Uptake of ozone and its impact on silver birch

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Abstract: This thesis deals with the impact of ground-level ozone (O_3) on silver birch, *Betula pendula*. The impact is studied from an ecophysiological perspective, focusing on how the O_3 molecules enter the leaves through the stomata and how the plant responds to O_3 by changing its acquisition and allocation of resources. By relating the plant responses to the stomatal uptake of O_3, this thesis contributes to the ongoing work within the Convention on Long-Range Transboundary Air Pollution (CLRTAP) to establish uptake-based Critical Levels for the impact of O_3 on plants. The O_3 effects on the growth and leaf senescence of young birch trees were studied in a two-year open-top chamber experiment at Östad, 50 km northeast of Göteborg, Sweden. O_3 inhibited photosynthesis and growth, and changed the carbon allocation to the disadvantage of the roots. The leaves in elevated O_3 were shed prematurely, without an efficient resorption of nitrogen to perennial parts of the plant. In order to estimate the stomatal uptake of O_3, different types of stomatal conductance (g_s) models were parameterised for juvenile as well as for mature birch. Multiplicative stomatal models were more successful in predicting g_s as compared to a combined stomatal-photosynthesis model. Juvenile trees had higher maximum g_s and a less pronounced stomatal closure in warm and dry air, as compared to mature trees. As a result, the capacity for stomatal uptake of O_3 was higher in juvenile trees than in mature trees. Stomatal closure in response to increasing evaporative demand prevented the twig xylem pressure from falling below –1.7 MPa in both juvenile and mature birch. The g_s models were used to estimate the stomatal uptake of O_3 in nine European O_3 experiments with birch. By relating the O_3-induced reduction in biomass production in these experiments to different indices of O_3 exposure, it was shown that the biomass reductions were more closely related to the stomatal uptake of O_3 than to the external exposure. Critical levels for the adverse impact of O_3 on birch are determined and discussed in relation to the Critical Levels within the CLRTAP. O_3 causes adverse effects on growth and leaf senescence of birch at levels that are frequently exceeded in southern Sweden. The predicted increases in both the use of birch in Swedish forestry and the concentrations of ground level O_3 suggest that the role of O_3 as a stress factor for Swedish forests is likely to increase in the future.

Keywords: allocation, *Betula pendula*, biomass, critical levels, growth, nitrogen resorption, ozone, ozone flux and uptake, photosynthesis, senescence, stomatal conductance

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