



Assessing and developing palynological tools for quantitative reconstructions of human impact on vegetation in Fennoscandian boreal forests

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Palynological methods are widely used in assessing the human impact on vegetation through time, yet these human induced changes in the vegetation in the northern boreal vegetation zone of Fennoscandia are often difficult to differentiate from those resulting from climatic variation. In the present study, three different approaches to interpret the human impact on vegetation are assessed: the modern pollen analogue technique, pollen accumulation rates and a modelling approach.

For the modern pollen analogue approach, 58 moss samples both from natural and human impacted sites were collected from northern Fennoscandia and analysed for their pollen content. Using RDA (redundancy analysis) and partial RDA it is possible to relate some pollen types to a specific human activity, e.g. *Rumex acetosa/acetosella*, *Achillea* type and *Solidago* type are related to settlement, whereas Gramineae and Cyperaceae are connected to trampling and grazing. A peat profile was collected from the vicinity of the Saariselkä tourist centre, Finnish Lapland, and 98 contiguous samples (2-4 mm thick) were analysed in order to interpret the human induced changes in the vegetation during the last centuries as reflected in the fossil pollen spectra. Principal components analysis (PCA) of the combined modern pollen analogue data set and the fossil pollen data set from the Saariselkä peat profile, however, shows that these human impacted pollen assemblages are not present in Saariselkä fossil pollen data, where human impact is seen only as a slight increase in the pollen of Gramineae.

Alongside pollen, coprophilous fungal spores were also counted from the fossil pollen slides to enable the estimation of the relative changes in the number of reindeer. The amount of coprophilous fungal spores is consistent with the increasing number of reindeer during the last decades.

On the basis of 15 ^{14}C -samples an age-depth chronology was created for the Saariselkä peat profile, which enabled the calculation of pollen accumulation rates (PAR, grains $\text{cm}^{-2} \text{year}^{-1}$). PARs show that the changes in pine forest density can be related to the historical data from the area, and that the PARs reveal the human impact slightly better than the pollen percentages do.

A subset of the moss samples ($n = 24$), together with the distance weighted plant abundance from a 10 km circle around the sampling sites, were used to establish pollen productivity estimates (PPE) for the six dominant taxa. PPEs are (reference taxon Gramineae = 1): *Pinus* 8.4, *Betula* 4.6, Cyperaceae 0.002, *Empetrum* 0.07, and *Vaccinium* 0.01. The radius of the relevant source area of pollen (RSAP) is estimated to be 1050 m. These estimates will be used in quantitative reconstructions of past vegetation by LOVE (Local Vegetation Abundance) model by Shinya Sugita (2006).

On the basis of these results, it can be concluded that the modern pollen analogue approach is not the best method for revealing slight human impact on the northern boreal vegetation. It is, therefore, recommended that when investigating human impact on comparable forest types i) further work with the modelling approach and ii) the use PARs should be employed.