POLLEN ANALYTICAL EVIDENCE FOR BRONZE-AGE CULTIVATION IN EASTERN FINLAND

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ABSTRACT

The land-use history of the surroundings of Lake Heinälampi, a small lake in Siilinjärvi (East Finland), with annually varved sediment, was studied palaeolimnologically. Pollen analysis revealed four phases of human activity, the oldest of which is dated to the Bronze Age. Two statistical methods were applied to the pollen data: DCA reveals the phases of both cultivation and geological history of the area. Rarefaction analysis produced estimates of species diversity and proved to be a sensitive method in identifying vegetation disturbances.

Introduction

Bronze-age cereal cultivation in South Finland has been shown both by archeological and palaeoecological evidence (reviews e.g. Meinander 1984 and Donner 1984). The historical province of Savo in East Finland has been considered a peripheral wilderness area with an economy based on hunting and fishing, where cereal cultivation was absent at that time (Meinander 1984).

In the present paper palaeoecological methods were applied in order to find and date the oldest signs of cereal cultivation and other human activities. The study site, Lake Heinälampi, was chosen for this study, because of the Pöljä subneolithic settlement site (Pälsi 1929), situated only 1 km west from the lake.

Lake Heinälampi - geology and history

Lake Heinälampi (63°07'N, 27°39'E) is situated in the Kuopio province in the commune of Siilinjärvi (fig 1). It is a small (3.2 hectares), 8 m deep lake with a 3.8 km^2 partly cultivated drainage area with fine silty soils. The bedrock consisting of Karelidic schists supports a relatively lush vegetation in this area, with many nemoral forest species such as lime (*Tilia cordata*) and mezereon (*Daphne merzereum*). Palaeolimnology of Lake Heinälampi has been previously reported by Grönlund 1991 and Sandman et al. 1990.

The geology and archaeology of the area are tightly linked to the history of the **Saimaa Lake complex**: the

Fig 1. Location of Lake Heinälampi in Finland

highest transgression shoreline lies at 103.8 m a.s.l. and the Pöljä site at 100 and 97.5 m a.s.l., that is, the Pöljä dwellings are situated on the regression shores formed after the Vuoksi opened ca. 5000 BP (Saarnisto

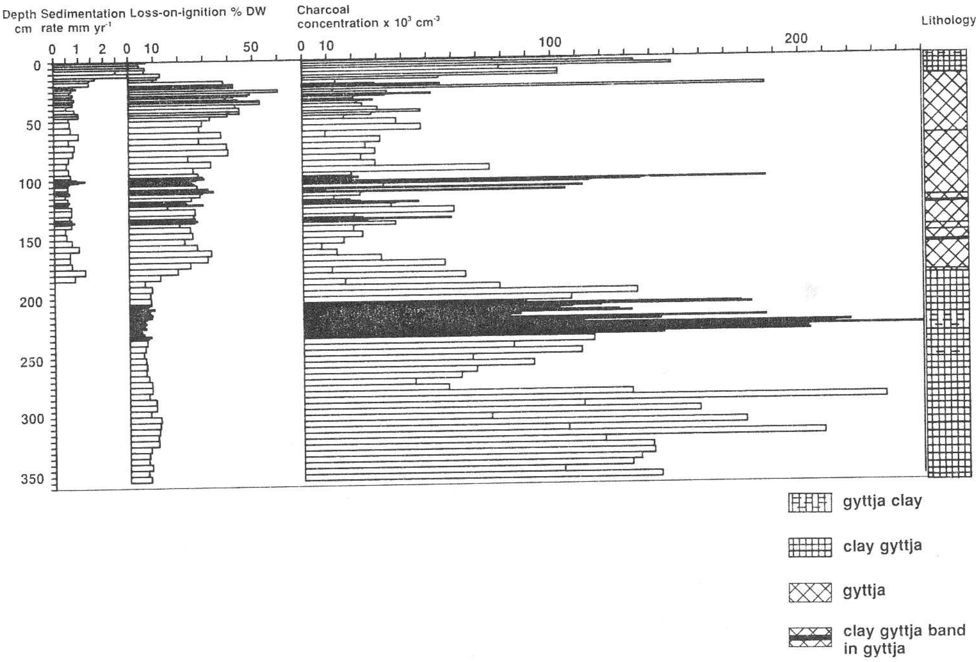

Fig 2. Sediment characteristics and charcoal particle concentration of the sediment. Dating of the core as in fig 3.

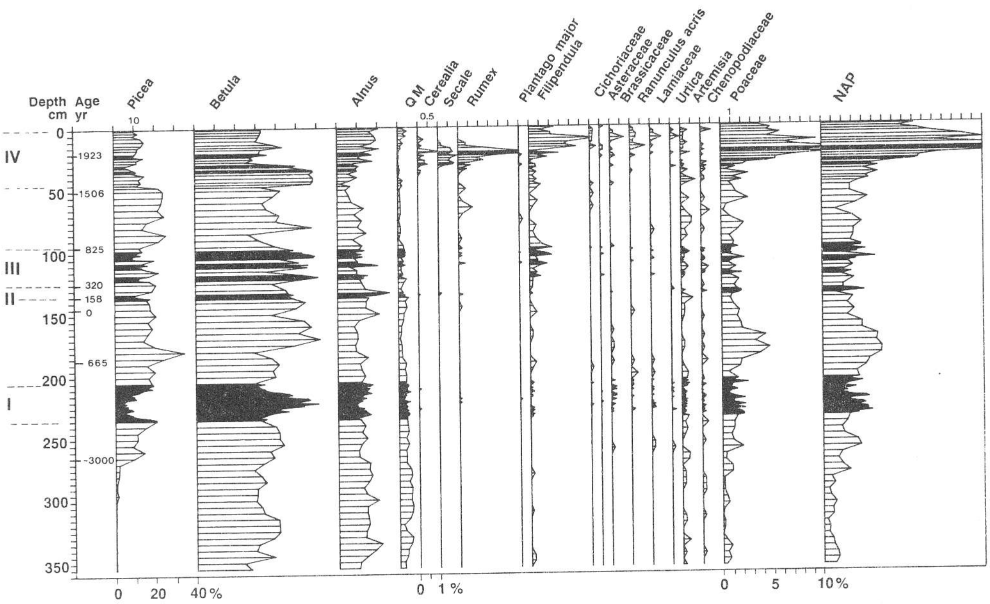

Fig 3. Relative pollen diagram of selected taxa. The numbers I-IV refer to phases of human activity (see text). The percentage base the sum of arboreal pollen for trees and the sum of land pollen for herb taxa. QM (= quercetum mixtum), southern deciduous tree species, NAP = non-arboreal-pollen. Dating is based on varves.

1970). The Pöljä group is generally dated to 2900 - 1800 BC (Carpelan 1978). As the elevation of Lake Heinälampi is only 89.9 m a.s.l. it is as a separate lake younger than the Pöljä subneolithic site.

There are no archaeological records from the metallic periods in the immediate vicinity of the lake. However, altogether 42 Lapp cairns are found within a radius of 20 km around Heinälampi, but only a few have been

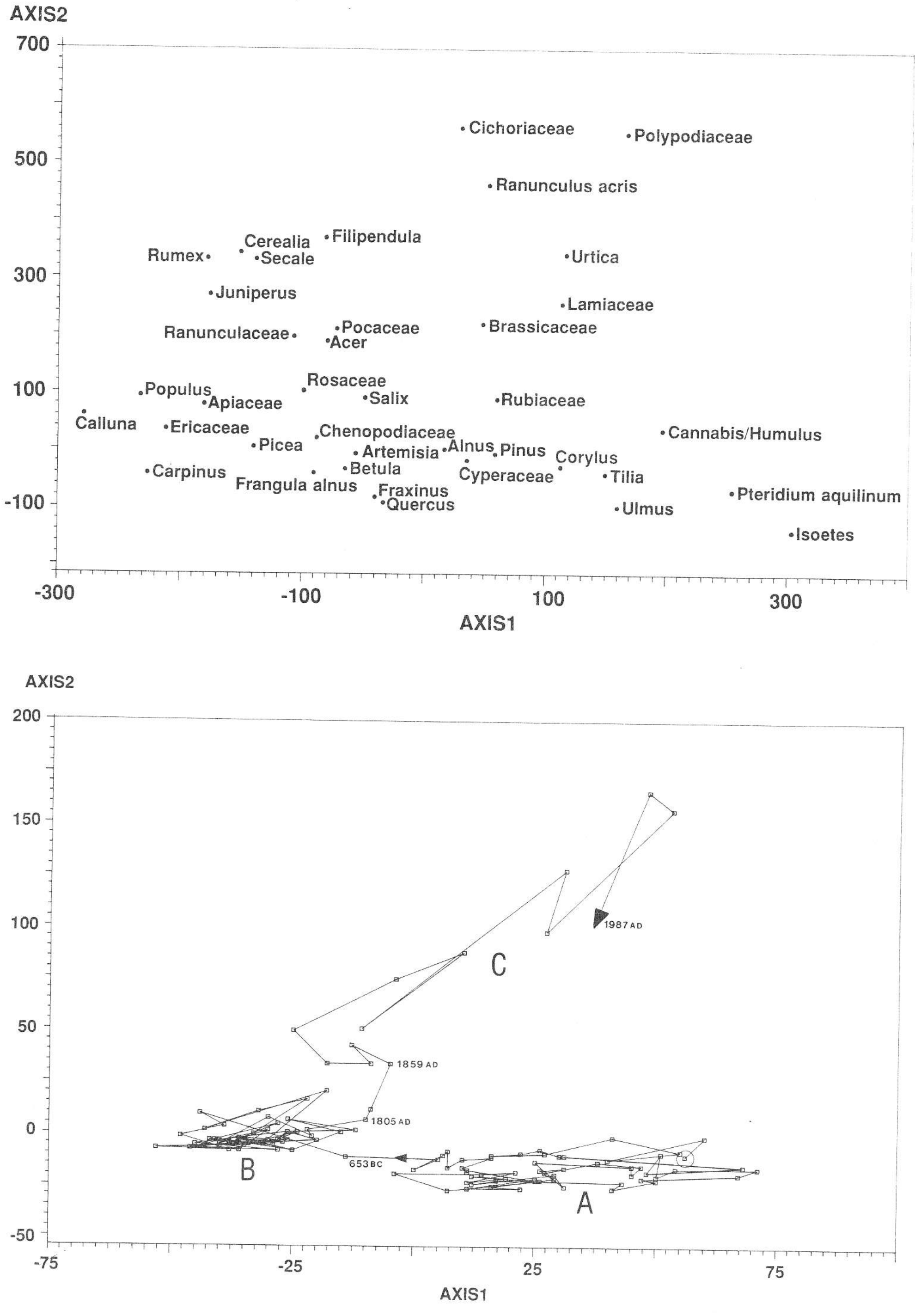

Fig 4. a) DCA-ordination of pollen species. b) Ordination of stratigraphic samples, axes 1 and 2. Eigenvalues: axis 1 = 0.099, axis 2 = 0.092.

archaeologically investigated (Pohjakallio 1982). One cairn relatively close to Heinälampi is dated to the Bronze Age. The nearest Iron Age finds are from the Kuopio area, 20 km south of Lake Heinälampi (Pohjakallio 1978).

Material and methods

Sampling and sample treatment

A 356 cm long sediment core was taken in 1988 with a piston corer. In the laboratory the fresh core was cleaned, photographed and cut into 1 cm high samples. The subsamples for pollen analysis were treated with standard procedures (Berglund & Ralska-Jasiewiczowa 1986). Loss-on-ignition (=organic content) was determined from these samples and diatom slides were prepared of selected levels. Results of the diatom analysis will be presented elsewhere (Grönlund et al., in prep.). The sediment proved to be regularly varved from the top down to 186 cm sediment depth. Varves were counted from the fresh core.

Statistical treatment of pollen data

Detrended correspondence analysis (DCA) is an ordination method that summarizes pollen assemblage patterns by positioning similar entities (species and samples) close together along the orthogonal DCA-axes (Hill & Gauch 1980). As palaeoecological data is highly multidimensional, this reduction in dimensionality greatly aids the correlation of sample levels, the interpretation of species turnover and the underlying environmental change. The DCA data set was composed of percentage (> 0.2 %) pollen data of terrestrial vascular species and spores of Polypodiaceae, *Pteridium aquilinum* and *Isoëtes* sp.

The pollen diversity, i.e., the number of pollen species was estimated with rarefaction analysis, which allows comparisons of species numbers when sample sizes are not equal (Hurlbert 1971, Simberloff 1979). The rarefaction data set consisted of terrestrial spore and pollen taxa. The rarefaction estimated species numbers, E(Sn), were calculated in a standardized count of 400 pollen grains in each sample. The analysis was performed with programs RARECEP and RAREPOLL by J.M. Line (see Birks et al. 1988).

Results and discussion

Sediment characteristics

The topmost 20 cm of the sediment consists of silty material eroded due to extensive field and forest ditchings since the 1930's (Sandman et al. 1990), which also account for the rapid sedimentation rate (fig 2). The sediment is varved organic gyttja down to 186 cm below which the sediment is highly minerogenic and unlaminated. The drastic increase in the organic content above 186 cm is due to the isolation of the lake from a larger basin during the regression phase of the Saimaa Lake complex. Annual laminae from the topmost 186 cm could be used in dating of the core; altogether 2652 varves were counted, the oldest varve date obtainable thus being 665 BC at 186 cm.

Cultural indication in the pollen spectra

In the pollen record, four different phases of human activity, separated by periods lacking signs of cultivation, can be distinguished (fig 3):

Phase I (235-205 cm; before 665 BC)

At the first phase two Cerealia-type pollen grains were found with a simultaneous increase in the relative amount of birch (*Betula* sp.) and a considerable decrease in spruce (*Picea abies*) pollen. Proportions and diversity of herb taxa increase at this stage, which reflects both the establishment of a pioneer vegetation to the shores emerged due to lake level regression and, also, human influence on the vegetation. This phase dates to the Bronze Age as it is obviously younger than the subneolithic period but clearly older than 665 BC, the oldest varve year.

Phase II (135-134 cm; 158-185 AD)

A short-lived but clear cultivation stage is dated to the Roman Iron Age. Pollen of Cerealia-type and rye (*Secale cerealia*) was found together with other culture indicating pollen types. Again, the proportion of spruce decreases. Also noteworthy is an increase of charcoal particle influx indicative for slash-and-burn cultivation being practiced in the area. At this stage Lake Heinälampi was already isolated with a relatively small drainage-area. The cultural indicator pollen was thus derived from a mainly local pollen source and slash-and-burn cultivation may have been practiced near the lake.

Phase III (125-95 cm; 320-825 AD)

No signs of cereal cultivation are revealed at this stage. However, human influence is indicated by fluctuations in spruce abundances and occurrence of pasture related pollen types e.g. plantain (*Plantago major/media*), sorrel (*Rumex* sp.), meadowsweet (*Filipendula ulmaria*) and aster-type (Asteraceae). The short-lived and presumably small cultivations need not to be actually manifested in the pollen analysis if one assumes that the fields were far enough from the lake.

Phase IV (47-0 cm; 1550 AD - present)

The most recent phase is characterized by drastic changes in tree pollen abundances: a sharp and stationary decline of spruce and an increase in birch (*Betula* sp.) and alder (*Alnus* sp.). Non-arboreal-pollen types reach their maximum. The changes are related to a dominantly slash-and-burn based cultivation practice, when shortening of slash-and burn rotational cycles led

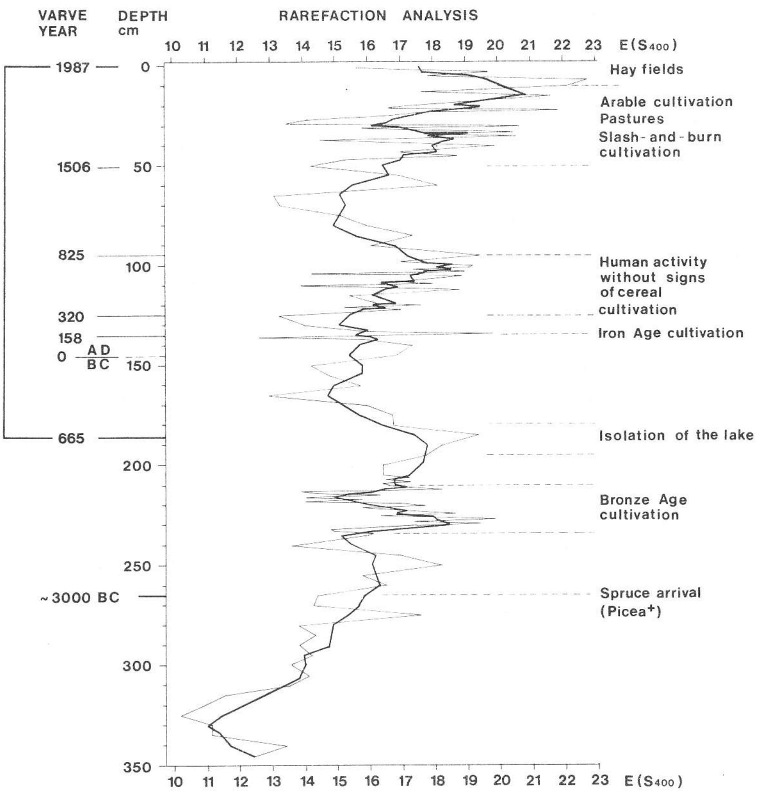

Fig 5. Stratigraphic plot of rarefaction estimates $E(S_{400})$ of species numbers (thin line) and floating mean of the estimates (thick line).

to an open landscape and no mature conifer forests existed nearby.

The first permanent fields near the lake shore were established as late as the early 1930's. This is reflected in the pollen spectra by the maximum abundances of weeds, and roadside or pasture indicating pollen types e.g. sorrel, meadowsweet, buttercup (*Ranunculus acris*-type) and wild grasses (Poaceae) at and above 20 cm sediment depth.

Detrended Correspondence Analysis (DCA)

By the DCA, the sample points are scattered in the ordination space in two well-defined groups and one looser group, that quite nicely accord with the temporal sequence of the samples. The groups are denoted as follows: A (352-187 cm), B (186-25 cm) and C (24-0 cm) (fig 4a and b):

Group A (before 653 BC) samples represent the time of "the big lake basin" and are associated with spores of quillworts (*Isoëtes* sp.) and bracken and pollen of hop/hemp (*Humulus/Cannabis*-type) and QM-forest species. The strong influence in the analysis of quillworts reflects the minerogenic quality of the sediment (Vuorela 1980), while the incidence of deciduous trees and bracken favourable light, climatic and edaphic conditions. These dominating pollen types cover up the first weak cultivation (phase I), not discernible in the ordination.

Group B (653 BC-1805 AD) samples appear very similar, i.e. they are situated very close each other mainly along the first DCA-axis. They are associated with both culture indicating species e.g. cereals, sorrels and juniper (*Juniperus communis*) and boreal forest species e.g. spruce, birch and heather (*Calluna vulgaris*). The cultivation phases in this group can not be individually distinguished, because they were of short duration and small-sized.

Group C (1859-1987 AD) samples are ordinated far from each other reflecting differences between the pollen assemblages. These samples are also scored high on both DCA-axes and associated with indicators of slash-and-burn cultivation and pasture. The samples representing the 1980's lack cereal pollen. The pollen assemblages indicate hay field cultivation for cattle and, also, redeposition of the deciduous tree pollen due to intensive soil erosion (Sandman et al. 1990).

The DCA results reflect the climatic conditions, the geological history of the lake and stages of human interference: the transition from the Subboreal period to the Subatlantic period and the isolation of Lake Heinälampi from the Saimaa Lake complex is manifested in the analysis by the marked differences between the DCA-groups A and B.

Rarefaction analysis

The peaks of the estimated species numbers E(Sn) are paralleled by the pollen phases of human activity, which were interpreted from the pollen diagrams (fig 5). The first cultivation, **phase I** and the isolation of the lake have high richness estimates. The cultivation **phase II** in the Iron Age was short and is therefore not clearly reflected in the rarefaction analysis. However, the pollen **phase III** has also a high E(S) although cereal pollen was not found. The intensive slash-and-burn phase (**IV**) increased the patchiness of the vegetation and consequently shows high species richness. The periods of low species richness are interpreted as times of weak disturbance i.e. stable vegetation.

Conclusions

This is the first report of Bronze Age cultivation from the eastern Finnish Lake District, where cereal cultivation has earlier been thought to be completely absent (e.g. Meinander 1984). An alternative explanation for the early cereal record in Heinälampi could be long-distance pollen transport, but the clear decline in spruce pollen and a general rise in NAP, also shown by the rarefaction analysis, strongly emphasise a local forest clearing period. The exact dating of the first cultivation phase was not possible, because the sediment was not annually laminated due to the geological history of the lake.

In this study also an Iron Age cultivation phase was found. Taavitsainen (1987) has argued that slash-and-burn agriculture could have been practiced during the Iron Age along with hunting and fishing in this peripheral wilderness area. Iron Age cultivation in the southern parts of the Savo province has earlier been shown by Simola et al. (1985, 1988).

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