Selection of herbaceous plant assortment for park ground cover using plants of natural phytocoenosis

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Abstract. The modern direction of landscape architecture to creation of ecological and naturalistic plant communities of perennial herbaceous species for the design of park walking routes in the style of “naturgarten” is highlighted in this paper. The principles of selection of herbaceous perennials developed by Russian scientists for planting in urban environments, as well as the principles of creating combinatorial plantings are given. The range of perennial herbaceous plants proposed to create a ground cover along the park walking route with an indication of their environmental requirements is presented in the Tables. The type and storey of plantings where these plants can be used, the flowering period and in the note the additional features of a particular species are indicated. This material can be further used in the design of structural modules of the ground cover according to the type of natural phytocoenoses for park areas with different environmental conditions.

1 Introduction

There is a tendency to create ecological gardens and parks in which biodiversity is maintained and expanded. A sustainable landscape is created in an urbanized environment and the use of water, energy resources and labor costs for agrotechnical care of such plantations are rationalized. All this is clearly seen at the present stage of development of the world landscape architecture.

In this regard, the study of decorative and ecological features of plants of the natural phytocoenosis is relevant at the present stage.

2 Research purpose

The substantiation of the range of herbaceous plants to create a park ground cover on the basis of the plants of the natural phytocoenosis.

3 Research tasks

1. Study of ecological requirements (relation to illumination, humidity, pH and soil fertility) of the plants of the natural phytocoenosis.
2. Evaluation of the flowering period and other decorative features of the plants of the natural phytocoenosis.

Scientific novelty lies in the analysis of ecological requirements and ornamental qualities of the plants of the natural phytocoenosis to justify the range of herbaceous plants with the aim of designing green ground cover in the style of Naturgarten preserving the decorativeness during the whole season.

4 Results

The study of ecological requirements and decorative features of the plants of the natural phytocoenosis allows to design a ground cover for open, closed and semi-open park spaces. As a result, the artistic value of the spaces adjacent to the walking route significantly increases.

Historically, in Russia, in urban landscaping, the flower beds were usually designed from annual flowering and decorative deciduous plants (with a very limited range) on a lawn background. Ornamental grasses and herbaceous perennials were not commonly used in the urban flower beds.

Modern ecological – naturalistic vision of the park flower beds and ground cover promotes the expansion of the range of herbaceous plants with the involvement of ornamental perennials and grasses close in their image to the plants of natural plant communities as well as the plants of the natural phytocoenosis that can grow together in the same area under the same environmental conditions.

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Table 1. The range of plants for greenbelt setting of open spaces (meadow phytocoenosis)

| № | Latin name | Family | Planting type | Storey of planting** | Ecological conditions | Flowering period | Notes |
|---|------------|-------|---------------|----------------------|----------------------|-----------------|-------|
| Calamagrostis acutiflora | Grasses (Poaceae) | Mono plantings, matrix, mixed | Upper, 150–200 cm | Sun | Drainage | Any soils | VII | The leaves are golden – yellow in autumn. Aggressive |
| Phalaris arundinacea | Grasses (Poaceae) | Mono plantings, matrix, mixed | Upper, 100–150 cm | Sun | Excessive but the plant is drought resistant | Any soils, pH: 6.0–8.1 | VI | Aggressive |
| Glyceria maxima | Grasses (Poaceae) | Mono plantings, matrix, mixed | Medium, 50–60 cm | Sun, semishade | Excessive | Light loam and peat soils, pH: 6.0–6.5 | VI–VIII | Leaves in autumn turn a reddish tone |
| Miscanthus sinensis | Grasses (Poaceae) | Mono plantings, matrix, mixed, single | Upper, 20–250 cm | Sun, semishade | Sufficient | Light loam and peat soil, pH: 6.1–7.8 | VII–VIII | Leaves in autumn turn yellow |
| Deschampsia cespitosa | Grasses (Poaceae) | Mono plantings, matrix, mixed | Medium and upper, 30–100 cm | Sun, semishade | Sufficient | Any soils, pH: 3.7–8.0 | V–VII | – |
| Carex hirta | Sedge family (Cyperaceae) | Mono plantings, matrix, mixed, blocks | Bottom and medium, 10–60 cm | Sun, semishade | Sufficient | From wet clay to dry, sandy | IV–VI | Aggressive |
| Carex acuta | Sedge family – Cyperaceae | Mono plantings, matrix, mixed, blocks | Medium, 40–100 cm | Sun, semishade | Excessive, Riparian plant | Any soils, but better muddy | VI | Aggressive |
| Primula veris | Primrose (Primulaceae) | Mixed, blocks | Bottom, 30 cm | Semishade | Sufficient | Light soil | V–VI | Yellow color |
| Ranunculus ficaria | Crowfoot family (Ranunculaceae) | Mixed, blocks | Bottom, 5–30 cm | Sun | Sufficient | Loam, pH: 6.5 | IV–V | Yellow color |
| Anemone nemorosa | Crowfoot family – (Ranunculaceae) | Mixed, block | Bottom, 25 cm | Semishade, shade | Sufficient | Light loam, pH: 6.5 | IV–V | White color |
| Alchemilla vulgaris | Rose family – Rosaceae | Mono plantings, mixed, blocks | Bottom, 30 cm | Sun, semishade | Sufficient | Loam, pH: 6.0 | V–IX | Green and yellow color |
| Pulmonaria obscura | Borage family – Boraginaceae | Mixed, block | Bottom, 30 cm | Semishade, shade | Sufficient | Light loam, pH: 6.1–7.8 | IV–V | Red-lilac-blue color |
| Polygonum bistorta | Buckwheat family – Polygonaceae | Mono plantings, blocks | Upper, 100 cm | Sun | Excess-sive | Any soil, but better fertile, peaty | V–VII | Pale pink color |
| Thalictrum aquilegifolium | Crowfoot family – Ranunculaceae | Matriz, mixed | Upper, 150 cm | Sun, semishade | Sufficient | Light loam, pH: 6.5 | VI–VII | White, purple color |
In this article, the criterion for plants selection was their natural appearance and high winter hardness. Such plants can be used to create a ground cover in the walking area of the park in accordance with the natural light conditions [3].

Table 1. Ending

| Plant Name                  | Family                  | Floral habit         | Height (cm) | Light requirement | pH      | Flower Color                  | Notes |
|-----------------------------|-------------------------|----------------------|-------------|------------------|---------|------------------------------|-------|
| Campanula latifolia         | Campanulaceae           | temporary plantings  | 70–150      | Sun, semishade    | 6.5–7.0 | White                        | VI–VII |
| Leucanthemum vulgare        | Asteraceae              | temporary plantings  | 45          | Sun              | Any     | White color                  | VI    |
| Tanacetum vulgare           | Asteraceae              | temporary plantings  | 80–120      | Sun              | Any     | VII–X Yellow color           | Undemanding |
| Geranium pratense           | Geraniaceae             | temporary plantings  | 60          | Light loam       | VI–IX | Pink color                  | Undemanding |
| Lythrum salicaria           | Lythraceae              | temporary plantings  | 80–120      | Sun, semishade    | Any     | Volatile oil plant           | Tolerates stagnant over-wetting |
| Salvia pratensis            | Lamiaceae               | temporary plantings  | 50–70       | Sun, semishade    | Any     | Pink blue-violet color       | Volatile oil |
| Veronica spicata            | Scrophulariaceae        | temporary plantings  | 70          | Light loam       | 6.5–7.0 | VI bright blue, blue color    | Biennial plant, environmentally plastic, high reproduction rate |
| Verbascum phlomoides        | Scrophulariaceae        | temporary plantings  | 80–200      | Light soils      | VI–X   | Yellow color                 | Pruning of withered blossoms to encourage reflowering |
| Nepeta × faassenii          | Lamiaceae               | temporary plantings  | 30–60       | Light loam       | 6.1–7.8 | VI–X lavender color          | Eugenia – leaves are dying by mid-summer |
| Tulipa acuminata            | Liliaceae               | temporary plantings  | 40          | Sabulous clay and light loam | V | Yellow with red stripes | Ephemeral – leaves are dying by mid-summer |

Notes: Planting type: mono plantings, matrix, temporary plantings, blocks, mixed, single. ** Planting storey: bottom (10–30 cm), medium (30–70 cm), upper (70–140 cm) *** Illumination: shade, semi-shade, sun **** Humidity: insufficient, sufficient, excessive

*Tulipa acuminata,* which is not typical for the natural phytocoenosis of the Non-Chernozem zone, was introduced into the proposed range to give more colorfulness to plantings in spring, especially since its appearance does not stand out from the general context.

One of the main tasks of a landscape designer working on the creation of park sceneries is the development of the original exclusive design providing the change of impressions. One of the possibilities to achieve this effect when creating pictures and landscapes in the style of "naturgarten" for different functional areas of the object (parade, walking, quiet recreation area), is to create compositions based on natural or more cultivated and even exquisite image of the same species of plants, but obtained as a result of selection [1, 2].

In this article, the criterion for plants selection was their natural appearance and high winter hardness. Such plants can be used to create a ground cover in the walking area of the park in accordance with the natural light conditions [3].
| No. | Latin name              | Family         | Planting type* | Storey of planting** | Ecological condition | Flowe-ring period | Notes                                      |
|-----|------------------------|----------------|----------------|----------------------|----------------------|------------------|--------------------------------------------|
| 1   | Molinia caerulea        | Poaceae        | Mono plantings, matrix, mixed | Medium – 70 cm       | Sun, semishade        | VIII–IX          | Grows early in spring                      |
| 2   | Luzula sylvatica        | Juncaceae      | Mono plantings, matrix, mixed | Bottom, medium, 20–70 cm | Semishade, shade     | V–VI             | Grows early in spring                      |
| 3   | Sagina subulata         | Caryophyllaceae| Mono plantings | Bottom 5–10 cm       | Sun                   | VI–IX            | Looks like moss                            |
| 4   | Poa pratensis           | Poaceae        | Mono plantings, matrix | Bottom, 20–70 cm     | Sun, semishade        | VI               | Foliage appears like moss                  |
| 5   | Milium effusum          | Poaceae        | Matrix, mixed    | Upper, 100 cm         | Shade, semishade      | VI–VII           | Foliage appears like moss                  |
| 6   | Corydalis solida(4.0)   | Fumarioideae   | “Excipients”, mixed, blocks | Bottom, 15 cm        | Shade, semishade      | IV–V Pink color | Foliage appears like moss                  |
| 7   | Hepatica nobilis        | Ranunculaceae  | “Excipients”, mixed, blocks | Bottom, 15 cm        | Shade, semishade      | IV–V Pink color | Foliage appears like moss                  |
| 8   | Gera-nium macrorhizum   | Geraniun       | Mono plantings, matrix | Bottom, 20–25 cm     | Sun, semishade        | VI               | Foliage appears like moss                  |
| 9   | Campanula latifolia     | Campanulaceae  | Temporary plantings, mixed | Upper, 70–150 cm     | Sun, semishade        | VI–VII           | Foliage appears like moss                  |
| 10  | Polygonatum multiflorum | Liliaceae      | Mono plantings, mixed | Medium, 30–90 cm     | Shade, semishade      | VI–VII           | Foliage appears like moss                  |
| 11  | Aster alpinus           | Asteraceae     | Mono plantings, mixed | Bottom, 25–30 cm     | Sun, semishade        | V–VI White color | Foliage appears like moss                  |
| 12  | Dryopteris filixmas     | Dryopteridaceae| Mono plantings, mixed | Upper, 120 cm         | Shade                 | – Grows well in a spruce forest             |
| 13  | Matteuccia struthioteris| Woodsiaceae    | Mono plantings, mixed | Upper, 150 cm         | Sun, semishade        | – Grows well in a spruce forest             |
| 14  | Rodgersia ascalifolia   | Saxifragaceae  | Mono plantings, mixed | Upper, 150 cm         | Shade, semishade      | VI White color | Foliage appears like moss                  |
| 15  | Podophyllum peltatum    | Berberidaceae  | Mono plantings, temporary plantings, blocks | Medium, 30–50 cm | Sun, semishade        | V–VI White color | Foliage appears like moss                  |
| 16  | Asarum europae          | Aristolochiaceae| Mono plantings, mixed | Bottom, 30 cm         | Shade, semishade      | Winter-green plant | Foliage appears like moss                  |

Notes:
* Planting type: mono plantings, matrix, temporary plantings, blocks, mixed, single plantings.
** Planting storey: bottom (10–30 cm), medium (30–70 cm), upper (70–140 cm)
*** Illumination: shade, semi-shade, sun
**** Humidity: insufficient, sufficient, excessive
In our research, we selected and analyzed the species of the plants of the natural phytocoenosis that could be used to create a ground park cover along the walking route passing through the open, semi-open and closed park spaces. In each case, there is a specific environmental situation in terms of the illumination of the areas, humidity, fertility and acidity of the soil. In addition, we took into account the seasonal changes in the decorativeness of the plants in order to ensure the aesthetic appeal of the surroundings of the route from spring to autumn.

Most often in the Non-Chernozem zone in the open areas, a meadow plant community is formed, which is dominated by perennial herbaceous plants (sedge and grass families), growing in conditions of sufficient or excessive moisture. A soddy type of soil formation is characteristic for meadows. Depending on the conditions of a particular place, the fertility and moisture content of these soils can be quite different.

The list of the plants for decoration of open areas that contribute to the image of meadow phytocoenosis is presented in Table 1 with the indication of their main environmental requirements, decorative period and planting place.

The forest phytocoenosis, which is developed within semi-open and closed park spaces, is a complex plant community consisting of woody, shrubby vegetation and a ground cover.

In comparison with the closed park spaces, semi-open spaces are lit better due to the sunrays penetrating them. A characteristic feature of the forest phytocoenoses is the formation of the forest litter from the leaf or coniferous litter, in which the root system of herbaceous perennials is located.

The selection of perennial herbaceous plants for the ground cover is recommended in accordance with the species composition of trees in the park.

Taking into account all above stated, the range of perennial grassy plants offered for the design of a ground cover of the closed and semi-open park spaces solved in the style of natural phytocenoses (1) is presented in Table 2.

In order to achieve the naturalism, the boundaries of artificially created plant communities should be smoothed. This goal may well be realistically, as most of the selected species of the plants have a pronounced plasticity relative to the environmental conditions of the area.

5 Conclusion

The proposed range of the herbaceous perennial plants can be used in the design of structural modules of the ground cover for park areas with different environmental conditions.

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