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Biofouling of granite-rapakivi in St. Petersburg monuments and in the quarry in Russia and Finland

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Granite-rapakivi was widely used in the architecture of St. Petersburg: the facades of buildings, embankments of rivers and canals, bridges, sculptural monuments, pedestals, facing the metro stations. This stone is rapidly destroyed due to the peculiarities of its structure. Biofouling of granite is insufficiently studied. Cause the destruction of granite can be bacteria, microscopic algae, fungi, mosses, lichens, higher plants, invertebrates and vertebrates. They often form specific lithobiotic communities that contribute to the destruction of granite-rapakivi. The objects of research were monuments of St. Petersburg (granite sculpture, facades, facing embankments) as well as granite-rapakivi quarries in Russia and Finland, where the stone was quarried for use in St. Petersburg. Sampling was carried out from the most typical biofouling sites. Different methods were applied for the study of damaged granite: petrographic analysis, light and scanning electron microscopy, methods for detection and identification of microorganisms, X-ray microprobe analysis.

As result the main forms of granite destruction were described: fractures, ovoid weathering, granular disintegration, surface films, crusts and layers, pitting and fouling. Lichens, mosses, herbaceous and micromycetes were dominated on the granite-rapakivi in quarries. For example, in a Monferran quarry (Virolahti region) the complicated lithobiotic community was revealed. It included 30 species of micromycetes, 31 species of lichens, 10 species of moss. Bacteriological analysis showed the dominance of bacteria Bacillus, and actinomycetes in microbial biofilms.

More than 100 species of plants were found on the granite embankments in St. Petersburg. They were confined to the cracks, seams of granite blocks. Plants and mosses were common to the granite embankments of rivers and canals in the central (historical) part of the city. Dimensions of mosses depend on the area of the deepening which they occupy. The most common species of moss was Pohlia nutans. This species was selected to assess the effect of vegetation on the destruction of the granite-rapakivi.

The contamination of the granite surface by the atmospheric pollutions contributes the formation of a saturated bacterial community with domination of spore-forming and mucous bacteria. On the surface of granite monuments in the urban environment the numbers of bacteria was 1,0x106 and over cells per gram of substrate. These bacteria are highly aggressive in relation to the substrate due to the active acid production. Dark-colored microscopic fungi were typical in areas of granite destruction. Using the scanning electron microscopy it was shown that colonies of black fungi are located in cracks and fissures of granite-rapakivi.

It can be concluded that the lithobiotic communities in the granite-rapakivi quarries are characterized by domination of mosses and lichens while in urban environment the microbial biofilms are predominated. Environmental conditions have an appreciable effect on surface of granite and development of lithobiotic community. The composition and structure of biofouling communities on the granite can be used for bioindication of ecosystems state.