Sedimentary Records of Human Occupation in the Eastern Finnish Lake District

Introduction

This paper presents an outline of the various palaeolimnological studies which have been carried out at the University of Joensuu, to gain insight into the ecological history of human occupation in the provinces of Savo and North Karelia in Eastern Finland. From early on (Huttunen and Meriläinen, 1978 ; Vuorinen, 1978), sediment laminations which are verifiable as annual varves (Simola, 1977 ; Simola *et al.*, 1984), have provided precise dating for many of these studies.

Conditions for the formation of varved lake sediments are rather favourable in the Finnish Lake District. The glaciated, generally flat terrain contains innumerable lake depressions, many of which are relatively deep. The lakes are dimictic with ice-cover in winter and often incomplete vernal circulation. Strong summer stratification develops especially in humic waters, in which radiation energy is retained in the surfical water. The deepest bottom thus easily develops anoxia – a common prerequisite for varves. The onset of varve formation has often been triggered off by human activities in the catchment. In Eastern Finland we know tens of lakes in which the varved sequence spans at least some centuries backwards from the present.

Sampling and sample treatment methods have been described by Huttunen and Meriläinen (1978) and by Simola *et al.* (1986). Simola (1991) deals with the structural elements of varved lake sediments.

Pollen-analytical studies of agriculture : complementing archaeology and evidencing population growth

The history of human occupation, especially the early phases of agriculture and concomitant vegetation changes, have been investigated by pollen analysis of laminated sediment deposits at several sites in Eastern

Finland; the lakes studied in this account are located between 61°40' – 63°07' N and 27°40' – 31°00' E (e.g. Simola *et al.*, 1985; Grönlund, 1991; Grönlund *et al.*, 1990, 1992). A summary (in Finnish) of these studies is presented by Simola *et al.* (1991b); a comprehensive review of the theme in English (Taavitsainen *et al.*) is in preparation.

So far the oldest evidence of agriculture in eastern interior Finland is from the Bronze Age (about 2500 B.P.), detected by pollen analysis in the sediment of a small lake in Siilinjärvi, north of Kuopio (Grönlund *et al.*, 1992). All the early signs of agriculture are of transient cultivation periods, and their weak palynological signals are well comparable with the present-day cultural pollen rain in Kuusamo, at the northern margins of arable cultivation in Finland (Hicks, 1985).

Palaeolimnological evidence of a grain cultivation period dating back to AD 600-700 in the Kerimäki area, east of the town of Savonlinna, led us to hypothesize an Iron Age origin for the numerous cup-stones known in that area (Simola *et al.*, 1985). Such cup-stones, presumed to have served as offering-places, are known from agricultural Iron Age contexts in the provinces of Finland Proper, Häme and the Karelian Isthmus. Due to an absence of any Iron Age archaeological finds in the Kerimäki area, they had been here interpreted as evidence of a medieval survival of the offering cult. Subsequent finds of Iron Age dwelling sites even in Kerimäki, by archaeological inventories of the Provincial Museum of Savonlinna, have given welcome support for our hypothesis. Furthermore, at another site, in the commune of Sulkava, in which an Iron Age cultivation phase was also verified by pollen analysis in a small lake (Grönlund *et al.*, 1990), a cup-stone has been since found in the vicinity of the lake (personal communication by Ms. Leena Lehtinen, Provincial Museum of Savonlinna).

Established, continuous cultivation in the Savo area first appears in suitable locations at around 1000 A.D. Summing up the cereal pollen rain in seven different lakes produced a pollen influx curve remarkably well-fitting to an exponential model, spanning from 850 to 1850 A.D. with an annual increment of 0.73 percent (Figs. 1, 2). Assuming simplistically that cereal production is proportional to consumption (Simola *et al.*, 1991b), the curve may be regarded as an estimate of the growth of the Karelian and Savonian tribes that have populated eastern interior Finland.

The steady population growth lasting for over a millennium was founded on swidden (or slash-and-burn) agriculture – a highly profitable means of ecosystem exploitation that, alas, requires vast land areas to remain sustainable (Taavitsainen, 1988). Population pressure was released by migration, first northwards, and during the 1600's, also to other uncultivated forested areas in Scandinavia (Finnskoga at the Swedish-Norwegian border; thence even to New Sweden in present-day Delaware in North America) and

North-Central Russia (Tver; at present the Kalinin area north of Moscow; see Simola *et al.*, 1991b and references therein). The unavoidable shortening of swidden cultivation cycles eventually led to an ecological and economic crisis: impoverishment of soils and shortage of construction timber (Heikin-

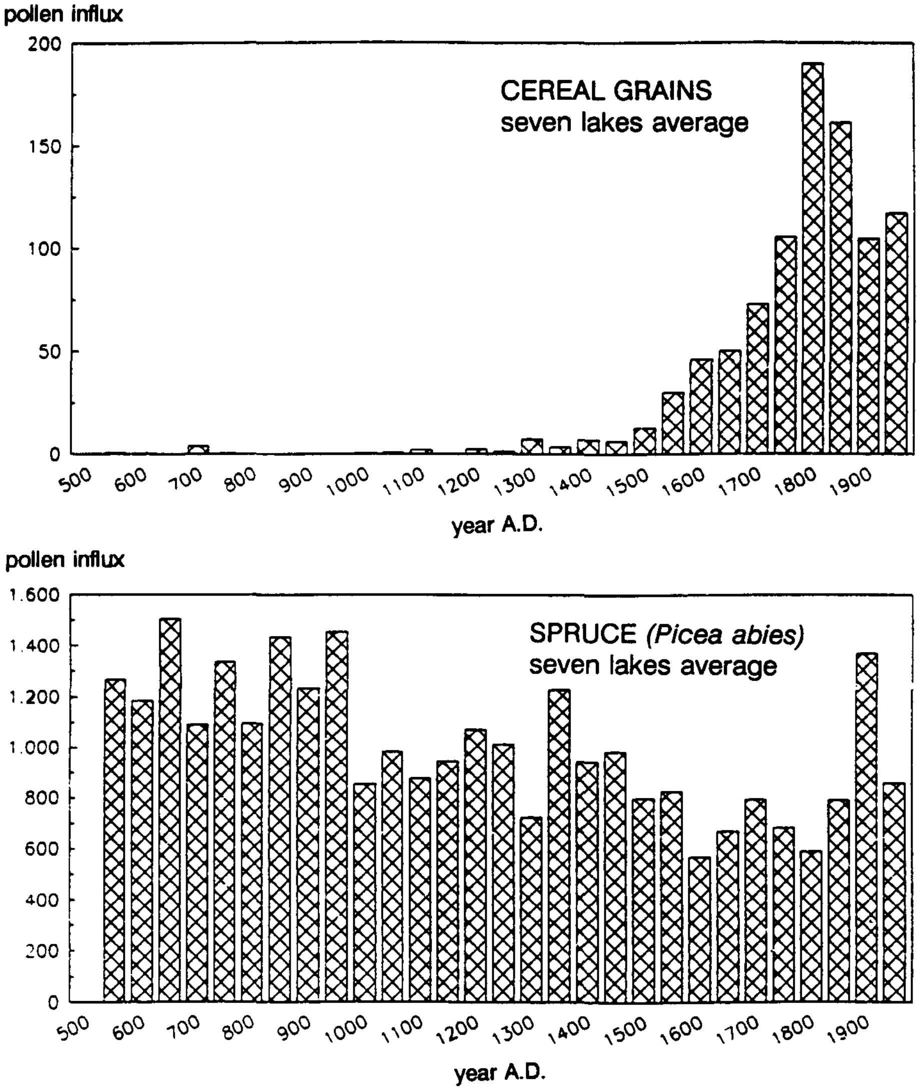

Fig. 1. Average influx of cereal pollen grains (upper panel) and spruce pollen (lower panel) in 50-year periods from A.D. 500 onwards in the varved sediments of seven small lakes in eastern Finland. Note different vertical scales for the two panels. The early signs of cultivation are weak and intermittent, but a definite decline of spruce, indicating burning of climax forests, is evident from about A.D. 1000. Cereal grains, together with other non-arboreal pollen, have their maximum in the sediments deposited during the 1800's, indicating maximal extent of the open swidden-agriculture landscape (Simola et al., *1991b).*

heimo, 1915, Soininen, 1974). The crisis could only be solved by changing over to permanent fields and cattle husbandry, which took place, partly forced by legislation, by the end of the 19th century in Eastern Finland, and is also seen in pollen diagrams as the decline of non-arboreal pollen since the mid-1800's (Simola *et al.*, 1991b).

Palaeolimnology: records of pollution and man-made catastrophes

Even the early cultivation phases affected lake ecosystems. This may be seen e.g. as changes in the sedimentary diatom flora indicating eutrophication that coincides with palynological evidence of cultivation (e.g. Vuorinen, 1978 and unpublished results). Expansion of the swidden cultivation led to increasing and more continuous leaching of soil nutrients, with often profound limnological consequences, including the onset of varve deposition in many lakes.

A specific cause of lake eutrophication was the retting of fiber plants, which brought quantities of decomposing organic material as well as nutrients directly into the lake. By pollen and macrofossil analyses it is possible to trace the preferred fiber-plant species, and even specific cultural practices: in Karelia, but not in Savo, nor in Western Finland, the male hemp plants were collected at flowering-time and retted separately to obtain the finest fibers, which is seen as very high hemp pollen quantities in some Karelian lake sediments (Grönlund *et al.*, 1986).

The ploughing history of permanent fields often appears as minerogenic bands in the sediment. More recent, prominent erosion events may be signs of various construction events in the lake's catchment (Sandman *et al.*, 1990).

Lowering of lake levels has been extensively practiced throughout Finland since the mid-1700's. Nearly all lakes and ponds in the inhabited areas have been more or less lowered; often only by some decimeters, in order to improve the drainage of moist shore meadows and fields, but in many instances by several meters, to gain new agricultural land from the exposed lake bottom. Some of these draining attempts turned into natural disasters, when the waters broke loose finding their own way instead of the attempted man-made outlet. One such legendary event was the catastrophic lowering of the large lake Höytiäinen near Joensuu in North Karelia in August 1859. As a result of dam failure the water level was lowered by 9.5 metres, exposing 170 km^2 of former lake bottom and flooding the recipient Saimaa lake system for some weeks. Stratigraphically this event is seen both in Lake Höytiäinen (Flower and Simola, 1990) as a change in the sediment quality, as well as in the different sub-basins of the Saimaa lake complex, at least 90 km downstream of the new outlet, as a distinct clay layer (Simola *et al.*, 1987). Even though this catastrophe seems not to have had any long-lasting effect on water quality, its trace serves as a useful horizon for core correlation and, incidentally, quite nicely marks the beginning of the industrial era in Eastern Finland (Simola *et al.*, 1987). Similar clay layers have been observed in Haukivesi, a more southern basin of Saimaa (probably from another lake lowering in 1860) and in northern Ladoga (Sandman and Simola, unpublished observations).

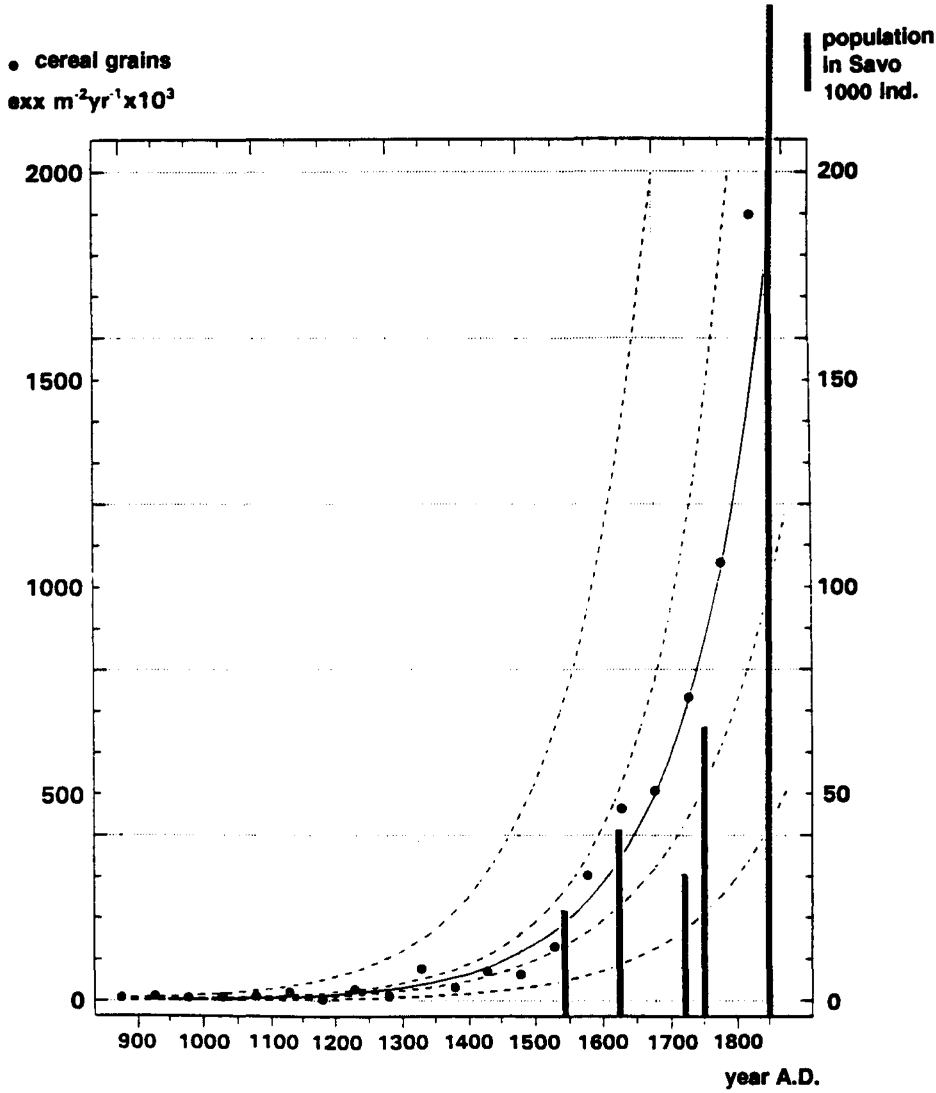

Fig. 2. A millennium of population growth: The cereal grain influx of Fig. 1 for the period A.D. 850-1850 (black dots), a fitted exponential function (thin line), indicating annual increase by 0.73 percent throughout the period, and population counts of the province of Savo (black bars, from historical sources), supporting the interpretation of cereal grain influx as a sufficient measure of population size. From Simola et al. *(1991b).*

Recent environmental change: no more unspoilt wilderness

In Finland, as elsewhere, increasing awareness of environmental problems has led to better control of point-source water pollution during the past few decades. This trend, however, is opposed by the fact that diffuse loading, due to modern forestry and peatland management practices, affects lakes even in wilderness areas which have, until now, remained outside human interference. In particular, the heavy use of fertilizers, to improve forest growth on drained peatlands, has caused remarkable eutrophication in many naturally oligotrophic headwater lakes (e.g. Simola, 1983). Fuel peat mining may be a particular cause of continuous and considerable loading of watercourses (Simola *et al.*, 1988).

Atmospheric deposition completes the history: there are no more pristine lakes in Finland (Verta *et al.*, 1989; Simola *et al.*, 1991a).

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