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Impact of pollen on throughfall biochemistry in European temperate and boreal forests

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Pollen is known to affect forest throughfall biochemistry, but underlying mechanisms are not fully understood. We used generalized additive mixed modelling to study the relationship between long-term series of measured throughfall fluxes in spring (April–June) at forest plots and corresponding airborne pollen concentrations (Seasonal Pollen Integral, SPIn) from nearby aerobiological monitoring stations. The forest plots were part of the intensive long term monitoring (Level II) network of the UNECE International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) with dominant tree genera *Fagus*, *Quercus*, *Pinus* and *Picea*, and were distributed all across Europe. We also conducted a 7-day laboratory dissolution experiment with bud scales and flower stalks of European beech (*Fagus sylvatica* L.), pollen of beech, common oak (*Quercus robur* L.), silver birch (*Betula pendula* L.), Scots pine (*Pinus sylvestris* L.), Corsican pine (*Pinus nigra* Arnold ssp. *laricio* (Poiret) Maire), Norway spruce (*Picea abies* (L.) Karst.) and sterilized pollen of silver birch in a nitrate (NO_3^--N) solution (11.3 mg N L^{-1}). Throughfall fluxes of potassium (K^+), ammonium (NH_4^+-N), dissolved organic carbon (DOC) and dissolved organic nitrogen (DON) showed a positive relationship with SPIn whereas NO_3^--N fluxes showed a negative relationship with SPIn. In years with massive seed production of beech and oak SPIn and throughfall fluxes of K^+ and DOC were higher, but fluxes of NO_3^--N were lower. The experiment broadly confirmed the findings based on field data. Within two hours, pollen released large quantities of K^+, phosphate, DOC and DON, and lesser amounts of sulphate, sodium and calcium. After 24-48 hours, NO_3^--N started to disappear, predominantly in the treatments with broadleaved pollen, while concentrations of nitrite and NH_4^+-N increased. At the end of the experiment, the inorganic nitrogen (DIN) was reduced, presumably because it was lost as gaseous

nitric oxide (NO). There was no difference for sterilized pollen, indicating that the involvement of microbial activity was limited in above N transformations. Our results show that pollen dispersal might be an overlooked factor in forest nutrient cycling and might induce complex canopy N transformations, although the net-impact on N throughfall fluxes is rather low.

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