Research and Analysis of the State and Development of Woody Plants in The Squares of the City of Krasnoyarsk

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Abstract. The article presents the results of studies in different areas of the city of Krasnoyarsk with different levels of anthropogenic load and different levels of air pollution. An analysis was made of the stability of the development of woody plants in the squares of the city of Krasnoyarsk using the example of birch drooping according to two indicators: the asymmetry coefficient for five parameters of the leaves and the asymmetry value for the area of the leaves. The results of the study showed that technogenic impacts lead to a change in the size and magnitude of the fluctuating asymmetry of the drooping birch leaves. In the area with average extent of pollution decrease in stability of the development, being expressed in increase of values of indicators of asymmetry is noted. The greatest decrease in stability of development is noted in selection with a maximum level of pollution. According to the conducted researches, wood plants react to influence of an urban environment, thus methods of a dendroindikation are a theoretical basis of development of recommendations for an assessment of a condition of an urban environment.

1. Introduction
The intensive process of urbanization caused a number of environmental problems associated with a sharp deterioration in the quality of the urban environment. A difficult technogenic situation in large industrial cities of Siberia, which have a low potential for environmental sustainability, leads to the degradation of natural landscape elements, in particular, urban vegetation [1], [2], [10].

2. Relevance, scientific significance of the question
The solution to the problem of technogenic impact on the environment of an industrialized city is becoming increasingly important. Plants throughout their lives are attached to the local territory and are affected by soil and air. Their condition most fully reflects the whole range of effects on the ecosystem. Air pollution has a negative effect on the leaf surface of plants. The most obvious sign of damage is the appearance on the leaves of chlorosis, necrosis, changes also occur at the level of plant morphology and biochemistry [1], [2]. Moreover, it is the landscaping system that can neutralize a significant part of the negative impacts of the urbanized environment.

3. Problem statement
However, at present, the consolidation of urban development, the creation of parking lots and administrative and commercial areas is, as a rule, due to green areas. This leads to a significant reduction (or even complete destruction), first of all, of small landscaping objects, in particular, such...
as urban squares. At the same time, it is the squares that create socially significant conditions that can significantly increase the level of comfort of the urban environment.

The current situation requires the development of scientifically based recommendations for the creation (design and reconstruction) of small urban landscaping objects with high landscape-ecological and aesthetic potential. The success of achieving this goal depends on objective knowledge and reliable assessments of the state of green spaces and growth trends of woody plants in various urban environments [1].

4. Materials and methods of research

To date, a large proportion in the urban landscaping system is occupied by squares. They significantly modify the urban environment, strengthen the factor of inclusion of natural components in it, therefore, studying the state of green spaces of father-in-law is a very urgent task. Therefore, the aim of the study is to assess the state of the environment and analyze the stability of the development of woody plants in the squares of the city of Krasnoyarsk using dendroindication methods.

The collection of materials was carried out in 2 control points, “Fruit and Berry Station” and in 9 squares in the city: “Botanical”, “Serebryan”, “Cosmonauts”, at the entrance of KhMZ, “Panyukovsky”, “Enthusiasts”, “Family”, “Odessa”, “Surikova”, located in the vicinity of stationary observation posts, which allows to reliably assess the level of influence of technogenic factors and the degree of plant responsiveness to them.

Table 1. Characteristics of the studied objects.

| Options         | Name and address of the object | №21 st. Timiryazeva «Nikolaev settlement» | №5 st. Telman | №9 st. Tchaikovsky | №7 st. Matrosova | №8 st. Kutuzova, 92 | №20 st. Solnechnaya, 8 | №3 st. Surikova |
|-----------------|--------------------------------|-----------------------------------------|---------------|-------------------|------------------|---------------------|----------------------|-----------------|
| Area, m²        | Botanical Square               | 11315                                   | 25872         | 89442             | 14641            | 21167               | 28200                | 12100           | 21167          | 15965          |
| Perimeter, m    | Square Silver                  | 466                                      | 680           | 2470              | 484              | 1151                | 677                  | 515             | 1090           | 494            |
| The dissection coefficient of the landscape drawing | Cosmonauts Square | 1,20                                     | 1,19          | 2,32              | 1,12             | 2,23                | 1,13                 | 1,32            | 2,11           | 1,10           |
| Contour Circle Index | square at the entrance KhMZ, Panyukovsky Square | 0,68                                     | 0,70          | 0,18              | 0,78             | 0,20                | 0,77                 | 0,57            | 0,22           | 0,82           |

Using the cluster analysis method, we assessed the significance of differences in combinations of meteoclimatic characteristics, such as temperature, wind speed, humidity, and anthropogenic loads (for five priority impurities), and we constructed schemes for combining observation posts by the similarity of these conditions.

An analysis of the results allowed us to distinguish three main groups according to the similarity of the climatic characteristics of the territories:
Mesoclimatic characteristics

![Mesoclimatic characteristics chart](image)

- The amount of precipitation during the growing season (May - September), mm
- Average wind speed, %
- The prevailing wind direction

**Figure 1.** Mesoclimatic characteristics of the study areas.

- territories located in residential areas and close to industrial enterprises (posts on Surikov St., Matrosov St., Tchaikovsky St., and Telman St.);
- territories located on the periphery of the city (posts in the Nikolaev settlement and Solnechnaya...
territories in the area of the Weather Station experimental field (green zone of the city) reliably differ in climatic conditions from all the studied areas located within the city boundaries.

Thus, an analysis of the microclimatic conditions of the territory of a large city located at the junction of eight types of landscapes showed that various mesoclimatic conditions develop on its territory, which depend both on the initial environmental conditions and also on the density of technogenic factors (Figure 1). These circumstances formed the basis for the selection of landscaping facilities for research. At the same time, it is necessary to take into account when creating landscaping objects and choosing technologies for their care.

Drooping birch was chosen as the object of study, since this species in the city of Krasnoyarsk meets all the requirements for bio-indicator plants [5], [6], [9].

Leaves from trees were collected in early September after the end of their intensive growth from shortened shoots of the lower part of the crown, from branches differently oriented to the cardinal points.

Assessment of the development of hanging birch stability was carried out according to two indicators: the asymmetry coefficient according to five leaf parameters (according to the method of V. Zakharov and others) and the asymmetry value according to the leaf area (according to the authors method). The magnitude of the asymmetry was estimated using the integral indicator - the value of the average relative difference per attribute. An estimate of the fluctuating asymmetry of the birch leaf leaves was determined as the ratio of the difference between the values from the left and right sides to their sum. The value of the relative differences between the sides per attribute for each sheet is determined as the arithmetic average of the relative differences between the signs of the left and right sides. The average relative difference per attribute for the entire sample was determined as the arithmetic average of the relative differences between the parties per attribute for the entire sheet. The obtained indicator characterizes the degree of asymmetry of the organism, for which V. M Zakharov et al. Developed a deviation scale in which values of the asymmetry index up to 0.055 characterize the state of the environment as a conditional norm, and a value of more than 0,7 evaluate it as a critical state of the environment [4], [7], [8].

5. Practical significance
The results of studies showed that under the influence of technogenic influences, changes in the size and magnitude of the fluctuating asymmetry of drooping birch leaves hang. The studies made it possible to establish the magnitude of the change in the asymmetry of leaf blades of drooping birch trees growing in different urban conditions of the city of Krasnoyarsk and to compare them with the level of anthropogenic load at the research sites (according to data from stationary observation posts).

The smallest level of disturbances in plant development stability is observed at two control sites in the area of the Fruit and Berry Station, where the level of air pollution is minimal. These objects are located outside the city, far from enterprises and highways. The value of the coefficient of asymmetry in five parameters of the leaves and the value of asymmetry in their area at this object does not exceed the conventional norm.

The values of the asymmetry of leaf blades in the drooping birch growing in the Botanichesky, Serebryany, and Cosmonauts squares are from 0.5 to 0.6, which corresponds to a satisfactory state of environmental quality. In the squares of "Enthusiasts", "KhMZ" and "Panyukovsky", the state is tense, the asymmetry of the sheet plates is from 0.6 to 0.7. The greatest decrease in the stability of plant development was noted in the samples of the “Family”, “Odessa” and “V.I. Surikov” public gardens; the level of environmental quality was from 0,7 and higher, which is characterized by a conflict both in the center of the square and on the periphery (figure 2).
Figure 2. A graph of the correspondence of the asymmetry coefficient for leaf parameters and the asymmetry value for leaf area.

6. Conclusion
Thus, the above studies allow us to conclude that the drooping birch is quite sensitive to the impact of the urban environment. The asymmetry coefficients of leaf blades reflect the state of the urban environment and plant growth conditions. The obtained dependences allow us to state the level of environmental pollution by the state of asymmetry of sheet plates. Thus, an analysis of the state of the environment of the city of Krasnoyarsk showed that the current environmental situation poses a significant additional burden on the natural complex and causes anthropogenic modification of complex natural factors characteristic of the region, which affects the change in the properties of individual biotic components and the quality of the environment, which should be considered and assessed taking into account the needs of all living organisms, and an assessment of the deviation of environmental parameters from their initial values is possible method om bioindication.

The advantage of this method is the relatively low cost of research, the high speed of obtaining information and the ability to characterize the state of the environment over a long period of time. The bioindication method is very informative for assessing the state of the urban environment and should find application in the work of environmental institutions to organize monitoring of the state of urban areas.
7. References

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