Preservation of the Biological Diversity of an Industrial City

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Abstract. Study of the taxonomic diversity of the native flora in the green plantations of the industrial city of Monchegorsk. Large areas of the northern taiga have been preserved in the forest parks. Among the native flora the most common are trees, shrubs and dwarf shrubs (68%). Coniferous are dominated (Pinus friesiana, Picea obovata). Deciduous tree species are represented by birch trees: (Betula czerepanovii, B. pubescens), willows (Salix caprea, S. glauca), rowan (Sorbus gorodkovii). Due to the advantageous location of Monchegorsk relative to the "Severonickel" plant, it is possible to preserve the natural flora within the city.

1. Introduction

The nature of the Arctic, in addition to potentially significant reserves of hydrocarbon and mineral resources, is characterized by significant biological diversity. In the western part of the Russian Arctic there are areas industrialized in the first half of the XX-th century. The Murmansk region is the most diversified with a developed mining industry, metallurgy and electric power industry [1]. The Russian Wildlife Fund (WWF Russia) estimated that about 80% of black carbon emissions from diesel plants associated with anthropogenic activities in the Russian sector of the Arctic come from the Murmansk region and the Norilsk industrial region [2]. The use of environmentally aggressive technologies, transport, and fuel negatively affects biodiversity and the preservation of the unique flora and fauna of the Arctic territories. Murmansk region is one of the centers of non-ferrous metallurgy in the North-West of Russia. The "Pechenganickel" and "Severonickel" factories of the Kola Mining and Metallurgical Company are considered as the largest sources of technogenic pollution in the Euro-Arctic region. The share of this enterprises account from 70 to 90% of the annual emissions of sulfur dioxide and almost 100% of nickel and copper in the Murmansk region. As a result of the long-term impact of technogenic emissions in the impact zones of these enterprises there were formed depressed territories, characterized by high acidity and extreme content of Cu and Ni in soils [4].

Researches of the influence of mining and metallurgy on the biota of cities of the Murmansk region has been conducted since the 90s of the XX century. Relevant for solving of urban planning, environmental and social issues are the study and conservation of the diversity of the flora of industrial cities [5, 6, 7, 8, 9, 10]. Objective of the research: to study the diversity of species of the native flora of the green plantations of the city of Monchegorsk.

2. Materials and methods

The studies were carried out in the city of Monchegorsk, located in the zone of the northern taiga, beyond the Arctic Circle (67 ° 56 22 N, 32 ° 52 26 E). The city was built in 1937 in connection with
the development of a copper-nickel deposit. Regarding the layout and building Monchegorsk is one of the best cities in the Kola Peninsula. It can be considered as an example of thoughtful design of an industrial city. The development of the city of Monchegorsk began in 1935. The author of the general plan of the city was the architect S. E. Brovtsev, he chose the landscape for construction in the foothills of the Monchetundra, taking into account the "wind rose". Large plots of northern taiga were preserved during the building of the city. The basis of the green spaces of Monchegorsk today is the natural vegetation that has been preserved in the City Park and large forest park areas. For each inhabitant of the city of Monchegorsk there are more than 15 m² of green plantations. Currently the area of urban green spaces is 112,94 hectares, of which 71.53 hectares are public spaces, 87% of the latter are represented by areas of the northern taiga [5]. Green plantations are in the zone of emissions of the copper-nickel plant "Severonikel", which is located in 13 km from the city. A study of 10 objects of landscape gardening was carried out in Monchegorsk (Fig. 1). A taxonomic analysis of the flora has been executed based on generally accepted methods. All plant species were divided into two fractions: native and adventive. The Latin names of the species are given according to S.K. Cherepanov [11].

Figure 1. Location of the objects of landscape plantations on the territory of the city of Monchegorsk.

Designations: 1. City park 2. Green zone on Metallurgov Avenue 3. Eco-park in the area of Leningradskaya Embankment 4. Forest park on the Fersman Street 5. Park on Revolution Square 6. Park on the square Five Corners 7. Park near the children's clinic 8. Park on Kirova Street 9. Alley named after Igor Yermakov 10. The territory of the Holy Ascension Cathedral.

3. Results and discussion
As a result of floristic studies, it was found that the ratio of species of indigenous and adventive flora of the green plantations of the city of Monchegorsk is 1:1. Among the native flora the most common are trees, shrubs and dwarf shrubs (68%). Coniferous are the foundation of green plantations, the lapland pine (*Pinus friesiana* Wichura) - endemic species of Northern Fennoscandia is especially widely spread. According to some authors this is single form of pine in the Murmansk region. In the structure of landscape objects of the city there are a lot of Siberian spruce (*Picea obovata*). Among deciduous trees various species of birches (*Betula czerepanovii, B. pubescens* и *B. pendua*) are widely spread. In the parks of the city of Monchegorsk grows rowan Gorodkova (*Sorbus gorodkovi* Pojark) – a rare endemic species of Fennoscandia, listed in the Red Data Book of Eastern Fennoscandia [12] and the Red Data Book of the Murmansk Region. One of the few representatives of the genus *Sorbus*,
which is found in the polar regions. This is a fast-growing and frost-resistant species, widely distributed in urban green plantations of the Murmansk region. Rowan Gorodkova are used for landscaping of the cities of the Kola Peninsula since 1941. Willows are often found among the native species of shrubs (Salix caprea, Salix glauca). Willows (Salicaceae) are most diverse in the flora of Subarctic and retain their position in the urban flora of the city of Monchegorsk, as they are highly resistant to anthropogenic factors. Recent studies, conducted in the vicinity of the "Severonickel" and "Pechenganickel" factories also indicate a high tolerance of the local species - Betula czerepanovii and Sorbus gorodkovii - to the effects of heavy metals [13, 14]. Among shrubs and dwarf shrubs of the native flora on the botanical objects the following are common: Rubus idaeus, Ribes nigrum, Rosa acicularis, Vaccinium vitis-idaea, V. myrtillus, V. uliginosum, Empetrum nigrum. The trees and shrubs of indigenous flora are the priority life forms in all northern urbanized territories, since they are most adapted to cold climate conditions [15]. Within native grassy species dominate: Trientalis europaea, Chamaepericlymenum suecicum, Chamenerion angustifolium, Poa pratensis, Festuca rubra, Alopecurus pratensis and others. Unlike the city of Murmansk [16] local species of the green plantations of the city of Monchegorsk are more diverse due to the conservation of natural phytocenoses. It is known that the composition of species of the indigenous component of the flora depends on the conservation of the natural habitats in the urban environment and indicates its ecotopic diversity.

The City Park is one of the unique landscape objects of the city of Monchegorsk, it was the first in the Murmansk region and for a long time was the only one in the city, its area is 8.0 hectares [5]. The basis of the park are large plots of the northern taiga. In green plantations dominate: Lapland pine (Pinus friesiana), Siberian spruce (Picea obovata), aspen (Populus tremula), white birch (Betula pubescens). Goat willow (Salix caprea), northern willow (Salix glauca), rowan Gorodkova (Sorbus gorodkovii), bird-cherry tree (Padus avium) are presented in smaller amounts. Among the trees there are not so much shrunk trees, there is partial damage of the trunks, crowns and leaves. Dwarf shrubs are fragmentarily preserved in the ground cover: Vaccinium vitis-idaea, V. myrtillus, V. uliginosum, Empetrum nigrum. Despite the proximity of the copper-nickel plant, lichens from the genera Cladonia and Peltigera Pers have been identified in the park. Epiphytic lichens are absent [17].

The central compositional axis of the city of Monchegorsk is Metallurgov Avenue (formerly Zhdanova Avenue). It was laid in February 1936, when builders cut through this street in the taiga. In 1951 - 1954 the development of the avenue's western part was completed and local species of trees were planted in order to protect it from dust and gases (Fig. 2). There are stretches along the entire Metallurgov Avenue, dominated by aspen (Populus tremula), birch (Betula czerepanovii), rowan (Sorbus gorodkovii), bird cherry tree (Padus avium). There are some preserved coniferous trees - Lapland pine (Pinus friesiana) and Siberian spruce (Picea obovata).

Forest park on Fersman Street is a large plot of preserved taiga, on its territory the lake Komsomolskoe is located, it is an artificially created reservoir. In a forested area pine trees dominate (Pinus friesiana), also birches (Betula czerepanovii, B. pubescens), rowan Gorodkova (Sorbus gorodkovii). In smaller quantities Siberian spruce (Picea obovata), aspen (Populus tremula), bird cherry tree (Padus avium), various willows are found.

In 2007 on the shore of the lake Imandra, near the Leningradskaya Embankment, the first ecological park on the Kola Peninsula was opened. Eco-park is a territory with well-preserved northern taiga with specially equipped ecological trails. Several routes have been developed here: ecologo-biological, tourist, local history. Conifers dominate at the territory (Pinus friesiana, Picea obovata), there are a lot of deciduous tree species (Sorbus gorodkovii Populus tremula Betula czerepanovii, Betula pubescens). Among the shrubs and dwarf shrubs are common: Rubus idaeus, Vaccinium vitis-idaea, V. myrtillus. V. uliginosum, Empetrum nigrum.
It should be noted that despite the large share of natural green spaces in the city of Monchegorsk, their condition is disturbed by recreational activities. The City Park for a long time has been subjected to unregulated exploitation. The imperfection of the road network and the lack of plant care led to a strong violation of the structure of the lower tiers. Fragmentation of the soil cover occurred - small accumulations of mosses, lichens, grasses and shrubs alternate with spots of bare soils [17]. The same problems are typical for the territory of the forest park on the Fersman Street. As a result of high recreational loads the ground cover is damaged and the coast of the lake is heavily polluted.

4. Conclusion
The results of studies of the floristic diversity of the green plantations of the city of Monchegorsk showed that the share of native species of natural forest communities in the structure of landscape objects is high. Due to the advantageous location of Monchegorsk relative to the "Severonickel" plant it is possible to preserve the natural flora within the city. In recent years experts have noted an environmental improvement in Monchegorsk. The reduction of emissions of pollutants into the atmosphere, especially sulfur dioxide and dust, containing non-ferrous metals are the main area of activity of the production units of the "Nornickel" company in the field of reducing environmental impact.

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