Problems of urban phytocenoses on the example of the city of Krasnoyarsk

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Abstract. The article proposes a classification of urban phytocenoses (vegetation) into natural (original), artificial and transitional ones. The characteristics of the bedding, species diversity, and living soil cover for each type of plant community are considered. Particular attention is paid to artificial urban phytocenoses, especially to species diversity and structure, as this criterion is one of the main ones in the formation of sustainable and effective gardening. The question is raised of the lack of both ecological and composition approaches in the design of artificial plant communities. Methods for increasing and maintaining the species diversity of artificial phytocenoses are proposed.

Environmental design as a whole is a fairly new and rapidly growing industry of knowledge. One of the goals of environmental engineering is the development of new sustainable ecosystems that are important for humans and the environment [1].

The most important part of any ecosystem is phytocenosis (vegetation) [2]. Phytocenoses can be conditionally divided into natural (areas of indigenous, natural phytocenoses), artificial (plant communities purposefully created by man) and transitional (natural ones with noticeable traces of targeted anthropogenic impact). It is almost impossible to meet natural phytocenoses in the territory of a modern city. Such plant communities constitute suburban forest parks, which in turn are a green belt and an integral part of the ecological framework. Large parks that are formed on the basis of natural vegetation and supplemented by humans can be considered as transitional phytocenoses in the city. The bulk of urban phytocenoses are artificially created plant communities.

Considering natural plant communities, it is impossible not to note the fact that they have a tiered formation of grassy and sometimes extra-tier vegetation. Transitional plant communities, compared with natural ones (table 1), have a lower level and a degraded soil cover. Artificial phytocenoses most often have one tier and a degraded soil cover. It is necessary to mention separately the criterion of the diversity of species that form the plant community. Natural phytocenoses are characterized by the assortment of plants, due to the type of forest. It may seem that there are not so many plant species in the suburban forests, however, each tier is usually represented by at least two or three species of woody plants; the ground cover consists of dozens of species of spore and vascular plants, developing under the canopy of stands and undergrowth.
Table 1. Characteristics of urban phytocenoses.

| Indicator         | Type of phytocenosis                  |
|-------------------|---------------------------------------|
|                   | natural                               |
|                   | transitional                           |
|                   | artificial                             |
| Tiered            | three distinct tiers:                 |
|                   | trees of the first magnitude, second  |
|                   | magnitude, undergrowth (shrubs)       |
|                   | one of the tiers often falls out       |
|                   | most often one tier                    |
| Ground cover      | corresponds to the type of forest     |
|                   | most often artificial, partially degraded |
|                   | artificial, at different stages of degradation |
| Variety of species| corresponds to the type of forest     |
|                   | medium or small                        |
|                   | small                                  |

It is worth to mention that natural phytocenoses near the city suffer from anthropogenic impact [3], which is manifested in a change in the composition of the vegetation due to: fires, trampling, illegal planting and felling of plants, transfer of weed grass seeds from the urban environment. The diversity of plant species in transitional phytocenoses is significantly lower primarily because of a decrease in the level of the entire plant community. Even in large city parks, most often there only one tier of trees (first or second magnitude) and an implicit tier of undergrowth from shrubs are. The second reason can be called the degradation of the soil cover, both natural and artificial (most often an ordinary cereal garden and park lawn). The reason for the degradation of the soil cover is not only trampling and general compaction of the soil, but also the lack of an ecological approach when choosing herbaceous plants. Artificial phytocenoses due to the lack of longitude and low species diversity are generally difficult to call communities. In essence, these are biogroups, often represented by a single type of plant, confined to certain urban areas, for example, the ordinary planting of an apple tree on a lawn in the adjoining strip of a residential building.

Using the city of Krasnoyarsk as a subject of study, we consider the problems of the species diversity of vegetation of artificial phytocenoses, which make up the bulk of urban plantings. The biodiversity of such plant communities is reduced by the system itself, established methods and norms for designing and creating urban green spaces. Traditionally, urban landscaping of Krasnoyarsk is an open space, covered with ordinary landscape gardening lawns, with ordinary plantings of woody plants (alley, hedge, row). Flower decoration is represented by regular flower beds from annual herbaceous plants with the participation of bulbous perennials in the spring flowering period.

The ubiquity of this practice leads to the fact that the near-stem areas of trees and shrubs are prone to sodding, and this leads to inhibition of the growth of young plantings and the inability to carry out full-fledged care [4]. Group plantings of woody plants are rare, mainly trees and shrubs are planted in a checkerboard pattern on an open area, in order to maximize the filling of free areas of open ground. Against the background of the city’s depressing multi-storey architecture [5], which is not large-scale for people, the lack of a composition approach to landscaping leads to a feeling of environmental disharmony by a person due to non-observance of the principles of scale, rhythm, and proportion [6].

Ground cover in most cases is represented by cereal lawns. But this technique is far from always justified. For example, under dense crowns, as well as in areas of branched surface root systems of woody plants, it is simply impossible to grow a classic lawn. The same can be said of steep slopes, especially of the southern exposure – cereals in such territories burn out, failing to form a full-fledged
turf, or "slide" off the slope along with surface runoff. The introduction of alternative lawns with the participation of perennial grass cover plants, low shrubs, especially under existing tree plantings, will form a ground cover that protects the roots of trees and shrubs of the upper tiers, preventing soil erosion and dust formation. In addition, such lawns are more durable, economical in maintenance and have a stable long decorative.

One of the criteria for creating highly efficient urban plantations is the choice of resistant species of woody and herbaceous plants that can exist in the difficult ecological and climatic conditions of the urban landscape in Siberia. The assortment of woody plants used for landscaping Krasnoyarsk does not differ in variety (table 2). It is also worth noting that the ecological requirements of plants in relation to the habitat and neighboring plants are not always taken into account.

| Trees                                      | Shrubs                                      |
|--------------------------------------------|---------------------------------------------|
| Acer negundo L.                            | Berberis amurensis Rupr.                    |
| Betula pendula Roth.                       | Berberis vulgaris L.                        |
| Tilia cordata Mill.                        | Caragana arborescens Lam.                   |
| Larix sibirica Ledeb.                      | Cotoneaster lucidus Schltdl.                |
| Malus baccata (L.) Borkh.                  | Lonicera tatarica L.                        |
| Malus niedzwetzkyana Dieck ex Koehne       | Ribes aureum Pursh                         |
| Picea pungens Engelm.                      | Rosa rugosa Thunb.                          |
| Picea obovata Ledeb.                       | Sorbaria sorbifolia (L.)                   |
| Populus alba L.                            | Syringa josikaea J.Jacq. ex Rchb.f.         |
| Populus balsamifera L.                     | Syringa vulgaris L.                         |
| Prunus maackii Rupr.                       |                                            |
| Sorbus aucuparia L.                        |                                            |
| Ulmus pumila L.                            |                                            |

In order to expand the assortment of woody plants in the landscaping of Krasnoyarsk, we can introduce such species of trees and shrubs as salix × fragilis L., prunus virginiana L., acer tataricum L., syringa amurensis Rupr., spiraea japonica Lf, spiraea betulifolia Pall., Spiraeae × billardii hort. ex K. Koch, spiraea × humalda Burv., spiraea × cinerea Zabel, spiraea densiflora Nutt. ex Rydb., hydrangea paniculata Siebold, salix purpurea L., physocarpus opulifolius (L.) Maxim., cornus alba L., euonymus alatus (Thunb.) Siebold, berberis thunbergii DC., aronia melanocarpa (Michx.) Elliott.

In addition to increasing the species composition of woody plants, it is necessary to provide for the introduction of varietal and form diversity of the listed species of trees and shrubs.

Important is the observance of the principles of creating tree stands. The basic principle for selecting plant species and varieties is environmental. It is understood that the requirements of the designed plants must comply with the existing climatic and environmental conditions on the site.

Together with the ecological principle, the principle of plant allelopathy must be observed. Following this principle, the project will provide for favorable combinations of plants and optimal planting distances between them. This principle is especially relevant for urban landscaping, as in the urban landscape it is necessary to carry out projects for the reconstruction of existing territories, create landscape objects, planting young plants under the canopy of an existing plantation. It is recommended to take into account the physiognomic principle of designing landscape compositions. Plants suitable for each other in habitus, as a rule, belong to the same forest conditions, form more stable phytocenoses and harmonious compositions for perception.

In addition, there is no comprehensive approach to landscaping. It consists in designing continuous links of the green belt of the city with all internal landscaping objects [7].

The decomposition and degradation of urban phytocenoses is observed annually due to the wrong approach to their design and lack of care. An increase in the diversity of the species composition of
vegetation in urban phytocenoses is one of the criteria for increasing their stability. The following ways to solve the problem of increasing and maintaining the biodiversity of artificial plant communities can be proposed:

- Revision and revision of the existing regulatory framework regarding the landscaping of the city.
- Expanding the assortment of woody plants.
- The using of phytocenological, environmental and compositional approaches in the design of landscaping.
- The implementation of urban woody vines in urban landscaping.
- Expanding the assortment of perennial herbaceous plants in order to create a living ground cover and floral design elements.
- Conducting regular care and plant protection measures.

Artificial phytocenoses, properly formed and maintained, will be more stable, which is especially important for the unstable ecosystem of the city. Sustainable plant communities are capable of performing both sanitary-hygienic and architectural-artistic functions for a long time [8].

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