

An Analysis of the Adventive Component of Tree and Shrub Plants of the Southeast of Russia

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Abstract—The given paper presents the results of a long-term study of the species diversity of tree and shrub plants used in landscaping of the urbanized areas of the south-east of Russia (using the example of the Voronezh region). 97 adventive species of trees and shrubs which belong to 27 families and 63 genera are established. The data on their occurrence and distribution on the objects of planting are analyzed. The taxonomic and biomorphological compositions as well as the geographical structure are investigated. The range of environmental groups of trees and shrubs was identified. The degree of implementation and the methods of importing adventive species into the composition of the urban plantations are shown.

Keywords—woody plants; shrubs; adventive flora; biomorphological and taxonomic composition; range of environmental groups

I. INTRODUCTION

Bringing organisms from one geographic region to another presents a significant environmental event which bears transborder and even global scopes. The scientific society admits this process as one of the key environmental problems in different countries of the world [1] [2] [3] [4] [5] [6] [7] [8] [9] [10]. There is a necessity of research about the specific features of geographical distribution, biology and ecology of allogenic species in different countries and administrative territories. That is extremely topical from the viewpoint of fundamental science and practice. Such research is necessary, first of all, in order to work out later effective measures of preventing biological invasions, in particular, species from among adventive plants in nature's

ecosystems as well as under conditions of cultural landscapes where native and alien plants are cultivated for the purpose of ensuring the resistance and ecological significance of vegetation plantations, an increase of their habitat forming, economical, recreational and esthetic value for local residents.

The development of urban ecosystems happens under the conditions of active introduction processes. Introduced species are especially popular when gardening cities [11] [12] [13] [14] [15]. In urban plantations of the south-east of Russia the bulk composition of wood exotic plants obviously prevails over the representatives of local native flora. Great attention to introduced species in practice of the gardening of cities is caused by the fact that under the conditions of the urbanized environment they, in many cases, are steadier and long-lived, grow quicker than local types. Their use ensures an essential increase in esthetic and sanitary and hygienic properties of greening landings, phytooptimization of the technogenic environment, promotes a reduction of costs of cultivation of landing material, the maintenance of urban green plantings.

The cities of the south-east of Russia including the north-east of the Voronezh region are located in a forest-steppe and a steppe zone where the mixed and broad-leaved woods are combined with steppified meadows and meadow steppes. The climate is moderately continental. Under the conditions of natural-anthropogenic including urbanized territories of the south-east of Russia the peculiarities and regularities of adventization have not been disclosed thoroughly. The towns especially those which are far from regional centres, unfortunately, are not covered by such ecological and

botanical researches, and therefore it is important to have a clear vision about the process of distribution of adventive plants and their behavior in phytocenoses of these urban systems. Against the background of different environmental problems of the last years, first of all, of anthropogenic and chemical and sanitary and hygienic character in cities and towns (for example, in the Saratov, Voronezh regions) the task of studying the process of forming adventive components of cultural floras including phytocenoses with woody and shrubby plants as functional cores of strong ecological frames, is now especially topical and important from scientific and theoretical positions in modern urban ecology as a whole, and in the system of urban environmental engineering and the management of artificial ecosystems in particular [4, 5, 9].

It should be noted that in many south-eastern regions and including the Voronezh region, and in particular in Novokhoporsk, Borisoglebsk, there is a constant process of an introduction the result of which is replenishment of the flora by overseas species of plants. It is connected with an increased interest to landscape building and the collection of introduced plants having high decorative qualities. The behavior of the introduced woody plants from other physiographic zones and territories is ambiguous: some types are quite acclimatized and naturalized, took root into natural phytocenoses. Other species from the places of cultivation do not leave, but play a considerable, and sometimes the leading role in the formation of city landscapes and greening complexes. In this situation overseas species of woody plants have been received an equal basis with local types, to be considered as a part of an urban dendroflora in the identification of which we took into consideration all types of tree species under the conditions of culture and the nature.

The purpose of our research is the inventory and the analysis of the contents of adventive species of woody and shrubby plants on the territory of the south-east of Russia (using the example of towns in the Voronezh region).

II. THE MATERIALS AND METHODS OF THE RESEARCH

The basis of the work is made by the materials of field research received by means of a route method. The geobotanical description of the areas of research and observations, an accounting of the data on the corresponding geological and geomorphological peculiarities of the area,

presence or absence of the main sources of anthropogenic transformation of landscapes were carried out, an accounting of wood and shrubby plants was carried out by a route method, their systematic position was being established. The woody and shrub plants were accounted by the route method, their systematic position was established. Accounting routes represented lines covering landscaped territories with planting of woody plants and shrubs. Within the landscaped territories we registered all the plants of the representatives of life-forms of woody plants and shrubs.

The objects of the research were the adventive woody plants and shrubs extended to the territories of the towns of the Voronezh region (Novokhoporsk, Borisoglebsk). During seven years (from 2012 to 2018) we conducted an environmental and botanical research of those territories.

III. THE RESULTS OF THE RESEARCH AND THEIR DISCUSSION

During the research on the territory of the northeast of the Voronezh region 139 species of woody plants and shrubs were registered. From them, two elements enter the city component of dendroflora – native (30% or 42 species) and adventive (70% or 97 species). An example of native dendroflora is representatives of the *Salicaceae* family, which are widely cultivated as they have high decorative qualities and are distinguished with vitality in culture.

The adventive component of dendroflora contains 97 species from 63 genera which is a part of 27 families from the divisions of *Magnoliophyta* and *Pinophyta*. The last division is presented by 12 species, or 12,4% from 7 genera and 3 families. Angiospermous are represented by 85 species or 87,6% from 56 genera 10 families dominate by the number of species in "Table I".

As for species varieties the leading position is held by the *Rosaceae* families – 12 species, or 19%; *Caprifoliaceae* – 7 species, or 11,1%; *Pinaceae* – 6 species, or 9,5%.

An increase in the role of the *Rosaceae* family is explained by a high share of decorative plants and fruit and berry cultures in gardens, parks and personal plots and also their use in gardening of the cities. For example, *Armeniaca vulgaris* Larm, *Cerasus vulgaris* Mill, *Spiraea salicifolia* L., *Cotoneaster lucidus* Schlecht.

TABLE I. THE RANGE OF THE LEADING FAMILIES OF THE URBAN DENDROFLORA IN THE VORONEZH REGION

p/o	Family	The place in a range	Number of species		Number of genera	
			Absolute quantity	Share in percents, %	Absolute quantity	Share in percents, %
1.	<i>Rosaceae</i>	1	23	32,4	17	39,5
2.	<i>Caprifoliaceae</i>	2	8	11,2	5	11,6
3.	<i>Pinaceae</i>	3	7	9,9	4	9,3
4.	<i>Oleaceae</i>	4	7	9,9	4	9,3
5.	<i>Fabaceae</i>	5-6	6	8,5	5	11,6
6.	<i>Salicaceae</i>	5-6	6	8,5	2	4,7
7.	<i>Cupressaceae</i>	7-8	4	5,6	2	4,7
8.	<i>Aceraceae</i>	7-8	4	5,6	1	2,3
9.	<i>Berberidaceae</i>	9-10	3	4,2	2	4,7
10.	<i>Vitaceae</i>	9-10	3	4,2	1	2,3
	Total:		73	75	43	68
	In total:		97	100	63	100

The range of the genera in "Table II" shows ways of the formation of adventive fraction the dendroflora of the towns. It is uniform introduction of decorative, food and other economically significant groups of plants (species, genera *Picea*, *Berberis*, *Acer*).

TABLE II. THE LEADING ADVENTIVE GENERA OF THE URBAN DENDROFLORA IN VORONEZH REGION

p/o	Sorts	Number of species	
		Absolute quantity	Share in percents, %
1.	<i>Acer</i>	4	13,4
2.	<i>Juniperus</i>	3	10,4
3.	<i>Picea</i>	3	10,4
4.	<i>Syringa</i>	3	10,4
5.	<i>Populus</i>	3	10,4
6.	<i>Parthenocissus</i>	3	10,4
7.	<i>Cerasus</i>	3	10,4
8.	<i>Salix</i>	3	10,4
9.	<i>Lonicera</i>	2	6,9
10.	<i>Sambucus</i>	2	6,9
	Total:	29	46
	In total:	63	100

According to I.G. Serebryakov's classification [16], a range the biomorph (life-forms) of woody plants is created by three types. The prevailing life forms are trees, they make 53% of the total number of the registered types, they are followed by shrubs (42%) and lianas (5%). The composition of adventive group of the dendroflora of the north-east of the region is presented by three life forms: shrubs make 35 species, or 36%; woody plants – 57 species, or 59%; lianas – 5 species, or 5% in "Fig. 1".

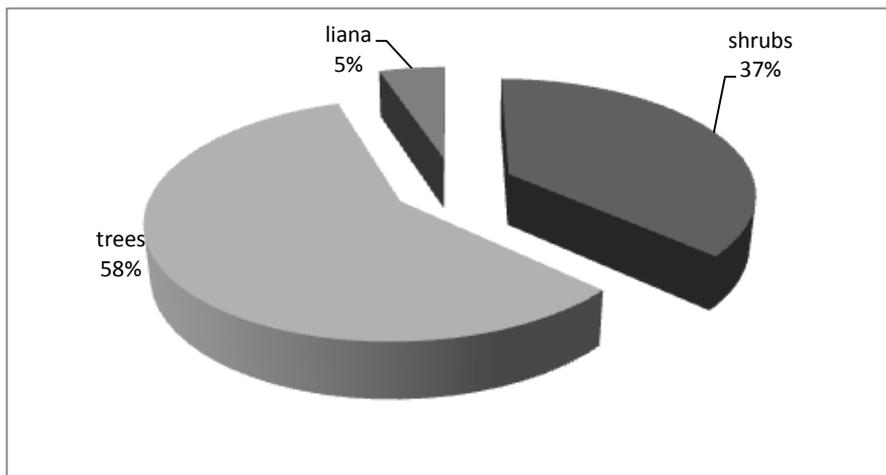


Fig. 1. A ratio of life forms of the adventive group as part of the urban dendroflora of the south-east of Russia (using the example of the Voronezh region).

In the formation of adventive fraction various geoelements and types of areas play an important role.

The North American geoelement holds the leading position and includes 32 species, or 33% (figure 2). The emergence of these species is caused by an introduction. *Thuja occidentalis* L., *Pinus strobes* L., *Acer negundo* L., *Robinia pseudoacacia* L. are representatives of the group.

The east-asian geoelement contains 17 species, or 17,6%. These are representatives of Siberia, China, the Far East: *Berberis thunbergii* DC., *Weigela praecox* (Lemoine) Beily, *Euonymus alatus* Thunb, *Hydrangea paniculata* Sieb, *Juglans mandshurica* Maxim, *Forsythia sieboldii*.

The Central Asian geoelement takes the third place. 11 species, or 11,3% They are: *Elaeagnus angustifolia* L., *Juglans regia* L., *Armeniaca vulgaris* Larm.

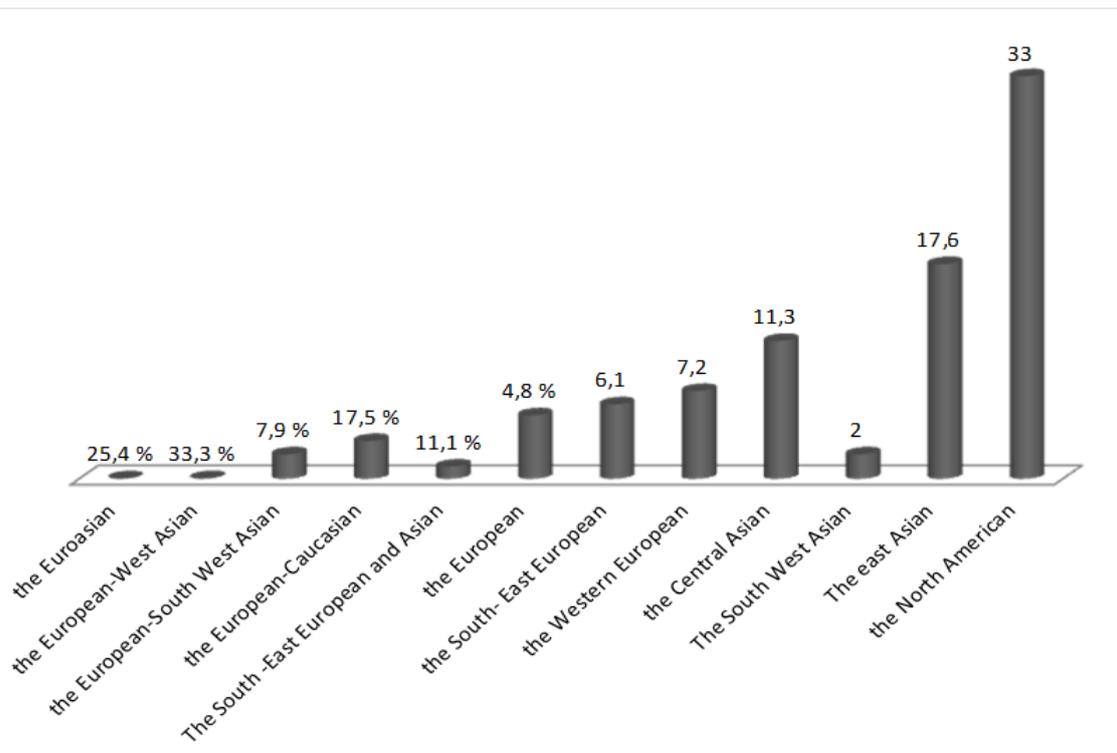


Fig. 2. A ratio of geoelements of the adventive fraction of the urban dendroflora in the Voronezh region.

Plants differently react to environmental factors: light, heat, moisture, feeding. Some prefer to live in a shadow when others develop only at good illuminating intensity. Some easily stand drought, others need excess humidification. The organisms having identical requirements to environmental conditions and reacting to particular environmental factors similarly, are united in ecological groups. For defining the resistance of species of plants to conditions of the urban environment we analysed a ratio of groups of plants according to three ecological parameters: 1) relation to humidification of the soil; 2) conditions of fertility of the soil; 3) conditions of illuminating intensity in "Table III".

In relation to humidification of the soil we distinguished 6 ecological groups. The largest of them are mesophytes (84,5%), then by a significant margin follow gigromesophytes (7,3%), xerophytes (5,2%). In relation to the nutrient status of the soil mesotrophs (87,6%) are most numerous, oligotrophic plants and eutropha divided the identical quantity (6,2% each) In relation to conditions of illuminating intensity 2 groups were singled out in which the leading position is held by light-demanding trees and shrubs (80,4%). Shade-enduring plants (19, 6%) are in the second place.

TABLE III. A RANGE OF ECOLOGICAL GROUPS OF THE ADVENTIVE DERDROFLORA

p/o	Ecological group	Number of species	Share in percents, %
<i>Conditions of humidification of the soil</i>			
1.	Xerophytes	5	5,2
2.	Mesoxerophytes	1	1
3.	Xeromesophytes	2	2
4.	Mesophytes	82	84,5
5.	Gigromesophytes	7	7,3
6.	Gigrophytes	0	0
<i>Nutrient status of the soil</i>			
1.	Eutrophs	6	6,2
2.	Mexotrophs	85	87,6
3.	Oligotrophs	6	6,2
<i>Illuminating intensity conditions</i>			
1.	Light-demanding	78	80,4
2.	Shade-enduring	19	19,6
3.	Shade-loving	0	0

As for the degree of introduction and a way of entering adventive types are subdivided into the following groups in "Table IV".

The leading position as part of adventive flora is held by xenophytes-ergaziolipophytes-kolonophytes (48 species or 49%). These types have got to the territory of these towns as a result of an introduction. Many woody and shrubby plants which are used in gardening belong to this group and they have got accustomed well to streets of the towns. For example, *Juniperus communis* L., *Thuja occidentalis* L., *Picea pungens* Engelm., *Larix sibirica* Ledeb., *Acer sacharinum* L., *Aesculus hippocastanum* L., *Sorbaria sorbifolia* (L.) A. Braun.

The second group of the advents by the number of species contains: xenophytes-ergaziofigophytes-epkophytes (13%) *Berberis thunbergii*, *Lonicera caprifolium* L., *Hyppophae rhamnoides* L., the so-called “fugitives from the culture” appearing out of the places of the planting.

The third place is taken by kenophytes-ergaziolipophytes-epkophytes (12%) *Euonymus alatus* Thunb., *Cercis canadensis* L., *Caragana arborescens* Lam.

TABLE IV. THE ADVENTIVE COMPONENT OF THE DENDROFLORA OF THE VORONEZH REGION

Groups of species according to the time and way of introduction		Groups of species according to the degree of naturalization			
		eferophytes	kolonophytes	epkophytes	agriophytes
archaeophytes	xenophytes	-	-	-	1
	ergaziolipophytes	-	-	-	-
	ergaziofigophytes	-	-	-	-
Kenophytes	xenophytes	3	1	-	1
	ergaziolipophytes	2	48	12	2
	ergaziofigophytes	-	8	13	6

IV. CONCLUSION

In the south-east of Russia the formation of cultural dendroflora is continuing, including the composition of woody and shrubby plantations of urban landscapes. A great meaning on this territory has a case of adventization of flora including the town conditions of the Voronezh region as a result of an intentional introduction and unintentional, mainly, accidental introduction of woody and shrubby plants while building and arrangement of town communities and new quarters.

An increase in the process of the adventization of urban dendroflora is accompanied not only by an introduction of new species, but also by a broad resettlement of earlier appeared advents. During the research we found 139 species of trees and shrubs, among of them are 97 adventive species which are related to 64 genera and 27 families. In the formation of the adventive fraction of flora the leading position is held by the species which got to the territory of the town as a result of a intentional and unintentional introduction.

Thus, it is found that the adventive woody and shrubby plants comprise rather a high percentage (70%) from the total number of the registered species of considered life-forms in the composition of dendroflora and they certainly have a significant impact on its formation. That follows from the data obtained on the spectrum of the geographical elements.

The development of a management system for urban plantations of different categories in the cities and towns of the south-east of Russia is impossible without taking into account the influence of the adventive plants from among the life-form of woody and shrubby plants which represent the basis of supporting ecological frames and allow us to optimize essentially the urban environment, significantly minimizing technogenic pollutions from various sources.

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