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Comparative Estimation of Floristic Diversity in Protected Natural Areas

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Abstract—A method for estimating floristic diversity at the species, genus, and family levels and the taxonomic structure of the flora of protected natural areas is proposed. The method is illustrated using the example of three nature reserves located in the Northern, Middle, and Southern Urals. The dependence of the characteristics of the regional floras on their positions in the system of botanical–geographic zones, the size of the protected area, and other factors have been studied in these reserves. The proportion of endemic plants and the degree of flora synanthropization have been determined.

Key words: biodiversity, national reserves, flora, regional characteristics, endemics, synanthropization.

Conserving and studying biological diversity is one of the most important problems of modern biology. Its significance is emphasized in international acts, such as the Convention on Biological Diversity accepted by the UN General Assembly in 1992 (*Convention*[...], 1994) and numerous studies (Solbrig, 1991; *Biologicheskoe raznoobrazie*[...], 1992; Schulze and Mooney, 1994; *Monitoring bioraznoobraziya*, 1997; *Sokhranenie biologicheskogo raznoobraziya*[...], 1997).

One of the approaches to the conservation of biological diversity, including vegetation diversity, is the creation and development of a network of protected areas, such as nature reserves and national parks. However, it is unknown to what degree the existing network of reserves is representative, i.e., reflects the characteristic features of the floras of different natural regions, and how great the differences are between the floras of individual reservations. Therefore, it is necessary to develop and improve methods for estimating plant diversity in protected natural areas.

In this study, we made a comparative estimation of floristic diversity in three national reserves (including two biosphere reserves) located in different parts of the Ural mountain land, with special emphasis on endemic and synanthropic plants.

STUDY REGION AND OBJECTS

Three national reserves—the Pechoro-Ilychskii Biosphere Reserve, the Visimskii Biosphere Reserve, and the Il'menskii Reserve (figure)—were used as model objects for the comparative study of floristic diversity.

The Pechoro-Ilychskii Biosphere Reserve was established in 1930 and acquired the status of a biosphere reserve in 1984. Its basic area is 7213 km^2, and the buffer zone covers 4975 km^2. The reserve is located in the Northern Urals, in the middle taiga subzone of the taiga zone (Gorchakovsky, 1968, 1989). The main part of the reserve is located in the foothills and on the western macroslope of the northern Ural Mountains in the interfluve of the Ilych and Pechora rivers. The reserve is divided into three large parts: the flatland, foothill, and highland parts. The westernmost flatland area is formed mainly by Permian rocks overlapping with glacial deposits, fluvioglacial sands, and moraine loams. The vegetation is almost exclusively pine (*Pinus sylvestris*) forests and sphagnum bogs. An area of low hills is located east of the flatland. This is an upland plain with absolute elevations of no more than 300 m above sea level. Its basis is formed by various Paleozoic sedimentary rocks. Two ridges of dense quartzy sandstone cross this area in the meridional direction. The plant communities located there are dominated by spruce (*Picea obovata*) forests of various types with an admixture of Siberian stone pine (*Pinus sibirica*). Fir (*Abies sibirica*) forests grow mainly on rich, sufficiently moistened soils on ridge slopes.

The highland part of the Pechoro-Ilychskii Biosphere Reserve consists of individual mountain peaks and massifs separated by deep river valleys. Elevations in this area average 750–850 m a.s.l. There are four clearly discernible mountain ridges with different geological structures stretching in the meridional direction. The western ridge is crowned on the north by the indented Kozhim-Iz massif with a maximum elevation of 1195.4 m a.s.l. (the highest point in the reserve). On the north and south, the uplands are cut by the Pechora and Ilych valleys. The mountain-forest, subgoltsy, and Alpine tundra zones, with fragments of cold goltsy

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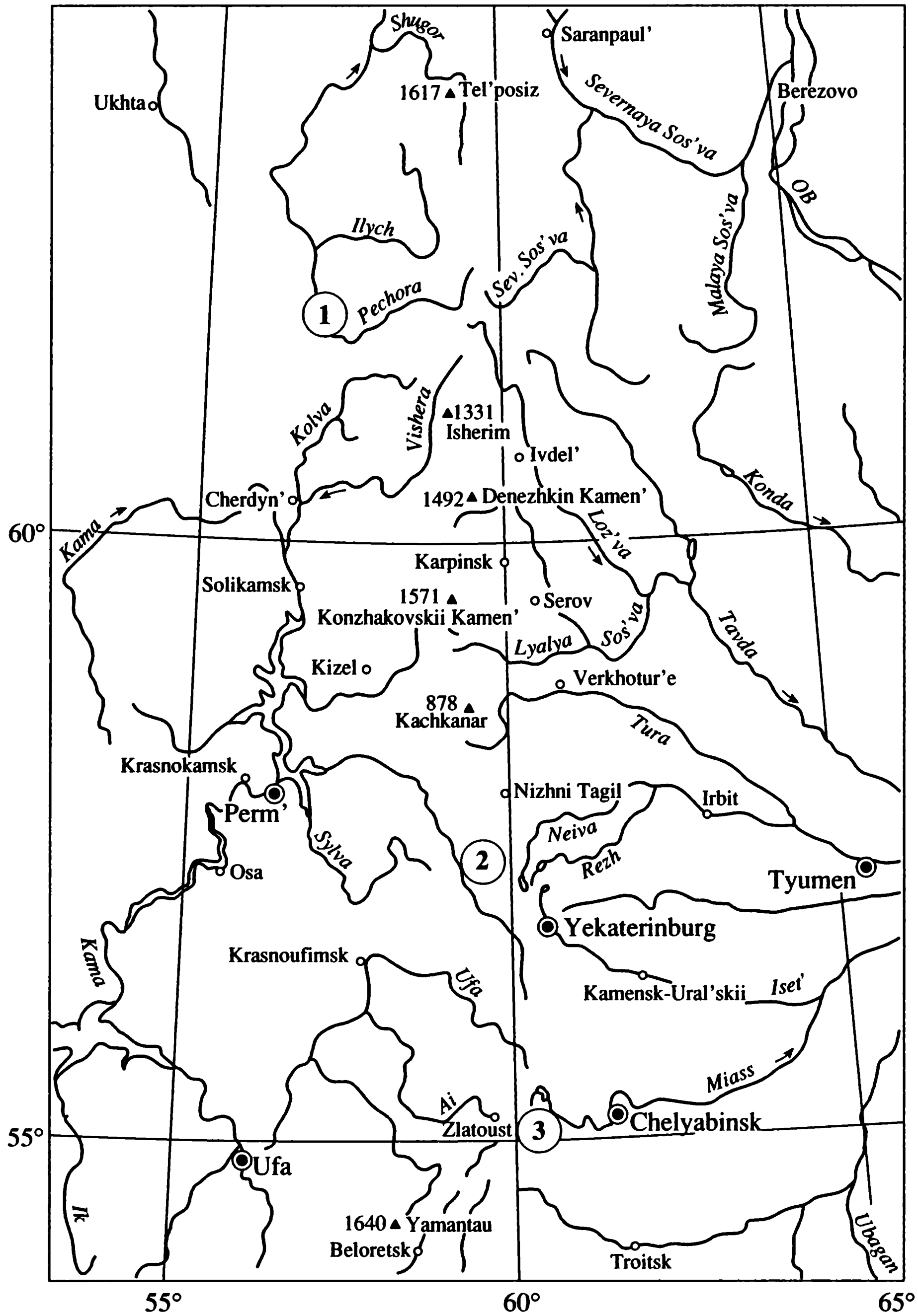

Geographic location of the (**1**) Pechoro-Ilychskii Biosphere Reserve, (**2**) Visimskii Biosphere Reserve, and (**3**) Il'menskii Reserve.

deserts, are clearly distinguishable in this area (Gorchakovsky, 1975). The lower mountain-forest zone is dominated by spruce forests with admixtures of *Abies sibirica* and *Pinus sibirica.* At higher elevations, the contribution of fir to the tree layer increases. In addition, spruce–fir forests with birch (*Betula pendula* and *B. pubescens*) are common there. The vegetation of the subgoltsy zone is formed by birch (*B. tortuosa*) elfinwood and a well-developed herbaceous cover, as well as by larch (*Larix sibirica*) light forests combined with mesophilic meadows (in the northern part of the reserve). The timberline is located at an elevation of 500–600 m. Dwarf shrub–moss and rocky tundras are prevalent in the Alpine tundra zone. The flatland and foothill parts of the reserve are waterlogged.

The Visimskii Biosphere Reserve was established in 1971 and acquired the status of a biosphere reserve in 2001. Until recently, the basic area of the reserve was 135 km^2, and that of the buffer zone was 661 km^2. In 2001, the basic area of the reserve was increased at the expense of the buffer zone. However, floristic characteristics have only been studied within the former basic area (135 km²). Therefore, we used data on this area in our study.

The reserve is located on the western macroslope and in the mountains of the Middle Urals within the southern taiga subzone. Its eastern part is located in the region of elevated massifs of the axial mountain-ridge zone of the Middle Urals, and its western part, in the region of the residual mountains of the western slope. The western part of the reserve has a low-hill and depression–flatland relief; and the eastern part is highland with the highest point at 699 m a.s.l. (Mount Bol'shoi Sutuk). The eastern part is formed by dense Late Mesozoic deposits, and the western part, by milder, mainly metamorphosed slate rocks. The bedrock is covered by Quaternary deposits. The reserve has a well-developed river system; the Sulem is the main river.

Forests form the basis of the vegetation cover in the reserve; most of them are at different stages of progressive succession, restoring after various anthropogenic alterations. The original forest vegetation on the flat tops and upper slopes of the mountains is represented by tall-grass fir–spruce forests, whereas the lower slopes are covered with fir–spruce forests containing linden (*Tilia cordata*) and fir–spruce forests with large ferns. In addition, there are secondary meadows that have replaced felled forests.

The Il'menskii Reserve was established in 1920. Its area is 303 km². The reserve is located in the foothills of the eastern macroslope of the Southern Urals. The area of the Il'menskii Reserve includes the Il'menskii and Ishkul'skii low ridges, which stretch in an almost meridional direction, with average elevations of 400–450 m and the highest point of 747 m a.s.l. (Mount Il'men-Tau). A well-developed foothill zone is located east of the ridges. The ridges are formed mainly by alkaline igneous rocks (miascites) lying among acid and alkaline metamorphic rocks (gneiss and amphibolite). In the foothill zone, there are also masses of granites surrounded with quartzites. There are a few low, roundish hills formed by serpentinites (ultrabasic rocks). The lake–river system of the eastern foothills forms an almost closed ring. It includes lakes (Bol'shoe Miassovo, Bol'shoi Tatkul', Bol'shoi Kisegach, etc.), creeks, bogs, streams, and springs.

The Il'menskii Reserve is located in the subzone of pine and birch boreal forests at the boundary between the taiga and the forest–steppe. The vegetation of this reserve is characterized by Alpine pine forests and the birch forests derived from them. At the tops of ridge and serpentinite hills, pine and larch light forests with grass cover of the steppe type grow; elevations and ridges are covered with boreal pine forests. Birch–alder (*Betula pubescens* and *Alnus glutinosa*) forests, birch–pine forests with an admixture of aspen (*Populus tremula*), and aspen forests grow in depressions. There are a few patches of linden (*Tilia cordata*) forests in the foothill zone.

The location of the reserve at the boundary with the forest–steppe is reflected in its vegetation, which is affected by rapid processes of steppification. Rocky-steppe communities accompanying serpentinite outcrops serve as the core of steppe vegetation in this area. Steppe vegetation is sometimes combined with herb–grass steppe meadows. There are also mountain-spring meadows and meadow herbs that have replaced felled forests. Bogs are mostly located in the eastern part of the reserve.

ORIGINAL MATERIAL AND THE SYSTEM USED FOR ITS TREATMENT

In order to determine the various parameters of floristic diversity, the information retrieval computer system Flora Zapovednykh Territorii Urala (The Flora of the Ural Protected Areas) was developed. The system was based on published data on the floras of the Pechoro-Ilychskii (Lavrenko *et al.*, 1995), Visimskii (Marina, 1987), and Il'menskii (Dorogostaiskaya, 1961) nature reserves, taking into account the results of recent research (Rusyaeva, 1985, 1990; Erokhina, 1996; Marina, 1996, 2001; Gorchakovsky and Kozlova, 1998; Kucherov and Gusarova, 2000; Kucherov, 2001; Kulikov, 2001, unpublished; Kucherov *et al.*, 2002; Demchenko and Kharitonova, 2002). These results were also included into the system as original data.

The integrated system comprises five logically linked subsystems; each of these subsystems is a block of structured information on a specific subject. The complete list of the fields of this system consists of 40 items. The system is based on a taxonomic database consisting of a consolidated floristic list of the three reserves (1370 species of vascular plants) and lists of their genera (474) and families (111). One subsystem contains data on the presence, occurrence, and distribution pattern of each species in each reserve.

To estimate floristic similarity, Jaccard's coefficient is usually used. This index of similarity takes into account positive coincidences. Jaccard's coefficient is calculated by the formula $K_j = c/(a + b - c)$, where a is the number of species in one floristic list, b is the number of species in the other list, and c is the number of species common to the two lists. This coefficient varies from 0 to 1, with $K_j = 1$ indicating a complete similarity of the floras, i.e., an absolute coincidence of the two lists (Shmidt, 1980). As we had to compare not only two, but also three lists simultaneously, we introduced an additional variable into the formula for Jaccard's coefficient and changed the designations of other variables as follows: b_1, b_2, and b_3 are the numbers of species in the first, second, and third lists, respectively; and c is the number of species common to three (or two) lists. Thus, we compared the floristic lists of the three reserves using the formula $K_j = c/(b_1 + b_2 + b_3 - c)$ and

Table 1. Species richness and species density in three nature reserves

Reserve	Area, km^2	Species richness	Percentage of the total number of species (PBR + VBR + IR)	Species density, number of species per 10 km^2
PBR	7213	778	56.8	1.1
VBR	135	436	31.8	32.3
IR	303	945	69.0	31.2
PBR + VBR + IR	7651	1370	100	1.8

Note: Here and in other tables, PBR is the Pechoro-Ilychskii Biosphere Reserve, VBR is the Visimskii Biosphere Reserve, and IR is the Il'menskii Reserve.

Table 2. Diversity of the compared floras at the species, genus, and family levels

Reserve	Number of			Percentage of the total (PBR + VBR + IR) number of		
	species	genera	families	species	genera	families
PBR	778	322	92	56.8	67.9	83
VBR	436	243	78	31.8	51.2	70
IR	945	415	105	69.0	87.6	95
PBR + VBR + IR	1370	474	111	100	100	100

the floristic lists of any two reserves (e.g., the Pechoro-Ilychskii and Visimskii reserves) using the formula $K_j = c/(b_1 + b_2 - c)$.

SPECIES RICHNESS AND SPECIES DENSITY

Although the reserves differ in area, the comparison of their floristic diversity is both possible and necessary. As noted by Khokhryakov (2000), the comparison of floras that occupy different areas and have common species often provides more valuable material for further consideration than the comparison of floras that occupy equal areas but are remote from one another. In this study, we estimated the floristic diversity of reserves differing in area. However, the comparison of their floristic diversities and the floristic diversity of each reserve relative to the total area of the three reserves yields interesting results. Floristic diversities of individual regions can be estimated from species richness (the number of species in the region) and species density (the number of species per unit area).

With respect to species richness (Table 1), the Il'menskii Reserve is in the first place: 945 species, or 69% of their total number in the three reserves; in the next is the Pechoro-Ilychskii Reserve (778 species, 56.8%), and the Visimskii Reserve is in the last (436 species, 31.8%). A direct relationship between species richness and the size of protected area is only observed when the Il'menskii and Visimskii reserves are compared: both parameters in the former reserve are approximately two times higher than in the latter. However, although the area of the Pechoro-Ilychskii Reserve is 23 times greater than that of the Il'menskii Reserve, the species richness of the former reserve is lower. The relative richness of the flora in the Il'menskii Reserve may be explained by the high diversity of its landscapes and the "edge effect," because the reserve is located at the boundary between the forest and forest–steppe zones.

However, the Il'menskii Reserve exceeds the other two reserves not only in the number of species, but also in the numbers of genera (415, 87.6%) and families (105, 95%). The difference is especially pronounced at the family level (Table 2). In the Visimskii Reserve, these parameters are the lowest, namely, 243 genera (51.2%) and 78 families (70%).

It is of interest to compare the levels of taxonomic similarity between different reserves, which are characterized by Jaccard's coefficient (Table 3). The Pechoro-Ilychskii and Il'menskii reserves are most similar to each other in the number of common taxa (Jacquard's coefficients for species, genera, and families are 0.11, 0.19, and 0.34, respectively). When the floras of the Visimskii and Il'menskii reserves are compared, Jacquard's coefficients for these parameters are the lowest (0.04, 0.07, and 0.2, respectively); hence, these two reserves exhibit the lowest floristic similarity to each other.

The species densities of the areas compared may be estimated by the number of species per 10 km^2 (Table 1). Although, as mentioned above, the area of the Il'menskii Reserve is more than two times greater than the area of the Visimskii Reserve, their species densities are almost the same (and relatively high: 31.2 and 32.3, respectively). However, species density in the substan-

Table 3. Common taxa in the compared floras

Reserve	Number of common taxa/Jaccard's coefficient			Percentage of the number in the summary list (PBR + VBR + IR)		
	species	genera	families	species	genera	families
PBR + VBR	50/0.04	40/0.08	21/0.14	3.61	8.4	19
PBR + IR	167/0.11	116/0.19	50/0.34	12.00	24.5	45
VBR + IR	48/0.04	43/0.07	31/0.2	3.50	9.1	28
PBR + VBR + IR	293/0.15	184/0.23	63/0.3	21.00	38.8	57

tially larger Pechoro-Ilychskii Reserve is considerably lower (1.1). This is explained not only by the lower floristic diversity in this reserve, but also by the fact that, if the plant cover is relatively homogeneous, an increase in area is always accompanied by a monotonic decrease in species density. The average species density in the total area of the three reserves is as low as 1.8.

Thus, we may draw a preliminary conclusion that species density in a large region with relatively uniform natural conditions remains approximately the same in protected areas smaller than 300 km^2 but decreases in larger areas.

TAXONOMIC STRUCTURE OF THE FLORA

The taxonomic (family–species) spectra of the total flora of the three reserves, as well as the taxonomic spectrum of each reserve (Table 4), allow us to estimate the family composition, the ratios between the dominant families, and their ranks depending on the numbers of species in them. The first three families of the spectra (the first "triad") and their ranks are most important for determining the characteristic features of regional floras and estimating their similarities and differences; the next three families (the second "triad") are of secondary importance. The first and second triads determine the type and subtype of the flora, respectively. However, the first and second families of the first triad are the same for the entire area of the former Soviet Union except for Central Asia; these are the Asteraceae and Poaceae, respectively. In this case, the characteristic features and, hence, the type of a specific regional flora should be determined from the third family of the first triad. Khokhryakov (2000) used this characteristic to distinguish seven types of Palearctic floras, including the Cyperaceae type (or arctoboreal–eastern Asian type) and the Rosaceae type (or conventionally European type).

Analysis of our data demonstrated that the floras of the Pechoro-Ilychskii Reserve and Visimskii Reserve should be assigned to the arctoboreal–eastern Asian type, and the flora of the Il'menskii Reserve, to the conventionally European type. This agrees with general phytogeographic patterns of the Ural mountain land: the elements of arctoboreal and Siberian origin prevail in its northern and middle parts, and elements of European origin, in the southern part.

The total flora of the three reserves, according to its taxonomic structure, is of the conventionally European type. This is largely determined by one its component, namely, the relatively rich flora of the Il'menskii Reserve characterized by a distinct European influence.

Analysis of the second triad of the taxonomic spectrum allowed us to distinguish the Rosaceae–Caryophyllaceae and Rosaceae–Scrophulariaceae subtypes (the Pechoro-Ilychskii and Visimskii reserves, respectively) within the arctoboreal–eastern Asian type and the Fabaceae subtype (the Il'menskii Reserve) within the conventionally European type.

Table 4. Dominant families in the floras of nature reserves in the Urals

No.	Family	Rank in the given area			
		PBR	VBR	IR	PBR + VBR + IR
1	Asteraceae	1	1	1	1
2	Poaceae	2	2	2	2
3	Rosaceae	4	4	3	3
4	Cyperaceae	3	3	4	4
5	Caryophyllaceae	5	7	5	5
6	Ranunculaceae	6	5	9	6
7	Fabaceae	13	8	6	7
8	Brassicaceae	9	10	7	8
9	Scrophulariaceae	8	6	8	9
10	Orchidaceae	10	9	12	10
11	Lamiaceae	17	9a	10	11
12	Apiaceae	15	9b	11	12
13	Polygonaceae	11	9c	13	12a
14	Salicaceae	7	9d	14	11a

Note: Families assigned ranks from 1 to 10 in the given reserve or in the total flora are listed. Some of the ten dominant families in the total list may have lower ranks in the lists of one or several individual reserve(s).

Table 5. Endemics and subendemics of the Urals in the floras of nature reserves

No.	Species	PBR	VBR	IR	PBR + VBR	PBR + IR	VBR + IR	PBR + VBR + IR
1	*Alchemilla brevituba* Juz.	+						
2	*Alchemilla cinerascens* Juz.			+				
3	*Alchemilla crassicaulis* Juz.	+						
4	*Alchemilla cunctatrix* Juz.	+						
5	*Alchemilla glabriformis* Juz.	+						
6	*Alchemilla gortschakowskii* Juz.	+						
7	*Alchemilla hyperborea* Juz.	+						
8	*Alchemilla iremelica* Juz.			+				
9	*Alchemilla lindbergiana* Juz.	+						
10	*Alchemilla macroclada* Juz.			+				
11	*Alchemilla parcipila* Juz.	+						
12	*Alchemilla pycnoloba* Juz.	+						
13	*Alchemilla rhiphaea* Juz.			+				
14	*Alchemilla semispoliata* Juz.	+						
15	*Anemonastrum biarmiense* (Juz.) Holub	+		+		+		
16	*Anemonoides uralensis* (DC.) Holub		+					
17	*Astragalus clerceanus* Iljin & Krasch.			+				
18	*Aulacospermum multifidum* (Smith) Meinsh.			+				
19	*Bromopsis vogulica* (Soczava) Holub	+						
20	*Centaurea integrifolia* Tausch.			+				
21	*Cicerbita uralensis* (Rouy) Beauverd.		+	+			+	
22	*Dianthus acicularis* Fisch.ex Ledeb.			+				
23	*Elymus uralensis* (Nevski) Tzvel.			+				
24	*Elymus viridiglumis* (Nevski) Czer.			+				
25	*Elytrigia pruinifera* Nevski			+				
26	*Elytrigia reflexiaristata* (Nevski) Nevski	+		+		+		
27	*Festuca pohleana* E.Alexeev.	+						
28	*Gagea samojedorum* Grossh.	+	+		+			
29	*Hieracium albocostatum* Norrl.ex Juxip	+	+	+				+
30	*Hieracium hosjense* Schljak. (*H.aggr.vulgatum* Fries)	+						
31	*Knautia tatarica* (L.) Szabo		+					
32	*Koeleria sclerophylla* P.Smirn.			+				
33	*Lagotis uralensis* Schischk.	+						
34	*Libanotis sibirica* (L.) C.A.Mey.			+				
35	*Lotus peczoricus* Min.& Ulle	+						
36	*Minuartia helmii* (Fisch.ex Ser.) Schischk.	+		+		+		
37	*Minuartia krascheninnikovii* Schischk.			+				
38	*Oxytropis approximata Less.*			+				
39	*Oxytropis gmelinii* Fisch.ex Boriss.			+				
40	*Oxytropis spicata* (Pall.) O. & B. Fedtsch.			+				
41	*Oxytropis uralensis* (L.) DC.	+		+		+		
42	*Schivereckia podolica* (Bess.) Andrz.ex DC.	+		+		+		
43	*Scorzonera glabra* Lipsch.et Krasch.ex Lipsch.	+		+		+		
44	*Serratula gmelinii* Tausch.			+				
45	*Silene baschkirorum* Janisch.			+				
46	*Tephroseris igoschinae* (Schischk.) B.Nordenst.	+						
47	*Thymus bashkiriensis* Klok.& Shost.			+				
48	*Thymus talijevii* Klok.& Shost.	+		+		+		
49	Total	25	5	29	1	7	1	1

ENDEMICS

The Ural mountain land was the center of the formation of floristic endemism. Ural endemics and subendemics are divided into three groups according to their genesis and biocenotic relationships: endemics of the Alpine zone, rock–mountain steppes, and broadleaved forests (Gorchakovsky, 1969). On the whole, the Ural flora includes more than 100 endemic plants. In the three reserves, 48 endemics grow, i.e., slightly less than 50% of all endemic species characteristic of the Ural mountain land (Table 5). The Il'menskii Reserve is relatively rich in endemics (29 species), their number in the Pechoro-Ilychskii Reserve is slightly smaller (25 species), and there are only five endemic species in the Visimskii Reserve. A characteristic feature of the endemic flora of the Pechoro-Ilychskii reserve is the presence of some typically Alpine tundra plants, including *Lagotis uralensis, Festuca pohleana, Bromopsis vogulica*, and *Tephroseris igoschinae*. The endemic flora of the Il'menskii Reserve is characterized by rocky Alpine steppe species (*Thymus baskiriensis, Dianthus acicularis, Astragalus clerceanus, Oxytropis gmelinii*, etc.) and species typical of broad-leaved forests, such as *Cicerbita uralensis* and *Serratula gmelinii*. Endemic species common for different reserves are few: seven species are common for the Pechoro-Ilychskii and Visimskii reserves, and only one common species is found in each of other combinations.

FLORA SYNANTHROPIZATION IN THE RESERVES

The flora of reserves cannot be prevented from anthropogenic impact. Natural reservations are places of economic and research activities and tourism; there are roads and paths there; reserves are sometimes open for livestock grazing, hay mowing, etc., although the areas and intensity of these activities are limited. As a result, there are places where the original plant cover has been partially or completely destroyed. This is where synanthropic plant communities (or communities that are at different stages of synanthropization) are formed. They include the species introduced from other regions (anthropophytes), whose role increases with an increase in anthropogenic impact (Gorchakovsky, 1984; Gorchakovsky and Kozlova, 1998).

Our comparative data (Table 6) indicate that synanthropic plants are most numerous in the Il'menskii Reserve (205 species), with more than half of them (115 species) being anthropophytes. In the Pechoro-Ilychskii and Visimskii reserves, there are fewer synanthropic plants (124 and 86 species), including anthropophytic plants (34 and 21 species, respectively). As is seen from these data, synanthropization of the plant cover in the Northern and Middle Urals is mainly determined by apophytes, which are better adapted to the relatively severe local climate; in the Southern Urals, the contributions of anthropophytes and apophytes are approximately the same.

Table 6. Synanthropization and apophytization levels in the floras of nature reserves

Characteristic	Reserve		
	PBR	VBR	IR
Number of apophytes	90	65	90
Number of anthropophytes	34	21	115
Total of synanthropic species	124	86	205
Synanthropization index, %	15.9	19.7	21.7
Apophytization index, %	72.6	75.6	43.9

The *synanthropization index* (the percentage of synanthropic species among all plant species) and *apophytization index* (the percentage of apophytes among all synanthropic species) are integrated characteristics of the rate and mode of anthropogenic transformation. In the given case, the comparison of the floras of three reserves located in the Northern, Middle, and Southern Urals demonstrates the following trend: the synanthropization index increases (from 15.0 to 21.7%) and the apophytization index decreases (from 72.6 to 43.9%) in the southward direction.

CONCLUSION

Analysis and comparison of floristic diversity of protected natural areas provide valuable information for characterizing their representativeness and for detecting specific regional features of the flora in individual areas. In addition, the results of this analysis make it possible to estimate the level of flora synanthropization in natural reservations, which indirectly characterizes the degree of disturbance of their original plant cover.

In the three protected natural areas studied, floristic diversity at the species, genus, and family levels was the highest in the Il'menskii Reserve and the lowest in the Visimskii Reserve.

Species richness and floristic diversity in reserves depend, among other factors, on their sizes. However, this dependence is distinct only if the reservations compared (or at least one of them) are relatively small (no more than 300 km^2 in size). If the area is larger, other factors, such as the heterogeneity of the plant cover and the geographic zone, have stronger effects. This parameter has the highest value in the reservations located at the interfaces between botanical–geographic zones or subzones, of which the Il'menskii reserve is an example. In this case, the so-called "edge effect" is observed, when plants typical of different (but adjacent) zones or subzones grow in a relatively small area but usually in different biotopes, thus enriching the local and regional floras.

The taxonomic (family and species) spectra are important for characterizing the flora of a given reservation. The comparison of protected areas located in different subzones shows that the first two families of the first triad of these spectra, as well as the relative ranks of these families, are the same in different reserves (the Asteraceae and Poaceae); however, the third family of the triad depends on the relative contributions of elements of different origins (e.g., arctoboreal Siberian and European plants) to the regional floras. This component of the spectrum is most important for determining the type of the flora. Based on the compositions of the floras, we assigned the regional floras of the reserves located in the northern and middle Urals to the arctoboreal Siberian type and the flora of the southern Ural reserve to the European type.

The results of the comparison performed in this study make it possible to estimate the similarities and differences between regional floras and may be used for developing a strategy for the conservation and monitoring of floristic diversity in protected areas.

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