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# ARCHAEOLOGICAL AND PALYNOLOGICAL STUDIES OF THE AGRICULTURAL HISTORY OF VÖRÅ AND MALAX, SOUTHERN OSTROBOTHNIA

*Abstract*

The article presents recent archaeological and palynological data and radiocarbon datings on the prehistoric settlement of the regions of Vörå (Fi. Vöyri) and Malax (Fi. Maalahti) in Southern Ostrobothnia.

The results obtained show that definite changes in economy and livelihoods occurred around 800–1200 AD when prehistoric agriculture, dating from the Early Iron Age, was interrupted and even ceased completely in certain localities. This is also reflected by a significant reduction in the archaeological material.

Single finds of Late Iron Age artefacts together with palynological data, however, reflect sporadic human activity that is hard to descern in closer detail in the areas concerned.

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## INTRODUCTION

Traces and remains of human activity preserved in the soil provide the main source material of archaeological research. The quantity and quality of this material depend on several factors: the method and practices of deposition, conditions of preservation over the centuries and millenia, the method and techniques of discovery and even the skill and opinions of the archaeologists concerned.

Only material culture is directly reflected by archaeological materials and data on ideological aspects or social relations must be obtained indirectly, through various methods of reasoning and comparison.

Until recent times, burial finds have provided practically the only basis for our concept of Iron Age settlement in Finland. This applies equally to Southern Ostrobothnia as well as to other parts of the country. Despite extensive fieldwork in the early 20th century involving a relatively large number of Iron Age remains, dwelling sites of the period have become a subject of systematic study only in the past few years (Meinander 1950, Miettinen 1982b).

As it is hardly ever possible to carry out complete excavations of cemeteries or dwelling sites, their find material must remain a random sample of an unknown entity. This material provides the starting point for the archaeological reconstruction of past settlement. In the present context, palynological studies have provided further data on past human activity thus complementing the archaeological record.

In 1984–1986 four peat profiles were analyzed by means of pollen analysis and radiocarbon-dated in order to throw more light upon the prehistoric settlement of the region and to attain further information on local agricultural history.

When interpreting pollen diagrams it is important to bear in mind that the pollen data obtained mainly represent regional vegetation and are strongly dominated by pollen of wind pollinated trees. The proportion of herb pollen (NAP) depends on several factors, the most important of which being the degree of open landscape – either natural or of cultural origin – in the vicinity of the sample site (Vuorela 1973, 1985a, Berglund 1985). The differences in the mechanisms of pollen production and dispersal among the herb species also prevent us from


Research areas.

making too definite conclusions on the basis of the results. The final outcome of herb pollen is, in fact, a result of extremely complicated, partly local, partly regional factors, which allow the critical scientist mainly to discuss the documented pollen data (cf. Behre 1981). Doing that he or she, however, emphasizes the herb pollen taxa and the anthropogenic pollen data not forgetting the human impact on the tree pollen data (AP).

Due to these limitations, the present sample sites were selected from bogs situated in the vicinity of archaeological excavations or areas rich in prehistoric finds.

The sites of Inmossen (62°52'N, 21°33'E) and Holsterbackmossen (62°53'N, 21°31'E) are situated in the village of Storsjö, Malax (Fig. 1) and Lintunemossen (63°07'N, 22°12'E) and Marjenemossen (63°08'N, 22°18'E) in Vörå (Fig. 5). The recent land uplift in the area is approx. 8.5 mm/y.

As to the stratigraphy of the first-mentioned bogs, the results preliminarily published by the authors (Miettinen 1986, Vuorela 1986a, 1987a, b) are referred to and more detailed pollen diagrams are presented.

The present results from Lintunemossen (preliminarily investigated by Tolonen et al. 1979) and Marjenemossen are discussed in more detail and connected with those from Malax.

The radiocarbon datings were carried out at the Radiocarbon Dating Laboratory, University of Helsinki.

## ARCHAEOLOGICAL BACKGROUND

### *The Storsjö region of Malax*

The latest archaeological fieldwork in the Storsjö region in southern Malax began in 1982 in connection with surveys of the area. Prior to this, A.O. Heikel had carried out excavations of the cairn cemetery of Nisseshagen in 1903 (Hackman 1905, Meinander 1950). From 1982 to 1986 the National Board of Antiquities and the Malax Museiförening, a local historical body, cooperatied in surveying the area and carrying out smaller trial excavations (Miettinen 1986a, 1988). In 1984 it was also possible to carry out palynological studies in the region (Vuorela 1986a).

The present landscape of the Storsjö region demonstrates the rapid rate of land upheaval in the area together with the effects of human activity (Fig. 1). The points of highest elevation (27.5–30 metres above sea level) were originally islands that had risen from the Litorina Sea in the first millenium BC. Around the birth of Christ a wide strait in the area separated the islands from each other which were in a protected inner archipelago location. A couple of hundred years later the strait had silted up to become a long bay opening to the north, the mouth of which became so shallow in the 5th and 6th centuries AD that Storsjö was finally isolated from the sea and formed a lake. This lake was dried in the 1770s for land reclamation purposes (Anttila 1967).

The prehistoric remains of the area have been exceptionally well preserved as they are at some distance from present settlement and fields. The monumental burial cairns of the Storsjö area have been known for long (Aspelin 1866). Later fieldwork has also revealed smaller cairns and stone settings, features of cultural layer and cup-marked or offering stones (Malax Museiförening 1984, Miettinen 1986a, 1988).

The *Nisseshagen* area with its cairns is slightly less than one kilometre long and is located to the east of Storsjö at an elevation of 17 to 20 metres above sea level. The terrain is formed by a low ridge of moraine and finer sand running north-south and spreading into an area of higher elevation at its northern end. Trial excavations in the areas between the cairns revealed cultural layer in several places and in one location the possible remains of an Iron Age house. Connected with the Iron Age cultural layer and the cairns are six cup-marked or offering stones (Fig. 2). Only two of the cairns at Storsjö have been excavated.

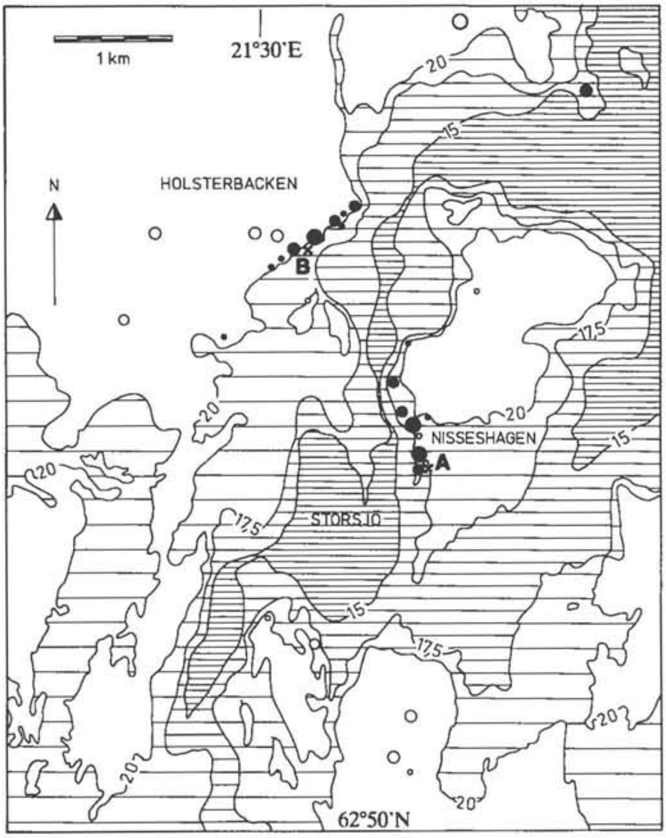


Fig. 1. The Storsjö area with the shorelines of c.AD ±0 (20 m), c.AD ±200/300 (17,5 m), and c.AD ±400/500 (15 m). The sampling sites for pollen analysis: A Inmossen, B Holsterbackmossen. The Iron Age remains are marked with dots and the possible Pre-Roman cairns with circles (after Miettinen 1986).

The largest cairn of the area was partly excavated in 1903 and in 1983 a small low cairn or stone setting was excavated. Both contained remains of cremations as well as datable finds. The large cairn revealed Migration period artefacts and the smaller material that can be dated mainly to the early Merovingian period. A general description of the archaeological material has been presented in another connection (Miettinen 1986a) and the 1903 finds in several previous studies (Hackman 1905, Meinander 1950, Kivikoski 1973). The grave excavated in 1983 revealed a stone setting of no definite structure covering a feature of sooty soil around which were concentrations of burnt bone. One of the latter contained a large iron knife and another a small firestriking tool of iron. The stone setting also contained fragments of ferrules of mountings and a small equal-armed brooch (Fig. 3). There are no parallels to the brooch in the Finnish material, the closest comparable specimens being from Central Europe and dating to the Merovingian period (Mrs. Marianne Schauman-Lönnqvist, Lic.Phil., personal communication). At the time of writing the bone material from the grave is still under analysis.

*Holsterbacken* is located north-west of Storsjö, approximately 2 kilometres from Nisseshagen. The site was originally at the mouth of a bay (Fig. 1). The area contains over twenty cairns, features of cultural layer and a cup-marked stone. Several of the cairns are of impressive size and appearance (Fig. 4) and most of them are on a terracelike formation sloping to the south-east in a group extending approximately one kilometre in length and lying at an elevation of roughly 20 metres a.s.l. None of the cairns have been excavated.

*Fig. 2.* A cup-marked stone (offering stone) at Storsjö. Photo: National Board of Antiquities.

Below the terrace is marshy forest changing to bog. A small islet of moraine is located at the upper edge of the bog at an elevation of 18 to 19 metres a.s.l. Trial excavations were carried out at this site in 1985 and 1986. The cultural layer was of a distinct black colour containing large amounts of iron slag and burnt clay, a few sherds of Iron Age pottery, a few fragments of grinding stones, a fragment of a crucible and several horse (?) teeth (National Museum of Finland 22849, 23570). Trial excavations revealed the bottom parts of at least three possible iron smelting pits of primitive construction. The analysis of this material has not yet been completed and osteological or radiocarbon results are not available (Miettinen 1988).

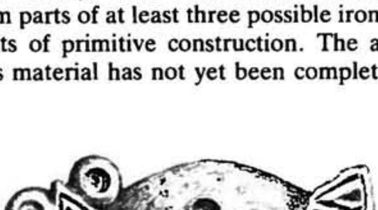

*Fig.* 3. The equal-armed bronze brooch from Nisseshagen, Malax (NM 21916:55). Drawing Riitta Ahola, National Board of Antiquities. 1:1.

*Archaeological interpretation of the Storsjö region*

Although the region concerned contains a considerable number of prehistoric remains, the limited amount of fieldwork conducted so far has revealed datable finds from only two graves at Nisseshagen, dating to the Migration period and the early Merovingian period respectively. The finds from cultural layer features are of an overall Iron Age character. The cup-marked stones found in connection with Iron Age settlement remains are clearly of Iron Age date in this case. At Nisseshagen they relate to the five different clusters of cairns in such a way that it can be assumed that they reflect different units of habitation. Thus, each "household" would have had several cairns of its own, a cup-marked stone (in one case two) and buildings as indicated by stone settings and fragments of clay daub found in the cultural layer.

*Fig. 4.* One of the monumental Iron Age cairns at Holsterbacken, Malax in 1986. Photo: National Board of Antiquities.

The larger cairns at Storsjö are of the same type as cairns dated to the Late Roman and Migration periods elsewhere in Southern Ostrobothnia (Meinander 1950, Keskitalo 1979, Ahtela 1981). Due to their elevation, the large cairns at Storsjö cannot be older than the third-fourth centuries AD. On the other hand, the large cairns appear to go out of use in Southern Ostrobothnia by the beginning of the Merovingian period. In this period the prevailing form of burial construction is a low stone setting, which is of a form usually impossible to distinguish from cairns laid at ground level without excavation. There are also cremation cemeteries on level ground from the Merovingian period (Meinander 1950). Consequently we can date the large cairns at Storsjö to approximately AD 200–600.

In addition to the large cairns there are also smaller cairns and stone settings which resemble on the one hand the low cairns of the Merovingian period and on the other hand cairns of the Early Metal period.

The archaeological finds offer few direct indications of economy or means of livelihood. The lower slab of a grinding stone found at Nisseshagen in 1952 may indicate agriculture and the finds of horse teeth in both areas may in turn indicate animal husbandry. The shallow shores of the bay originally formed by Lake Storsjö and the shore meadows that came about in the course of time offered no doubt excellent opportunities for grazing. The moraine and sandy soils higher up could in turn have been cultivated with Iron Age techniques. In addition to smaller fields near the habitations there were possibly also other cultivated areas further off. Although the archaeological record does not directly indicate hunting and fishing, their importance and especially the use of marine resources must not be underestimated.

Smaller cairns at elevations of 25 to 30 metres and certain hut floor-like depressions in the Storsjö region are among the archaeological remains of the earliest settlers of the area. Cairns and hut floor depressions belonging to this Early Metal period phase of settlement have been excavated and studied in many of the nearby localities in the past few years (see e.g. Miettinen 1980, 1982, 1986b, Seger 1986a, 1986b). This phase can be dated to the first millenium BC and apparently also to the first centuries AD

*The Vörå region*

As in the case of Malax, also at Vörå most of the archaeological fieldwork dates from the early years of this century. In the 1970s and '80s Vörå Folkhögskola, a local educational body, the commune of Vörå and the National Board of Antiquities co-operated in arranging small-scale salvage and trial excavations, mostly in the near surroundings of previously known Iron Age sites and remains. From 1985 to 1987 further surveys were carried out in the eastern and northern parts of the commune.

The site of *Lintunemossen* is located near the Iron Age centre of settlement in Vörå (Fig. 5). The general image of Iron Age settlement and culture in the region has changed appreciably since a summary of available results was published in 1979 (Tolonen et al. 1979). With a few exceptions only finds that have come to light at a later date are discussed in the present paper.

In 1977 excavations were carried out at Svedjeholmen, adjacent to Lintunemossen, of a large cairn with a central stone (Fig. 5, no. 12). Finds included fragments of burnt bone and a branch-shaped brooch of bronze (Fig. 6). Brooches of this type from Southern Ostrobothnia have been dated to the late 4th century or the 5th century AD (Kivikoski 1973, Keskitalo 1979). Finds of clay daub from the fields near the site of Lågpeltkangas are probably from house-floors destroyed in field cultivation. These may be of the same type that Aarne Äyräpää excavated on the west slope of the Gulldynt site in the 1930s (Meinander 1950, Valonen 1977). Small-scale excavations carried out at Gulldynt

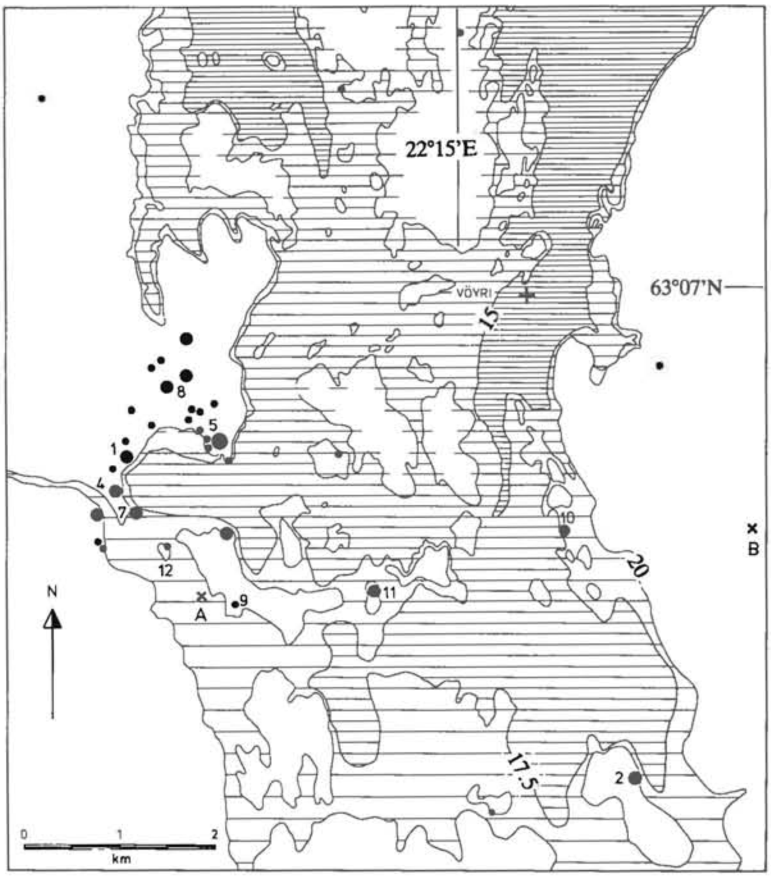


*Fig. 5.* The Vörå region. The shorelines and Iron Age remains Nos. 1–11 after Tolonen et al. 1979. No. 12 Svedjeholmen (1977). Sampling sites for pollen analysis 1986: A Lintunemossen, B Marjenemossen.

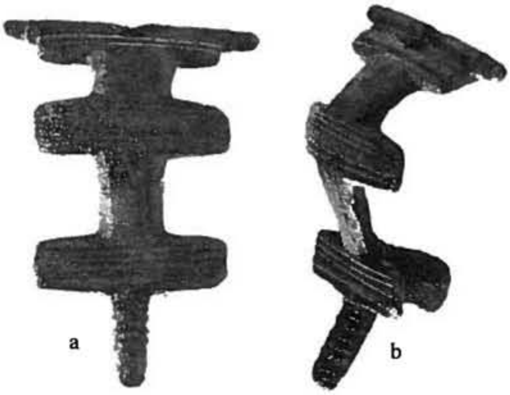

*Fig. 6.* Branch-shaped brooch (NM 20179:4) from Svedjeholmen, Vörå, seen from above (a) and the side (b). Photo: National Board of Antiquities. 1:1.

in 1975–1977 did not provide any further information on the above.

Of the excavated sites the level-ground cemetery of Lövbacken was the only one that has come to light in recent years. In 1984–1985 it was possible to excavate parts of this cemetery that had not been destroyed in road-building in the 1960s. The cemetery is ca 4 kms SE of Gulldynt and thus outside the previously defined concentration of settlement finds and it is dated to the early Merovingian period (Miettinen 1985).

To the east of the Vörå river near the cremation burial ground of Tunis a concave shield-boss was found in a private garden. This artefact was acquired by the National Museum of Finland in 1984 (NM 22440) and represents the most common shield-boss type of the Merovingian period in Finland (Kivikoski 1973). The Tunis cemetery which was subsequently destroyed by later settlement appears thus to have been of larger extent than assumed by Tegengren in his studies in the 1930s (Meinander 1950).

As elsewhere, it has not been possible to carry out total excavations of any of the cemeteries at Vörå. Thus, their archaeological dating and the dating of settlement in general are based on few and random excavations. It is quite certain that if, for example, a cairn cemetery would be completely excavated, including the intervening areas between the cairns, the results might provide new and possibly surprising data. Future studies and fieldwork in Vörå will no doubt broaden and increase our knowledge of the nature and dating of Iron Age settlement among other phenomena.

The Marjenemossen site is located slightly less than 3 km east of the Vörå river and about 6 kms east of Lintunemossen. The nearest Iron Age remains are the Merovingian period Tunis cemetery ca 2 km to the west and the cemetery area of Pörnullbacken approximately 2 km SSW of the site (Fig. 5, Nos. 2 & 10). Marjenemossen is thus to some degree outside the area of Iron Age settlement in the region.

## *Archaeological conclusions regarding the Vörå region*

On the basis of datable archaeological material, settlement began in the valley of the Vörå river around 200 AD (Tolonen et al. 1979). Cairns discovered in recent surveys of the northern and eastern parts of the region are located at elevations mainly corresponding to Early Metal period shorelines (ca 25–35 metres asl) and indicate settlement older than hitherto assumed at a time when the river valley was still a bay.

The Migration period was the main phase of the Iron Age culture of Southern Ostrobothnia and the early stages of the Merovingian period which followed are also represented by numerous finds in Vörå and other locations (Meinander 1977). In the late 8th century AD the former cemeteries in Vörå were no longer used for burial and the period after ca 800 AD is represented by only a few stray finds that remain problematic both in terms of context and settlement-historical significance. A spearhead dating to ca AD 800 (Meinander 1950, 179) was found at Pörnullbacken in the early years of this century. The artefact (NM 11324) bears traces of fire which may indicate a cremation burial. As early as 1834 a number of artefacts were found in a field known as Kaparåkern on the southern slope of Pörnullbacken hill. The context of the finds is unclear. According to presently held interpretations, the find consists of 50 beads, a coniform Merovingian period shield-boss, a sword blade and a spearhead (NM 15; Meinander 1950, 178). The spearhead resembles the Viking period type G specimens, differing however in the curved form of the edges of the blade and their connection with the socket. In the type in question the sides are usually more or less straight and the lower corners of the blade form distinct angles (Kivikoski 1973). The blade part of the Kaparåkern specimen is also shorter and broader than generally observed in

*Fig. 7 a.* The round convex-concave brooch from Bergby, Vörå (NM 9743), dating to the 11th century. The brooch is a stray find from vicinity of the Gulldynt cementery. Photo: National Board of Antiquities. 1:1.

spearheads of the type. The majority of spearheads of this type are dated to the 11th century, although their chronological significance should not be overstressed (Lehtosalo-Hilander 1982, 36).

The third single stray find to be mentioned in this connection is a round convex-concave brooch found at Krook in Bergby (Fig. 7a). The artefact is dated to the late Viking period or the 11th century (Kivikoski 1973, Abb. 663). Local sources mention that sand was at some stage transported to the site from Gulldynt, but it is unclear whether the brooch is also from Gulldynt. If this is the case, it would be clearly younger than the other finds from Gulldynt. This brooch is not of any central importance for the history of settlement in the region (Meinander 1977), which must also apply to the spearheads from Pörnullbacken and Kaparåkern (Fig. 7b). If we assume that all of the above artefacts, including the spearhead from Kaparåkern were actually found in the reported locations, they must be incorporated in some kind of explanatory framework. A cautious assumption would be that they indicate human activity of some kind that cannot be defined in any greater detail in an area that underwent numerous and considerable changes in the 8th century AD. As a result of this course of development, settlement in this area, as well in Southern Ostrobothnia in general, can no longer be traced archaeologically.

*Fig. 7 b.* The spearhead from Kaparåkern (NM 15), found 1834 in a field. Photo National Board of Antiquities. 1:2.

## POLLEN ANALYSIS

### *Material and methods*

All the bogs investigated represent relatively young *Pinus*–dominated *Sphagnum* bogs typical of this region (Vuorela 1987a) which is a clay plain previously submerged by the Littorina Sea (Eronen & Haila 1981). Among the field vegetation at each site *Vaccinium uliginosum, Ledum palustre, Calluna vulgaris* and *Rubus chamae-*

*morus* predominate, at Inmossen also *Menyanthes trifoliata.*

The sampling techniques for all of the profiles include use of the peat knife (Vuorela 1985) and metal boxes for the upper 0–50 (60) cm and the smaller Russian peat bore (Eronen 1976) for the bottom–most parts of the profiles. At Inmossen subsamples were taken every 2.5 cm and in the rest of the profiles every 2 cm.

All the subsamples were treated with KOH and acetolysis (Faegri and Iversen 1975) and counted to the basic sum of 1000 AP. For pollen concentration values spores of *Lycopodium* (Stockmarr 1971) were used.

In the diagrams the pollen data were divided into ecological groups as follows:

For Inmossen and Holsterbackmossen:
trees
shrubs and dwarf shrubs
natural open land vegetation
settlement indicators
cryptogams
aquatics

For Lintunemossen and Marjenemossen correspondingly:
trees
shrubs
natural mineral soil vegetation
anthropogenic indicators
local bog/shore vegetation

The stratigraphy of the profile from Lintunemossen, Vörå is as follows:

| | |
|---|---|
| 0–140 cm | *Sphagnum* peat with remains of *Eriophorum,* especially at the levels of 60–70 cm, 90 cm and 115–140 cm. |
| 140–160 cm | *Carex* peat with remains of *Equisetum* and *Phragmites* and wood at 140–145 cm. |
| 160–165 cm | clay gyttja |
| 165 cm– | clay |

The stratigraphy of the profile from Marjenemossen, Vörå is as follows:

| | |
|---|---|
| 0–125 cm | *Sphagnum* peat with layers of charcoal dust at the levels of 18 and 32 cm and remains of *Eriophorum* at 45–55 cm, 70–80 cm and 90–100 cm. Remains of wood occur at 70–75 and 85–90 cm. |
| 125–150 cm | *Carex* peat with remains of wood at 140–145 m. |
| 150–160 cm | Magno Caricetum peat |
| 160 cm– | clay gyttja |

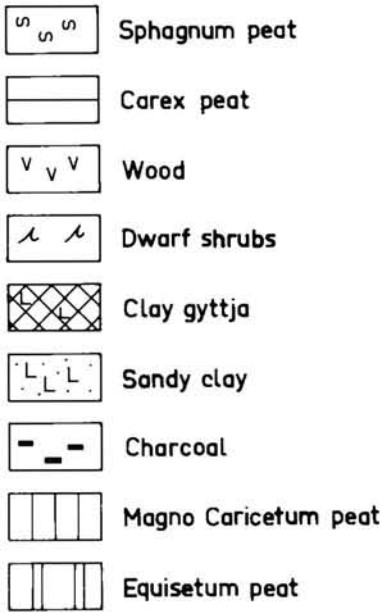


*Fig. 8.* Stratigraphical symbols used in the diagrams from Malax

Regarding the stratigraphy of Inmossen and Holsterbackmossen (Fig. 8) see Vuorela (1986).

### *Pollen results from Malax*

#### Inmossen

The lower part of the profiles (Figs 9–11) is strongly affected by the redeposition of the pollen as a result of floods caused by the sealing off of the main outlet of ancient Lake Storsjö in the 4th and 5th centuries AD (Vuorela 1986). The phenomenon can be seen in the stratigraphy, but it is also reflected by loss-on-ignition and by the pollen data. This process prevents us from interpreting the development of the settlement in the area of those days. The evidence of agricultural activities, including Cerealia, is partly mixed with pollen of natural coastal vegetation, such as Poaceae, Cyperaceae and *Filipendula,* while *Urtica, Spergula arvensis, Rumex,* Chenopodiaceae and *Polygonum aviculare* may be considered as settlement indicators (Fig. 10).

The middle parts of the *Carex* peat preceding the phase of redeposition are C14-dated to 1360±130 B.P. (Hel-1982) and the lower part of that following the retreat of the water to 1240±140 B.P. (Hel-1981). According to these dates, wet circumstances may have lasted for a

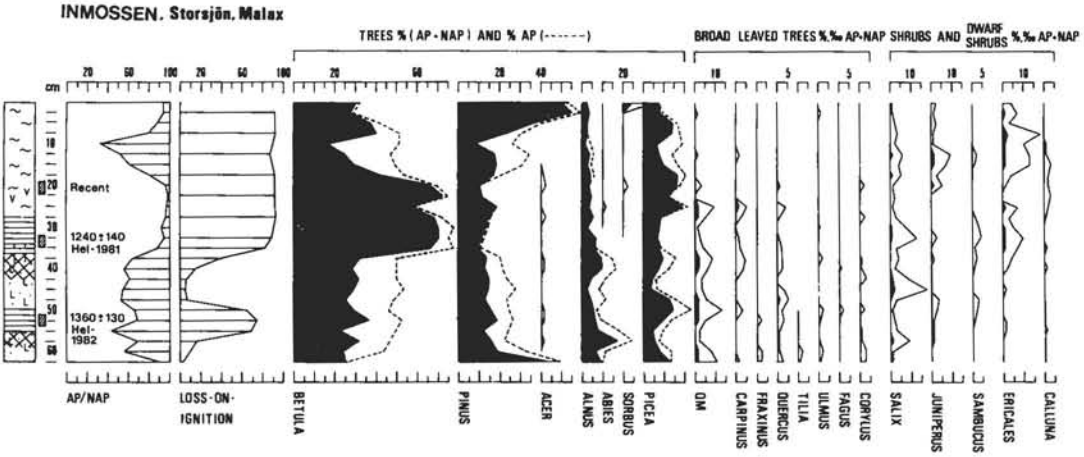


*Fig. 9.* Inmossen: Relative arboreal pollen diagram with radiocarbon dates.

couple of centuries, which was long enough to change the livelihoods of the local settlement. This is also proved by a more or less total reforestation of the area, mainly by *Betula* in connection with a clear change in the relative herb pollen (NAP) data.

Even though the anthropogenic indicators and especially Cerealia seem to reflect a period of decreasing or even temporary lack of agricultural activities, pollen of Apiaceae, *Ranunculus acris type*, *Artemisia* and *Filipendula* seem to reflect a certain kind of activity, probably grazing in the *Betula*-dominated forests (Fig. 10). It is also interesting to note that "new" anthropogenic pollen types, such as Cannabaceae, *Vicia* type and *Plantago lanceolata* appear slightly before the last Cerealia pollen grains preceding the reforestation period.

During this period, corresponding in the stratigraphy mainly to the *Carex* peat, the rate of peat growth was extremely slow (cf. Vasari & Väänänen 1986). This is also indicated by the high pollen concentration values (Fig. 11) while those in the upper most 20 cm of the profile indicate increasing rate of growth of *Sphagnum* peat.

The relatively high pollen frequencies of Ce-

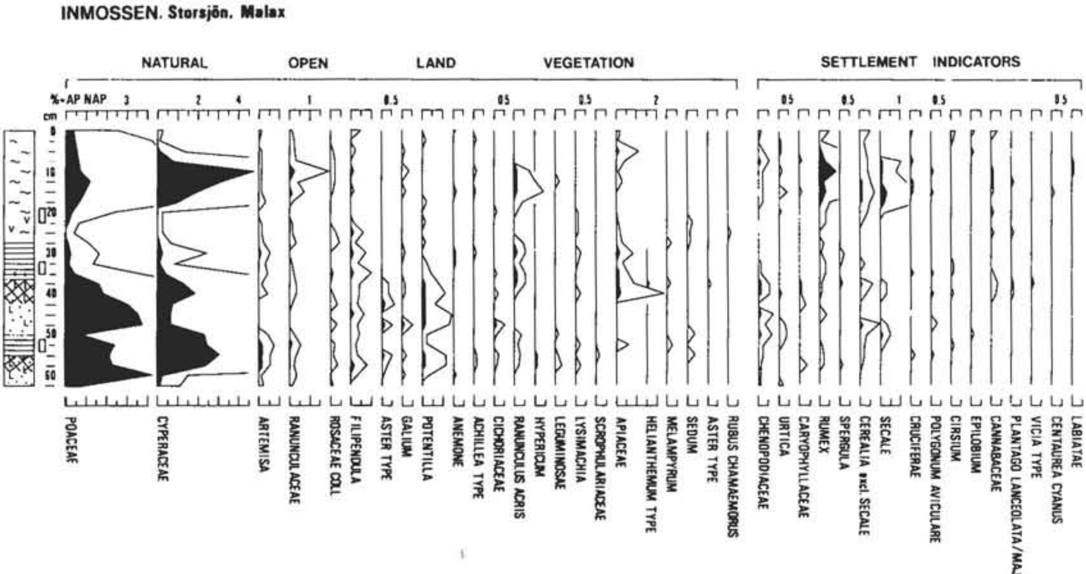


*Fig. 10.* Inmossen: Relative non-arboreal pollen diagram.

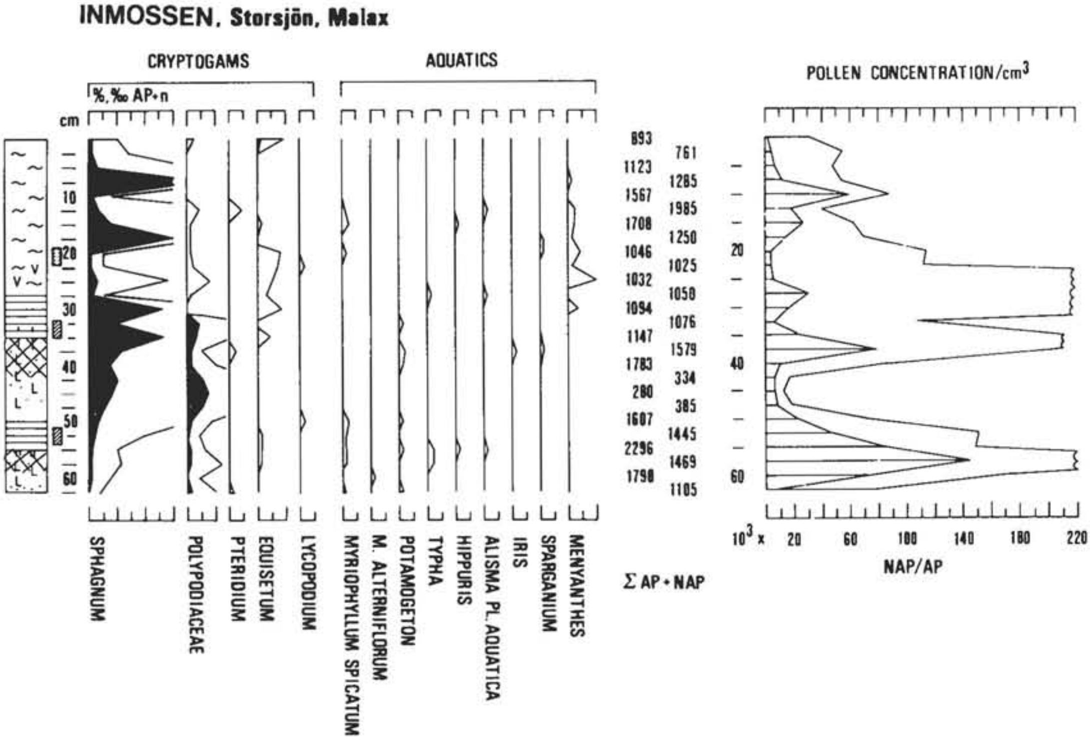


*Fig. 11.* Inmossen: Relative pollen diagram for cryptogams and aquatics.

realia and *Rumex* at the 22.5–7.5 cm level do not indicate the size of the fields (Vuorela 1985a, 1986b) but preferably Late Medieval *Secale*-dominated cultivation and destruction of forests allowing more effective pollen dispersal. Unfortunately, the beginning of this period could not be C14-dated. Open landscape is also indicated by the AP/NAP relation and pollen of Poaceae, Cyperaceae, *Salix, Juniperus* and Ericales, especially *Calluna*. The decrease of *Picea* may also indicate strong human influence on the forests.

The continuously wet conditions in the surroundings of Lake Storsjö are reflected by *Menyanthes* still occuring around the sample site (Fig. 11).

Holsterbackmossen (Figs 12, 13, 15).

The C14-datings from Holsterbackmossen, especially that from the 44–46 cm level (770±100 B.P.; Hel-2067) show that the early floods causing redeposition in Inmossen (17 m a.s.l.) correspondingly caused strong erosion in the present area, having a more open location by the same lake basin, at 18 m a.s.l. Thus, the lower part of the *Carex* peat may still be affected by older secondary material – also indicated by coarse sand. Correspondingly, the clear evidence of agricultural activities in the limnic sediments corresponds to the pre-flood settlement, i.e. the first centuries AD.

The pollen data of *Carex* peat indicate natural vegetation of wet deciduous forests, strongly dominated by *Alnus*. Pollen types, such as Rosaceae coll. (probably *Rubus idaeus*), *Filipendula* and *Lysimachia* reflect nitrate-rich soil (Figs 12, 13). Later the forest type changed from *Alnus*-dominated through *Betula*-dominated to *Picea*-dominated, this being the natural succession in coastal South-Ostrobothnia (Kujala 1926; Fig. 14). The forest seems to have been affected by paludification even before it was again affected by human activity. Relatively high values of *Menyanthes* and *Typha* pollen indicate continuously high ground water level (Fig. 15).

At the 22.5 cm level, however, human activity increases as reflected by Poaceae and by settlement indicators. The C14-age of this phase (100±100 B.P.; Hel-2066) seems to have been affected by recent vegetation, as was the case in Inmossen. The short-term increase of *Alnus* at

HOLSTERBACKMOSSEN, Storsjön, Malax

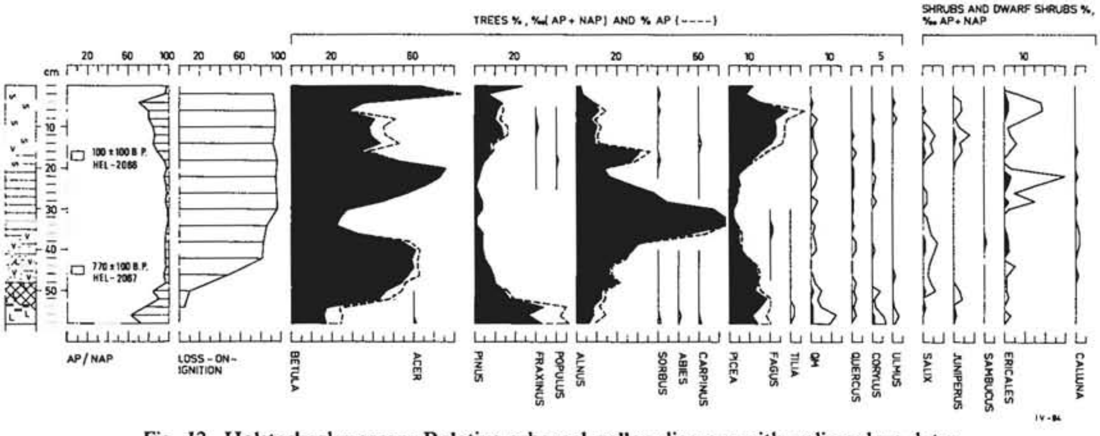


*Fig. 12.* Holsterbackmossen: Relative arboreal pollen diagram with radiocarbon dates.

the beginning of this agricultural period which still continues, could be connected with deforestation for agricultural purposes and could thus be of anthropogenic origin.

*Discussion regarding the Malax diagrams*

At both sites investigated in Malax, clear pollen evidence was found confirming the archaeological interpretation of Iron Age settlement. Even though strong erosional processes at Inmossen have redeposited these indicators and at Holsterbackmossen correspondingly caused a hiatus in the layers from the Iron Age, the early Cerealia occurrences together with the remnants of charcoal in the limno-telmatic horizon of Holsterbackmossen can be interpreted to be of Iron Age origin.

Unfortunately, the C14-datings could not determine the duration of the particularly clear vegetational changes in the surroundings of Lake Storsjö which took place approx. 1300 B.P. and were predominantly caused by an increase in the ground water level. These changes which are discussed in more detail by Vuorela (1986a) seem to have had a strong influence on local settle-

HOLSTERBACKMOSSEN, Storsjön, Malax

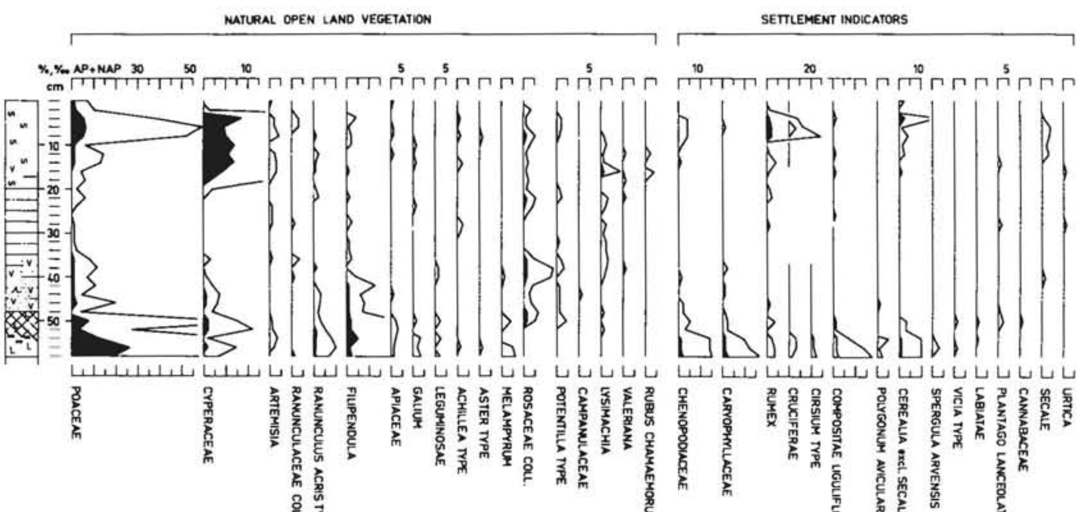


*Fig. 13.* Holsterbackmossen: Relative non-arboreal pollen diagram.

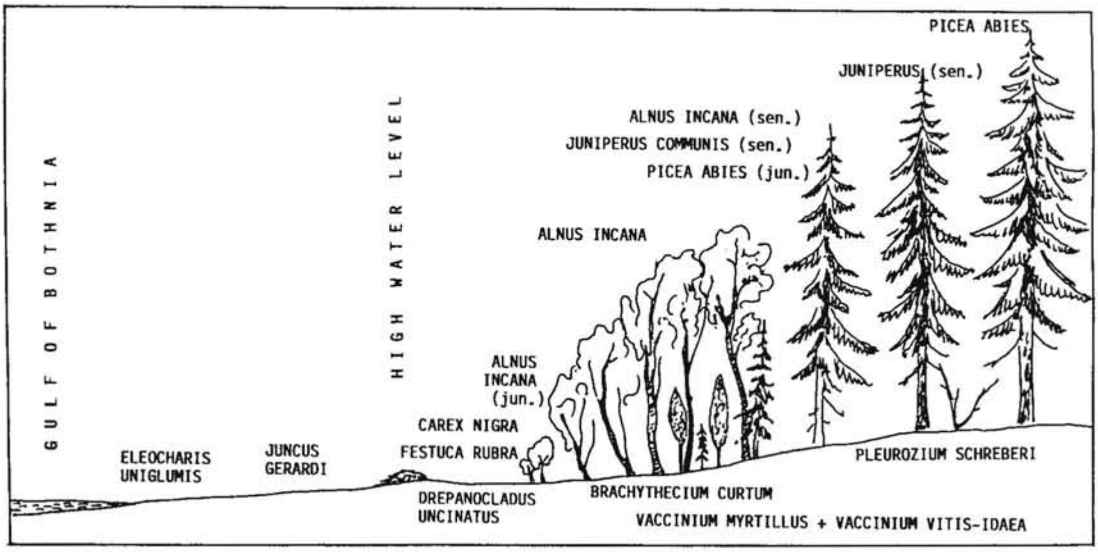


*Fig. 14.* Natural vegetational succession in coastal southern Ostrobothnia (after Kujala 1926; nomenclature after Hämet-Ahti & al 1984).

ment. Cultivation activities had to be reduced or probably even moved to a drier elevation – how far away is not yet known. The sandy areas of Nisseshagen on the western and northern sides of Inmossen could still have been used for grazing while all kinds of settlement indicators seem to vanish from the diagram of Holsterbackmossen in connection with reforestation to reappear together with recent agricultural practices.

## *Pollen results from Vörå*

As a result of the fact that the location of Marjenemossen is 10 m higher than that of Lintunemossen, the former site emerged from the sea approximately 1000 years earlier. The situation around ±0 BC can easily be seen in the map (Fig. 5) where the 20 m isobase corresponds to the shore line of that time. At that period Lintune-

HOLSTERBACKMOSSEN, Storsjön, Malax

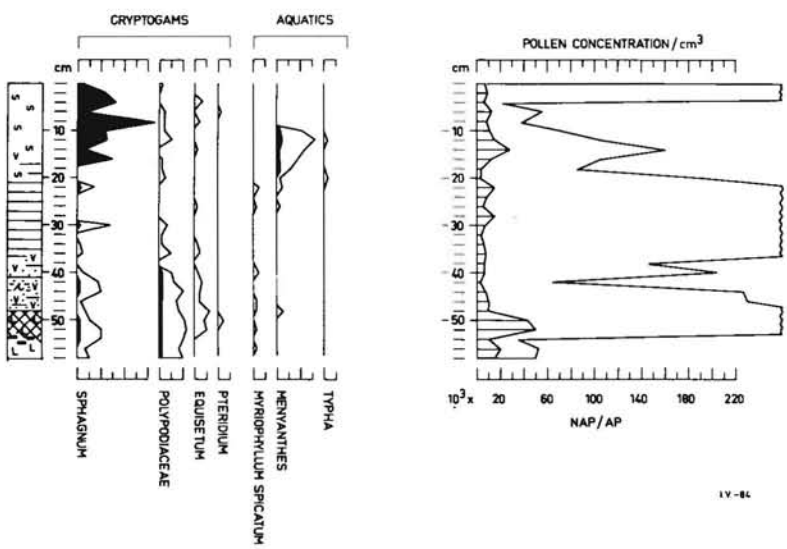


*Fig. 15.* Holsterbackmossen: Relative pollen diagram for cryptogams and aquatics.

mossen was still submerged by the early sound which nowadays is restricted to the Vörå river, while the recent Marjenemossen bog was already located at 6–7 m a.s.l. at a distance of about 1 km from the coast. This difference between the distances of the investigated sites and the coastline, is of particular importance with respect to the vegetational succession and the use of coastal areas (cf. Fig. 14). The lowest vegetational zone where the soil and nutrients are suitable for any kind of cultivation, is that of *Alnus incana* while that situated between the *Alnus* forest and the high-water level is suitable only for grazing. The peat under the *Alnus* stands is highly humified *Carex* peat composed of a relatively rich field vegetation. Later when *Picea* overtook the forest, the reduced field vegetation together with the acid waste of the spruce formed peat less suitable for cultivation. This forest type of wide coastal areas in southern Ostrobothnia was later affected by paludification and during the last 1–2 millenia developed into pine-dominated *Sphagnum* bogs (Fig. 16; Vuorela 1987a). This succession can also be seen in the diagrams of Lintunemossen and Marjenemossen; in the former area Iron Age cultivation took place during the early *Alnus* stage of the bog. This is why the settlement indicators including Cerealia and weeds of that period have been mixed with pollen data of natural coastal herb vegetation. In Marjenemossen there are 1000 years between the coastal phase and the prehistoric phase of agriculture which took place there in the successive *Picea*-zone (cf. Fig. 14). This means that the latter phase in Marjenemossen is easily distinguishable and datable in the diagrams.

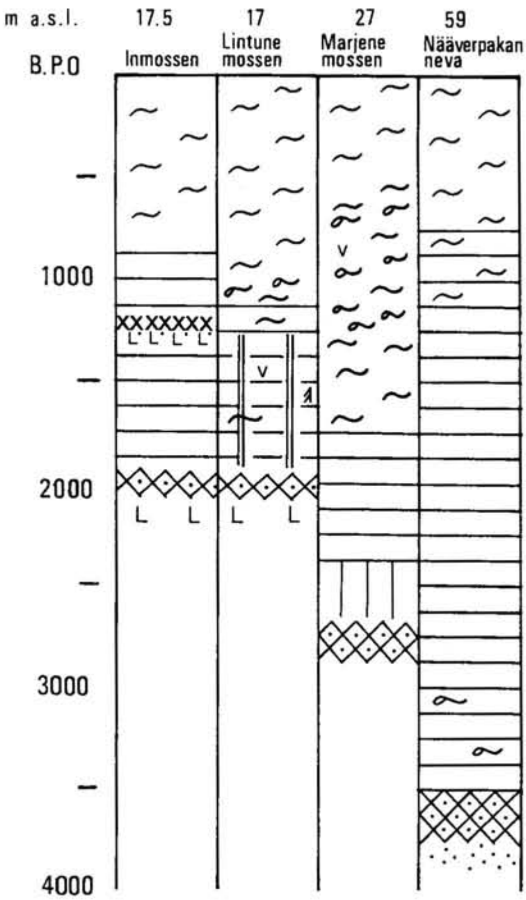


*Fig. 16.* The stratigraphy of four Sphagnum-bogs from Southern Ostrobothnia: Inmossen (Malax), Lintunemossen and Marjenemossen (Vörå), Nääverpakanneva (Purmo, cf. Vuorela 1982), drawn in chronological scale (after Vuorela 1987a).

Due to undisturbed sedimentation and peat growth in Lintunemossen and Marjenemossen, it was possible to divide the pollen diagrams into local pollen assemblage zones (p.a.z.) which emphasize vegetational changes in the vicinity of the bog.

Lintunemossen (Figs 17–19).

Local p.a.z. a and b ( – 1160±990 B.P.)

The shore vegetation dominates the pollen data at the limnotelmatic horizon of the Lintunemossen profile. The open landscape is dominated by Cyperaceae and Poaceae while the nitrophilous species: *Filipendula ulmaria* and *Rubus idaeus* (Rosaceae coll.) occur in the successive *Alnus* phase (Figs 17, 18).

Anthropogenic indicators which partly get mixed with the natural shore vegetation are confirmed by Cerealia in the vegetational *Alnus* zone (mainly p.a.z. b) occurring together with *Artemisia, Rumex,* Cichoriaceae, Chenopodiaceae, Carypophyllaceae and *Urtica* (Fig. 18). Simultaneously the relative pollen frequencies of Ericaceae increase reflecting the natural development, as seen in Fig. 19. All the early Cerealia occurrences belong to the *Alnus* phase, being dated to the period ending around 1160±90 B.P. (cal AD 790).

Local p.a.z c (1160±90 B.P.; Hel-2291 – 890±90 B.P.; Hel-2288)

The main question concerning this pollen

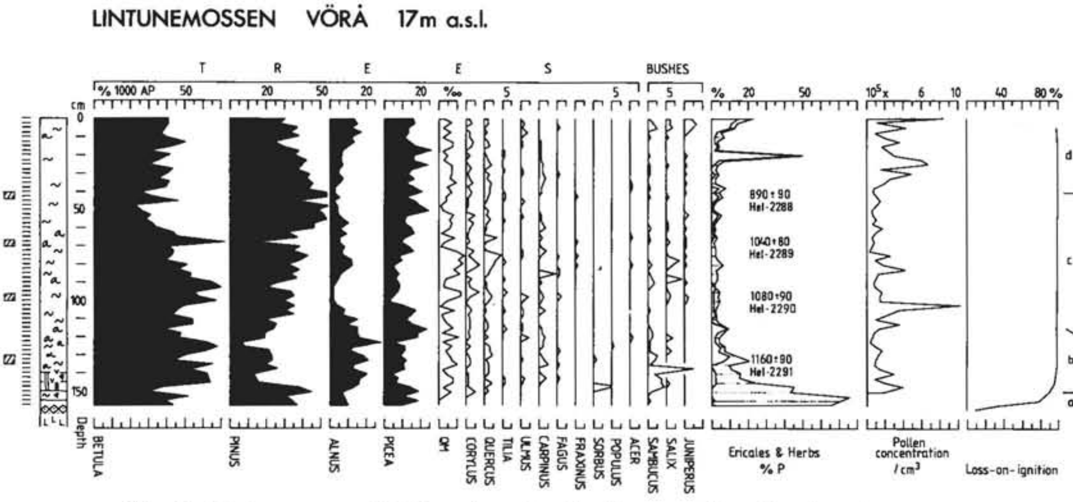


*Fig. 17.* Lintunemossen: Relative arboreal pollen diagram with radiocarbon dates.

assemblage zone is the reason for the disappearance of Cerealia at the boundary of b/c. An attempt will be made to obtain an answer to this and to form a reliable picture of livelihoods in the region during p.a.z. c which falls between the prehistoric phase and the beginning of recent agriculture.

According to the diagram (Fig. 18) pollen of several anthropogenic indicators (e.g. *Artemisia,* Chenopodiaceae, *Rumex, Urtica* and *Pteridium* occur sporadically throughout this period and herb pollen mainly compensate the decrease of Ericales pollen. Among the herb pollen types, especially Cyperaceae and Poaceae increase both of which, together with pollen of Chenopodiaceae could be considered as evidence of human activity in the area. The occurrences of Rosaceae coll. (probably *Rubus idaeus*) at the 60–70 cm level, immediately after the simultaneous occurrences of *Pteridium, Urtica,*

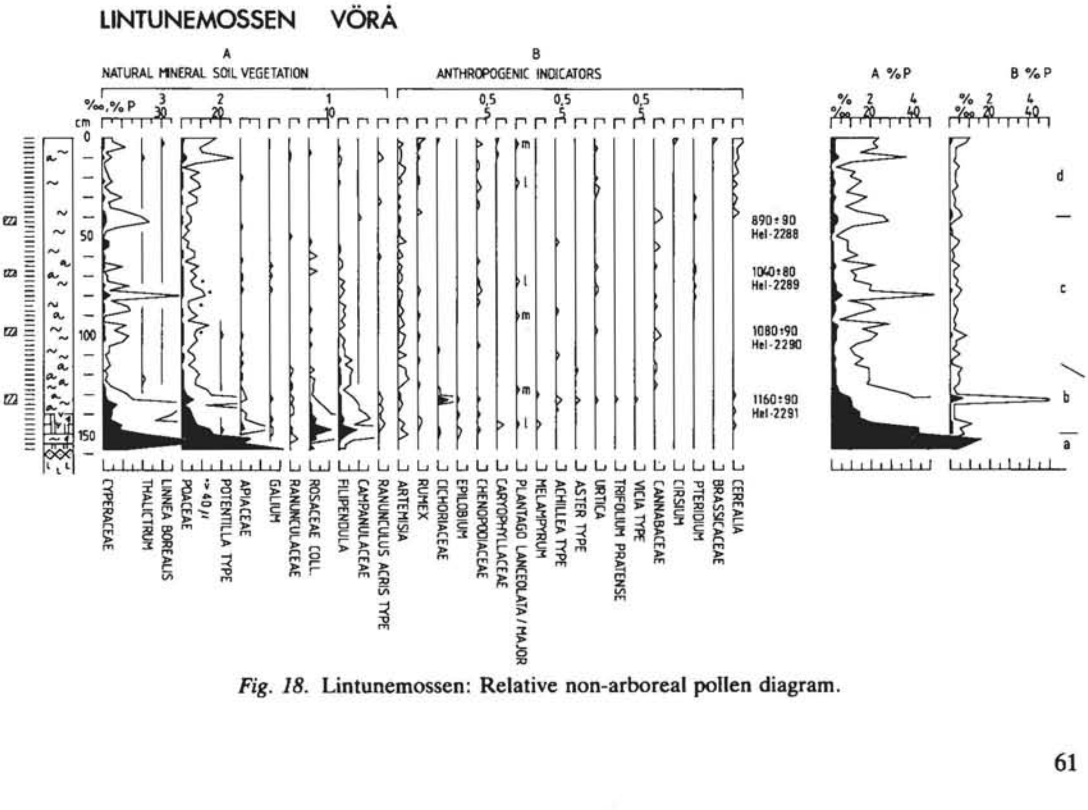


*Fig. 18.* Lintunemossen: Relative non-arboreal pollen diagram.

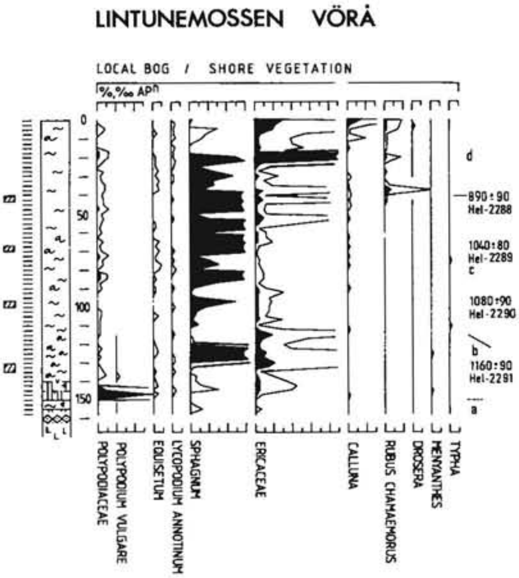


*Fig. 19.* Lintunemossen: Relative pollen and spore diagram for bog and shore vegetation.

*Galium* and Apiaceae are also worth mentioning.

Local p.a.z. d (890±90 B.P. – present time)

This pollen assemblage zone represents the period of recent cultivation which, according to radiocarbon dating (890±90 B.P.; Hel-2288) began in the 11th century AD. Even though the agricultural activities here show clear pollen evidence, the relatively modest weed pollen data compared with that of the previous pollen assemblage zones, especially (c), is worth mentioning. The location of the sampling site in the middle of the bog may be one reason for this phenomenon as we shall see in connection with the results from Marjenemossen.

The most evident indicators of agriculture in this part of the diagram are Cerealia, *Rumex*, Chenopodiaceae, Caryophyllaceae and *Urtica* while *Artemisia, Plantago major* and increasing frequencies of Poaceae could be interpreted as settlement indicators. The considerably high frequencies of *Rubus chamaemorus* (Fig. 19) could be a result of ditching which also affects hydrology and could be reflected in the local bog vegetation (*Sphagnum*, Ericales, *Calluna*).

Marjenemossen (Fig. 20–22)

The results from Marjenemossen correspond to those from Lintunemossen. One of the most important differences between the two diagrams is the possibility in Marjenemossen of distinguishing between the coastal phase and the prehistoric cultivation phase (pollen assemblage zones a and b) and thus the dating of this activity is possible. Chronologically this coincides with the start of the local vegetational *Picea*-phase (Fig. 20) and took place around 1780±110 B.P. (Hel-2321) – 1170±120 B.P. (Hel-2320) corresponding to ap-

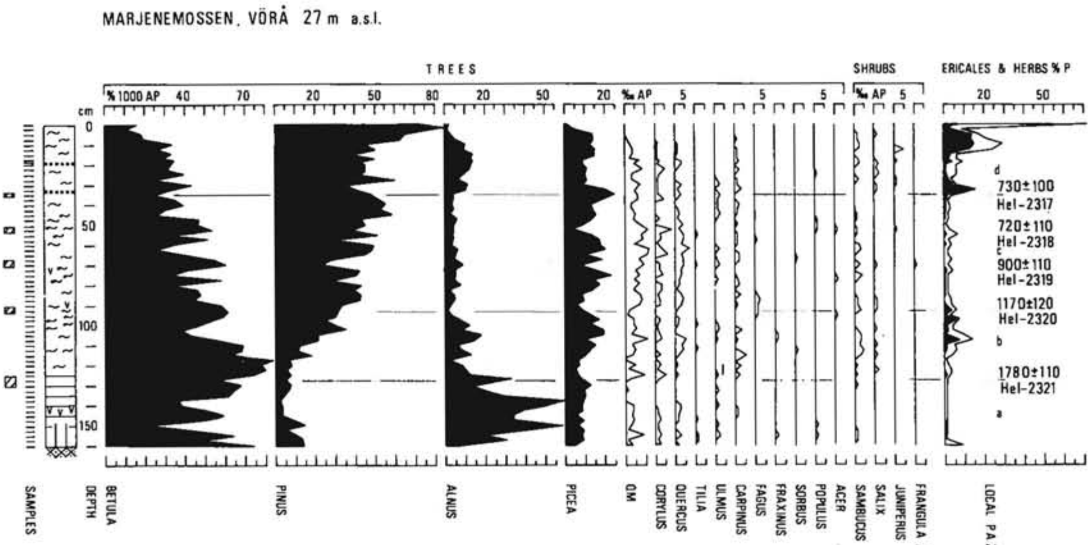


*Fig. 20.* Marjenemossen: Relative arboreal pollen diagram with radiocarbon dates.

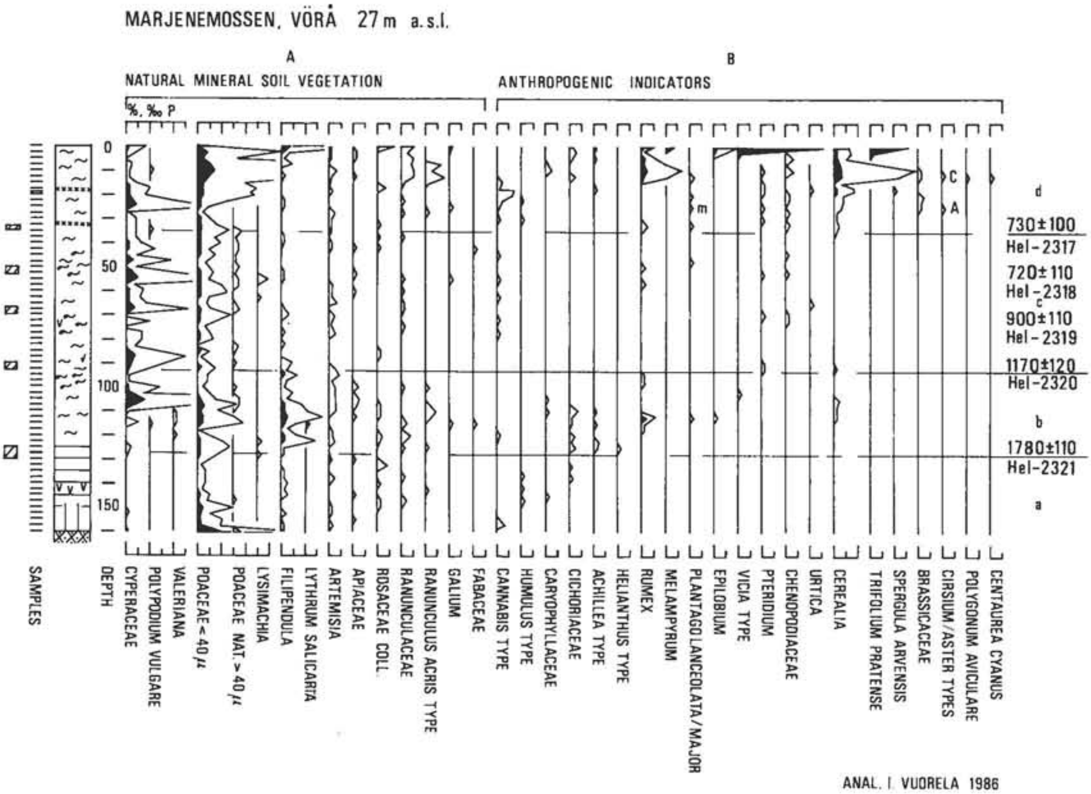


*Fig. 21.* Marjenemossen: Relative non-arboreal pollen diagram with radiocarbon dates.

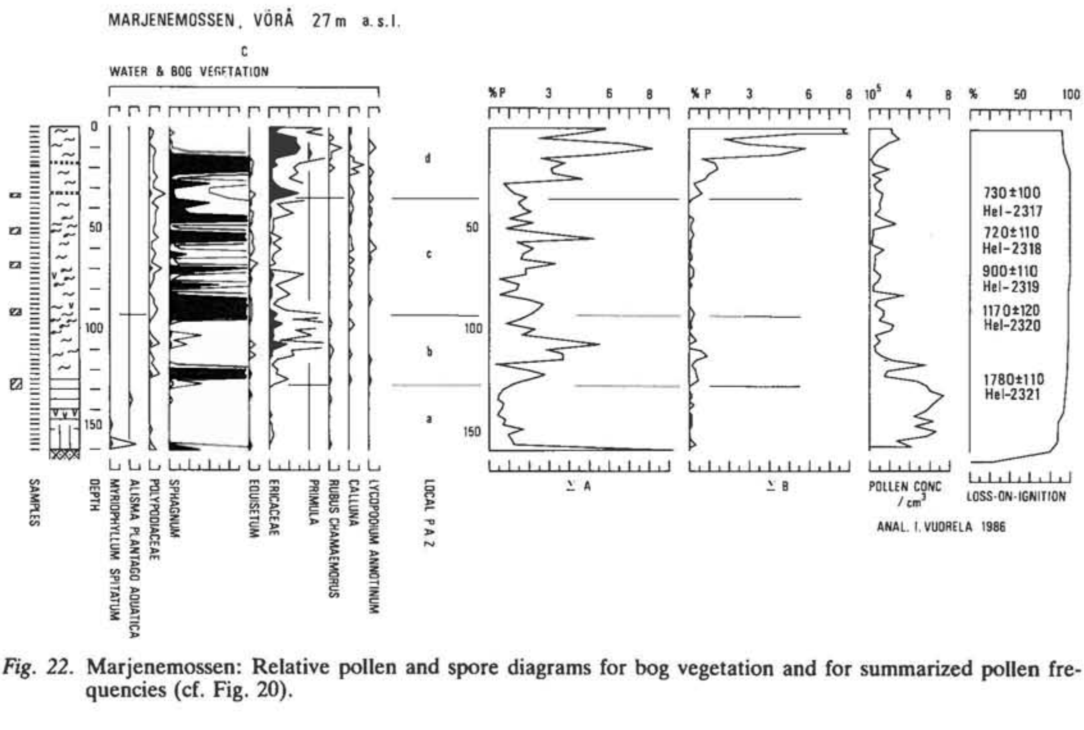


*Fig. 22.* Marjenemossen: Relative pollen and spore diagrams for bog vegetation and for summarized pollen frequencies (cf. Fig. 20).

prox. cal AD 240–850. The results agree with those from Lintunemossen.

Prehistoric agriculture (local p.a.z. b) is clearly indicated not only by Cerealia but also by a distinct occurrencce of cultural indicators (*Rumex, Epilobium, Plantago lanceolata,* Cichoriaceae, *Achillea* type and Caryophyllaceae; Fig. 21). Simultaneously the pollen frequencies of Poaceae, *Artemisia* and *Filipendula* reincrease after having decreaed at the end of the coastal phase. Ericaceae pollen (Fig. 22) seem to reflect the natural vegetational succession (cf. Fig. 14) while those of *Rubus chamaemorus* may serve as indicators of ditching.

Local p.a.z. c (1170±120 B.P.; Hel-2320 – 730±100 B.P.; Hel-2317 (cal AD 850–1260)

According to the pollen data prehistoric agriculture was reduced or even came to an end as was the case also at Lintunemossen. At Marjenemossen this took place around 1170±120 B.P. and lasted until 730±100 B.P. when recent agricultural practices began. The phenomena occurring in local p.a.z. c resemble those in Lintunemossen on the basis of the following phenomena: the lack of Cerealia, the increase in Cyperaceae, occurrences of natural Poaceae pollen exceeding 40 microns and sporadical occurrences of several anthropogenic indicators, such as *Urtica,* Chenopodiaceae, *Pteridium* and *Rumex.* The most prominent feature in Marjenemossen is *Cannabis* pollen in all the pollen assemblage zones, especially in c and d. This pollen type was not separated from the *Cannabis* type in the present diagram from Lintunemossen, but was determined in the preliminary investigations (Tolonen et al. 1979). The occurrences of *Cannabis,* which is a typical anthropochore (Linkola 1921), will be discussed in later context.

Local p.a.z. d (730±100 B.P. – recent times, cal AD 1260–1980)

The pollen indicators of modern agriculture in the diagrams from Marjenemossen resemble those found at Lintunemossen. The main difference here is the considerably higher frequencies of Cerealia and "weed" pollen, obviously resulting from the location of the sampling site close to the edge of the bog, thus minimizing the filter effect of bog vegetation (Vuorela 1985a). The relatively high frequencies of *Cannabis* pollen at the 20–30 cm level most evidently indicate cultivation of this fiber plant in the vicinity of the bog.

*Discussion of features found in local p.a.z. c.*

At both of the Vörå sites the two undisputably agricultural periods (p.a.z. b and d) are separated from eachother by p.a.z. c which lacks the main evidence of cultivation – Cerealia-pollen – and is characterized by a decrease in anthropogenous pollen data. Table 1 shows the synchronous nature of these features at both Lintunemossen and Marjenemossen.

Three main questions arise from the results concerning the period represented by the local pollen assemblage zone c which corresponds to approx. cal AD 850–1200. The first is the reason for the lack of Cerealia. Does the present material give any explanation for this phenomenon?

If man himself through hostilities or diseases caused the change in the livelihoods, this cannot be shown by means of pollen analysis. On the other hand, climatic causes could be seen to affect ecosystems within the bog itself. The main feature in this sense is the rapid growth of

*Table 1.* Uncalibrated and calibrated C14-dates for local pollen assemblage zones (a–d); calibration (after Pearson & Stuiver 1986, Stuiver & Pearson 1986).

| | LINTUNEMOSSEN | MARJENEMOSSEN |
|---|---|---|
| RECENT CULTIVATION | 890±90 B.P. – Recent<br>cal AD 1180 – 1980 | 730±100 B.P. – Recent<br>cal AD 1260 – AD 1980 |
| BREAK OF CULTIVATION | 1160±90 B.P. – 890±90 B.P.<br>cal AD 860 – 1180 | 1170±120 B.P. – 730±100 B.P.<br>cal AD 850 – 1260 |
| PRE-HISTORICAL CULTIVATION | 1750 b.p. – 1160±90 B.P.<br>cal AD 250 – 900 | 1790±110 B.P. – 1170±120 B.P.<br>cal AD 240 – 850 |
| COASTAL PHASE | 2000 b.p. – 1700 b.p. (+)<br>100 B.C. – AD 100 | 3000 b.p. – 1780±110 B.P.<br>1100 b.c. – cal AD 240 |

*Sphagnum* peat in p.a.z. c (cf. Fig. 16). During these 200–300 years the peat layer which had started to develop during the preceding p.a.z., increased at Lintunemossen by 80 cm (approx. 3 mm/y) the corresponding figure for Marjenemossen being 60 cm (1.5 mm/y). Could it have been the wet and cool summers of the 7th–9th centuries (Hillmer 1984) that caused radical changes in the livelihoods of Southern Ostrobothnia? This explanation was strengthened by the results of R. Solantie, published in this volume (Solantie 1988) and by the dendrochronological standard curves of the Laboratory of Wood Anatomy in Lund (Bartholin 1984).

The second problem concerns *Cannabis;* was the plant cultivated in the area in the Viking period or does the pollen evidence of this anthropochore (Linkola 1921) only reflect long-distance transport of pollen. Two pollen grains of *Cannabis* were found from the telmatic horizon of Marjenemossen corresponding to the time of the earliest cultivation of this plant in Scandinavia (Hjelmqvist 1955). No anthropogenic indicators, however, confirm the locality of this activity.

The second sporadic find coincides with Iron Age cultivation (p.a.z. b) and it could be of local origin. Questions arise mainly about the occurrences found in p.a.z. c both at Marjenemossen and by Tolonen (Tolonen et al. 1979) also from Lintunemossen. Was *Cannabis* cultivated in the area in the Viking period? This possibility, in theory, cannot be excluded, but why should grain cultivation have not been practised simultaneously? The fact that the modest weed pollen data of this period do not indicate any kind of local fields, in a positive case points to very extensive cultivation, probably of a shifting kind. This explanation, however, seems to require further evidence among the anthropogenic indicators. Even though it is less probable that cultivation of *Cannabis* would have continued throughout the p.a.z. c, occasional fields could have been in existence. As this anthropochore is found even today in natural circumstances originating from former cultivation or from other anthropogenic sources of dispersal (Hämet-Ahti et al. 1984) this could also have been the case in the Viking period in S. Ostrobothnia where the water routes flowing to the Gulf of Botnia must always have formed an important system of communication between the inland and the coast.

This leads to the third question: if *Cannabis* was not cultivated in the investigation area, was the area then totally abandoned or can we find indicators of some kind of human activity?

Certain features in the pollen diagrams show that some kind of human interference took place during cal AD 780–1250. One of these is the relative pollen curve of *Picea* in which we can see considerable fluctuations lacking any natural explanation. Of the herb pollen flora the evenly occurring sporadical indicators have been discussed.

The most plausible theory for the *Cannabis* pollen occurrences comes from NW-Europe where, due to the lack of lakes, *Cannabis* has since prehistoric times been soaked in mires (Behre; oral information). Since it is most probable that local settlement still existed at reasonable distances from the former permanent dwellings, it was possible to use the bogs for preparing *Cannabis*. This kind of human presence was probably connected with extensive grazing activities and natural communication along the rivers through the area and could have caused the special features present in the pollen data.

Among more natural features in the pollen data of p.a.z. c the increasing frequencies of Cyperaceae and natural Poaceae should be mentioned, the latter consisting partly of pollen exceeding 40 microns. The occurrences of these grass pollen at both sites coincide with the maximum phases of Cyperaceae thus indicating exceptional circumstances during those periods. In the literature on anthropogenic pollen indicators corresponding phenomena have been interpreted as indications of human activity. In Kuusamo, N. Finland, the increase in Cyperaceae was considered to be an indication of artificial changes in the ground water table in order to improve the area for grazing purposes (Vasari & Väänänen 1986). Correspondingly, temporary changes in the mean size of Poaceae in Kent, southern England, were regarded as palaeoecological evidence of hydrological changes by man affecting either the catchment area or the mire itself (Moore et al. 1986). In Vörå these phenomena, however, seem to be of natural origin.

## SUMMARY

The pollen data obtained from the present peat cores confirm on one hand the previously existing picture of the prehistoric changes in the intensity of the settlement at least in the area investigated, which is based on archaeological material (Fig. 23, cf. Vuorela 1987a).

On the other hand, especially in Vörå, they add *Cannabis* pollen as an important detail to

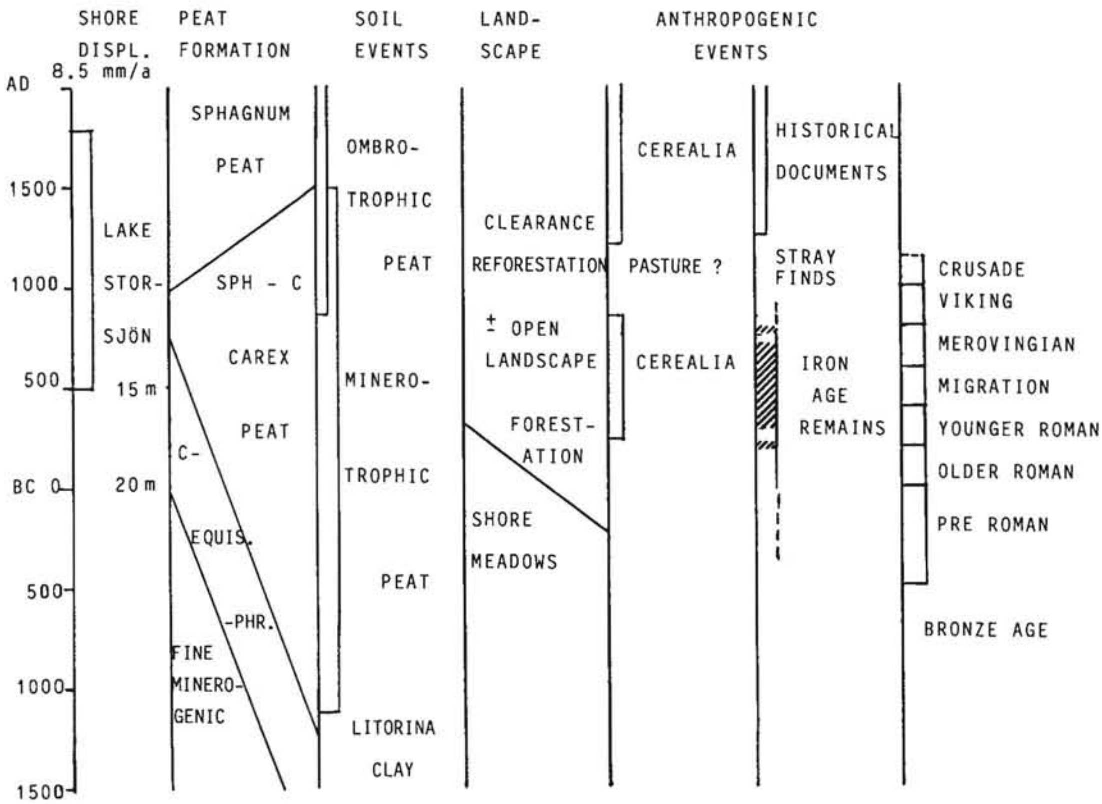


*Fig. 23.* Summarizing diagram, based on archaeological, stratigraphical and palynological data from Malax and Vörå.

the indicators of human activity even during the period from AD 850–1250 when the rest of anthropochores and the apophytes reflect an undisputable cultural regression.

The reason for this has been discussed emphasizing the indication of increasing humidity both by stratigraphical and by palynological evidence.

Even though the locality of the present results must be kept in mind, the similarities in the C14-dates for the limits of the pollen assemblage zones corresponding to the periods of changing intensity of the settlement should be stressed.

### *Acknowledgements*


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## REFERENCES


Ahtela, E. 1981: Piirteitä Vähäkyrön rautakautisesta asutuksesta. *Helsingin Yliopiston arkeologian laitos. Moniste* 25, 134 pp.

Anttila, V. 1967: Järvenlaskuyhtiöt Suomessa. *Kansatieteellinen Arkisto* 19.

Aspelin, J.R. 1866: Kertomus Maalahden pitäjästä. *Suomi* II:6.

Bartholin, T., 1984: Dendrochronology in Sweden. In: Mörner, N.-A. & Karlén, W. (eds). *Climatic Changes on a Yearly Millennial Basis.* D. Reidel Publishing Company. 2 p.

Behre, K-E., 1981: The interpretation of Anthropogenic indicators in pollen diagrams. *Pollen et Spores* 23 (2): 225–245.

Berglund, B.E. 1985: Early Agriculture in Scandinavia: Research problems related to pollenanalytical studies. *Norw. Arch. Rew.* Vol. 18 (1–2): 77–90.

Eronen, M. 1976: Suomen kvartääristratigrafian tutkimuksen menetelmistä ja keskeisistä kysymyksistä. Summary: Problems and methods of Quanternary stratigraphy in Finland. – *Terra* 88: 71–88.
Eronen, M. & Haila, H. 1981: The highest shore-line of the Baltic in Finland. – in: Florilegium Florinis Dedicatum (L-K. Königsson and K. Paabo, Eds.): *Striae* 14: 157–158.
Faegri, K. & Iversen, J. 1975: *Textbook of pollen analysis,* 3 ed., 195 pp., Munksgaard, Copenhagen.
Hackman, A. 1905: *Die ältere Eisenzeit in Finnland.* I. Die Funde aus den fünf ersten Jahrhunderten n. Chr. Text und Atlas. 376 pp.
Hillmer, G. 1984: Klimaschwankungen in historischer Zeit. – *Acta Univ. Carolinae. Geol.* 1: 71–83.
Hjelmqvist, H. 1955: Die älteste Geschichte der Kulturpflanzen in Schweden. – *Opera Botanica* 1(3): 1–168.
Hämet-Ahti, L.-Suominen, I.-Ulvinen, T.-Uotila & P.-Vuokko, S. (Eds.) 1984: *Retkeilykasvio.* Forssa. 544 pp.
Keskitalo, O. 1979: Suomen nuoremman roomalaisen rautakauden löydöt. *Helsingin Yliopiston arkeologian laitos. Moniste* 20. 236 pp.
Kivikoski, E. 1973: *Die Eisenzeit Finnlands.* Bildwerk und Text. Neuausgabe. 150 pp + 146 Tafeln.
Kujala, V. 1926: Untersuchungen über die Waldvegetation in Süd- und Mittelfinnland. I. Zur kenntnis des ökologisch-biologischen Charakters der Pflanzenarten unter spezieller berucksichtigung der Bildung von Pflanzenvereinen. A. Gefässpflanzen. – *Comm. Inst. Quaest. Forest. Finlandiae* 10: 1–140.
Lehtosalo-Hilander, P-L., 1982, Luistari II. The Artefacts. *Suomen Muinaismuistoyhdistyksen Aikakauskirja* 82:2. 197 pp.
Linkola, K. 1916: Studien über den Einfluss der Kultur auf die Flora in den Gegenden nördlich vom Ladogasee. I. Allgemeiner Teil. – *Acta Soc. Fauna Flora Fennica* 45 (1): 1–429.
Malax Museiförening, Arkeologigruppen (Ed.) 1984: *Offerstenar i Malax.* 32 pp. Vasa.
Meinander, C.F. 1950: Esihistoria. *Etelä-Pohjanmaan historia* I–II: 7–236.
Meinander, C.F. 1977: Forntiden i svenska Österbotten. – *Svenska Österbottens historia* I: 10–43.
Miettinen, M. 1980: Forntid i Pörtom. *Boken om Pörtom.* – 102 pp.
Miettinen, M: 1982a: Den förhistoriska tiden i Petalax. – *Petalax historia* I: 7–77.
Miettinen, M: 1982b: Arkeologisk fältverksamhet i svenska Österbotten 1974–1982. – *Österbotten* 1981–1982: 3–24 pp.
Miettinen, M. 1985: Många fynd från merovingertiden. Första undersökningen på Lövbacken. *Vörå årspublikation* 1985: 85–87 pp.
Miettinen, M. 1986a: Cultural Palaeoecology in Malax, Southern Ostrobothnia: Archaeological background. – in Nordic Late Quaternary Biology and Ecology (L.K. Köningsson, Ed.). *Striae* 24: 161–164.
Miettinen, M. 1986b: An Early Iron Age cairn from Frönäsudden, southern Ostrobothnia. – *Fennoscandia archaeologica* III: 59–66 pp.
Miettinen, M. 1988. Järnåldersbosättningen kring Storsjön. Malax sn, i ljuset av arkeologiska fynd och pollenanalys. Föredrag vid det 17. nordiska arkeologmötet i Åbo 1985. *Iskos* 7.
Moore, P.D., Evans, A.T. & Chater, M. 1986: Palynological and stratigraphic evidence for hydrological changes in mires associated with human activity. – In Behre, K.E. (ed.): *Anthropogenic indicators in pollen diagrams.* Balkema, Rotterdam: 209–220.
Pearson, G.W. & Stuiver, M. 1986: High-Precision Calibration of the Radiocarbon Time Scale, 500–2500 BC. – *Radiocarbon* 28 (2B): 839–862.
Seger, T. 1986a: Trofastbacken: Excavation of a Pre-Roman House in Korsnäs, S. Ostrobothnia, Finland. – *Iskos* 6: 175–184.
Seger, T. 1986b: Orrmoan: A Pre-Roman Dwelling site in Korsnäs, S. Ostrobothnia, Finland. – *Finskt Museum* 1986: 22–32.
Solantie, R. 1988. Climatic conditions for the cultivation of rye with reference to the history of settlement in Finland. *Fennoscandia archaeologica* V: 3–20.
Stockmarr, J. 1971: Tablets with spores used in absolute pollen analysis. – *Pollen et Spores* 13: 615–621.
Stuiver, M. & Pearson, G.W., 1986: High-Precision Calibration of the Radiocarbon Time Scale, AD 1950–500 BC. *Radiocarbon* 28 (2B): 805–838.
Tolonen, K., Siiriäinen, A. & Hirviluoto, A.-L. 1979: Iron Age cultivation in SW Finland. *Finskt Museum* 1976: 5–66.
Valonen, N., 1977: En gård från järnåldern och dess traditioner: Gulldynt i Vörå, Österbotten. *Ethnologia Fennica* 1977/1–2: 5–41.
Vasari, Y. & Väänänen, K. 1986: Stratigraphical indications of the former use of wetlands. – In Behre, K.-E. (ed): *Anthropogenic indicators in pollen diagrams:* 65–72.
Vuorela, I. 1973: Relative pollen rain around cultivated fields. – *Acta Botanica Fennica* 102: 1–27.
Vuorela, I. 1982: Vad berättar pollenanalysen om människoaktiviteten på Hundbacka. – *Bottnisk kontakt* I (ed. Ch. Westerdahl): 21–24.
Vuorela, I. 1985a: Comments on early agriculture in Scandinavia. Source areas of pollen spectra in Southern Finland. – *Norw. Arch. Rev.* 18(1–2): 97–99.
Vuorela, I. 1985b: The peat knife – an improved tool for collecting peat samples for pollen analysis. – *Memoranda Soc. Fauna Flora Fennica* 61: 103–105.
Vuorela, I. 1986a: Cultural palaeoecology in Malax, Southern Ostrobothnia. Pollen Analysis. – In *Nordic Late Quaternary Biology and Ecology* (L.-K. Königsson, Ed.). Striae 24: 165–168.
Vuorela, I. 1986b: Palynological and historical evidence of slash-and-burn cultivation in South-Finland. – In Behre, K.-E. (ed.): *Anthropogenic indicators in pollen diagrams:* 53–64.
Vuorela, I. 1987a: Type region: Coastal S. Ostrobothnia, Finland. – *IGCP 158. Palaeohydrological changes in the temperate zone in the last 15000 years.* Symposium at Höör, Sweden, 18–26 May 1987, Posters: 135–138.
Vuorela, I. 1987b: Pollenanalyser från Vörå mossar. – *Vörå årspublikation* 1987: 56–58.

## NOTE

After the manuscript was submitted, two C14-dates from Malax have been obtained: one (Hel-2550) 1680±110 B.P., cal AD 230 (381) 450 (one sigma) of the cultural layer of the area investigated in 1984 at Nisseshagen, and the other (Hel-2549) likewise 1680±110, cal AD 230 (381) 450 (one sigma) from the iron-working site of Holsterbacken. Calibration according to Stuiver & Pearson (1986).