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FLORISTIC COMPOSITION AND BIOLOGICAL SPECTRUM OF THE BOGDKHAN MOUNTAIN, MONGOLIA

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Abstract

The Bogdkhan mountain of Mongolia is strictly protected and possesses a unique ecosystem, because of its location in the transitional zone of Siberian taiga and the Asian steppe. Floristic composition and the biological spectrum of the Bogdkhan Mountain were studied during July 2019 to September 2020. A total of 522 vascular plants were recorded belonging to 249 genera and 63 families. Asteraceae was found to be the most dominant family (13.22%; 33 genera and 69 taxa) followed by Poaceae (8.43%; 21 genera and 44). The classified life-form spectra of all the species recorded from the study area revealed the predominance of hemicryptophytes (63.03%) followed by geophytes (11.30%), therophytes (10.34%), phanerophytes (9.58%), chamaephytes (5.36%), and hydrophytes (0.38%). The notable changes found in the biological spectrum, which are chamaephytes from 12 to 5.36%, geophytes from 8 to 11.30% and therophytes from 8 to 10.34%. Variaty of reasons might cause change the life form, such as climate change, anthropogenic impacts, etc. Hemicryptophytes and chamaephytes dominate the flora of the mountain due to the cold mountain niche. The floristic diversity of this mountain tends to decline further videnced from the observed lesser divergence values of geophytes and therophytes.

Introduction

The Bogdkhan Mountain is one of the well known protected areas of Mongolia and the oldest continuously protected areas of the world (Jargal, 2003; Wurts, 2013) and is located in the southwest of the Khentei Mountain range (Tsegmid, 1969). Phytogeographically, it is included in the region of Khentei mountain taiga (Junatov, 1977; Grubov, 1982; Ulziikhutag, 1989), also to the region of Transbaikalian mountain – hillock forest-vegetation following forest-vegetation classification (Junatov, 1977; Tsedendash, 1995). Previous studies recorded 2823 taxa of vascular plants belonging to 662 genera and 128 families for the flora of Mongolia, out of which 1087 species were recorded from the region of Khentei mountain taiga (Gubanov, 1996). In addition, 44 taxa of vascular plants were further added for Khentei Mountains (Dulamsuren and Mühlenberg, 2003).

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The Bogdkhan Mountain is in a mountainous forest-steppe zone with a predominance of larch forests, rich pine forests, spruce forests that follow the upper reaches of small mountain ranges and very small areas of pine (Junatov, 1977; Ganbold *et al.*, 1993; Dugarjav, 2006). This area is considered to be the southern border of the Mongolian taiga forest. The steppe vegetation is broadly distributed on this mountain slopes and meadow steppe and meadow vegetation can be seen at the foot of the mountain and sub-belts such as pseudo-taiga, subtaiga, taiga and subgoltsy (Tsedendash, 1995).

The first floral investigation in the Bogdkhan Mountain, was carried out by the Soviet-Mongolian Joint Biological Expedition team in 1989-1990 which recorded 579 species belonging to 259 genera and 69 families (Ganbold *et al.*, 1993). Further, 26 species were newly added to this list by Hilbig *et al.* (2004). The vegetation of the Bogdkhan Mountain, categorized under 17 different vegetation communities comprising of four altitude levels (hillock, lower montane, upper montane, and subalpine belt), grouped under 20 distribution types (Hilbig *et al.*, 2004). However, Enkhmaa (2015) recorded 746 species belonging to 295 genera and 75 families, however, the checklist and information of herbarium where the collections were deposited, were not provided. In addition, Sanchir (2008), and Enkhmaa (2017) reported a number of threatened and economically useful plants from this area.

In terms of climate change in Mongolia, there is a temperature rise by 1.66°C during 1940 to 2001 (Batima *et al.*, 2005). According to an estimate, the temperature is further expected to rise by 5-7°C, along with summer precipitation by 40-60 mm till 2100 in mountainous regions (Bayasgalan *et al.*, 2009). Hence, changes in vegetation communities and between ecosystems have been increasing (Dulamsuren *et al.*, 2011; Natsagdorj, 2012; Bolormaa *et al.*, 2017).

Considering the above facts, the ecosystem of Bogdkhan Mountain is vulnerable because of its isolated location at the southernmost point of the Khentei Range, which is adjacent to the steppe to the south and closest to the most densely populated Ulaanbaatar city. The Bogdkhan Mountains have further been exposed to tourism, construction, and approach roads (Erdenechimeg, 2013; Naranbaatar *et al.*, 2018; Gradel *et al.*, 2019). Tourism operations are actively developing 'ger' (Mongolian traditional house) camps in 24 valleys; and about 17 thousand livestock graze in Bogdkhan Mountain (Erdenechimeg, 2013; Naranbaatar *et al.*, 2018). It was documented that 22.4% of pastures were overgrazed and 10.9% were polluted or damaged (Erdenechimeg, 2013). The landscape cover decreased by 0.8 - 2.6% in the forest, meadow, and shrub area, and the steppe area increased by 1.5% (Naranbaatar *et al.*, 2018). Moreover, many regular activities such as jogging, hiking, skiing, the traditional prayer for mountain, and shamanic rituals, and other seasonal activities such as picking nuts, fruits, and mushrooms have negatively affected the flora of the Bogdkhan Mountain to some extent (Erdenechimeg, 2013; Naranbaatar *et al.*, 2018).

Therefore, we aimed to conduct detailed floral investigations for the Bogdkhan Mountain and to understand its floristic composition, diversity and ecology. We hypothesized that the Bogdkhan Mountain ecosystem might be changing rapidly and becoming more vulnerable because of its geographical-transitional location and diverse drivers. Furthermore, investigation of vegetation and diversity will allow a better understanding of the natural changes which may ultimately contribute to efficient management of the protected areas of Mongolia.

Materials and Methods

Study area: The Bogdkhan Mountain is a protected area located 30-40 km south of Ulaanbaatar city with relative altitude of 1200-1500 m, and absolute altitude of 2268 m above sea level with its highest peak, called Tsetsee-Gun (Fig. 1). The mountain area is 41,651 ha, thereof forest area covering 53.2% or 22,129 ha square (Shirendev and Munkhtuya, 2015). Tuul River,

one of the biggest rivers in Mongolia flows by northern downhill of Bogdkhan Mountain. The topography is alpine, rugged and mostly steep and streams originated from the valleys (MNEM, 1998). The main annual average temperature is -0.5 ºC, the coldest month is January, with a minimum average temperature of -22.5 ºC, and the warmest month is July, with a maximum average temperature of 18.7ºC. The average WI and CI for three stations are 45.1 and -41.9, respectively. The annual average total precipitation is 268.5 mm, and summer precipitation occurs between May and September and accounts for 86.5% of the total annual rainfall (Table 1).

Table 1. Climate united data of stations located in the near Mt. Bogdkhan, Mongolia.

Station name	Average temperature (°C)			Index		Precipitation	
	Year	Jan.	Jul.	Warmth	Coldness	Total (mm)	Summer (%)
Buyant-Ukhaa	-1.4	-25.5	19.4	46.6	-53.8	244	86.7
Zuunmod	-0.4	-20.6	18.1	42.9	-38.8	258.9	85.4
Amgalan	0.2	-21.3	18.7	45.9	-33	302.5	87.5
Average	**-0.5**	**-22.5**	**18.7**	**45.1**	**-41.9**	**268.5**	**86.5**

Taxonomic method: Fourty field surveys were conducted 5 times during flowering seasons in June, July, August of 2019; July and August of 2020. Twenty-five sampling points, including eleven largest valleys of Bogdkhan Mountain, were targetted during the field trip and 1200 voucher specimens were collected from mountain steppe, mountain slopes, meadow, riverside, forest fringes, larch forest, pine forest, spruce forest, mixed forest, and rocks (Fig. 1; Table 2).

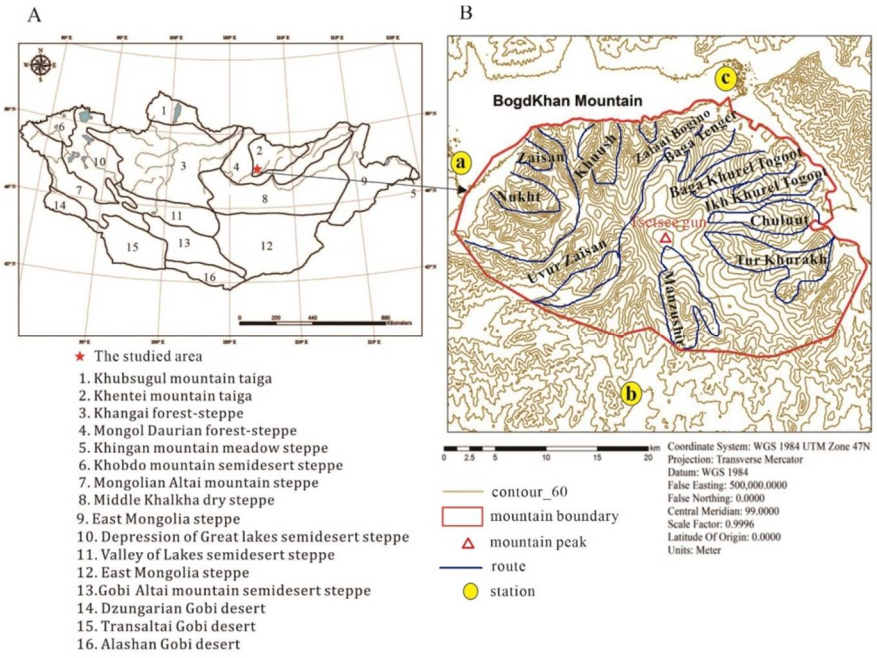

Fig. 1. A. Geographical location of Bogdkhan Mountain belongs a region of Khentei mountain taiga (2), according to phytogeographical 16 regions with names in Mongolia by Ulziikhutag (1989). B. Route map of the studied area in Bogdkhan Mountain, and marked location of meteorological stations: a – Buyant-Ukhaa, b – Zuunmod, c – Amgalan.

Samples of each taxon were prepared following standard herbarium techniques (Maden, 2004) and deposited in the Herbarium of Natural History Museum of Mongolia (MMNH). These specimens were identified using the key to the Vascular Plants of Mongolia (Grubov, 1982) and several volumes of Flora of Mongolia (Nyambayar, 2009; Urgamal, 2009; Dariimaa, 2014; Dariimaa and Saruul, 2017; Dariimaa *et al.*, 2015). Plant classification followed APG IV (2016), and nomenclature according to Plants of the World Online (POWO, 2020), and International Plant Names Index (IPNI, 2020).

Table 2. The locations with habitat and coordinate data.

Site no.	Location	Habitat	Period	GPS data	Voucher code
1	Baga Tenger	Mountain steppe; larch-birch forest;	20-22 Jul. 2019; 10-11 Aug. 2020	47.7874920˚ N; 106.951960˚ E; 1503 m	BT
2	Chuluut	Mountain steppe; meadow; rocks	27-28 Jul. 2020	47.829890˚ N; 106.105490˚ E; 1522.6 m	Ch
3	Baga Khurel togoot	meadow; larch forest; rocks	22-23 Jun. 2019	47.8677˚ N; 107.0535˚ E; 1584 m	SR
4	Khuush	Meadow; mixed forest; rocks	26-27 Jun. 2019; 20-21 Jun. 2019	47.863433˚ N; 106.8703˚ E; 1593 m	Kh
5	Manzushir	Meadow; pine forest; mixed forest; alpine meadow and spruce forest	28-30 Jul. 2019; 10-15 Aug. 2019; 04-06 Aug. 2020;	47.780330˚ N; 106.994830˚ E; 2006 m	M
6	Nukht	Mixed forest; mixed forest	01 Aug. 2019; 29 Aug. 2020	47.79225˚ N; 106.849567˚ E; 1606 m	N
7	Uvur Zaisan	Riverside; forest fringe, mixed forest; rocks	27-29 Aug. 2019; 21-22 Aug. 2019	47.794083˚ N; 106.899767˚ E; 1756.9 m	UZai
8	Ikh Khurel togoot	Mountain slopes, riverside; larch forest fringes	29-30 Jun. 2019; 04-05 Aug. 2020	47.877133˚ N; 107.04225˚ E; 1374 m	KhT
9	Tur Khurakh	Mountain steppe; meadow; rivesrside; larch forest; mixed forest; rosks	05-12 Jul. 2019; 14-16 Jun. 2019; 28-30 Jul. 2020; 20-22 Aug. 2020	47.783260˚ N; 107.115530˚ E; 1513 m	TKh
10	Zaisan	Mountain steppe; larch forest, forest fringe; riverside; rosks	17-18 Jun. 2019; 24-26 Jul. 2020	47.860667˚ N; 106.9074˚ E; 1468 m	Zai
11	Zalaat Bogino	Mountain steppe	03 Aug. 2020	47.8882050˚ N; 106.974340˚ E; 1244.4 m	ZalB

The analysis of floristic characteristics was based on the total number of species including the collection of vascular plant specimens in investigated areas. Besides, earlier specimens collected from the study area and deposited in the herbaria such as Moscow University (MW), Central Siberian Botanical Garden (NSK), Gatersleben (GAT), Institute of Botanical Garden and Research, Mongolian Academy of Science (UBA), National University of Mongolia (UBU), and Natural History Museum of Mongolia (MMNH) were also consulted. In table 6, family and taxa names are listed in alphabetical order and each is presented with the following information: accepted name with authority, family name, life-form, chorotypes, global and regional red list categories, endemism, and relict. A biogeographical analysis was performed according to Tolmachev (1974)

and Ganbold (2010) based on plant distribution and phytogeographic origin. Each taxon was categorized into five large distributional groups; the Asian group was divided into 8 subgroups. Chorotypes, life-form are marked with their abbreviations (Table 6). Threatened species were defined according to International Union for Conservation of Nature (IUCN, 2020); Regional Red List (Nyambayar *et al.*, 2011; Tsendeekhuu *et al.*, 2019) and Mongolian Red Book (Shiirevdamba *et al*., 2013). Endemism was defined according to the conspectus of flora in Mongolia (Urgamal *et al.*, 2014; Urgamal and Ouyntsetseg, 2017) and relict plants were noted according to Ulziikhutag (1989).

Statistical analysis: Floristic similarities to phytogeographical regions of Mongolia were compared using Jaccard similarity coefficiant (Niwattanakul *et al.*, 2013).

Plant life-forms were defined according to Raunkiear's classification (1934) based on the position of renewing buds in concern to the soil surface: phanerophytes (Ph), chamaephytes (Ch), hemicryptophytes (H), geophytes (G), hydrophytes (Hy) and therophytes (Th). We computed the proportion of species in each life-form class, compared with Raunkiaer's normal spectrum using a chi- square test ($\dot{X}^2$) (Moradi *et al.*, 2010).

$$x^2 = \frac{\sum(O-E)^2}{E};$$

$\dot{X}^2$-chi square; *O*-Observed value; *E*-Expected value

In addition, Pearson correlation was applied to compare the result life-form spectrum of the present study with different studies.

$$r = \frac{\sum(x - \dot{x})(y - \dot{y})}{\sqrt{\sum(x - \dot{x})^2}\sqrt{\sum(y - \dot{y})^2}}$$

r -correlation coefficient; x -values of the x-variable in a sample; $\dot{x}$ -mean of the values of the x-variable; y -values of the y-variable in a sample; $\dot{y}$ -mean of the values of the y-variable.

Results and Discussion

Floristic composition: The present study revealed 522 vascular plants taxa belonging to 249 genera, 63 families for the flora of Bogdkhan Mountain (Table 6). These taxa belong to 4 classes, each including 11 Pteridophytes, 8 Gymnosperms, 97 Monocots and 406 Dicots (Table 3). The most dominant family was found to be Asteraceae (13.22%; 33 genera/69 taxa), followed by Poaceae (8.43%; 21/44), Rosaceae (7.85%; 18/41), Fabaceae (6.70%; 11/35), Ranunculaceae (5.94%; 12/31), Cyperaceae (4.02%; 2/21), Brassicaceae (3.64%; 15/19), Caryophyllaceae (3.64%; 9/19), Lamiaceae (3.26%; 12/17), Salicaceae (3.45; 2/18), comprising 59.77% of all species on the mountain (Fig. 2). The flora of Bogdkhan mountain is similar by 73% or similarity coefficient 0.73 to Khentei mountain taiga region (number of region is 2), 62.5% to the Khingan mountain meadow steppe (5), 61% to Middle Khalkha dry steppe (8) (Fig. 3).

Biological spectrum: Of the total species recorded from the study area, 88.31% are herbs (461 taxa), 5.55% shrubs (29), 5.17% trees (27), 0.57% creepers (3) and 0.38% climbers (2). The biological spectrum showed that hemicryptophytes were the dominant life-forms, accounted for 329 species, 63.03% of all species in the mountain, followed by geophytes 59 (11.30%), therophytes 54 (10.34%), phanerophytes 50 (9.58%), chamaephytes 28 (5.36%) and hydrophytes 2 (0.38%) (Table 4). In addition, the observed flora was compared with Raunkiaer's (1934) normal spectrum which accounts for altitudinal zones in the northern cold temperate. The $\dot{X}^2$ test results showed significant differences between the Bogdkhan Mountain and Raunkiaer's normal spectrum (p<0.05). The observed proportions were higher than expected for the phanerophytes, geophytes

and therophytes. Chamaephytes (3.67) had the highest individual value determined from the X^2 test, followed by geophytes (1.36) and therophytes (0.69) (Table 4).

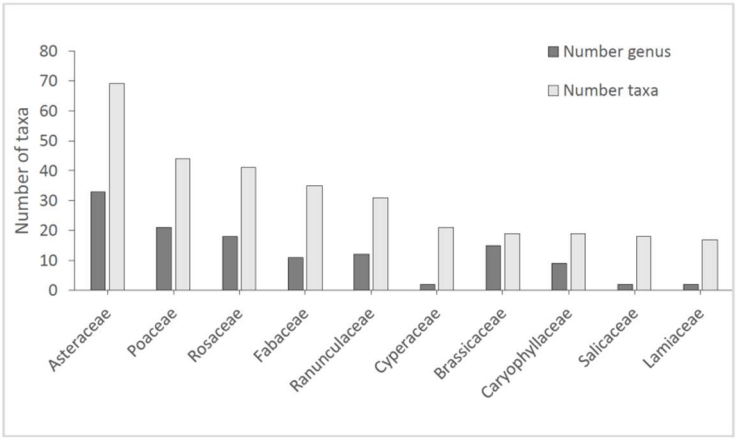

Fig. 2. The richest families occupying percentage, their number of genera and taxa.

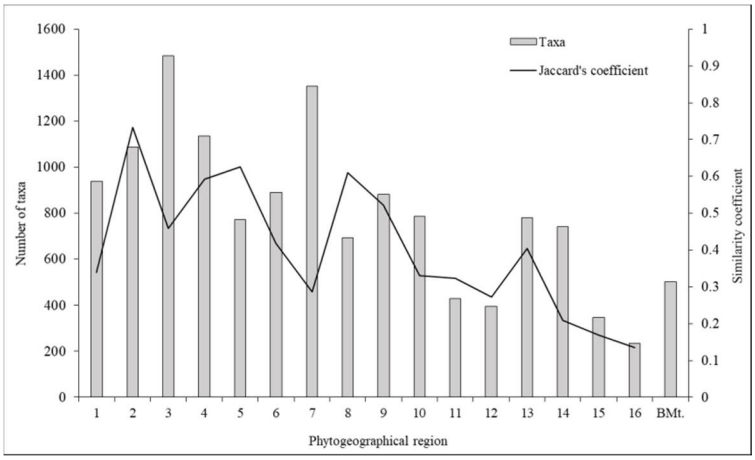

Fig. 3. Similarity coefficients of Bogdkhan Mountain (BMt.) compared to phytogeographical regions (names of 16 regions shown in Fig. 1).

We compared the life-form spectrum of the present study with the results of previous studies that were conducted in neighboring phytogeographical regions (Table 5). There was a likeness between neighbor phytogeographical regions. The results of X^2 test and correlation analysis demonstrated a significant correlation between the life-form spectrum in the Bogdkhan Mountain and those of other studies investigated in the neighboring regions which are Khangai and Mongol Daurian forest-steppe, Middle Khalkha dry steppe.

Chorological distribution: Species geographical distribution showed 5 groups viz. Cosmopolitan (10 taxa; 1.92% of the total flora), Asia-American (17 taxa; 3.26%), Holarctic (68 taxa; 13.03%), Eurasian (156 taxa; 29.89%) and Asian (271 taxa; 51.92%). The most important global distribution occurs in the Asian category with 8 subgroups. The South Siberia-Mongolian

and East Asian elements represent 58 taxa each (11.11% of the total flora), followed by East-Siberia-Mongolian 46 (8.81%), Asian Endemic 40 (7.66%), Central Asian 31 (5.94%), Altai-Dzungaria-Mongolian 17 (3.26%), Siberia-Mongolia 16 (3.07%) and Mongolian Endemic 5 (0.96%) (Fig. 4).

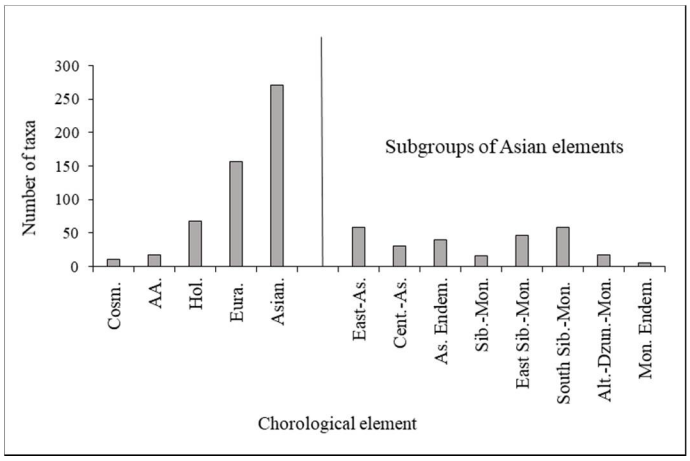

Fig. 4 The number of taxa for chorological elements to total flora of Bogdkhan Mountain in Mongolia. Abbreviation: Chorological groups: Cosmopolitan (Cosm.), Asia–American (AA), Holarctic (Hol.), Eurasian (Eura.), Asian (As.); subgroups: Eastern Asian (East. As.), Central Asian (Cent. As.), Asian Endemics (As. Endem.), Siberia-Mongolian (Sib.-Mon.), East Siberia-Mongolian (East Sib.-Mon.), South Siberia Mongolian (South Sib.-Mon.), Altai–Dzungarian Mongolian (Alt.-Dzun.-Mon.), and Mongolian Endemic (Mon. Endem.).

Table 3. Floristic composition in the Bogdkhan Mountain, Mongolia.

Group and class		Family	Genus	Species	Subspecies	Variaty	Total of taxa
Pteridophyta		6	9	11	-	-	11
Gymnosperm		3	5	7	-	1	8
Angiosperm	Monocots	9	35	94	3	-	97
	Dicots	45	200	393	12	1	406
Total		**63**	**249**	**505**	**15**	**2**	**522**

Table 4. Comparison of the biological spectrum between Mt. Bogdkhan and Raunkiaer's normal spectrums.

Life-form	Ch	Ph	H	G	Hy	Th	Total
Species number	28	50	329	59	2	54	522
Biological spectrum	5.36	9.58	63.03	11.30	0.38	10.34	100
Raunkiear's normal spectrum	12	8	63	8	1	8	100
Deviation	6.64	-1.58	-0.03	-3.30	0.62	-2.34	-
X^2	**3.67**	0.31	0.00	**1.36**	0.38	**0.69**	**6.41**

IUCN categories and endemism: A total of 96 taxa occurring in the study area are listed in the IUCN (global) Red List, including 2 categorized as Near Threatened species (e.g., *Allium altaicum* and *Diplazium sibiricum*). A total of 88 species (or taxa) are listed under Least Concern, 5 as Data

Deficient and one Not Evaluated (*Elymus sibiricus*) categories. According to the (regional) Mongolian Red List, 32 taxa have been registered as threatened, with 1 Critically Endangered species (*Neottia camtschatea*), 2 Endangered (*Juniperus pseudosabina* and *Juniperus sabina*), 8 Vulnerable (*Saussurea latifolia, Solidago dahurica, Sambucus williamsii, Caryopteris mongholica, Chelidonium majus, Allium altaicum, Corallorhiza trifida* and *Festuca komarovii*), 9 Near Threatened, and 11 Least Concern species.

Table 5. Comparison of results in the studied area and other studies conducted in Mongolia.

References	Present study	Bataa, 2013	Tserendulam *et al.*, 2018	Batdelger *et al.*, 2021
Phytogeographical region	Khentei mountain taiga	Mongol Daurian forest-steppe	Middle Khalkha dry-steppe	Khangai forest-steppe
Location	Bogdkhan Mt.	Khongor district	Hustai National Park	Ulziit Mt.
Elevation (m)	1200-2268	700-1500	750-1843	2100-2953
Annual precipitation (mm)	268.5	322	222	199
Annual temperature (^{o}C)	-0.5	3	0	-3.5
Ph	9.58	2	8.7	8.28
Ch	5.36	5	5.1	1.91
H	63.03	70	56.8	71.97
G	11.3	15	10.5	7.32
Hy	0.38	-	0.2	0.64
Th	10.34	8	18.7	9.87
Total species	522	141	493	314
X^2 with this study	0	9.04	6.92	5.82
Pearson Correlation	**1**	**0.989**	**0.988**	**0.995**

In the Mongolian Red Book, 7 species, viz. *Solidago dahurica, Sambucus williamsii, Rhododendron dauricum, R. parvifolium, Gentiana macrophylla, Juniperus sabina* and *Neottia camtschatea* were mentioned under "very rare" (critically endangered of IUCN catagory) category. In the flora of Bogdkhan Mountain, 5 endemics (*Taraxacum ussuriense, Oxytropis pseudoglandulosa, Thermopsis alpina, Caryopteris mongholica, Thymus gobicus*), and 3 relict (*Allium altaicum, Thermopsis alpina* and *Haplophyllum dauricum*) species were recorded.

Our results indicate that the Bogdkhan Mountain has relatively high species diversity. The richest families are Asteraceae and Poaceae in this mountain which is due to the high reconcilability with arid and semi-arid climate condition (Kargar *et al.*, 2017), and these richest families are also commonly registered to the other plant composition studies of Mongolian flora and vegetation (Gubanov, 1996; Bataa, 2013; Enkhmaa, 2015; Tserendulam *et al.*, 2018; Batdelger *et al.*, 2021). The Bogdkhan Mountain flora is most similar to that the region of Khentei mountain taiga (coefficient 0.73), because of the transitional location for the geographical and phytogeographical region. Previously, the Bogdkhan Mountain was considered under the phytogeographical region of Khentei taiga mountain (Ulziikhutag, 1989).

For biological spectrum, we compared our results with the earlier studied three different phytogeographical regions (Khongor district in the forest-steppe of Mongol-Daurian, Khustai National Park in the steppe of Middle-Khalkha, Ulziit Mountain in the forest-steppe of Khangai Mountain). Correlation coefficient was found to be very similar (0.989; 0.988; 0.995) to each other. The study showed that all study areas were in the same cold temperate zone of climate condition. Despite the similarity of the biological spectrum, the vegetation structure and species composition of the flora were considerably different (Fig. 4).

Table 6. Taxa list for the Vascular plant flora of the Bogdkhan Mountain, Mongolia.

Scientific name	Voucher code	Life-form	Chorotype	Global Red list	Regional Red list	Mongolian Red book	Endemism	Relict
1. Adoxaceae E. Mey.								
Adoxa moschatellina L.	Kh323-1	G	Hol.					
Sambucus williamsii Hance	TKh082	Ph	East As.		VU	VR		
2. Amaranthaceae Juss.								
Axyris amaranthoides L.	M662	Th	Hol.					
A. hybrida L.	UZai150-5	Th	Alt.-Dzun.-Mon					
Chenopodiastrum hybridum (L.) S.Fuentes, Uotila & Borsch	Zai228	Th	Hol.					
Ch. album L.	KhT008	Th	Cosm.					
Corispermum mongolicum Iliin	KhT009	Th	Cent.-As.					
3. Amaryllidaceae J.St.-Hil.								
Allium altaicum Pall.	Tkh013	G	Cent.-As.	NT	VU		SubEn	R
A. amphibolum Ledeb.	Ch028	G	South Sib.-Mon.					
A. anisopodium Ledeb.	NSK0061803	G	East As.					
A. bidentatum Fisch. ex Prokh. & Ikonn.-Gal.	GAT0007968; MW0173326	G	Alt.-Dzun.-Mon					
A. eduardi Stearn ex Airy Shaw	SR008	G	Cent.-As.					
A. leucocephalum Turcz. ex Ledeb.	UZai645	G	East Sib.-Mon.					
A. maximowiczii Regel	TKh486	G	East Sib.-Mon.		NT			
A. polyrhizum Turcz. ex Regel	Kh511	G	Alt.-Dzun.-Mon.				SubEn	
A. prostratum Trevir.	NSK0061830	G	East As.	DD				
A. ramosum L.	KhT024	G	Eura.	LC	LC			
A. schoenoprasum L.	UZai150-2	G	Hol.	LC				
A. tenuissimum L.	GAT0007943	G	South Sib.-Mon.					
A. victorialis L.	TKh559; M043	G	Eura.					
4. Apiaceae Lindl.								
Aegopodium alpestre Ledeb.	MW0186138	H	South Sib.-Mon.					
Angelica decurrens (Ledeb.) B.Fedtsch.	TKh135	H	Eura.					
Anthriscus sylvestris (L.) Hoffm.	M010	H	Eura.					
Bupleurum bicaule Helm	SR031	H	East As.					
B. scorzonerifolium Willd.	SR421	H	As. Endem.					
Carum carvi L.	Zai230	H	Eura.	LC				
Kadenia salina (Turcz.) Lavrova & V.N.Tikhom.	Ch033	H	Sib.-Mon.					
Peucedanum vaginatum Ledeb.	MW0186674	H	South Sib.-Mon.					
Seseli condensatum (L.) Rchb.f.	MW0186232	H	South Sib.-Mon.					
S. seseloides (Fisch. & C.A.Mey. ex Ledeb.) M.Hiroe	Kh-T31	H	East As.					
Sphallerocarpus gracilis (Besser ex Trevir.) Koso-Pol.	TKh173	H	East As.					

Scientific name	Voucher code	Life-form	Chorotype	Global Red list	Regional Red list	Mongolian Red book	Endemism	Relict
5. Asparagaceae Juss.								
Maianthemum bifolium (L.) F.W.Schmidt	KhTo382	G	Eura.					
Polygonatum odoratum (Mill.) Druce	Ch045	G	Eura.	LC				
6. Aspleniaceae Newman								
Cystopteris fragilis (L.) Bernh.	N129	H	Eura.	LC				
Diplazium sibiricum (Turcz. ex Kunze) Sa.Kurata	UBU19690617	H	Eura.	NT				
Gymnocarpium jessoense (Koidz.) Koidz.	MW0168154	H	South Sib.-Mon.	LC				
7. Asteraceae Bercht. & J.Presl								
Achillea asiatica Serg.	MW0191966	H	Eura.					
A. millefolium L.	M522	H	Hol.	LC				
Antennaria dioica (L.) Gaertn.	UBU19860803	H	Eura.	LC				
Arctogeron gramineum (L.) DC.	UBU20060618	H	South Sib.-Mon.					
Artemisia adamsii Bess.	TuP09	Ch	East Sib.-Mon.					
A. annua L.	TKhP155	Th	Eura.					
A. dracunculus L.	KhT019	Ch	Hol.					
A. freyniana (Pamp.) Krasch.	Ch-Zam003	H	East As.					
A. frigida Willd.	UZai642	Ch	Hol.					
A. glauca Pall. ex Willd.	KhT017	Ch	Hol.					
A. gmelinii Weber ex Stechm.	Kh515	Ch	As. Endem.		LC			
A. integrifolia L.	TKh493	H	South Sib.-Mon.					
A. laciniata Willd.	SR9-1	H	Eura.					
A. macrocephala Jacquem. ex Besser	TKh041	Th	Cent.-As.					
A. mongolica (Fisch. ex Besser) Nakai	KhT22-3	H	Cent.-As.					
A. scoparia Waldst. & Kit.	MMNH2016.1.224	H	Cent.-As.					
A. sericea Weber ex Stechm.	MP101	H	Eura.					
A. sieversiana Ehrh. ex Willd.	KhT006	Th	Eura.					
A. tanacetifolia L.	MW0193204	H	Eura.					
Aster alpinus L.	SR9-6	H	Eura.					
A. biennis Ledeb.	TKh010	Th	East As.					
A. hispidus Thunb.	KhT011	Th	East As.					
Carduus crispus L.	Tkh012	Th	Eura.					
C. nutans L.	N007	Th	Eura.		LC			
Chrysanthemum zawadzkii Herbich	TKh047	H	Eura.	DD				
Ch. zawadzkii subsp. *peleiolepis* (Trautv.) Zuev	MW0192116	H	Sib.-Mon.					
Cirsium esculentum (Siev.) C.A.Mey.	TKh557	H	Eura.					

Scientific name	Voucher code	Life-form	Chorotype	Global Red list	Regional Red list	Mongolian Red book	Endemism	Relict
Crepidiastrum tenuifolium (Willd.) Sennikov	TKh077	H	As. Endem.					
Crepis crocea (Lam.) Babc.	MW0194822	H	East Sib.-Mon.					
Echinops latifolius Tausch	Zai019	H	East Sib.-Mon.					
Erigeron acris L.	M661	H	Hol.					
E. lonchophyllus Hook.	TKh080	H	AA	LC				
Filifolium sibiricum (L.) Kitam.	TKhP90	H	South Sib.-Mon.					
Galatella dahurica DC.	SRP9	H	East As.					
Hieracium korshinskyi Zahn	TKh070	H	As. Endem.					
H. virosum Pall.	Kh509	H	Eura.					
Ixeris chinensis subsp. *versicolor* (Fisch. ex Link) Kitam.	KhT018	H	East Sib.-Mon.					
Klasea centauroides (L.) Cass. ex Kitag.	TKhP90	H	East Sib.-Mon.					
K. marginata (Tausch) Kitag.	SR410	H	As. Endem.					
Lactuca sibirica (L.) Benth. ex Maxim.	UZai635	H	Hol.	LC				
Leontopodium campestre (Ledeb.) Hand.-Mazz.	TKh060; UBU19590714	H	Cent.-As.					
L. conglobatum (Turcz.) Hand.-Mazz.	MW0191729	H	Sib.-Mon.					
L.leontopodioides Beauverd	Ch032	H	East Sib.-Mon.					
Leuzea uniflora (L.) Holub	Kh584	H	East As.					
Ligularia sibirica (L.) Cass.	TKh106	G	Eura.	DD				
Neopallasia pectinata (Pall.) Poljakov	SR002	H	Cent.-As.					
Parasenecio hastatus (L.) H.Koyama	M003	H	Eura.					
Pentanema britannicum (L.) D.Gut.Larr., Santos-Vicente, Anderb., E.Rico & M.M.Mart.Ort.	TKhP024	H	Eura.					
Saussurea amara (L.) DC.	KhT014	H	Eura.					
S. baicalensis B.L.Rob.	KhP26	H	South Sib.-Mon.					
S. latifolia Ledeb.	TKh298	H	Cent.-As.		VU			
S. parviflora (Poir.) DC.	TsG112	H	Eura.					
S. salicifolia DC.	BT442	H	South Sib.-Mon.					
S. schanginiana (Wydler) Fisch. ex Herder	TKh80	H	As. Endem.					
Scorzonera austriaca Willd.	TKh06	H	Eura.					
S. radiata Fisch. ex Ledeb.	Kh276	H	South Sib.-Mon.					
Senecio nemorensis L.	TKh103	H	Eura.					
Solidago dahurica (Kitag.) Kitag. ex Juz.	M644	G	Eura.		VU	VR		
Sonchus arvensis L.	TKh172	H	Cosm.					

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Tanacetum vulgare L.	UZai646	H	Hol.					
Taraxacum bicorne Dahlst.	MW0194475	H	Cent.-As.					
T. ceratophorum (Ledeb.) DC.	MW0194499	H	AA					
T. leucanthum (Ledeb.) Ledeb.	MP104	H	Alt.-Dzun.-Mon.					
T. longicorne Dahlst.	MW0194565	H	East Sib.-Mon.					
T. mongolicum Hand.-Mazz.	TKh039	H	East Sib.-Mon.					
T. officinale F.H.Wigg.	Zai163	H	Cosm.	LC				
T. ussuriense Kom.	TKh102	H	Mon. Endem.				En	
Tephroseris integrifolia (L.) Holub	SR408	H	Eura.					
Tragopogon trachycarpus S.A.Nikitin	MW0194307	H	East Sib.-Mon.					
8. Berberidaceae Juss**.**								
Berberis sibirica Pall.	M021	Ch	Alt.-Dzun.-Mon.					
9. Betulaceae Gray								
Betula fruticosa Pall.	TKh126; TKh159; SR11-1; TKh116	Ph	East As.	LC				
B. glandulosa Michx.	TKh63-1; M032; MW0175050; UBA738	Ph	AA	LC				
B. microphylla Bunge	Kh263; KhTo8-1; N126-1; N127-3; Uzai001	Ph	Alt.-Dzun.-Mon	LC				
B. pendula Roth	TKh104; TKh164; UZai143-1	Ph	AA	LC				
B. pendula subsp. *mandshurica* (Regel) Ashburner & McAll.	KhTo4-1; SR12-1; SR20-1; TKh147	Ph	East As.					
10. Boraginaceae Juss.								
Amblynotus rupestris (Georgi) Popov	TKh016; Zai013; MW0188217	H	South Sib.-Mon.					
Lappula intermedia (Ledeb.) Popov	SR9-3; MW0188260	Th	East Sib.-Mon.					
Mertensia davurica (Sims) G.Don	MW0188567	H	South Sib.-Mon.					
Myosotis sylvatica Hoffm.	Kh257; TKh121; Zai160; Zai004; SR9-3	H	Eura.	LC				
11. Brassicaceae Burnett								
Alyssum lenense Adams	MW0180243	Th	Cent.-As.					
Arabis hirsuta (L.) Scop.	Kh294	H	Eura.	DD				

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Capsella bursa-pastoris (L.) Medik.	ChP030	Th	Cosm.	LC				
Catolobus pendulus (L.) Al-Shehbaz	TKh045	Th	Eura.					
Clausia aprica (Stephan ex Willd.) Korn.-Trotzky	TKh138	H	Eura.					
Descurainia sophia (L.) Webb ex Prantl	TKh083	Th	Hol.					
Dontostemon integrifolius (L.) Ledeb.	TKh040	Th	East Sib.-Mon.					
Draba eriopoda Turcz. ex Ledeb.	Nt043	Th	Cent.-As.					
D. lanceolata Royle	ZB016	H	AA					
D. nemorosa L.	TKh151	Th	Hol.					
Erysimum cheiranthoides L.	TKh148	Th	Eura.					
E. flavum (Georgi) Bobrov	SR015	H	South Sib.-Mon.					
E. marschallianum Andrz. ex M. Bieb.	UZai150-1	Th	Eura.					
Lepidium densiflorum Schrad.	KhT013	Th	East Sib.-Mon.					
Noccaea cochleariformis (DC.) Á.Löve & D.Löve	Zai177	H	As. Endem.					
Odontarrhena obovata C.A.Mey.	BT007	H	As. Endem.					
Rorippa palustris (L.) Besser	TKh094	Th	Hol.	LC				
Sisymbrium loeselii L.	KhT003	Th	Eura.		LC			
Stevenia tenuifolia (Stephan ex Willd.) D.A.German	MW01880320	H	Cent.-As.					
12. Campanulaceae Juss.								
Adenophora stenanthina (Ledeb.) Kitag.	M642	H	South Sib.-Mon.					
A. tricuspidata (Fisch. ex Schult.) A.DC.	Kh506	H	East As.					
Campanula glomerata L.	KhToP01	H	Eura.					
C. stevenii subsp. *turczaninovii* (Fed.) Victorov	SR10-2	H	Eura.					
13. Caprifoliaceae Juss.								
Linnaea borealis L.	SR429	Ch	Hol.					
Lonicera caerulea subsp. *altaica* (Pall.) Gladkova	M023	Ph	Eura.					
Patrinia rupestris (Pall.) Dufr.	TsG60	H	East As.					
P. sibirica (L.) Juss.	M019	H	Eura.					
Scabiosa comosa Fisch. ex Roem. & Schult.	TKh001	H	East Sib.-Mon.					
Valeriana officinalis L.	N005-1	H	Eura.	LC				
14. Caryophyllaceae Juss.								
Cerastium glomeratum Thuill.	Zai001	Th	Eura.					
Dianthus chinensis L.	TKh105	H	Eura.					

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D. superbus L.	KhT016	H	Eura.	LC				
Eremogone capillaris (Poir.) Fenzl	TKh002	H	East Sib.-Mon.					
Gypsophila davurica Turcz. ex Fenzl	M001	H	East Sib.-Mon.					
G. vaccaria (L.) Sm.	SR402	Th	Cent.-As.					
Moehringia lateriflora (L.) Fenzl	Kh299	H	Hol.	LC				
Pseudostellaria rupestris (Turcz.) Pax	UBA711/78	H	South Sib.-Mon.					
Silene aprica Turcz. ex Fisch. & C.A.Mey.	TKh095	H	South Sib.-Mon.					
S. chamarensis Turcz.	M024	H	South Sib.-Mon.					
S. jeniseensis Willd.	Kh308	H	South Sib.-Mon.					
S. orientalimongolica Kozhevn.	MW0177641	H	Sib.-Mon.					
S. repens Patrin	SR 15-1	H	Eura.					
S. songarica (Fisch., C.A.Mey. & Avé-Lall.) Bocquet	Tkh008	H	Cent.-As.		NT			
Stellaria cherleriae (Fisch. ex Ser.) F.N.Williams	MW0177013	H	East Sib.-Mon.					
S. crassifolia Ehrh.	TKh-43	H	Hol.					
S. dichotoma L.	TKh028	H	South Sib.-Mon.		LC			
S. graminea L.	TKh141	H	Eura.					
*S. pedunculari*s Bunge	Zai237	H	Eura.					
15. Celastraceae R.Br.								
Parnassia laxmannii Pall. ex Schult.	TKh079	H	South Sib.-Mon.					
P. palustris L.	TKh526	H	Hol.	LC				
16. Convolvulaceae Juss.								
Convolvulus ammannii Desr.	TKhP141	H	Alt.-Dzun.-Mon					
C. arvensis L.	ZB030	H	Eura.					
17. Crassulaceae J.St.-Hil.								
Orostachys malacophylla (Pall.) Fisch.	SR464	H	East As.					
O. spinosa (L.) Sweet	TKh091	H	Eura.					
Phedimus aizoon (L.) 't Hart	TKh055	H	East As.		LC			
Rhodiola rosea L.	TsG156	H	Eura.	LC				
Sedum purpureum (L.) Schult.	M660	G	Eura.					
18. Cupressaceae Gray								
Juniperus communis var. *saxatilis* Pall.	M113-1	Ph	Eura.					
J. pseudosabina Fisch. & C.A.Mey.	Kh508	Ph	South Sib.-Mon.	LC	EN			
J. sabina L.	UZai648	Ph	Eura.	LC	EN	VR		
19. Cyperaceae Juss.								
C. accrescens Ohwi	MW0172379	H	East As.					

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C. amgunensis F.Schmidt	MW0171906	H	Eura.					
C. cespitosa L.	TKh42-1	H	Eura.	LC				
C. curaica Kunth.	MW0172035	H	Alt.-Dzun.-Mon.	LC				
C.duriuscula C.A.Mey.	TKh033	G	AA					
C. globularis L.	M62-4	G	Eura.					
C. iljinii V.I.Krecz.	MW0172206	H	East Sib.-Mon.					
C. korshinskyi Kom.	M101-2	H	East As.					
C. media R.Br.	MW0172294	H	Hol.					
C. melananthiformis Litv.	M114-3	H	Cent.-As.					
C. myosuroides Vill.	M114	H	AA					
C. obtusata Lilj.	MW0172352	G	Hol.					
C. orbicularis Boott	MW01723666	G	As. Endem.	LC				
C. pamirensis subsp. *dichroa* Malyschev	UZai144-1	H	Alt.-Dzun.-Mon					
C. pediformis C.A.Mey.	KhTo6-3	H	As. Endem.					
C. schmidtii Meinsh.	TKh73-1	G	East As.					
C. utriculata Boott	UZai151-3	G	Eura.	LC				
Eleocharis palustris (L.) Roem. & Schult.	M13	H	Hol.					
Eriophorum angustifolium Honck.	M039	H	Hol.	LC				
E. brachyantherum Trautv. & C.A.Mey.	MW0171498	H	AA	LC				
E. latifolium Hoppe	TKh603	H	Eura.	LC				
20. Dennstaedtiaceae Losty								
Pteridium aquilinum (L.) Kuhn	UZai632	G	Eura.					
21. Elaeagnaceae Juss.								
Hippophae rhamnoides L.	SR011	Ph	Eura.					
22. Ephedraceae Dumort.								
Ephedra monosperma J.G.Gmel. ex C.A.Mey.	TKh501	Ch	South Sib.-Mon.	LC				
23. Equisetaceae Michx. ex DC.								
Equisetum palustre L.	TKh099	G	Hol.	LC				
E. pratense Ehrh.	Kh290	G	Hol.					
E. sylvaticum L.	UBU19590728	G	Hol.	LC				
24. Ericaceae Juss.								
Empetrum nigrum subsp. *sibiricum* (V.N.Vassil.) Kuvaev	TKh 557	Ch	Hol.					
Monotropa hypopitys L.	N648	G	Hol.					
Orthilia secunda (L.) House	MW0186725	H	Eura.					
Pyrola asarifolia Michx.	KhTo370	H	Eura.					
P. rotundifolia L.	TKh647	H	Hol.					

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Rhododendron dauricum L.	TKh66-2	Ch	East Sib.-Mon.		NT	VR		
Rh. parvifolium Adams	Kh577	Ch	AA		LC	VR		
Rh. tomentosum Harmaja	TKh 558	Ch	Cosm.	LC				
Vaccinium vitis-idaea L.	KhTo385	Ch	Hol.	LC				
25. Euphorbiaceae Juss.								
Euphorbia esula L.	TKh062	H	South Sib.-Mon.					
26. Fabaceae Lindl.								
Astragalus cornutus Pall.	BT010	H	Eura.					
A. filiformis (DC.) Poir.	UBU20070820	H	Cent.-As.					
A. frigidus (L.) A.Gray	Zai012	G	Eura.					
A. laguriformis Freyn	Zai238	H	South Sib.-Mon.					
A. laxmannii Jacq.	KhT022	H	Eura.					
A. melilotoides Pall.	SR030	H	East As.					
A. mongholicus Bunge	UBU19670819	H	Cent.-As.	LC				
A. rytidocarpus Ledeb.	UBU196486	Ch	South Sib.-Mon.					
A. tenuis Turcz.	UBU19640705	H	East Sib.-Mon.					
Caragana leucophloea Pojark.	TKh646	Ch	Cent.-As.					
C. pygmaea (L.) DC.	BT002	Ch	South Sib.-Mon.					
Hedysarum alpinum L.	TKh174	H	Eura.	LC				
H. inundatum Turcz.	M029	H	East Sib.-Mon.					
Lathyrus humilis (Ser.) Fisch. ex Spreng.	Kh289	H	Eura.					
L. palustris L.	MP105	H	Eura.	LC				
L. pratensis L.	MP98	H	Eura.	LC				
Medicago falcata L.	TKh084	H	Eura.					
M. ruthenica (L.) Trautv.	KhT025	H	As. Endem.					
Melilotus suaveolens Ledeb.	SR021	H	As. Endem.					
Onobrychis arenaria (Kit.) DC.	Kh514	H	Eura.					
Oxytropis grandiflora DC.	MW0183806	H	East Sib.-Mon.					
O. lapponica (Wahlenb.) J.Gay	KhT012	H	Eura.					
O. myriophylla (Pall.) DC.	TKh007	H	East Sib.-Mon.					
O. nitens Turcz.	TKh-90	H	East Sib.-Mon.					
O. oxyphylla (Pall.) DC.	TKh-90	H	East Sib.-Mon.					
O. pseudoglandulosa Gontsch. ex Grubov	Kh322	H	Mon. Endem.				En	
Thermopsis alpina Ledeb.	TKh025	H	Mon. Endem.				En	R
Th. mongolica Czefr.	SR010	H	South Sib.-Mon.					
Trifolium eximium Stephan ex Ser.	BTP29	H	Sib.-Mon.					
T. lupinaster L.	Kh256	H	Eura.					
Vicia amoena Fisch. ex Ser.	Kh275	H	East As.	LC				

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V. cracca L.	TKhP36	H	Eura.	LC				
V. megalotropis Ledeb.	MW0184499	H	As. Endem.					
V. unijuga A.Braun	Zai018	H	East As.					
V. venosa (Willd. ex Link) Maxim.	Kh288	H	East As.					
27. Gentianaceae Juss.								
Gentiana aquatica var. *pseudoaquatica* (Kusn.) S.Agrawal	MW0187729	Th	East As.					
G. decumbens L.f.	KhT023	H	Eura.					
G. macrophylla Pall.	TKh078	H	Sib.-Mon.		NT	VR		
G. squarrosa Ledeb.	SR001	Th	As. Endem.					
Gentianella amarella subsp. *acuta* (Michx.) J.M.Gillett	Kh598	Th	AA					
G. azurea (Bunge) Holub	Tkh002	Th	Alt.-Dzun.-Mon.					
Gentianopsis barbata (Froel.) Ma	M643	Th	Eura.		LC			
Halenia corniculata (L.) Cornaz	TKh042	Th	As. Endem.					
Lomatogonium carinthiacum (Wulfen) A.Braun	M663	Th	As. Endem.					
L. rotatum (L.) Fr.	Tkh004	Th	AA	LC				
28. Geraniaceae Juss.								
Erodium stephanianum Willd.	TKh038	Th	South Sib.-Mon.					
Geranium platyanthum Duthie	MW0184647	H	East As.					
G. pratense L.	Kh518	H	Eura.					
G.pseudosibiricum J.Mayer	Kh258	H	Eura.					
G. sibiricum L.	SRP14	H	Eura.					
G. wlassovianum Fisch. ex Link	TKh053	H	East As.					
29. Grossulariaceae DC.								
Ribes aciculare Sm.	TsG154	Ph	Alt.-Dzun.-Mon		NT			
R. diacantha Pall.	Kh513	Ph	East As.					
R. petraeum Wulfen	M017	Ph	South Sib.-Mon.					
R. pulchellum Turcz.	TsG156	Ph	East As.					
30. Iridaceae Juss.								
Iris humilis Georgi	Zai007	G	Eura.	DD	LC			
I. lactea Pall.	TKhP32	G	Cent.-As.					
I. ruthenica Ker Gawl.	Zai008	G	As. Endem.					
I. tigridia Bunge ex Ledeb.	TKh487	G	South Sib.-Mon.					
31. Juncaceae Juss.								
Juncus castaneus subsp. *leucochlamys (*V.J.Zinger ex V.I.Krecz.) Hultén	M042	G	Hol.					
J. ranarius Songeon & E.P.Perrier	TKh124	H	Eura.					
Luzula multiflora subsp. *sibirica* V.I.Krecz.	M591	H	Eura.					
L. rufescens Fisch. ex E.Mey.	MW173066	H	East As.					

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32. Juncaginaceae Rich.								
Triglochin maritima L.	TKhP025	G	Cosm.	LC				
T. palustris L.	MP108	G	Cosm.	LC				
33. Lamiaceae Martinov								
Caryopteris mongholica Bunge	SR019	Ch	Mon. Endem.		VU		En	
Dracocephalum foetidum Bunge	Ch-Zam002	Th	Cent.-As.					
D. grandiflorum L.	TKh642	H	As. Endem.					
D. nutans L.	BT643	H	Eura.					
Galeopsis bifida Boenn.	TKh100	Th	Eura.					
Lagopsis supina (Stephan ex Willd.) Ikonn.-Gal.	TKh051	Th	East As.					
Lamium album L.	TKhP36	H	Hol.	LC				
Leonurus deminutus V.I.Krecz.	TKh013	Th	East Sib.-Mon.					
L. sibiricus L.	Ch029	Th	South Sib.-Mon.					
Lophanthus chinensis Benth.	Zai021	H	East Sib.-Mon.					
Nepeta multifida L.	Ch013	H	Sib.-Mon.					
Panzerina lanata (L.) Soják	Ch-Zam004	H	East Sib.-Mon.					
Phlomoides tuberosa (L.) Moench	Ch014	G	Eura.					
Scutellaria galericulata L.	Kh585	H	Eura.	LC				
S. scordiifolia Fisch. ex Schrank	Zai223	Th	East As.					
Thymus baicalensis Serg.	TKh161	Ch	South Sib.-Mon.					
Th. gobicus Czern.	TKh057	Ch	Mon. Endem.				En	
34. Liliaceae Juss.								
Hemerocallis minor Mill.	BTP12	G	East As.					
Lilium pumilum Redouté	UZai643	G	East As.		NT			
35. Linaceae DC. ex Perleb								
Linum perenne L.	TKh072	H	Eura.					
36. Onagraceae Juss.								
Epilobium angustifolium L.	UBU20100625	H	Hol.	LC				
E. davuricum Fisch. ex Hornem.	MW0185683	H	South Sib.-Mon.					
E. palustre L.	TKh142	H	Hol.	LC				
37. Orchidaceae Juss.								
Corallorhiza trifida Châtel.	TKh491	G	Hol.	LC	VU			
Dactylorhiza salina (Turcz. ex Lindl.) Soó	UBA:B-39	G	Sib.-Mon.					
Goodyera repens (L.) R.Br.	BT93-2	G	Hol.	LC				
Neottia camtschatea (L.) Rchb.f.	MW12375964	G	Alt.-Dzun.-Mon.		CR	VR		
38. Orobanchaceae Vent.								
Cymbaria daurica L.	BT008	H	East As.					
Euphrasia hirtella Jord. ex Reut.	TKh141	Th	Eura.					
E. maximowiczii Wettst. ex Palib.	M114-2	Th	East As.					
E. syreitschikovii Govor.	TKh050	Th	Cent.-As.				SubEn	

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Odontites vulgaris Moench	TKh153	Th	Eura.					
Orobanche coerulescens Stephan ex Willd.	M002	H	Eura.					
Pedicularis flava Pall.	TKh069	H	East Sib.-Mon.					
P. labradorica Wirsing	TKh479	H	East As.	LC				
P. resupinata L.	TKh143	H	Eura.					
P. rubens Stephan ex Willd.	Zai206	H	East Sib.-Mon.					
P. uliginosa Bunge	M034	H	South Sib.-Mon.					
Rhinanthus minor L.	TKh523	H	Eura.					
39. Papaveraceae Juss.								
Chelidonium majus L.	N008	H	Eura.	LC	VU			
Corydalis sibirica (L.f.) Pers.	Kh297	Th	East As.					
Hypecoum erectum L.	SRP15	Th	Eura.					
Papaver canescens Tolm.	P127-1	H	Cent.-As.					
P. nudicaule L.	TKh093	H	Sib.-Mon.					
40. Pinaceae Spreng. ex F.Rudolphi								
Larix sibirica Ledeb.	BTP28	Ph	Eura.	LC				
Picea obovata Ledeb.	M-0132810	Ph	Eura.	LC				
Pinus sibirica Du Tour	Kh286	Ph	Eura.	LC				
P. sylvestris L.	UBU20070618	Ph	Eura.	LC				
41. Plantaginaceae Juss.								
Hippuris vulgaris L.	TKhW02	Hy	Cosm.					
Linaria acutiloba Fisch.	TKh024	H	South Sib.-Mon.					
L. buriatica Turcz. ex Ledeb.	Ch046	H	East Sib.-Mon.					
Plantago cornuti Gouan	Zai170	H	As. Endem.					
P. depressa Willd.	SR027	H	As. Endem.					
P. major L.	TKh03	H	Eura.	LC				
Veronica incana L.	TKh05	H	Eura.					
V. linariifolia Pall. ex Link	BT012	H	East As.					
V. longifolia L.	TKh098	H	Eura.					
V. pinnata L.	MW0189775	H	Cent.-As.					
42. Plumbaginaceae Juss.								
Goniolimon speciosum (L.) Boiss.	Ch002	H	Eura.					
Limonium flexuosum (L.) Chaz.	SR420	H	East Sib.-Mon.					
43. Poaceae Barnhart								
Agropyron cristatum (L.) Gaertn.	TKh005	H	Eura.	LC				
Agrostis divaricatissima Mez	TKh123	H	East As.					
A. vinealis Schreb.	TKh470	H	East Sib.-Mon.					
Alopecurus brachystachyus M.Bieb.	Kh321	H	East Sib.-Mon.					
Anthoxanthum glabrum (Trin.) Veldkamp	MW0169024	H	East As.					
A. nitens (Weber) Y.Schouten & Veldkamp	TKh241	H	AA					

Scientific name	Voucher code	Life-form	Chorotype	Global Red list	Regional Red list	Mongolian Red book	Endemism	Relict
Arctopoa subfastigiata (Trin.) Prob.	KhT22-2	H	Alt.-Dzun.-Mon.					
Beckmannia syzigachne (Steud.) Fernald	TKh132	G	Eura.	LC				
Bromus inermis Leyss.	SR9-4	G	Eura.					
B. japonicus Houtt.	Kh300	G	Eura.					
B. pumpellianus Scribn.	KhTo8-4	G	AA					
Calamagrostis epigejos (L.) Roth	M116-3	H	Eura.					
C. lapponica (Wahlenb.) Hartm.	MW0169632	H	Hol.	LC				
C. macilenta (Griseb.) Litv.	TKh87-1	H	Alt.-Dzun.-Mon.					
C. obtusata Trin.	KhTo6-2	H	Eura.					
C. purpurea (Trin.) Trin.	N126-2	H	Hol.					
Elymus confusus (Roshev.) Tzvelev	M99-1	H	East As.					
E. gmelinii (Trin.) Tzvelev	UZai135-1	H	As. Endem.					
E. mutabilis (Drobow) Tzvelev	MW0171288	H	Eura.	LC				
E. repens (L.) Gould	SR9-10	G	Eura.					
E. sibiricus L.	SR13-3	G	Eura.	NA				
Festuca komarovii Krivot.	TKh88	H	Sib.-Mon.		VU			
F. lenensis Drobow	TKh243	H	South Sib.-Mon.					
F. ovina L.	M111-3	H	Hol.					
Helictochloa hookeri (Scribn.) Romero Zarco	Kh131-1; SR006	H	AA					
Hordeum brevisubulatum (Trin.) Link	MW0171136	H	As. Endem.	LC				
H. roshevitzii Bowden	ZalB001; MW0171173	H	South Sib.-Mon.	LC				
Koeleria glauca (Spreng.) DC.	UBU20060617	H	Eura.					
K. macrantha (Ledeb.) Schult.	TKh061	H	Hol.					
Leymus chinensis (Trin.) Tzvelev	SR9-8	H	As. Endem.					
L. secalinus (Georgi) Tzvelev	TKh041	H	Hol.					
Melica turczaninowiana Ohwi	UBU20050706	H	East Sib.-Mon.					
Neotrinia splendens (Trin.) M.Nobis, P.D.Gudkova &	KhT001	H	Eura.					
Poa angustifolia L.	UBU19630618	H	Eura.	LC				
P. attenuata Trin.	MW0170365	H	South Sib.-Mon.					
P. krylovii Reverd.	SR9-9	H	East Sib.-Mon.					
P. palustris L.	KhTo1-2	H	Hol.	LC				
P. pratensis L.	TKh471	H	Eura.	LC				
P. sibirica Roshev.	TKh75-2	H	Eura.					
P. versicolor Besser	M103-2	H	Eura.					
Pseudoroegneria reflexiaristata (Nevski) A.N.Lavrenko	KhTo22-1	H	Eura.					
Setaria viridis (L.) P.Beauv.	BT-97	Th	Hol.					

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Sibirotrisetum sibiricum (Rupr.) Barberá	TKh602	H	Hol.					
Stipa krylovii Roshev.	SR459	H	Sib.-Mon.					
44. Polemoniaceae Juss.								
Polemonium villosum Rudolph ex Georgi	Zai015; UBU20050628	H	South Sib.-Mon.					
45. Polygalaceae Hoffmanns & Link								
Polygala comosa Schkuhr	TKh59-1	H	Eura.					
P. sibirica L.	TKh073	H	Eura.					
P. tenuifolia Willd.	MW0185140	H	South Sib.-Mon.					
46. Polygonaceae Juss.								
Bistorta alopecuroides (Turcz. ex Kom.) Nakai	TKh221	G	South Sib.-Mon.		LC			
B. elliptica (Willd. ex Spreng.) V.V.Petrovsky, D.F.Murray & Elven	UBA19890829	H	Sib.-Mon.					
B. vivipara (L.) Delarbre	TKh101	G	Hol.					
Fallopia convolvulus (L.) Á.Löve	KhT002	Th	Hol.					
Koenigia alpina (All.) T.M.Schust. & Reveal	TKh133	H	Eura.					
Persicaria angustifolia (Pall.) Ronse Decr.	TKh003	H	East Sib.-Mon.					
P. hydropiper (L.) Delarbre	TKh150	H	Hol.	LC				
Polygonum aviculare L.	Ch048	Th	Cosm.	LC				
Rheum rhabarbarum L.	TKhP40	H	East Sib.-Mon.					
Rumex acetosa L.	UBA178	H	Hol.					
R. acetosella L.	TKh122	H	Eura.	LC				
R. gmelinii Turcz. ex Ledeb.	TKh049	H	East As.					
R. thyrsiflorus Fingerh.	TKh087	H	Eura.					
47. Polypodiaceae J.Presl & C.Presl								
Dryopteris fragrans (L.) Schott	UZai631	H	Hol.	LC				
Polypodium virginianum L.	BT542	H	Cosm.					
48. Primulaceae Batsch ex Borkh.								
Androsace dasyphylla Bunge	MW0187070	H	Cent.-As.					
A. filiformis Retz.	M011	H	Eura.					
A. incana Lam.	Zai014	H	South Sib.-Mon.					
A. lactiflora Fisch. ex Willd.	TKh098	Th	As. Endem.					
A. septentrionalis L.	Kh304	Th	Hol.					
Lysimachia europaea (L.) U.Manns & Anderb.	BT95-1	G	Hol.					
Primula farinosa L.	UBU20110619	H	Eura.	LC				
P. nivalis subsp. *subintegerrima* (Regel) Vorosch.	TKh66-3	H	East Sib.-Mon.					
P. nutans Georgi	MW0187020	H	South Sib.-Mon.	LC				

Scientific name	Voucher code	Life-form	Chorotype	Global Red list	Regional Red list	Mongolian Red book	Endemism	Relict
49. Pteridaceae E.D.M.Kirchn.								
Hemionitis michelii (Christ) Christenh.	UBA61/78	H	East As.					
50. Ranunculaceae Juss.								
Aconitum baicalense (Regel) Turcz. ex Rapaics	Uzai 134-2	H	Sib.-Mon.					
A. barbatum Patrin ex Pers.	MW0178265	H	South Sib.-Mon.					
A. septentrionale Koelle	M015	H	Eura.					
A. turczaninowii Vorosch.	UBU20080902	H	Sib.-Mon.		NT			
Actaea cimicifuga L.	N002	Ch	Sib.-Mon.					
A. rubra (Aiton) Willd.	TKh533	Ch	Eura.					
Anemonastrum crinitum (Juz.) Holub	TKh134	H	South Sib.-Mon.					
A. sylvestris (L.) Galasso, Banfi & Soldano	Kh260	H	Eura.					
Aquilegia sibirica Lam.	M016	H	As. Endem.					
A. turczaninowii Kamelin & Gubanov	MW0178102	H	East Sib.-Mon.					
A. viridiflora Pall.	TKh-77	H	As. Endem.					
Caltha palustris L.	TKh103	H	Hol.	LC				
Clematis alpina subsp. *sibirica* (L.) Kuntze	TKh145	Ch	Eura.					
C. tangutica (Maxim.) Korsh.	Kh582	Ch	Cent.-As.					
Delphinium grandiflorum L.	KhTo467	H	As. Endem.					
Leptopyrum fumarioides (L.) Rchb.	TKh083	Th	AA					
Pulsatilla ambigua (Turcz. ex Hayek) Zämelis & Paegle	Kh247	H	South Sib.-Mon.					
P. bungeana C.A.Mey.	MW0178530	H	Cent.-As.					
P. patens subsp. *flavescens* (Zucc.) Zämelis	Zai187	H	Eura.					
P. tenuiloba (Turcz.) Juz.	Tu003	H	East Sib.-Mon.					
P. turczaninovii Krylov & Serg.	TKh115	H	East As.					
Ranunculus japonicus Thunb.	KhTo329	H	East Sib.-Mon.					
R. monophyllus Ovcz.	M105-2	H	Eura.					
R. natans C.A.Mey.	TKh102	Hy	Cent.-As.					
R. pedatifidus Sm.	MW0178941	H	Cent.-As.					
R. pulchellus C.A.Mey.	MW0179012	H	Sib.-Mon.					
Thalictrum foetidum L.	Zai185	H	Eura.					
Th. minus L.	Kh244	H	Hol.					
Th. petaloideum L.	TKh136	H	As. Endem.					
Th. simplex L.	KhTo343	H	As. Endem.					
Trollius asiaticus L.	M008	H	As. Endem.					

Scientific name	Voucher code	Life-form	Chorotype	Global Red list	Regional Red list	Mongolian Red book	Endemism	Relict
51. Rosaceae Juss.								
Agrimonia pilosa Ledeb.	Ch036	H	Eura.	LC				
Argentina anserina (L.) Rydb.	UBU20030622	H	Hol.					
Chamaerhodos altaica (Laxm.) Bunge	KhP56	H	Alt.-Dzun.-Mon					
Ch. erecta (L.) Bunge	TKh070	Th	As. Endem.					
Comarum palustre L.	UBU20080915	H	Hol.	LC				
Cotoneaster laxiflorus J.Jacq. ex Lindl.	Kh581-1	Ph	Eura.					
C. mongolicus Pojark.	Kh580	Ph	East Sib.-Mon.				SubEn	
Crataegus sanguinea Pall.	TKh158	Ph	Eura.		NT			
Dasiphora fruticosa (L.) Rydb.	M031	Ph	Hol.					
Filipendula palmata (Pallas) Maximowicz.	TKH154	H	East As.					
F. ulmaria (L.) Maxim.	SR-15	H	Hol.					
Fragaria orientalis Losinsk.	Kh270	H	East As.					
Geum aleppicum Jacq.	KhTo23-2	H	Hol.					
Malus baccata (L.) Borkh.	Zai240	Ph	East As.	LC	NT			
Potentilla acaulis L.	Zai247	H	Eura.					
P. conferta Bunge	UBU20030628	H	Eura.					
P. crantzii (Crantz) Beck ex Fritsch	UBU20030623	H	As. Endem.					
P. evestita Th.Wolf	Zai002	H	As. Endem.					
P. flagellaris D.F.K.Schltdl.	TKh135	H	East As.					
P. fragarioides L.	KhTo-2	H	East As.					
P. multifida L.	TKh067	H	Hol.					
P. nivea L.	M025	H	As. Endem.					
P. pensylvanica L.	Ch017	H	AA					
P. sericea L.	TKh-90	H	Eura.					
P. tanacetifolia Willd. ex D.F.K.Schltdl.	TKh171	H	South Sib.-Mon.					
P. virgata Lehm.	M45	H	Eura.					
Prunus padus L.	MW0182491	Ph	Eura.					
Rosa acicularis Lindl.	KhTo332	Ph	Hol.	LC				
Rubus arcticus L.	TKh492	H	Hol.	LC				
R. humulifolius C.A.Mey.	UZai636	Ch	Eura.					
R. idaeus subsp. *strigosus* (Michx.)	Kh284	Ph	Eura.					
R. saxatilis L.	UBU20110718	H	Hol.					
Sanguisorba officinalis L.	Kh251	H	Hol.	LC				
Sibbaldianthe adpressa (Bunge) Juz.	TKh06-001	H	As. Endem.					
S. bifurca (L.) Kurtto & T.Erikss.	TKh008	H	Eura.					
Sorbus aucuparia subsp. *sibirica* (Hedl.) McAll.	UZai627	Ph	Eura.					
Spiraea alpina Pall.	M027	Ph	Cent.-As.					

Scientific name	Voucher code	Life-form	Chorotype	Global Red list	Regional Red list	Mongolian Red book	Endemism	Relict
S. chamaedryfolia L.	Kh273	Ph	As. Endem.					
S. hypericifolia L.	TKh023	Ph	East Sib.-Mon.					
S. media Schmidt	KhTo358	Ph	Eura.					
S. salicifolia L.	UZai 150-3	Ph	As. Endem.					
52. Rubiaceae Juss.								
Galium boreale L.	Kh296	H	Eura.					
G. verum L.	BTP29	H	Hol.	LC				
53. Rutaceae Juss.								
Haplophyllum dauricum (L.) G.Don	TKh063	G	South Sib.-Mon.					R
54. Salicaceae Mirb.								
Populus suaveolens Fisch. ex Poit. & A.Vilm.	M122-1	Ph	East As.	LC				
P. tremula L.	SRP16	Ph	Eura.	LC				
Salix abscondita Lacksch.	Kh507	Ph	East As.					
S. bebbiana Sarg.	Kh312	Ph	AA	LC				
S. berberifolia Pall.	M155-1	Ch	South Sib.-Mon.					
S. divaricata Pall.	MW0174484	Ph	East As.					
S. gmelinii Pall.	KhTo360	Ph	Eura.					
S. kochiana Trautv.	Kh131-b	Ph	South Sib.-Mon.					
S. microstachya Turcz. ex Trautv.	UBU0008	Ph	East Sib.-Mon.					
S. miyabeana Seemen	M521	Ph	East As.					
S. myrtilloides L.	TKh566	Ph	Hol.					
S. pseudopentandra (Flod.) Flod.	Kh131	Ph	Hol.					
S. recurvigemmata A.K.Skvortsov	UBU19630636	Ch	Eura.	LC				
S. rhamnifolia Pall.	TKh048	Ph	Hol.					
S. rorida Laksch.	TKh110	Ph	South Sib.-Mon.					
S. saposhnikovii A.K.Skvortsov	SR535	Ph	Eura.					
S. schwerinii E.L.Wolf	TKh473	Ph	As. Endem.	LC				
S. taraikensis Kimura	M116-2	Ph	East As.					
55. Santalaceae R.Br.								
Thesium longifolium Turcz.	UBU20070623	H	East As.					
Th. refractum C.A.Mey.	KhTo 8-5	H	Cent.-As.					
Th. repens Ledeb.	TKh645	H	South Sib.-Mon.					
56. Saxifragaceae Juss.								
Chrysosplenium sedakowii Turcz.	Kh323	H	South Sib.-Mon.					
Saxifraga bronchialis L.	TKh480	G	East As.					
S. cernua L.	UBU20080630	H	Eura.					
S. sibirica L.	TKh648	H	Eura.					
57. Scrophulariaceae Juss.								
Scrophularia incisa Weinm.	TKh652	Ch	Alt.-Dzun.-Mon					
58. Solanaceae Juss.								
Hyoscyamus niger L.	TKh020	Th	Hol.					

Scientific name	Voucher code	Life-form	Chorotype	Global Red list	Regional Red list	Mongolian Red book	Endemism	Relict
59. Tamaricaceae Link								
Myricaria longifolia (Willd.) Ehrenb.	ZalB003	Ph	South Sib.-Mon.		LC			
60. Thymelaeaceae Juss.								
Stellera chamaejasme L.	TKh015	H	As. Endem.					
61. Urticaceae Juss.								
Urtica angustifolia Fisch. ex Hornem.	TKh035	H	East As.					
U. cannabina L.	BTP93	H	Alt.-Dzun.-Mon.					
62. Violaceae Batsch								
Viola biflora L.	TKhP34	H	Hol.					
V. brachyceras Turcz.	M-116	G	South Sib.-Mon.					
V. dissecta Ledeb.	M103-1	G	As. Endem.					
V. uniflora L.	M035; NS0001861	H	South Sib.-Mon.					
63. Woodsiaceae Herter								
Woodsia ilvensis (L.) R.Br.	KhTo377	H	Eura.	LC				

Abbreviation: **Life-form:** Ph (phanerophytes), Ch (chamaephytes), Th (therophytes), H (hemicriptophytes), G (geophytes), and Hy (hydrophytes); **IUCN and Mongolian red list:** EN (Endangered), VU (Vulnerable), NT (Near Threatened), LC (Least Concern); **Endemism:** E (endemic), SE (subendemic); **Relict:** relict (RL); **Chorological groups:** Cosmopolitan (Cosm.), Asia–American (AA), Holarctic (Hol.), Eurasian (Eura.), Asian (As.); **subgroups:** Eastern Asian (East. As.), Central Asian (Cent. As.), Asian Endemics (As. Endem.), Siberia-Mongolian (Sib.-Mon.), East Siberia-Mongolian (East Sib.-Mon.), South Siberia Mongolian (South Sib.-Mon.), Altai–Dzungarian Mongolian (Alt.-Dzun.-Mon.), and Mongolian Endemic (Mon. Endem.).

Based on Raunkiaer (1934) classification system, the life-form composition in the Bogdkhan Mountain was dominated by hemicryptophytes, followed by geophytes, therophytes, phanerophytes, chameaphytes and a low percentage occupying hydrophytes. The 63.03% of total flora in the study area was dominated by hemicryptophytes, which is in agreement with the results of Bataa (2013), Tserendulam *et al.* (2018) and Batdelger *et al.* (2021). Abundant hemicryptophytes were mostly dominating in the cold temperate region and mountainous climate condition (Archibold, 1995; Tuvshintogtokh, 2014). Results of the X^2 test showed that Raunkiaer's normal spectrum was remarkably different from the amount of chamaephytes, geophytes and therophytes, while the differences between the amounts of phanerophytes, hemicryptophytes and hydrophytes were not significant. The total number of chamaephytes (3.67) was low which showed the maximum divergence compared to the normal spectrum. However, chamaephytes were common in high mountainous (Cain, 1950; Tuvshintogtokh, 2014). We suppose this decrease may relate to the climate change or mountainous location which is transitional location from taiga to steppe. We suggest that this decline may be due to climate change or a mountainous location that is transitional from taiga to steppe. Geophytes (1.36) were slightly increasing, which might be affected by steppe or arid condition in Bogdkhan Mountain.

Next in abundance was the therophytes (0.69), which showed a minor increase according to the normal spectrum. However, it seems less correlation but further negative impact on the ecosystem would be high if current anthropogenic and overgrazing effects in the studied area continue. Our study found that annual plant species were prevalent in some valleys with buildings, and tourist camps, along the hiking road and foothills. Kargar *et al.* (2017) stated that not only

environmental factor will increase therophytes, but also diverse anthropogenic impacts, such as unregulated tourism, timber harvesting, population settlement etc. In addition, an increase of therophytes causes humidity extremes and water shortages (Moradi *et al.*, 2009). We agree with the conclusion of Hilbig *et al.* (2004) that the conditions of the Bogdkhan Mountain change rapidly due to anthropogenic influences. The underlying causes for the increasing anthropogenic influences are related to land use, which has been intensified near the city of Ulaanbaatar since the 1990s during the transitional phase of socialism to a democratic society (Erdenechimeg, 2013; Naranbaatar *et al.*, 2018; Gradel *et al.*, 2019). Asian elements with 8 subgroups occupied the most percentage followed Eurasian, Holarctic, Asia-American and Cosmopolitan elements, which were influenced to this mountain vegetation. It is in agreement with the results reported by previous studies (Ulziikhutag, 1989; Ganbold, 2010; Tserendulam *et al.*, 2018; Batdelger *et al.*, 2021). The presence of endemic, relict and vulnerable (8 Vulnerable, 2 Endangered and 1 Critically Endangered) species emphasizes on the need for conserving the rich flora of Bogdkhan Mountains.

Cold temperate with mountainous climate conditions in the Bogdkhan Mountain might allow hemicryptophytes and chamaephytes to be dominant. We consider that the floristic composition of Bogdkhan Mountain could be decreasing in future, due to increasing of therophytes. Given such a situation, the causes for decreases in mountain flora are influences of anthropogenic factors, especially population settlements, and constructions in the mountain. In addition, it was noted that overgrazing in some parts of the studied area, especially in the lower belt of the mountain, has led to an increase in therophytes. Therefore, overgrazing is viewed as a cause of the deterioration of the ecosystem in the area. We finally conclude with a strong recommendation to improve the protection management of the Bogdkhan Mountain in the near future.

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References

APG, 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical J. Linn. Soc. **181**:1-20.

Archibold, O.W. 1995. The coniferous forests: Ecology of World Vegetation, Springer, Dordrecht. Netheland, pp. 238-279.

Bataa, T. 2013. Vegetation conditions in various plant communities in Khongor district, Darkhan-Uul province in Mongolia. United Nations University, Land Restoration Training Programme [final project].

Batdelger, G., Bazarragchaa, B., Janchiv, A., Enebish, G., Yang, S., Peak, W. and Lee, J. (2021). Contribution to the flora of Ulziit Mountain in forest steppe region of Mongolia. Bangladesh Journal of Plant Taxonomy, **28**(1):195-215.

Batima, P., Natsagdorj, L., Gomboluudev, P. and Erdenetsetseg, B. 2005. Observed climate change in Mongolia. Assessments of Impacts and Adaptation to Climate Change Working Paper **12**:1-26.

Bayasgalan, B., Mijiddorj, R., Gombluudev, P., Oyunbaatar, D., Bayasgalan, M., Tas, A., Narantuya, T. and Molomjamts, L. 2009. Climate change and sustainable livelihood of rural people in Mongolia. The adaptation continuum: groundwork for the future. ETC Foundation, Leusden. pp. 193-213.

Bolormaa, D., Lkhagvasuren, D., Gantuya, J., Gankhuyag, L. and Altanzul, R. 2017. Results of pasture monitoring research. Journal of Agricultural Science **12**:41-45 [in Mongolian].

Cain, S.A. 1950. Life-forms and phytoclimate. The Botanical Review **16**(1):1-32.

Dariimaa, S. 2014. Flora of Mongolia. Vol. **14a**. Mongolian Academy of Sciences, Institute of General and Experimental Biology. Bembi san press, Ulaanbaatar, Mongolia, 277 pp. [in Mongolian].

Dariimaa, S. and Saruul, N. 2017. Flora of Mongolia. Vol. **14b**. Mongolian Academy of Sciences, Institute of General and Experimental Biology. Uudam soyol publishing, Ulaanbaatar, Mongolia, 220 pp. [in Mongolian].

Dariimaa, S., Ganbold, E., Nyambayar, D., Urgamal, M., Zumberelmaa, D. and Enkhmaa, U. 2015. Flora of Mongolia. Vol. **1**. Mongolian Academy of Sciences, Institute of General and Experimental Biology. Munkhiin useg press, Ulaanbaatar, Mongolia, 220 pp. [in Mongolian].

Dugarjav, C. 2006. Larch forests of Mongolia. Bembi San press, Ulaanbaatar, Mongolia, 218 pp. [in Mongolian].

Dulamsuren, C. and Mühlenberg, M. 2003. Additions to the flora of the Khentei, Mongolia. Willdenowia **33**(1):149-159.

Dulamsuren, C., Hauck, M., Leuschner, H.H. and Leuschner, C. 2011. Climate response of tree-ring width in *Larix sibirica* growing in the drought-stressed forest-steppe ecotone of northern Mongolia. Annals of Forest Science **68**:275-282.

Enkhmaa, U. 2015. Taxonomic structure of the flora of Bogdkhan Mountain in Mongolia. Problems of Botany of South Siberia and Mongolia. - Proc. 7th Int. scientific-pract. Conf. Barnaul. pp. 71-78 [in Russian].

Enkhmaa, U. 2017. Chick list the flora of rare, endangered and economic plants in Bogdkhan Mountain. Journal of Institute of General and Experimental Biology, Mongolian Academy of Science **33**:114-130 [in Mongolian].

Erdenechimeg, N. 2013. Current state and prospects of protected area management (On the example of Bogdkhan Uul Strictly Protected Area). Proceedings of the Mongolia Academy of Sciences **01**:20-28 [in Mongolian].

Ganbold, E., Grubov, V.I., Gubanov, I.A., Darijmaa, S., Kamelin, R.V., Ulzijchutag, N. and Enkhmaa, U. 1993. Vascular plants of Bogdo-Ula state reservation (North Mongolia). Bot. Jorn. **78**:53-60.

Ganbold, E. 2010. Flora of Northern Mongolia (systematic, ecology, geography, evolution history) Nauka, Moscow. Russia, 254 pp. [in Russian].

Gradel, A., Sukhbaatar, G., Karthe, D. and Kang, H. 2019. Forest management in Mongolia–A review of challenges and lessons learned with special reference to degradation and deforestation. Geography, Environment, Sustainability **12**(3): 133-166.

Grubov, V.I. 1982. Key to Mongolian vascular plants with illustrations. Nauka. Leningrad, Russia, 441 pp. [in Russian].

Gubanov, I.A. 1996. Conspectus of the flora of Outer Mongolia: vascular plants. Valang, Moscow, Russia, 136 pp.

Hilbig, W., Jäger, E.J. and Knapp, H.D. 2004. Die Vegetation des Bogd-uul bei Ulaanbaatar (Mongolei)–Standortsbindung und pflanzengeographische Stellung. Feddes Repertorium: Zeitschrift für botanische Taxonomie und Geobotanik, **115**:265-342. [in German].

IPNI, 2020. International Plant Names Index. <www.ipni.org> IPNI, Richmond, London. Retrieved on 13 September 2020.

IUCN, 2020. 2020 IUCN Red List of Threatened Species. <www.iucnredlist.org> IUCN, Gland, Switzerland. Retrieved on 01 November 2020.

Jargal, J. 2003. Protected area status in Mongolia. Mongolian journal of Biological sciences **1**:49-54.

Junatov, A.A. 1977. Osnovnye čerty rastitel'nogo pokrova Mongol'skoj Narodnoj Respubliki. Izd. Acad. Nauka, Moscow, USSR, 223 pp. [in Russian and Mongolian].

Kargar C.H., Akbarjavadi S., Zahedi Amiri, G. and Jafari, M. 2017. The floristic composition and biological spectrum of vegetation in the Meymeh region of Northern Isfahan province, Iran. Journal of Applied Ecology and Environmental Research **15**:415-28.

Maden, K. 2004. Plant collection and herbarium techniques. Our nature **2**:53-57.

MNEM, 1998 (eds. Adiyasuren, T. and Shiirevdamba, T.). Ministry of Nature and the Environment of Mongolia. Ecosystems atlas of Bogdkhan Mountain. Ulaanbaatar. Mongolia, 40 pp.

Moradi, G., Mohadjer, M.R.M., Amiri, G.Z., Shirvany, A. and Zargham, N., 2010. Life form and geographical distribution of plants in Posthband region, Khonj, Fars Province, Iran. Journal of forestry Research **21**(2):201-206.

Naranbaatar, G., Bandi, D. and Gantulga, G. 2018. Distribution and population size of Gray wolves in Bogdkhan Uul SPA and factors affecting their population size. Journal of Institute of General and Experimental Biology **34**:21-32 [in Mongolian].

Natsagdorj, L. 2012. Regarding trends in annual productivity of vegetation in relation to current climate change. Proceedings of the Mongolian Academy of Sciences **3**:24-30 [in Mongolian].

Niwattanakul, S., Singthongchai, J., Naenudorn, E. and Wanapu, S. 2013. Using of Jaccard coefficient for keywords similarity. Proceedings of the international multi conference of engineers and computer scientists **1**:380-384.

Nyambayar, D. 2009. Flora of Mongolia. vol. **17.** Mongolian Academy of Sciences, Institute of General and Experimental Biology. Bembi san press, Ulaanbaatar, Mongolia, 137 pp. [in Mongolian].

Nyambayar, D., Oyuntsetseg, B. and Tungalag, R. 2011. Mongolian red list and conservation action plans of plants. Admon printing, Ulaanbaatar, Mongolia, 189 pp.

POWO, 2020. Plants of the World Online. <www.plantsoftheworldonline.org.> POWO, Kew Richmond, London. Retrieved on 10 September 2020.

Raunkiaer, C. 1934. The life-forms of plants and their bearing on geography. The Life Forms of Plants and Statistical Plant Geography, At the Clarendon Press, Oxford, Great Britain, pp. 2-104.

Sanchir, C. 2008. Vascular plants: (ed. Enkhtuul, R.), Red Book on Bogdkhan Mountain. Ulaanbaatar, Mongolia, pp. 46-70.

Shiirevdamba, T., Adiya, Y., Ganbold, E. and Tserenkhand, G. 2013. Mongolian Red Book. Admon printing, Ulaanbaatar, Mongolia, pp. 152-288.

Shirendev, T. and Munkhtuya, A. 2015. Bogdkhan Mountain Strictly Protected Area. Ulaanbaatar. 237 pp. [in Mongolian].

Tolmachev, A.I. 1974. Introduction in Plants Geography. Nauka, Leningrad, Russia, 244 pp. [in Russian].

Tsedendash, G. 1995. Forest vegetation of the Khentey Mountains. Ph.D. Thesis. National University of Mongolia. 186 pp. [in Mongolian].

Tsegmid, S. 1969. Physical geography of Mongolia. Ulaanbaatar: National publishing. 404 pp. [in Mongolian].

Tsendeekhuu, T., Jamsran, T., Gombobaatar, S. and Suran, D. 2019. Mongolian Red List. vol. **2**. Mongolica publishing, Ulaanbaatar, Mongolia, pp. 8-230.

Tserendulam, T., Bayarsaikhan, U., Oyuntsetseg, B. and Wesche, K. 2018. The vascular plant flora of Hustai National Park, Mongolia: Composition, life forms, ecological groups and geographical elements. Feddes Repertorium **129**:137-160.

Tuvshintogtokh, I. 2014. The steppe vegetation of Mongolia. Bembi san press, Ulaanbaatar, Mongolia, pp. 16-47 [in Mongolian].

Ulziikhutag, N. 1989. Overview of the flora of Mongolia. National publishing, Ulaanbaatar, Mongolia, 207 pp. [in Mongolian].

Urgamal, M. 2009. Flora of Mongolia. vol. **10.** Mongolian Academy of Sciences, Institute of General and Experimental Biology. Bembi san press, Ulaanbaatar, Mongolia, 130 pp. [in Mongolian].

Urgamal, M. and Oyuntsetseg, B. 2017. Atlas of the endemic vascular plants of Mongolia. Bembi san press, Ulaanbaatar, Mongolia, 107 pp.

Urgamal, M., Oyuntsetseg, B., Nyambayar, D., Dulamsuren, C. 2014. Conspectus of the vascular plants of Mongolia. Admon printing, Ulaanbaatar, Mongolia, 334 pp.

Wurts, K. 2013. Mongolian National Parks: Competing Interests and Institutional Viability in a Still Emerging Protected Areas System. Independent Study Project (ISP) Collection. 1702.

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