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[Short Communication]

On the Quantitative Aspects of the Flora of Mongolia

Lkhagva Ariuntsetseg and Bazartseren Boldgiv

Department of Ecology, Faculty of Biology, National University of Mongolia, Ulaanbaatar 210646, Mongolia, e-mail: ariuntsetseg@biology.num.edu.mn; boldgiv@biology.num.edu.mn

Introduction

Mongolia is one of the most interesting research areas for botanical systematists and biogeographers because of the country's geographical location in a depth of the Euro-Asian continent that, according to the world phytogeographical classification by Takhtajan (1978), spans over the Altai-Sayan province belonging to Circumboreal region in the north and northwest, the Manchurian province belonging to Eastern Asiatic region in the east of Boreal subkingdom, the Dzungaro-TienShan and Mongolian provinces belonging Iran-Turanian region in the south-west and south of Tethyan subkingdom of Holarctic kingdom. Although the first attempt to explore the flora of Mongolia is credited to D. G. Messerschmidt, who collected the first herbariums from north-eastern Mongolia (valleys of Ulz and Onon rivers), the first inventory list of vascular plants of Mongolia including 489 species was put together by K. I. Maximovicz in 1859. These researchers were followed by dozens of researchers, mostly from Russia, Poland, Germany and other countries. Meanwhile, the conformity of Mongolian territory with the phytogeographical classification by V. L. Komarov in 1908 and of the world by Takhtajan (1978) were revised and there are several works on this issue (Ulziikhutag, 1989). According to the latest classification by Grubov and Yunatov (1952), Mongolia is divided into sixteen phytogeographical regions based on floral composition, vegetation and geographical characteristics. A detailed historical review of these research efforts could be found in the works by Ulziikhutag (1989), Hilbig (1995) and Gubanov (1996). Moreover, some families and genera of vascular plants, as well as phytogeographical regions are revised by researchers. For example, a monograph of flora and vegetation of East Mongolia was published by Dashnyam (1974) and Dzungarian Gobi and its oasis vegetation was studied by Gal (1975). A list of such studies is enormous and reviewing them will be a challenge. Researches on flora and vegetation of Mongolia are still ongoing with higher rate than ever before.

Nowadays, there are two publicly accepted major works on the flora and plant geographical regions of Mongolia. *The Conspectus of Vascular Plants of Mongolia* by Gubanov (1996) is the latest that includes all the updates in the flora since 1980s. This work appeared after *The Keys to the Vascular Plants of Mongolia* by Grubov (1982), which is still considered the first major result of studies on flora of the country.

Here we present a comparison of these two comprehensive works. Our purpose was to determine not only how many species were added to the Mongolian flora, but also to differentiate the updated species by taxonomic groups and phytogeographical regions. We believe that such a comparison is important to determine which families and genera or which phytogeographical regions have been most extensively studied between the publication periods of these two major works. We mostly considered the vascular plant diversity of phytogeographical regions in Mongolia in the context of biogeography than separate taxonomic units. The next purpose was to check the similarity between geographical regions by using the latest major work, namely Gubanov (1996), and to estimate an endemism level of each region.

Before carrying out analyses, we developed a database of the flora of Mongolia which allowed us to perform the comparison. So far, the database only includes data from Grubov (1982) and Gubanov (1996), but we plan to extend it with data from other sources.

Results

The flora of Mongolia as described by Grubov (1982) consisted of 2286 species belonging to 601 genera, 86 families, 9 classes of 3 phyla. In the recent conspectus by Gubanov (1996), a total of 740 species belonging to 244 genera, 50 families, 5 classes of 3 phyla were added newly

to the flora of Mongolia. This is a significant addition as the flora of Mongolia was expanded by 32.37 percent at the species level. However, it should be noted that there have been no increase in the number of taxonomic units higher than the familial level. These newly added species were distributed unevenly to families and genera. Ten families and genera of vascular plants that have been enlarged in terms of species richness by Gubanov's effort are shown in Table 1. Results of taxonomic studies of the families Compositae and Leguminosae by Dariimaa (1990) and Ulziihutag (2003), respectively, account for the most diverse groups in the flora. In addition, the ten families and genera shown in Table 1 were the most species-rich taxa in the flora and ratio of the species-rich families and genera did not alter after Gubanov's addition. Besides these genera shown in Table 1, there are four more taxa, namely *Vicia*, *Polygonum*, *Delphinium*, and *Juncus*, which were enlarged by eight new species (Gubanov, 1996).

Table 1. Ten families and ten genera that were significantly enriched by species addition in Gubanov (1996).

Family	Species number	Percent of species added family (%)	Genera	Species number	Percent of species added to genera
Compositae	127	17.16	*Astragalus*	51	6.89
Leguminosae	105	14.19	*Artemisia*	42	5.68
Gramineae	57	7.70	*Potentilla*	32	4.32
Rosaceae	49	6.62	*Taraxacum*	22	2.97
Cyperaceae	36	4.86	*Carex*	22	2.97
Liliaceae	31	4.19	*Allium*	22	2.97
Labiatae	30	4.05	*Oxytropis*	18	2.43
Ranunculaceae	30	4.05	*Poa*	11	1.49
Umbelliferae	30	4.05	*Aconitum*	9	1.22
Polygonaceae	23	3.11	*Lappula*	8	1.08

Information on how many species were added to the sixteen phytogeographical regions is provided in Table 2. We estimated the percentage increase of both taxonomic units and phytogeographical regions. The highest enrichments in genera and species levels are found to be for the Dzungarian Gobi and Mongol-Altai regions, and the lowest are observed for the Valley of Lakes.

The increment pattern might be interpreted mostly by the intensity of research activities carried out in different regions. Currently, no data on factors affecting species numbers and interpreting vascular plant diversity gradient of the regions exist, and no attempt to elucidate such pattern has been done.

Moreover, we estimated the level of endemism of plants in different phytogeographical regions as the number and percentage of species that appear to be confined to a particular region (Table 3). The entire territory of Mongolia is considered as one of the regions with lower endemism degree (Bykov, 1979). However, the Dzungarian Gobi has the highest endemism level among others, while the Valley of Lakes shows the lowest level. Our result on endemism level of Khangai region matches with data by Bannikova *et al*. (1986).

In contrast to endemic species, there are 13 species (namely, *Phragmites communis, Phragmites australis, Agropyron cristatum,*

Table 2. Percentage increase of vascular plant taxa in phytogeographical regions of Mongolia. Spelling of names for phytogeographical regions is adopted from Grubov (1982).

Regions	Family	Genera	Species
Khovsgol	0.00	4.65	16.80
Khentei	0.00	5.01	15.78
Khangai	1.37	4.94	19.36
Mongol-Daurian	0.00	6.80	18.92
Great Khingan	1.54	8.05	21.42
Khobdo	0.00	6.21	15.24
Mongolian Altai	0.00	9.30	25.69
Middle Khalkha	1.69	8.59	16.04
East Mongolia	1.56	10.06	22.87
Dep. Gr. Lakes	0.00	7.99	16.15
Valley of Lakes	0.00	6.09	12.74
East Gobi	0.00	6.21	15.10
Gobi Altai	0.00	4.83	14.81
Dzungarian Gobi	0.00	10.53	26.73
Trans-Altai Gobi	0.00	7.55	16.08
Alashan Gobi	0.00	8.20	13.70

Table 3. Species richness and estimated endemism percentage of the sixteen phytogeographical regions of Mongolia.

Regions	Total spp.	Endemic spp.	Endemism (%)
Khovsgol	1050	55	5.24
Khentei	1240	46	3.71
Khangai	1609	48	2.98
Mongol-Daurian	1257	41	3.26
Great Khingan	822	57	6.93
Khobdo	953	25	2.62
Mongolian Altai	1463	142	9.71
Middle Khalkha	745	2	0.27
East Mongolia	951	35	3.68
Dep. Gr. Lakes	863	46	5.33
Valley of Lakes	469	3	0.64
East Gobi	442	10	2.26
Gobi Altai	868	19	2.19
Dzungarian Gobi	768	71	9.24
Trans-Altai Gobi	361	12	3.32
Alashan Gobi	249	6	2.41

Eleocharis palustris, Juncus bufonius, Iris lactea, Polygonum sibiricum, Knorringia sibirica, Chenopodium album, Halerpestes salsuginosa, Glaux maritima, Artemisia sieversiana and Artemisia frigida), which occur in all phytogeographical regions of Mongolia.

Differences between floral composition of various phytogeographical regions are of great interest, and hence we constructed a dendrogram using the Bray-Curtis dissimilarity measure, which is one of the most commonly used metrics for vegetation studies (Bray & Curtis, 1957), and the group-average clustering algorithm (Fig. 1).

It is visible that the phytogeographical regions are grouped into five main clusters. Each of these clusters includes the regions that are geographically adjacent to one another, and reflects the main landscape patterns of Mongolia. For example, boreal forest group includes the Mongol Daurian, Khentei, Khangai, and Khovsgol regions, where species of phyla Pteridophyta and Gymnospermae are abundantly distributed. High mountain group includes the Mongol Altai, Khobdo and Gobi-Altai regions, while the steppe group includes the East Mongolia, Great Khingan and Middle Khalkha. The Central Asian desert group includes Dzungarian Gobi and Depression of Great Lakes regions, and the Gobi group includes the Alashan Gobi, Trans-Altai Gobi, East Gobi and the Valley of Lakes. One of the interesting patterns is the highest dissimilarity between the regions located in the southern Mongolia, such as the Alashan Gobi, Trans-Altai Gobi, East Gobi and the Valley of Lakes, which are highly distinct from other regions. Less dissimilarity or more similarity is observed between Khentei and Mongol Daurian regions. Overall, the regions are relatively different from each other, and this fact confirms the well established classification of the phytogeographical regions in Mongolia.

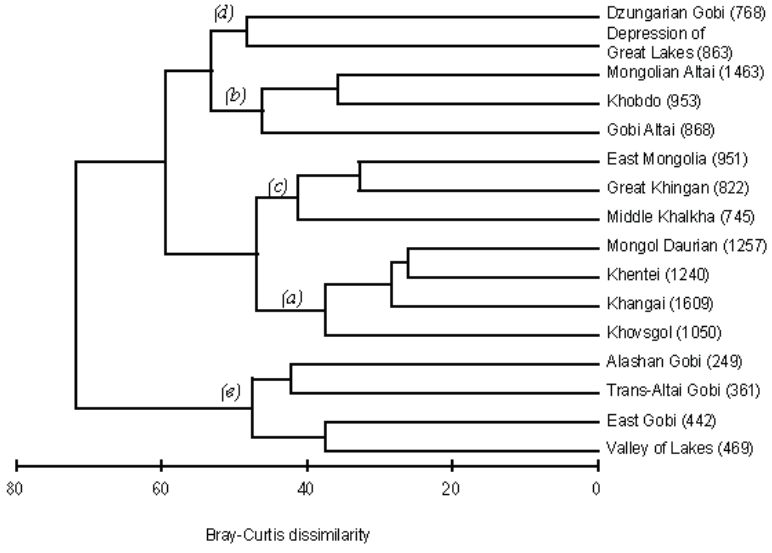

Figure 1. A dendrogram depicting the dissimilarity the phytogeographical regions of Mongolia. Species composition in each phytogeographical region was based on Gubanov (1996). (a) boreal forest group, (b) high mountain group, (c) steppe group, (d) Central Asian desert group and (e) the Gobi group. Numbers in parentheses indicate vascular plant species richness recorded for each region by Gubanov (1996).

Judging on the above results it can be declared that further biogeographical research should be expanded in the regions with high endemism to elucidate factors affecting the species diversity of various regions and diversity gradient between them.

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Хураангуй

Монгол орны цоргот ургамлын аймаг болон ургамал-газар зүйн мужуудын цоргот ургамлын аймаг болон ургамлын төрөл зүйлийг тодорхойлох хамгийн анхны томоохон бүтээл болох В. И. Грубовын "Монголын цоргот ургамлыг таних бичиг" 1982 онд хэвлэгдэн гарч байжээ. Түүнээс хойш Монголын цоргот ургамлын аймагт олон зүйл шинээр нэмэгдэж бүртгэгдсэн ба эдгээрийг нэгтгэн А. А. Губанов 1996 онд "Монголын цоргот ургамлын конспект"-ийг хэвлүүлжээ. Монголын ургамлын аймаг, ургамал-газар зүйн мужийн ургамалжилтын судалгаа хийдэг судлаачдын хамгийн ойрын гарын авлага болсон дээрх хоёр бүтээлийг харьцуулж, В. И. Грубовын бүтээл хэвлэгдсэнээс хойшхи 14 жилийн хугацаанд Монголын ургамлын аймагт ямар хүрээ, анги, овог, төрөлд хамаарах хэдэн зүйлийн ургамал нэмэгдсэн, ургамал-газар зүйн аль мужид хамгийн их зүйл шинээр бүртгэгдсэн зэрэг тоон мэдээллүүдийг тооцож гаргалаа. Мөн А. А. Губановын бүтээлийн өгөгдлөөр ургамал-газар зүйн мужуудыг хооронд харьцуулж, ургамал-газарзүйн мужуудын эндемизмийн хувийг тогтоов.

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