Identification of introduced coniferous plants in parks and gardens of the Saratov region

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Abstract. The article shows research on the main identified coniferous plants on the territory of the Saratov region. Relationships of families, sorts and species of coniferous plants of the Saratov Volga region are revealed there. The relation of representatives of different sorts and species in the coniferous plants families of the mentioned region is established. The distribution of species (units) is given according to the degree of their application in the culture and their importance for the region. We have determined the extent to which coniferous plants are used for gardening. The largest number of coniferous plants was found in parks and gardens, in landscaping of cities, small settlements and villages on the territory of the Saratov Volga region. The main conclusions were made.

1. Introduction
The creation of green spaces in the Saratov region has its own rich history. The garden and park zone of the region includes old manors located in cities and towns of such districts as Balashovsky, Tatishchevsky, Atkarsky, Baltaysky, Volsky, Khvalynsky and others.

Gardens and parks have a unique layout that matches to the natural landscape. Creating them they used the elements of regular and landscape styles. The species of wood and shrubby plants that were used in creating plantings of gardens and parks, landscaping cities and villages are also of great interest. The artistic expressiveness was often achieved by including the motif of natural environment and contrasts in the interior of the park. The park landscape was created on the basis of movement-viewing it when passing through alleys and focusing on special characteristics of the area. The dendrological group of plants was chosen according to the size of alleys as well as their combination and placement were determined.

Doing the research we studied not only the history, systematics and geography of species included in the range of plantings, but also their response to environmental conditions. We identified the factors limiting introduction, determined the possibility of neutralizing their negative impact on plants, and determined the degree of prospects of particular species among coniferous exotic plants for their wide introduction into culture. We have identified families, sorts and species of coniferous plants that grow not only in city parks and gardens, but also in historical garden and park complexes located on the coastlines.

The purpose of the study is to expand the range of coniferous plants, taking into account existing sustainable species and their distribution in the reconstruction and restoration of gardens and parks, including coastal areas, as well as landscaping of historical territories of cities and towns in the Volga region.
The tasks of the study are to determine the possibility of using sustainable coniferous plants to restore the landscape and architectural heritage of the Saratov region, in particular coastal territories, including coastal ones, and to organize the comfortable environment in the historical city and town centers.

The scientific novelty of the article is to determine the main types of coniferous plants in historical landscape areas and in communities of the Saratov Volga region.

2. Materials and methods
The main research methods we used are: the study of archival and literary sources related to the history of gardening, the using of coniferous plants, in the Saratov region; work with primary sources (documentation on the design and creation of gardens and parks in the region, reports on the landscaping works); visual inspection of green zones in cities, villages, countryside, rural areas, arboretums, research centers; cameral processing of material, working with determinants and atlases of trees and bushes.

We studied such objects as the gardens and parks located in the manor "Razdolye" in the village Pads in Balashov district, Kuibyshev Park, established in Balashov, Mincha manor in the village Polchaninovka in the Tatishechev district, the estate of graph Nesselrode in the village Zarevshchina in Balaysky district, the Botanical garden of Saratov state University, the arboretum Association "Elite Povolzhya", a very successful decorative nursery in Atkarsk, the arboretum in Bazar - Karabulak ski foresty, the Cosmonaut Embankment and Korolkow Garden of SSAU, the embankment in Engels and others. The materials include both objects and archival, literary, project sources, works of scientists As well as local historic materials.

3. Results and Discussion
We analyzed coniferous green zones according to the type of climate in the Saratov region, which influenced the formation of the species composition of trees and bushes in the gardening range. We found that among the coniferous plants used in the gardens and parks of the region, were Picea obovata Ledeb., Pseudotsuga menziesii (Mirb.) Franco (for example, in the Park of the former Naryshkin estate – in Pady village of Balashovsky district), there are also representatives of the genus Larix Mill., Pinus L., Juniperus L., Thuja Tourn. (in the estate of the graph A. D. Nesselgrade in Balaysky district).

Introduction centers created in the XX century are of great scientific and practical interest. In this aspect, a special place take the Botanical garden of the SSU, the arboretum of the Association "Elite of the Volga region", a very successful nursery in Atkarsk, the arboretum of the forestry in Bazarny Karabulak, etc. These centers have rich collections of trees and bushes that might enrich the species composition of plantings in the Saratov region. For example, the collection of trees and bushes in the Arboretum of the Vyazovsky educational and experimental forestry, organized in the seventies of the last century, now includes about 170 species from 29 families belonging to coniferous and angiosperms taken from various floral areas. Of great scientific and practical interest are the plantings of cities and towns in such regions as Saratov, Engels, Balashov, Balakovo, Volsk, Petrovsk, Pugachev, Krasnoarmeysk, Novouzensk, etc.

Kuibyshev Park is also of interest. It was created in the first half of the XX century in the city of Balashov. The Park contains a certain amount of material on the successful introduction of trees and bushes into the Saratov region. The park is about 70 years old. Decorative biogroups have been created on lawns. Along the perimeter, the park is fenced off from the city by hedges and biogroups, which include coniferous exotic plants Thuja occidentalis L. A birch alley has been created at right angles to the monument. There are flower beds and lawns of regular geometric shape, framed by low hedges of Cotoncaster lucidus Schlecht. In the background of lawns, decorative groups are beautifully distinguished, including individuals of coniferous plants Picea abies (L.) Karst., P. glauca (Moench) Voss, P. pungens Engelm. Tapeworms introduced Pseudotsuga menziesii (Mirb.) Franco. The natural flora of the Saratov region is poor in ornamental trees and bushes. You can hardly find coniferous...
high-stemmed plants, which can be used to solve the problem of ornamental gardening, which, of course, determines the relevance of introduction into the culture the non-regional species of trees and shrubs from both angiosperms and gymnosperms. However, it should be noticed that the trees and shrubs in Kuibyshev Park are characterized by a fairly rich species diversity, their geographical and floristic position. The Park contains 32 species from 24 genera representing 15 families. Two of them are families of gymnosperms, and 13 families are angiosperms. You can see there plants from North America, Europe, the Caucasus, Transcaucasia, Asia Minor, the Iran, Afghanistan, Turkey, North Africa, Middle Asia, Kazakhstan, Mongolia and Siberia.

Special attention in the Park is attracted by coniferous exotics, which significantly increase the decorative, aesthetic and ecological significance of the plantings. First of all, it should be noticed that *Pseudotsuga menziesii* (Mirb.) Franc is among the introduced species. This North American plant has some advantages to many other introduced species because of its bioecological characteristics: habitus, decorativeness, adaptation to environmental conditions and the degree of its anthropogenic pollution, and, above all, because of its resistance to air pollution. Some of these plants can reach a maximum height of 115 m at home, and live about 1500 years long. *P. menziesii* (Mirb.) Franc., having a strong root system, in comparison with some angiosperms, suffers less from moisture deficiency in dry periods in the Saratov region. This type of plants has a wider ecological spectrum than, for example, the European species – *Picea excelsa* Link., characterized by a superficial root system. *R. menziesii* (Mirb.) Franc, in the Park they make the first tier in height among other high-stemmed plants of the same age and the intensity of growth increases every year. *P. canadensis* Britt. u *P. pungens* Engelm. belong to such coniferous plants as *P. canadensis* Britt. and *P. pungens* Engelm, which make parks more beautiful and very nice. They live longer than the European species *R. excelsa* Link. They are more resistant to drought and pollution. For better understanding of the Park's plantings, we would like to show you a wonderful range of angiosperm species that, in combination with coniferous exotics, create a great effect not only during the growing season, but also in autumn, during periods of leaf blooming and leaf fall. In winter, the Park does not lose its decorative effect due to the creativity of specialists in decorative gardening and the skillful use of coniferous exotics.

Along the perimeter and inside the Park, you can find plants from the Eastern part of the North America - *Thuja occidentalis* L. and a representative of the *Horse-chestnut-Hippocastanaceae* Torr, et Gray - horse chestnut (*Aesculus hippocastanum* L.). Its natural range is the Balkans. Maple trees-*Aceraceae* Lindl., represented in the Park by 4 species: K. ash-leaved (*A. negundo* L.), which is a representative of the North American plants. From the Central and southern part of Russia came *A. platanoideas* L., in the Caucasus and Asia Minor, and in the saccharine or silvery (*A. saccharinum* L.), which is also native to the North America. The Park's hedges are made mainly from a representative of the fam. *Rosaceae* – *Rosaceae* Juss.– Shiny cotoneaster (*Cotoneaster lucidus* Schlecht.). In the Park, you can also find highly decorative biogroups of beautiful bushes with flowers that represent generic complexes of lilac, rose, barberry, honeysuckle, Physocarpus, mountain ash, etc.

Today, the Park is being reconstructed. The hedges and biogroups are renewed, some poplar and ash trees are cut down as well as other plants that have reached sub-senile and senile age. Due to the annual planting in the Park, the percentage of coniferous plants is increasing. We present the taxonomy of the species composition of coniferous plants in Kuibyshev Park, which we included as one of the research objects for studying the seasonal growth and development of introduced plants, their resistance to high and low air temperatures and moisture deficiency, it means to the main factors limiting the using of coniferous plants in the Saratov region. The species that make up the Park's plantings includes plants from fam.*Cupressaceae* F. W. Neger-fam.Cypress – *Thuja occidentalis* L.-Western Thuja; fam. *Pinaceae* Lindl.– fam. Pine-*Picea excelsa* Link.– European Fir tree, *P. canadensis* Britt.– Canadian Fir tree, *P. pungens* Engelm.– Prickly Fir tree and *Pseudotsuga menziesii* (Mirb) Franco-false Menzies.

For the development of Park construction, landscaping of cities, villages, rural areas and countryside, agricultural and industrial areas, it is very important to study the taxonomy of species
introduced to the region from among coniferous trees and bushes. Such research has both scientific and practical significance.

We have established the number of introduced families, genera and species of coniferous plants (figure 1).

**Figure 1.** Ratio of families, genera and species of coniferous stands (CS) of the Saratov Volga region: 1– number of families; 2– number of genera; 3– number of species.

From figure 1 it can be seen that 29 species from 15 genera belonging to five families were introduced to the Saratov Volga region. The species representation of genera in families of coniferous plants introduced to the Saratov region is shown in figure 2.

**Figure 2.** Correlation of representatives of genera and species in families of coniferous plants of the Saratov region: 1 – Cupressaceae F. Neger; 2 – Ginkgoaceae Engelm.; 3 – Pinaceae Lindl; 4 – Taxaceae Lindl; 5 – Ephedraceae Dum.
As a result of our analysis of literature sources and our own research, we concluded that among the coniferous plants introduced to the Saratov region, the largest number of species is represented by the family Pinaceae Lindl. – 15 species and fam. Cupressaceae F. Neger – 9 species. These families are represented in the cultural dendroflora and the largest number of genera (representatives of six genera were introduced from each family). From other three families were taken Engelm.– Ginkgo L., taxaceae Lindl.– Taxus L. And SEM. Ephedraceae Dum.– Ephedra L.

It is very important to analyze the natural area and original geography of plants and the conditions they are growing now, the conditions of introduction. It helps determine the prospects of these species for certain area and find out the facts which cause changes in their growth.

Floristic sources of introduction of coniferous exotics (gymnosperms of woody and bushy plants) to the Saratov region were taken from different countries. We have established flora as a percentage of the total number of green spaces. Coniferous plants from North America – 9.9%, Europe – 37.2%, Asia – 51.8% and Africa-1.1%. The total number of coniferous exotics from Asian flora in the cultural dendroflora of the Saratov region is large and makes up to 51.8 %. We found that the largest number of species was introduced in the Saratov region from China (8.9%), Western Siberia (7.7%), Eastern Siberia, the Far East and Mongolia (5.6% each).

4.4% of the species were brought from the flora of Central Asia and the Urals. There are very few kinds of plants taken from the North American flora – only 9.9%, we suppose it is because of the difficulty of mobilizing the source material for introduction to the Saratov region. African flora makes up only 1.1% due to environmental conditions.

We have determined the degree of introduction of introduced certain coniferous plants into gardening in the Saratov region based on the analysis of research. The results are shown in table 1.

Table 1. Distribution of species cultivated in the Saratov Volga region by the degree of their introduction to culture and prospects in green zones.

| No | Family            | Number of species | Category of type |
|----|------------------|-------------------|------------------|
| 1  | Cupressaceae F.Neger | 9                 | 2 5 2            |
| 2  | Pinaceae Lindl.   | 15                | 7 5 3            |
| 3  | Taxaceae L.       | 2                 | – – 2            |
| 4  | Ephedraceae Dum.  | 1                 | – 1 –            |
| 5  | Ginkgoaceae Engelm.| 1                 | – – 1            |
|    | In total:         | 28                | 9 11 8           |

In the green zones of the Saratov region, the Pinaceae family is represented by the largest number of species – 7 species (table 1). Five species of this family are quite promising for planting in our region, and to determine the prospects of three species taken into Botanical collections and arboretums, they need to be tested further in the conditions of the research area.

When making a research we studied not only the types and kinds of plants but also the response of the trees to changes of abiotic factors. We have done this for many years and got some interesting results.

The following indicators were registered: the occurrence of the species in green zones, the age of plants, their habitus, dryness, trunk curvature, tree trunk fluidity, annual growth, decorative effect. Based on the research, the prospects and economic value of a particular type were also determined.

The analysis shows that most of the plants have successfully passed the initial introduction test and now are quite promising for a wide introduction to landscape architecture (figure 3).

Figure 3 shows that the total number of species introduced in Saratov region, is 28 the number of species, 9 are widely introduced into the culture, 11 are promising for wider use in landscape architecture, 8 are species that require further experimental study in the Saratov region. It should be noticed that most species that are going to be promising for gardening and species that need further
testing to determine the extent of their future prospects, are concentrated in research centers and arboreta of this region.

Species from the genera *Larix*, *Picea*, *Pinus*, *Pseudotsuga*, *Juniperus*, and *Thuja*, representing the families *Pinaceae* and *Cupressaceae*, are most widely distributed in parks and gardens, as well as in landscaping of cities, country sides, and villages. These are primarily species from the genus *Picea*: *Picea abies*, *P. canadensis*, *P. obovata*, and *P. pungens*, the genus *Pseudotsuga-Pseudotsuga menziesii*, the genus *Pinus-Pinus sylvestris*, and the genus *Thuja-Thuja occidentalis*. The genera *Juniperus-Juniperus communis* and *J.sabina*, from the fam. *Cupressaceae* are less common. Species from generic complexes representing other families are extremely rare in the parks of the region. They can only be found in Botanical expositions and arboreta.

Based on our research, we concluded that nowadays, about fifty species of angiosperms and gymnosperms of trees and bushes are widely used in the landscaping of cities, villages and country sides of the Saratov region. A number of species are found in green zones singly or in small groups. As already mentioned above, among the gymnosperms involved in gardening are *Thuja occidentalis*, *Picea excelsa*, *P. canadensis*, *P. pungens*, *Pinus sylvestris* and *Pseudotsuga menziesii*.

In total, 199 species of woody plants were introduced to the region, including coniferous exotics represented by 28 species from 15 genera belonging to 5 families, which is 14.5% of the total number of introduced plants. 50 species of green spaces participate in gardening of the Saratov region, including 6 species of coniferous plants, which is 12% of the total number of species (figure 4).

According to our data, the percentage of conifers introduced into gardening is very low, it is about 0.2 -0.3% of the total number of trees and bushes in the gardens and parks of cities and villages in the region.

About 45-55% of the area's green zones require reconstruction that means replacing old plants among angiosperms of woody and bushy plants that have reached the sub-senile and senile age. The better decorative effect and ecological significance of plantings can be achieved by including the wider introduction of coniferous exotics. Almost all trees and bushes that make up the cultural dendroflora of the Saratov Volga region suffer from shortage of moisture, which significantly affects the degree of their beauty and environmental effectiveness. Lack of regular maintenance of plantings leads to their early aging and death. This is due to the fact that in the conditions of the Saratov region,
the strength of the impact of the abiotic factor – moisture deficiency, goes beyond the ecological valence of most introduced species. Plants in the southern part of the region suffer most of all.

**Figure 4.** Correlation of angiosperms and gymnosperms introduced to the Saratov region: 1 – the total number of introduced plants; 2 – including coniferous plants; 3 – total types in the range of gardening; 4 – coniferous exotic plants.

Thus, increasing their effectiveness can be achieved both by introducing new species that are resistant to abiotic factors, and by creating optimal conditions for their maintenance in culture.

### 4. Conclusion
We made the following conclusions:

- 29 species from 15 genera belonging to five families were introduced to the Saratov Volga region;
- Among the coniferous plants introduced to the Saratov region, the largest number of species is represented by the family Pinaceae Lindl – 15 species and fam.Cupressaceae F. Neger - 9 species;
- The European part of Russia (9.9%), the Crimea (5.5%), the Caucasus, Central and Western Europe 4.4% each represented the largest percentage of species from European sources to the total number of coniferous exotics introduced to the Saratov region. The whole of Europe in the cultural dendroflora of coniferous exotics is represented by 37.2% of the total number of gymnosperms of woody and bushy plants introduced to the Saratov region, whereas the total number of coniferous exotics of Asian flora in the cultural dendroflora of the Saratov region is large and makes up to 51.8 %;
- The plants of North American flora make up only 9.9%, which is primarily due to the difficulty of mobilizing the source material for introduction to the Saratov region. Africa flora is very poor, only 1.1%, because of environmental conditions of a new region;
- In the green spaces of the Saratov region, the Pinaceae family is represented by the largest number of species – 7 species;
- The majority of plants have successfully passed the introduction test and are quite promising for wide introduction to landscape architecture, and the total number of species introduced to the Saratov region is 28. The number of species widely introduced to culture is 9, promising for wider use in landscape architecture is 11, and the number of species requiring further experimental study in the Saratov region is 8;
The species from the genera Larix, Picea, Pinus, Pseudotsuga, Juniperus and Thuja are most widespread in parks and gardens, in landscaping of cities, country sides and villages of the region;

A total number of woody plants that were introduced to the Saratov Volga region is 199 species, including 28 species of coniferous exotics from 15 genera belonging to 5 families, which make up 14.5% of the total number of introduced plants.

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