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Morphophysiological response of coniferous plants to industrial pollution in northwest Russia

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The significance of plants for the biosphere cannot be overestimated. Plants are biosphere components performing an enormous amount of geochemical work due, first of all, to their ways of mineral nutrition and water metabolism. In situ studies of the nutrient and water status of plants in areas with elevated industrial pollution levels permit early detection of changes in physiological processes in various plant species, and determination of how lasting these changes would be. The effects of industrial pollution with sulphur and heavy metals on the content and ratio of N:P:K and water potential were studied in the needles and needled shoots of Scots pine (Pinus sylvestris L.) and Norway spruce (Picea obovata Ledeb.) in 1991-1992 and 1996-2000. Sample plots were situated in dwarf shrub-lichen pine stands and true moss-dwarf shrub spruce stands in the Lapland reserve, 30 km away from the "Severonickel" smelter (Kola Peninsula). Simultaneously, the vitality status of the trees was determined visually (crown form, life span, needle damage and defoliation), grouping them into categories I - IV. Accumulation of sulphur and heavy metals was the same in needles from pine and spruce trees, and did not depend on the vitality status of the trees. Comparison of needle morphometric indices revealed significant distinctions in needle weight and length between trees of different vitality statuses. Study of the NPK content, N:P:K ratio and water potential in the needles and needled shoots of pine and spruce trees revealed nonlinear dependence of these indices on the vitality status of the trees. Both these results and data from cluster analysis allowed singling out three functional states (clusters) each with a certain biochemical status. The quantitative and qualitative structure of the clusters differed in pine and spruce trees. Possible mechanisms of adaptation of pine and spruce trees to anthropogenic impacts are discussed.