Floristry and plant biogeography of the Eastern part of the Volga Upland

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Abstract. Analysis of taxonomic indicators traditionally leads the overall analysis of flora. In this case, first of all, it is necessary to consider the range of families. The triad of leading families deserves special attention, according to the third member of which it is customary to distinguish the type of flora. The type of flora characterizes the corresponding territory within which a floristic "zone" is distinguished. According to the published data on the floras of the administrative units of the Volga basin, we have previously outlined the boundaries within the territory of the Middle and partly the Lower Volga region, on which the Fabaceae-type of flora is revealed. At the same time, the Upper Volga region is represented by Rosaceae-type floras. However, these selected administrative units are too large to outline more specific boundaries. In this article, we propose a similar analysis based on the data of the floras of physical-geographical regions with an area of 2.3–9.7 thousand km². For the analysis, we selected six areas belonging to the forest-steppe province of the Volga Upland, which is part of the Middle Volga region. We found that the border of the floristic zones (Fabaceae and Rosaceae) runs along the considered area of the Volga Upland. With respect to physical-geographical regions the border runs on one side between Korsun-Sengileevsky and Sredne-Sviyazhsky areas, on the other, between Zasursky and Tsivil-Kubinsky areas. Within the studied territory, the border is determined by the occurrence of representatives of the genera Alchemilla and Potentilla (for Rosaceae), as well as Vicia and Astragalus (for Fabaceae). The prevalence in the number of the common lady's mantles is more noticeable to the northwest. The genera Carex, Galium, Viola, Potentilla, Artemisia, Salix, Vicia, and Veronica are leading in the frequency of occurrence in the head part of the spectra of floras in the territory under consideration.

1. Introduction

Analysis of taxonomic indicators traditionally leads the overall analysis of flora. In this case, first of all, it is necessary to consider the range of families - their list, ranked by the number of species. It is believed that the head part, consisting of 10–15 families and containing most of the flora species, reflects all its main features [1].

The triad of leading families deserves special attention, according to the third member of which it is customary to distinguish the type of flora. The type of flora characterizes the corresponding
territory, within which a floristic “zone” is distinguished [2]. A P Khokhryakov stated the existence of such zones on the territory of the Palearctic. At the same time, he noted that they "do not have clearly defined boundaries that could be unambiguously compared with the boundaries of the sections of any of the systems of floristic or botanical-geographical zoning" [2]. Referring to the work of L I Malyshch [3], Khokhryakov classifies the extra-Arctic Eastern Europe as a “legume zone”, within which there may exist regional and local Cyperaceae-type and Rosaceae-type floras.

We analyzed the published data on flora in a number of administrative units within the Middle and partly Lower Volga Regions. After that, we outlined the boundaries at which the Fabaceae-type of flora is identified. This is a combined territory that includes Samara, Saratov and Ulyanovsk Oblasts, as well as the Republic of Tatarstan [4].

T.I. Plaksina’s data on flora on the territory of the Volga-Ural Region, including Samara Oblast, partially Ulyanovsk and Saratov Oblasts, the Republics of Tatarstan and Bashkortostan, also demonstrate the predisposition to the Fabaceae-type floras. The dominance of the Fabaceae-type flora in the Russian Federation is confirmed by the combined data of various researchers [6].

The areas of administrative units vary within a fairly wide range from 53.6 (Samara Oblast) to 100.2 (Saratov Oblast) thousand km$^2$ and more. Therefore, we believe that in order to establish specific, more precise boundaries of floras, it is necessary to study less extensive areas. Thus, on the example of the Samara Oblast, we record the presence of various types of flora [4].

Lists of vascular plants of individual geographic locations are material for the floras of such vast territories. They are compiled on route, taking into account herbarium collections and can contain a different number of species (from 150 to 600 and more). However, this is often not enough to represent the flora. For a complete representation of this kind of flora, it is necessary to combine floristic lists of geographic points located close to each other. When the lists are successively combined, all the features of the flora appear in stages. On the example of various territories of Samara Trans-Volga Region, we prove that the type of flora is finally established when there are 400–700 species in the sample [7, 8]. This number of species corresponds to an area of 400–800 km$^2$ for the territory of Samara Trans-Volga Region [9].

However, the specified sample (400–700 species) does not yet show all the features of the flora. Only with an increase in the number of species to 1000 or more is it possible to achieve the values of taxonomic indicators characterizing the flora more fully, including the characteristics of the genus spectrum [7]. Focusing on this indicator, we can analyze the territory according to the data of the floras of the physical and geographical regions. They also have different areas - from 2.3 to 9.7 thousand km$^2$ [10], but its general order is much less than the above-mentioned administrative units. Moreover, the number of species that make up the flora of each is sufficient to characterize it.

2. Materials and Methods

2.1 Natural conditions
Physical-geographical zoning by A.V. Stupishin [10] describes the territory of the eastern part of the Volga Upland. It is represented by the forest-steppe province of the Volga Upland, which contains, in whole or in part, twelve physical-geographical regions within the research area (figure 1).
The climate of the Volga Upland, including Samarskaya Luka, is colder and humid compared to the territories of the Trans-Volga region. The most important feature of the Volga Upland is the layered (denudation) structure of the surfaces of the watershed plateaus. Throughout the entire territory, the surfaces are located at two, in some places three clearly expressed altitude levels. The middle layer lies at altitudes of 180–240 m, and the upper layer (high plateau) reaches 280–350 m. The upper plateau is composed of rocks of the Paleogene, rich in silica and completely devoid of carbonates (sands, sandstones, opokas, diatomites). The low plateau is developed in the Lower Cretaceous clays and in the carbonate rocks (chalk, calcareous marls) of the Upper Cretaceous [11].

The relief plays an important role in the formation of the climate [12]. Despite the predominance of flat forms and a small difference in heights, the influence mainly affects the microclimatic regime. So, in the higher places of the region, more forested, the amount of precipitation increases by 10-15% compared to the surrounding plains. Various forms and heights of the relief cause a very variegated precipitation pattern in many places. The relief affects the distribution of the height of the snow cover, frost, wind, etc.

Since different regions of the province have their own relief features, one can expect to a certain extent differences in other natural conditions. This determines the composition of the biota.
Samarskaya Luka (Zhigulevsky District) belongs to the highest part of the Volga Upland. A.S. Zakharov distinguishes it as a separate province [13].

The greatest distribution of the high surface (upper tier) is observed in the west of the Ulyanovsk Predvolzhye. Here the high plateau is continuous. Inzensky area (51), in the western part of Ulyanovsk Oblast, has a cool climate with increased humidity relative to the entire territory under consideration. A significant part of this area is occupied by pine and pine-broadleaf forests.

The high plateau has been preserved only in the form of isolated remnant massifs to the northeast and east of the area of its continuous distribution. Here it is possible to distinguish a plateau with two relief steps. Korsun-Sengileevsky (50) and Sviyago-Usinsky (52) areas in this area have a warm climate with moderate or sufficient moisture. There are outcrops of chalk rocks in Korsun-Sengileevsky area.

The rest of the areas do not have a two-tiered structure. Sredne-Sviyazhsky area (48) is characterized by shallow dissection. This is the driest region, dominated by steppe areas, developed by man. Zasursky area (46) is located almost entirely on the territory of the Republic of Chuvashia. Its surface is represented by a hilly plain and 65% of its territory is occupied by mixed forests. Soils are sandy and sandy loam.

Tsivil-Kubninsky area (47) includes the center and east of the Republic of Chuvashia. Its surface is represented by alternation of low flat asymmetric watersheds and asymmetric valleys with an average absolute elevation of 140–180 m. The most common are gray forest soils.

The Cheboksarskij upland-plain area with a mature erosional landscape (40) represents the northern edge of the Volga Upland. Its surface is represented by a hilly elevated plain with average absolute heights of 160–170 m. Soddy-podzolic soils prevail here.

The territory has a forest-steppe vegetation. Pine, pine-broadleaved and deciduous forests grow here. They are subdivided into broad-leaved and small-leaved ones. Zasursky and Cheboksarskij areas have the largest forest area. Now, however, under the influence of man, the forest area has decreased quite significantly. The vacated areas have been plowed up; shrub and meadow vegetation has been preserved on plots unsuitable for agriculture.

Steppe vegetation is represented by meadow and feather-grass-fescue steppe. There are stony steppes on chalk outcrops, some of which were formed as a result of the destruction of pine and pine-oak forests on chalk slopes, and some are indigenous steppe communities. Sandy steppes formed on sandy Paleogene and ancient alluvial deposits after the felling of pine forests of the Volga Upland.

2.2 Initial data and processing
FD SUR electronic database [14] contains data on the studied flora in the form of floristic descriptions (lists of encountered species). The authors made floristic descriptions themselves during field research from 1999 to 2020. In addition, we used the published data of other researchers [15-20, etc.].

We compiled initial lists of species using the route method, which covers an area of 5-10 km for a single geographic location. Subsequently, we supplemented the lists with data on the collected and specific herbarium material. Each list of species contained in FD SUR database may be the result of a single visit to a geographic location or a series of visits in different years and periods of the growing season. That is, a series of visits within 5–7 km² can be displayed in one list. Thus, the final initial lists differ in the number of species (30–600), in the phytocenotic confinement of the description, as well as in the frequency of observations.

We chose for the analysis six physical-geographical regions, the data for which are presented most comprehensively. The lists for each physical-geographic region are derived from FD SUR database by combining the resulting original available lists. Using this software, we built taxonomic spectra of physical-geographical regions. In total, we used 141 original lists (from 14 to 57 for each area). We analyzed the Zhigulevsky physical-geographical region according to the data of S.V. Saksonov [21]. For comparison, we used the data of M.M. Gafurova in Cheboksarskij (40) and Tsivil-Kubninsky (47) areas [22].
We did not include Prisursky (45), Volgo-Sviyazhsky (49), Syzransko-Tereshkinsky (53) and Yuzhno-Syzranskij (54) areas in the analysis, since we do not have the required amount of data.

3. Results and Discussion

The head part of the family spectrum reflects the main features of the floras. We note both common features and some differences. The entire territory under consideration is not homogeneous in terms of flora. Its northern part, which includes Zasur area, as well as Tsivil-Kubninsky and Cheboksarskij areas [22], belongs to the Rosaceae-type flora. We observe a similar situation in Samarskaya Luka (table 1). The floras of the forest-steppe provinces of the Samara-Ulyanovsk Volga region are characterized by the following sequence of the leading families of the spectrum: *Asteraceae, Poaceae, Fabaceae, Rosaceae, Brassicaceae* [4]. It corresponds to Korsunsko-Sengileevsky, Sviyago-Usinsky and Inzensky areas. But not all the sequence of these families is identical (table 1). The Fabaceae type is most distinctly expressed in Korsun-Sengileevsky area. Here the difference between the shares of the families Rosaceae and Fabaceae is most noticeable. We believe that this testifies to the relative homogeneity of the flora of the territory according to this characteristic. In the other two floras, the proportions of legumes and Rosaceae differ not so significantly. This suggests that local floristic differences are possible on the territory. For example, local floras of various types have been noted [23] in Sviyago-Usinsky area.

Table 1. Head parts of the family spectra of floras in physical-geographical regions

| №  | 46  | 48  | 50  | 51  | 52  | 55  |
|----|-----|-----|-----|-----|-----|-----|
|    | 917 | 1171| 1008| 1083| 1214| 1300|
| 1  | Ast (12.1) | Ast (14.4) | Ast (14.6) | Ast (14.9) | Ast (14.1) | Ast (15.4) |
| 2  | Poa (9.1) | Poa (9.9) | Poa (10.4) | Poa (9.7) | Poa (1.0) | Poa (9.6) |
| 3  | Ros (6.1) | Fab (5.6) | Fab (7.2) | Fab (5.9) | Fab (6.2) | Ros (6.1) |
| 4  | Cyp (5.5) | Ros (5.5) | Brass (5.7) | Ros (5.9) | Ros (6.1) | Brass (4.7) |
| 5  | Fab (5.1) | Brass (5.0) | Ros (5.5) | Brass (5.2) | Brass (4.8) | Fab (4.5) |
| 6  | Scr (4.5) | Car (4.3) | Lam (4.5) | Car (4.3) | Car (4.3) | Car (4.5) |
| 7  | Car (4.4) | Cyp (4.1) | Car (4.4) | Lam (4.2) | Cyp (4.3) | Cyp (4.4) |
| 8  | Brass (4.1) | Lam (3.4) | Scr (3.5) | Cyp (3.5) | Lam (3.6) | Lam (3.6) |
| 9  | Lam (3.7) | Scr (3.3) | Api (3.2) | Scr (3.5) | Scr (3.9) | Scr (3.5) |
| 10 | Api (2.7) | Api (3.1) | Pol (2.7) | Api (3.1) | Api (32)  | Ran (3.2) |

A joint analysis of family and genus spectra (table 2) clarifies the reasons for this particular order of families. As shown earlier, the shares of the Rosaceae families are determined by the genera Potentilla and Alchemilla, and the Fabaceae are, respectively, Astragalus, Vicia, and Lathyrus [24]. It is shown that the Rosaceae-type flora of the more northern administrative regions is determined by the abundance of the genus Alchemilla. For example, in Chuvashia, 26 representatives of this genus are shown [25], and in Vladimir Oblast - 32 [26]. Thus, indeed, the role of the genus Alchemilla is increasing towards the northwestern part of the former Soviet Union [3].

In Samara Oblast, we noted only 12 species of the genus Alchemilla, and they are distributed extremely unevenly. In the southern part of the oblast, representatives of this genus are absent, the bulk of them are concentrated in the Volga region, where large forests are most preserved. Such, for example, is the territory of the Zhigulevsky physical-geographical region. In addition, in Sviyago-Usinsky area there is a local flora with similar habitat conditions [23]. As already mentioned, along with the abundance of the genus Alchemilla, representatives of the genus Potentilla determine the appearance of the Rosaceae-type flora of the territory. This is especially typical for the territories of Samara and Ulyanovsk oblasts, where the number of these two genera is comparable. The prevalence in the number of the common lady's mantles is more noticeable to the northwest.
In Zasursky (46) physical-geographical region forests occupy a significant area. This determines the presence of a sufficient number of ecotopes for representatives of the genera Alchemilla and Potentilla. The Chavash Varmane National Park and the Alatyr section of the Prisursky Reserve are located within this region. The flora of these territories has been studied quite fully [16, 25], which allows us to attribute them to the Rosaceae type according to the corresponding taxonomic characteristics.

The abundance of Astragalus, Vicia, Lathyrus and Medicago [24], in turn, determines the Fabaceae-type of flora. Moreover, either the genus Astragalus or the genus Vicia dominate the spectrum of legumes. We observe the first case in the floras of Korsun-Sengileevsky (50), Inzensky (51) and Sviyago-Usinsky (52) physical-geographical regions of the Volga region (table 2). The genus Vicia is the second most important in this area in the Fabaceae family. The dominance of the genus Vicia in legumes is another variant of the manifestation of the flora of the Fabaceae type, which can be observed in Sredne-Sviyazhsky area (48). This flora does not have other genera of the Fabaceae family in the head part of the generic spectrum. Also, the genus Vicia in the Fabaceae family remains the most numerous in Prisursky area.

Zhigulevsky area (55) is very peculiar in floristic terms. In the head part of the genus spectrum, there is not a single representative of the Fabaceae family. Moreover, the genus Astragalus has more species here than Vicia.

**Table 2.** Head parts of the genus\(^a\) spectrum of floras in physical-geographical regions (number of species in %)

|   | 46 | 48 | 50 | 51 | 52 | 55 |
|---|----|----|----|----|----|----|
| 1 | Carex (4.3) | Carex (3.0) | Carex (1.8) | Carex (2.6) | Carex (3.1) | Carex (3.2) |
| 2 | Viola (1.9) | Galium (1.5) | Galium (1.7) | Galium (1.6) | Galium (1.7) | Galium (1.9) |
| 3 | Alch (1.6) \(^a\) | Art (1.3) | Astr (1.6) | Astr (1.3) | Astr (1.6) | Viola (1.5) |
| 4 | Pot (1.5) | Vicia (1.2) | Art (1.4) | Pot (1.3) | Viola (1.4) | Pot (1.2) |
| 5 | Salix (1.5) | Salix (1.2) | Pot (1.3) | Viola (1.2) | Sal (1.7) | Art (1.2) |
| 6 | Juncus (1.4) | Ver (1.2) | Viola (1.2) | Art (1.1) | Art (1.2) | Salix (1.2) |
| 7 | Galium (1.4) | Pot (1.1) | Ver (1.1) | Juncus (1.0) | Ver (1.1) | Cent (1.1) |
| 8 | Potam (1.3) | Euph (1.0) | Cent (1.1) | Camp (1.0) | Vicia (1.0) | Ran (1.1) |
| 9 | Ver (1.3) | Chen (1.0) | Cirsiun (1.0) | Vicia (1.0) | Camp (1.0) | Tarax (1.1) |
| 10 | Cam (1.1) | Viola (1.0) | Juncus (1.0) | Salix (1.0) | Alch (1.0) | Potam (1.1) |
| 11 | Vicia (1.1) | Camp (1.0) | Vicia (1.0) | Poa (1.0) | Cam (1.0) | Euph (1.0) |

\(^a\) abbreviations: Astr - Astragalus; Alch - Alchemilla; Pot - Potentilla; Ver – Veronica; Cam - Campanula; Euph - Euphorbia; Chen - Cheno-podium; Art - Artemisia; Cent - Centaurea; Ran – Ranunculus; Tarax – Taraxacum; Potam – Potamogeton

The Brassicaceae family is one of the leading and is at the beginning of the top ten, like most of the floras of the Middle Volga region. However, the heads of the genus spectra do not contain any genus from this family. This gives reason to believe that its species abundance is determined by the totality of genera, and not by the number of any one of them. There is no obvious dominant in this family.

In the family Cyperaceae, which is also present in the head part of the spectra of most of the floras under consideration, on the contrary, there is a clearly dominant genus Carex. The abundance of its representatives is "a common feature of the Euro-Siberian (including North Asian) floras" [27]. On the territory of Samara-Ulyanovsk Volga region, Carex is in the first place among all floras with 1000 species or more [7]. There are some differences in the share of the Cyperaceae family in the considered floras. In the flora of Prisurskii area (46), it is located higher in the spectrum and is included in the first five. Accordingly, the proportion of the genus Carex in the spectrum of genera is...
noticeably higher, which is obviously also explained by a decrease in the abundance of representatives of other genera.

We cannot speak unambiguously about the occupied place in the spectrum about any other genus. We can only single out a group of dominant genera by species abundance in the territory under consideration. We conducted a similar study earlier on the territory of Samara-Ulyanovsk Volga region based on the presence of the leading genera in the top five in 12 physical-geographical regions [28].

The results of the analysis of the frequency of occurrence of genera in the first ten genus spectra (table 2) are shown in table 3. The first three positions in terms of frequency of occurrence can be considered as belonging to the head part of the genus spectrum. Thus, we can assert that the genera Carex, Galium, Viola, Potentilla, Artemisia, Salix, Vicia, and Veronica are leading for the territory under consideration. This list is somewhat different from the one received earlier. It lacks the genus Astragalus, but has Viola, Vicia and Veronica. These differences indicate the uniqueness of the Volga floras.

Representatives of the genus Astragalus are certainly present in the flora of all regions, but their number is different. The largest number of species of this genus we find in the areas, where the severity of two relief stages is noted (50, 52). Outcrops of various parent rocks (Paleogene or Cretaceous) create conditions for the dispersal of representatives of this genus. Most astragalus species prefer calcium-containing substrates [29].

The genus Alchemilla can be considered the leading one for the northern part of the considered territory. Obviously, the abundance of its representatives and the sharp decline in the representatives of the genus Astragalus determine the transition of flora types. In the case under consideration, this occurs on the border of Korsun-Sengileevsky and Sredne-Sviyazhsky areas with Zasursky and Tsvil-Kubninsky areas. Above this marked border, the Fabaceae-type flora is no longer noted. The flora of the southernmost areas indicated on the map (figure 1) - Syzran-Tereshkinsky area (53) and South Syzransky area (54) - corresponds to the Fabaceae-type [4]. Representatives of the genus Alchemilla are not recorded in the southern part.

Table 3. Frequency of occurrence of genera in the floras of physical-geographical regions of the eastern part of the Volga Upland in the top ten genus spectra

| Genus                  | Frequency of occurrence (times) |
|------------------------|---------------------------------|
| Carex, Galium, Viola   | 6                               |
| Potentilla, Artemisia, Salix, Vicia | 5                              |
| Veronica               | 4                               |
| Astragalus, Campanula, Juncus | 3                              |
| Centaurea, Euphorbia, Alchemilla | 2                              |
| Cirsium, Poa, Potamogeton, Chenopodium, Ranunculus, Taraxacum | 1                              |

4. Conclusion
The variety of natural conditions on the territory of the Volga Upland determines the formation of different types of flora. The Fabaceae-type and Rosaceae-type are most common here. The border of flora types runs on one side between Korsun-Sengileevsky and Sredne-Sviyazhsky areas, on the other, between Zasursky and Tsvil-Kubinsky areas. This border is determined by the occurrence of representatives of the genera Alchemilla and Astragalus. The territory of Samarskaya Luka (Zhigulevsky area) in this sense is special, located within the floristic unit of the Fabaceae type. The conditions for the habitation of various Alchemilla species are created thanks to the elevated relief and preserved large forests. This determines the Rosaceae-type of flora.
The genera Carex, Galium, Viola, Potentilla, Artemisia, Salix, Vicia, and Veronica are leading in the frequency of occurrence in the head part of the spectra of floras in the territory under consideration.

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**References**

[1] Schmidt V M 1980 *Statistical methods of comparative floristry* (St. Petersburg: Publishing House of St. Petersburg Univ.)

[2] Khokhryakov A P 2000 Taxonomic spectra and their role in comparative floristry *Botanical journal* 85(5) 1–11

[3] Malyshev L I 1972 Floristic spectra of the Soviet Union. *The history of flora and vegetation of Eurasia* (Leningrad) pp 17-40

[4] Ivanova A V, Kostina N V, Rozenberg G S and Saksonov S V 2016 Family spectra of floras of the Volga basin territory *Botanical journal* 101(9) 1042-1055

[5] Plaksina T I 2001 *Abstract of the flora of the Volga-Ural region* (Samara)

[6] Geltman D V et al 1998 The composition of the flora of vascular plants of the Russian Federation *Izvestia RAN. Biological series* 1 93-97

[7] Ivanova A V, Kostina N V and Aristova M A 2020 Dependence of taxonomic parameters of floras on sample sizes *Bulletin of Saratov State University. New series. Series: Chemistry. Biology. Ecology* 20(4) 404-416

[8] Ivanova A V 2018 Features of the taxonomic structure of the flora of the southeastern part of the Soksky physical-geographical region /Systematic and floristic studies of Northern Eurasia: materials of the II Intern. conf. (to the 90th anniversary of the birth of Professor A.G. Yelenevsky) Vol.1 (Moscow: Moscow State Pedagogical University) pp. 226-229.

[9] Ivanova A V and Kostina N V 2015 Identification of the area of the minimum-area of a specific flora taking into account the anthropogenic transformation of the territory *Bulletin of Samara Scientific Center of RAS* 17(4) 77-80.

[10] Stupishin A V 1964 *Physical and geographical regionalization of the Middle Volga region* (Kazan: Publishing House of Kazan Univ).

[11] Dedkov A P 1978 *Relief. Natural conditions of the Ulyanovsk region* (Kazan: Publishing house of Kazan Univ.) pp. 73-101.

[12] Kolobov N V and Khairullin R R 1978 Climate *Natural conditions of the Ulyanovsk region* (Kazan: Publishing house of Kazan Univ.) pp 141-164

[13] Zakharov A S 1971 *Relief of the Kuibyshev region* (Kuibyshev: Book. Publishing house)

[14] Aristova M A, Rozenberg G S, Kudinova G E, Rozenberg A G, Ivanova A.V, Vasyukov V M, Kostina N V and Saxonov S V 2018 *Database "Floristic descriptions of sites in Samara and Ulyanovsk regions" (FD SUR)* Database registration certificate RU 2018621983 10.12.2018

[15] Vasyukov V M, Senator S A, Zibzeev E G, Korolyuk A Yu and Saksonov S V 2019 *Materials to the flora of the Volga region of Samara and Ulyanovsk regions and the Republic of Tatarstan Phytodiversity of Eastern Europe* 13(3) 276–289

[16] Nalimova N V T 2006 The list of higher vascular plants growing on the territory of the state natural reserve "Prisurskiy" according to research from 1998 to 2002. *Scientific works of the state nature reserve "Prisursky"* 15 22-61

[17] Rakov N S 2009 Ecopark "Black Lake" in the city of Ulyanovsk *Phytodiversity of Eastern Europe* 7 89-145
[18] Rakov N S, Vasyukov V M, Ivanova A V, Savenko O V, Saxonov S V and Senator S A 2008 Akulovskaya steppe is a valuable botanical object of the Ulyanovsk region Phytodiversity of Eastern Europe 5 78-107.

[19] Konovalenko E I 2008 The results of the inventory of vascular plants in the city of Alatyr and its immediate environs Scientific works of the state nature reserve "Prisursky 19 16-32.

[20] Senator S A, Vasyukov V M and Saksonov S V 2018 Materials for the flora of the Usa river basin (Middle Volga region) Samarskaya Luka: problems of regional and global ecology 27(1) 153-178

[21] Saksonov S V 2006 Samaroluk floristic phenomenon (Moscow: Nauka)

[22] Gafurova M M 2014 Vascular plants of the Chuvash Republic. Flora of the Volga basin (Togliatti: Kassandra)

[23] Ivanova A V, Kostina N V and Vasyukov V M 2020 Taxonomic diversity of the Fabaceae family in the Samara-Ulyanovsk Volga region Ecosystems 23(53) 32-47

[24] Ivanova A V, Kostina N V and Aristova M A 2019 Generic spectrum in the analysis of flora of Samara-Ulyanovsk Volga region Bulletin of Saratov State University. New series. Series: Chemistry. Biology. Ecology 19(2) 196-206

[25] Gafurova M M 2012 Flora of the national park "Chavash varmane". Vascular plants: an annotated list of species Scientific works of the national park "Chavash varmane" 4 1-162

[26] Seregin A P 2012 Flora of the Vladimir region: Synopsis and atlas (Tula)

[27] Kamelin R V 2018 Geography of plants. Tutorial (St. Petersburg Publishing House)

[28] Ivanova A V, Kostina N V and Aristova M A 2019 Features of taxonomic spectra of flora of the forest-steppe part of the Samara-Ulyanovsk Volga region Ecosystems 18 14-23.

[29] Knyazev M S 2014 Legumes (Fabaceae Lindl.) of the Urals: speciation, geographical distribution, historical and ecological formations (Yekaterinburg: Bot. garden. Ural Branch of the RAS)