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Comparative floristic diversity of Southwest Primorye and neighboring areas of the Russian Far East

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Southwest Primorye is located in the southern most part of the Russian Far East. The flora of this area is one of the most thoroughly studied and contains 1,530 species of vascular plants, belonging to 622 genera and 154 families, representing 55.6% of the flora of the Primorsky Territory. The flora native to Southwest Primorye encompasses 1,356 species from 547 genera and 148 families. Adventitious plants are represented by 174 species from 127 genera and 37 families. Among other areas of the Russian Far East, only Southwest Primorye has flora in common with the Korean Peninsula, which contains plant species in the subtropical and tropical latitudes: *Mitrasacme indica* Wight, *Halosciastrum melanotilingia* [Boissieu] M. Pimen. et V. Tichomirov, *Streptolirion volubile* Edgew., *Lipocarpha microcephala* [R. Br.] Kunth, *Pueraria lobata* [Willd.] Ohwi, *Belamcanda chinensis* [L.] DC., *Zoysia japonica* Steud., *Deinostema violacea* [Maxim.] Yamazaki and *Parthenocissus tricuspidata* [Siebold et Zucc.] Planch. Most of the flora is represented by the species restricted to Southwest Primorye (seven endemic species) or the Korean Peninsula (seven hemiendemic species). A total of 50.2% of the 10 largest families are nemoral (preboreal) floras, located in the transitional zone of the boreal and nemoral floras. In terms of the structure of the ranked taxonomic spectrum of the largest families, the flora of Southwest Primorye is more similar to that of Northeast China with influence of the Korean flora.

Keywords: indigenous plants, natural flora, Primorye, Russian Far East, taxonomical spectra

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Introduction

Southwest Primorye is an area of the Primorsky Territory located south of the watershed of the Gryaznaya and Ananjevka Rivers, including adjacent islands in Peter the Great Bay. The territory of Southwest Primorye is located between N 42°-43° and E 130°-132°, covering an area of approximately 9,000 km^2. It stretches northeast for 250 km, with the width between the Chinese border and the coastline of Peter the Great Bay varying, on the average, from 30 to 40 km. In the south, the territory of Southwest Primorye is restricted by the Tumannaya River (Doomangang), which represents its borders with North Korea and China.

This subregion of the Russian Far East belongs to the physiographic province of the Manchurian Mountains (East Manchurian mountain range). The landscape here is quite diverse, from the shallow coastal bays and the vast marshy coastal plains to the foothills of the Eastern Manchurian Mountains. Elevations are 400-600 m for prevailing mountains and 150-300 m for the foothills, although the height of some mountain structures and individual hills is almost 1,000 m above sea level. Southwest Primorye has a monsoon climate in a temperate zone, with relatively little snow, cold winters, and a humid summer-autumn period. While the air temperature in the winter remains below −15°C, summers are relatively hot and humid, with frequent intense fog that often turns into drizzle. Daily temperatures in July and August exceed +20°C. Precipitation usually occurs in July and August, sometimes in the form of heavy rain. The annual maximum precipitation could reach 800-900 mm, of which 10-20% falls during winter. The average annual temperature in Southwest Primorye is the highest

among areas within the Primorsky Territory, as high as +5.6°C in the center regions (Gamow Cape).

Despite the small size, Southwest Primorye has very diverse plant communities and rich natural flora, compared with the other territories of the Russian Far East. In accordance with identified boundaries, this part of the Primorye is a natural area that could be described as a uniquely floristic Far Eastern subregion. In this southern part of the Russian Far East, the influence of the rich flora from the Korean peninsula is the most obvious. Floral materials in Southwest Primorye were initially collected by an eminent Russian botanist, the academician Komarov V.L, in 1896 and 1897 on his way to Manchuria.

Based on currently available data, the floras of Southwest Primorye represent 1,530 native (indigenous) and adventitious species (Kozhevnikov *et al*., 2015). The goal of this study was to compare the floristic characteristics of Southwest Primorye with those of neighboring regions and to identify geographical areas that have the largest number of species that are also found in Southwest Primorye.

Materials and Methods

A list of Southwest Primorye floras is provided by Kozhevnikov *et al*. (2015). In a comparative analysis, such approaches as differentiation of the head part of the family and genera spectra (Malyshev, 1972; Tolmaczev, 1974; Malyshev *et al*., 1998), as well as the model spectra (Khokhryakov, 2000), were used. To compare the floras, the congruent spectra of the largest families (ranks of 1-20) and genera (ranks of 1-21) were used for the complex of native (indigenous) species. Spectra of families and genera of flora native to the Ussuri Floristic District (Kharckevicz, 1985-1996), which encompasses the rest of the compared territories (three subareas and Southwest Primorye), were used as a model. For a more correct designation of the content (volume) of the analyzed flora, the definition of natural flora (Kozhevnikov, 2003) consists of two main components: (1) native species growing due to natural factors, with no human intervention (indigenous flora), and (2) the complex of invasive (alien) species (adventive flora).

The concept of the model spectrum, developed for the Palearctic flora by Khokhryakov (2000), allowed us to classify the flora of the primary families of the first two triads at the top of a ranked taxonomic spectrum. As experience has shown, this method uses the physiognomic characteristics from the top of the taxonomic spectrum to perform high quality and clearly understandable comparisons of floras, without the use of mathematical methods. The types and subtypes of the floras were determined according to the composition of the families of the first triad and the first family of the second triad, respectively.

When performing a comparative analysis of floras in the Amur River basin, it was also proposed to select flora from the first family of the third triad of the taxonomic spectrum (Kozhevnikov and Kozhevnikova, 2007). Classification based on this approach assumed the existence of transitional forms, with implicit dominance of the leading families. Ecocenotic preferences of species and their affinity to certain botanical and geographical landscapes, as well as the general characteristics of their geographical distribution, were reflected in their inclusion in the relevant floristic complexes and geographical elements. The scheme for the floristic complexes and geographical elements developed for the flora of Central Siberia (Malyshev and Peshkova, 1984) was implemented, with the necessary additions and changes made to analyze the flora of the Russian Far East (Kozhevnikov, 2001; 2007; Kozhevnikov and Kozhevnikova, 2011; Kozhevnikov *et al*., 2015). Conclusions regarding species relatedness to particular floristic complexes and ecocenotic groups were made mainly based on the general nature of the species growing in the cold-temperate regions of Eurasia.

Floras in Southwest Primorye were represented either according to the species belonging to different ecocenotic groups (for indigenous) or by the degree of acclimatization for adventitious plants (Table 1). Basic geographical elements and groups in the floras of Southwest Primorye are provided in Table 2. Exclusively adventive

Table 1. Floristic complex types observed among the flora of Southwest Primorye.

Type	Explanation
Hypoarctic	Tundra, Mari Forest, Grass Deciduous Forest
Arctic & Alpine & Montane	Subalpine, Hypoarctic Montane, Montane
Forest	Light Coniferous Forest, Dark Coniferous Forest, Nemorous Forest
Steppe	Steppe, Montane Steppe, Forest Steppe
Meadow Flood Plane	Aquatic, Marsh, Meadow (Meadow Flood Plane), Valley Petrophilous, River-Bed, Shrub
Maritime	Water Littoral, Supralittoral, Littoral Meadow, Maritime Petrophyte, Maritime Meadow
Alien or Adventitious	Agriophyty - transformes, Epekophytes - invasive plants, Kolonophytes - naturalized plants, Ephemerophytes - casual alien plants

Table 2. Geographical elements and groups among the flora of Southwest Primorye.

Type of elements	Explanation of groups
Circumpolar	Circumpolar regular, mainly Asian, mainly American, Circumboreal, Multizone, Multizone-Bipolar
Asian-American	Asian-American regular, mainly Asian, mainly American, Amphi-Pacific
Eurasian	Eurasian regular, Multizone, Multiregional, Europe-Siberian, and only for invasive adventitious species - Europe-Caucasian, Europe-Persian, Europe - Middle Asian
Eurasian-Mediterranean	Eurasian-Mediterranean regular, Multizone, Multiregional, Multizone - Multiregional
Pan-Asian	Pan-Asian regular, East & South Asian, East & South Asian, with penetration in Australia, West & South Asian, North & East Asian, North & Central Asian, Central & East Asian, Central & South Asian
East Asian	East Asian regular, Amurian, Amur-Chinese, Amur-Korean, Dahuria-Manchurian, Ussuri-Korean, Amur-Japanese, China-Korean, Manchurian, Korea - South Primorye, South Chinese, Japan-Chinese
West Pacific	West Pacific regular, North Japanese, Okhotsk Sea & Japan Sea Rim, South-West Pacific, Japan Sea Rim, Primorye-Korean, South Primorye-Korean, Japan-Korean, Japanese
North Asian	East Siberian - Far Eastern, Siberian - Far Eastern, South Siberian, South Siberian - Far Eastern
Central Asian	Mongolia-Dahurian, South Siberian - Middle Asian, South Siberian - Mongolian
Australian	Australian - East Asian, extratropical
Tropical	Pan-Tropical, Asian-American, Paleotropic, Paleotropic, with penetration in East Asia, Paleotropic, with penetration in East Asia & Australia
Endemic	Sikhote-Alin - Amgun - Sakhalin, Central Amurian, Khanka, Sikhote-Alin - South Kurile, East Primorian, Sikhote-Alin - Sakhalin, Primorian, Khasanian, South Primorian, South Primorye - Khanka

Table 3. Comparative data on the natural flora of the separate territories of the Russian Far East (RFE). The boundaries of the territories are shown in Fig. 1.

Territories	Natural flora			Specific species*			Endangered species***		Endemic to RFE
	Native	Adventitious	Total	Native	Adventitious	Total	Russia	Primorye	
Amur Region	1630	229	1859	153	12	165	33	57	50
Jewish Autonomous Region	1280	198	1478	7	0	7	32	56	26
South Khabarovsk Territory	1886	436	2322	106	39	145	49	75	135
Primorsky Territory	2109	643	2752	399	208	607	91	213	159
South Primorsky Territory	1897	625	2522	254	186	440	88	200	117
Southwest Primorsky Territory	1356	174	1530	49 (163)**	1 (7)**	50 (170)**	62	132	45
Sakhalin Region (Isl. Sakhalin)	1299	229	1528	316	27	343	45	37	106

* Species present in only one of the compared areas. Exceptionally, the South Primorye territory includes the Southwest Primorye.
** Species in both South and Southwest Primorye.
*** The species included in the Red Book of the Russian Federation (Trutnev, 2008) and/or the Red Data Book of the Primorsky Territory (Kozhevnikov, 2008)

(alien) species are represented by geographical elements, such as European, Europe-Mediterranean, West Asian, South Asian, and American (North American, Central American, South American).

Results and Discussion

In the Russian Far East, southern subregions are distinguished by very diverse flora, representing indigenous and adventitious species complexes (Kozhevnikov, 2003). The Primorsky Territory has the most diverse flora among areas in the southern part of the entire region, while the largest number of species of vascular plants is concentrated in South Primorye (Kozhevnikov *et al*., 2005). Furthermore, the territory of Primorye, related to the basin of the East Sea, is floristically much richer and unique in comparison with the territory of the Amur River basin, with 2,596 and 2,215 species, respectively (Kozhevnikov and Kozhevnikova, 2014).

The data shown in Table 3 confirmed the floristic richness of the southern territories of the Russian Far East (Fig. 1). Additionally, more information about the southern part of the Kuril Archipelago (South Kuril floristic area: by Kharkevicz, 1985-1996) is available, with 1,315 known species of natural flora (Bakalov, 2009). Despite its modest size, the Southwest Primorye, located in the basin of the East Sea, has rich and unique natural flora.

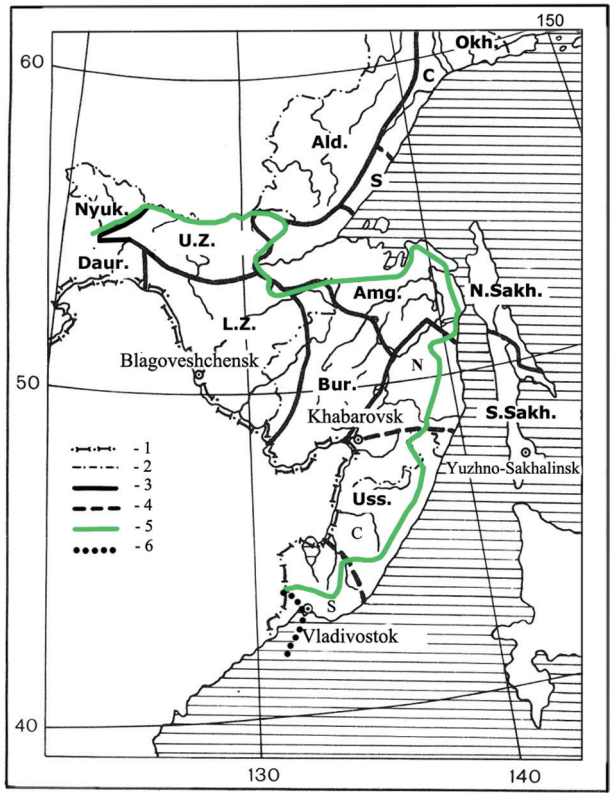

Figure 1. Geographical location of Southwest Primorye, structured in administrative units, and floristic regionalization of the southern part of the Russian Far East (RFE). 1 - national boundary of the Russian Federation; 2 - boundaries of administrative units; 3 - boundaries of floristic districts; 4 - boundaries of floristic subdistricts; 5 - boundary of Amur River basin (watershed line); 6 - boundaries of Southwest Primorye. Floristic districts: Okh. - Okhotsk (with subdistricts: C - central, S - southern), Ald. - Aldan, Nyuk. - Nyukzha, Daur. - Dauria, N. Sakh. - North-Sakhalin, U.Z. - Upper-Zeya, L.Z. - Low-Zeya, Bur. - Bureya, Amg. - Amgun, Uss. - Ussuri (with subdistricts: N - northern, C - central, S - southern), S. Sakh. - South Sakhalin. Floristic regionalization is given according to edition "Vascular plants of Soviet Far East" (Kharkevich, 1985-1996; Kharkevich and Tzvelev, 2003).

The natural flora of Southwest Primorye is currently represented by 1,530 species of vascular plants, belonging to 622 genera and 154 families that account for 55.6% of the flora in Primorye (Kozhevnikov *et al*., 2015). The native flora of Southwest Primorye encompasses 1,356 species from 547 genera and 148 families. The complex of adventitious plants contains 174 species from 127 genera and 37 families.

The groups of specific (or differential) indigenous species, representing the features of the species composition of the territories being compared, are of particular interest to taxonomists. A total of 254 species were unique to South Primorye, with 49 taxa unique to Southwest Primorye. A total of 163 species were common between South and Southwest Primorye. Only 43 taxa were unique to the remainder of South Primorye, an area several fold larger than the size of Southwest Primorye. In the nemoral forests, East Asian *Rhododendron schlippendachii* Maxim. (China-Korean type) is an example of the flora of Southwest Primorye that reflected the transboundary distribution of several species across Russia, China, and Korea. Numerous species (*Epimedium koreanum* Nakai, *Lonicera monantha* Nakai, *Carex holotricha* Ohwi, *Iris vorobievii* N.S. Pavlova, *Atragene koreana* [Kom.] Kom, *Viola diamantiaca* Nakai) and East Asian taxa (*Conioselinum smithii* [H.Wolff] Pimenov et Kljuykov, *Pseudostellaria heterophylla* [Miq.] Pax, *Lespedeza cyrtobotrya* Miq., *Pueraria lobata* [Willd.] Ohwi, *Rabdosia serra* [Maxim.] Hara, *Viola yazawana* Makino) were found in Western Pacific nemoral forests (distributed mainly or exclusively in the basin of the East Sea). Nemoral forest species consisted of 26 taxa, which comprise more than half of the species unique to Southwest Primorye.

Six exotic taxa (12.3%) were among the Russian Far East group of species, with a vast distribution in the subtropical and tropical latitudes of Southwest Primorye. Most notable was the presence of the *Cyperaceae* family (*Cyperus tenuispica* Steud., *Fimbristylis dichotoma* [L.] Vahl, *Lipocarpha microcephala* [R. Br.] Kunth, *Pycreus polystachyos* [Rottb.] Beauv.), which was recently found among the flora discovered during the last 15-20 years south of the Russian Far East. The special status of the flora of Southwest Primorye was due to the specific taxa of higher rank; the family *Loganiaceae* (*Mitrasacme indica* Wight) and the genera *Halosciastrum* Koidz. (*H. melanotilingia* [Boissieu] M. Pimen. et V. Tichomirov), *Streptolirion* (*S. volubile* Edgew.), *Lipocarpha* R. Br. (*L. microcephala*), *Pueraria* DC. (*P. lobata*), *Belamcanda* Adans. (*B. chinensis* [L.] DC.), *Zoysia* Willd. (*Z. japonica* Steud.), *Deinostema* (*D. violacea* [Maxim.] Yamazaki) and *Parthenocissus* Planch. (*P. tricuspidata* [Siebold et Zucc.] Planch). They represented a connection with flora in the more southern (warm-temperate, subtropical, and tropical) areas of East Asia. They were the natural flora most represented in this region of Russia.

A relatively small group of adventitious plants in Southwest Primorye was found to consist of 174 (11.4%) species. This was particularly evident in the comparison between the floras of South Primorye and Primorye in general, where the levels of adventization were 24.7% and 23.3%, respectively.

The general patterns of ecological and geographical differentiation of species native to Southwest Primorye were described previously by Kozhevnikov *et al*. (2015). Table 4 shows the floristic complexes and geographical elements present among the natural flora of this area, including the number of species per complex. Species native to East Asia, from Forest (432) and Meadow Flood

Table 4. Floristic complexes of the natural flora in Southwest Primorye in connection with their geographical distributions.

Geographical elements	Floristic complexes							
	Hypoarctic	Arctic, Alpine & Montane	Forest	Steppe	Meadow Flood Plane	Maritime	Adventitious	Total number of species (frequency, %)
Circumpolar	5	9	34	8	86	6	15	163 (10.7)
Asian-American	2	2	13	1	20	15	–	53 (3.7)
Eurasian	–	1	29	7	21	3	31	92 (6.0)
Eurasian-Mediterranean	–	–	10	5	33	1	60	109 (7.1)
Pan-Asian	1	2	70	31	65	1	8	178 (11.6)
East Asian	–	6	432	87	186	16	8	735 (48.1)
West Pacific	–	1	24	–	14	32	1	72 (4.7)
North Asian	–	–	3	8	3	–	1	15 (1.0)
Central Asian	–	–	–	3	–	–	1	4 (0.3)
Tropical	–	–	1	–	13	–	2	16 (1.0)
Australian	–	–	–	–	–	1	–	1 (0.07)
Endemic of RFE	–	–	19	4	7	15	–	45 (2.9)
American*	–	–	–	–	–	–	29	29 (1.9)
European*	–	–	–	–	–	–	5	5 (0.3)
Europe-Mediterranean*	–	–	–	–	–	–	5	5 (0.3)
Mediterranean*	–	–	–	–	–	–	4	4 (0.3)
West Asian*	–	–	–	–	–	–	1	1 (0.07)
South Asian*	–	–	–	–	–	–	3	3 (0.2)
Total number of species (frequency, %)	8 (0.5)	21 (1.4)	635 (41.5)	154 (10.1)	448 (29.3)	90 (5.9)	174 (11.4)	1530 (100)

* The floras' geographical elements are represented by Adventitious species only.

Plane (186) complexes, were clearly dominant. On the contrary, among the West Pacific species, there were more Maritime Meadow (32) than Forest (24) species. Among the species endemic to the Russian Far East, the majority were in the Forest (19) and Maritime Meadow (15) floristic complexes. There were numerous species in the East Asian Steppe (87) and Circumpolar Meadow Flood Plane (86) floristic complexes. Most of the species in the Adventitious complex were Eurasian-Mediterranean (60) and Eurasian (31) species, representing more than half the number of species in that complex. The American (29) and Circumpolar (15) species were also significantly represented in the Adventitious complex.

A species profile of Southwest Primorye's flora consisted of 45 species endemic to the Russian Far East, among which seven taxa (*Saussurea kurentzoviae* Barkalov, *Carex pulchrifolia* A. E. Kozhevnikov, *Calamagrostis chassanensis* Probat., *Poa verae* Probat., *Poa zhirmunskii* Probat., *Salix reinii-affinis* A.E. Kozhevnikov et Z.V. Kozhevnikova) were endemic only to Southwest Primorye. These seven species were distributed over the Littoral Meadow (two species from Maritime Meadow and one from Maritime Petrophyte), Meadow Flood Plane (two species from the Shrub group and one from Meadow group), and Forest (one species from Nemorous Forest) floristic complexes. The group of hemiendemic (South Primorye-Korean) species included seven taxa (*Jacobaea chassanica* [Barkalov] A.E. Kozhevnikov, *Halosciastrum melanotilingia* [Boissieu] M. Pimen. et V. Tichomirov, *Carex holotricha*, *Lonicera monantha*, *Iris vorobievii*, *Arundinella chassanica* Tzvel. et Probat., *Atragene koreana* [Kom.] Kom.). This group of hemiendemic species was more homogeneous than the endemic group, with six species in the Nemorous Forest and one (*J. chassanica*) in the Meadow Flood Plane floristic complexes.

The taxonomic spectra of natural and adventitious flora of Southwest Primorye has also been described by Kozhevnikov *et al.* (2015). The taxonomic spectra of the families and genera, consisting of a complex of species in Southwest Primorye and comparable areas south of the Russian Far East mainland, are presented in Tables 5 and 6. In the floras of the Holarctic regions and territories, quantitative relationships among the largest families of the taxonomic spectrum are very stable (Tolmaczev, 1974; Khokhryakov, 2000). In the northern and temperate parts of the Holarctic, the percentage of the largest families decreased consistently, from the north to south, in the composition of both regional and local floras with natural botanical-geographical boundaries. Thus, this character, for which calculation first 10 families of the taxonomic spectrum is taken, to some extent, reflects the zonal position of the studied flora.

The total number of species in the Asian Arctic floras represented in the taxonomic spectrum for the 10 largest families range from 63.4% (South Chukotka)

Table 5. Dominant families of the native flora in the Ussuri Floristic District (FD) and its separate areas.

Family	Ranks / Number of Species				
	Ussuri Floristic District (FD)				Southwest Primorye
	Total	Northern	Central	Southern	
Asteraceae	1/217	1/120	1/175	1/181	2/128 ↓
Cyperaceae	2/211	3/110	2/165	2/180	1/129 ↑
Poaceae	3/196	2/118	3/136	3/154	3/100 ↓
Ranunculaceae	4/106	5/ 60	4/88	5/83	4/63
Rosaceae	5/102	4/64	5/79	4/87	5/58
Polygonaceae	6/78	6/43	6/61	6/67	6/45
Lamiaceae	7/72	10/33	7/54	7/62	9/38 ↓
Caryophyllaceae	8/63	7-9/35	8/50	8-9/53	8/40
Fabaceae	9/57	7-9/35	9/48	8-9/53	7/43 ↑
Apiaceae	10/48	13-15/24	12/38	10/42	10/37
Brassicaceae	11-12/46	13-15/24	13/33	14/29	14-15/20 ↓
Scrophulariaceae	11-12/46	7-9/35	11/39	13/36	12-13/26
Orchidaceae	13/45	11-12/30	10/40	11/39	11/30 ↑
Violaceae	14/40	17/19	16-17/22	12/37	12-13/26 ↑
Ericaceae	15-16/34	11-12/30	15/27	17/22	92-108/2 ↓↓
Salicaceae	15-16/34	13-15/24	14/29	15-16/23	14-15/20 ↑
Saxifragaceae	17/28	16/20	16-17/22	18/20	23-24/12 ↓
Crassulaceae	18-19/24	27-33/10	19/19	15-16/23	19-22/13 ↓
Juncaceae	18-19/24	18/17	18/20	20-22/18	25-28/11 ↓
Primulaceae	20/22	27-33/10	21-24/16	19/19	29-31/10 ↓
Number of species in top 10 ranking families	1150 (51.2)	653 (50.1)	896 (51.1)	962 (50.7)	681 (50.2)
Number of families	164	140	155	159	148
Number of species	2246	1304	1753	1896	1356

↑ or ↓ - increase or decrease in the taxonomic rank.

Table 6. Dominant genera among the native flora in the Ussuri Floristic District and its separate areas.

Genera	Ranks / Number of Species				
	Ussuri Floristic District (FD)				Southwest Primorye
	Total	Northern	Central	Southern	
Carex	1/145	1/82	1/122	1/122	1/91
Viola	2/40	3/19	3-5/22	2/37	2/26
Artemisia	3/37	2/21	2/31	3/30	3/21
Saussurea	4/29	5/16	3-5/22	4-5/19	7-8/12 ↓↓
Poa	5/27	6/15	8/17	4-5/19	6/13 ↓
Salix	6/26	4/18	3-5/22	6-7/18	4-5/15 ↑
Calamagrostis	7/25	10-12/12	7/19	8-9/17	18-24/8 ↓
Potentilla	8/24	7-9/14	6/20	6-7/18	4-5/15 ↑
Aconitum	9/20	18-24/9	10-13/15	11-13/15	9-11/11
Allium	10-12/18	14-17/10	9/16	11-13/15	9-11/11
Juncus	10-12/18	7-9/14	10-13/15	14/14	14-17/9 ↓
Potamogeton	10-12/18	10-12/12	10-13/15	8-9/17	12-13/10
Corydalis	13-15/17	18-24/9	17-21/11	18-23/11	14-17/9 ↓
Persicaria	13-15/17	10-12/12	10-13/15	10/16	9-11/11 ↑
Ranunculus	13-15/17	7-9/14	14/14	15-16/13	12-13/10 ↑
Thymus	16/16	83-137/3	22-25/10	18-23/11	157-240/2 ↓↓
Galium	17/15	18-24/9	15/13	11-13/15	7-8/12 ↑↑
Geranium	18-21/14	29-34/7	17-21/11	18-23/11	18-24/8
Ribes	18-21/14	14-17/10	17-21/11	15-16/13	66-98/4 ↓↓
Saxifraga	18-21/14	13/11	22-25/10	28-34/9	99-156/3 ↓↓
Scutellaria	18-21/14	14-17/10	16/12	18-23/11	30-40/6 ↓↓
Number of genera	681	523	605	640	546
Number of species	2246	1304	1753	1896	1356

↑ or ↓ - increase or decrease of the taxonomic rank.

to 75.8% (Isl. Vrangel) of their species diversity, but in most subprovinces in the Arctic floristic region, approximately 65-70% of the diversity is represented (Yurtsev *et al*., 2002). For the boreal floras of the Holarctic, the percentage of the 10 largest families varied from 55 to 60%. In the flora of the Korean peninsula (Lee, 1993) and Northeast China (Kitagawa, 1979), the percentages of the 10 largest families are 42.6 and 49.3%, respectively (Kozhevnikov, 2003). This phenomenon could also be seen clearly in the Russian part of the Far East, where the percentages of indigenous species in the 10 largest families are 64.4% (Chukotka Autonomous Area with Magadan Region), 59.8% (Kamchatka Region and the Koryak Autonomous District), 52% (Sakhalin Region), and 51.9% (Primorye; Kozhevnikov, 2003). The top 10 families represented 50.2% of the flora of Southwest Primorye and 50.1-51.2% within the Ussuri Floristic District (Table 5). This was in accordance with the nemoral (preboreal) floras, located in the transitional zone between boreal and nemoral floras.

In the flora of Southwest Primorye, the first six families were *Asteraceae*, *Cyperaceae*, *Poaceae*, *Ranunculaceae*, *Rosaceae*, and *Polygonaceae*. According to Khokhryakov (2000), the flora of this area as well as the flora of the Ussuri Floristic District was generally the *Cyperaceae* type and *Ranunculaceae* subtype. The position of the *Cyperaceae* family were changed from second to first place, although the *Cyperaceae* and *Asteraceae* were only different for one species, reflecting the taxonomic diversity significantly increased in the floras of Northeast China and Korea. Significant changes were observed in the third triad of the spectrum, including the exchange of ranks between the *Lamiaceae* and *Fabaceae* families. The *Fabaceae* family was in seventh place in Southwest Primorye. Therefore, if the flora of the Ussuri Floristic District in a whole should be referred to the *Lamiaceae* - variant, the flora of Southwest Primorye - to the *Fabaceae*. It is interesting that the flora of northeastern North America (Magee and Ahles, 2007), according to florogenic characteristics, is closely related to the flora of Eastern Asia, as the flora of the Ussuri Floristic District included the *Cyperaceae* type, *Ranunculaceae* subtype, and *Lamiaceae* variant.

Based on the characteristics at the top of the taxonomic spectrum of the Northeast China (Kitagawa, 1979) and Korean (Lee, 1993) floras, they should belong to the *Cyperacea* type, but with different subtypes and variants. *Ranunculaceae* was the subtype when *Polygonaceae* was the variant, and *Rosaceae* was the subtype when *Orchidaceae* was the variant for the floras of Northeast China and Korea, respectively. Thus, a strong influence from the *Orchidaceae* family, especially characteristic of the subtropical and tropical floras, was apparent among the flora of Korea. The structure of the ranked taxonomic spectrum of the Southwest Primorye flora was more similar to the flora of Northeast China. It is appropriate to note that the flora of the Amur River basin (in the sector of the Russian Far East), as well as the flora of Northeast China, belong to the *Polygonaceae* variant (Kozhevnikov and Kozhevnikova, 2007).

The most significant changes in the composition of the largest families in the flora of Southwest Primorye were associated with species diversity and the rank of the *Ericaceae* family. Its influence naturally and significantly decreased from the north (ranked 11 and 12 in the northern subdistrict of Ussuri DF) to the south (ranked from 92 to 108 in Southwest Primorye), with the number of species reduced from 30 to 2 (*Rhododendron mucronulatum* Turcz. and *Rh. schlippenbachii*), respectively. The southern subdistrict of the Ussuri Floristic District, which comprises Southwest Primorye, had 20 species representing the following nine genera: *Andromeda* L. (1), *Arctous* Niedenzu (1), *Cassiope* D. Don (2), *Chamaedaphne* Moench (1), *Ledum* L. (6), *Oxycoccus* Hill (2), *Rhodococcum* (Rupr) Avrorin (1), *Rhododendron* L. (7), and *Vaccinium* L. (1). The reduction in species diversity occurred for the boreal and arctalpine species. A reduction in the influence from several families (*Saxifragaceae*, *Juncaceae*, *Primulaceae* and *Lamiaceae*) was observed in the Southwest Primorye flora. The influence from three families (*Fabaceae*, *Orchidaceae*, *Violaceae*) was increased slightly.

Generic spectra that are more sophisticated and diverse reflect differences among the floras of individual territories. The taxonomic spectra of the leading native flora genera of Southwest Primorye, and comparable areas south of the Russian Far East mainland, are presented in Table 6. The positions of the largest genera, *Carex*, *Viola*, and *Artemisia*, were the same for all floras of the Ussuri Floristic District. The top flora of Southwest Primorye were similar to the flora of Northeast China, where the same genera were dominant in the first triad. The only difference was in the positioning of the *Viola* and *Artemisia* genera. The genus *Artemisia* was in second place (54 species) in Northeast China and *Viola* in third place (40). Among the flora of Korea, *Carex* (131 species) and *Viola* (44) were in first place, *Salix* (34) in third place, and *Artemisia* (26) was moved to seventh place.

The dominant position of the genus *Carex*, in particular, is well known among the floras of the Holarctic and in North and East Asia. The genus *Viola* showed a clear tendency toward increased species diversity in the seashore areas of East Asia, which was one of the centers of its species diversity. Forty violet species have been identified in the vast territory of Siberia, which is three times larger than the area of the Russian Far East, with 52 species of violets, ranking seventh in the taxonomic

spectrum (Kharckevicz, 1985-1996; Peschkova, 1996; Kozhevnikov, 2003). Twenty-six violet species are represented among the flora of Mongolia (Sanchir and Jamsran, 2014), while 48 are among the flora of Japan (Ohwi, 1965).

The genus *Artemisia* is most highly represented in the continental and arid areas of South Siberia and Mongolia, where this genus has 84 and more than 100 species, respectively (Gubanov, 1996; Krasnoborov, 1997; Sanchir and Jamsran, 2014). This is one of the largest among the genera in Mongolia's flora, ranking fourth in the taxonomic spectrum (Grubov, 1982), and similar to the *Fabaceae* type. This flora is native to the hinterland of Eurasia. Species diversity is substantially reduced in the oceanic regions of East Asia. There are 26 species in Korea (Lee, 1993) and 30 species in Japan (Ohwi, 1965).

According to the characteristics of the first triad of genera in the taxonomic spectrum, Southwest Primorye's flora is more similar to the flora of Northeast China. The genus *Viola* has a very significant impact on the flora of the Ocean East Asian regions, south of the Russian Far East, and Northeast China. Regarding the remaining top genera of the taxonomic spectrum of Southwest Primorye, the most significant decline in rank was for the genera *Thymus*, *Saxifraga*, *Ribes*, *Scutellaria*, and *Saussurea*. Alternatively, the rank of the genus *Galium* was significantly increased. Less significant changes in rank occurred among the genera *Salix*, *Potentilla*, *Persicaria*, and *Ranunculus* (increase in rank) and among *Poa*, *Calamagrostis*, *Juncus*, and *Corydalis* (decrease in rank).

By summarizing comparisons of the flora of Southwest Primorye with flora of neighboring territories, we could make the general conclusion that, according to the taxonomic structure and the position of the largest families and genera, the flora of Southwest Primorye was more similar to that of Northeast China. The flora of Southwest Primorye was also strongly influenced by Korean flora. A more detailed analysis of the relationship of the flora of Southeast Primorye to the floras of neighboring areas, such as Northeast China and the Korean Peninsula, requires implementing special mathematical methods. Also required is a more differentiated approach to compare the floras of both Northeast China and the Korean peninsula. In the future, it would also be appropriate to evaluate comparable floras within the Manchurian floristic province (Takhtajan, 1978).

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