on Mongolia's contributions to the Convention on Biological Diversity (CBD) lists positive and negative developments in nature conservation (Gombobaatar *et al*., 2014). Knowledge on the native flora and fauna is apparently increasing, and national IUCN Red List assessments were conducted (IUCN., 2016). The Mongolian government has been supporting a number of actions, e.g. the establishment of protected areas, since 2012 to achieve the CBD targets (Gombobaatar *et al*., 2014). The country's diversity is threatened by climate change, habitat degradation, pollution and densification (Gombobaatar *et al*., 2014), and the Mongolian Red List of Plants (2012) determined the status of over 150 species of plants classified as Endangered according to the IUCN Red List criteria (Gombobaatar *et al*., 2014). In total, 110 plant species are regionally threatened (Critically Endangered, Endangered, or Vulnerable) in Mongolia. According to the Mongolian IUCN Red List (Nyambayar *et al*., 2011), 16 of these species are categorized as Critically Endangered, 39 species as Endangered and 55 species as Vulnerable. Almost 60% of the assessed plant species are threatened by habitat loss and degradation (IUCN., 2016). The Mongolian vegetation is adapted to the continental climate and traditional land use. The number of vascular plant species in Mongolia is around 3,000 distributed across 660 to 680 genera and 130 families, and including more than 150 endemic and 200 sub-endemic species (Nyambayar *et al*., 2001, Urgamal *et al*., 2013). The reported species richness is 12 to 30 vascular plant species, with a vegetation cover of 30 to 70% (Tuvshintogtokh, 2014).

The aim of this survey was to observe the current situation of the flora in the north-western Mongolian territories, which are very remote and difficult to access. We aim to provide a checklist of plant species existing in the grasslands of the region for future scientific botanical investigations. Moreover, we want to reflect on the collected and determined plant species in the context of degradation and nature conservation.

Material and Methods

Study area

The study area extends from 49.900°N to 47.350°N and from 92.200°E to almost 101.630°E (Figure 1). The climate is cold, semi-arid and typically continental, with hard and cold winters and extremely hot summers, around 250 days of sun per year, and temperatures between -40°C and +40°C.

Vegetation analysis

A vegetation analysis was conducted in June and July 2016, with a total of 15 locations examined. At each location, the plant species composition was recorded and the grazing intensity was determined through direct observation of the present livestock or estimated from the density of livestock feces. All vascular plant species were determined according to Hauck *et al*. (2010), Rechinger (1999) and Pyak *et al*. (2008) as well as the Virtual Guide

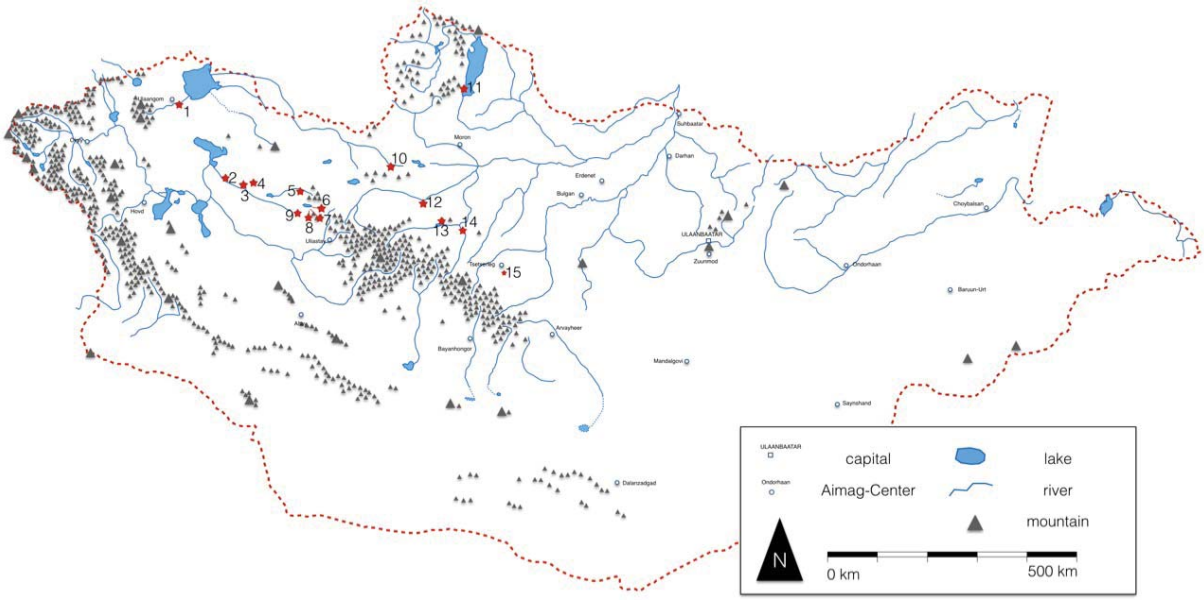

Figure 1. Map of Mongolia showing mountain areas, major water bodies and the 15 survey locations in the area between 49.900°N and 47.350°N and between 92.200°E and 101.630°E.

to the Flora of Mongolia (DFG 2017) and the Catalogue of Life (2017). Only species for which correct identification was guaranteed were recorded. The Internet resource *Mongolian Endemic Plants* (2017) was used to determine endemic species.

Degradation indicators

The steppe sub-type was identified for each location (Tuvshintogtokh, 2014). Following the listing of all plant species in a location, the degradation indicator plants at that location were determined (Tuvshintogtokh, 2014), and qualitatively correlated to the land use observation from the field.

Conservation status

To assess the conservation status of the observed plant species, we used the IUCN Red List Data (IUCN 2017) and the Mongolian Red List and Conservation Action Plans of Plants (Nyambayar *et al*., 2011). The IUCN Red List assessment criteria provide a scientific system for determining the threat status of species at the national and regional level. The IUCN Red List categories are: Extinct (EX), Extinct in the Wild (EW), Regionally Extinct (RE), Critically Endangered (CE), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (VC), Data Deficient (DD), and Not Applicable (NA). The categories Vulnerable, Endangered, and Critically Endangered are based on the rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation of the assessed species.

Results

A total of 106 vascular plant species belonging to 73 genera and 26 families were recorded (Table 1). The following plant families were the most abundant, covering nearly 50% of all species: Compositae (17 species), Poaceae (7 species), Ranunculaceae (7 species), Leguminosae (6 species), Cyperaceae (6 species) and Caryophyllaceae (6 species). The most diverse genus was *Artemisia* with five species. Five endemic species were recorded: *Dontostemon integrifolius* was observed at three locations (#3, #5, #13; see Annex 1), while *Allium flavovirens* (location #14), *Galatella macrosciadia* (location #4), *Heteropappus biennis* (location #14) and *Stipa tianschanica* (location #13) were each observed at a single location only. These species indicate the unique flora of Mongolia.

All surveyed locations were classified into three steppe sub-types: desert steppe, dry steppe and mountain steppe. Location #1 and

Table 1. Summary of the recorded vascular plant species in north-western Mongolia by family.

	Amaranthaceae	36	*Crepidifolium akagii* (KITAG.) SENNIKOV	72	*Pedicularis longiflora* RUDOLPH
1	*Bassia prostrata* (L.) A.J. SCOTT	37	*Dendranthema zawadskii* (HERBICH) TZVELEV	73	*Pedicularis myriophylla* PALL.
2	*Kochia prostrata* (L.) C. Schrad.	38	*Echinops sp.*		**Papaveraceae**
3	*Koeleria cristata* PERS.	39	*Galatella macrosciadia* DC.	74	*Papaver nudicaule* L.
	Amaryllidaceae	40	*Heteropappus biennis* TAMAMSCH. EX GRUB.		**Plantaginaceae**
4	*Allium cf. prostratum* TREVIR.	41	*Hypochaeris sp.*	75	*Plantago cf. salsa* PALL.
5	*Allium flavovirens* Regel	42	*Inula britannica* L.	76	*Veronica cf. austriaca* L. *agg.*
6	*Allium sp.*	43	*Inula sp.*	77	*Veronica pinnata* L.
	Apiaceae	44	*Leontopodium ochroleucum* BEAUVERD	78	*Veronica spicata* L. *ssp. incana*
7	*Bupleurum scorzonerifolium* WILLD.		**Crassulaceae**		**Plumbaginaceae**
8	*Peucedanum baicalense* KOCH	45	*Sedum aizoon L.*	79	*Goniolimon speciosum* (L.) BOISS.
	Betulaceae		**Cyperaceae**		**Poaceae**
9	*Betula cf. microphylla* BUNGE	46	*Blysmus compressus* (L.) PANZ. EX LK.	80	*Agropyron cristatum* (L.) GAERTN.
10	*Betula fruticosa* PALL.	47	*Carex cf. pachystelis* J. GAY	81	*Bromus sp.*
	Boraginaceae	48	*Carex cf. physodes* M. BIEB.	82	*Elymus repens* (L.) GOULD
11	*Eritrichium villosum* (LEDEB.) BUNGE	49	*Carex cf. stenophylla* WAHLENB.	83	*Eremopyrum orientale* (L.) JAUB. & SPACH
12	*Lappula sp.*	50	*Cyperaceae sp.*	84	*Erigeron sp.*
	Brassicaceae	51	*Eriophorum angustifolium* HONCK.	85	*Stipa cf. capensis* THUNB.
13	*Alyssum obovatum* (C.A.MEY.) TURCZ.		**Ephedracae**	86	*Stipa tianschanica* ROSHEV.
14	*Clausia aprica* (STEPHAN) TROTSKY	52	*Ephedra sinica* STAPF		**Polygonaceae**
15	*Dontostemon integrifolius* (L.) LEDEB.		**Fabaceae**	87	*Bistorta vivipara* (L.) S.F.GRAY
	Campanulaceae	53	*Caragana pygmaea* (L.) DC.		**Potamogetonaceae**
16	*Campanula stevenii ssp. turczaninovii*	54	*Caragana sp.*	88	*Potamogeton filiformis* PERS.
	Caprifoliaceae		**Gentianaceae**		**Primulaceae**
17	*Scabiosa comosa* FISCH	55	*Gentiana decumbens* L.F.	89	*Androsace sp.*
	Caryophyllaceae	56	*Gentiana sp.*		**Ranunculaceae**
18	*Dianthus chinensis* L.		**Geraniaceae**	90	*Aconitum barbatum* PATRIN EX PERS.
19	*Dianthus sp.* L.	57	*Geranium pseudosibiricum* J.MAYER	91	*Aconitum septentrionale* KOELLE
20	*Dianthus superbus* L. *ssp. Superbus*		**Haloragaceae**	92	*Delphinium grandiflorum* L.
21	*Minuartia sp.*	58	*Myriophyllum spicatum* L.	93	*Halerpestes sarmentosa* (ADAMS) KOM.
22	*Silene repens* PATRIN		**Juncaceae**	94	*Pulsatilla sp.*
23	*Stellaria dichotoma* L.	59	*Juncus castaneus SM. ssp. leucochlamys*	95	*Ranunculus cf. japonicus* THUNB.
	Celastraceae		**Lamiaceae**	96	*Ranunculus trichophyllus* CHAIX EX VILL.
24	*Parnassia palustris* L.	60	*Dracocephalum foetidum* Bunge		**Rosaceae**
	Chenopodiaceae	61	*Scutellaria grandiflora SIMS*	97	*Potentilla acaulis* L.
25	*Chenopodiaceae sp.*	62	*Nepeta multifida* L.	98	*Potentilla cf. conferta* BUNGE
26	*Chenopodium glaucum* L.	63	*Thymus gobicus* CZERN.	99	*Potentilla fruticosa* L.
27	*Chenopodium sp.*		**Leguminosae**	100	*Rosa sp.*
	Compositae	64	*Lotus cf. corniculatus* L.	101	*Sanguisorba officinalis* L.
28	*Artemisia cf. adamsii* BESSER	65	*Medicago ruthenica* TRAUTV.		**Rubiaceae**
29	*Artemisia cf. frigida* WILLD.	66	*Medicago sp.*	102	*Galium cf. verum* L.
30	*Artemisia cf. gmelinii*	67	*Oxytropis ambigua* (PALL.) DC.		**Salicaceae**
31	*Artemisia palustris* L.	68	*Oxytropis cf. filiformis* DC.	103	*Salix cf. ledebouriana* TRAUTV.
32	*Artemisia sp.*	69	*Oxytropis filiformis* DC.	104	*Salix retusa* L.
33	*Aster alpinus* L.		**Orobanchaceae**	105	*Salix sp.*
34	*Asterothamnus centrali-asiaticus*	70	*Pedicularis cf. uliginosa* BUNGE		**Zygophyllaceae**
35	*Cirsium esculentum* C.A.MEY.	71	*Pedicularis elata* WILLD.	106	*Tribulus terrestris* L.

#2 were classified as desert steppe, and the indicator species *Kochia prostrata* and *Tribulus terrestris* occurred in both of these locations. The vegetation at location #1 was heavily influenced by livestock grazing. The average vegetation height in the desert steppe locations was 17.5 cm, and the average vegetation cover in these locations was the lowest at 52.5%. At the most representative location of the desert steppe sub-type, the vegetation cover was 15%. Five locations were classified as dry steppe (Table 2). The following indicator plant species were observed at these locations: *Artemisia adamsii, Artemisia frigida, Artemisia palustris, Bassia prostrata, Dracocephalum foetidum* and *Kochia prostrata*. The average vegetation height in the dry steppe locations was 28 cm, and the average vegetation cover was 73.5%. The majority of the surveyed locations (eight) were classified as mountain steppe. The following indicator plant species for this steppe sub-type were recorded: *Artemisia palustris, Nepeta multifida* and *Potentilla acaulis*. The average vegetation height in the mountain steppe locations was 31.82 cm, and the average vegetation cover was the highest at 77.72%.

All locations were used as grassland pastures, but the intensity of land use varied between them

Figure 2. Desert steppe at location #01: 49.906295°N, 92.213734°E; altitude: 956 m. Photo by Eipeldauer, A. (2016).

Figure 3. Dry steppe at location #04: 48.652549°N, 94.568369°E; altitude: 1,590 m. Photo by Eipeldauer, A. (2016).

Figure 4. Mountain steppe at location #09: 48.208002°N, 95.928092°E; altitude: 1,888 m. Photo by Eipeldauer, A. (2016).

(Table 2). Grazing livestock were observed at 10 locations. At locations #5, #9 and #15, no visible livestock feces could be observed. At locations #1, #2, #4 and #12, the following degradation indicator species for overgrazing were recorded: *Artemisia adamsii, Dracocephalum foetidum, Ephedra sinica, Potentilla acaulis* and *Tribulus terrestris.* At locations #3, #5, #13, #14 and #15, we observed the following degradation indicator species for heavy to moderate grazing: *Artemisia*

Table 2. Coordinates of the surveyed locations and respective land use, density of feces (low: 1 to 30%, moderate: 10 to 39%, high: 40% or more of the ground cover) and livestock observation, classification of steppe sub-type (desert, dry or mountain steppe), and grazing level according to indicator plant species.

Location	N, latitude	E, longitude	Altitude (m)	Land use	Veg. height (cm)	Cover (%)	Live-stock	Feces	Steppe sub-type	Grazing level
#01	49.906295	92.213734	956	intensive	15	(90)	Yes	high	desert steppe	overgrazing
#02	48.701321	93.637529	1080	intensive	20	15	Yes	moderate	desert steppe	overgrazing
#03	48.628793	93.948121	1183	low	40	60	No	low	dry steppe	moderate/ heavy
#04	48.652549	94.568369	1590	intensive	40	60	Yes	high	dry steppe	heavy/ overgrazing
#05	48.607018	95.781119	1920	low	40	30	No	no	mountain steppe	moderate/ heavy
#06	48.294612	96.291365	2032	intensive	15	70	Yes	high	mountain steppe	overgrazing
#07	48.263486	96.223542	2425	moderate	20	90	-	low	mountain steppe	-
#08	48.232860	96.161061	2732	low	20	40	Yes	low	mountain steppe	-
#09	48.208002	95.928092	1888	low	60	100	-	no	mountain steppe	-
#10	49.251442	98.100695	1772	intensive	10	100	Yes	high	dry steppe	-
#11	50.583917	100.166188	1661	moderate	20	95	Yes	moderate	dry steppe	-
#12	48.601331	99.181319	1584	Intensive	15	90	Yes	high	dry steppe	heavy/ overgrazing
#13	48.185470	99.774533	2076	Moderate	20	80	Yes	moderate	mountain steppe	moderate/ heavy
#14	48.131357	100.277910	1853	Low	30	60	Yes	low	mountain steppe	moderate/ heavy
#15	47.347618	101.629662	1910	Low	100	100	No	no	mountain steppe	moderate/ heavy

frigida, Artemisia palustris, Kochia prostrata and *Nepeta multifida.*

None of the observed vascular plant species were assessed in the Mongolian IUCN Red List (Nyambayar *et al*., 2011). A total of eight species (*Betula fruticosa, Blysmus compressus, Ephedra sinica, Eriophorum angustifolium, Myriophyllum spicatum, Parnassia palustris, Ranunculus trichophyllus* and *Sanguisorba officinalis*) were categorized as species of least concern (LC) according to the global assessment of threatened species in the IUCN Red List (2016). All observed species of LC are either widespread with stable populations and do not face any major threats, or information on the current population size or major threats is not available (IUCN 2016).

Discussion

The observed vegetation in the Mongolian north-west shows a high diversity of plant families and genera: 26 families and 73 genera were recorded in total. Species distributed by wind, like species of the families Compositae and Poaceae, were among the most abundant, which is very characteristic for the vegetation of the Eurasian steppe.

The Mongolian flora is threatened by overgrazing and degradation resulting in habitat loss (Shagdar & Yadamsuren, 2017). We observed a large number of indicator species, e.g. *Artemisia adamsii* in the dry steppe locations and *Dracocephalum foetidum* in the mountain steppe locations. The observation of indicator species correlates qualitatively with the observation of grazing livestock, the feces cover density, and land use intensity.

Vegetation composition is a useful tool for assessing the impact of land use changes on biodiversity (Shagdar & Yadamsuren, 2017). An inventory of the Mongolian flora, therefore, provides an important baseline of knowledge for decision making processes. In this context, the

IUCN Red List of Mongolian Plants provides a supportive framework to assess the situation of Mongolia's nature conservation planning. Completion of the Red List and Conservation Action Plans for Mongolian Plants is challenging due to a lack of information (Nyambayar *et al*., 2011). More efforts to establish an inventory of Mongolian plant species should be supported to assess the degradation process.

Intensive land use is expected to increase in future, and with it degradation and species extinction are also facing due to habitat loss. Strategic implementation of a system to restore seasonal grazing and rehabilitate land is missing (Rosales & Livinets, 2006), but the extraordinarily complex situation of the grassland ecosystem in north-western Mongolia necessitates an integrated approach. The restoration of grasslands that suffer from degradation, deforestation and densification must be pursued. Implementation of appropriate community-based policies could support sustainable development of the region´s natural resources and biodiversity. While the duration of this survey was too short for any profound interpretations, we were nevertheless able to provide vegetation assessment and occurrence information on plant species in a remote und widely under-documented region of Mongolia.

Conclusion

The Mongolian native culture is well adapted to the availability of the natural resources in the region. Sustainable use of the natural resources of the Mongolian grasslands supports the continued existence of traditional land use in the north-western territories of the country. Today globalization, climate change and urbanization have a social, economic, and ecological impact. In many of the surveyed areas, the observed vegetation and species composition is affected by overgrazing and intensive land use. Our observations emphasize the important role of protected areas for the conservation of native plant species diversity in north-western Mongolia. The presented study is a detailed summary of set of botanical field observations with no claim to completeness. Further studies and investigations are urgently needed.

Acknowledgements

This field survey would not have been possible without the support of all co-authors, as well as our local guide Oyunna and translator Jagga. Classification of the observed plant species was supported by the University of Natural Resources and Life Sciences, Vienna. We would like to thank the people of Mongolia for their hospitality and openness. Finally, we would like to thank Stephan Stockinger, whose comments on English language and style helped to improve this paper.

References

Berger, J., Buuveibaatar, B. & Mishra, C. 2013. Globalization of the cashmere market and the decline of large mammals in Central Asia. *Conservation Biology*, 27(4): 679-689.

BTI, 2016. Mongolia Country Report. Gütersloh: Bertelsmann Stiftung, 2016. https://www.bti-project.org/fileadmin/files/BTI/Downloads/Reports/2016/pdf/BTI_2016_Mongolia.pdf

Catalogue of Life 2017. Species 2000 & ITIS Catalogue of Life. Species 2000 Secretariat, Leiden, Netherlands. http://www.catalogueoflife.org/content/terms-use (06.04.2017).

Christensen, L., Coughenour, M. B., Ellis, J. E. & Chen, Z. Z. 2004. Vulnerability of the Asian typical steppe to grazing and climate change. *Climatic Change*, 63(3): 351-368.

DFG, 2017. The Virtual Guide to the Flora of Mongolia. Founded by the DFG in the program "Scientific Library Services and Information Systems (LIS)": 07/2007 - 11/2010, 11/2011 - 11/2014 and a joint project of: Universität Greifswald, Universität Halle, Mongolian Academy of Science, University of Khovd, BGBM Berlin-Dahlem, Universität Kassel, Universität Osnabrück. http://floragreif.uni-greifswald.de/floragreif/ (12.04.2017).

German, D. A., Hájek, M., Hájek, O., Hájková, P., Horsáková, V., Kocí, M. & Resl, P. 2017. Refugial ecosystems in central Asia as indicators of biodiversity change during the Pleistocene–Holocene transition. *Ecological Indicators*, 76: 357-367.

Gombobaatar, S., Myagmarsuren, S., Conaboy, N., Munkhjargal, M., 2014. Convention on

Biological Diversity: the 5th National Report of Mongolia. Ministry of Environment and Green Development, Ulaanbaatar, Mongolia.

Hauck, M. H. & Solongo, Z. B., 2010. *Flowers of Mongolia*. Biermann, Telgte, Germany.

Hoekstra, J. M., Boucher, T. M., Ricketts, T. H. & Roberts, C. 2005. Confronting a biome crisis: global disparities of habitat loss and protection. Ecology Letters, 8(1): 23-29.

IUCN, 2016. *The IUCN Red List of Threatened Species. Version 2016-3*. <http://www.iucnredlist.org>. Downloaded on 06.04.2017.

Liu, Z., Liu, G., Fu, B. & Zheng, X. 2008. Relationship between plant species diversity and soil microbial functional diversity along a longitudinal gradient in temperate grasslands of Hulunbeir, Inner Mongolia, China. Ecological Research, 23(3): 511-518.

Mongolian Government. 2009. http://mofa.gov.mn/livestock

Mongolian Endemic Plants. 2017. http://www.terrestrial-biozones.net/Endemic%20Floras/Mongolian%20Endemics.html. Downloaded on 12.04.2017.

Nyambayar, D., Oyuntsetseg, B., & Tungalag, R. 2011. Regional Red List Series Vol. 9. Plants (Part 1). Zoological Society of London, National University of Mongolia. (In English and Mongolian) http://zslsites.org/assets/nrl/Plant_Red_List_English_For_Original.pdf

Pyak, A. I., Shaw, S. C., Ebel, A. L., Zverev, A. A., Hodgson, J. G., Wheeler, B. D. & Oyunchimeg, D. 2008. *Endemic Plants of the Altai Mountain Country*. Hampshire: Wild Guides.

Rechinger, K. H. 1999. *Flora Iranica, Vol. 175. Papilionaceae IV, Astragalus II*. Akademische Verlagsgesellschaft.

Shagdar, D. & Yadamsuren, O. 2017. Plant species composition and vegetation cover of Kherlen Toono Mountain, Mongolia. *Journal of Asia-Pacific Biodiversity*, 10(1): 132-136.

Suttie, J.M. 2006. Country Pasture/Forage Resource Profiles Mongolia. FAO, Rome, Italy. http://www.fao.org/ag/agp/agpc/doc/counprof/PDF%20files/Mongolia.pdf

Tuvshintogtokh, I. 2014. Grassland in Mongolia and Their Degradation Indicator Plants. Institute of Botany, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia. https://www.researchgate.net/profile/Indree_Tuvshintogtokh2/publication/271509448_GRASSLAND_IN_MONGOLIA_AND_THEIR_DEGRADATION_INDICATOR_PLANTS

Rosales, M. & Livinets, S. 2006. Grazing and Land Degradation in Cis Countries and Mongolia. Environment and Development Initiative (LEAD) Animal Production and Health Division FAO. http://www.fao.org/fileadmin/templates/lead/pdf/e-conf_05-06_background.pdf

Urgamal, M., Oyuntsetseg, B. & Nyambayar, D. 2013. Synopsis and recent additions to the flora of Mongolia. *Proceedings of the Institute of Botany, Mongolian Academy of Sciences*, 25: 53-72.

*****

Annex 1. Floristic checklist of plant species at 15 locations in north-western Mongolia, recorded in June and July 2016.

Plant species	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Aconitum barbatum PATRIN EX PERS.															+
Aconitum septentrionale KOELLE											+				
Agropyron cristatum (L.) GAERTN.		+			+										
Allium cf. prostratum TREVIR.				+											
Allium flavovirens REGEL														+	
Allium sp.				+											
Alyssum obovatum (C.A.MEY.) TURCZ.							+								
Androsace sp.							+								
Artemisia adamsii BESSER												+			
Artemisia frigida WILLD.												+			
Artemisia gmelinii WEBER EX STECHM.						+									
Artemisia palustris L.					+							+	+	+	
Artemisia sp.				+								+			
Aster alpinus L.							+								
Asteraceae sp.										+					
Asterothamnus centrali-asiaticus NOVOPOKR.				+											
Bassia prostrata (L.) A.J.SCOTT				+											
Betula cf. microphylla BUNGE							+								
Betula fruticosa PALL.							+								
Bistorta vivipara (L.) S.F.GRAY							+				+				
Blysmus compressus (L.) PANZ. EX LK.	+														
Bromus sp.					+										+
Bupleurum scorzonerifolium WILLD.												+			
Campanula stevenii M.BIEB. ssp. *turczaninovii*								+			+				
Caragana pygmaea (L.) DC.	+														
Caragana sp.					+										
Carex cf. pachystelis J.GAY							+								
Carex cf. physodes M.BIEB.						+									
Carex cf. stenophylla WAHLENB.										+					
Clausia aprica (STEPHAN) TROTSKY													+		
Kochia prostrata (L.) C. Schrad.			+												
Minuartia sp.								+							
Oxytropis filiformis DC.					+										
Peucedanum baicalense (REDOWSKY EX WILLD.) KOCH								+							
Chenopodiaceae sp.				+											
Chenopodium glaucum L.						+									
Chenopodium sp.												+			
Cirsium esculentum C.A.MEY.												+			
Crepidifolium akagii (KITAG.) SENNIKOV				+											
Cyperaceae sp.					+	+						+			
Delphinium grandiflorum L.															+
Dendranthema zawadskii (HERBICH) TZVELEV											+				
Dianthus chinensis L.					+										+
Dianthus sp. L.	+														
Dianthus superbus L. *ssp. superbus*							+								
Dontostemon integrifolius (L.) LEDEB.			+		+								+		
Dracocephalum foetidum Bunge												+			
Echinops sp.			+												
Elymus cf. repens (L.) GOULD						+						+			
Ephedra sinica STAPF				+											
Eremopyrum orientale (L.) JAUB. & SPACH													+		
Erigeron sp.								+							
Eriophorum angustifolium HONCK.					+										
Eritrichium villosum (LEDEB.) BUNGE							+								
Galatella macrosciadia DC.				+											
Galium verum L.										+					
Gentiana decumbens L.F.										+					
Gentiana sp.										+					
Geranium pseudosibiricum J.MAYER															+
Goniolimon speciosum (L.) BOISS.												+	+		
Halerpestes sarmentosa (ADAMS) KOM.	+	+								+					
Heteropappus biennis (LEDEB.) TAMAMSCH. EX GRUB.														+	
Hypochaeris sp.						+									
Inula britannica L.												+			

Inula sp.	+														
Juncus castaneus SM. *ssp. leucochlamys*		+													
Koeleria cristata PERS.						+				+		+			
Lappula sp.					+										
Leontopodium ochroleucum BEAUVERD							+								
Lotus corniculatus L.	+														
Medicago ruthenica TRAUTV.	+														
Medicago sp.	+														
Minuartia sp.							+								
Myriophyllum spicatum L.						+									
Nepeta multifida L.															+
Oxytropis ambigua (PALL.) DC.								+							
Oxytropis filiformis DC.											+				
Papaver nudicaule L.															
Parnassia palustris L.										+					
Pedicularis cf. uliginosa BUNGE										+					
Pedicularis elata WILLD.											+				
Pedicularis longiflora RUDOLPH									+						
Pedicularis myriophylla PALL.								+							
Plantago cf. salsa PALL.	+														
Potamogeton filiformis PERS.						+									
Potentilla acaulis L.						+									
Potentilla cf. conferta BUNGE							+								
Potentilla fruticosa L.											+				
Pulsatilla sp.													+		
Ranunculus cf. japonicus THUNB.											+				
Ranunculus trichophyllus CHAIX EX VILL.										+					
Rosa sp.											+				
Salix cf. ledebouriana TRAUTV.	+														
Salix retusa L.								+							
Salix sp.										+					
Sanguisorba officinalis L.							+				+				+
Scabiosa comosa FISCH. EX ROEM. & SCHULT.														+	+
Scutellaria grandiflora SIMS	+				+										
Sedum aizoon L.															+
Silene repens PATRIN															+
Stellaria dichotoma L.					+										
Stipa cf. capensis THUNB.													+		
Stipa tianschanica ROSHEV.			+												
Thymus gobicus CZERN.						+						+	+		
Tribulus terrestris L.	+	+													
Veronica austriaca L. *agg.*													+		
Veronica pinnata L.													+		
Veronica spicata L. *ssp. incana*							+								