Introduction as a way to increase biodiversity of urban dendroflora

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Abstract. Urban green spaces introduce elements of nature into the city, preserve the connection of man with nature, and expand urban landscapes. Introduction and acclimatization is the basis for the selection and successful introduction of economically valuable plants into the culture. A limited floristic assortment of local dendroflora determines the relevance of the introduction of trees and shrubs in the Arkhangelsk region. Arboretum named after I.M. Stratonovich was created in Arkhangelsk to study the acclimatization and introduction of plants from the southern regions to local conditions in northern Russia. Representatives of various geographical areas are gathered in the arboretum in a limited area. There are about 200 species from 50 genus and 19 families. Resistant plants to the conditions of the northern climate are selected. The range of woody species at the main objects of landscape architecture of Arkhangelsk was studied and analyzed. Conducted research expands the scientific and informational level of knowledge about the possibility of moving to the North economically valuable tree and shrub species. This will positively affect the biodiversity of the north dendroflora.

1. Introduction
The problem of biodiversity conservation has an important place among the main environmental problems. Important policy decisions, both regionally and internationally, are being taken to conserve biodiversity. This issue is of great importance for future generations [1]. Preservation and maintenance of biodiversity is fundamental in human contact with the environment. It forms the basis for maintaining normal environmental conditions and is a guarantee of the future supply of food to the population.

Plants are the basic component of the urban ecosystem. The resistance of species to urban conditions, including introduced ones, is the most important criterion for the creation of effective green spaces. Green urban spaces fulfill a role of psychological, social, cultural needs of city resident, and contribute significantly to the aesthetic appeal of city.

The basis for the selection and successful introduction of economically valuable plants into the culture are introduction and acclimatization. A limited floristic assortment of local dendroflora determines the relevance of the introduction of trees and shrubs in the Arkhangelsk region. According to various literature data, the native composition of trees and shrubs is about 11 species [2–4].

Prospects of introduction of different species can be evaluated on the basis of diverse experimental long-term data.
2. Results and discussions

Botanical and dendrological gardens were created at different times for acclimatization and introduction of plants from southern regions to local north conditions. One of the oldest introduction sites in the European North is the arboretum named after L.M. Stratonovich. This dendrological garden was created in 1934. Resistant plants to the conditions of the northern climate were selected for the 85-year period of acclimatization and introduction.

Representatives of various geographical areas are collected in a limited area. Currently, the collection of introducers of arboretum is about 200 species from 50 genus and 19 families. The most represented families are Rosaceae, Caprifoliaceae, Oleacea and Fabaceae.

The largest number of exotics represents the Far East, China and Japan. These are such species as Larix kaempferi (Lamb.) Carrière, Alnus japonica (Thunb.) Steud., Betula ulmifolia Sieb. Et Zucc., Acer ukrunduense Trautv. & C.A.Mey., Acer ginnala (Maxim.) Maxim., Prunus maackii Rupr., Pyrus ussuriensis Maxim. ex Rupr., Malus baccata (L.) Borkh., Malus mandshurica (Maxim.) Kom., Syringa villosa Vahl, Syringa emodi Wall. ex G. Don, Syringa villosa subsp. wolfii (C.K.Schneid.) Jin Y.Chen & D.Y.Hong, Syringa sweginzowii Koehne & Lingels., Crataegus chlorosarca Maxim., Crataegus chlorosarca var. atrocarpa E.Wolf., Crataegus dahurica Koehne ex C.K.Schneid. and etc.

North American dendroflora is represented by Tilia americana L., Acer negundo L., Prunus virginiana L., Prunus pensylvanica L.f., Crataegus flabellata (Bosc ex Spach) K.Koch, Crataegus gragina Eggl., Physocarpus opulifolius (L.) Maxim., Symphoricarpos albus (L.) S.F.Blake and etc.

European species introduced: Quercus robur L., Fraxinus excelsior L., Ulmus laevis Pall., Ulmus glabra Huds., Acer platanoides L., Acer tataricum L., Tilia cordata Mill., Prunus cerasus L., Prunus fruticosa Pall., Euonymus verrucosus Scop., Euonymus europaeus L., Lonicera tatarica L. and etc.

These species represent the flora of Siberia and Altaí: Sambucus racemosa L., Larix gmelinii (Rupr.) Kuzen., Crataegus Russanovii Chin., Tilia sibirica Bayer.

The smallest number of species introduced from the Caucasus and Crimea – Crataegus Schroederi Coehne., Crataegus tournefortii Ashe ex Eggl., Tilia caucasica Rupr., Viburnum lantana L.

The change of place of growth did not allow some species to adapt to new conditions. Many species of trees from the southern regions diedback after the first wintering. Some species have disappeared over a six-year period. Some southern species survive, but another such as Hippophaë rhamnoides L., Pyrus ussuriensis Maxim. ex Rupr., Taxus baccata L., Chaenomeles japonica (Thunb.) Lindl. ex Spach and etc. diedback in years with extreme winter temperatures. Most of the trees tested in the arboretum, retained their life form, characteristic of the homeland. The change in habit and shape of the crown occurred to Thuja occidentalis L., Salix alba L., Alnus glutinosa (L.) Gaertn., Alnus japonica (Thunb.) Steud., Acer platanoides var. schwedleri (K.Koch) Hartw., Prunus pensylvanica L.f., Prunus virginiana L. In the conditions of the Arkhangelsk they took the form of bushes and multi-stem trees. Thus, the leading place in the collection belongs to shrubs, accounting for 75 % of the total number of species of the collection. The proportion of trees is 25 %.

Plants were taken from the arboretum for urban landscaping. These are the most resistant to climatic, soil, urban factors, as well as requiring minimal costs for their care. Urban plantations are a collection of tree and shrub species in an architectural structure.

The urban environment can be considered as a model of global change in the biodiversity of the natural environment. Urban vegetation performs aesthetic, sanitary-hygienic and microclimatic functions. Aesthetic function is the design of the city. Trees and shrubs are part of the object of landscape art. Sanitary and hygienic functions include dust protection, noise protection, protection against solar radiation, phytoncidity, absorption of carbon dioxide and sulfur oxide and oxygen evolution. The microclimatic role is to increase humidity, change temperature, reduce wind speed, etc.

Introducers increase the dendroflora of recreational forests, gardens and city parks. This is characterized by valuable biological and economic (food and drug) properties, decorativeness, resistance to environmental pollution by industrial emissions and improve the comfort of an urbanized environment.
Introduction of arboreal plants into regions with harsh weather conditions should be considered as one of the possible ways to solve the problem of improving the comfort of city dwellers in an unfavorable climate of European North of Russia.

The experience of successful introduction is clearly shown in table 1 on the example of the main objects of landscape architecture in the Arkhangelsk. 3946 pieces of trees and shrubs were explored and studied.

### Table 1. Assortment and occurrence of tree-shrub vegetation in parks.

| Species Description | Petrovskii park | Lomonosovskii park | Park otdykhka on Galushin street |
|---------------------|----------------|--------------------|----------------------------------|
|                      | Quantity (pcs) | %                  | Quantity (pcs)                  | %                      | Quantity (pcs) | %                  |
|----------------------|----------------|--------------------|----------------------------------|------------------------|----------------|--------------------|
| 1 Tilia sibirica Bayer | 33             | 3,6                | 8                                | 0,7                    | 25             | 1,3                |
| 2 Betula pubescens Ehrl.* | 41             | 4,5                | 520                              | 44,6                   | 1414           | 75,4               |
| 3 Ulmus glabra Huds. | 32             | 3,5                | 1                                | 0,1                    | 8              | 0,4                |
| 4 Populus tremula L.* | 52             | 5,7                | 74                              | 6,4                    | 57             | 3,0                |
| 5 Pinus sylvestris L. | -              | -                  | 10                              | 0,1                    | 49             | 2,6                |
| 6 Populus balsamifera L. Prunus padus L. / maackii (Rupr.) Kom. | 245           | 27,1               | 103                              | 8,8                    | 128            | 6,8                |
| 7 Malus sylvestris (L.) Mill. | 24/2           | 2,7                | 1                                | 0,1                    | 23             | 1,2                |
| 8 Cornus alba L. | 10             | 1,1                | 24                              | 2,1                    | -              | -                  |
| 9 Lonicera tatarica L. | 51             | 5,6                | 88                              | 7,6                    | 4              | 0,2                |
| 10 Salix caprea L. | 1              | 0,1                | 337                             | 28,9                   | 51             | 2,7                |
| 11 Sorbus aucuparia L. | 18             | 2,0                | 6                                | 0,5                    | 61             | 3,3                |
| 12 Rosa canina L. | 5              | 0,6                | -                               | -                      | -              | -                  |
| 13 Fraxinus excelsior L. | 3              | 0,3                | -                               | -                      | 2              | 0,1                |
| 14 Alnus incana (L.) Moench | 1              | 0,1                | -                               | -                      | 4              | 0,2                |
| 15 Syringa josikaea J. Jacq. ex Rchb. | 94             | 10,4               | -                               | -                      | 7              | 0,4                |
| 16 Ribes nigrum L. | -              | -                  | -                               | -                      | 5              | 0,3                |
| 17 Crataegus sanguinea Pall. | 15             | 1,7                | -                               | -                      | 4              | 0,2                |
| 18 Caragana arborescens Lam. | 104            | 11,5               | -                               | -                      | 1              | 0,1                |
| 19 Sorbaria sorbifolia (L.) A. Braun. Sambucus racemosa L. var. laciniata W. D. J. Koch ex DC. | 5              | 0,6                | -                               | -                      | 3              | 0,2                |
| 20 Quercus robur L. | 1              | 0,1                | -                               | -                      | -              | -                  |
| 21 Picea pungens Engelm. | 39             | 4,3                | -                               | -                      | -              | -                  |
| 22 Viburnum opulus L. | 6              | 0,7                | -                               | -                      | -              | -                  |
| 23 Acer tataricum L. / negundo L. / platanoides L. | 10/1/4         | 1,7                | -                               | -                      | -              | -                  |
| 24 Tilia cordata Mill. | 62             | 6,9                | -                               | -                      | -              | -                  |
| 25 Spiraea salicifolia L. | 13             | 1,4                | -                               | -                      | -              | -                  |
| **TOTAL**           | 907            | 100                | 1165                            | 100                    | 1876           | 100                |

Note: * - local species
The biodiversity of tree-shrub vegetation in Petrovskii Park (figure 1) exceeds almost 2 times the neighboring parks. This is due to its central location and landscaping work in 2009-2010. Hedges are created of Caragana arborescens Lam. and Syringa josikaea J. Jacq. ex Rechb. This plants share the walking part of the Park and the busy Central highway. Functional zoning of this territory is performed by Populus L. and Tilia L.

Recreation Park on Galushin street (figure 2) is located along the Severnaya Dvina river. A large number of trees Betula pubescens Ehrh. and Populus balsamifera L. are used to create row planting and alley along the road and path.

Lomonosov Park (figure 3) is locates between residential area of the city and the memorial complex. This parts are shared by of Populus balsamifera L. and Salix caprea L. Alley of Betula pubescens EHRH. were created in the walking part of the park.

![Figure 1. Map of Petrovskii Park.](image1)

![Figure 2. Map of Park on Galushin street.](image2)

![Figure 3. Map of Lomonosov Park.](image3)
Local species predominate in the composition of the parks of northern cities. These are such species as Betula L., Sorbus L., Populus tremula L. Adventitious species used in landscaping areas are Populus L., Syringa L., Acacia Mill and etc. 27 species grow in the studied parks, most of them are introducers.

3. Conclusions
Urban green spaces introduce elements of nature into the city, preserve the connection of man with nature, and expand urban landscapes. Results of conducted research expand the scientific and informational level of knowledge about the possibility of moving to the North economically valuable tree and shrub species. It will positively affect the biodiversity of the north dendroflora.

References
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