Magsar et al. Journal of Ecology and Environment (2017) 41:16
DOI 10.1186/s41610-017-0034-3

Journal of Ecology and Environment

SHORT COMMUNICATION Open Access

Survey of medicinal plants in the Khuvsgul and Khangai Mountain regions of Mongolia

Urgamal Magsar[1], Kherlenchimeg Nyamsuren[1], Solongo Khadbaatar[1], Munkh-Erdene Tovuudorj[1], Erdenetuya Baasansuren[2], Tuvshintogtokh Indree[1], Khureltsetseg Lkhagvadorj[2] and Ohseok Kwon[3*]

Abstract

We report the species of medicinal plants collected in Khuvsgul and Khangai Mountain regions of Mongolia. Of the vascular plants that occur in the study region, a total of 280 medicinal plant species belonging to 164 genera from 51 families are reported. Of these, we collected voucher specimen for 123 species between June and August in the years 2015 and 2016. The families Asteraceae (46 species), Fabaceae (37 species), and Ranunculaceae (37 species) were represented most in the study area, while *Astragalus* (21 species), *Taraxacum* (20 species), and *Potentilla* (17 species) were the most common genera found.

Keywords: Medicinal plants, Khuvsgul and Khangai mountains, Phytogeographical region, Mongolia

Background

Mongolia occupies an ecological transition zone in Central Asia where the Siberian Taiga forest, the Altai Mountains, Central Asian Gobi Desert, and the grasslands of the Eastern Mongolian steppes meet. Mongolia has some of the world's highest mountains and with an average elevation of 1580 m is one of the few countries in the world that is located at a high elevation. The highest peak in Mongolia is 4374 m above sea level. There are magnificent glaciers in the highest parts of the Mongol Altai range towering over Mongolia, Russia, and China, and the humps and hollows of the ice age period have been preserved in the Khuvsgul, Khangai, Khentii, and Altai Mountains. The far northern areas of the Khuvsgul Province forms the southern reaches of Siberia and are covered by larch and pine forests known by the Russian word "taiga." The Khuvsgul Mountains are situated on the northern side of the Khangai Mountain range and are formed by the Ulaan, Taiga, and Khoridol Saridag Lakes, 3491 m above sea level. Rivers of the Tes Basin and the River Delger of the Selenge Basin flow from the zone to the west and east, respectively.

The Khangai Mountains with its highest peak, Otgon Tenger, reaching 3905 m and capped with a permanent glacier, is situated in Central Mongolia. From this region, the Khangai range splits and continues as the Bulnai, the Tarvagatai, and the Buren mountain ranges. The point where it splits represents the Khangai Mountain.

Systematic exploratory studies including those on medicinal plant resources were undertaken from the 1940s when the Government of Mongolia invited Russian scientists including Drs. I. A. Tsatsenkin, A. A. Yanatov, and V. I. Grubov who focused on rare and useful plant species giving emphasis on plant species of medicinal value. This was followed by a Joint Russian-Mongolian Complex Biological Expedition conducted since 1970.

Currently, it is estimated that about 3127 species (included 131 sub-species and 32 varieties) and 683 genera of vascular plants exist in Mongolia (Urgamal et al. 2014, Urgamal and Sanchir 2015). Of these, 845 species are medicinal plants, 150 species are rich sources of vitamins, 200 species contain essential oils, 250 species contain tanning matter, more than 200 species are plants that can be used for dyeing, 231 species are rich in flavonoid, 200 species are useful in many industries, more than 480 species are ornamental plants, 280 species contain alkaloids, 65 species contain coumarin, and 68 species are used to control sand movement (Ulziykhutag 1989). About 32% of the total vascular plants found in Mongolia are registered as medicinal plants, of which more than 200 plants species could be used for manufacturing modern western medicine (see Additional file 1).

* Correspondence: ecoento@knu.ac.kr
[3]School of Applied Biosciences, College of Agriculture and Life Sciences Kyungpook National University, Daegu 41944, Korea
Full list of author information is available at the end of the article

BioMed Central

© The Author(s). 2016 **Open Access** This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated.

Although substantial work has been undertaken to identify and record the distributions of medicinal plants in Mongolia, studies in the Khuvsgul and Khangai mountains are incomplete.

The purpose of this study was to identify the medicinal plants in Khuvsgul and Khangai mountain ranges of Mongolia and record their distribution across the study area. The study also aimed to determine the species composition of vascular plants in the study area and compare their floral analysis, ecological groups, the habitat type in which they were found, their distribution, and their usefulness based on traditional knowledge. The plant specimens were collected in joint surveys with our Mongolian partners in Khuvsgul and Khangai mountain regions of Mongolia and taken to Korea for botanical, chemical, and pharmacological investigations. Information on traditional knowledge was also collected in collaboration with our Mongolian partners.

Materials and methods

The study was conducted in two mountain areas of the Northern (Khuvsgul) and Central (Khangai) provinces of Mongolia (Fig. 1). The first study area in the Khuvsgul and Khangai (Tarvagatai mountain range) regions was surveyed in July and August 2015, and the second study area located in only the Khangai (Suvarga Khairkhan Mountain range) region was surveyed in June and July 2016 (Table 1).

Specimens of the 280 medicinal plant species were taken from the Herbarium, Ulaanbaatar Academy (UBA) of the Department of Botany, Institute of General and Experimental Biology, Mongolian Academy of Sciences. This additional data was also used in this study.

The five study sites were surveyed, and medicinal plants that were most used were collected. Below, we list some of these species:

Site 1

Bupleurum scorzonerifolium Willd., *Delphinium grandiflorum* L., *Aster alpinus* L., *Odontites vulgaris* Moench, *Aconitum turczaninowii* Vorosch., *Epilobium angustifolium* L., *Iris ruthenica* Ker-Gavler, *Lathyrus humilis* (Ser.) Spreng., *Lathyrus pisiformis* L., *Mertensia davurica* (Sims) G. Don, *Paeonia anomala* Pall., *Phlomis tuberosa* L., *Potentilla fruticosa* L., *Rhaponticum uniflorum* (L.) DC., *Sphallerocarpus gracilis* (Bess. ex Trev.) Koso-Pol., *Vaccinium vitis-idea* L., and *Ledum palustre* L.

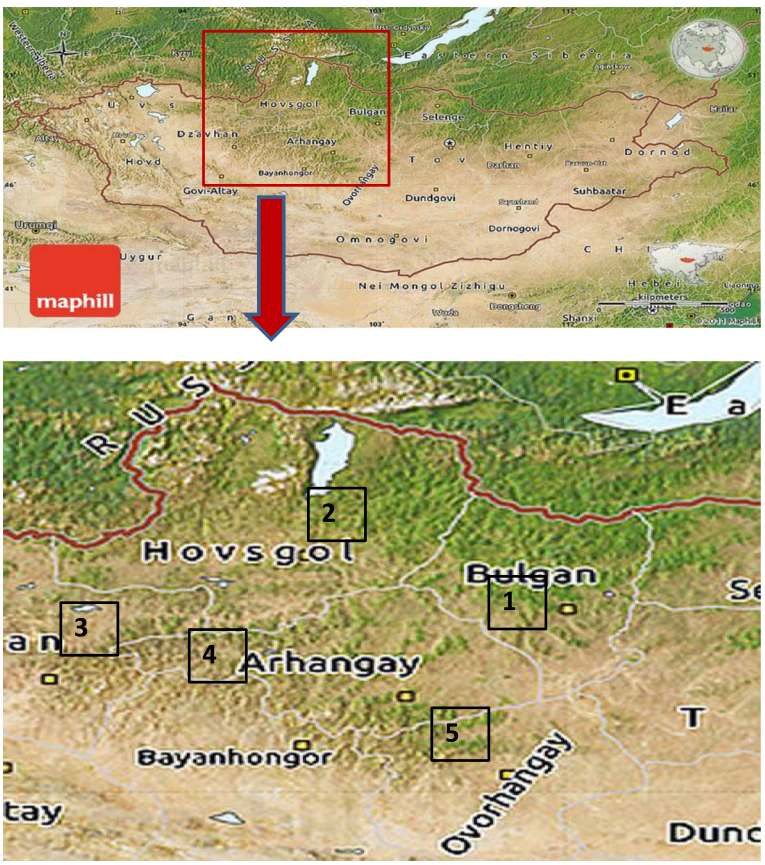

Fig. 1 Location of the study area and the main specimen collection sites (1–5)

Table 1 Details of the five main study sites

Site number	Place name	Mountain range	Location	Habitat	No. of species collected
1	Bulgan aimag, Bugat sum, Tuluugiin davaa	Khangai	N 48.94757; E 103.06188	Forest, forest steppe	72
2	Khuvsgul aimag, Khatgal sum, Khuvsgul lake	Khuvsgul	N 50.31757; E 101.16188	Forest, forest steppe	39
3	Zavkhan aimag, Ikh-Uul sum, Tarvagatai mountain	Khangai	N 48.21757; E 97.27188	Taiga, forest, forest steppe	50
4	Arkhangai aimag, Tsetserleg sum, Tsagaan davaa	Khangai	N 47.66873; E 101.31152	Forest, forest steppe, mountain steppe	53
5	Arkhangai aimag, Tsenkher sum, Tsenkheriin rashaan	Khangai	N 47.01361; E 101.53124	Forest, forest steppe, mountain steppe, steppe	66

Site 2

Aconitum turczaninovwii Vorosch., *Betula platyphylla* Sukacz., *Delphinium elatum* L., *Gentiana decumbens* L., *Potamogeton perfoliatus* L., *Potamogeton pusillum* L., *Taraxacum dealbatum* Hand-Mazz, *Triglochin palustris* L., *B. scorzonerifolium* Willd., *Rosa acicularis* L., *P. anomala* Pall., *Sanguisorba officinalis* L., *Clematis alpina* var. *sibirica* (L.) Kuntze, *Ledum palustris* L., *E. angustifolium* L., *Silene jenesseensis* Willd., *Echinops gmelinii* Turcz., *P. fruticosa* L., and *Galium boreale* L.

Site 3

Stellera chamaejasme L., *Vicia cracca* L., *Aquilegia sibirica* Lam., *Geranium pseudosibiricum* J. Mayer, *Myosotis caespitosa* Schultz, *R. acicularis* L., *Persicaria vivipara* (L.) Ronse Decr., *Polemonium chinense* (Brand) Brand, *S. officinalis* L., *Stellaria dichotoma* L., *Bupleurum scor zonerifolium* Willd., *Cerastium cerastoides* (L.) Britt., *G. boreale* L., *Lilium martagon* L., *Pedicularis tristis* L., *Potentilla longifolia* Willd. ex Schlecht., *Potentilla tanacetifolia* Willd. ex Schlecht., *Campanula glomerata* L., *Dracocephalum grandiflorum* L., *Astragalus alpinus*, *Dracocephalum ruyschiana* L., *Fragaria orientalis* Losinsk., *Hedysarum alpinum* L., and *Libanotis condensata* (L.) Crantz.

Site 4

Arctous alpina (L.) Nied., *Artemisia glauca* Pall. ex Willd., *Artemisia rutifolia* Stephan ex Spreng., *Potentilla anserina* L., *Ribes rubrum* L., *Spiraea hypericifolia* L., *Spiraea media* Schmidt, *Veronica ciliata* Fisch., *Polygala sibirica* L., *Chrysanthemum zavadskii* Herbich, *Cotoneaster melanocarpus* (Ledeb.) Lodd., G. Lodd. & W. Lodd. ex M. Roem., *Betula ovalifolia* Rupr., *Cotoneaster mongolicus* Pojark., *Ligularia sibirica* (L.) Cass., *Plantago depressa* Willd., *Senecio nemoralis* L., *Thalictrum minus* L., *Echinops latifolius* Tausch, *Elachanthemum intricatum* (Franch.) Ling & Y.R. Ling, *Ligularia fischeri* (Ledeb.) Turcz., *Rhodiola quadrifida* (Pall.) Fisch. & C. A. Mey., and *Thalictrum simplex* L.

Site 5

Cerastium arvense L., *Capsella bursa-pastoris* (L.) Medic., *Equisetum palustre* L., *Filipendula palmata* (Pall.) Maxim., *Hedysarum neglectum* Ledeb., *P. anomala* Pall., *Pulsatilla bungeana* C.A. Mey., *Sedum aizoon*

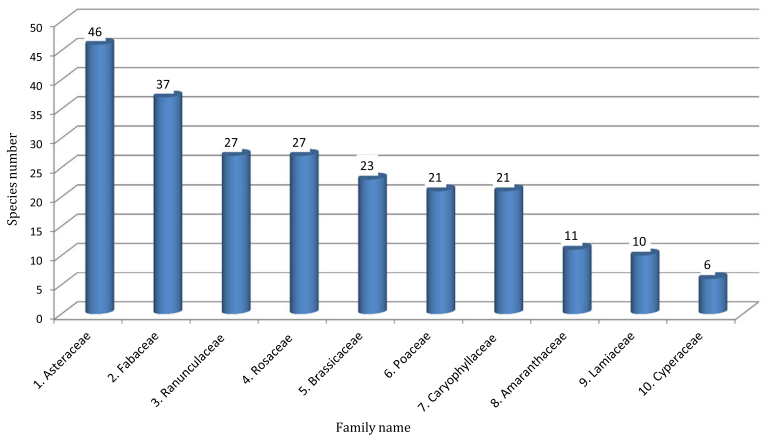

Fig. 2 The number of species representing the most common families in the study site

L., *Thalictrum foeditum* L., *Potentilla acaulis* L., *Potentilla conferta* Bunge, *Salix bebbiana* Sarg., *Salix glauca* L., *L. palustre* L., *Aconitum turczaninovii* Vorosch., *Actaea cimicifuga* L., *B. platyphylla* Sukacz., *Anemone sibirica* L., *Bupleurum bicaule* Helm., *Geranium transbaicalicum* Serg., *Artemisia adamsii* Besser, *Vicia unijuga* A. Br., *Parnassia palustris* L., *Rheum compactum* L., *Viola uniflora* L., and *Artemisia frigida* Willd.

The nomenclature and taxonomy used here follow the works of APG IV (2016), and Urgamal et al. (2014), Urgamal & Sanchir (2015). Additionally, we have used the following monographs and taxonomic databases available at these websites: 3Tropics (2016) and The Plant List (2016). The sampling and preservation of materials for the herbarium were done according to classical methodologies (Grubov 1982, Ulziykhutag 1985, Ganbold 2010, Ligaa et al. 2009, Urgamal & Kwon 2015). The identification of plant parts was done using an MEC-2 binocular (8×).

Results

Based on our research, we identified and recorded 280 species of medicinal plants belonging to 164 genera from 51 families in the Khuvsgul and Khangai Mountain regions of Mongolia.

The families represented by the most number of species include Asteraceae, Fabaceae, and Ranunculaceae. The most common genera found in the study site were *Artemisia* (10 species), *Oxytropis* (8 species), and *Potentilla* (8 species) genera (Fig. 2). Table 2 lists the 10 most common families and genera of the medicinal plants collected in our study.

Of the medicinal plants that we collected, 9 species (3%) were found growing in the taiga, 42 species (15%) in the forests, 132 species (47%) in the forest steppe, 54 species (19%) in the mountain steppe, and 43 species (16%) in the steppe (Fig. 3).

Table 2 The ten most common genera and families of medicinal plants collected in our study

Family	Species	Percent of total	Genus	Species	Percent of total
1. Asteraceae	46	16.43	1. *Artemisia*	10	3.57
2. Fabaceae	37	13.21	2. *Potentilla*	8	2.86
3. Ranunculaceae	27	9.64	3. *Oxytropis*	8	2.86
4. Rosaceae	27	9.64	4. *Salix*	6	2.14
5. Brassicaceae	23	8.21	5. *Vicia*	5	1.79
6. Poaceae	21	7.50	6. *Astragalus*	5	1.79
7. Caryophyllaceae	21	7.50	7. *Saussurea*	4	1.43
8. Amaranthaceae	11	3.93	8. *Allium*	4	1.43
9. Lamiaceae	10	3.57	9. *Polygonum*	4	1.43
10. Cyperaceae	6	2.14	10. *Pedicularis*	3	1.07

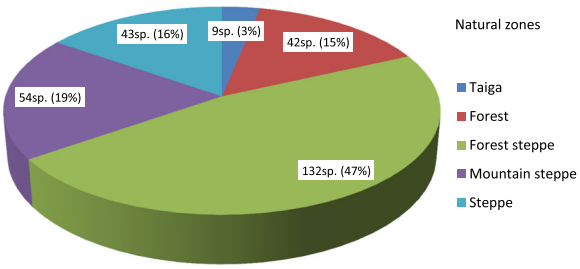

Fig. 3 Types of habitats from where the medicinal plants were collected from in the study site

Different plant parts were used as medicine—in 4.1% of the medicinal plants found in the study site all parts were used, while in 74.0% of the species the leaves were used, in 24.9% flowers, in 10.4% fruit and seeds, in 8.3% bark and needles, and in 23.9% of the species the root were used (Fig. 4).

Discussion

In this study, we identified and recorded a total of 280 species of medicinal plants belonging to 164 genera and 51 families that occur in the Khuvsgul and Khangai Mountain regions of Mongolia.

Among these plants, the following species of liquorice were found to be in great demand and were in grave danger of being lost in the wild: *Astragalus membranaceus*, *Astragalus mongolicus*, *Saposhnikovia divaricata*, *Adonis mongolica*, *Aconitum kusnezoffii*, *Cistanche deserticola*, *Saussurea involucrata*, *Ephedra sinica*, *Scutellaria baicalensis*, *Cynomorium songaricum*, *Dactylorhiza salina*, *Sophora flavescens*, *and Zygophyllum potaninii*. These plants are very widely used by local people for food, traditional medicine, and livestock fodder and are usually harvested without any official permission and control.

Conclusions

Our study showed to identify and determine the species composition of vascular plants in the study area and

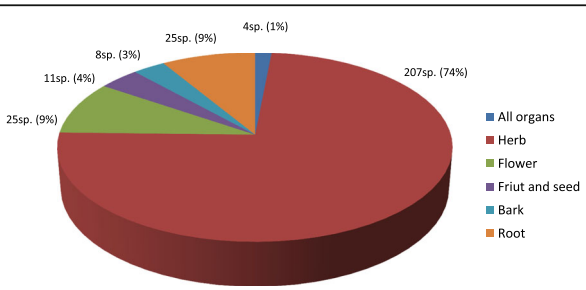

Fig. 4 The parts of the collected medicinal plants that are known to have medicinal properties

compare their floral analysis, ecological groups, the habitat type in which they were found, their distribution, and their usefulness based on traditional knowledge the medicinal plants that when both in Khuvsgul and Khangai mountain ranges of Mongolia were combined and record their distribution across the study area.

The investigated species composition of medicinal vascular plants in the Khuvsgul and Khangai mountains were classified and described to the flora of Mongolia.

Mongolian medicinal plants were most frequently observed in Khuvsgul and Khangai mountain ranges, and density was strongly associated with plant biomass. Results imply that varying medicinal plants of Khuvsgul and Khangai mountains are playing an important role in vascular flora of Mongolia.

This may contribute to this species' predominance in various two (Khuvsgul and Khangai mountain ranges) ecosystems where medicinal vascular plants dominate Mongolia.

Additional file

Additional file 1: List of collected of plant voucher specimens of herbarium by Urgamal (XLSX 46 kb)

Abbreviations

UBA: Ulaanbaatar Academy; APG: Angiosperm Phylogeny Group

Acknowledgements

The authors are grateful for the access to the collection at the Department of Botany, Institute of General and Experimental Biology of Mongolian Academy of Sciences. This work was supported by a grant from the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR No. 2016-04-203).

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Funding

This work was supported by a grant from the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR No. 2016-04-203).

Availability of data and materials

Please contact author for data requests. The data are not publicly available due to sensitive information regarding surface information of the study area.

Authors' contributions

UM carried out the survey in Mongolia. KN, SK, MT, EB, and TI participated and worked together to collect the specimen in the field. KH helped to organize the manuscript. OK conceived of the study and helped to draft the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

Not applicable.

Author details

[1] Department of Botany, Institute of General and Experimental Biology, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia. [2]Department of Biology, School of Natural Sciences, National University of Mongolia, Ulaanbaatar, Mongolia. [3]School of Applied Biosciences, College of Agriculture and Life Sciences Kyungpook National University, Daegu 41944, Korea.

Received: 22 September 2016 Accepted: 1 October 2016
Published online: 17 April 2017

References

Angiosperm Phylogeny Group (APG IV, 2016). (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society, 181*(1), 1–20.

Ganbold, E. (2010). *Flora of the Northern Mongolia* (Series of the Russian Mongolian Complex Biological Expedition). Moscow: Tom LIII (in Russian).

Grubov, V. I. (1982). *Key to the vascular plants of Mongolia*. Leningrad: Nauka (in Russian).

Ligaa et al. (2009). Medical plants of Mongolia used in Western and Eastern medicine. Moskow, Russia. Vol.54.

The Plant List 2016. http://www.theplantlist.org. Accessed 25 Nov 2016.

Ulziykhutag, N. (1985). *Key to the Fodder Plants in the Pasture and Haymaking of Mongolia*. Ulaanbaatar: State Publishing, (in Mongolian).

Ulziykhutag, N. (1989). *Overview of the Flora of Mongolia*. Mongolian: State Publishing.

Urgamal, M., & Kwon O. (2015). *The Handbook for Traditional Knowledge on Biological Resources* (Vol. 1, p. 632). Mongolia: SeoHyeong Publishing. Printed in Republic of Korea. © 2015 National Institute of Biological Resources (NIBR). ISBN 978-89-6811-202-7 (93470).

Urgamal, M., & Sanchir, C. (2015). Preliminary analysis of the vascular flora of Mongolia. In *Commemoration of the 45th anniversary of the joint Russian-Mongolian complex biological expedition, RAS and MAS; and 50th anniversary of the Institute of the General and Experimental Biology, MAS. Proceedings of International Conference of Ecosystems of the Central Asia under current conditions of socio-economic development, 08-10 September, 2015* (Vol. 1, pp. 262–264). Ulaanbaatar, Mongolia.

Urgamal, M., Oyuntsetseg, B., Nyambayar, D., & Dulamsuren, C. (2014). Conspectus of the vascular plants of Mongolia. In C. Sanchir & T. Jamsran (Eds.), (p. 224). Ulaanbaatar, Mongolia: "Admon" Press.

W3 Tropicos 2016. Missouri Botanical Garden. http://www.tropicos.org. Accessed 26 Nov 2016.

Submit your next manuscript to BioMed Central and we will help you at every step:

- We accept pre-submission inquiries
- Our selector tool helps you to find the most relevant journal
- We provide round the clock customer support
- Convenient online submission
- Thorough peer review
- Inclusion in PubMed and all major indexing services
- Maximum visibility for your research

Submit your manuscript at
www.biomedcentral.com/submit

BioMed Central