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Spruce and surface water acidification: an extended summary

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Introduction

It has been proposed that vegetation and soil changes resulting from changes in land use cause surface-water acidification. The expansion of spruce forest, from natural colonization and from afforestation, has been one of the major changes that has taken place in the vegetation of South Sweden during this century. Spruce has been favoured at the expense of broad-leafed trees by forest management and has been planted on open land, abandoned farm land and in forests. Since the 1920s, the area covered by spruce forest has increased by 2.3 million ha† in Götaland and Svealand, and the frequency of spruce trees in the forests has increased from 11.5 to 33.5 % (data from Department of Forest Survey, Swedish University of Agricultural Science, Umeå). Götaland and Svealand comprise the southernmost third of Sweden, the area that suffers most from lake acidification.

Spruce colonization alters soil conditions. In several investigations, in which conditions in spruce and birch stands have been compared, significantly lower pH values have been recorded in spruce forest soils. It has been suggested that spruce expansion also leads to lake-water acidification, but this has not been confirmed. Unfortunately, it is difficult to design an investigation aimed at studying the acidification effects of spruce forest under prevailing levels of atmospheric pollution because there are problems in distinguishing between true vegetation–soil effects, effects of air pollution, and combined effects.

To assess whether spruce forest *per se* causes lake-water acidification, we have studied the effects of the natural immigration of spruce that reached northern Sweden from the northeast about 3000 years ago, before there was any acid precipitation from fossil-fuel combustion. Palaeoecological studies indicate that spruce colonized land that was occupied by birch, alder and pine.

Methods and study sites

Lakes in areas with poor soil conditions, and thus sensitive to acidification, were selected for the investigation. A further criterion was that the lake catchments should have no, or very small amounts, of peatland, as peat growth and peatland expansion may alter lake-water pH. Eight lakes were studied, six are acidic today (pH 4.5–5.2). In two of them the recent pH trends have also been reconstructed by diatom analysis. These studies verify that the lakes were acidified during the last few decades.

Pollen analysis was used to determine the level of spruce immigration in each sediment core and to reconstruct the vegetation history. Diatom analyses were done on sediment samples taken both below and above the spruce immigration level, to reconstruct pH history before, during and after the spruce immigration; pH was reconstructed by weighted averaging. Diatoms were also classified into Hustedt's pH preference groups.

† 1 ha = 10^4 m^2.

Results and conclusions

Although the diatom assemblages changed slightly in some of the lakes during the periods studied, there was no increase in the relative frequencies of acidophilous and acidobiontic taxa. There were no signs of acidification of the lakes at, or within a few hundred years after the spruce immigration as indicated by diatom-inferred pH. The present investigation does not, therefore, indicate that spruce expansion *per se* causes lake acidification. It is important, however, to point out that spruce canopies are effective filters for aerosols, and that a combination of spruce and air pollutants may contribute to surface-water acidification.

This is an extended summary of a paper to be published elsewhere.

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