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Features of the phytocenosis structure in the urban ecosystem of the southern industrial centre

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Abstract. The structure of the urban phytocenosis and its constituent plant life forms are analysed. The percentage ratio of life forms found on the objects of landscape construction has been determined, dendrological groups for green construction in Volgograd have been designed and recommended.

1. Introduction

Tree plantings in industrial cities perform various functions. They form the basis of phytocenosis, create a microclimate, carry aesthetic load, and play a protective role. Since the second half of the 19th century, atmospheric pollution has become a new anthropogenic environmental factor. Currently, the chemical industry and motor transport have become sources of air pollution. At the present stage, the development of production is such that even one enterprise throws a whole “bunch” of harmful gaseous substances into the air. Polluted air causes a number of effects. In humans and animals exacerbated by chronic diseases. Under these conditions, wood species, having absorption properties, purify atmospheric air from harmful gaseous impurities.

In fact, green plants are a kind of filter or lungs of a modern city. Well-functioning, healthy tree plantings are capable of purifying huge amounts of air. At the same time, the plantations also experience the harmful effects of gaseous pollutants. Such an effect is observed in the form of both a direct effect on the assimilation apparatus, and by indirect effects through the soil. Therefore, the success of the green filter depends on the degree of resistance of the species that make it up.

The problem of increasing the sustainability of plantings in the urban ecosystem is very important. There are a variety of techniques, including agrotechnical, which can improve the sustainability of urban planting, but they are all temporary. At the same time, natural communities show us ways to create a long-term stable cenosis, where the vegetative body of a plant is in harmony with the external environment throughout its life. The life forms of plants represent the habit, historically established as an adaptation to environmental conditions. As a result of natural selection, the life forms of plants are extremely diverse. Due to the effective use of ecosystem space by life forms, the stability and self-regulation of phytocenosis is increased.

2. Life forms of plants and their place in the structure of phytocenosis

Plants of different species and life forms with different environmental features take part in the formation of phytocenosis. All life forms of woody plants belong to two sections - woody (trees, bushes, shrubs,



tree and shrub lianas, cushion plants) and semi-woody plants (semi-shrubs, semi-shrubs, semi-shrubs and semi-shrub vines) [1].

As a result of the participation of various life forms of plants in the organization of the biocenosis, the phyto-community acquires a special structure in the form of layering. The layering is inherent in any phytocenosis, but it is especially pronounced in the natural biocenosis, for example, in the forest. Natural ecosystems, for example, forest is characterized by multi-tiered [2].

The tallest trees make up the first tier. As a rule, these are forest type trees - the main forest formers. Their trunk, the only one during the whole ontogenesis, has long maintained a sharp predominance in length and thickness over the lateral branches. Even in the crown, the main axis is noticeably distinguished in thickness among the lateral branches (species of spruce, fir, larch, pine, oak, poplar). After cutting or dying off the trunk of many tree species of this type (sequoia, oak, beech, elm, birch), two or more secondary (coppice) trunks can grow from dormant buds [3].

Less tall trees form the second tier. These are bush-type trees, which, when grown, have several trunks, developing from dormant (or accessory) buds at the base of the mother trunk. Trees of this type (gray alder, rowan, sinuous birch) are transitional forms from trees to shrubs. In the same tier, there are forest-steppe or fruit-type trees, which are characterized by a trunk that early loses its predominance in growth over the lateral branches. Their crown begins near the surface of the soil, and in the crown itself the main axis does not stand out among the strong lateral branches (types of apple, apricot, plum, quince, maples). Tree creepers rise in the second and first tiers.

Shrubs of the undergrowth occupy the third tier, and shrubs, grasses, mosses and lichens - the fourth and fifth. Longlines in phytocenosis have a heterogeneous structure and consist of parts that differ in the life forms of plants, their species composition and ecological properties [3].

Life forms of plants are very diverse. These are forest, bushy, forest-steppe, seasonally-succulent type trees, stanza trees, pillow trees, as well as shrubs, semi-shrubs and shrubs, lianas. All of them, located in their tiers, make up the structure of plantations.

In the plant community, some plant species create favourable and even necessary conditions for others to live. Any ecosystem is stable with its multi-tiered and leads to a more complete and uniform use of the occupied space by the phytocenosis, allows a large number of individuals to exist on the same territory [2].

3. Objects and results of research

Green urban plantings are woody plantations with a certain functional and aesthetic significance. Urban phytosystems are formed artificially, and their layering is usually simplified. Often urban plantings are represented by single-row planting of a single tree species, which reduces their resilience, which leads to susceptibility to pests and diseases and reduces the life of plants [4].

However, the variety of life forms of trees and shrubs determines the duration and fullness of their functioning, leads to the preservation of not only the phytocenosis, but also the health of citizens and the aesthetic beauty of the city itself. Working as a green filter tiered tree stands purify the air from pollutant gases, thereby protecting the population from the harmful effects of industrial emissions [5].

To determine the most frequently used life forms and identify the structure of phytocenoses at green construction sites in the city of Volgograd, we examined the greening of urban areas of limited use (residential neighborhood, kindergarten, school), as well as public facilities (park, street).

The objects of study became woody plants in a residential area in Richard Sorge street, on the territory of secondary school in the Krasnooktyabrsky district and kindergarten, as well as green landings at the playground of Richard Sorge street, and the following central streets: Lenin Avenue, Zhukov Avenue, University Avenue, Raboche-Krestyanskaya street, in the park at the foot of Mamayev Kurgan.

In a residential neighborhood of Richard Sorge street there are life forms such as trees, upright shrubs and vines. The life form of the tree is represented by species such as *Bignonia catalpa* (*Catalpa bignonioides*), *Robinia pseudoacacia* (*Robinia pseudoacacia*). The shrub is represented by a rose of May (*Rosa majalis*), common lilac (*Syringa vulgaris*). Liana - grapes maiden pyatilistochkovym

(*Parthenocissus quinquefolia*). Thus, this facility contains three life forms, among which are as follows: 58% of trees, 29% of shrubs and 13% of vines. The structure of tree plantations consists of 2 tiers.

On the territory of kindergarten, life forms are represented by trees, shrubs and vines. The assortment of trees consists of bignoneid catalpa (*Catalpa bignonioides*), silver birch (*Betula pendula*), white poplar (*Populus alba*), and common apricot (*Armeniaca vulgaris*). The range of shrubs consists of common privet (*Ligustrum vulgare*), and lianas - of maiden five-leaved grapes (*Parthenocissus quinquefolia*). The total number of trees, shrubs and vines in the territory is 94 pcs. Among them there are 38 trees (40%), 46 shrubs (49%), 10 lianas (11%). Woody plants form 2-tier stands.

Green areas of the playground in Richard Sorge street consists of trees: Babylon willow (*Salix babylonica*), warty birch (*Betula pendula*), white poplar (*Populus alba*); shrubs: common lilac (*Syringa vulgaris*), calinifolia (*Physocarpus opulifolius*), white deren (*Swida alba*) and creepers: girl's grapevine (*Parthenocissus quinquefolia*). The percentage of trees, shrubs and vines in the territory is 33%, 50% and 17%, respectively. Green plantings forms 2-tiers.

On the territory of secondary school in the Krasnooktyabrsky district, landscaping is represented by trees such as white poplar (*Populus alba*), pyramidal poplar (*Populus italica*), warty birch (*Betula pendula*), Babylon willow (*Salix babylonica*), and maple (*Acer negundo*), Elm rough (*Ulmus glabra*), spruce spiny (*Picea pungens*) and shrub - common alder (*Ligustrum vulgare*). The total number of trees and shrubs in the territory is 90. Among them, there are 68 trees (76%), 22 shrubs (24%). Thus, on this object only 2 life forms are observed, which make up 2 tiers.

Green areas on the central highways of Volgograd (Lenin Avenue, Zhukov Avenue, University Avenue, Raboche-Krestyanskaya street, etc.) are 1-tiered plantations and they consist of single-row planting of elm small-leaved (*Ulmus pumila*), Robinia pseudoacacia (*Robinia pseudoacacia*), and ash-leaved maple (*Aser negundo*). It should be noted that ordinary tree planting along the central highways is greatly weakened, their viability is lowered [6].

In the park at the foot of Mamayev Kurgan (in Zapolotnovskaya, the most afforested part), there are 32 species of woody plants. Among them there are forest-type trees such as: pine (*Pinus sylvestris*), spruce (*Picea pungens*), Norway maple (*Aser platanoides*) and field (*A. campestre*), green ash (*Fraixinus lanceolata*), Robinia pseudoacacia (*Robinia pseudoacacia*) etc. constituting 68%. High shrubs, such as: skumpy tannery (*Cotinus coggygria*), tamarix ramified (*Tamarix ramosissima*), medium bushes: *Berberis vulgaris*, Tatar honeysuckle (*Lonisera tatarica*) make up 32%. The structure of green plantings, therefore, in the most forested areas consists of 3 tiers. Unfortunately, it is possible to say that there are no bush-like trees at this facility, trees are stanza, trees are pillows, as well as semi-shrubs, shrubs and lianas.

On the average, in the surveyed territories, the percentage ratio of trees, shrubs and vines is 55%, 36.8%, 13.7%, respectively. Green tree plantations consist of 1-3 tiers, while in the dry steppe zone on landscaping sites the ratio of trees and shrubs per hectare should be 8.4% and 91.6%, respectively [7]. On the school grounds, the density of plantings per 1 hectare of urban greened territory is as follows: trees - 180 pieces (6.2%), including: medium - 170 pieces, large 10 pieces, shrubs - 2,700 pieces (93.8%). In kindergarten, the estimated plant density per 1 ha of the greened area for the steppe conditions: trees - 6.2%, shrubs - 93.8% [8].

Thus, studies have shown that the diversity of life forms used in urban gardening is very scarce. Such objects as trees, shrubs and vines dominate on the objects of landscaping. The life forms of a tree are represented mainly by forest-type trees (spruce, poplar, birch, maple, elm) and less fruit-like (ordinary apricot, Tatar maple). When organizing plantings, no attention is paid to preserving the structure of plantings like the natural one. Layering in arrays is simplified, thus the structure of the phytocenosis in urban planning is impoverished.

4. Design and recommendations

Trees and shrubs are important in landscaping, as they allow you to create multi-tiered plantations and thereby enrich the species diversity of the urban environment.

For landscaping the city, it is recommended to use, besides the previously discussed issues, such life forms as stan-trees, trees-pillows, semi-shrubs, shrubs, which will be included in various dendrological groups. In order to enrich the tree assortment and increase the sustainability of urban plantings, dendrological groups were developed for landscape construction in the city of Volgograd.

In the dendrological group No 1 there is a multi-tiered (5-tier) tree composition:

- forest type: small-leaved linden (*Tilia cordata*), English oak (*Quercus robur*), Norway maple (*Acer platanoides*); maple leaf (*Platanus x acerifolia*);
- forest-steppe type: black mulberry (*Morus nigra*), rowan (*Sorbus aria*);
- bush type: hawthorn semi-mild (*Crataegus submollis*);
- trees - stanians: mountain pine (*Pinus pumila*);
- trees - pillows: thuja western f. globular (*Thuja occidentalis*),
- and also bushes: panicle hydrangea (*Hydrangea paniculata*) and shrubs: common heather (*Callúna vulgáris*) [9].

Dendrology group has noise absorbing ability, it is smoke and gas resistant. Shrubs represented in the group are well tolerated in urban conditions. Ecological features of this group are manifested in high winter hardiness and low soil requirements. Agrotechnical methods of plant care do not present difficulties [10].

To create a dendrogroup No 2 with such life forms as a liana and stanza trees, the following plants can be used: Siberian prince (*Atragea sibirica*), Schisandra chinensis, Chinese dwarf birch (*Betula nana*) and mountain pine (*Pinus pumila*). The ecological features of the group consist in the fact that the plants in it are moderately demanding to soil fertility and moisture, rather winter-hardy.

5. Conclusion

Thus, the structure of phytocenosis created artificially in an urban environment should be as close as possible to the natural one. In green building it is necessary to use various life forms: trees of different types, shrubs, semi-shrubs and lianas. This approach enriches the species diversity of the urban environment, increases the layering and sustainability of plantations. Tiered tree plantations are resistant as a result of the active interaction of various organisms on all "floors" in the structure of the phytocenosis. In addition, a microclimate is formed in such a community, contributing to the growth and development of vegetation. In particular, the air humidity under the canopy of trees increases, the amount of organic waste and, as a result, the activity of soil organisms increases.

Multi-tiered tree planting more effectively perform noise-dust-gas protection functions. The use of various life forms in the structure of urban phytocenosis will allow creating long-term and sustainable tree plantings in the urban ecosystem.

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