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Quantitative indicators and functional diversity of soil microbial communities in the Russian Arctic cities

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Soil microbial properties are highly sensitive to anthropogenic disturbance and a considerable impact of urbanization on soil microbial activity and diversity was reported for various cities and climates. The quantitative parameters of the soils' microbiome in Arctic cities including the structure of microbial biomass and the number of ribosomal genes remain overlooked. This research aimed to compare quantitative indicators, as well as the functional diversity of soil microbial communities in the Arctic cities of Murmansk and Apatity located on the Kola Peninsula.

Murmansk (68.967 N, 33.083 E) is the biggest Arctic city in the world, located in the natural zone of the forest-tundra. Apatity (67.5°N, 33.4°E) is the fifth largest city in polar zone, located in the northern taiga zone.

Samples were collected from the topsoil horizons according to the standard sampling procedure with possible measures to prevent contamination. Quantitative assessment of the content of ribosomal genes of bacteria, archaea, and fungi was performed by real-time polymerase chain reaction (PCR). The prokaryotes and fungal biomass were determined by luminescence microscopy method. Community level physiological profiling (CLPP) was based on MicroResp^{TM} approach using substrates representing C sources of different quality: amino acids, carbohydrates, carboxylic and phenolic acid.

The number of archaea was an order of magnitude higher in Murmansk (predominantly 10^{10} of 16s rRNA genes/g soil) than in Apatity (predominantly 10^{9} of 16s rRNA genes/g soil); the number of 16s rRNA genes copies of bacteria was an order of magnitude lower in Murmansk (10^{9}-10^{10}) compared to Apatity; the number of copies of the ITS rRNA genes of fungi was the same for both locations - 10^{9} on average.

The biomass of prokaryotes was 5 times higher in Murmansk (5-25 µg/g soil) compared to Apatity (1-6 µg/g soil); the fungal biomass was 3.3 times higher in Murmansk (50-1000 µg/g soil) than in Apatity (40-300 µg/g soil). The length of the mycelium of actinomycetes in the soils of Murmansk (1-100 m/g of soil) was an order of magnitude higher than that in Apatity (0-10 m/g of soil); the

length of the fungal mycelium was 3.5 times longer in Murmansk (10-600 m/g of soil) than in Apatity (0-170 m/g of soil).

Soil microbial communities in Arctic cities had a similar physiological profile. Groups of microorganisms consuming carbohydrates and carboxylic acids prevailed. The soils of both cities contained microorganisms capable of decomposing complex organic compounds with a benzene ring, such as phenolic acids (vanillic and lilac), which indicates the potential for the destruction of difficult-to-decompose substances.

Thus, soil microbial communities in Arctic cities differ to a greater extent in quantitative parameters than in qualitative ones (on example of functional diversity). Probably, the quantitative parameters are more influenced by microclimatic conditions, type of vegetation, level of anthropogenic load, etc.

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