

СИСТЕМАТИКА ОТДЕЛЬНЫХ ТАКСОНОВ

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PLANTS OF THE FAMILY APIACEAE IN THE FLORA OF MONGOLIA

Classification, distribution, ecology-geographical status and phylogeny of taxa of the family Apiaceae in the Mongolian flora is revealed and their taxonomic positions are revised.

Introduction

Firstly V.I. Grubov (1955) registered 46 species, 26 genera in the family Apiaceae in Mongolia. Then, Ts. Jamsran et al. (1972) reported 14 species of 9 genera and D. Magsar and U. Ligaa (1977) – 6 species of 4 genera in addition to previous, and D. Magsar, U. Ligaa (1977) concluded the information and facts of classification, distribution, ecology and habitat on 53 species of 31 genera and V.I. Grubov (1982) – on 55 species of 28 genera; N. Ulziykhutag (1984) – on 65 species of 36 genera; D. Magsar et al. (1986) – on 58 species of 32 genera; and N. Ulziykhutag (1989) – on 59 species of 30 genera. The reports confirmed that the family Apiaceae is one of largest families in the flora of Mongolia.

The researchers continued more detailed studies in this family. For example, I.A. Gubanov (1996) reported distribution on 66 species of 34 genera and M. Urgamal (2009) – on 71 species of 35 genera; N. Manibazar (2010) – on 80 species of 41 genera; and M. Urgamal (2012, 2013) – on 76 species of 39 genera. Mongolian researchers have been studying taxonomy of the most large genera. For example, the taxonomy of *Angelica* (Urgamal, 2006), *Bupleurum* (Urgamal, 2006; Urgamal, Sanchir, 2007, 2013), *Cnidium* (Urgamal, 2006, 2007), *Ferula* (Suran, 1996; Suran, Jamsran, 1997; Urgamal, 2000, 2001, 2009), *Peucedanum* (Magsar, Ligaa, 1977; Urgamal, 2008, 2009), *Saposhnikovia* (Urgamal, 2006), *Seseli* (Urgamal, 2004, 2009, 2012) has been reported.

Recently, researchers considered the phylogeny of the family Apiaceae based on molecular analysis (Calvino, Downie, 2007; Carolina et al. 2007; Downie et al., 1998, 2000, 2001, 2010; Plunkett, 2001; Plunkett, Downie, 1999; Urgamal, 2013).

Materials and Methods

The family Apiaceae specimens from the Herbarium (UBA) of the Institute of Botany, Mongolian Academy of Sciences, Herbarium (UBU) of the National University of Mongolia, Herbarium (PE) of the Institute of Botany, Chinese Academy of Sciences, Herbarium (LE) Institute of Botany, Russian Academy of Sciences, Herbarium of the Tracy's of Texas University A&M (USA) and as well as additional data were used for the study. In a total, there were over 2800 sheets of specimens collected by numerous scientists during a period from between 1867 to 2011.

This study was conducted using morphological, ecological and geographical traditional methods of plant systematics. The nomenclature and taxonomy was based following works of M.G. Pimenov, M.V. Leonov (1993), V.M. Vinogradova (1994), She Menglan et al. (2005), S.R. Downie et al. (1998, 2010) and classification websites and taxonomical databases of Angiosperm Phylogeny Group (APG III, 2009), Angiosperm Phylogeny Web (APWeb, version 13), World Checklist of Selected Plant (WCSP), International Plant Names Index (IPNI), W3 Tropicos (2014). Mongolian names of taxa were referred by H. Ulziykhutag (1984).

The geographical analysis was carried out according to V.I. Grubov (1959, 1963), A. Takhtajan (1978), and geographical distribution data of all species of family Apiaceae was analyzed in botanical-geographical regionalization of the Mongolia developed by V.I. Grubov (1982). In distribution section, following description of each species, numbers are given for respective regions where species occurs (fig. 2).

The ecological analysis mainly was conducted following C. Raunkiaer (1907), I.G. Serebryakov (1964), N. Ulziykhutag (1989); endemism and conservation status were made according to V.I. Grubov (1984), V.M. Vinogradova (1994), including Mongolian laws (Law of Natural Plants, 1995), Mongolian Red Book (1987, 1997) and Mongolian Plant Red List (2012). The habitat of each species is provided in details, mainly as referred in V.I. Grubov (1982).

Results

Taxonomy and classification system

Up to date, we have officially registered 76 species belonging to 39 genera, 6 subtribes, 12 tribes (4 clades) and 2 subfamilies (*Saniculoideae* and *Apioideae*) belonging to the family Apiaceae that occur in Mongolian flora. From I.A. Gubanov works (1996), 7 genus (*Anethum* L., *Apium* L., *Coriandrum* L., *Daucus* L., *Foeniculum* Mill.,

Pastinaca L., *Petroselinum* Hill) and 11 species (*Anethum graveolens* L., *Angelica saxatilis* Turcz. ex Ledeb., *Apium graveolens* L., *Bupleurum pusillum* Krylov, *Coriandrum sativum* L., *Daucus carota* L., *Ferula caspica* M. Bieb., *Foeniculum vulgare* Mill., *Oenanthe javanica* (Blume) DC., *Pastinaca sativa* L., *Petroselinum crispum* Hill) were newly added, and 1 species (*Ferula gracilis*) was excluded. In addition to that two genus (*Kadenia*, *Kitagawia*) and three species (*Kadenia salina*, *Kitagawia baicalensis*, *K. terebinthacea*) are new combinations.

We updated classification system (by Downie et al., 2010) of the family Apiaceae in Mongolia and changed its system orders of tribes and genera (table 1).

Table 1

Classification system of the family Apiaceae in Mongolian flora (by Downie et al., 2010)

Subfamilies	Tribes and clades	Subtribes	Gen./Sp.
1. Saniculoideae Burnett 1835	1. Saniculeae W. D. J. Koch 1824	1. Saniculinae Coss. & Germ. 1845	1/1
2. Apioideae Seem. 1866	2. Bupleureae Spreng. 1820		1/8
	3. Pleurospermeae M. F. Watson & S. R. Downie 2000		2/2
	<i>Physospermopsis</i> Clade		1/1
	4. Scandiceae Spreng. 1820	2. Scandicinae Tausch 1834	2/2
		3. Daucinae Dumort. 1827	1/1
		4. Ferulinae Drude 1897	1/7
	5. Oenantheae Dumort. 1827		3/4
	<i>Cachrys</i> Clade		1/1
	6. Coriandreae W. D. J. Koch 1824	5. Coriandrinae Tausch 1834	1/1
	7. Pyramidoptereae Boissier 1872		2/2
	8. Careae Baill. 1879		2/3
	9. Pimpinelleae Spreng. 1820		1/1
10. Apieae Takht. ex V. M. Vinogr. 2004		4/4	
<i>Acronem</i> Clade		1/1	
<i>Sinodielsia</i> Clade		3/5	
11. Selineae Spreng. 1820		10/29	
12. Tordylieae W. D. J. Koch 1824	6. Tordyliinae Drude 1897	2/3	
2 subfamilies	12 tribes, 4 clades	6 subtribes	39/76

Identification keys for all levels of subfamilies, tribes, subtribes, genera and species, conspectus of all taxa are given.

Geographical analysis

The geographic ranges of all species of family Apiaceae of Mongolia lie within the limits of the Holarctic Kingdom. Based on the distribution data types of area of each species are distinguished in 12 groups (table 2). The Holarctic includes 5 species, Eurasian – 12 species, Asian-Northern American – 1 species, Asian – 51 species. In the Asian types the following subtypes are original: Asian – 9 species, Eastern Asian – 7 species, Central Asian – 8 species, Siberian-Mongolian – 7 species, Mongolian – 20 species. In the Mongolian subtypes Altay-Dzungarian-Mongolian consists of 6 species, Mongolian-Daurian-Manchurian – 1 species and Southern Siberian-Mongolian – 13 species.

The family Apiaceae species have been found in all botanical-geographical regions (16) in Mongolia, among them Mongolian Altain mountain steppe (44 species) region has the highest, and Alashan Gobi desert region (3 species) – lowest species diversity (fig. 2).

Among the species *Cicuta virosa* (15 regions), *Bupleurum bicaule* (13 regions) and *Carum carvi*, *Sphallerocarpus gracilis*, *Peucedanum falcaria* (12 regions) are the most widespread species on the territory of Mongolia (table 3). Also, we found new 30 distribution areas of 24 species belonging to 14 genera in 15 phytogeographical regions of the Mongolia (Urgamal, 2009, 2013).

Table 2

Classification of geographical types of areas of the family Apiaceae in Mongolia

Geographical types	Subtypes and groups	Species	Percent
A. Multicontinental		18	26.09
1. Holarctic		5	7.25
2. Eurasian		12	17.39
3. Asian-Northern American		1	1.45
B. Continental			
4. Asian		51	73.91
	4.1 Original Asian	9	13.04
	4.2 Eastern Asian	7	10.14
	4.3 Siberian-Mongolian	7	10.14
	4.4 Central Asian	8	11.59
	4.5 Mongolian (dominate)	20	28.98
	4.5.1 Southern Siberian-Mongolian	13	18.84
	4.5.2 Mongolian Daurian-Manchuur	1	1.45
	4.5.3 Altay-Dzungarian-Mongolian	6	8.70

Lifeform and Ecological analysis

Mongolian Apiaceae family members are mostly perennials (84.21 %), 4 annual species (5.26 %) and 8 binual species (10.52 %) according to the Serebryakov’s (1964) plant lifeform classification and hemicryptophytes according to Raunkiaer’s (1907) classification. The family Apiaceae is distributed in all climatic zones of Mongolia. We classified all species of this family into 11 ecological groups (fig. 3), according to their each species habitat peculiarities. Basing on the predominant occurrence of the plants (collections database), following ecological groups were distinguished: xerophytes (8 species), mesoxerophytes (7 species), xeromesophytes (7 species), mesophytes (21 species), mesohalophytes (2 species), hydrophytes (2 species), mesokryophytes (7 species), hygrophytes (2 species), xeropetrophytes (9 species), xero-psammophytes (3 species) and hygro-halophytes (1 species).

Endemism and Conservation status

Therefore, there are 8 species of subendemic plants and divided into following two groups of subendemic plants (fig. 4, table 4). 4 species (newly added 2 species) are very rare and 13 species of the family Apiaceae (newly added 5 species) are rare plants in Mongolian flora (Table 5).

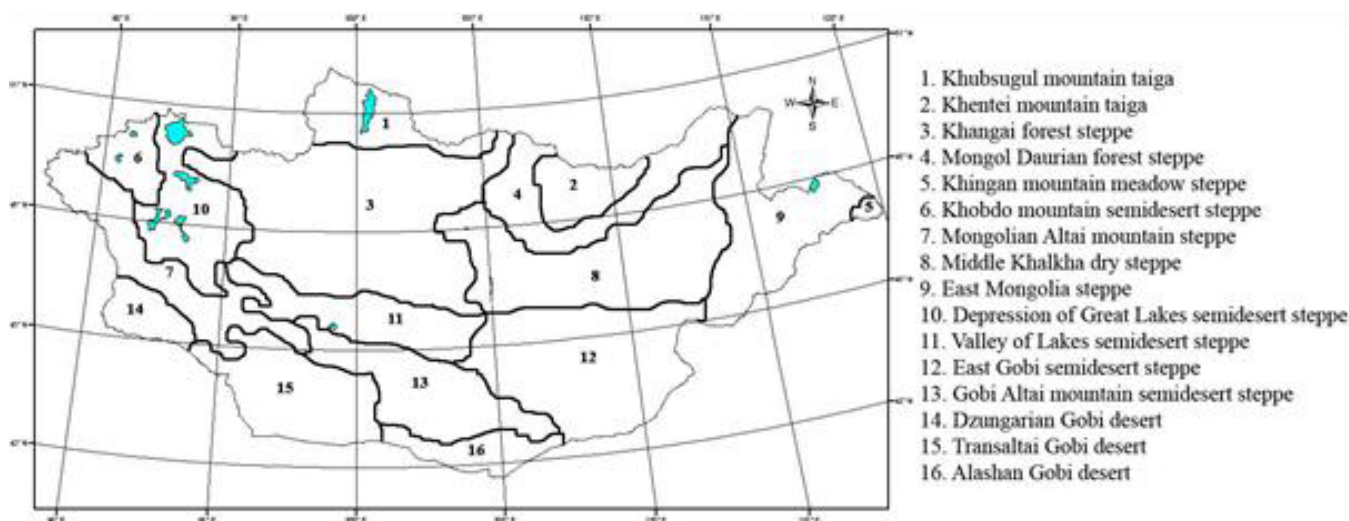


Fig. 1. Phytogeographical regions of Mongolia (by Grubov, 1982).

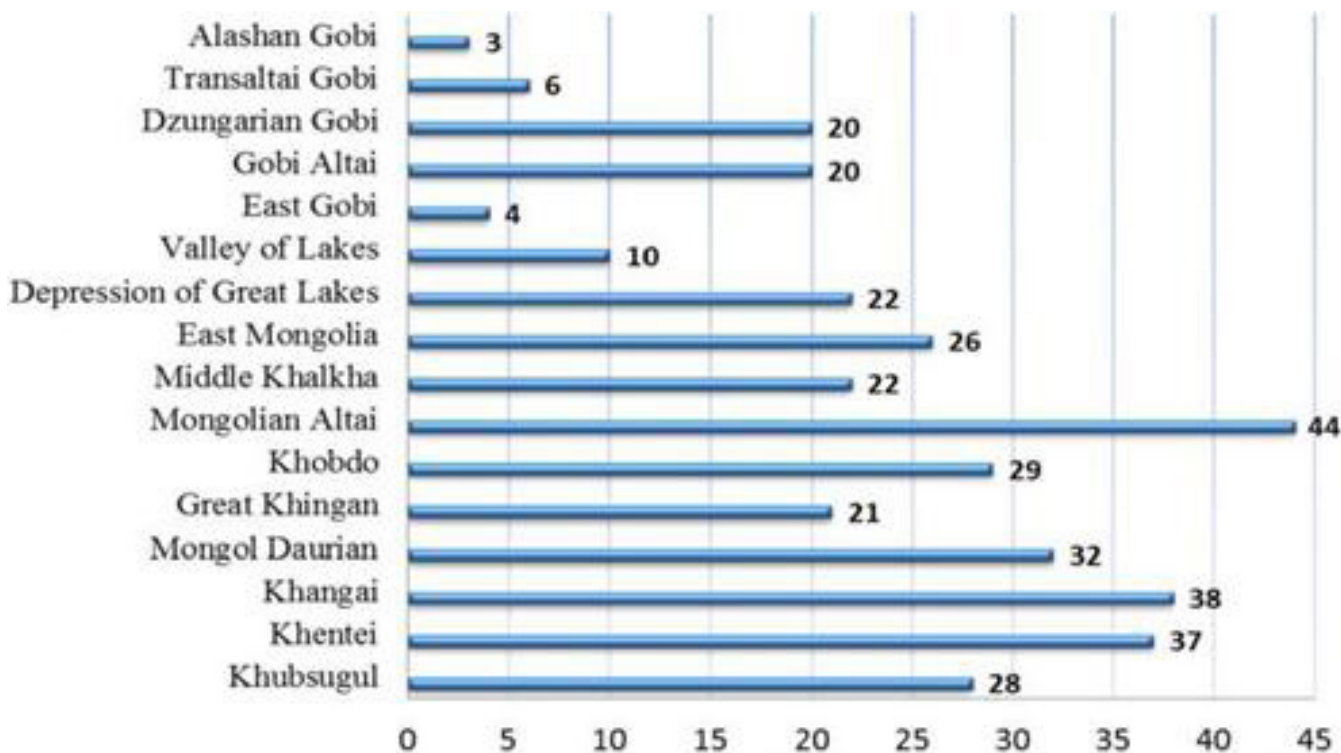


Fig. 2. Numbers of species of the family Apiaceae in botanical-geographical regions of the Mongolia.

Table 3

List of species and distribution data of the family Apiaceae of the Mongolia

Species latin name	Botanical-geographical regions
1. <i>Eryngium planum</i> L. 1753	4
2. <i>Bupleurum aureum</i> Fisch. ex Hoffm. 1814	7
3. <i>B. multinerve</i> DC. 1828	2, 3, 4, 5, 6, 7+, 9+
4. <i>B. mongolicum</i> V.M. Vinogr. 1985	7, 13, 14
5. <i>B. sibiricum</i> Vest ex Roem. & Schultes 1820	2, 3, 4, 5, 8+, 9+
6. <i>B. bicaule</i> Helm 1809	1-13
+ 7. <i>B. pusillum</i> Krylov 1903	1+, 2+, 3+, 6+, 7+, 13+
8. <i>B. krylovianum</i> Schischk. ex Krylov 1935	3+, 7
9. <i>B. scorzonerifolium</i> Willd. 1809	1, 2, 3, 4, 5, 8, 9
10. <i>Pleurospermum uralense</i> Hoffm. 1814	1, 2, 3, 4, 5, 6, 8, 9
11. <i>Aulacospermum anomalum</i> Ledeb. 1833	7
12. <i>Hansenia mongholica</i> Turcz. 1844	1, 2
13. <i>Sphallerocarpus gracilis</i> (Besser ex Trevir.) Koso-Pol. 1829	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13
14. <i>Anthriscus sylvestris</i> (L.) Hoffm. 1814	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
+ 15. <i>Daucus carota</i> L. 1753	cultivated plant
16. <i>Ferula potaninii</i> Korovin ex Pavlov 1935	14
17. <i>F. bungeana</i> Kitag. 1956	5+, 8, 9, 10, 11, 12, 13, 14, 15, 16
18. <i>F. dissecta</i> (Ledeb.) Ledeb. 1844	3, 6+, 7, 10+, 14+
19. <i>F. mongolica</i> (V.M. Vinogr. & Kamelin) V.M. Vinogr. & R. Kamelin 1990	3, 7, 10, 14, 15
20. <i>F. feruloides</i> (Stued.) Korovin 1947	7
+ 21. <i>F. caspica</i> M. Bieb. 1808	7+, 14+
22. <i>F. dubjanskyi</i> Korovin ex Pavlov 1934	7, 14
23. <i>Cicuta virosa</i> L. 1753	1+, 2-15
24. <i>Sium suave</i> Walter 1788	1, 2, 3, 4, 5, 6, 7, 8, 9+, 10, 14+
25. <i>Oenanthe aquatica</i> (L.) Poir. 1798	10
+ 26. <i>Oe. javanica</i> (Blume) DC. 1830	10+
27. <i>Prangos ledebourii</i> Herrnst. & Heyn 1977	7, 14

End of table 3

Species latin name	Botanical-geographical regions
+ 28. <i>Coriandrum sativum</i> L. 1753	cultivated plant
29. <i>Bunium setaceum</i> (Schrenk ex Fisch. & C.A. Mey.) H. Wolff, 1927	6, 7
30. <i>Schulzia crinita</i> (Pall.) Spreng. 1813	1, 2, 3, 6, 7
31. <i>Carum carvi</i> L. 1753	1+, 2, 3, 4, 5, 7-10, 13, 14, 16+
32. <i>C. buriaticum</i> Turcz. 1844	1+, 2, 3, 4, 5, 6, 8, 9
33. <i>Aegopodium alpestre</i> Ledeb. 1829	1, 2, 3, 4, 5, 13
34. <i>Pimpinella thellungiana</i> H. Wolff 1927	4, 5, 9
+ 35. <i>Apium graveolens</i> L. 1753	cultivated plant
+ 36. <i>Petroselinum crispum</i> (Mill.) Nyman ex A.W. Hill 1925	cultivated plant
+ 37. <i>Foeniculum vulgare</i> Mill. 1768	cultivated plant
+ 38. <i>Anethum graveolens</i> L. 1753	cultivated plant
39. <i>Pachypleurum alpinum</i> Ledeb. 1829	1, 2, 3, 6, 7, 14+
40. <i>Lithosciadium multicaule</i> Turcz. 1844	1, 3, 4, 6, 7, 13
41. <i>L. kamelinii</i> (V.M. Vinogr.) Pimenov ex Gubanov 1996	7
42. <i>Cenolophium denudatum</i> (Fisch. & Hornem.) Tutin 1967	3, 7, 10, 14
43. <i>Conioselinum longifolium</i> Turcz. 1844	1, 2+, 4+, 7+, 9, 10
44. <i>C. vaginatum</i> (Spreng.) Thell. 1926	1, 2, 3, 4
45. <i>Sajanella monstrosa</i> (Willd.) Sojak 1980	2
46. <i>Stenocoelium athamantoides</i> (M. Bieb.) Ledeb. 1829	6, 7
47. <i>Seseli glabratum</i> Willd. ex Spreng. 1820	7
48. <i>S. eriocarpum</i> (Schrenk) B. Fedtsch. 1915	7, 13, 14
49. <i>S. abolinii</i> (Korovin) Schischk. 1950	7, 10, 11+, 13
50. <i>S. buchtormense</i> (Fisch.) W.D.J. Koch, 1824	7, 14
51. <i>S. condensatum</i> (L.) Rehb. f. 1867	1, 2, 3, 6, 7, 8, 10, 14+
52. <i>S. grubovii</i> V.M. Vinogr. & Sancier 1985	7, 13, 14, 15
53. <i>S. mucronatum</i> (Schrenk) Pimenov & Sdobnina 1973	14
54. <i>S. seseloides</i> (Fisch. & C.A. Mey. ex Turcz.) Hiroe 1958	1+, 2, 3, 4, 5, 6, 7, 9+
55. <i>Cnidium dauricum</i> (Jacq.) Turcz. ex Fisch. & C.A. Mey. 1835	2, 3, 4, 5, 6, 7, 8, 9, 10
# 56. <i>C. salinum</i> Turcz. 1844	2, 3, 4, 8, 9, 10, 11, 13
57. <i>C. monnieri</i> (L.) Cusson 1782	4, 9
58. <i>Paraligusticum discolor</i> (Ledeb.) V.N. Tichom. 1973	7
59. <i>Angelica czernaevia</i> (Fisch. & C.A. Mey.) Kitag. 1936	5, 9
60. <i>A. sylvestris</i> L., 1753	6, 7+
61. <i>A. dahurica</i> (Fisch. ex Hoffm.) Benth. & J. D. Hook. ex Franch. & Sav. 1873	2, 3, 4, 5, 9
62. <i>A. archangelica</i> subsp. <i>decurrens</i> (Ledeb.) Kuvaev, 1981	1, 2, 3, 4+, 6, 7, 14
+ 63. <i>A. saxatilis</i> Turcz. ex Ledeb. 1844	2+
64. <i>A. tenuifolia</i> (Pall. ex Spreng.) Pimenov 1985	1, 2, 3, 4, 6, 7, 8, 10, 13+
65. <i>Ferulopsis hystrix</i> (Bunge ex Ledeb.) Pimenov, 1991	2, 3, 4, 6, 7, 8, 9+, 10, 11, 13, 15
66. <i>Phlojodicarpus sibiricus</i> (Stephan ex Spreng.) Koso-Pol. 1922	1, 2, 3, 4, 7+, 8, 9, 13+
67. <i>Ph. villosus</i> (Turcz. ex Fisch. & C.A. Mey.) Turcz. ex Ledeb. 1844	1, 2, 3, 6
# 68. <i>Peucedanum terebinthaceum</i> (Fisch. ex Trevir.) Ledeb. 1844	2, 4, 5, 9
# 69. <i>P. baicalense</i> (Redowsky ex Willd.) W.D.J. Koch 1824	1, 2, 3, 4, 5, 6, 7+, 8, 10
70. <i>P. falcaria</i> Turcz. 1832	1+, 3, 4+, 6-8, 10, 11, 13-15, 16+
71. <i>P. vaginatum</i> Ledeb. 1829	1, 2, 3, 4, 6, 7, 8+, 11+, 13+
72. <i>P. puberulum</i> (Turcz.) Schischk. 1951	2, 3, 6, 8, 13
73. <i>Saposhnikovia divaricata</i> (Turcz.) Schischk. 1951	2, 3, 4, 5, 6, 8+, 9
+ 74. <i>Pastinaca sativa</i> L. 1753	cultivated plant
75. <i>Heracleum dissectum</i> Ledeb. 1829	1, 2, 3, 4, 5, 6, 7, 9, 10, 11+, 13
76. <i>H. sibiricum</i> L. 1753	1+, 2+, 3, 9, 13

+ newly added species and new distribution region of since Gubanov's (1996) conspectus

new combination name species and genus of since Gubanov's (1996) conspectus

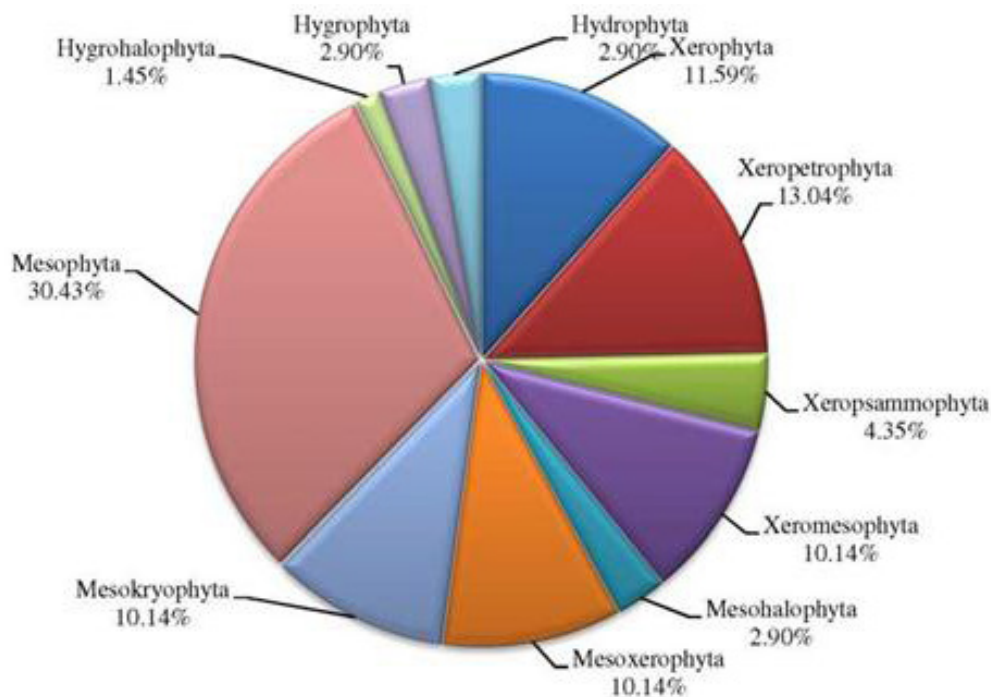


Fig. 3. Percent of ecological group species of the family Apiaceae in the Mongolia.

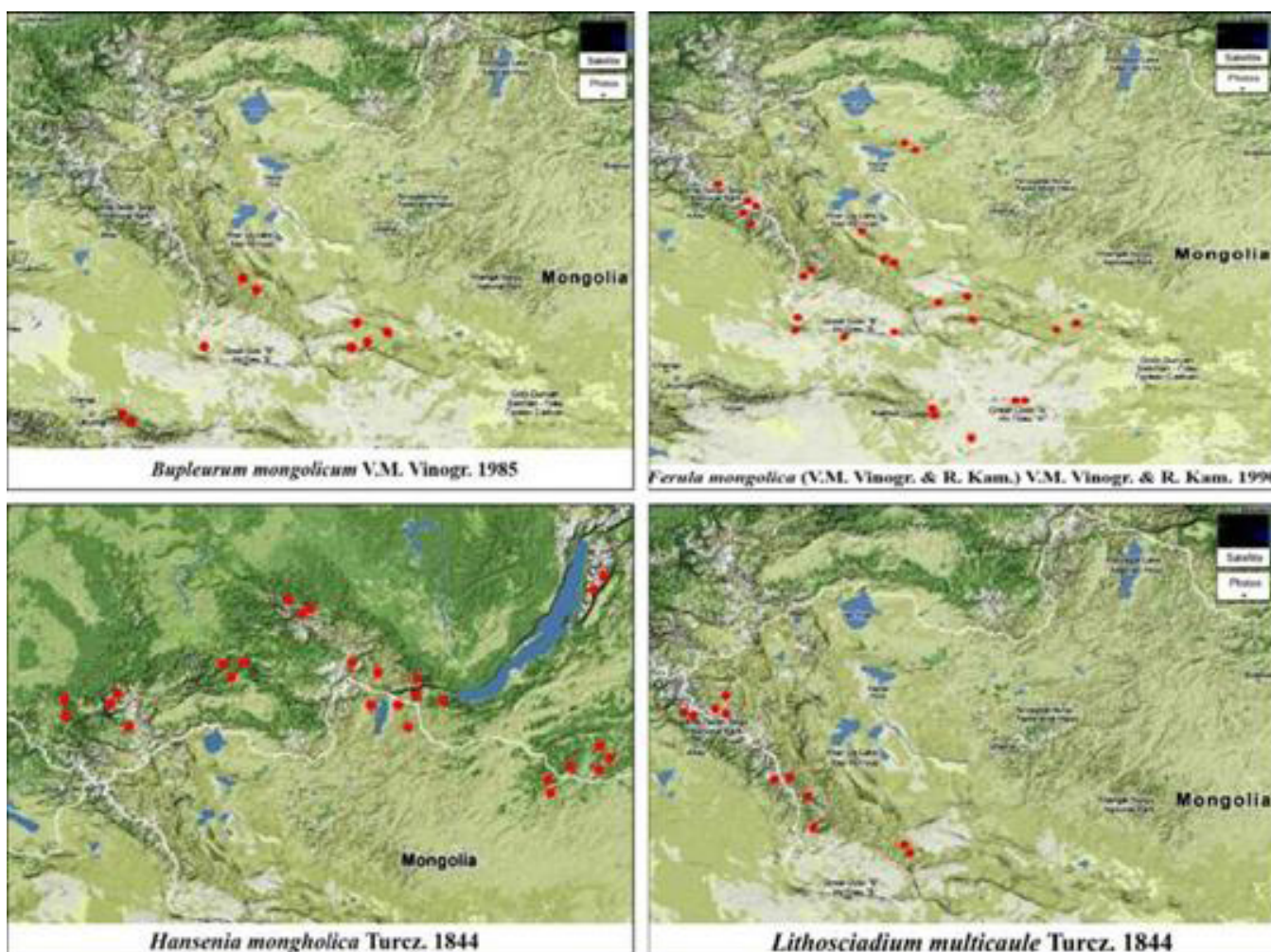


Fig. 4. Distribution of subendemic Apiaceae in Mongolia.

Table 4

Subendemic species of the family Apiaceae in the Mongolia

Subendemic two groups	Species list	Sources
1. Dzungarian-Mongolian subendemic	<i>Bupleurum mongolicum</i> <i>Ferula bungeana</i> <i>F. mongolica</i> <i>Lithosciadium kamelinii</i> <i>Seseli grubovii</i>	N. Ulziikhutag, 1989 V.I. Grubov, 1984 V.M. Vinogradova, 1994 V.M. Vinogradova, 1994 V.M. Vinogradova, 1994
2. Southern Siberian-Mongolian subendemic	<i>Ferulopsis hystrix</i> <i>Hansenia mongholica</i> <i>Peucedanum puberulum</i>	V.I. Grubov, 1984 E. Ganbold, 2010 I.A. Gubanov, 1982

Table 5

Rare and very rare species of the family Apiaceae in the Mongolia

Conservation status	Species list	Sources
Rare plants		
1. Stream from foreign plant	1. <i>Eryngium planum</i>	Law of Natural Plants (1995)
2. Distant place of centre areas	2. <i>Prangos ledebourii</i> *	M. Urgamal, 2009
	3. <i>Seseli glabratum</i> *	M. Urgamal, 2013
	4. <i>S. mucronatum</i> *	M. Urgamal, 2013
	5. <i>Aulacospermum anomalum</i>	Law of Natural Plants (1995)
3. Not widespread in only Mongolia	6. <i>Bunium setaceum</i>	Law of Natural Plants (1995)
	7. <i>Cenolophium denudatum</i>	Law of Natural Plants (1995)
	8. <i>Oenanthe aquatica</i>	Law of Natural Plants (1995)
	9. <i>Oe. javanica</i>	Law of Natural Plants (1995)
	10. <i>Paraligusticum discolor</i> *	M. Urgamal, 2013
	11. <i>Peucedanum terebinthaceum</i>	Law of Natural Plants (1995)
	12. <i>Sajanella monstrosa</i> *	M. Urgamal, 2009
	13. <i>Seseli eriocarpum</i>	Law of Natural Plants (1995)
Very rare plants	1. <i>Ferula feruloides</i>	Law of Natural Plants (1995), Mongolian Red Book (1987, 1997), Mongolian Plant Red List (2012)
	2. <i>F. potaninii</i> *	M. Urgamal, 2013
	3. <i>Lithosciadium kamelinii</i> *	M. Urgamal, 2013
	4. <i>Stenocoelium athamantoides</i>	Law of Natural Plants (1995), Mongolian Red Book (1987, 1997), Mongolian Plant Red List (2012)

* - newly add (Urgamal, 2009, 2013) to the list of rare and very rare plants (by criteria of Mongolian Red book and Law of Natural Plants) in Mongolia.

Phylogenetic analysis

For the first time in Mongolia, we have carried out phylogenetic analysis of tribes (fig. 5) and all genera of the family Apiaceae in Mongolian flora.

Discussion

We updated classification system (by Downie et al., 2010) of the family Apiaceae in Mongolia and changed its system orders of tribes and all genera. The species composition of the family Apiaceae in the flora of Mongolia is revealed and their taxonomic positions was revised. Identification keys for the all in level of subfamilies, tribes, subtribes, genera and species, conspectus of all taxa are given. Morphological features, which previous researchers described, fit and can be used for identifying the genera and species.

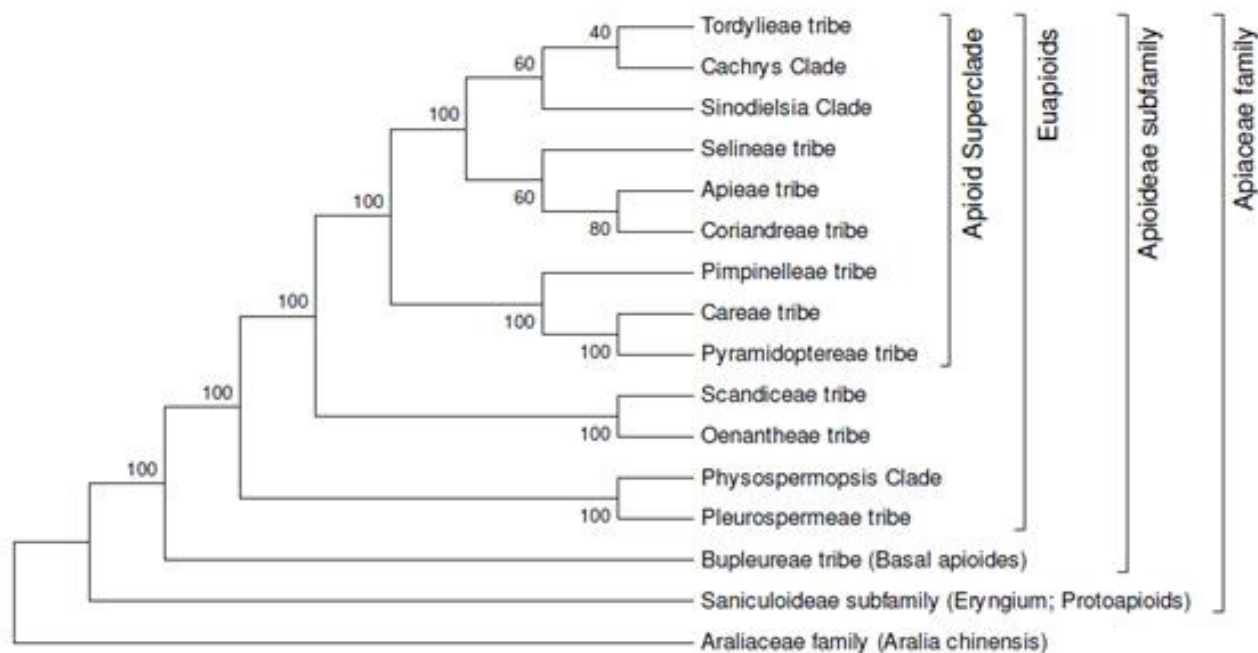


Fig. 5. Phylogenetic tree of tribes of the family Apiaceae in Mongolian flora.

Among the ecological-geographical groups, the highest number of species occurs in forest-steppe and steppe natural zones in Mongolia. Mesophytes and xero-mesophytes are dominating ecological groups. According to the geographical analysis, species of Asian type and South Siberian-Mongolian groups considered as a richest area in Apiaceae species as about 73.91 % of total species occurring in these regions and distribution dominate in the flora of Mongolia.

Therefore, we found and added 2 very rare species (*Ferula potaninii*, *Lithosciadium kamelinii*), 5 rare species (*Paraligusticum discolor*, *Prangos ledebourii*, *Sajanella monstrosa*, *Seseli glabratum*, *S. mucronatum*) from the Mongolian flora.

It must be integrated both morphological and molecular data in the future analysis of higher level relationships in family Apiaceae.

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