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Terricolous lichens as biomonitor of environmental pollution in the Northern Eurasia

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Lichens absorb substances, including trace elements, through dry and wet deposition, and have been widely used as long-term biomonitors of air pollution. In the Northern Eurasia terricolous lichens have a widespread environmental occurrence and thus offer a possibility of testing both short- and long-range atmospheric transport of matter (including pollutants).

We studied multi-element composition of terricolous lichens (mostly of genera Cladonia and Cetraria) collected in 2004–2010 in Kola Peninsula, Karelia, Arkhangelsk Region, Komi Republic, Polar Ural, northern part of Western Siberia. In total, 145 samples were analyzed. The unwashed lichen samples were air dried and homogenised to a fine powder in an agate crusher. Samples were treated in a four-step chemical digestion procedure (full dissolution via acid attack) for major and trace element analysis. Element concentrations were determined by inductively coupled plasma-mass spectrometry (ICP-MS). Parts of dry samples were analyzed by instrumental neutron activation analysis (INAA). An enrichment factor (EF) was calculated for each element (X) relative to the composition of Earth's crust: EF = ((X/Al) in lichen) / ((X/Al) in the earth's crust). Al was used as a crustal indicator. In most samples the contents of Ti, V, Cr, Mn, Fe, Co, rare earth elements (REEs), Th, U are at the background level and their EFs are below 10. Such low EF values indicated that, relative to average values for crystal rocks, there was no significant enrichment of these elements in the lichen. For some elements (Se, Cd, Zn, Sb, Pb, As, Ni, Cu) consistently higher EF values were obtained. These higher values were interpreted in terms of sources of both anthropogenic and natural origin other than crustal rock and (or) soil. These elements could be derived by long-range atmospheric transport. Highest concentrations of Cu, Ni, Pb in lichens and EF by these elements were registered in the proximity of Monchegorsk and Nickel Cu-Ni smelters (Kola Peninsula). In the vicinity of Kostomukshsky Ore-dressing Mill lichens are enriched by Fe. In lichens collected at the White and Barents seas coasts, high Na content and EF values were revealed. In general, elemental composition of lichens in the Northern Eurasia reflects complex influence of atmospheric deposition of aerosols from both natural and anthropogenic sources.

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