



The vascular flora of the Sutai Khairkhan Mountain Nature Reserve, Mongolia

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Manuscript received: 28.08.2021

Review completed: 05.01.2022

Accepted for publication: 26.01.2022

Published online: 28.01.2022

ABSTRACT

In this study we examined the floristic diversity of the Sutai Khairkhan Mountain Nature Reserve in western Mongolia's Altai Mountain range. This nature reserve area was established in 2019 and compared to nearby reserves, its flora is relatively understudied. From field surveys in 2014, 2019, and 2020, we collected about 400 herbarium specimens from various habitats and different altitudes in the reserve. We identified total of 317 taxa including 10 subspecies and three varieties of vascular plants belonging to 157 genera and 45 families. Among these, five species are nationally endemic, 27 species are endemic to Altai Mountains, and 37 species are threatened, including two critically endangered, 11 endangered, 16 vulnerable, and eight near threatened. In addition, we rediscovered *Microula tibetica* var. *pratensis* (Maxim.) W.T. Wang after 40 years. This first complete checklist of the SKMNR flora amplifies the value of protecting the diverse and threatened plants in the reserve and creates a baseline to assess future population changes.

Keywords: *Microula tibetica*, vascular plants, protected area, west Mongolia, Altai endemic.

РЕЗЮМЕ

Гүндэгмаа В., Дашмаа Ц., Билэгтмандах Ч., Цэгмэд З., Норрис Ж., Оюунцэцэг Б., Эрст А.С., Баасанмунх Ш., Флора сосудистых растений заповедник Гора Сутай Хайрхан, Монголия. Изучено флористическое разнообразие горного заповедника Сутай Хайрхан (SKMNR), расположенного на территории горного хребта Алтай в Западной Монголии. Заповедник был основан в 2019 году и, по сравнению с соседними заповедниками, его флора относительно мало изучена. В ходе полевых исследований, продолжавшихся с 2014 по 2020 г., было собрано около 400 гербарных образцов из различных местообитаний в разных высотных поясах. В результате ревизии гербарных фондов и полевых исследований было выявлено 317 таксонов, которые включают 10 подвидов и три разновидности сосудистых растений, относящихся к 157 родам и 45 семействам. Пять видов являются эндемиками Монголии, 27 видов являются эндемиками гор Алтая и 37 видов находятся под угрозой исчезновения, в том числе два – в критическом состоянии, 11 исчезающих и 16 уязвимых и восемь находящихся под угрозой исчезновения. Кроме того, спустя 40 лет, был заново найден *Microula tibetica* var. *pratensis* (Maxim.) W.T. Wang. Этот вид считался исчезнувшим для этой территории. Изучение известных местонахождений и вновь полученные данные дали возможность оценить статус редкости этого таксона на основе критериев МСОП – исчезающий вид в Монголии. Полученный список флоры SKMNR имеет важное значение для природоохранных целей, а также является основой для оценки будущих изменений в популяциях редких и эндемичных растений заповедника.

Ключевые слова: *Microula tibetica*, сосудистые растения, охраняемая территория, Западная Монголия, эндемик Алтая

The Altai Mountains, also known as the Altai Mountain Country (AMC), are located in the western part of the Altai-Sayan Ecoregion, and lies at the junction of four countries: Russia, Kazakhstan, China, and Mongolia (Kamelin 2005, Vaganov et al. 2019). One of the biggest parts of the AMC is located in western Mongolia which includes the Khovd (Kho), Mongolian Altai (MA), and Dzungarian Gobi (DzG) phytogeographical regions according to Grubov (1982). West Mongolia is a center of high vascular plant diversity comprises approximately 2000 taxa, which contains large number of endemic and threatened plant species compared to other parts of Mongolia (Pyak et al. 2008, Olonova et al. 2010, Oyuntsetseg et al. 2017, Baasanmunkh et al. 2019a, b, 2021a). Several high elevation mountains in the Mongolian part of the Altai Mountain range include Munkhkhairkhan, Jargalant, Bumbat, Baatar, Sutai Khairkhan, and Tsambagarav. The Sutai Khairkhan Mountain Nature Reserve (SKMNR) belongs to the Mongolian Altai (MA) phytogeographical region in western Mongolia (Grubov 1982).

In the past, the flora of western Mongolia was quite well studied by botanists mainly from Mongolia, Russia and Germany. A number of researchers have given much attention to the new species and new records of the vascular plants from western Mongolia (Zhao et al. 2018, Gundegmaa & Munkh-Erdene 2018, Nobis et al. 2019, Pyak & Pyak 2018, Pyak et al. 2020, Ovchinnikova 2020, Baasanmunkh et al. 2020, Shiga et al. 2020). Additionally, in western Mongolia, a few studies on floristic diversity have recently been conducted in the protected areas such as Strictly Protected Areas (SPA), National Parks (NP) as well as Nature Reserves (NR). For example, Oyuntsetseg et al. (2017) contributed a floristic survey on the Munkhkhairkhan NP and Baasanmunkh et al (2021a) provided an annotated checklist of vascular plants in the Dzungarian Gobi region including the Great Gobi B Strictly Protected Area (SPA) and part of Bulgan Ikh Ongog NP. Despite this research, several nature reserve areas, particularly in western Mongolia, such as the SKMNR, are still underexplored, particularly in regards to documenting their floristic diversity, endemism, and threatened vascular plants. The SKMNR covers a 172713.9-hectare area and was established in 2019 under the Ministry of Environment, Green Development and Tourism (<https://eic.mn/spa/>). Moreover, the Sutai Khairkhan Mountain is one of the sacred mountains in Mongolia, according to UNESCO (<https://whc.unesco.org/en/tentativelists/6068/>).

To date, approximately 3200 species of vascular plants have been recognized in Mongolia (Urgamal et al. 2014, 2019a, Shiga et al. 2020, Baasanmunkh et al. 2021b, Yano et al. 2021). In addition, several new species and new records were described from western Mongolia (Zhao et al. 2018, Nobis et al. 2019, Pyak et al. 2019, Ovchinnikova 2020). More recently, *Saussurea odorata* E. Pjak was described as a new species to science from the Mongolian Altai (MA) region (Pyak et al. 2020) and critically endangered *Saussurea bogedaensis* Yu J.Wang & J.Chen was also newly discovered in Mongolia in the Dzungarian Gobi region (Baasanmunkh et al. 2020). Additionally, nine aquatic plants were recently found at the Khar-Us Lake NP in western Mongolia (Shiga

et al. 2020). As shown by these recent publications, a number of new plant species are still being found and many unknown species remain to be discovered in Mongolia.

Based on our three years of field observations, this paper provides the first full checklist of floristic diversity of the Sutai Khairkhan Mountain NR area and reviews the conservation status of rare species.

MATERIAL AND METHODS

The Sutai Khairkhan Mountain Nature Reserve (46°40'–46°34'N 99°26'–93°53'E) is located in the Khovd and Gobi-Altai provinces of Mongolia and belongs to the MA phytogeographical region of Mongolia (Figs 1, 2). The dominant vegetation types here are alpine, high mountain, and mountain steppe. The Sutai Khairkhan, the mountain at the center of the SKMNR, rises 4000 m a.s.l. and is one of the highest mountains in the Altai Mountain system.

The field study was conducted in 2014, 2019 and 2020. During this time, we collected approximately 400 herbarium specimens from different elevations and various vegetation types. Species were identified using the standard guides of Grubov (1982), Flora of Mongolian series, Flora of China (eFlores 2008), and Endemic Plants of the Altai Mountain Country (Pyak et al. 2008). The accepted name of each species follows the Plants of the World Online (POWO 2020, <http://www.plantsoftheworldonline.org/>). The status of national endemic plants follows Baasanmunkh et al. (2021c), and endemic plants of the AMC follows Erst et al. (2021). Threatened plant species were based on Nyambayar et al. (2011), Oyuntsetseg et al. (2018) and Urgamal et al. (2019b). The regional distribution points for each species were based on Grubov (1982), Gubanov (1996), Urgamal et al (2014), German (2015) and Baasanmunkh et al. (2021a). The voucher specimens were deposited in the herbarium of the National University of Mongolia (UBU). The species data of each protected areas were derived from literature (if available) as well as Mongolian Protected Areas (<http://mpa.gov.mn/>). The grid distribution map of *Microula tibetica* var. *pratensis* (Maxim.) W.T. Wang was created in ArcGis, using the same approach as Baasanmunkh et al. (2022).

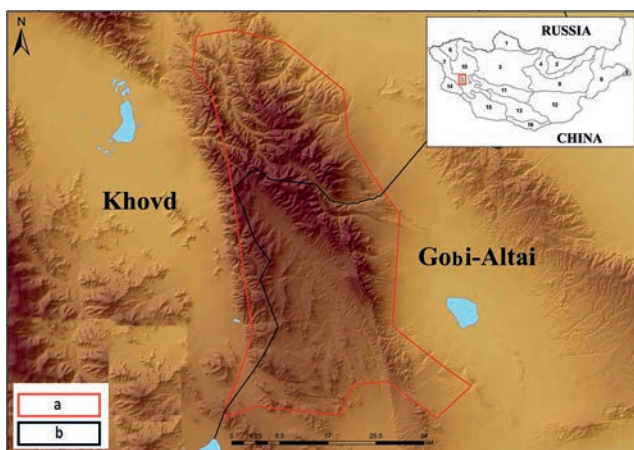


Figure 1 Study area of the Sutai Khairkhan Mountain Nature Reserve (a) in relations to a boundary between provinces (b) and floristic regions of Mongolia (1–16) after Grubov (1982)

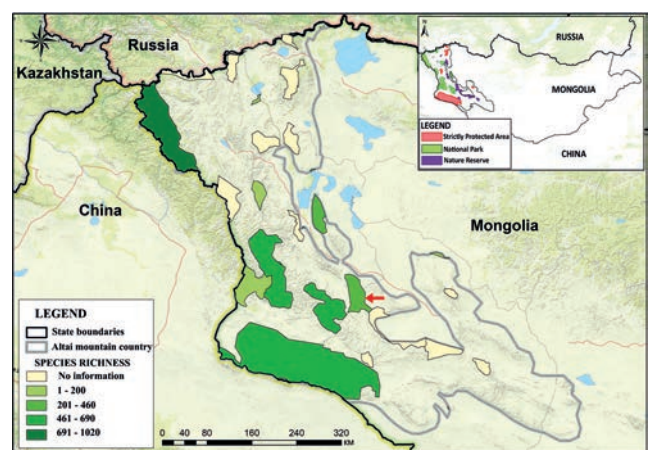


Figure 2 The species richness pattern of the protected areas in the Altai Mountain range of western Mongolia. The SKMNR is marked by a red arrow.

RESULTS

From three years of field surveys, approximately 400 herbarium collections were gathered; many of these samples have one or several duplicates. From the collections, we identified 317 vascular plant taxa (10 subspecies and 3 varieties) belonging to 157 genera and 45 families in the SKMNR (Fig. 2; Appendix 1). The angiosperms are represented by 308 species belonging to 151 genera. Additionally, four species of fern and fern allies in three genera as well as three species of gymnosperms belonging to three genera, were noted. Among these, the family with the greatest species diversity was Asteraceae with 48 species, followed by Fabaceae (27 species), Rosaceae (27 species), Caryophyllaceae (24 species) and Poaceae (23 species). The largest genus was *Potentilla* L. with 17 species followed by *Oxytropis* DC. (13 species), *Artemisia* L. (11 species) and *Saussurea* DC. (9 species), shown in Table 1.

In addition, 11 species were newly found in the MA region (Table 2) which were previously only recorded in several other phytogeographical regions of the country. For example, *Microula tibetica* var. *pratensis* (Maxim.) W.T. Wang was found again in the MA region, after 40 years; we provided more information about this rediscovery below (see Taxonomic treatment).

We also found 37 threatened plants including critically endangered (two species), endangered (11 species), vulnerable (16 species) and near threatened (8 species) from the SKMNR (Table 3). Examples of some rare and threatened plants were also photographed for documentation, namely *Leiospora exscapa* (C.A. Mey.) F. Dvorák (Fig. 3A), *Corydalis inconspicua* Bunge ex Ledeb. (Fig. 3B), *Saussurea glacialis* Herder (Fig. 3C), *Draba altaica* (C.A. Mey.) Bunge (Fig. 3D), and *Waldheimia tridactylites* Kar. & Kir. (Fig. 3E) in this area. For example, *S. glacialis* was frequently distributed in Mongolia but there are no wild photographs to date.

DISCUSSION

The Mongolian Altai region has one of the highest diversities of vascular plants compared to other regions of Mongolia (Neuffer et al. 2003, Urgamal et al. 2014, Gundegmaa et al. 2018, Baasanmunkh et al. 2019, 2021). Approximately 1700 species of vascular plants have been recognized in this region which accounts for 53 % of Mongolia's vascular plants (Gubanov 1996, Neuffer et al. 2003, Urgamal et al. 2014, Bekket et al. 2015, Oyuntsetseg et al. 2017, Baasanmunkh et al. 2021). In addition, we found 11 species which had not been recorded before in the MA region, according to Urgamal et al. (2014). Furthermore, we re-discovered the wild population of *Microula tibetica* var. *pratensis* (Maxim.) W.T. Wang after 40 years.

The Altai Mountain parts of Mongolia has a large number of endemic plants and threatened plant species compared to other parts of Mongolia (Pyak et al. 2008, Oyuntsetseg et al. 2018, Baasanmunkh et al. 2019b, Erst et al.

2021). Recently, Erst et al. (in press) updated and revised the checklist of endemic plants of the AMC which contains 302 species with representative herbarium barcodes. Among these, we documented 27 species in the SKMNR which shares about 9 % of the species in the AMC. Furthermore, Erst et al. (in press) determined that the species richness is 312 species based on botanical-geographical subdivisions of the AMC. According to Erst et al. (2021), there are two subdivisions, namely Khobdo-Tonkhil (ZM3) and South-Mongolia (UM), that have relatively few species with 10 and 4 species, respectively. However, our results show a much higher species richness of about 27 endemic plants that occur in the SKMNR ZM3 subdivision because of our more comprehensive field surveys.

Since 2011, over 600 species' regional conservation status in Mongolia has been assessed (Nyambayar et al. 2011, Oyuntsetseg et al. 2018, Baasanmunkh et al. 2019, Urgamal et al. 2019, Baasanmunkh et al. 2021c). We documented about 30 of these threatened species in the SKMNR.

The Sutai Khaikhan Mountain NR is a small area compared to the whole Altai Mountain range; however, it contains a high diversity of vascular plants including endemic and threatened plant species (Fig. 2). Additionally, because it is one of the largest mountain ranges in western Mongolia, its flora must not be overlooked as it is significant to our understanding of the conservation of these

Table 1. The most represented families (≥ 14 taxa) and genera (≥ 8 taxa) in the Sutai Khaikhan Mountain Nature Reserve.

Family	Number of taxa	Genus	Number of taxa
Asteraceae	48	<i>Potentilla</i>	17
Fabaceae	27	<i>Oxytropis</i>	13
Rosaceae	27	<i>Artemisia</i>	11
Caryophyllaceae	24	<i>Saussurea</i>	9
Poaceae	23	<i>Astragalus</i>	8
Ranunculaceae	14	<i>Pedicularis</i>	8

Table 2. List of newly recorded species in the Mongolian Altai region.

Taxon	Family
<i>Astragalus brevifolius</i> Ledeb.	Fabaceae
<i>Carex coriophora</i> Fisch. & C.A.Mey. ex Kunth	Cyperaceae
<i>Dasiphora parvifolia</i> (Fisch. ex Lehm.) Juzz.	Rosaceae
<i>Eritrichium alpinum</i> Ovczinnikova	Boraginaceae
<i>Koeleria macrantha</i> (Ledeb.) Schult.	Poaceae
<i>Leymus chinensis</i> (Trin.) Tzvelev	Poaceae
<i>Microula tibetica</i> var. <i>pratensis</i> (Maxim.) W.T. Wang	Boraginaceae
<i>Minuartia stricta</i> (Sw.) Hiern	Caryophyllaceae
<i>Persicaria minor</i> (Huds.) Opiz	Polygonaceae
<i>Potentilla tergemina</i> Sojak	Rosaceae
<i>Stellaria longifolia</i> Muhl. ex Willd.	Caryophyllaceae

Table 3. Status of taxa, endemic, and threatened plants in the Sutai Khaikhan Mountain Nature Reserve.

IUCN status	Family	Genus	Species	Endemic & Altai Endemic species	Threatened species
Total	45	157	317	32	37
Critically Endangered (CR)	2	2	2	–	2
Endangered (EN)	6	8	11	5	11
Vulnerable (VU)	11	15	16	4	16
Near threatened (NT)	7	8	8	3	8

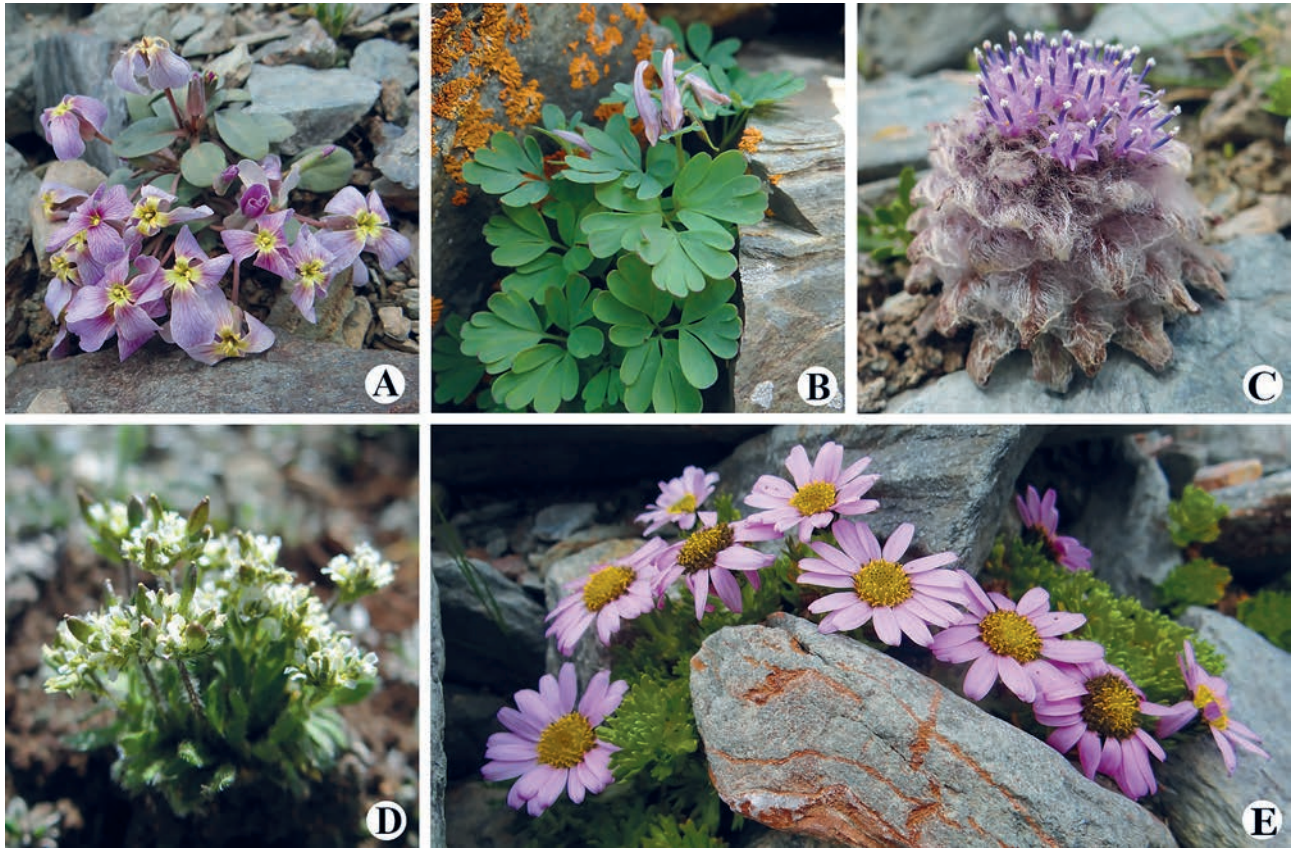


Figure 3 Examples of select rare and threatened plants from the Sutaï Khaïrkhan Mountain Nature Reserve. A – *Leiospora exscapa* (C.A. Mey.) F. Dvořák; B – *Corydalis inconspicua* Bunge ex Ledeb.; C – *Saussurea glacialis* Herder; D – *Draba altaica* Bunge; E – *Waldbeimia tridactylites* Kar. & Kir. Photo: V. Gundegmaa

rare alpine plants. This complete checklist improves the current floristic knowledge of the SKMNR area, increases its conservation value, and provides a baseline for future research. This checklist is only foundational; additional studies should include vegetation surveys, hotspot richness surveys, and detailed distribution map of rare species in the SKMNR to further inform management and conservation strategies. Because alpine vegetation can move higher in elevation due to climate changes, and Mongolian's mountain taiga is predicted to be replaced by steppe species (Sainnemekh et al. 2022), monitoring the changes in plant community and rare species distribution, is needed. New distribution records of rare or endemic species can greatly affect our understanding of their abundance, threats, and genetics. Therefore, close studies of these species are needed to update the Mongolian Red List and inform the reserve's management to protect plant hotspots from overgrazing or other human disturbances.

Taxonomic treatment

Microula tibetica var. *pratensis* (Maxim.) W.T. Wang (Boraginaceae) = *Tretocarya pratensis* Maxim.

In the literature, *Tretocarya pratensis* Maxim. was first recorded in the Khangai region of central Mongolia (Grubov 1982, Biazrov et al. 1989). In addition, we examined the herbarium specimens from all available herbaria which we found four herbarium specimens only from Mongolian Academy of Science (UBA), Mongolia. These four specimens were collected from the Khangai region of Mongolia

between 1971 and 1976. Since 1976, there have been no record of wild populations and herbarium specimens in the country. Almost 40 years later, we found it on the Sutaï Khaïrkhan Mountain, where there were less than 50 individuals within 1 km² (Fig. 4D). In general, *Tretocarya pratensis* Maxim. was treated synonym of *Microula tibetica* var. *pratensis* (Maxim.) W.T. Wang by Zhu et al. (1995). According to Zhu et al. (1995), this varieties occurs only in the Qinghai, Xinjiang, and S. Xizang of China, but it is already distributed in Mongolia (Grubov 1982, Biazrov et al. 1989). In addition, Yu et al. (2012) confirmed two varieties *Microula tibetica* var. *pratensis* and *M. tibetica* var. *tibetica* are distinguished by nutlets and corolla limbs based on nutlet micro-morphology. Based on our collections, *Microula tibetica* var. *pratensis* is similar to *M. tibetica* var. *tibetica* but could easily be distinguished by the corolla limbs (1.2–1.8 mm wide; Fig. 4B) and nutlets with abaxial aperture (Fig. 4C) according to Zhu et al. (1995) and Yu et al. (2012).

Specimens examined. MONGOLIA. Khangai Region: Bayankhongor Province, Gurvanbulag sum, Shar Usnii Gol, 1971, D. Tsagaanmaam et al. s.n. (UBA); Bayankhongor Province, Erdenetsogt sum, Ovgor Khvren Mt, Namiin Gol, 22 July 1977, E. Ganbold et al. s.n. (UBA); Zavkhan province, Otgon sum, Otgontenger Mt, Chuluutiin gol, 3100 m a.s.l., 1974, (UBA); Khuvsgul Province, Arbulag sum, Sumber brigad, Dund gilaadiin am, 1976, D. Tsagaanmaam et al. s.n. (UBA). Mongolian Altai Region: Gobi-Altai Province, Tonkhil sum, Sutaï Mt, 46°34'59.59"N 93°37'55.32" E, 3281 m a.s.l., 16 July 2019, V. Gundegmaa et al. (UBU) (Fig. 5).

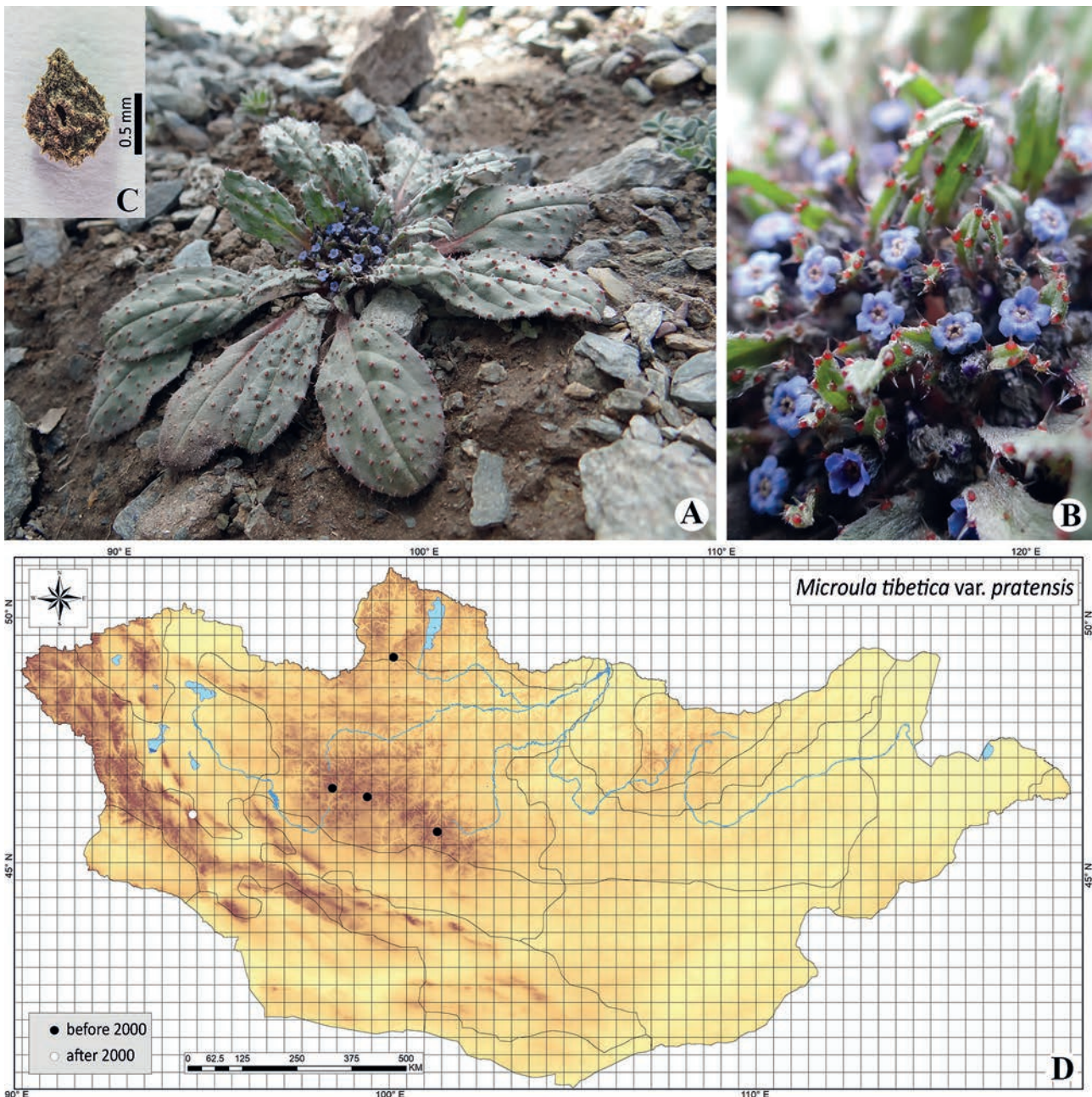


Figure 4 *Microula tibetica* var. *pratensis* (Maxim.) W.T. Wang. A – general habitat; B – flowers; C – abaxial part of nutlet with aperture; D – distribution map (new wild locations in blue and herbarium collections in green). Photo: A, B – V. Gundegmaa, D – L. Jargal

ACKNOWLEDGEMENTS

Our gratitude goes to Dr. D. Narantsetseg and Dr. Ya. Shiilegmaa (Mongolian National University of Education) for supporting our field survey. We also give many thanks to Dr. Zhao Liqing (Normal University of Inner Mongolia) for crosschecking plants and providing advice on our research. We extend our thanks to Mr. L. Jargal who took a photo of *Microula tibetica* nutlets. The research of Batlai Oyuntsetseg was supported by the National University of Mongolia (Grant No. P2021-4186). The research of Andrey Erst was supported by CSBG SB RAS (Grant No. AAAA-A21-121011290024-5).

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Figure 4 *Microula tibetica* var. *pratensis* (Maxim.) W.T. Wang. A – general habit; B – flowers; C – abaxial part of nutlet with aperture; D – distribution map (new wild locations in blue and herbarium collections in green). Photo: A, B – V. Gundegmaa, D – L. Jargal

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Appendix 1. A checklist of vascular plants in the SKM NR, with the growth form, status, elevation, phytogeographical regions, and herbarium code for each species. (Growth form: H – herb, T – tree, S – shrub, SS – subshrub; Status: E – Endemic, AE – Altai Endemic, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened. Distribution of phytogeographical regions based on Urganal et al. (2014) and new distribution records marked by +): 1 – Khuvsgul, 2 – Khentei, 3 – Khangai, 4 – Mongolian Dauria, 5 – Foothills of Great Khingan, 6 – Khovd, 7 – Mongolian Altai, 8 – Middle Khalkh, 9 – East Mongolia, 10 – Depression of Great Lakes, 11 – Valley of Lakes, 12 – East Gobi, 13 – Gobi Altai, 14 – Dzungarian Gobi, 15 – Transaltai Gobi, and 16 – Alashan Gobi.

Taxon	Growth form	IUCN status	Elevation, m a.s.l (low to high)	Region	Herbarium code
FERNS AND FERN ALLIES					
Aspleniaceae					
<i>Asplenium altaense</i> (Kom.) Grubov	H		2100–2500	1,3,4,7,10,13	SU20190306
Cystopteridaceae					
<i>Cystopteris fragilis</i> (L.) Bernh.	H		2600–3300	1–10,13,14,15	SU20190310
Ophioglossaceae					
<i>Botrychium lunaria</i> (L.) Sw.	H		2800–3000	1,2,3,4,5,7,9	SU20200507
Woodsiaceae					
<i>Woodsia ilvensis</i> (L.) R. Br.	H		2600–3000	1,2,3,4,7,8,9	SU20190307
<i>Woodsia glabella</i> R. Br.	H		2600–3100	1,7,10	SU20190311
GYMNOSPERMS					
Pinaceae					
<i>Larix sibirica</i> Ledeb.	T		2000–2500	1,2,3,4,6,7,8,10,14	SU20200220
Cupressaceae					
<i>Juniperus pseudosabina</i> Fisch. & C.A.Mey.	S	EN	2600–3000	1,2,3,4,7,8,13	SU20140601
Ephedraceae					
<i>Ephedra monosperma</i> J.G.Gmel. ex C.A.Mey.	SS		1500–2500	1–8,10,12,13	SU20190204
ANGIOSPERMS					
Amaranthaceae					
<i>Blitum virgatum</i> L.	H		1600–2000	3,4,6,7,12–15	SU20200908
<i>Chenopodium album</i> L.	H		1500–2100	1–16 (all regions)	SU20200610, SU20200912
<i>Chenopodium frutescens</i> C.A.Mey.	SS	AE	1500–2000	6,7,10	SU20140310
<i>Grubovia dasyphylla</i> (Fisch. & C.A. Mey.) Freitag & G. Kadereit	H		1500–2200	3–16	SU20200903
<i>Krascheninnikovia ceratoides</i> (L.) Gueldenst.	SS		1500	1,3,4,6,7,8,10–16	SU20190101, SU20200906
<i>Salsola collina</i> Pall.	H		1700–2300	2–15	SU20200907
<i>Suaeda tschujensis</i> Lomon. & Freitag	H	AE	1500–2000	6,7	SU20140206
Amaryllidaceae					
<i>Allium altaicum</i> Pall.	H	VU	2800–3050	1,2,3,6,7,8,10,13,14	SU20140504
<i>Allium mongolicum</i> Regel	H		1500–2100	3,4,6–16	SU20200802
<i>Allium polyrhizum</i> Turcz. ex Regel	H		1600–2000	1,2,3,4,7–13,15,16	SU20200803
<i>Allium prostratum</i> Trevir.	H		1800–2300	1–13	SU20190106
<i>Allium pumilum</i> Vved.	H	AE	2000–2600	6,7,14	SU20190105
Apiaceae					
<i>Bupleurum bicaule</i> Helm	H		1500–2300	1,2,3,4,6–13	SU20200602, SU20200709
<i>Bupleurum mongolicum</i> V.M. Vinogr.	H		3000–3350	7,13,14	SU20201510
<i>Carum carvi</i> L.	H		1800–3000	1–5,7,8,9,10,14	SU20200215
<i>Ferulopsis hystrix</i> (Bunge) Pimenov	H		1900–2700	2,3,4,6–11,13,15	SU20190108, SU20200101, SU20200206
<i>Neogaya simplex</i> (L.) Meisn.	H		2100–3000	1,2,3,4,6,7,13,14	SU20190504
<i>Ostericum tenuifolium</i> (Pall. ex Schult.) Y.C. Chu	H		2200–3000	1,2,3,4,6–10,13	SU20190508, SU20200503
<i>Seseli buchtormense</i> (Fisch. ex Hornem.) W.D.J. Koch	H		2100–3000	7,14	SU20201405
<i>Seseli condensatum</i> (L.) Rchb. f.	H		2100–3000	1,2,3,6,7,8,10,14	SU20201310
Asteraceae					
<i>Ajania grubovii</i> Muldashev	SS	E	1500	7,14	SU20140102
<i>Artemisia argyrophylla</i> Ledeb.	SS	AE	1800–2100	1,3,6,7,13,15	SU20200410
<i>Artemisia campestris</i> subsp. <i>borealis</i> (Pall.) H.M.Hall & Clem	H		2000–2600	1,2,3,4,6,7,10,13	SU20190203, SU20200910, SU20201002
<i>Artemisia dracunculus</i> L.	H		1500–2500	1–15	SU20140202, SU20140304, SU20190102, SU20190201, SU20201001
<i>Artemisia dracunculus</i> var. <i>pamirica</i> (C.Winkl.) Y.R.Ling & Humphries	H		1800–2500	3,6,7,10,11,12,13	SU20200204, SU20200302, SU20200404

Appendix 1. Continued

Taxon	Growth form	IUCN status	Elevation, m a.s.l (low to high)	Region	Herbarium code
<i>Artemisia frigida</i> Wild.	SS		1500–2100	1–16 (all regions)	SU20190203, SU20190202, SU20200402
<i>Artemisia laciniata</i> Wild.	H		1600–2500	1–5,7,8,9,10,12,14	SU20190202, SU20200304
<i>Artemisia macrocephala</i> Jacquem. ex Besser	H		1500–2600	1–16 (all regions)	SU20190205, SU20200203
<i>Artemisia mongolica</i> (Fisch. ex Besser) Nakai	H		1600–2000	1–15	SU20190301
<i>Artemisia pycnorrhiza</i> Ledeb.	H		1500–2500	1–4,6,7,8,10,11,13,14	SU20190103, SU20200305
<i>Artemisia stebmanniana</i> Besser	SS	LC	1500–2500	2,3,6–15	SU20200601
<i>Artemisia xerophytica</i> Krasch.	S		2000–3000	6,7,8,10–16	SU20190104
<i>Askellia pygmaea</i> (Ledeb.) Sennikov	H	VU	2900–3250	1,3,6,7	SU20190305, SU20201502
<i>Aster alpinus</i> L.	H		1600–2700	1–10,13	SU20200702
<i>Aster altaicus</i> Willd.	H		1500–2100	1,2,3,4,6,7,8,10,12–16	SU20140306
<i>Aster flaccidus</i> subsp. <i>flaccidus</i>	H		2100–2500	1,2,3,4,6,7	SU20200202
<i>Asterothamnus centrali-asiaticus</i> Novopokr.	SS	LC	1800–2000	7,8,9,11–16	SU20140406
<i>Asterothamnus heteropappoides</i> Novopokr.	SS	AE, NT	1500–1800	6,7,10,14	SU20140502
<i>Cirsium esculentum</i> (Siev.) C.A.Mey.	H		2000–2800	1,2,3,4,6–11,14	SU20201302
<i>Crepidiastrum tenuifolium</i> (Willd.) Sennikov	H		1800–2300	1–11,13,14	SU20200603
<i>Crepis chrysantha</i> (Ledeb.) Turcz.	H		3000–3300	1,2,3,6,7,10	SU20190403
<i>Doronicum turkestanicum</i> Cavill.	H		3050–3200	3,7,14	SU20190311
<i>Erigeron altaicus</i> Popov	H	AE	2100–2600	7,14	SU20190308, SU20200301
<i>Erigeron eriocalyx</i> (Ledeb.) Vierh.	H		2100–2500	1,2,3,6,7,13	SU20200303
<i>Erigeron petiolaris</i> Vierh.	H		2200–2500	3,7	SU20200306
<i>Leontopodium nanum</i> (Hook.f. & Thomson ex C.B.Clarke) Hand.-Mazz.	H		2100–3200	7,16	SU20140503, SU20200403
<i>Leontopodium ochroleucum</i> Beauverd	H		2100–3300	1,2,3,6,7,13	SU20140402, SU20200308
<i>Saussurea glacialis</i> Herder	H	EN	<3500	3,6,7,13	SU20190501, SU20201505
<i>Saussurea latifolia</i> Ledeb.	H	VU	1600–2500	3,7	SU20190107
<i>Saussurea leucophylla</i> Schrenk	H		2000–2200	1,3,6,7,13	SU20190109
<i>Saussurea orgadlayi</i> Khanm. & Krasnob.	H	AE, EN	3000–3300	7	SU20140505, SU20201203
<i>Saussurea pricei</i> N.D.Simpson	H		2000–3000	3,6,7,8,10,11,13,14	SU20140305
<i>Saussurea pseudoalpina</i> N.D.Simpson	H		2600–3000	1,2,3,6,7,13,14	SU20201705
<i>Saussurea saichanensis</i> Kom. ex Lipsch.	H	E	2000–3000	1,2,3,6,7,13,14	SU20140501
<i>Saussurea schanginiana</i> (Wydler) Fisch. ex Herder	H		3000–3300	1,2,3,6,7,13	SU20140405
<i>Saussurea subcaulis</i> (Ledeb.) Serg.	H	VU	3000–3300	1,3,6,7,13	SU20140302
<i>Scorzonera ikonnikovii</i> Lipsch. & Krasch.	H		1800–2300	3,6–15	SU20200703
<i>Senecio dubitabilis</i> C.Jeffrey & Y.L.Chen	H		1800–2200	2,3,7,8,10–15	SU20200608
<i>Tanacetum changaicum</i> (Krasch. ex Grubov) K.Bremer & Humphries	H	E, EN	2900–3300	3,7,10	SU20190312, SU20201210
<i>Tanacetum lanuginosum</i> Sch.Bip. & Herder	H		3000–3300	1,6,7,13	SU20190313
<i>Tanacetum pulchrum</i> (Ledeb.) Sch.Bip.	H	VU	3000–3300	3,7,13	SU20140409
<i>Taraxacum ceratophorum</i> (Ledeb.) DC.	H		2300–3000	3,6,7	SU20201406
<i>Taraxacum dissectum</i> (Ledeb.) Ledeb.	H		2000–3000	1,2,3,4,6–10,12,13	SU20200106
<i>Taraxacum junatovii</i> Tzvelev	H	E	2600–3000	3,7,13,14	SU20140306
<i>Taraxacum lyratum</i> (Ledeb.) DC.	H	AE	2600–3000	1,3,6,7,13	SU20201304
<i>Tephrosieris integrifolia</i> (L.) Holub	H		3000–3300	1,2,3,4,6,7,8,9,13	SU20190314
<i>Tephrosieris pricei</i> (N.D.Simpson) Holub	H		1800–2000	1,3,6,7,13,14	SU20190315
<i>Waldheimia tridactylites</i> Kar. & Kir.	H		<3500	1,3,6,7,13	SU20190403, SU20201404
Boraginaceae					
<i>Amblynotus rupestris</i> (Georgi) Popov	H		2200–3000	1–9,13	SU20200309
<i>Craniospermum canescens</i> DC.	H	AE, VU	2000–2500	3,7,13,14	SU20140204
<i>Eritrichium alpinum</i> Ovczinnikova	H	AE, VU	2100–2800	6, 7+	SU20200310
<i>Eritrichium pauciflorum</i> DC.	H		2100–2600	1–8,13	SU20200312
<i>Micronla tibetica</i> var. <i>pratensis</i> (Maxim.) W.T.Wang	H		3000–3300	3, 7+	SU20190401
<i>Myosotis alpestris</i> F.W.Schmidt	H		2500–3300	1,2,3,4,6,7,9,14	SU20200313
<i>Myosotis asiatica</i> (Vestergr.) Schischk. & Serg.	H		2100–2800	1,2,3,4,6,7,9,14	SU20200505
<i>Myosotis austrosibirica</i> O.D.Nikif.	H		2100–2800	7,13	SU20190309

Appendix 1. Continued

Taxon	Growth form	IUCN status	Elevation, m a.s.l (low to high)	Region	Herbarium code
Brassicaceae					
<i>Dontostemon senilis</i> Maxim.	H		1500–2100	6,7,8,10–16	SU20200607
<i>Draba altaica</i> (C.A.Mey.) Bge	H	VU	3000–3300	6,7,10	SU20201407
<i>Draba cana</i> Rydb.	H		2100–2500	1,2,3,4,6,7,13	SU20200313
<i>Draba lanceolata</i> Royle	H		2600–3300	1,2,3,4,6,7,13	SU20190316
<i>Draba nemorosa</i> L.	H		2600–3300	1–10,13	SU20190502
<i>Draba oreades</i> Schrenk	H		<3500	1,3,6,7,13	SU20190503, SU20201506
<i>Leiospora excarpa</i> (C.A.Mey.) F.Dvorák	H	AE	<3500	1,6,7	SU20190402
<i>Pachyneurum grandiflorum</i> (C.A.Mey.) Bunge	H	AE	3000–3300	1,3,6,7,13	SU20190408
<i>Ptilotrichum canescens</i> (DC.) C.A.Mey.	H		1500–2100	1–4,6–9,11,12,13,15,16	SU20140103
<i>Smelowskia alba</i> (Pall.) Regel	H		3000–3350	1,3,4,6,7,10,13	SU20190307
<i>Smelowskia altaica</i> (Pobed.) Botsch	H	AE, VU	3000–3300	6,7	SU20190303
<i>Smelowskia calycina</i> (Stephan ex Willd.) C.A.Mey.	H		<3500	1,3,6,7,13,14	SU20190401
Caprifoliaceae					
<i>Lonicera caerulea</i> subsp. <i>altaica</i> (Pall.) Gladkova	S		2200–2600	1,2,3,4,6,7,13,14	SU20140401
<i>Lonicera microphylla</i> Willd. ex Schult.	S		2000–2800	3,6,7,9,10,13,14,16	SU20140307
<i>Valeriana petrophila</i> Bunge	H		3000–3300	1,3,6,7,13	SU20190304
Caryophyllaceae					
<i>Cerastium arvense</i> L.	H		2100–2600	1–7,9,10,13,14	SU20200510, SU20200511
<i>Cerastium lithospermifolium</i> Fisch.	H		<3500	1,3,6,7,10,13	SU20190406, SU20190407, SU20201403
<i>Cerastium pusillum</i> Ser.	H		2600–3300	1,2,3,6,7	SU20201403
<i>Cherleria biflora</i> (L.) A.J.Moore & Dillenb.	H		2500–3300	1,2,3,6,7	SU20201702
<i>Dianthus chinensis</i> L.	H		2100–2500	1–11,13	SU20140105
<i>Dianthus repens</i> Willd.	H		2500–2800	6,7	SU20140207
<i>Dianthus superbus</i> L.	H		2100–2500	1–10,13	SU20200504
<i>Dichodon cerastoides</i> (L.) Rchb.	H		2600–3000	1–7,10,14	SU20200508
<i>Eremogone androsacea</i> (Grubov) Ikonn.	H	EN	2200–3000	13,7	SU20200411
<i>Eremogone meyeri</i> (Fenzl) Ikonn.	H		2300–3000	2,3,4,6,7,9,10,12,13	SU20140105
<i>Eremogone mongolica</i> (Schischk.) Ikonn.	H	AE, EN	2500–3000	7	SU20200413
<i>Heterochroa desertorum</i> Bunge	H		1500–2300	1,2,3,4,6–13,16	SU20190113
<i>Minuartia stricta</i> (Sw.) Hiern	H	NT	2500–3200	1,2,3,7+	SU20190303, SU202016
<i>Sabulina verna</i> (L.) Rchb.	H		2500–3250	1,2,3,6,7,14	SU20201408
<i>Silene amoena</i> L.	H		2100–3300	6,7,10,14	SU20190315
<i>Silene chamarensis</i> Turcz.	H		2100–3300	1,2,3,6,7,9,10,12,13	SU20190114
<i>Silene songarica</i> (Fisch., C.A.Mey. & Avé-Lall.) Bocquet	H		2600–3000	1–7,9,12,13	SU20190317, SU20201204
<i>Silene uralensis</i> subsp. <i>apetala</i> (L.) Bocquet.	H		2000–3000	1,2,3,6,7,10,13,14	SU20140303
<i>Stellaria brachypetala</i> Bunge	H		2000–2600	3–7,9,11,13,14	SU20200501
<i>Stellaria dichotoma</i> L.	H	LC	1800–2500	1–14	SU20200902
<i>Stellaria imbricata</i> Bunge	H	AE	2000–2500	6,7,14	SU20190318
<i>Stellaria longifolia</i> Muhl. ex Willd.	H		2100–2800	1,2,3,4,5,7+,9	SU20200509
<i>Stellaria palustris</i> Ehrh. ex Hoffm.	H		2100–2500	2,3,7,9	SU20200319
<i>Stellaria pulvinata</i> Grubov	H	AE, VU	2000–2800	6,7	SU20190207
Crassulaceae					
<i>Orostachys spinosa</i> (L.) Sweet	H		1500–2200	1,2,3,4,6–15	SU20200102
<i>Rhodiola quadrifida</i> (Pall.) Fisch. & C.A.Mey.	H		2900–3300	1,2,3,6,7,13	SU20190410, SU20201206
<i>Rhodiola rosea</i> L.	H	VU	2500–3300	1–8,13,14	SU20140412
<i>Rhodiola stephani</i> (Cham.) Trautv. & C.A.Mey.	H	AE	3000–3300	7	SU20190321, SU20140604
Cyperaceae					
<i>Carex atrofusca</i> Schkuhr	H		2600–3000	1,3,7	SU20190316
<i>Carex coriophora</i> Fisch. & C.A.Mey. ex Kunth	H		2600–3000	1,2,3,4,5,7+,8,9	SU20200408
<i>Carex duriuscula</i> C.A.Mey.	H		1500–3300	1–14,16	SU20200414
<i>Carex melanocephala</i> Turcz.	H		2600–3000	1,3,7	SU20201101, SU20201206
<i>Carex myosuroides</i> Vill.	H		2600–3300	1,2,3,5,6,7,10,13,14	SU20201102, SU20201211
<i>Carex pediformis</i> C.A.Mey.	H		2100–3000	1–9,13,14	SU20190322, SU20200412
<i>Eriophorum angustifolium</i> Honck.	H		2900–3300	1–7,9,10,11	SU20140413
<i>Eriophorum humile</i> Turcz.	H		3000–3300	1,2,3,6,7	SU20140414

Appendix 1. Continued

Taxon	Growth form	IUCN status	Elevation, m a.s.l (low to high)	Region	Herbarium code
Euphorbiaceae					
<i>Euphorbia mongolica</i> (Prokh.) Prokh.	H		1800–2500	3,6,7,10,11,12,13	SU20190114
<i>Euphorbia potaninii</i> Prokh.	H		2600–3000	3,6,7,10,13	SU20140313
Fabaceae					
<i>Astragalus brevifolius</i> Ledeb.	H		1500–2500	1,2,3,4,6,7+,8,11,12,13	SU20200211
<i>Astragalus dilutus</i> Bunge	H		2000–2500	3,6,7,10,12,13,14	SU20190115
<i>Astragalus ellipsoides</i> Ledeb.	H		1500–2500	7,15	SU20190217
<i>Astragalus gubanovii</i> N.Ulziykh.	H		1500–2500	7,10	SU20140111
<i>Astragalus laxmannii</i> Jacq.	H		2000–2500	1,3,6,7,8,13	SU20201106
<i>Astragalus leptostachys</i> Pall.	H		1600–2000	3,6,7,13	SU20201004
<i>Astragalus tschujensis</i> Bunge	H	AE	1800–2300	7	SU20200904
<i>Astragalus vallerstris</i> Kamelin	H		1500–2000	3,7,10-14	SU20200707
<i>Caragana bungei</i> Ledeb.	S		1800–2200	3,6,7,10,11,13,14,15	SU20200606
<i>Gueldenstaedtia monophylla</i> Fisch.	H	VU	2000–2100	6,7,10,12,13,16	SU20200705
<i>Hedysarum alpinum</i> L.	H		2900–3200	1–7,9	SU20190335, SU20190336
<i>Hedysarum inundatum</i> Turcz.	H		2500–2800	1,2,3,6,7,10,13	SU20140214
<i>Oxytropis acanthacea</i> Jurtzev	H	AE, NT	1500–2500	6,7	SU20201610
<i>Oxytropis aciphylla</i> Ledeb.	SS	LC	1500–1800	3,6,7,10–16	SU20200805
<i>Oxytropis altaica</i> (Pall.) Pers.	H	AE	2000–3000	6,7	SU20200412
<i>Oxytropis ampullata</i> (Pall.) Pers.	H		1500–2000	2,3,7,8,9,12,13	SU20200708
<i>Oxytropis bungei</i> Kom.	H		1500–2500	3,6,7,8,10–14	SU20190216
<i>Oxytropis intermedia</i> Bunge	H	AE	2600–3000	3,6,7	SU20200613
<i>Oxytropis oligantha</i> Bunge	H		2600–3300	3,6,7,10,13	SU20140516
<i>Oxytropis pauciflora</i> Bunge	H		2000–3000	1,6,7,13	SU20140515
<i>Oxytropis pumila</i> Fisch.ex DC.	H		1600–2100	3,6,7,8,10,11,13	SU20200706
<i>Oxytropis sapsoshnikovii</i> Krylov	H	AE, EN	2000–3000	7,10	SU20140303
<i>Oxytropis sutaiica</i> N.Ulziykh.	H	EN	2500–3100	3,7	SU20140610
<i>Oxytropis trichophylla</i> Bunge	H		2000–2500	3,6,7,10,11,13,14	SU20190117
<i>Oxytropis tschujae</i> Bunge	H	AE	2000–2500	1,7	SU20190216
<i>Trifolium eximium</i> Stephan ex Ser.	H		3100–3300	1,2,3,4,6–11,13	SU20140317
<i>Vicia costata</i> Ledeb.	H		1500–2800	2,3,4,6–14,16	SU20140214
Gentianaceae					
<i>Comastoma falcatum</i> (Turcz.) Toyok.	H		2600–3300	1,6,7,13	SU20190335
<i>Comastoma tenellum</i> (Rottb.) Toyok.	H		2500–3000	1,2,3,6,7,13	SU20200513
<i>Gentiana algida</i> Pall.	H	EN	2950–3300	1,2,3,6,7,13	SU20140703
<i>Gentiana aquatica</i> var. <i>pseudoaquatica</i> (Kusn.) S.Agrawal	H		2600–3000	1,2,3,4,6,7,8,9,13	SU20201105
<i>Gentiana decumbens</i> L.f.	H		1500–2800	1–11,13,14	SU20140104
<i>Gentiana riparia</i> Kar. & Kir.	H	CR	3000–3100	7,14	SU20201104
<i>Gentianella amarella</i> subsp. <i>acuta</i> (Michx.) J.M.Gillett	H		2100–2500	1,2,3,4,6,7,8,9,13	SU20201403
<i>Gentianella azurea</i> (Bunge) Holub	H		2600–3100	2,3,6,7,13	SU20200112
<i>Gentianopsis barbata</i> (Froel.) Ma	H	LC	2100–2500	1–11,13,14	SU20140207
<i>Lomatogonium carinthiacum</i> (Wulfen) A.Braun	H		2600–2900	1,2,3,4,6,7,8,11,13	SU20140417
Geraniaceae					
<i>Erodium tibetanum</i> Edgew. & Hook.f.	H		1500–2300	4,6,7,8,10–16	SU20140208
<i>Geranium pratense</i> L.	H		2100–2800	1,2,3,4,6,7,8,9,12,13	SU20200110
<i>Geranium pseudosibiricum</i> J.Mayer	H		2100–2800	1–8,10	SU20200111
Grossulariaceae					
<i>Ribes aciculare</i> Sm.	S	NT	2000–2800	2,3,4,6,7,8,10,13,14	SU20140315, SU20140316
<i>Ribes petraeum</i> Wulfen	S		2000–2600	1,2,3,4,7,14	SU20140416
Iridaceae					
<i>Iris potaninii</i> Maxim.	H	LC	1500–2400	1,2,3,4,6–13	SU20190115
Juncaceae					
<i>Luzula multiflora</i> subsp. <i>sibirica</i> V.I.Krecz.	H		2800–3300	1,2,3,4,6,7	SU20140306
Lamiaceae					
<i>Dracocephalum fruticosum</i> Stephan ex Willd.	SS		1600–2400	3,4,6,7,8,10-13,16	SU20190118
<i>Dracocephalum imberbe</i> Bunge	H		2100–2500	1,6,7	SU20190120
<i>Dracocephalum origanoides</i> Stephan ex Wild.	H		2600–3250	1,3,4,6,7,8,9,13,14	SU20190334
<i>Dracocephalum origanoides</i> subsp. <i>bungeanum</i> (Schischk. & Serg.) A.L.Budantsev	H		2000–2500	1,6,7,13	SU20190416
<i>Lagochilus ilicifolius</i> Bunge ex Benth.	H		1800–2100	3,7,8,10–16	SU20190113
<i>Lagopsis marrubiastrum</i> (Stephan) Ikonn.-Gal.	H		2600–3250	3,6,7,13,14	SU20190330, SU20200115

Appendix 1. Continued

Taxon	Growth form	IUCN status	Elevation, m a.s.l (low to high)	Region	Herbarium code
<i>Nepeta sibirica</i> L.	H		1800–2250	2,3,6,7,10,13,14	SU20190122, SU20200806
<i>Panzerina canescens</i> (Bunge) Sojak	H	NT	1600–2200	6,7,10,13	SU20140213
<i>Panzerina lanata</i> (L.) Soják	H		1500–2150	2,3,4,6–14,16	SU20200807
<i>Ziziphora pamiroalaica</i> Juz.	H		2150–2500	7,14	SU20200121
Liliaceae					
<i>Gagea serotina</i> (L.) Ker Gawl.	H		2600–3100	1,2,3,6,7,13	SU20140515
<i>Tulipa uniflora</i> (L.) Besser ex Baker	H	VU	2000–2800	3,5,7,8,9,10,14	SU20190114
Orchidaceae					
<i>Neottia camtschatea</i> (L.) Rchb.f.	H	CR	2100–3100	1,2,3,7	SU20200512
Orobanchaceae					
<i>Enphrasia pectinata</i> Ten.	H		2000–2200	1–10,13,14	SU20200710
<i>Orobancha cernua</i> Loeffl.	H		1850–2100	5,7–15	SU20140315
<i>Pedicularis abrotanifolia</i> M.Bieb. ex Steven	H	LC	2000–2500	1,3,6,7,13,14	SU20200511
<i>Pedicularis achilleifolia</i> Stephan ex Willd.	H		2900–3250	1,3,6,7,8,10,14	SU20140514
<i>Pedicularis amoena</i> Adams ex Steven	H		2850–3300	1,2,3,6,7,13,14	SU20190329
<i>Pedicularis flava</i> Pall.	H		2600–3250	2,3,4,6–11,13,15	SU20140608
<i>Pedicularis moschata</i> Maxim.	H	AE	2150–2500	6,7,10	SU20190328
<i>Pedicularis oederi</i> Vahl	H		3100–3250	1,2,3,6,7	SU20140414
<i>Pedicularis sibirica</i> Vved.	H		3000–3280	1,3,7	SU20201103
<i>Pedicularis uliginosa</i> Bunge	H		2700–3020	1,2,3,4,6,7,10,13	SU20190327
Papaveraceae					
<i>Corydalis inconspicua</i> Bunge ex Ledeb.	H	VU	3000–3350	1,2,7	SU20190413
<i>Hypecoum lactiflorum</i> (Kar. & Kir.) Pazij	H		1600–2100	3,4,6–16	SU20140111
<i>Papaver chakassicum</i> Peschkova	H		2980–3250	6,7	SU20140314
<i>Papaver lapponicum</i> (Tolm.) Nordh.	H		3000–3300	7	SU20190326
<i>Papaver pseudocanescens</i> Popov	H		2500–3200	1–7,13	SU20190325, SU20201409
Plantaginaceae					
<i>Lagotis integrifolia</i> (Wild.) Schischk.	H		2900–3150	1,2,3,7,13	SU20140607
<i>Linaria altaica</i> Fisch.	H		2050–2500	3,6,7,10,14	SU20140513
<i>Linaria hepatica</i> Bunge	H	NT	2100–2550	6,7,11,13,14	SU20190110
<i>Plantago depressa</i> Willd.	H		2000–2500	1–10,12,13	SU20190109
<i>Plantago komarovii</i> Pavlov	H	NT	2000–2500	1,3,6,7,13	SU20190325
<i>Plantago major</i> L.	H		1800–2100	2–14	SU20200109
<i>Veronica ciliata</i> Fisch.	H		3100–3200	1,2,3,6,7	SU20200414
<i>Veronica densiflora</i> Ldb.	H		2000–2500	2,7	SU20140107
<i>Veronica spicata</i> L.	H	VU	2100–2550	7,14	SU20190411
Plumbaginaceae					
<i>Limonium congestum</i> (Ledeb.) Kuntze	H	AE	2900–3150	6,7,10	SU20190215
Poaceae					
<i>Agropyron cristatum</i> (L.) Gaertn.	H		1500–2800	1–16 (all regions)	SU20190211, SU20200612
<i>Alopecurus magellanicus</i> Lam.	H		2600–3250	1,2,3,4,6,7,8,13	SU20140416
<i>Anthoxanthum glabrum</i> (Trin.) Veldkamp	H		2100–2500	1–10	SU20200512
<i>Anthoxanthum monticola</i> (Bigelow) Veldkamp	H		2600–3200	1,2,3,6,7,10	SU20200511
<i>Anthoxanthum nipponicum</i> Honda	H		2050–3000	2–7	SU20201212
<i>Cleistogenes songorica</i> (Roshev.) Ohwi	H		1500–2450	4,7–16	SU20200805
<i>Elymus sibiricus</i> L.	H		1600–2000	1–10,13–16	SU20140208
<i>Festuca altaica</i> Trin.	H		1900–2550	1,3,4,6,7	SU20190214, SU20201408
<i>Festuca lenensis</i> Drobow	H		1500–2200	1–9,13,15	SU20200804
<i>Hordeum brevisubulatum</i> (Trin.) Link	H		1500–2000	1–14,16	SU20190213, SU20200209
<i>Koeleria altaica</i> (Domin) Krylov	H		2000–3000	1–10,13	SU20190324
<i>Koeleria macrantha</i> (Ledeb.) Schult.	H		1600–2500	1,2,3,4,5,7+,8–13	SU20201103
<i>Leymus chinensis</i> (Trin.) Tzvelev	H		1500–2100	1–6,7+,8–14	SU20201306
<i>Leymus secalinus</i> (Georgi) Tzvelev	H		1500–2000	1,2,3,4,6–16	SU20200605
<i>Neotrinia splendens</i> (Trin.) M.Nobis, P.D.Gudkova & A.Nowak	H		1500–2100	2,3,4,5,7–16	SU20200704
<i>Phleum alpinum</i> L.	H	VU	2000–3000	7	SU20140607
<i>Poa alpina</i> L.	H		2000–3000	1,3,6,7,15	SU20200208
<i>Poa attenuata</i> Trin.	H		1500–2500	1,2,3,4,6–10,12–15	SU20190323, SU20201201
<i>Poa glauca</i> subsp. <i>altaica</i> (Trin.) Olonova & G.H.Zhu	H		1500–3000	1,2,3,6,7,10,13	SU20140414, SU20201003

Appendix 1. Continued

Taxon	Growth form	IUCN status	Elevation, m a.s.l (low to high)	Region	Herbarium code
<i>Ptilagrostis mongholica</i> (Turcz. ex Trin.) Griseb.	H	LC	1500–2000	1,2,3,4,7	SU20190322, SU20200611
<i>Stipa glareosa</i> P.A.Smirn.	H		1500–2100	3,6–16	SU20200801
<i>Stipa krylovii</i> Roshev.	H		1500–2000	1–14	SU20190212
<i>Trisetum spicatum</i> (L.) K.Richt.	H		2600–3100	1,2,3,4,6,7,13	SU20140605
Polygonaceae					
<i>Atraphaxis pungens</i> (M.Bieb.) Jaub. & Spach	S		1800–2100	2–16	SU20200611
<i>Bistorta elliptica</i> (Willd. ex Spreng) V.V.Petrovsky, D.F.Murray & Elven	H		2600–3300	1,2,3,6,7	SU20140309
<i>Bistorta vivipara</i> (L.) Delarbre	H	LC	2500–3250	1–4,6,7,8,10,13,14	SU20190320, SU20201101
<i>Koenigia alpina</i> (All.) T.M.Schust. & Reveal	H		2600–3300	1,2,3,4,6,7,8,14	SU20190114
<i>Oxyria digyna</i> (L.) Hill	H		3000–3300	1,2,3,6,7,13	SU20190317, SU20201205
<i>Persicaria minor</i> (Huds.) Opiz	H		2500–2800	7+,10,14	SU20140207
<i>Rheum compactum</i> L.	H		2600–3150	1,2,3,4,6,7,12,13,14	SU20190318
<i>Rheum nanum</i> Siev.ex Pall.	H		1500–2000	7,8,10–16	SU20200701
<i>Rumex thyrsiflorus</i> Fingerh.	H		2850–3200	1–14	SU20190319
Primulaceae					
<i>Androsace bungeana</i> Schischk. & Bobrov	H		2000–2600	1,2,3,6,7,9	SU20190319
<i>Androsace dasyphylla</i> Bunge	H		2600–3280	1,2,3,6,7,13	SU20140207
<i>Androsace lactiflora</i> Fisch. ex Willd.	H		2300–3000	1,2,3,4,6,7,9,14	SU20190316, SU20200208
<i>Androsace lehmanniana</i> Spreng.	H		2800–3300	1,2,3,6,7,9	SU20201306
<i>Androsace maxima</i> L.	H		2500–3200	2,3,4,6–10,13,14,15	SU20140308
<i>Androsace septentrionalis</i> L.	H		2300–3000	1–9,12,13	SU20200605
<i>Primula algida</i> Adams	H		2900–3250	3,6,7	SU20140513
<i>Primula bukukunica</i> Kovt.	H		3000–3280	7,11,13	SU20190410
<i>Primula longiscapa</i> Ledeb.	H		2100–2800	3,6,7,10,13,14	SU20200319
<i>Primula nivalis</i> Pall.	H		3050–3220	1,2,3,6,7,10	SU20140512
Ranunculaceae					
<i>Aconitum glandulosum</i> Rapaics	H		2600–3000	1,2,3,4,6,7,13,14	SU20140508
<i>Clematis alpina</i> subsp. <i>sibirica</i> (L.) Kuntze	SS		2100–2500	1,2,3,4,6,7,8,10,13	SU20140301
<i>Delphinium crassifolium</i> Schrad. ex Spreng.	H		2800–3200	1,2,3,5,6,7	SU20140407
<i>Delphinium inconspicuum</i> Serg.	H	AE	2800–3100	3,6,7,14	SU20140408
<i>Halerpestes sarmentosa</i> (Adams) Kom.	H		2600–3280	3,4,6–16	SU20201305
<i>Leptopyrum fumaroides</i> (L.) Rchb.	H		1600–2200	1,2,3,4,6,7,8,9,13	SU20200901
<i>Pulsatilla bungeana</i> C.A.Mey.	H		1800–2100	4,6,7	SU20140205
<i>Ranunculus longicaulis</i> Ledeb. ex A.Spreng.	H		2300–2800	1,2,3,6,7,11,14	SU20140509
<i>Ranunculus pedatifidus</i> Sm.	H		2400–2900	1–7,9,13	SU20200407
<i>Ranunculus pseudohirculus</i> Schrenk.	H		3100–3300	1,2,3,6,7,13,14	SU20140411
<i>Ranunculus saporzhnikovii</i> Schegol.	H	AE	3080–3250	7	SU20140409
<i>Thalictrum alpinum</i> L.	H		2500–3280	1,2,3,4,6,7,13	SU20190303, SU20201207
<i>Thalictrum foetidum</i> L.	H		2100–2800	1,2,3,4,6–10,13,14	SU20190112
<i>Trollius altaicus</i> C.A.Mey.	H		2600–3000	6,7,14	SU20140506
Rosaceae					
<i>Argentina anserina</i> (L.) Rydb.	H		1600–3000	1–11,13,14,15	SU20201303
<i>Chamaerhodos erecta</i> (L.) Bunge.	H		2100–2500	1–13	SU20200406
<i>Cotoneaster uniflorus</i> Bunge	S		2250–2900	1,2,3,7,8,13	SU20140510
<i>Dasiphora parvifolia</i> (Fisch. ex Lehm.) Juz.	S		2100–2800	2,3,4,6,7+,8	SU20200409, SU20200410
<i>Dryas oxyodonta</i> Juz.	SS		3100–3280	1,2,3,4,6,7	SU20201208
<i>Farinopsis salesoviana</i> (Stephan) Chrtk & Soják	SS		2600–3200	6,7,10,13,14	SU20140401
<i>Potentilla agrimonioides</i> M.Bieb.	H		2500–3000	6,7,14	SU20190111
<i>Potentilla altaica</i> Bunge	H		2000–2600	1,6,7	SU20190110
<i>Potentilla apbanes</i> Soják	H		2100–3000	3,6,7,10,13,14	SU20200408
<i>Potentilla astragalifolia</i> Bunge	H		1800–2200	3,6,7,10,11	SU20200604
<i>Potentilla conferta</i> Bunge	H		2000–3100	1–9,12,13,14	SU20200911
<i>Potentilla crebridens</i> Juz.	H		2150–2900	1,2,3,6,7	SU20190210, SU20200502
<i>Potentilla gelida</i> C.A.Meyer.	H		2100–2950	1,2,3,6,7,9,13,14	SU20140312, SU20201209
<i>Potentilla kryloviana</i> Th.Wolf	H		2000–3050	3,7,14	SU20201202
<i>Potentilla nivea</i> L.	H		1900–3100	1,2,3,4,6,7,13,14	SU20190206, SU20200210

Appendix 1. Continued

Taxon	Growth form	IUCN status	Elevation, m a.s.l (low to high)	Region	Herbarium code
<i>Potentilla ozjorensis</i> Peschkova	H		2000–2950	1,3,4,7	SU20200205
<i>Potentilla pamirica</i> Th.Wolf	H		2500–3180	6,7,10,14	SU20201403
<i>Potentilla pamiroalaica</i> Juz.	H		2950–3200	7,14	SU20201301
<i>Potentilla rhipidophylla</i> Sojak	H	E	2000–2600	7	SU20190304
<i>Potentilla sericea</i> L.	H		2100–3000	1,2,3,4,6–13,15	SU20200405
<i>Potentilla tergemina</i> Sojak	H		2600–3100	2,3,4,5,7+,9	SU20190303
<i>Potentilla tericholica</i> Sobolevsk.	H		2100–2800	6,7	SU20200207
<i>Potentilla turkestanica</i> Sojak	H		2950–3200	7,14	SU20200211
<i>Rosa laxa</i> Retz.	S	NT	2500–2800	6,7,13,14,15	SU20140705
<i>Sibbaldia adpressa</i> (Bge.) Juz.	H		1800–2600	1–13,15,16	SU20200606
<i>Sibbaldianthe bifurca</i> (L.) Kurtto & T.Erikss.	SS		1700–2500	1–14	SU20190209
<i>Spiraea alpina</i> Pall.	S		2200–3000	1,2,3,6,7	SU20140511
Rubiaceae					
<i>Galium verum</i> L.	H		1800–2500	1–10,13,14	SU20200108
Salicaceae					
<i>Populus laurifolia</i> Ledeb.	T		1700–2600	2,3,6,7,10,13,14	SU20140410
<i>Salix arctica</i> subsp. <i>torulosa</i> (Ledeb.) Hultén	S		3000–3250	1,3,6,7	SU20140507
<i>Salix berberifolia</i> Pall.	S		3000–3100	1,2,3,6,7,13	SU20140603
<i>Salix turczaninowii</i> Laksch.	S		2900–3100	1,2,6,7	SU20140404
Saxifragaceae					
<i>Saxifraga cernua</i> L.	H		2500–3000	1,2,3,6,7,8,9,13	SU20190316, SU20201402
<i>Saxifraga hirculus</i> L.	H	EN	2800–3100	1–7,13	SU20190401
<i>Saxifraga macrocalyx</i> Tolm.	H		2900–3150	1,6,7,13,14	SU20190314
<i>Saxifraga sibirica</i> L.	H		3000–3200	1,3,6,7,10,13,14	SU20190302, SU20201401
Solanaceae					
<i>Physocblaina physaloides</i> (L.) G.Don	H		1800–2200	1,3–9,11,12,13	SU20140201
Ulmaceae					
<i>Ulmus pumila</i> L.	T		1600–2500	2–5,7,8,9,11,13,16	SU20140606
Urticaceae					
<i>Urtica cannabina</i> L.	H		1800–2600	2–10,12,13,14	SU20200104
Viburnaceae					
<i>Adoxa moschatellina</i> L.	H		2200–2500	1,2,3,5,6,7,13	SU20200506
Violaceae					
<i>Viola dissecta</i> Ledeb.	H		2800–3100	1–5,7,9,13	SU20140602
Zygophyllaceae					
<i>Zygophyllum melongena</i> Bunge	H		1500–2100	3,6,7,10,11,13,14	SU20140106