Conference Paper

Comparison of Partial Floras of Communication: Tape Habitats in the Cities of the Southern Part of Udmurtia

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Abstract

The purpose of this study is to establish the similarities and differences between the combined partial flora of railways and highways in the cities of the southern half of Udmurtia. Studies were accomplished by the partial floras and route methods. The combined partial flora of railways contains the greatest number of species – 648. Adventive species comprise 61% of the total. As such, the abundance of the flora of railways depends on the presence of pathways of alien species (Mozhga – 485 species, Kambarka – 439, Votkinsk – 300). The flora of the city roads is represented by 512 species. The greatest variety of flora is found in the partial flora of the Kambarka highways (376 species): There are less in Votkinsk and Mozhga (348 and 350 species, respectively). The aboriginal portion (199 species, 53%) makes a significant contribution to the diversity of the partial flora of the Kambarka highways. This is due to the peculiarities of the physiographic and administrative characteristics of the cities.

Keywords: partial flora, communication-tape habitats, urban flora, flora of the Udmurt Republic, invasive plants

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1. Introduction

The class of communication-tape habitats refers to anthropogenically-transformed habitats with intensively transformed vegetation and includes ecotopes along various routes of communication [1]. The greatest contribution to the biodiversity of these areas is made by railways and highways [2–5]. Interest in studying the flora in these places arose at the moment of their appearance [6, 7]. Nowadays, most researchers recognize these sites as the main migration routes of alien species of plants and the places in which they are most concentrated. The rudiments of the plants penetrate here, with vehicles transporting various types of cargo and materials for construction,

the food industry, agriculture and other economic needs [8]. For alien plants, the difficulty of railway habitats is that they are systematically treated with herbicides and mowed. Roadsides, especially those connecting large settlements and the major streets of the cities, are also regularly mowed.

The purpose of this study is to establish the similarities and differences between the combined partial flora of railways and highways in the cities of the southern half of Udmurtia. According to the phyto-geographical regionalization of the European part of Russia, the studied area is part of the West Siberian-Ural taiga province of the Eurasian taiga region [9]. Floristic research was conducted in the administrative boundaries of three cities - Votkinsk, Mozhga and Kambarka. The towns of Votkinsk (founded in 1757) and Kambarka (founded in 1767) appeared after the construction of steel factories [10, 11]. The construction of a glass factory in 1835 and the workers' village under it gave rise to the development of Mozhga [12].

The first railroad in Udmurtia was started in 1895. It connected the Votkinsk plant with piers on the Kama River. The building of the Kazan-Ekaterinburg railway, linking the European part of Russia to Siberia in 1914, ran through Mozhga and Kambarka, the towns investigated [10–12].

2. Methods

Railways and roads were considered in a broad sense. The group of railway habitats consists of railway tracks, platforms, stations, embankment slopes, slopes, cuvettes and exclusion zones. Car habitats include the actual surface of roads (asphalt, gravel, soil), the slopes of embankments, and cuvettes. Identified by Yurtsev's method, the collection of material was completed via the route method. The study of flora in Votkinsk began in 2008, while those in Mozhga and in Kambarka started in 2012. The investigation included the collection of herbarium material and writing floristic lists. More than 1,000 herbarium sheets were collected. The herbarium materials are stored in the Herbarium of Udmurt State University (UDU). The materials of the computer database 'Herbarium of the Flora of the Udmurt Republic' were also taken into account during the analysis.

3. Results

In the study, we analyze lists of species of the combined partial floras of railways and highways in the investigated urban floras. It is determined that the combined partial

flora of the railways in the cities in the southern half of Udmurtia is represented by 648 species from 64 families, which is 31% of the total flora of the Udmurt Republic [13].

The aboriginal fraction is formed by 251 species of vascular plants from 50 families, 38.7% of the total combined partial flora. The families leading by number of species are presented in Table 1. The 10 leading families comprise 65.7% of all aboriginal flora. In comparison with the aboriginal flora of Udmurtia, the families of *Polygonaceae* and *Apiaceae* appear in the PF spectrum. These families contain a large number of anthropotolerant species. For example, *Anthriscus sylvestris* (L.) Hoffm., *Chaerophyllum bulbosum* L., *Pastinaca sylvestris*, and *Rumex acetosella* L., species of the *Polygonum* genus, are often found along railways. This fraction is characterized by the prevalence of herbaceous perennials – 65.9% (166 species) of the total number of species. This is characteristic of the aboriginal flora in Udmurtia as a whole and is associated with the temperate-cold floras of the Holarctic.

Table 1: The leading families of the aboriginal fraction of Udmurtia and the combined partial floras of the railways and highways in Votkinsk, Mozhga and Kambarka.

Families	PF Railways			PF Highways			Udmurt Republic		
	Rank	Number of Species	%	Rank	Number of Species	%	Rank	Number of Species	%
Asteraceae	1	38	15.1	1	41	16.0	1	108	10.7
Rosaceae	2	19	7.6	3	18	7.0	4	66	6.6
Poaceae	3	18	7.2	4	17	6.6	2	89	8.8
Fabaceae	4	17	6.8	2	23	9.0	8	38	3.8
Caryophyllaceae	5	14	5.6	5	15	5.9	5	47	4.7
Scrophulariáceae	6	13	5.2	7	13	5.1	7	38	3.8
Lamiaceae	7	12	4.8	6	14	5.5	9	31	3.1
Polygonaceae	8	12	4.8	–	–	–	–	–	–
Cyperáceae	9	11	4.4	–	–	–	3	78	7.8
Apiaceae	10	10	4.0	8	11	4.3	–	–	–
Ranunculaceae	–	–	–	9	10	3.9	6	40	4.0
Brassicaceae	–	–	–	10	9	3.5	10	29	2.9
Total		164	65.3		171	66.8		564	56.1

Source: Authors' own work.

The alien fraction is represented by 393 species of 54 families, 61% of the total combined partial flora and 53% of all adventive species found along the railways in the republic [14]. The predominance of alien plants is also characteristic of the railways of Moscow [4–6]. The leading families of adventive flora are represented in Table 2. They make up 292 species (73.5%) of all adventive plants. All these families, except for

Boraginaceae, are in the top ten leading alien flora in Udmurtia. The largest part, 52% (208 species), of the total combined flora is constituted by herbaceous shorter-lived annuals and biennials that are quite natural to the alien adventive of Udmurtia [14].

Table 2: The leading families of the adventive fraction of Udmurtia and the combined partial flora of the railways and highways in Votkinsk, Mozhga and Kambarka.

Families	PF Railways			PF Highways			Udmurt Republic [14]		
	Rank	Number of Species	%	Rank	Number of Species	%	Rank	Number of Species	%
Poaceae	1	61	15.5	2	33	12.9	1	181	14.9
Asteraceae	2	59	15.0	1	44	17.2	2	164	13.5
Rosaceae	3	36	9.2	4	22	8.6	4	93	7.7
Chenopodiaceae	4	36	9.2	3	23	9.0	6	54	4.4
Brassicaceae	5	32	8.1	5	18	7.0	3	97	8.0
Fabaceae	6	26	6.6	6	16	6.3	5	56	4.6
Caryophyllaceae	7	14	3.6	7	9	3.5	9	32	2.6
Lamiaceae	8	11	2.8	8	7	2.7	7	43	3.5
Polygonaceae	9	9	2.3				8	33	2.7
Boraginaceae	10	9	2.3	9	6	2.3			
Onagraceae				10	6	2.3			
Solanaceae							10	28	2.3
Total		**293**	**74.6**		**184**	**71.9**		**781**	**64.2**

Source: Authors' own work.

The richest partial flora grows along the railways of Mozhga (485 species) and Kambarka (439 species). In Votkinsk, the number is lower, with only 300 species revealed. Such a distribution can be explained by the fact that the main line of a railway connecting Moscow and Ekaterinburg goes through the territory of Mozhga and Kambarka. This is one of the main ways in which adventive plants penetrate the territory of Udmurtia. In Votkinsk, however, there is only a dead-end railway line. This is also confirmed by an analysis of the adventive flora. Most adventive species were discovered along the railways of Mozhga – 305 species (63% of all the found species in this habitat and 65.8% of all the adventive species in Mozhga) – and Kambarka – 240 species (54.7% and 62%, respectively). This is connected with the active exploitation of the railway. Trains going west import *Atriplex sibirica* L., *Commelina communis* L., *Isatis campestris* Steven ex DC., *Ononis arvensis* L., etc., to Udmurtia from East Asia and Siberia. Meanwhile, *Diplotaxis tenuifolia* (L.) DC., *Eruca sativa* Mill., *Reseda lutea* L., etc., are imported from Europe, the Mediterranean and Central Asia. In Votkinsk, the adventive component is made up of 175 species, 50% of all the partial flora of railways and 43% of all the adventive species of the town. A large number of various types of

poplars, which often hybridize, are noted along the railways. There are also plants, fruits and seeds imported as food for people or farm animals: *Lens cilinaris* Medik., *Avena georgica* Zuccagni, and *Hordeum distichon* L. The similarity of the adventive fractions of the studied partial flora can be seen in the classification of the species according to their life forms. More than half of all the species are herbaceous shorter-lived annuals and biennials (Mozhga– 54.3%; Kambarka – 55.6%, Votkinsk – 57.0%): this is characteristic of the combined partial flora of railways and all the adventive flora of Udmurtia.

The aboriginal fraction of the partial flora is not numerous. The greatest diversity can be observed in the partial flora of Votkinsk, where it comprises 50% (175 species). In Kambarka and Mozhga, the impact of this fraction on flora formation is lower. The aboriginal part is 45.3% (199 species) and 37% (180 species), respectively.

Thus, traffic intensity on the railways, its character, and population numbers in the towns have the greatest influence on the variety of vascular plants in the partial flora of railways and urban flora.

The combined partial flora of highways in the towns of the southern half of Udmurtia is represented by 512 types of vascular plants from 62 families, 25% of all flora in Udmurtia [13]. The aboriginal part of the flora is represented by 256 species from 46 families, 50% of all the partial flora of highways. The leading families are presented in Table 1. The presence of the *Apiaceae* family and the growing roles of the *Fabaceae*, *Rosaceae* and *Lamiaceae* families (represented mainly by synanthropic species) unites the combined partial flora of railways and highways and emphasizes the peculiarity of anthropogenic habitats. 70% (178 species) of all types of the native fraction are represented by herbaceous perennials, which is also natural for the aboriginal fraction of Udmurtia.

The alien component is represented by 256 species from 45 families, 50% of all combined partial flora and 81.5% of all alien species of Udmurtia found along highways [14]. The dominating families are presented in Table 2. The growing role of *Chenopodiaceae*, *Caryophyllaceae* and the appearance of *Boraginaceae* and *Onagraceae* in the flora of highways, in comparison with the alien flora of Udmurtia, indicates the prevalence of xenophytes. Over half of the species (54%; 138 species) are herbaceous shorter-lived annuals and biennials.

The partial flora of the highways of Kambarka is richest – 376 species. The number of species in Votkinsk and Mozhga is lower – 348 species and 350 species, respectively.

In general, the adventive plants have significant influence on flora formation along the railways and highways. The invasive component of the adventive fraction of flora

seems to have the most active impact. Among the partial flora of railways, the greatest number of species recognized as invasive are found in the territory of Kambarka (57 species). The smallest number of invasive species is observed in the towns of Votkinsk and Mozhga – 55 and 51 species, respectively. The proportion of the partial flora of highways is similar. The leading number of invasive species is in Kambarka, with 63 species: there are 54 such species in Mozhga and 51 in Votkinsk. Since communication-tape habitats are classified as anthropogenically-transformed habitats, the invasive species of these territories are classified into two groups: phytocenosis modifiers and ruderal cenosis modifiers. Invasive species, found in large quantities in their natural habitat, form a group of biocenosis transformers [15]. These species also occur on railways and highways. However, these species are similarly aggressive. For example, *Heracleum sosnowkyi Manden* is aggressive in the flora of the railways and highways of Mozhga and the highways of Votkinsk. In Kambarka, however, these species grow solitarily or in small groups and show no threat to local diversity. *Lupinus polyphyllus Lindl*. is found separately along highways and railways, and is widely spread in other habitats (cemeteries, waste ground near the horticultural cooperatives, fallow land) in the towns of the southern half of Udmurtia. *Echinocystis lobata* (Michx.) Torr. & Gray is a popular cultivated plant. It is widespread among all the partial flora of railways. It is more rarely found along the highways, striving to riverbeds and streams.

Acer negundo L. is widely spread in all the partial flora. It spreads its seeds quite well. Railways are not overgrown with maple thanks to the active use of herbicides and the cutting down of trees along roadsides.

Saponaria officinalis L., *Conyza canadensis* (L.) Cronqist, *Lactuca serriola* L., *L. tatarica* (L.) C.A.Mey., *Lepidotheca suaveolens* (Pursh) Nutt., *Apera spica-venti* (L.) Beauv., *Puccinellia distans* (Jacq.) Parl., etc. (60 species in all), which are able to form dense, often monodominant thickets along the railways and highways, are less aggressive.

4. Conclusion

The flora of communication-tape habitats makes a significant contribution to the formation of the floras of both urban habitats and the whole Republic of Udmurtia. The combined partial floras of railways and highways have certain similarities. In the aboriginal fraction of these floras, the role of the *Fabaceae*, *Rosaceae* and *Lamiaceae* families is increasing, while perennials predominate among life forms. The role of *Chenopodiaceae* is increasing in the adventive fraction, while among the life forms shorter-lived annuals and biennials prevail. The formation of the combined partial flora is defined

by the physico-geographical position of cities, the presence/absence of large railways and the population number.

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