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Lichens as biomonitor of atmospheric aerosol composition in the Northwest European Russia

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Numerous studies have shown that aerosols are of importance for atmospheric chemistry and climate of the Arctic. At the coasts of Arctic seas and in their catchment areas delivery of chemical elements and compounds are registered in natural archives, for example in lichens. Lichens absorb substances, including trace elements, through dry and wet deposition, and have been widely used as biomonitors. We studied multi-element composition of terricolous (mostly of genera Cladonia and Cetraria) and fruticose epiphytic (mostly of genera Alectoria, Usnea and Bryoria) lichens collected in 2004–2009 in Kola Peninsula, Karelia, Arkhangelsk Region and Komi Republic of NW Russia, mostly in the frame of International Polar Year activity. About 110 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) and 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 contents of Ti, V, Cr, Mn, Fe, Co, rare earth elements (REEs), Th, U are at the background level and their EFs are less than 10. These low EF values indicated that, relative to average values for crustal rocks, there was no enrichment of these elements in the lichen concerned. 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 sources 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 not far from 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 value were revealed. In general, elemental composition of lichens in the Northwest European Russia reflects complex influence of atmospheric deposition of aerosols from both natural and anthropogenic sources.

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