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Pollen evidence and radiocarbon dating of human activity within the natural forest vegetation of the Pohjanmaa region (northern Finland)

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&
MERVI HJELMROOS

RÉSUMÉ

REYNAUD, C. & M. HJELMROOS (1980). Les activités humaines sur la végétation naturelle de la région de Pohjanmaa (Finlande septentrionale) mises en évidence par la palynologie et les datations au Carbone 14. *Candollea* 35: 257-304. En anglais. résumé français.

L'analyse palynologique des sédiments de 9 tourbières et lacs, situés dans la région de Pohjanmaa (Finlande septentrionale), permet de retracer l'importance des activités humaines de défrichement et de prise de possession du sol pour l'élevage et l'agriculture. L'échantillonnage, basé sur un pas très serré, et le très grand nombre de pollens comptés par spectre (jusqu'à 8000 grains avec une moyenne de 3000 grains) suggèrent que les hommes sont présents dans la vallée du fleuve Oulujoki depuis la fin du Néolithique ancien, soit vers 6000 ans BP. Les activités humaines ont débuté par l'installation de campements plus ou moins mobiles et l'économie de ces premiers colonisateurs reposait sur l'élevage, la chasse et la pêche. Ensuite, la pression économique de ces groupements humains s'est accentuée, et des défrichements sur une plus large échelle ont été opérés: une agriculture itinérante s'est mise en place. Dès le début de l'âge des métaux (3000 ans BP), la mise en culture de champs permanents est synchronique avec le même phénomène dans le sud de la Finlande pour la majorité des sites étudiés. Des défrichements extensifs ont été menés par le feu, un moyen dont l'usage s'est poursuivi jusqu'aux premières décennies du XX^{e} siècle dans toute la Finlande. Sur la base des découvertes archéologiques, deux vagues d'immigration se sont succédées en Pohjanmaa en provenance du sud-est de la Finlande, portant avec elles des techniques nouvelles de poterie et la pratique des cultures céréalières.

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ABSTRACT

REYNAUD, C. & M. HJELMROOS (1980). Pollen evidence and radiocarbon dating of human activity within the natural forest vegetation of the Pohjanmaa region (northern Finland). *Candollea* 35: 257-304. In English, French abstract.

A palynological examination of the sediments from nine different sites has definitively shown that man was present in the Pohjanmaa region since the younger Stone Age. The role of man, in the natural environment, was sporadic until the early Metal Age, and became more systematic and intense during the Lapp Iron Age. On the basis of the results obtained, two sociocultural changes can be established. The first is contemporary with the Säräisniemi Culture, around 6000 BP, and saw the appearance of both pottery and permanent or semi-permanent dwelling sites, with some localised clearances of the land, and the practise of rearing animals side by side with hunting and fishing. The second upheaval came towards the end of the early Metal Age, around 1500 years BP, and is marked, in the Pohjanmaa region as well as in southern Finland, by the occupation of the land by larger human groups which practised a permanent form of agriculture through the use of the "slash and burn" method.

INTRODUCTION

The Pohjanmaa region falls within the Middle Boreal zone as defined by AHTI & al. (1968). Between 50 and 70% of the total land area is forested, the dominant species being pine *(Pinus silvestris)*, spruce *(Picea abies)* and birch *(Betula pubescens)* ("Atlas of Finland", 1960). Mires occupy a larger area than elsewhere in Finland, covering more than 51% of the region, and extend into areas recovered from the sea by land uplift. Arable land is situated on the best soil and around both the Oulujoki and Torniojoki estuaries, it represents between 5 and 15% of the total land area, elsewhere only 1 to 5%.

Four years ago, a project was started concerning human settlement and human interference with the forest vegetation of northern Finland, as indicated by pollen analysis and dated by radiocarbon analyses. Some of the results, concerning the island of Hailuoto, have already been published (REYNAUD & HJELMROOS, 1976). The nine other sites investigated were chosen mainly for their situation in river valleys running into the Gulf of Bothnia. River systems in Finland have played an important role in communications and so attracted early human settlement. For the most part, dwelling places in northern Finland are situated in the river valleys (Fig. 1), and along the major shores which developed during the various phases of the Litorina sea.

It is commonly accepted that the Finns established themselves around the Bay of Bothnia during the 16th century, when the Lapps living by hunting, fishing and raising reindeer withdrew to North Finland (SMEDS, 1960; KIVIKOSKI, 1961; KEMIJOKI 8000, 1974). Until recently, however, the palaeo-ethnobotanical evidence was so scanty that northern Finland was believed to be a "peripherial area" as far as the history of human settlements was concerned (VASARI, 1976). In southern Finland, in contrast, Vuorela has

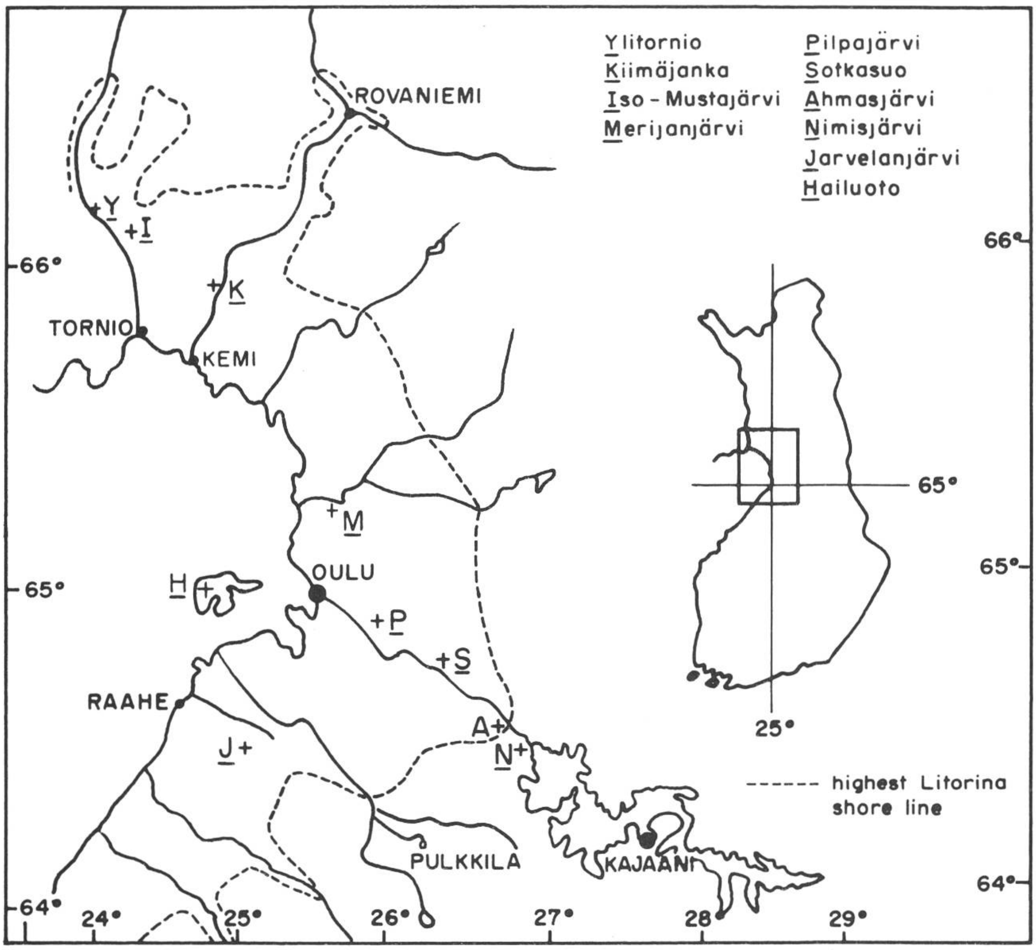


Figure 1.

shown that agriculture in permanent fields was first practised 1400 years ago (VUORELA, 1975).

The aim of this work was to establish unambiguous palynological indicators of human activity within the coniferous forest in northern Pohjanmaa. The time period analysed goes back in archaeological terms to the end of the Mesolithic period.

ARCHAEOLOGICAL BACKGROUND

The retreat of the ice margin from the Finnish area of the Tornio valley, after the last glaciation in northern Europe, took place at the latest by 7000 B.C. (8950 yr BP), at which stage the land surface had been depressed by the weight of the ice to such an extent that the subsequent Yoldia shore-line lay some 200 m above the present shore in the Tornio and Kemijoki valleys (SIIRIÄINEN, 1974). At first, a tundra landscape prevailed, and no true Stone Age cultures are recognised in Finland for this period, although a few finds in southern Finland have been dated to the Preboreal-Boreal transition, e.g. few artefacts from Antrea, a sledge runner from Heinola and an ice pick of elk bone from Kirkkonummi.

The Stone Age in Finland is divided into a number of successive cultures on the basis of material from the South of the country. The oldest of these, the Suomusjärvi cultural phase has an early manifestation known as the Askola culture which would appear to be slightly younger than the oldest phases of the Kunda culture on the Arctic Ocean coast in the North, dating back to around 8000-7000 B.C. (9950-8950 yr BP). No dwelling sites have yet been attributed to either the Askola or the Kunda culture in northern Finland, however, although it is possible that such might be discovered. The oldest dated dwelling site in the Lapland area would seem to be that of Lamminvaara at Sinettä, near Rovaniemi, from around 5500 B.C. (7450 yr BP), from which some quartz artefacts and fragments of schist objects have been recovered. Prior to this find, a wooden carving of an elk head had been recovered from the paludified shore meadow of a nearby lake, Lehtojärvi, which has been dated both by the radiocarbon method and by pollen analysis to around 7700-7600 B.C. (9650-9550 yr BP). Such a quantity of artefacts typical of the Suomusjärvi culture of approx. 6500-4000 B.C. (8450-5950 yr BP), primitive axes, schist points and quartz objects, have been discovered over an extensive area of northern Finland and Sweden that it would seem probable that people of this culture occupied both sites of the head of the Gulf of Bothnia.

The adoption of ceramics apparently did not imply any great change in the occupations of the primitive peoples of the northern coniferous forests. The Combed-ware culture, which received its name from the typical ornamentation used on its vessels, is represented by its early ceramics (Type I: 1) at many sites in northern Finland, even though ceramics are otherwise relatively rare at Neolithic dwelling sites in this region. It is at this stage at the latest that the area to the North of the Oulu river can be shown to have possessed its own culture, distinct from that represented by the Stone Age material from southern Finland. Thus the Combed-ware period has its own northern variant, the Säräisniemi 1 ceramics, the northernmost attested occurrence of which is on the shore of the Varanger fjord in northern Norway. This possesses a rich material of artefacts formed from the local amphibolite schist, which is easily split into long strips and which may be used to make one's own shaping tools. The best known such artefacts are the "northern round-headed axe" and above all the Rovaniemi axe, a pointed implement found in at least two main types, the distribution of which is centred upon the Tengeliö basin in the Tornio valley. Some of the Rovaniemi axes would also have been suitable for wood-carving, for instance, but in general, the use of these implements, often of prodigious size, still remains obscure. They appear to have remained in use at least up until the end of the Bronze Age, around 1000 B.C. (2950 yr BP).

The late Stone Age culture in northern Finland cannot be separated into discrete cultural phases and periods as can its southern counterpart. The Corded-ware culture, for instance, does not extend as far as Lapland by any means, although one or two individual boataxes did reach this region. The transition to the Bronze Age is similarly slow in the North, no change having yet taken place by the middle of the second millenium B.C. On the other hand, fairly certain Scandinavian Bronze Age finds have been recorded in northern Finland well into the northern most parts of Lapland, e.g. Sodankylä and Inari, with an additional specialized feature emerging in the form of ten or so axe moulds of soapstone, most of which must have originated from the area of the eastern Russian Ananyino culture. These moulds, together with a small number of crucible fragments, provide evidence of a fairly well-developed culture, based on the casting of bronze objects. Around the same time, about 1300 B.C.-400 A.D. (3250-1550 yr BP), we also find a type of ceramics particular to northern Finland, the Säräisniemi 2 type, composed of asbestos and talc, which may be subdivided into several groups on the basis of its ornamentation. Probably by virtue of its relations with the East, Lapland also came to possess the oldest iron artefacts in Finland, two curved iron daggers with ornamentation discovered in Savukoski, and dated to around 300 B.C. (2250 yr BP).

The art of iron founding apparently spread into Lapland from the East, probably before the birth of Christ, at a time when even stone implements were still in use in the area. Very few finds of early Iron Age artefacts are reported from the area North of the Oulu river, however, and it seems very much that the principal inhabitants of the area, at that time, were the Lapps, who lived chiefly by hunting and possibly reindeer herding, so that no definite indications of Iron Age or earlier agriculture have yet been found, by archaeological means.

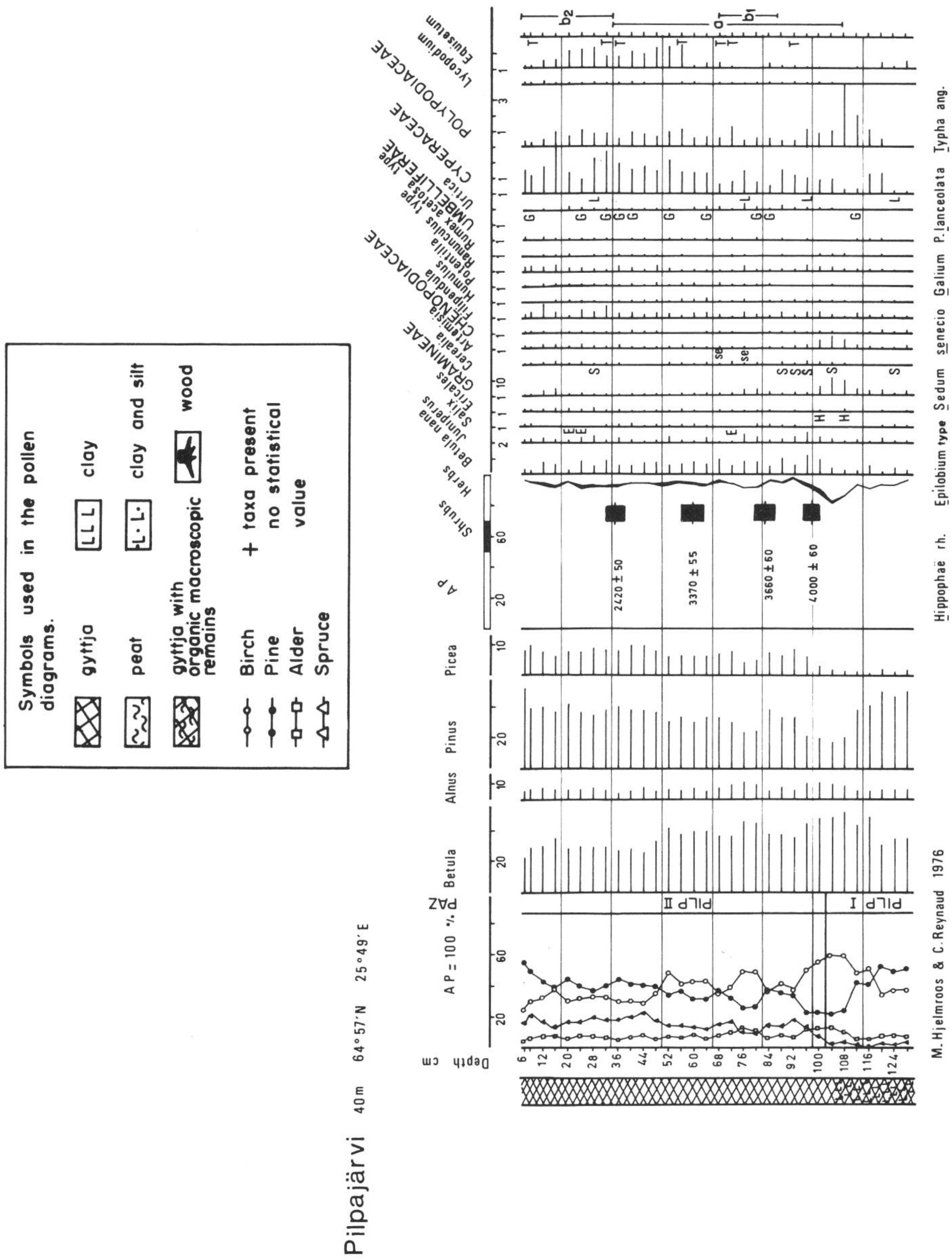
The local production of ceramics appears to have come to an end with the disappearance of the Säräisniemi 2 ceramics around 400 A.D. (1550 yr BP), and our knowledge of the early Iron Age is very limited. The archaeological material from the middle Iron Age, around 500 A.D., which is largely to be interpreted as isolated finds, shows clear indications of Norwegian origin, although it may also include some items brought in from the very South of Finland. The most outstanding among these Norwegian articles is almost certainly a magnificent gilded brooch, decorated with Germanic animal figures, which has been found recently North of Rovaniemi and still remains to be dated (KOIVUNEN, 1975). The finds continue to be dominated almost exclusively by Norwegian elements up until the 10th century, when a marked increase in articles of other origin begins to make itself felt. Although the majority of these finds have been looked on as objects dropped or lost by the nomadic Lapps or tradesmen or explorers from outside Lapland, the valuable jewelry items included among them at least would point to the presence in Finnish Lapland of people with a different economy and way of life from that of the Lapps themselves. Indeed, the Norwegian sagas, and the legend of Ottar from the 9th century speak not only of the Lapps (or "Finns" as they are called), but also of another people, the Kainu, who lived on both sides of the northern Gulf of Bothnia, the "Kainuu Sea", and in later sources, there is also mention of the Karelians. Recent research, carried out by the University of Oulu at one of the main centres of settlement in the Tornio valley in the Middle Ages, Kainuunkylä, near Ylitornio, has unearthed evidence of settlement dating back at least to the 12th or 13th century, with signs of livestock rearing, dwelling houses and iron smelting, and a group of Swedish scientists, in the area on the opposite bank of the river, have similarly encountered, beside the church at Hietaniemi, a group of ancient remains of a very early style which may well date from the late Iron Age.

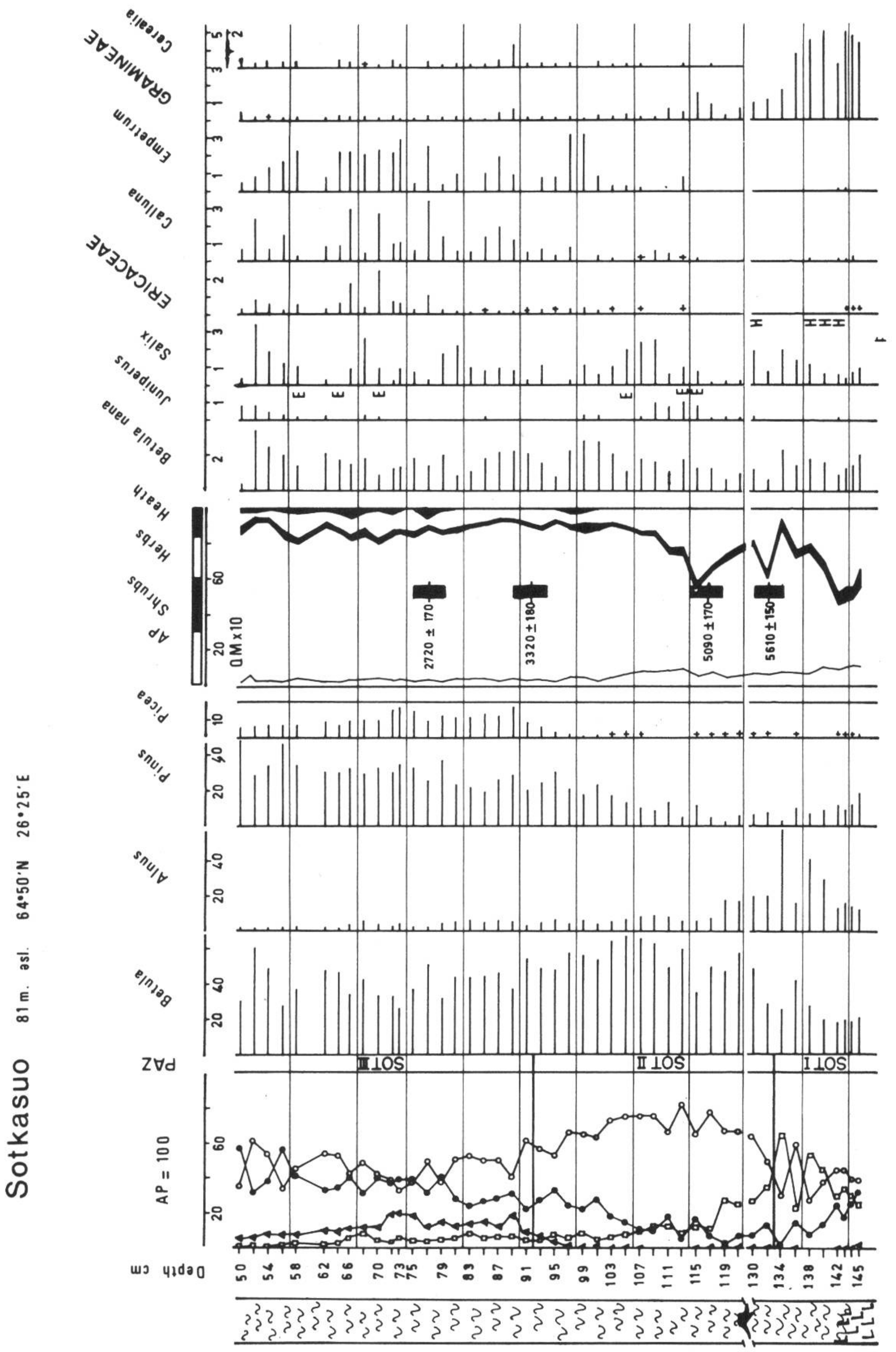
Five certain finds and an uncertain one of silver treasure have been made in northern Finland, containing items from all parts of northern Europe, possibly including some from the Novgorod area of Russia. Such finds have been made in Finland only at dwelling sites from the middle Iron Age, a fact which would suggest that they were not of Lapp origin.

Since there are very few extant historical documents concerning northern Finland from the Middle Ages, it has been necessary to undertake extensive research in a variety of scientific fields in order to ascertain what peoples were present in Lapland in the Iron and Middle Ages (Koivunen, 1978; Vahtola, 1976). Similarly it is by no means yet certain which means of livelihood the various peoples present may have pursued. Since it must also be admitted that extensive tracts of even the most important settlement area of northern Finland are still poorly covered archaeologically, a considerable alteration and clarification can be expected to take place in future in our concept of the prehistory of northern Finland and its situation in the Middle Ages.

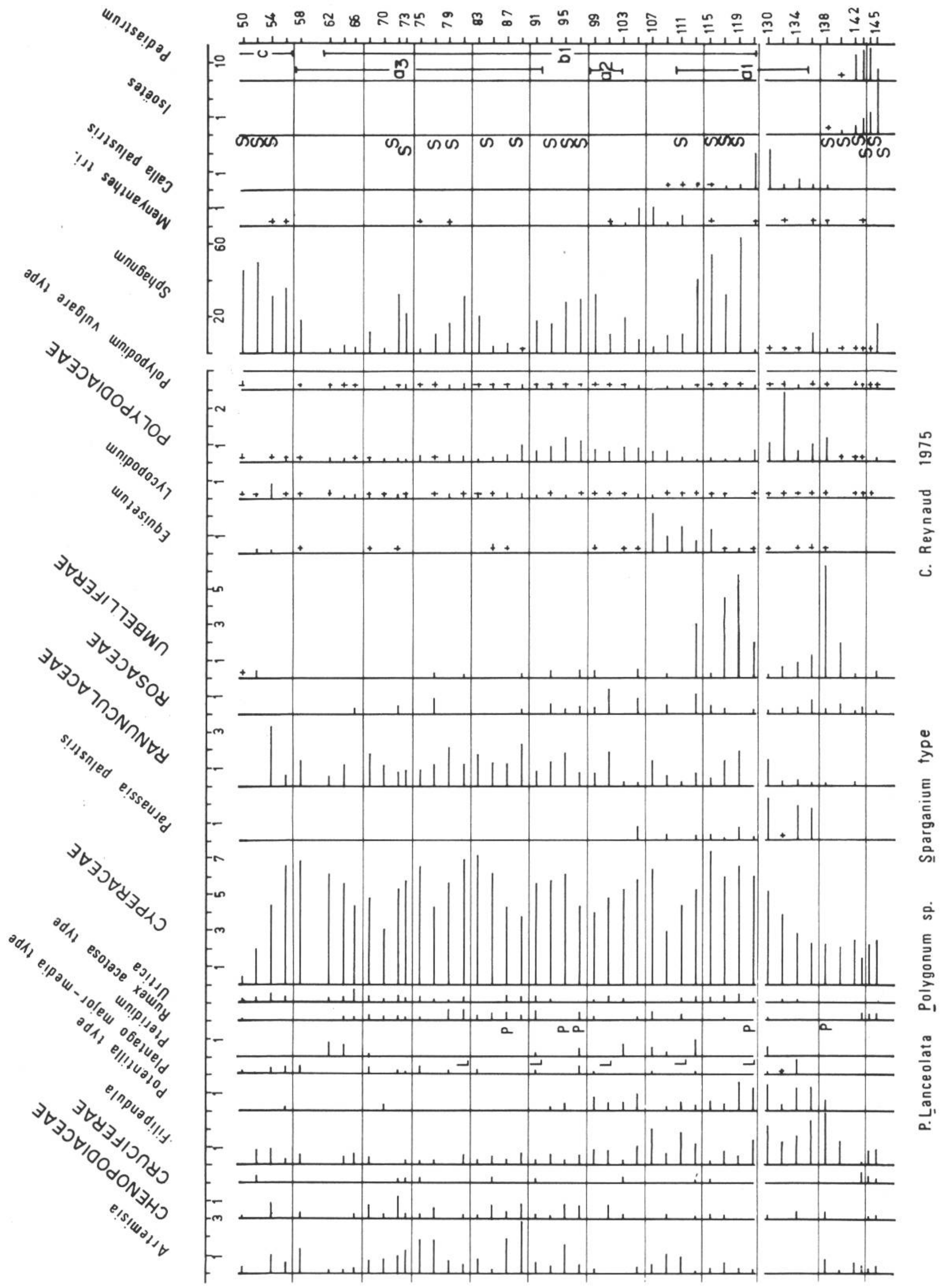
FIELD WORK

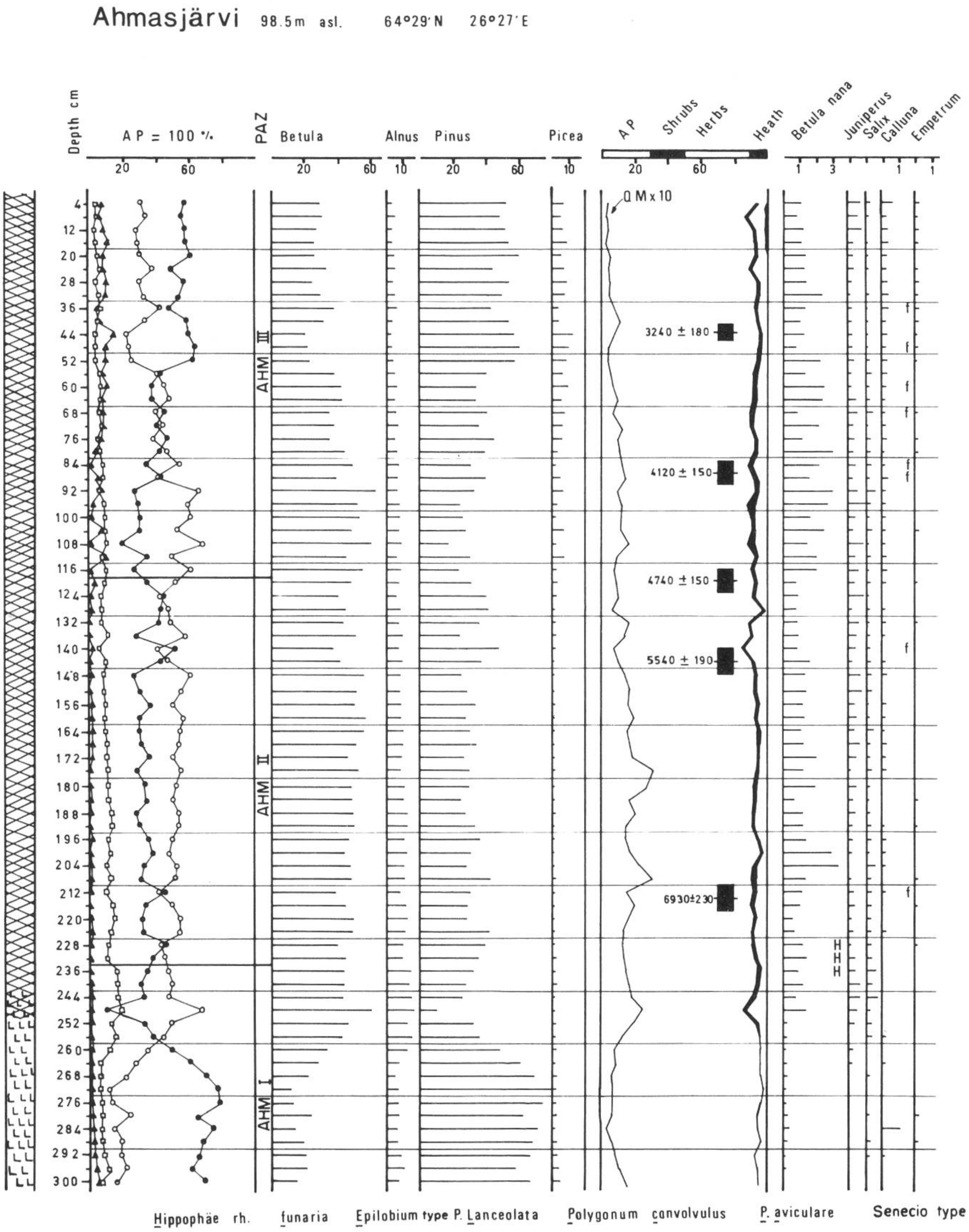
The peat deposits (Sotkasuo, Kiimajänkä, Merijänjärvi) were sampled with a "Russian" peat borer (West, 1968), after preliminary investigations with a Hiller sampler which enabled a check on the general stratigraphy of the sediments. The lake sediment samples were obtained with a one meter long Livingstone type sampler operated through the lake ice during the winter. For both the lakes and the mires, the sampling site was located in the central area of the basin, in order to avoid too strong an influence of the local vegetation. On extrusion from the sampling chamber, the cores were wrapped in polythene, labelled and stored in a cold room until laboratory treatment.

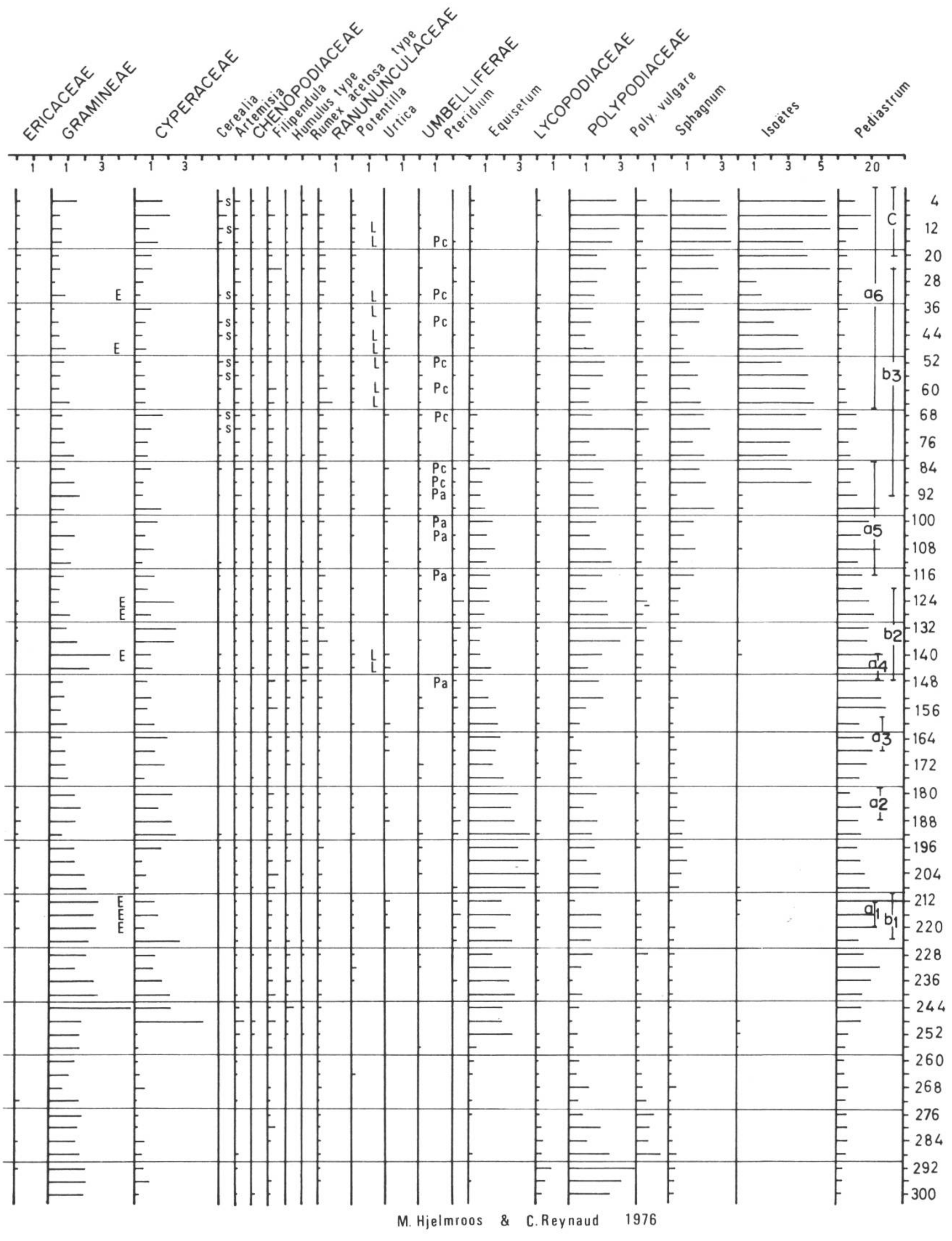

Symbols used in the pollen diagrams.
gyttja
clay
peat
clay and silt
gyttja with organic macroscopic remains
wood
Birch
Pine
Alder
Spruce
+ taxa present no statistical value
Pilpajärvi 40m 64°57'N 25°49'E
Depth cm
AP = 100 %
PAZ
Betula
Alnus
Pinus
Picea
AP
Shrubs
Herbs
Betula nana
Juniperus
Salix
Ericales
GRAMINEAE
Cerealia
Artemisia
CHENOPODIACEAE
Filipendula
Humulus
Potentilla
Ranunculus
Rumex acetosa type
UMBELLIFERAE
Urtica type
CYPERACEAE
POLYPODIACEAE
Lycopodium
Equisetum
PILP II
PILP I
2420 ± 50
3370 ± 55
3660 ± 60
4000 ± 60
Hippophaë rh.
Epilobium type
Sedum
senecio
Galium
P.lanceolata
Typha ang.
M. Hjelmroos & C. Reynaud 1976

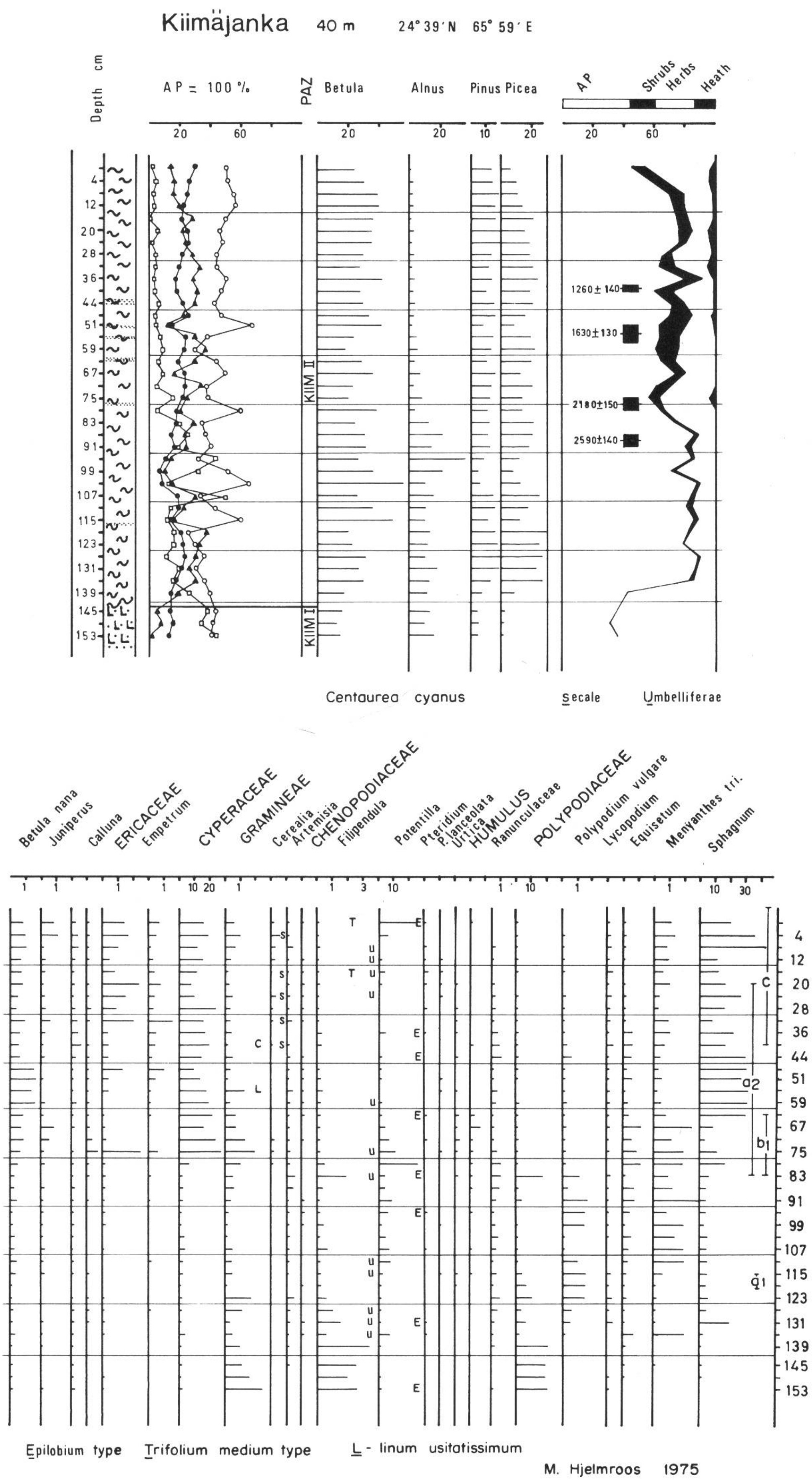


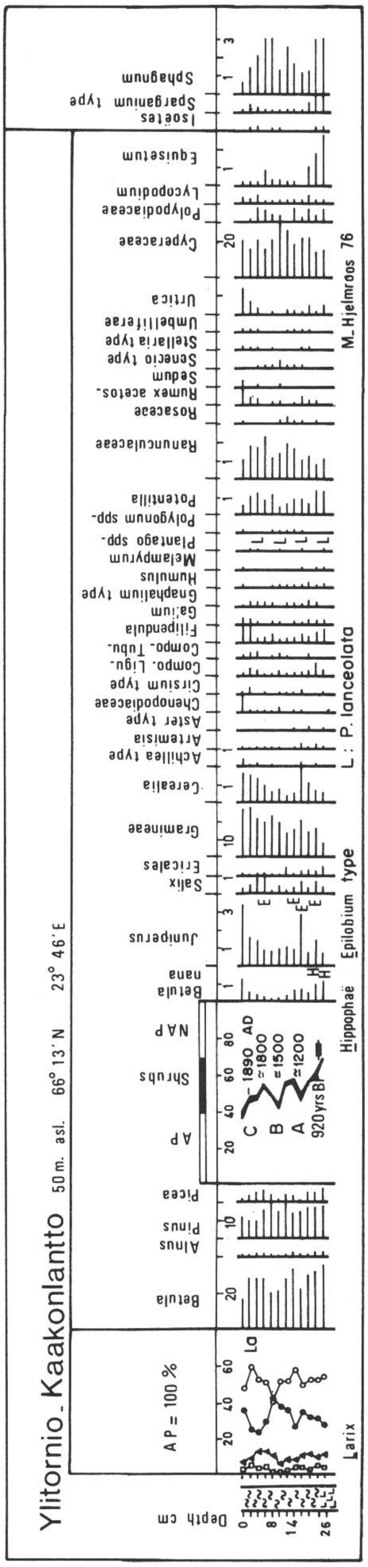
Sotkasuo
81 m. asl. 64°50'N 26°25'E
AP = 100
PAZ
SOT I
SOT II
SOT III
Betula
Alnus
Pinus
Picea
AP
Shrubs
Herbs
Heath
QM x 10
2720 ± 170
3320 ± 180
5090 ± 170
5610 ± 150
Betula nana
Juniperus
Salix
ERICACEAE
Calluna
Emperrum
GRAMINEAE
Cerealia
Depth cm
Epilobium type
Hippophaë rh.
Pteridium

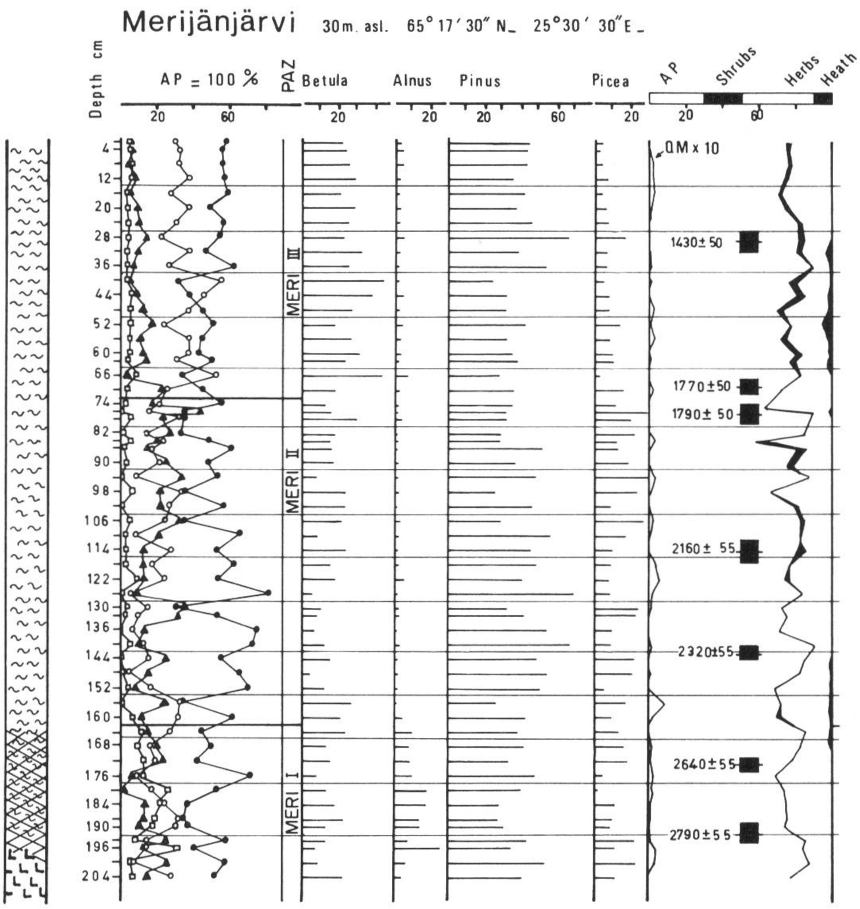

Pediastrum
Isoetes
Calla palustris
Menyanthes tri.
Sphagnum
Polypodium vulgare type
POLYPODIACEAE
Lycopodium
Equisetum
UMBELLIFERAE
ROSACEAE
RANUNCULACEAE
Parnassia palustris
CYPERACEAE
Urtica
Rumex acetosa type
Pteridium
Plantago major-media type
Potentilla type
Filipendula
CRUCIFERAE
CHENOPODIACEAE
Artemisia
50 54 58 62 66 70 73 75 79 83 87 91 95 99 103 107 111 115 119 130 134 138 142 145
c
a3
b1
a2
a1
C. Reynaud 1975
P. Lanceolata
Polygonum sp.
Sparganium type

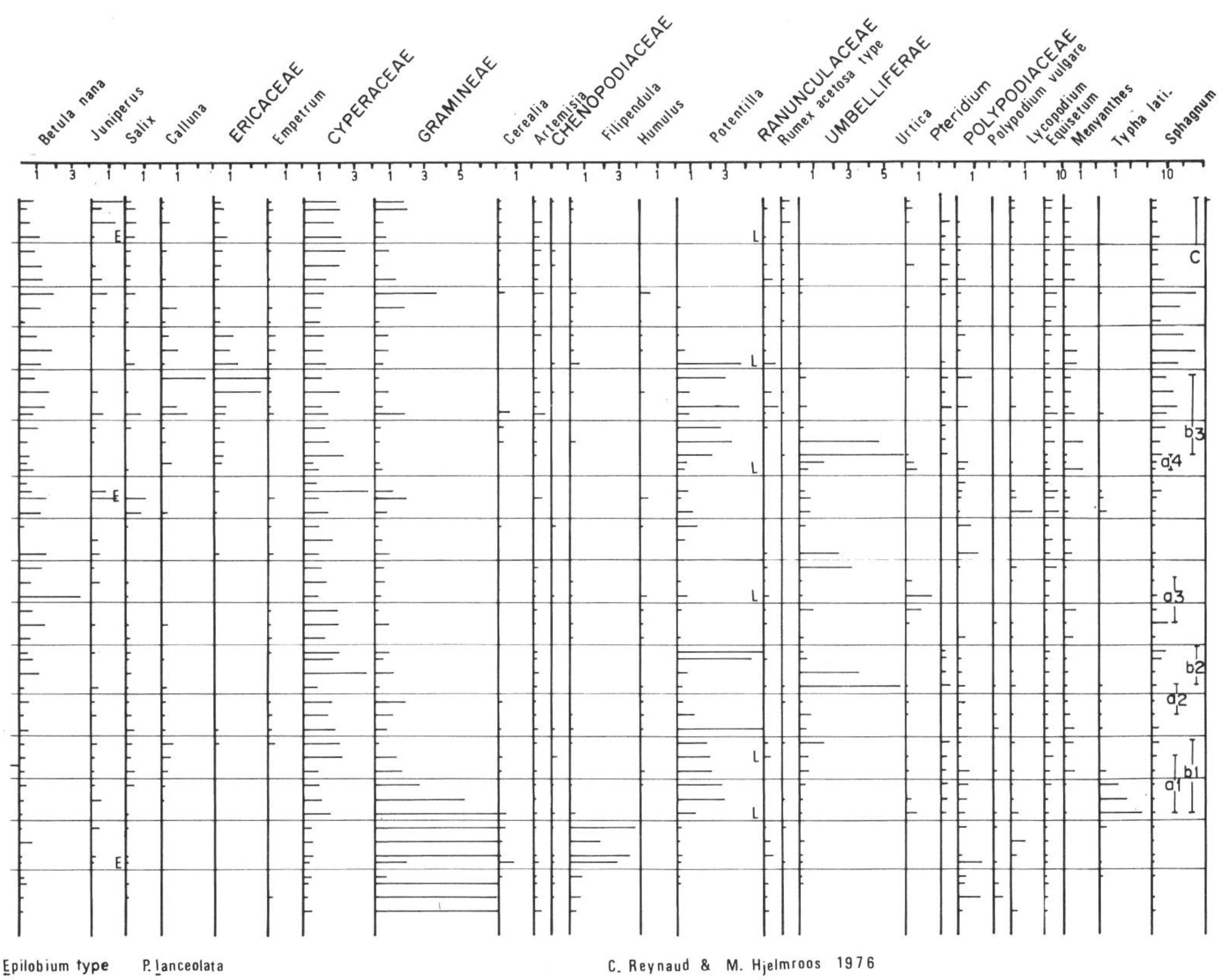

Ahmasjärvi 98.5m asl. 64°29'N 26°27'E
Depth cm
AP = 100 %
PAZ
Betula
Alnus
Pinus
Picea
AP
Shrubs
Herbs
Heath
Betula nana
Juniperus
Salix
Calluna
Empetrum
QM x 10
3240 ± 180
4120 ± 150
4740 ± 150
5540 ± 190
6930±230
AHM III
AHM II
AHM I
Hippophäe rh.
funaria
Epilobium type
P. Lanceolata
Polygonum convolvulus
P. aviculare
Senecio type

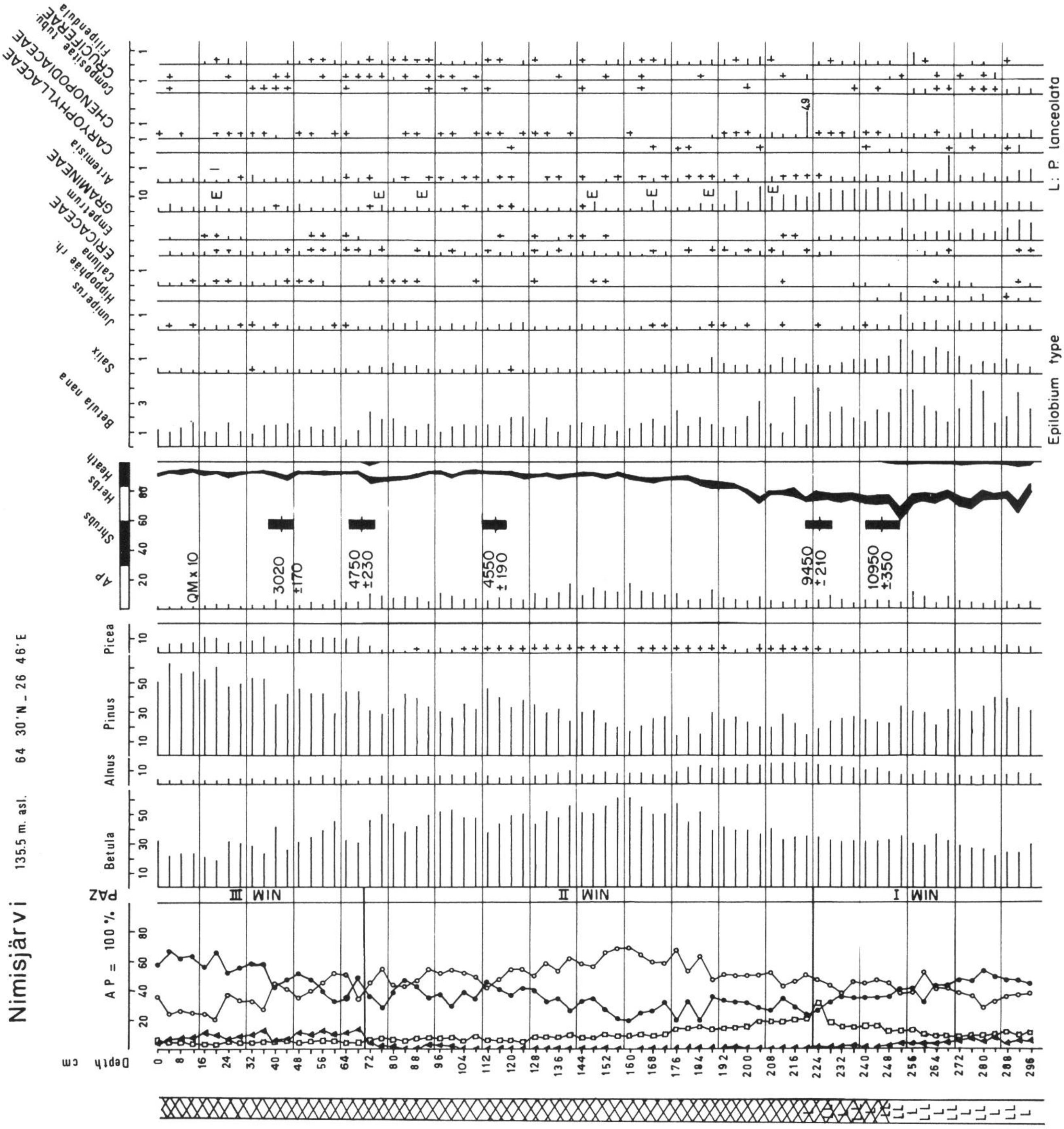

ERICACEAE
GRAMINEAE
CYPERACEAE
Cerealia
Artemisia
CHENOPODIACEAE
Filipendula
Humulus type
Rumex acetosa type
RANUNCULACEAE
Potentilla
Urtica
UMBELLIFERAE
Pteridium
Equisetum
LYCOPODIACEAE
POLYPODIACEAE
Poly. vulgare
Sphagnum
Isoëtes
Pediastrum
c
a6
b3
a5
b2
a4
a3
a2
a1
b1
M. Hjelmroos & C. Reynaud 1976

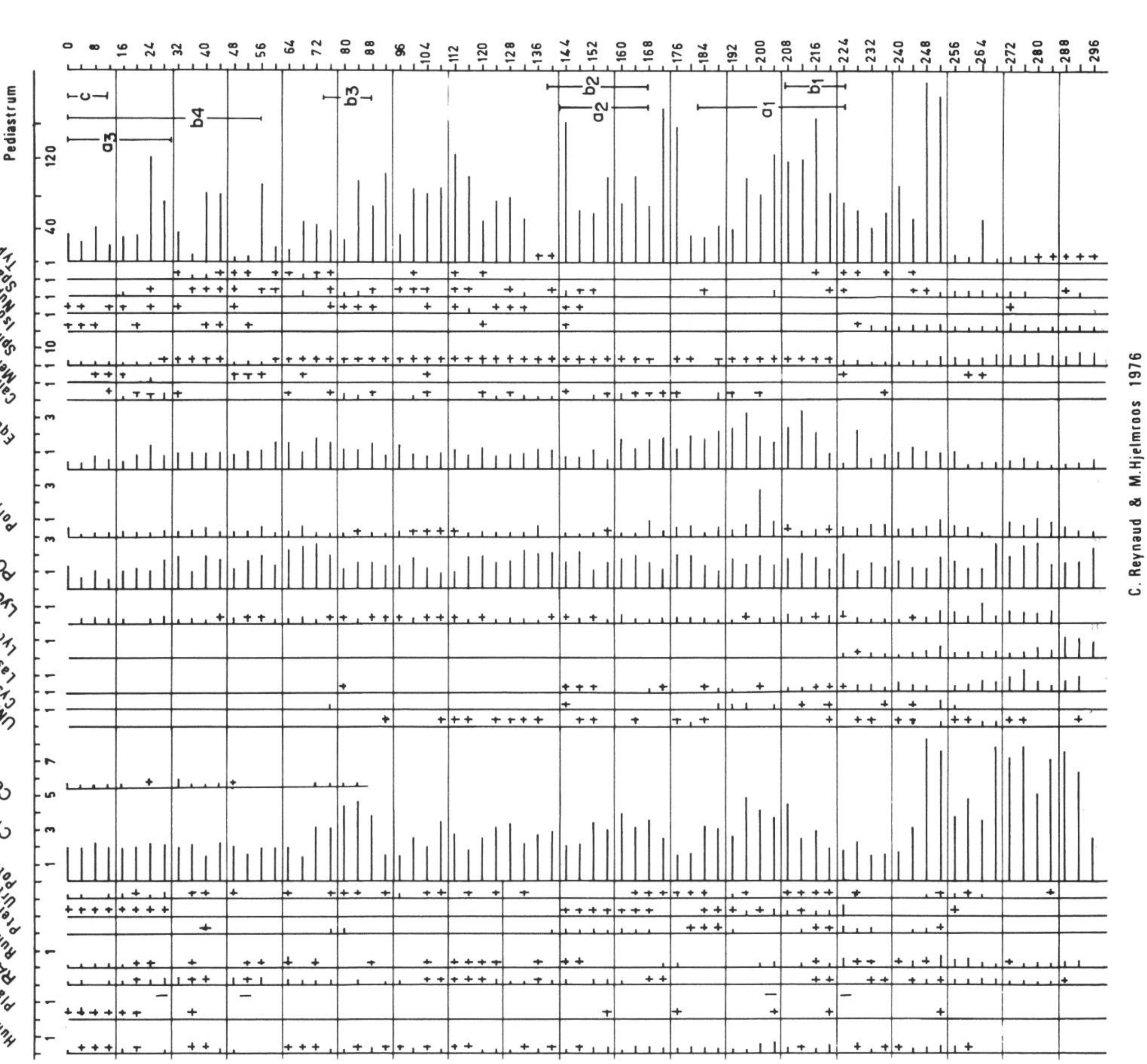

Kiimäjanka 40 m 24° 39′ N 65° 59′ E
Depth cm
AP = 100 %
PAZ
Betula
Alnus
Pinus
Picea
AP
Shrubs
Herbs
Heath
KIIM II
KIIM I
1260 ± 140
1630 ± 130
2180 ± 150
2590 ± 140
Centaurea cyanus
Secale
Umbelliferae
Betula nana
Juniperus
Calluna
ERICACEAE
Empetrum
CYPERACEAE
GRAMINEAE
Cerealia
Artemisia
CHENOPODIACEAE
Filipendula
Potentilla
Pteridium
P. lanceolata
Urtica
HUMULUS
Ranunculaceae
POLYPODIACEAE
Polypodium vulgare
Lycopodium
Equisetum
Menyanthes tri.
Sphagnum
Epilobium type
Trifolium medium type
L - linum usitatissimum
M. Hjelmroos 1975

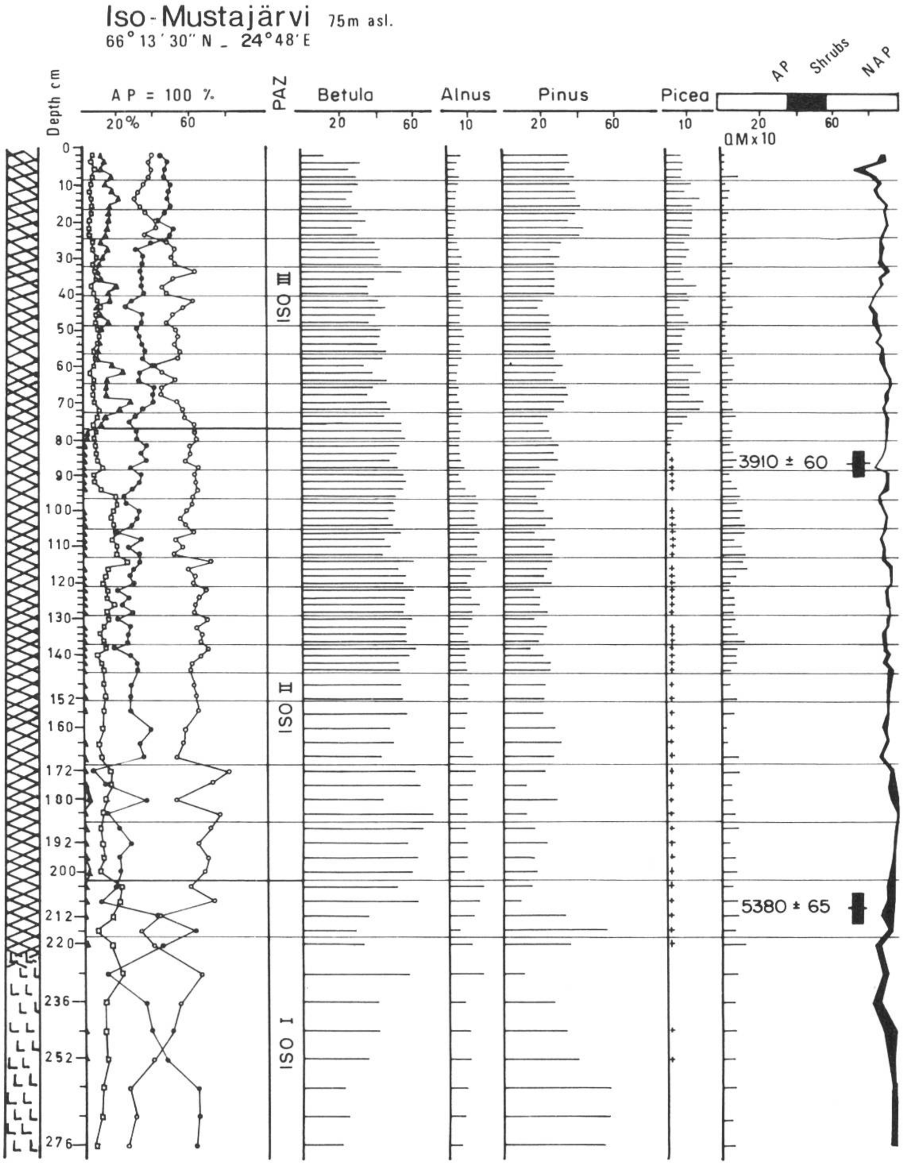

Ylitornio_Kaakonlantto 50 m. asl. 66° 13' N 23° 46' E
AP = 100 %
Larix
Depth cm
Betula
Alnus
Pinus
Picea
AP
Shrubs
NAP
C 1890 AD
B ≃1800
≃1500
A ≃1200
920 yrs BP
Betula nana
Juniperus
Salix
Ericales
Gramineae
Cerealia
Achillea type
Artemisia
Aster type
Chenopodiaceae
Cirsium type
Compo. Ligu.
Compo. Tubu.
Filipendula
Galium
Gnaphalium type
Humulus
Melampyrum
Plantago spp.
Polygonum spp.
Potentilla
Ranunculaceae
Rosaceae
Rumex acetos.
Sedum
Senecio type
Stellaria type
Umbelliferae
Urtica
Cyperaceae
Polypodiaceae
Lycopodium
Equisetum
Isoëtes
Sparganium type
Sphagnum
Hippophaë
Epilobium type
L: P. lanceolata
M. Hjelmroos 76

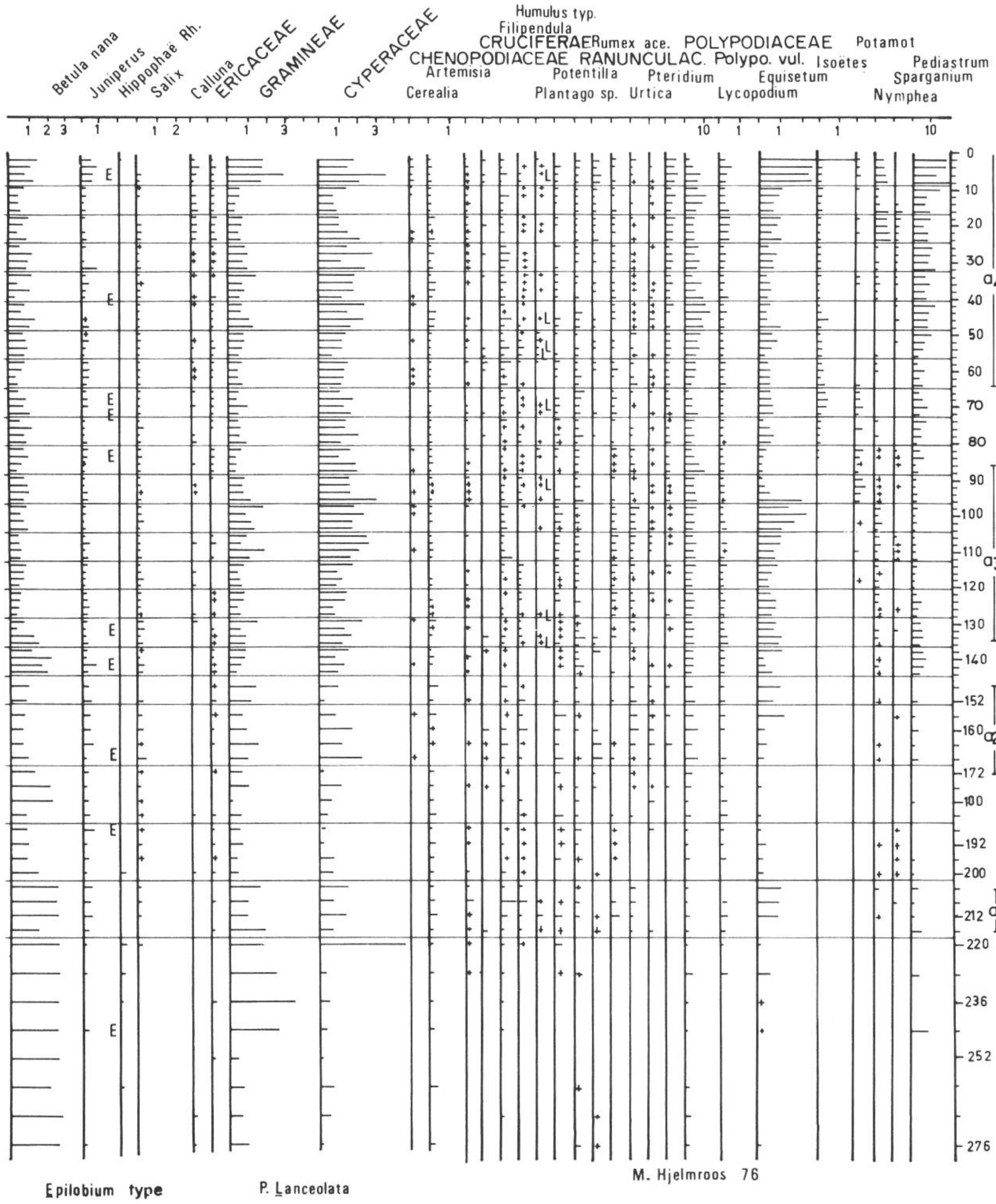

Merijänjärvi 30m. asl. 65° 17′ 30″ N_ 25°30′ 30″E_
Depth cm
AP = 100 %
PAZ
Betula
Alnus
Pinus
Picea
AP
Shrubs
Herbs
Heath
QM x 10
MERI III
MERI II
MERI I
1430± 50
1770±50
1790± 50
2160± 55
2320±55
2640±55
2790±55

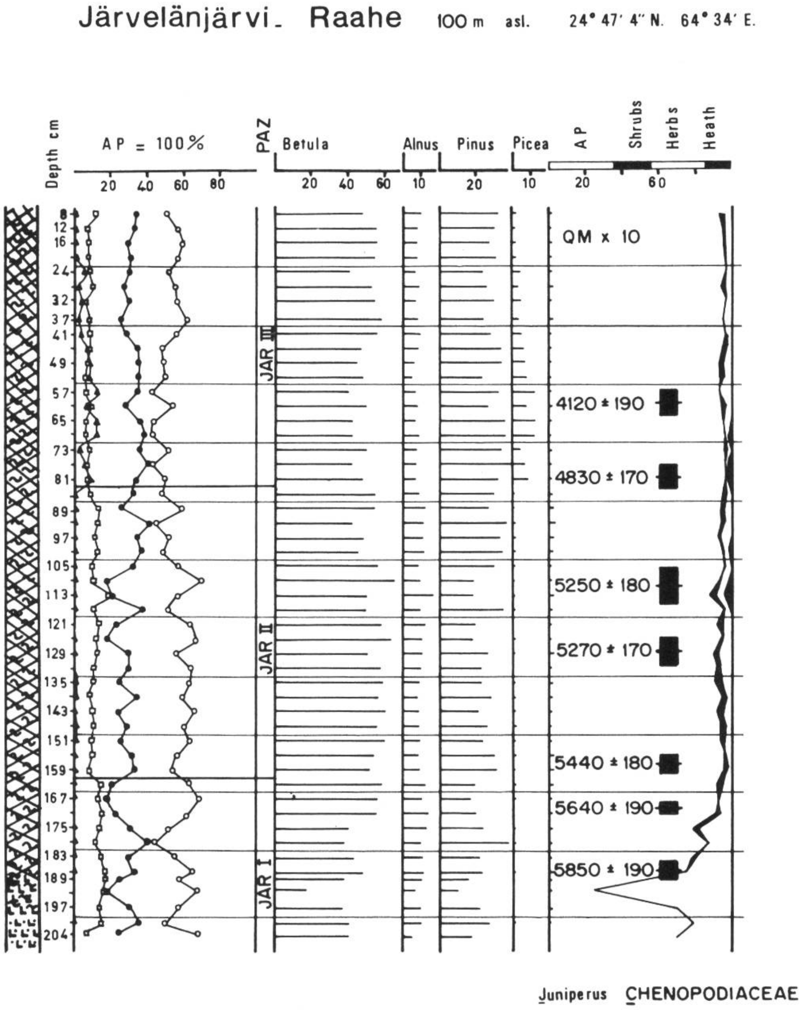

Betula nana
Juniperus
Salix
Calluna
ERICACEAE
Empetrum
CYPERACEAE
GRAMINEAE
Cerealia
Artemisia
CHENOPODIACEAE
Filipendula
Humulus
Potentilla
RANUNCULACEAE
Rumex acetosa type
UMBELLIFERAE
Urtica
Pteridium
POLYPODIACEAE
Polypodium vulgare
Lycopodium
Equisetum
Menyanthes
Typha lati.
Sphagnum
Epilobium type
P. lanceolata
C. Reynaud & M. Hjelmroos 1976

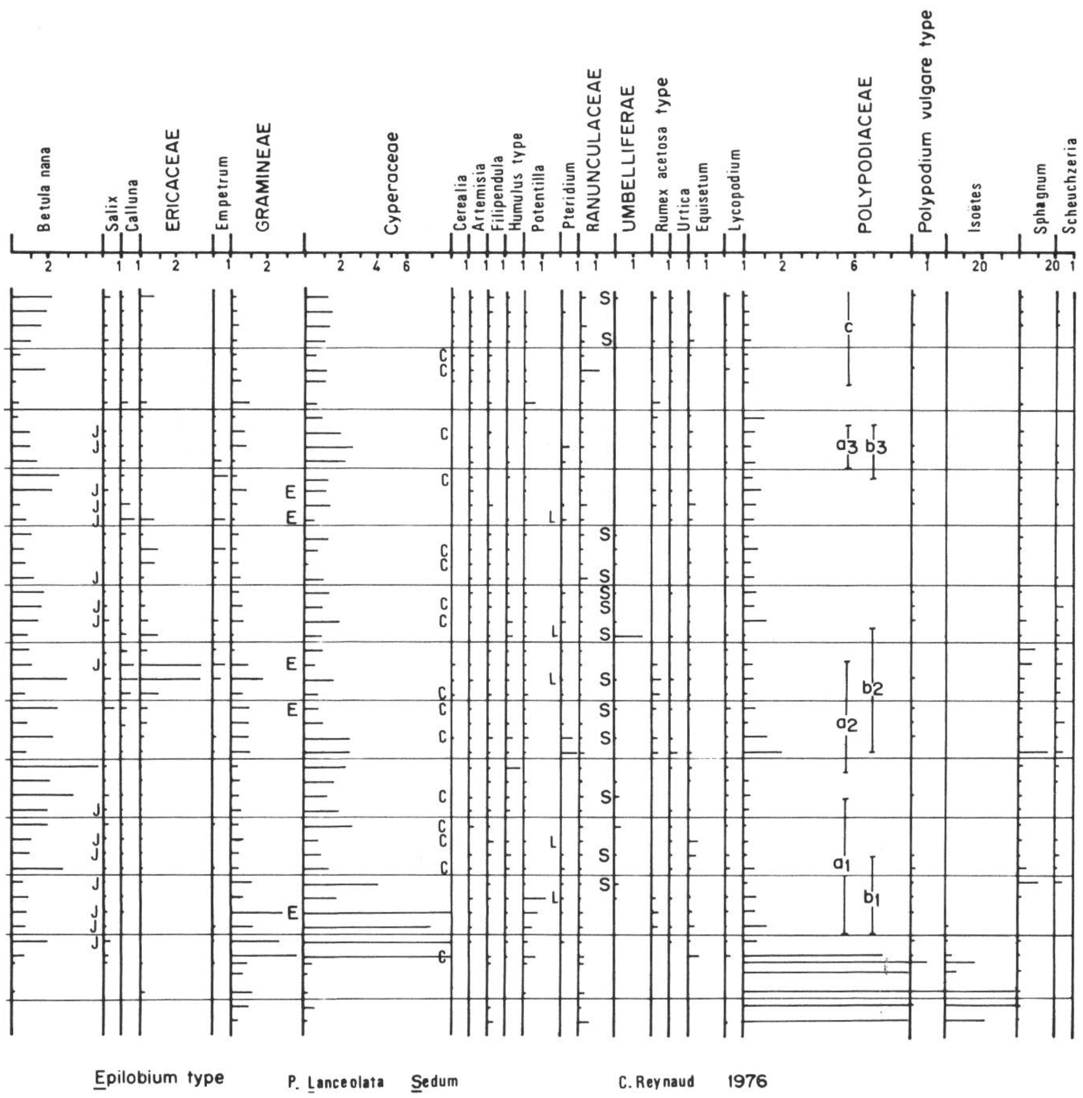

Nimisjärvi
135.5 m. asl.
64 30'N _ 26 46'E
Depth cm
AP = 100 %
PAZ
NIM I
NIM II
NIM III
Betula
Alnus
Pinus
Picea
AP
Shrubs
Herbs
Heath
QM x 10
3020 ±170
4750 ±230
4550 ±190
9450 ±210
10950 ±350
Betula nana
Salix
Juniperus
Hippophae rh.
Calluna
ERICACEAE
Empetrum
GRAMINEAE
Artemisia
CARYOPHYLLACEAE
CHENOPODIACEAE
Compositae tubl.
CRUCIFERAE
Filipendula
Epilobium type
L: P. lanceolata


Pediastrum
Typha lati. type
Sparganium type
Nuphar
Isoetes
Sphagnum
Menyanthes
Calla pal.
Equisetum
Poly. vulgare
POLYPODIACEAE
Lycopodium annotinum
Lycopodium sp.
Lastrea type
Cystopteris type
UMBELLIFERAE
Cerealia
CYPERACEAE
Potentilla
Urtica
Pteridium
Rumex acetosa type
Plantago major type
RANUNCULACEAE
Humulus type
C. Reynaud & M.Hjelmroos 1976


Iso-Mustajärvi 75m asl.
66° 13' 30" N _ 24°48' E
Depth cm
AP = 100 %
20% 60
PAZ
Betula
Alnus
Pinus
Picea
AP Shrubs NAP
QM x 10
ISO III
ISO II
ISO I
3910 ± 60
5380 ± 65


Betula nana
Juniperus
Hippophaë Rh.
Salix
Calluna
ERICACEAE
GRAMINEAE
CYPERACEAE
Humulus typ.
Filipendula
CRUCIFERAE
Rumex ace.
POLYPODIACEAE
Potamot
CHENOPODIACEAE
RANUNCULAC.
Polypo. vul.
Isoëtes
Pediastrum
Artemisia
Potentilla
Pteridium
Equisetum
Sparganium
Cerealia
Plantago sp.
Urtica
Lycopodium
Nymphea
Epilobium type
P. Lanceolata
M. Hjelmroos 76


Järvelänjärvi - Raahe 100 m asl. 24° 47' 4" N. 64° 34' E.
Depth cm
AP = 100%
PAZ
Betula
Alnus
Pinus
Picea
AP
Shrubs
Herbs
Heath
QM x 10
JAR III
JAR II
JAR I
4120 ± 190
4830 ± 170
5250 ± 180
5270 ± 170
5440 ± 180
5640 ± 190
5850 ± 190
Juniperus CHENOPODIACEAE


Betula nana
Salix
Calluna
ERICACEAE
Empetrum
GRAMINEAE
Cyperaceae
Cerealia
Artemisia
Filipendula
Humulus type
Potentilla
Pteridium
RANUNCULACEAE
UMBELLIFERAE
Rumex acetosa type
Urtica
Equisetum
Lycopodium
POLYPODIACEAE
Polypodium vulgare type
Isoëtes
Sphagnum
Scheuchzeria
Epilobium type
P. Lanceolata
Sedum
C. Reynaud 1976

STRATIGRAPHY

Ylitornio-Kaakonlantto

0-22	cm	*Carex* peat.
22-26	cm	clay and silt.

Merijänjärvi

2-164	cm	*Carex-Equisetum* peat.
164-196	cm	gyttja with abundant macroscopic plant remains.
196-204	cm	clay and silt.

Pilpajärvi

0-112	cm	silty gyttja.
112-128	cm	silt/sand.

Iso-Mustajärvi

0-224	cm	gyttja.
224-276	cm	clay and silt.

Sotkasuo

0-50	cm	*Sphagnum* peat. This section has not been analysed, the water content being too high.
50-121	cm	*Carex* peat.
121-130	cm	wood remains.
130-142	cm	*Carex* peat with *Equisetum* fragments.
142-145	cm	clay and silt with a few *Equisetum* fragments.

Ahmasjärvi

4-242	cm	gyttja.
242-248	cm	gyttja and clay.
248-300	cm	clay and silt.

Järvelänjärvi

The top sediments, being very loose, were not analysed.

8-189	cm	gyttja with abundant macroscopic plant remains.
189-197	cm	clay with macroscopic remains of *Equisetum*.
197-204	cm	clay and sand.

Kiimajänkä

0-142	cm	*Carex-Eriophorum* peat with numerous mineral layers.
142-153	cm	clay and sand.

Nimisjärvi

0-220	cm	gyttja.
220-248	cm	gyttja and clay.
248-296	cm	clay and silt.

LABORATORY TECHNIQUES

The cores were carefully split into two halves and sampled from the internal face, in an attempt to prevent external contamination which might have occurred during the extrusion of the sediment in the field. The usual sampling interval was 4 cm. 1 cm^3 of sediment was treated, according to the recommendations of FAEGRI & IVERSEN (1964), and mineral matter was removed by treatment with 40% hydrofluoric acid for one or two days. The pollen grains, stained with fuchsin, were mounted in glycerol and the cover slips sealed with ercalene lacquer. Both authors performed the pollen counts on a "Wild" M20 microscope using a × 40 objective for routine counting, and a × 100 objective for critical identifications.

POLLEN IDENTIFICATION AND COUNTING

Angiosperm pollen grains and spores of Spermatophyta, Pteridophyta and *Sphagnum* were determined, using the keys provided by FAEGRI & IVERSEN (1964) and BEUG (1961). For critical identifications, the authors made comparisons with the reference pollen collections of the Department of Botany of the University of Oulu (Finland), and the Quaternary Laboratory of the University of Lund (Sweden).

Betula nana pollen grains can be recognized by both relative size and pollen morphology (REYNAUD, 1974 and the bibliography quoted there in). The presence of *Betula nana* pollen grains in fossil spectra provides a good indication of the degree of opening of the forest, especially in the case of mires. The tiny pollen of *Urtica* can easily be confused with certain fungal spores which are abundant in peat. Its presence, associated with other markers, is a good indication of permanent or semi-permanent settlement, and cattle rearing.

Gramineae pollen grains, exceeding 45 μm in size and with a pore diameter larger than 8 μm, were identified as *Cerealia.* Although some authors succeeded (in Finland, HUTTUNEN & TOLONEN, 1972; VUORELA, 1975) in separating the different genera, *Hordeum, Triticum, Avena* and *Secale,* we could identify with certainty among the *Cerealia* group, only the last mentioned genus. Because of their large size, *Agropyron* and *Elymus* pollen fall in the *Cerealia* group. This pollen is sometimes found in those sediments deposited during the marine/freshwater isolation phase of a lake.

It was not possible to separate hops *(Humulus)* and hemp *(Cannabis)* pollen grains although this has been successfully performed by GODWIN (1967). No size measurements were applied on the few *Humulus* type pollen grains recorded, as this would have had no significant statistical value.

Large numbers of pollen grains were counted, up to 8000 for each fossil spectrum, the average number running to 3000 grains per slide, giving a total of 300-400 NAP. This was done in order to achieve a reliable standard of palaeoethnobotanical evidence for human impact on the natural landscape. Since all the sites investigated are surrounded by pine, birch and spruce (both the former two trees being heavy pollen producers), the quantitative importance of the pollen grains, released by the hemerophilous flora among the bulk of the regional pollen rain, is weak.

CONSTRUCTION AND ZONING OF THE POLLEN DIAGRAMS

The various pollen diagrams are divided into two parts. In the first section (AP sum = 100%) are included all the regional tree pollen which contribute to the bulk of the regional pollen rain (birch, alder, pine, spruce). Temporary variations, which occurred between the four main components from one spectrum to another, provide a good picture of the main climatic and/or anthropogenic changes in the equilibrium of the forest. In the second section, all the pollen grains from trees, shrubs, heaths and herbs are expressed as percentages of the total pollen sum (AP + NAP = 100%). Aquatic pollen grains, spores of *Sphagnum* and other microfossils such as green algae and *Pediastrum* species are expressed as percentages of the total pollen sum (AP + NAP).

Among the herbs, only the most significant taxa, linked to human influence upon the natural vegetation, are depicted in the pollen diagrams. No attempt has been made to classify the pollen of the hemerophilous flora into different groups, since the number of different species is low as is their importance relative to one another (see for example ENGELMARK, 1976).

All the sediments analysed in the present investigation are referrable to the Flandrian period. As recommended by WEST (1970), the pollen diagrams are zoned on the basis of biostratigraphical pollen assemblages and significant zone boundaries are radiocarbon dated. In all diagrams, the initial letter of the site name is used to identify the biozones, and small letters to define anthropogenic phases. In southern and eastern Finland, there are abundant, well dated pollen diagrams (DONNER, 1971; HYVÄRINEN, 1972; TOLONEN & RUUHIJÄRVI, 1976), but in the Pohjanmaa region, no pollen diagram with reliably dated zone boundaries is available. Therefore, we take the immigration of *Picea* into the area as the only synchronous zone boundary throughout the different sites studied.

INDICATORS OF HUMAN INFLUENCE

In order to follow those changes in the vegetation which are due to human settlement, in connection with agriculture and animal raising, the palynological record of the different hemerophilous taxa must be analysed. We will follow the general plan proposed by DOROGOSTAISKAYA (1975), who divides all "the plants growing in the territory of any of the far northern settlements" into two main categories. The first main group includes "indigenous species" which can be subdivided into: 1) seemingly "indifferent to man's influence", and 2) indigenous plants favoured by man's activities and called apophytes.

We regard the following recorded microfossils as produced by plants insensible to human impact: *Betula nana, Salix* sp., *Hippophaë rhamnoides.* Cyperaceae, Rosaceae, *Parnassia palustris, Lycopodium* spp. Pollen grains of indigenous species, favoured by man's activities, apophytes, are more numerous: *Juniperus, Calluna,* Gramineae (excluding *Phragmites communis*), *Plantago* spp., *P. major, Artemisia* spp., Caryophyllaceae, Chenopodiaceae, Cruciferae, *Potentilla, Rumex acetosa* and *R. acetosella, Pteridium, Ranunculus* sp., *Filipendula* spp., *Equisetum* spp., *Epilobium* type and *Polypodium* spp. The taxa listed call for three comments. Firstly, that among such large families as, for example, Gramineae, all the genera cannot be considered as apophytes. AHTI & HÄMET-AHTI (1971) reported that in the Kuusamo area (N.E. Finland), 6 native Gramineae are unresponsive to human interference, namely *Phragmites communis, Molinia coerulea, Festuca rubra* and three species of *Agrostis.* Secondly, it is noteworthy that many of the taxa listed show a preference for newly exposed soils with a low organic content. In Finland, one can find *Artemisia bottnica, Atriplex latifolia, Sagina nodosa, Isatis tinctoria,* for example, on river banks and/or along sea shores where erosion processes are active.

Lastly, some pollen grains (e.g. *Epilobium* type), including different plant species not directly favoured by man although a careful determination, were found. In the Onagraceae family, only *Chamaenerion angustifolium* is considered as a true apophyte.

As it is impossible to determine the different apophytes to the species level on the basis of their pollen, *Artemisia,* Chenopodiaceae, Cruciferae and Caryophyllaceae are regarded as erosiophilous indicators. Nevertheless, they provide supplementary evidence when associated with unambiguous cultural indicators in fossil spectra.

The second main group includes all adventitious plants, and these too can be divided into two sub-groups: 1) anthropocores which include ruderal and weedy species, and 2) synanthropic (or cultivated) plants. There is little information available with regard to plants growing in northern Finland which might have been collected by man. *Polygonum* spp., *Urtica* spp. and *Plantago lanceolata* can be regarded as true anthropocores. Finally, in the synanthropic sub-group, we place cereals, flax (2 pollen grains found in Kiimajänkä sediments), and possibly hops.

Another possible classification of the indicators of human interference can be made on the basis of ecological factors. It is now fairly well established that prehistoric man modified his natural environment by using fire for hunting and later land-clearing. In the area investigated, the "slash and burn" cultivation method was still active some 50 years ago, although much less practised than in N.E. Finland (HEIKINHEIMO, 1915). We consider as indicative of fire (the appearance of light demanding and/or nitrophilous plants) such plants as *Chamaenerion angustifolium, Pteridium,* tree *Betula,* and most of the Gramineae sp. whose pollen grains are sometimes associated with stratigraphical evidence such as ash/silt layers in sediments (VUORELA, 1975). The regeneration of heaths and *Calluna* is improved by fire (UGGLA, 1958). Such regeneration linked with clearance phases was demonstrated in pollen diagrams by IVERSEN (1941; see also DURNO, 1965; TUTTIN, 1969; SIMMONS, 1974 and TINSLEY, 1975). Our radiocarbon dated pollen-analytical evidence for the increasing importance of heaths and *Calluna* suggests that the increase, when associated with other palaeoethnobotanical evidence, is most likely not caused by some climatic change. Grazing prevented forest regeneration. In the Pohjanmaa region, *Pteridium* is growing at its northern climatic boundary and is nowadays uncommon (HULTEN, 1950; KUIJALA, 1964). The work of OINONEN (1967a, b) shows that regeneration of bracken spores in Finland is associated with the effect of fire, produced either naturally or anthropogenically caused (REYNAUD & HJELMROOS, 1976).

Animal raising and grazing are revealed in pollen diagrams by the appearance and/or increase of the following taxa: *Urtica, Plantago lanceolata, Ranunculus, Juniperus* and Gramineae. The status of *Filipendula,* in relation to animal raising, is still debated although it was proved to have been used as dry fodder for cattle during the winter time in Norway (HAFSTEN, 1965).

RADIOCARBON DATES AND RATES OF SEDIMENTATION

The pollen zone boundaries, which mark the main pollenfloristic changes and the different phases of human activity, are dated by 39 radiocarbon dates, dating having been carried out by the ^{14}C Laboratory of the University of Helsinki (Director: H. Jungner), and the ^{14}C Laboratory of the Quaternary Institute, University of Lund (Director: S. Håkansson).

All the dates, calculated in conventional radiocarbon years (half-life: $T^1/_2$ = 5568 yr), are listed in Table 1 with the associated corrected ages on the basis of the more probable half-life 5730 yr (GODWIN, 1962).

After the deglaciation, few well marked phytogeographical changes occurred in North Finland, which makes it difficult, within a defined region, to establish any correlation between the different sites. The main vegetational modification is the regional spread of spruce (see for its palaeoecological significance, the results of AARTOLAHTI, 1966; MOE, 1970; TALLANTIRE, 1972 and TOLONEN & RUUHIJÄRVI, 1976). The various dates obtained seem in agreement with the general plan for the chronostratigraphic division of postglacial sediments (except for the site of Nimisjärvi) already proposed

Sample	*Depth below sediment surface (cm)*	*Age BP $T\frac{1}{2} = 5730$*	*Age BP $T\frac{1}{2} = 5568$*	*Corrected ages*	*A.D./B.C.*	*Lab. No.*
Nimisjärvi						
Isolation phase	240-254	11 278	10 950±350		9 000 BC	Hel-760
Pollen zone limit NIM I/NIM II	220-228	9 733	9 450±210		7 500 BC	Hel-759
First. *P. lanceolata* Middle part of NIM II	110-119	4 687	4 550±190		2 600 BC	Hel-758
Spruce immigration pollen zone limit NIM II/NIM III	66-74	4 892	4 750±230		3 618 BC	Hel-756
Pine increase, spruce decline	38-46	3 110	3 020±170		1 070 BC	Hel-757
Ahmasjärvi						
Phases a_1 & b_1	210-218	7 138	6 930±230		4 980 BC	Hel-883
Phases a_4 & b_2	140-148	5 706	5 540±190	6 364	3 590 BC	Hel-946
Spruce immigration	116-123	4 882	4 740±150	5 471	2 790 BC	Hel-884
Starting point of the "Cerealia" curve	83-90	4 243	4 120±160	4 706	2 170 BC	Hel-885
Spruce decrease	41-46	3 337	3 240±180	3 578	1 290 BC	Hel-947
Järvelänjärvi						
Forest immigration	185-189	6 025	5 850±190	6 681	3 900 BC	Hel-960
First *P. lanceolata* just above JAR I/JAR II pollen zone limit	169-172	5 809	5 640±190	6 468	3 690 BC	Hel-886
Phases a_1 & b_1	156-160	5 603	5 440±180	6 259	3 490 BC	Hel-950
Phases a_2 & b_2	125-130	5 428	5 270±170	6 076	3 320 BC	Hel-948
Heath maximum and forest clear ance	106-116	5 408	5 250±180	6 054	3 300 BC	Hel-949
Spruce immigration pollen zone limit JAR II/JAR III	74-84	4 975	4 830±170	5 574	2 880 BC	Hel-887
Spruce maximum; phases a_3 & b_3	56-64	4 244	4 120±190	4 706	2 170 BC	Hel-951

Table 1. — Radiocarbon dates.

Sample	*Depth below sediment surface (cm)*	*Age BP $T\frac{1}{2} = 5730$*	*Age BP $T\frac{1}{2} = 5568$*	*Corrected ages*	*A.D./B.C.*	*Lab. No.*
Sotkasuo						
Pollen zone limit SOT I/SOT II	130-135	5 778	5 610±150	6 437	3 660 BC	Hel-680
First forest clearance beginning of the heath curve	114-119	5 243	5 090±170	5 875	3 140 BC	Hel-724
Pollen zone limit SOT II/SOT III	89-94	3 420	3 320±180	3 682	1 370 BC	Hel-722
Beginning of the heath curve; Spruce maximum	75-80	2 802	2 720±170	2 912	770 BC	Hel-723
Iso-Mustajärvi						
Phase a_1	206-215	5 541	5 380±65	6 194	3 430 BC	LU-1431
Limit P^O; just below ISO II/ISO III limit	84-93	4 027	3 910±60	4 433	1 960 BC	LU-1432
Kiimajänkä						
Beginning of the forest clearance	87-91	2 668	2 590±140	2 748	640 BC	Hel-888
Maximum of the forest clearance	75-79	2 245	2 180±150	2 245	230 BC	Hel-961
Pollen of flax	51-57	1 679	1 630±130	1 619	AD 320	Hel-955
Decrease of spruce and beginning of phase "c"	38-40	1 298	1 260±140	1 231	AD 690	Hel-956
Pilpajärvi						
Limit PILP I/PILP II	94-100	4 120	4 000±60	4 553	2 050 BC	LU-1369
Phase b_1	79-87	3 770	3 660±60	4 117	1 710 BC	LU-1370
Middle part of PILP II	56-64	3 471	3 370±55	3 744	1 420 BC	LU-1371
Beginning of the "cerealia" curve	30-38	2 492	2 420±50	2 536	470 BC	LU-1372

Merijanjärvi						
First *Epilobium* pollen grains just above the limit clay/peat	188-193	2 874	2 790±55	2 999	840 BC	LU-1311
First *P. lanceolata*, phase a_1 & b_1 .	169-175	2 719	2 640±55	2 811	690 BC	LU-1312
End of the *Calluna;* phases a_2 & b_2	138-142	2 390	2 320±55	2 414	370 BC	LU-1316
Phase a_3 & *Urtica* maximum	110-115	2 224	2 160±55	2 222	210 BC	LU-1315
Picea decrease	72-78	1 844	1 790±50	1 810	AD 160	LU-1313
Beginning of the heath curve....	66-70	1 823	1 770±50	1 794	AD 180	LU-1314
Beginning of the phase "c"	25-32	1 473	1 430±50	1 405	AD 520	LU-1317
Ylitornio-Kaakonlantto						
Minerogenic/organogenic transition	22	948	920±50	901	AD 1 030	LU-1318

Table 1. — Radiocarbon dates (continuation).

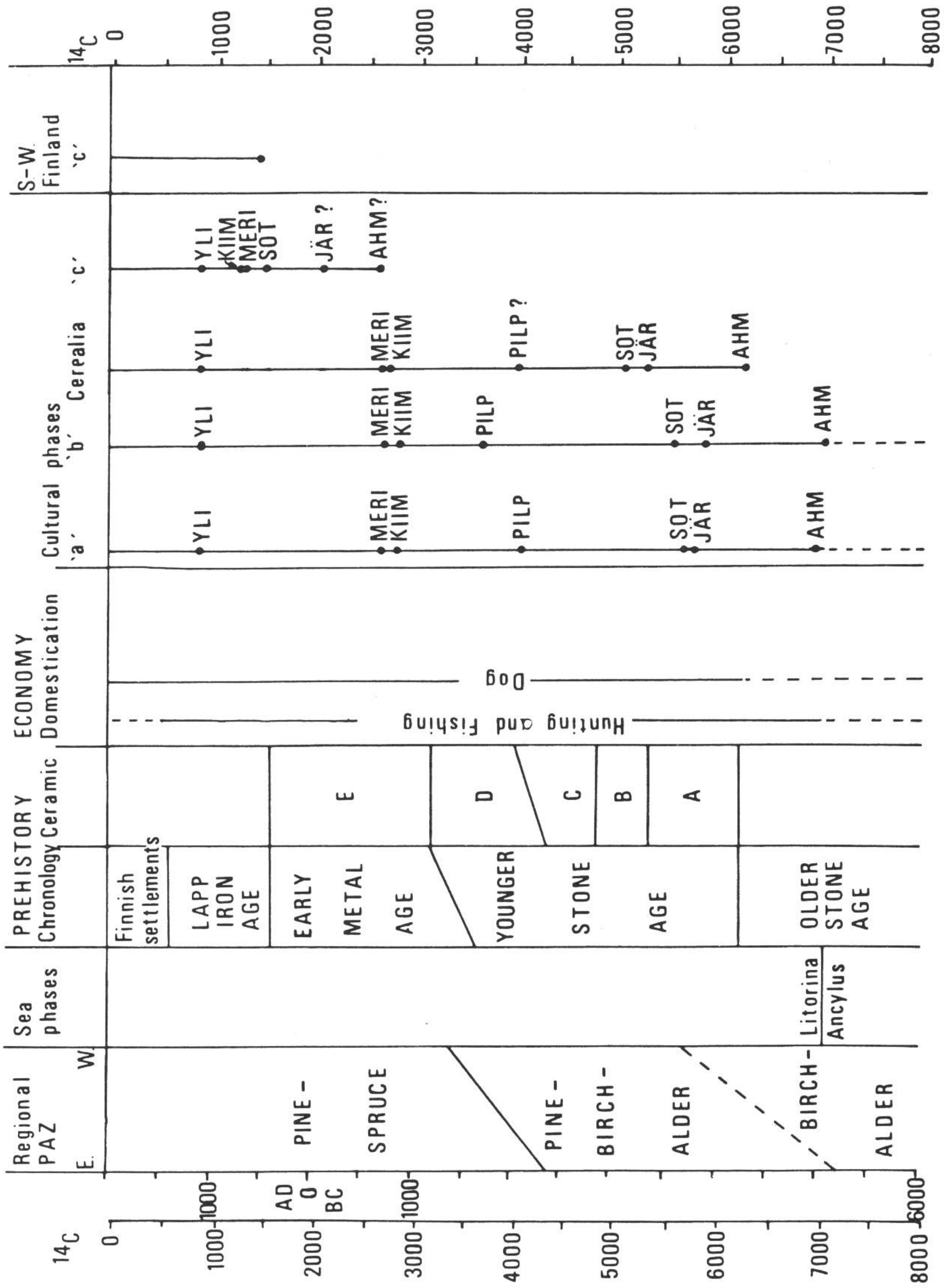
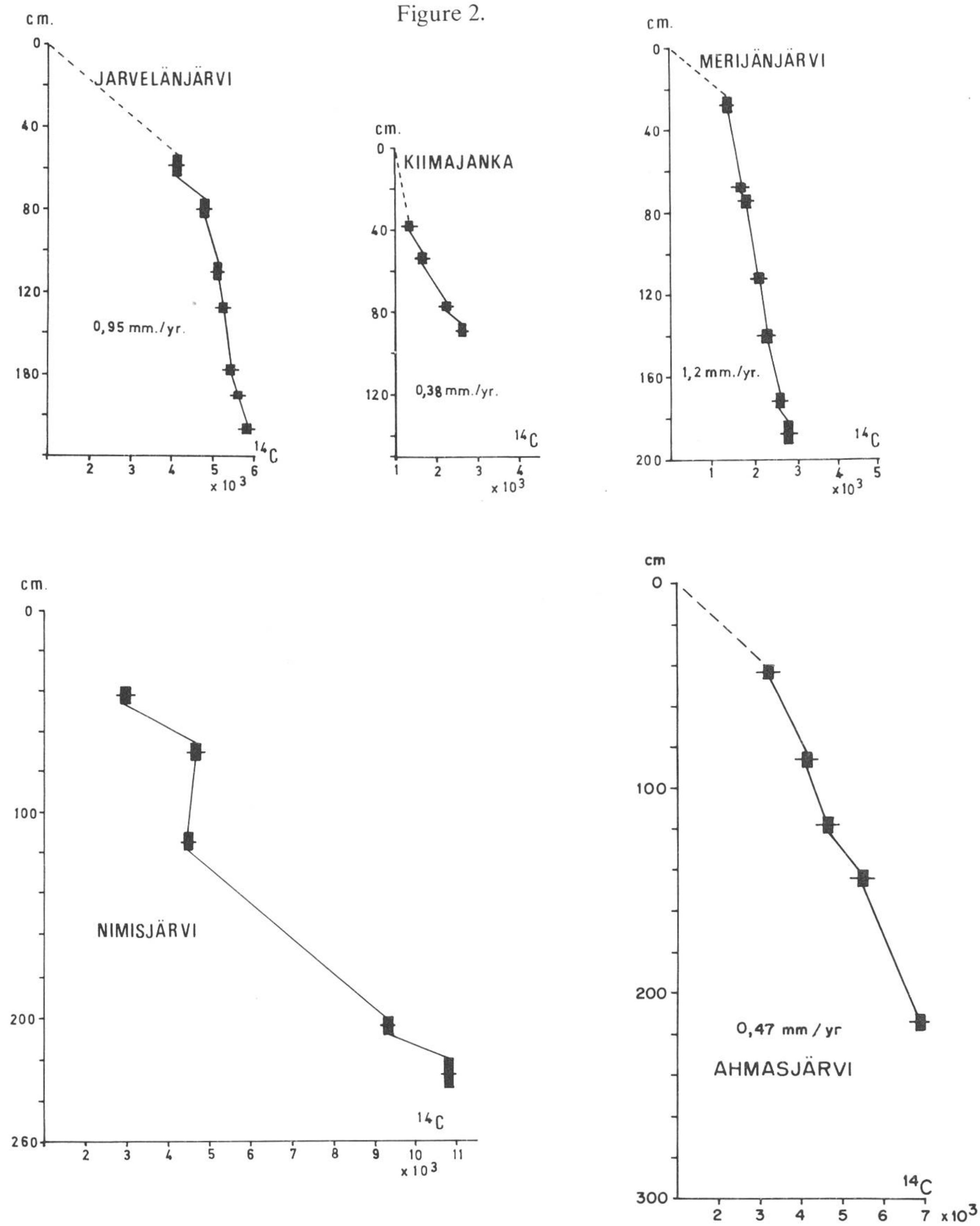

Regional PAZ
E.
W
Sea phases
PREHISTORY Chronology Ceramic
ECONOMY Domestication
Cultural phases
'a'
'b'
Cerealia
'c'
S-W. Finland 'c'
14C
PINE - SPRUCE
PINE - BIRCH - ALDER
BIRCH - ALDER
Litorina
Ancylus
Finnish settlements
LAPP IRON AGE
EARLY METAL AGE
YOUNGER STONE AGE
OLDER STONE AGE
E
D
C
B
A
Hunting and Fishing
Dog
YLI
MERI
KIIM
PILP
SOT
JÄR
AHM
PILP ?
JÄR ?
AHM?
AD
0
BC
1000
2000
3000
4000
5000
6000
7000
8000

Table 2.

Figure 2.



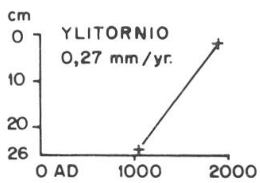


Figure 3

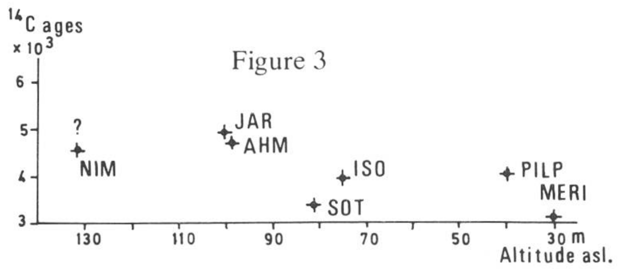
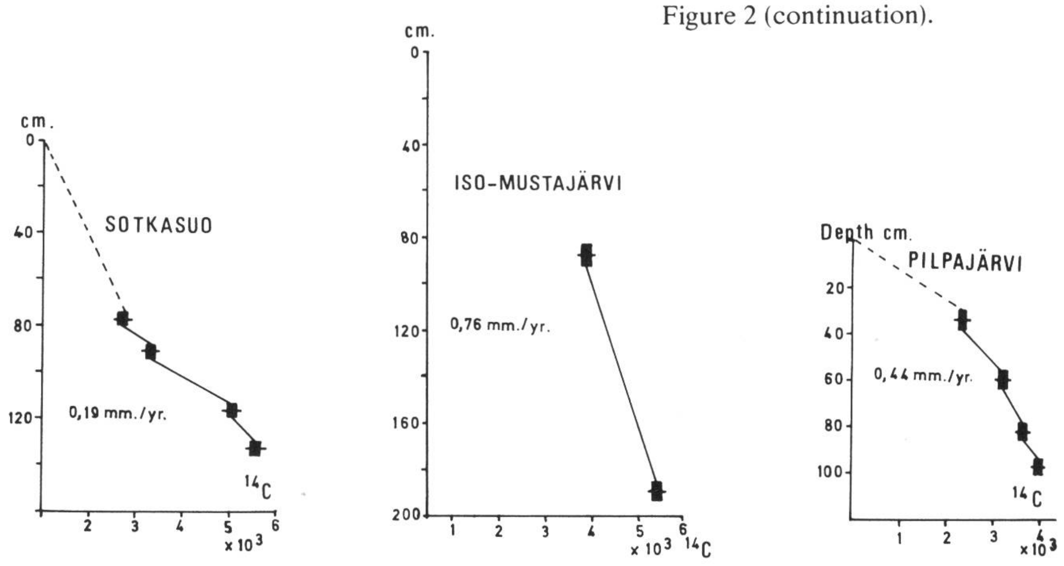


Figure 2 (continuation).



(DONNER, 1966, 1971; HYVÄRINEN, 1972 and REYNAUD, 1976). The dates for the Nimisjärvi sediments are deemed too old and might have been affected by the "hard-water" effect, the valley of the Oulujoki river being situated in a limestone area. By inspection, dates for the same biostratigraphical events, at the other sites, seem to be reliable.

The mean rates of sedimentation and peat accumulation show large variations from site to site, as shown in Fig. 2. Both lakes Pilpajärvi and Ahmasjärvi have rather similar sedimentation rates, 0.44 mm/yr and 0.47 mm/yr respectively. The rate of deposition for the lake Järvelänjärvi and Iso-Mustajärvi (calculated on the basis of only two dates in the latter case) are higher, namely 0.95 mm/yr and 0.75 mm/yr; the rate of sedimentation was not calculated for Nimisjärvi, since the dates are dubious, and it is not possible to estimate to what degree the absolute ages are affected by the hard-water effect, and whether this is constant throughout the core. The average rates of peat growth, for the sites Kiimajänkä, Sotkasuo and Ylitornio, are rather similar, 0.38 mm/yr, 0.44 mm/yr and 0.27 mm/yr respectively, but that for Merijänjärvi much higher, 1.2 mm/yr.

REGIONAL DEVELOPMENT OF THE VEGETATIONAL LANDSCAPE

One observes that the biostratigraphical assemblages, for the various sites, present a regional unity as far as the evolution of the vegetational landscape is concerned. Nevertheless, for the mire sediments, the pollen assemblages contemporary with the immigration of forest are richer in the pollen of local herbs than the same assemblages from the lake sediments. We distinguished the following local PAZ's at the different sites.

Sotkasuo

Sot	I	145-133	cm:	Birch-alder-herbs PAZ.
Sot	II	133-92	cm:	Birch-pine PAZ.
Sot	III	92-50	cm:	Birch-pine-spruce PAZ.

Pilpajärvi

Pil	I	128-104	cm:	Birch-pine-alder PAZ.
Pil	II	104-6	cm:	Birch-pine-spruce PAZ.

Iso-Mustajärvi

Iso	I	276-202	cm:	Birch-pine-alder PAZ.
Iso	II	202-76	cm:	Birch-pine PAZ.
Iso	III	76-0	cm:	Birch-pine-spruce PAZ.

Ahmasjärvi

Ahm	I	300-234	cm:	Pine-birch-alder PAZ.
Ahm	II	234-118	cm:	Birch-pine PAZ.
Ahm	III	118-4	cm:	Pine-birch-spruce PAZ.

Merijänjärvi

Mer	I	204-162	cm:	Pine-birch-alder PAZ.
Mer	II	162-74	cm:	Pine-spruce-birch PAZ.
Mer	III	74-2	cm:	Pine-birch PAZ.

Järvelänjärvi

Jär	I	204-161	cm:	Birch-pine-herbs PAZ.
Jär	II	161-83	cm:	Birch-pine PAZ.
Jär	III	83-8	cm:	Birch-pine-spruce PAZ.

Kiimajänkä

Kii	I	153-145	cm:	Birch-alder-herbs PAZ.
Kii	II	145-0	cm:	Birch-pine-spruce PAZ.

Nimisjärvi

Nim	I	296-222	cm:	Pine-birch-alder PAZ.
Nim	II	222-70	cm:	Pine-birch PAZ.
Nim	III	70-0	cm:	Pine-birch-spruce PAZ

Ylitornio-Kaakonlantto

The genesis of peat deposits, situated on the higher terrace of the Tornio river, began 920 yr BP.

Yli I . 26-0 cm: Birch-pine-spruce PAZ.

Birch-alder PAZ

The first PAZ in each diagram (with the exception of the Ylitornio one) contains two principal arboreal elements, birch and alder, which colonized the biotopes around the lakes and marshes produced by land-uplift. Around the Kiimäjankä and Merijänjärvi sites, the relative important presence of alder persisted a long time after the isolation phase occurred. It is interesting to note that in both pollen diagrams *Alnus* registers a sudden decrease dated at about 2600 yr BP. Conifers (pine and spruce) were elements of minor importance in the composition of the hardwood forest. But at least close to the sites of Ahmasjärvi and Merijänjärvi, pine might have been present. The relative importance of spruce pollen in the Ahmasjärvi and Nimisjärvi sites, 5% of the AP sum, long before the regional immigration of spruce, requires comments. Spruce spread to Finland from the east, and established itself in the Pohjanmaa region about 3500 yr BP (Aartolahti, 1966; Tallantire, 1972; Tolonen & Ruuhijärvi, 1976). The spruce pollen grains identified as such were in a good state of preservation, which precludes the possibility of redeposition. Transport over long distances could provide another possible explanation, but at values of over 2% AP, spruce formed a significant part of the local vegetation (Donner, 1972; Hicks, 1974). The palynological evidence suggests that around the lake Oulujärvi, spruce could already have formed a part of the pioneer forest, and that is maintained itself in favourable locations before spreading further at a later stage. A mosaic of humid and dry biotopes existed, which suited the more or less heliophilous plants such as *Salix* spp., Cyperaceae, *Filipendula, Potentilla, Equisetum* and Umbelliferae. Among the Gramineae, *Phragmites communis* type was abundant. On the most humid biotopes, *Sphagnum* sp., *Equisetum* sp., *Menyanthes trifoliata* and *Calla palustris* were found, species which can withstand temporary flooding.

The aquatic vegetation is, on the whole, fairly scanty and comprises *Typha latifolia, Sparganium/Typha angustifolia* and *Potamogeton* spp. At Järvelänjärvi, Sotkasuo and Nimisjärvi, *Isoëtes* is abundantly present. Vegetational development at those sites, situated between 100 m and 80 m a.s.l., began earlier and pine *(Pinus silvestris)* was present from an earlier date.

Pine-birch PAZ

This pollen assemblage zone is recorded at the Ahmasjärvi, Nimisjärvi, Järvelänjärvi, Sotkasuo and Iso-Mustajärvi sites. With the exception of the

Nimisjärvi site, a relative decrease in alder takes place, reflecting a contraction in the humid biotopes. Spruce is permanently present in this zone at very low relative values. Pine progressively established itself alongside birch, and the importance of the local herbaceous vegetation diminishes. Shrub pollen (*Salix, Juniperus* and *Betula nana* for all sites but Järvelänjärvi and Ahmasjärvi where it rises) shows a decrease at the transition from the birch-alder PAZ to the pine-birch PAZ. The ericaceous plants (Ericaceae, *Calluna vulgaris, Empetrum* sp.) are present in this zone in consistent proportions. Certain variations notably for *Calluna vulgaris,* must be explained not only by natural but also by anthropogenic factors. The Polypodiaceae group and *Polypodium vulgare* are well represented. The various spores, included in the Polypodiaceae curve, are emited by plants which have rather different ecological requirements, but nevertheless adapt well to shade in a general manner. The aquatic vegetation, on the whole, proliferates with *Potamogeton, Nuphar, Sparganium* and/or *Typha angustifolia* and *Typha latifolia.*

Pine-birch-spruce PAZ

The transition from the preceding biozone is marked by an increase in the relative values of *Picea* pollen, and a corresponding decrease in *Betula, Alnus* and the exotic QM pollen. Figure 3 illustrates how the age in uncorrected radiocarbon years in the lower boundary of the pine-birch-spruce zone depends on the altitude and geographical position of the site in relation to the immigration route followed by *Picea.* However, these dates are grouped between 3500 and 4900 BP, and do not deviate significantly from the dates already published (TALLANTIRE, 1972).

The arrival of spruce in the forest was accompanied by modifications in the equilibrium of the other taxa. Ericacae, *Empetrum* and *Calluna vulgaris* are now present. At Iso-Mustajärvi, Ahmasjärvi and Nimisjärvi sites, the aquatics are subject to a last evolution with the increase of *Isoëtes* spores, a good indicator of more abundant mineral material in the lake sediments. This biostratigraphical event can be dated around 4000 yr BP.

HUMAN IMPACT

Human interference with the forest vegetation in northern Scandinavia is related to: *a)* forest clearance by fire for temporary cultivation (referred to in Finland as the "slash and burn" method); *b)* cultivation in permanent fields; *c)* settlement involving animal husbandry. However, since Finland has a rather monotonous forest composition with only pine, spruce, birch and alder being abundant, human activity has not modified the vegetational landscape as radically as it has in southern Sweden or in England, for example. On the other hand, for an area so remote from the areas of densest human presence, the appearance of pollen of the hemerophilous flora in fossil spectra, although scanty, can be regarded as a reliable indication of human presence close to the sites. We have distinguished grazing stages, phases of clearance by fire, possible cultivation stages and stages of cultivation in permanent fields.

GRAZING STAGES

The grazing stages are marked "a" on the right of the various diagrams. Pastoral activities can be recognized by the appearance of/or the increasing values of *Plantago lanceolata, Urtica* sp., *Juniperus* sp., *Calluna vulgaris* and wild grasses. We consider that the presence of *Urtica* is indicative of permanent (may be semi-permanent) settlement near the site investigated, as nettle has never been recorded as part of the natural flora of Finland during post-glacial times.

Nimisjärvi

a_1: 224-184 cm 9450 ± 210 yr BP.
a_2: 168-144 cm
a_3: 28-0 cm

The radiocarbon dates 9450 ± 210 yr BP (uncorrected age) for the stage a_1 is obviously too old and was discarded on the basis of the history of deglaciation in Finland (HYVÄRINEN, 1972). Geologically, the Oulu river valley runs through a limestone area. So too old dates can be explained by the "hard-water" effect (DONNER & JUNGNER, 1974).

Järvelänjärvi

a_1: 181-147 cm 5640 ± 190 yr BP; 5440 ± 180 yr BP.
a_2: 135-113 cm 5270 ± 170 yr BP; 5250 ± 180 yr BP.
a_3: 57-41 cm 4120 ± 190 yr BP.
a_4: 32-8 cm

The radiocarbon date for the immigration of spruce, 4830 ± 170 yr BP seems in agreement with the general pattern of the history of spruce in Finland. As far as the ^{14}C method is concerned, the other dates are believed reliable.

Ahmasjärvi

a_1: 220-212 cm 6930 ± 230 yr BP.
a_2: 188-180 cm
a_3: 168-160 cm
a_4: 148-140 cm 5540 ± 190 yr BP.
a_5: 116-84 cm 4740 ± 150 yr BP; 4120 ± 150 yr BP.
a_6: 68-4 cm

Sotkasuo

a_1:	134-111 cm	5610 ± 150 yr BP; 5090 ± 170 yr BP.
a_2:	103-99 cm	
a_3:	93-50 cm	3320 ± 180 yr BP.

Iso-Mustajärvi

a_1:	216-204 cm	5380 ± 65 yr BP.
a_2:	172-148 cm	
a_3:	136-86 cm	3910 ± 60 yr BP.
a_4:	66-0 cm	

Pilpajärvi

a:	104-34 cm	4000 ± 60 yr BP.

Kiimajänkä

a_1:	119-115 cm	
a_2:	83-20 cm	2590 ± 140 yr BP.

Merjänjärvi

a_1:	176-160 cm	2640 ± 55 yr BP.
a_2:	148-140 cm	2320 ± 55 yr BP.
a_3:	122-110 cm	2160 ± 55 yr BP.
a_4:	78-74 cm	1790 ± 50 yr BP.

FOREST FIRE AND POSSIBLE CULTIVATION AFTER CLEARANCE

This phase is marked "b" on the pollen diagrams. Fires constitute a natural process in the regeneration of the virgin coniferous forest (WRIGHT, 1974). Man used fire very early to secure his way of life and the first major forest-clearances involving fire, called the "Landnam" phase in Denmark, are dated to 3000-4000 yr BC (IVERSEN, 1973). In northern Sweden (Umeå region), it seems that land clearance and cultivation originated from South Sweden, developed along the changing coast line during middle Neolithic (ENGELMARK, 1976). In the Salpausselkä region of Finland, Huttunen gives a date for the first "Landnam" of around 4300 yr BP (HUTTUNEN & TOLONEN, 1975). The microfossil indicators of possible land-clearance by using fire in the Pohjanmaa region are as follow: *Funaria* spores, *Chamaenerion angustifolium Calluna vulgaris* (UGGLA, 1958), *Juniperus, Pteridium* (OINONEN, 1967a, b), *Potentilla* and the wild grasses (HICKS, 1976). The decreasing relative values of Polypodiaceae spores, contemporaneously with the appearance of fire indicators, suggest a contraction of the forested area. A close examination of the erosiophilous species can help to distinguish between natural fires and anthropogenically caused ones in that forest-clearance and cultivation created fresh soils where erosiophilous species thrived well. As stated earlier, birch was the first tree to invade the deserted fields.

The first few *Cerealia* pollen grains were often found in phases "b" and could indicate very localised agriculture close to the sites.

Nimisjärvi

b_1: 224-212 cm distinct rise in the birch pollen curve at 208 cm.
b_2: 168-140 cm presence of *Cerealia* at 148 cm, 144 cm, 140 cm.
b_3: 88-76 cm distinct rise in the birch pollen curve at 76 cm; presence of *Cerealia* at 84 cm.
b_4: 56-0 cm presence of *Secale* pollen.

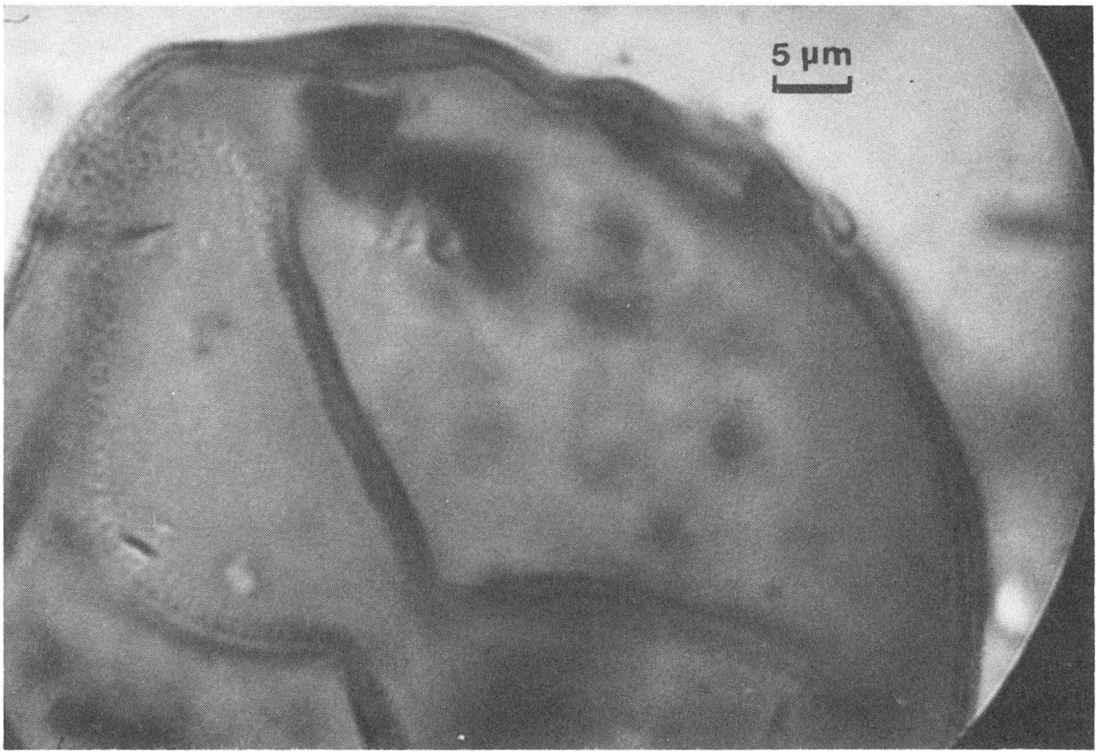
The curve for wild grasses shows a succession of peaks, very often associated with *Chamaenerion angustifolium* (*Epilobium* type in the various pollen diagrams).

Järvelänjärvi

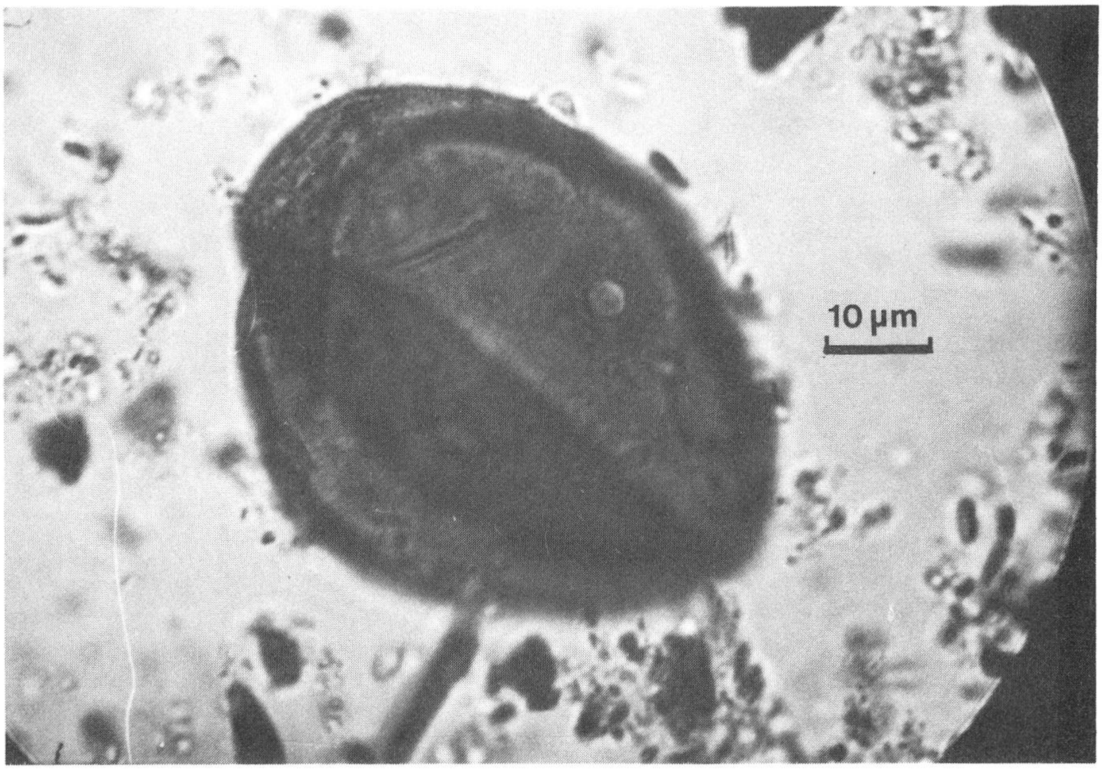
b_1: 183-159 cm 5640 ± 190 yr BP.
b_2: 133-101 cm birch curve registers short term fluctuations; presence of *Cerealia* pollen.
b_3: 73-57 cm 4120 ± 190 yr BP.

Ahmasjärvi

b_1: 224-208 cm 6930 ± 230 yr BP.
b_2: 148-120 cm 5540 ± 190 yr BP; 4740 ± yr BP; presence of *Cerealia* pollen: photograph No. 1.



Photograph 1. — Ahmasjärvi: 148 cm; Gramineae pollen grain determined as *Cerealia*.



Photograph 2. — Iso-Mustajärvi: 168 cm; pollen grain of *Cerealia*.

b_3: 92-24 cm 4120 ± 150 yr BP; continuous curve for *Cerealia* pollen with *Secale* type.

It is in phase b_3 that *Calluna* and the curve for erosiophilous plants show maximum relative values. During b_2 and b_3 phases, many pollen grains of the field weeds, *Polygonum convolvulus* and *P. aviculare,* were recorded, and much pollen of *Senecio* type was found. The values for the erosiophilous species increase from the 84 cm level, indicating the development and extension of fresh soils. The continuous *Cerealia* curve begins at 4120 yr BP and ends temporarily at 3240 yr BP.

Iso-Mustajärvi

b_1: 168-148 cm presence of *Cerealia* pollen: photograph No. 2.
b_2: 110-96 cm presence of *Cerealia* pollen.
b_3: 48-36 cm presence of *Cerealia* pollen.

The Gramineae curve registers a series of short term fluctuations from the 168 cm level. The erosiophilous species show a similar pattern.

Sotkasuo

b_1: 130-62 cm.

The first unambiguous clearance phase, most likely caused by fire, is dated to 5090 ± 180 yr BP. The appearance of the first *Cerealia* pollen grains is dated to 5090 yr BP, with a peak dated at 3320 ± 180 yr BP. The beginning of the *Cerealia* curve is situated much higher (117 cm) than the isolation phase, and lies just above fossil wood remains.

Pilpajärvi

b_1: 84-66 cm 3660 ± 60 yr BP; presence of *Cerealia* pollen.
b_2: 36-6 cm 2420 ± 50 yr BP; presence of *Cerealia* pollen.

b_2 clearance phase is not quite clear.

Kiimajänkä

b_1: 87-63 cm 2590 ± 140 yr BP; presence of *Cerealia* pollen.

The first appearance of *Cerealia* pollen grains is dated to 2180 ± 150 yr BP. The values of Polypodiaceae and *Polypodium vulgare* spores decrease at the 83 cm level while the *Sphagnum, Betula nana, Juniperus* and Cyperaceae curves show a steep rise from 79 cm. The very high values for *Potentilla* sp. can be explained by the opening of the forest canopy. After the maximum extension of the clearance phase at this site, which is dated to 2180 ± 150 yr BP, the natural coniferous forest did not regenerate (and shrubs developed and also invaded) the bog surface. The high values for Cyperaceae and *Sphagnum* may be due to a change in the moisture content of the peat, which could be attributed to man. Mineral layers occur in association with the main clearance phases.

Merijänjärvi

b_1: 176-156 cm 2640 ± 55 yr BP; presence of *Cerealia* pollen.
b_2: 140-130 cm 2320 ± 55 yr BP.
b_3: 74-48 cm 1790 ± 50 yr BP; presence of *Cerealia* pollen.

At 75 cm, the *Picea* curve declines steeply whereas the *Betula* and *Alnus* curves increase. The first *Cerealia* are found just above the minerogenic/organogenic transition and are dated to 2790 ± 55 yr BP. It may be possible that some *Agropyron* and/or *Elymus* pollen, which belong to the shore natural flora, are included within the *Cerealia*. The *Alnus* declines (from level 176 cm) is synchronous with the apparition of *Calluna* and *Cerealia* pollen grains, suggesting that cultivation was very close to the site investigated (compare with level 87 cm in Kiimajänkä for a similar situation).

PERMANENT FIELD CULTIVATION

This stage is marked "c" on the diagrams. It will be analysed in more detail from the Ylitornio site. No significant changes in the natural forest composition are registered, although the *Picea* curve confirms an opening up of the forest cover. Permanent field cultivation is revealed by the increasing relative values of the erosiophilous species and wild grasses, as well as in the beginning of the continuous *Cerealia* curve with constant relative values.

Nimisjärvi

c: 12-0 cm.

Järvelänjärvi

c: 32-8 cm.

As the upper part of the sediment was not sampled, it is possible that the indicators of permanent field cultivation were not recorded.

Ahmasjärvi

c: 16-4 cm.

Kiimajänkä

c: 40-0 cm.

Iso-Mustajärvi

c: 12-0 cm.

Sotkasuo

c: 52-50 cm.

As the topmost part of the sediment was not analysed, we face the same problem as for Järvelänjärvi "c" phase.

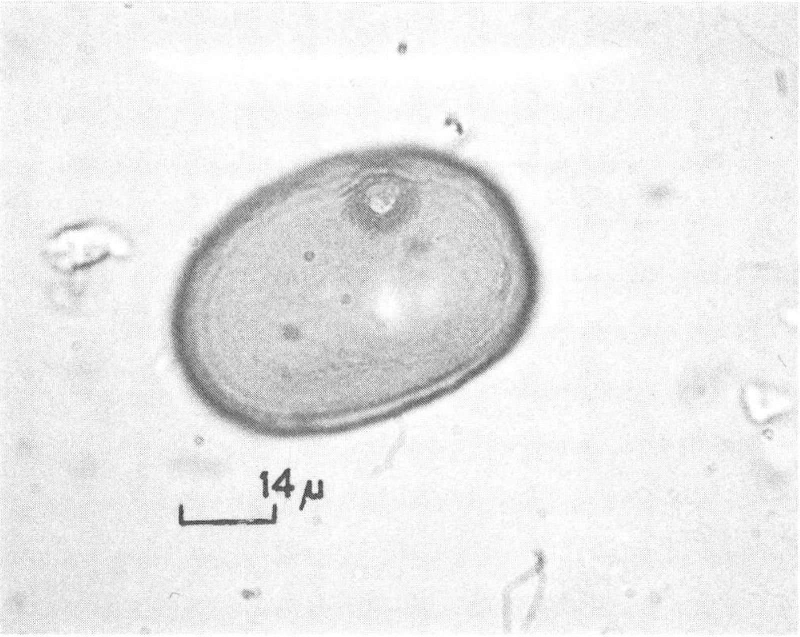
Pilpajärvi

"c" phase is not conspicuous.

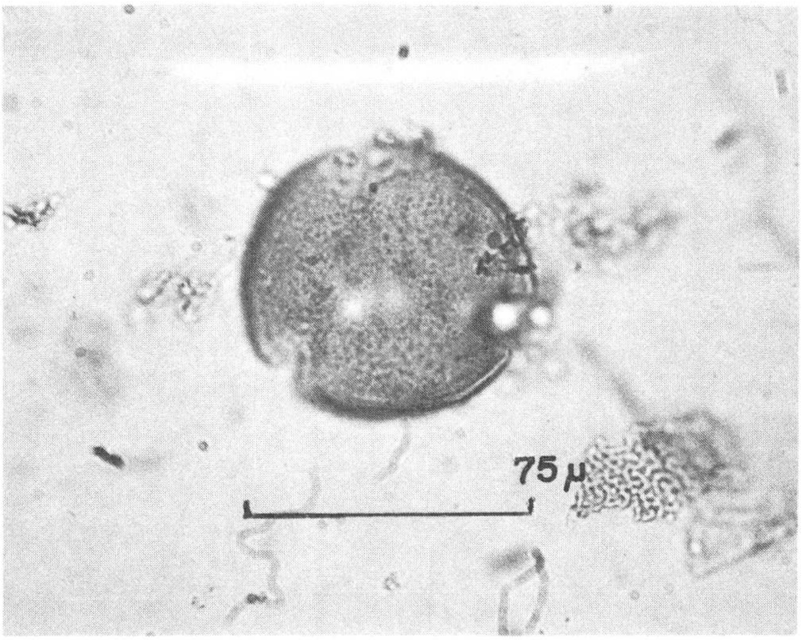
The first appearance of *Secale* pollen is dated at 1260 ± 140 yr BP (photograph No. 3). From the same level, pollen grains of *Centaurea cyanus* were recorded; the cultivation of rye seems to be well-founded. From 55 cm, two grains of *Linum usitatissimum* were identified (photograph No. 4). Although flowers of flax are insect pollinated, we believe that flax was locally grown in 1630 ± 130 yr BP. *Trifolium medium* type pollen grains at 2 and 14 cm depth would indicate cattle raising alongside field cultivation.

Ylitornio-Kaakonlantto

The investigation site is situated close to an old dwelling place, excavated by the Department of History of the University of Oulu. The oldest finds belong to the Lapp Iron Age (Koivunen, personal communication). The accumulation of peat began 920 yr BP (uncorrected age) on the highest terrace of the Tornio river, most likely following forest-clearance. Numerous pollen grains of *Chamaenerion angustifolium* were found at 22 cm depth and the AP/NAP ratio shows a gradualy increasing NAP proportion. From 24 cm depth, the NAP relative proportion oscillates between 40 and 60% of the total



Photograph 3. — Kiimajänkä: 40 cm; pollen grain of *Secale.*



Photograph 4. — Kiimajänkä: 55 cm; pollen grain of *Linum usitatissimum.*

pollen sum. Taking as a basis for comparison the records of pollen rain along transects from cultivated fields to forest in South Finland (VUORELA, 1973), it can be shown that peat accumulated immediately after the formation of the terrace of Ylitornio-Kaakonlantto. At 2 cm depth, three pollen grains of *Larix* sp. were recorded. Larch does not belong to the natural vegetation of northern Finland, but was planted in the Tornio valley in 1890 AD (PARVELA, 1932). On the basis of these two dates, the calculated mean rate of peat accumulation is 0.26 mm/yr. The forest composition does not show any radical modification. *Picea,* present at low relative values, was one of the components of the forest in the vicinity of this site. Nevertheless, decreasing values are observed during the clearance phases marked A, B and C in the diagram. During intermediate phases A-B and B-C, *Betula* "alba" values increase, reflecting the colonization of the deserted fields by birch. Our radiocarbon dated palaeoethnobotanical evidence argues for permanent human settlement since 1060 AD. The relatively abundant presence of pollen types of weeds (*Achillea* sp., *Cirsium* sp., *Senecio* sp.) can be explained in the permanence of the extensively cultivated field. As has been demonstrated for Hailuoto (REYNAUD & HJELMROOS, 1976), fossil pollen spectra, pertaining to historical times, record accurately the history of agriculture on the site. In northern Finland, the pattern of the evolution of agriculture, as recorded by the pollen evidence, is closely linked to the historical facts; population movements, wars, etc.

One can distinguish three main forest-clearance phases: A, about 1200 AD; B, about 1500 AD and C, about 1800 AD. The first forest-clearance by fire registered in the pollen diagram at about 1200 AD (all calendar years calculated on the basis of corrected radiocarbon ages; DAMON & al., 1973) should be compared with the strikingly similar results obtained for Hailuoto (REYNAUD & HJELMROOS, 1976).

DISCUSSION AND CONCLUDING REMARKS

The palynological evidence, from the various sites examined, testifies to a very early and fairly dense human presence in the Pohjanmaa region. The economic activities of the various communities have been divided, according to their nature and the kind of impact they had on the natural vegetation.

Phases, grouped under "a", concern the rearing of animals which would appear to have had little effect locally on the composition of the forest. Phases, grouped under "b", represent a local modification of the environment within the radius of activity of the human colony, which to all appearances practised shifting form of agriculture after clearing the land by fire. Phase "c" corresponds to a constant use of the land, with the related aspect of permanent human settlement. These various groups have been dated in radiocarbon years, and compared with the regional palaeogeographic evolution (Table 2).

The immigration of pine, which is metachronous from east to west and on which the lower boundary of the pine-birch-alder PAZ is based, is contemporary with the highest level of the Litorina sea, that is to say approximately 7000 yr BP (ERONEN, 1974). The first traces of human activity, discerned at Nimisjärvi and Ahmasjärvi during the older Stone Age, are situated on the area bordered by the highest level of the Litorina sea.

Man had already used fire to clear the forest, and the evidence suggests that in the Ahmasjärvi region, the cultivation of cereals started at about 6250 yr BP, that is to say the beginning of the younger Stone Age, with the arrival from the east of Combed-ware pottery. The problem, however, is to establish with certainty the date of the introduction of cereal cultivation, which characterised the "Neolithic revolution". The appearance of Combed-ware pottery, around 6200 BP, suggests continuous contacts with the inhabitants of Central Europe. Objects and jewelry fashioned from amber, coming from regions east of the Baltic sea, discovered in the valleys of the Oulujoki and Kemijoki (KEHUSMAA, 1972), date from the younger Stone Age. Lines of communication, therefore, existed between northern Finland and the southern coast of the Baltic sea, as well as with eastern Finland. One can, therefore, reasonably assume that an exchange of agro-pastoral techniques existed alongside the trade in various objects.

In southern Scandinavia, the introduction of cereals dates from circa 5450 yr BP (IVERSEN, 1941, 1973; WELINDER, 1975), and cultivation by the "slash and burn" method also began at this time. The sites of Ahmasjärvi and Nimisjärvi, situated along the natural line of communication of the river Oulujoki, withnessed the development of a relatively important human colony, which cleared the land and cultivated cereals around 6000 yr BP. This group had learnt the art of pottery and has left important archaeological proofs of this, notably at Säräisniemi, which has given its name to the Säräisniemi Culture.

The discovery of cereal pollen, dating from about 6000 yr BP in Pohjanmaa, is not very surprising, since the history of the "Neolithic Revolution", from its cradle in the Middle East right up to northern Europe, testifies to an almost synchronous development of pottery and the practise of sedentary agriculture. The clearing of land in the Järvelänjärvi and Sotkasuo areas can also be included in the period of Säräisniemi Culture. Sedentary or semi-sedentary agriculture was already practised at that time, but the time span of the stay of the various human groups is difficult to evaluate. Hunting and fishing undoubtedly provided the chief source of food. The possibility that men resorted to fire in order to concentrate the game and thus facilitate hunting in a fairly hostile natural environment is also not to be excluded.

During the early Metal Age, human impact on the natural vegetation is more strongly reflected in the pollen diagrams, especially in the case of the Kiimajänkä and Merijänjärvi sites. At Kiimajänkä, the exploitation of the arable land began around 2640 yr BP and declined 400 years later. The establishment of arable land was achieved at the expense of the spruce forests which occupied the best land. The abandoned cultivated land was later invaded by shrubs and birch, which succession is faithfully recorded in the fossil pollen spectra. The human groups continued to use the best land by practising shifting agriculture, thus causing local upheavals in the equilibrium of the forest.

The succession of land-clearances, recorded at the Merijänjärvi site, suggests that, demographically, the human colony was fairly important.

Archaeologically, the early Metal Age was, for northern Finland, a period of particularly intense contacts with the regions of the Urals and the Volga basin (KIVIKOSVI, 1961).

Finally, around 1500 yr BP, a new evolutionary process manifested itself simultaneously at most of the sites, irrespective of their geographical positions (with the exception of Pilpajärvi and Ylitornio-Kaakonlantto). This marks the beginning of the cultivation of cereals in permanent fields (phase "c" in pollen diagrams). The Lapp Iron Age, as is becoming evident from new discoveries, is a very rich archaeological period (KOIVUNEN, 1975). The age of the beginning of phase "c" for the Ahmasjärvi and Järvelänjärvi sites has been calculated on the basis of the rates of sedimentation. The great difference between these, and the results obtained for the Sotkasuo, Merijänjärvi and Kiimajänkä sites, obliges us to discard temporarily the dates calculated for Ahmasjärvi and Järvelänjärvi. The age for the beginning of permanent field culture in the Pohjanmaa region seems to be the same as for southern Finland, circa 1400 yr BP (REYNAUD & TOBOLSKI, 1974; VUORELA, 1975; HUTTUNEN & TOLONEN, 1976). The chronology of regional land clearing, in historical times, confirms the results obtained on the island of Hailuoto (REYNAUD & HJELMROOS, 1976). One must note, during these various periods of land-clearance, the relative increase in values of pollen of the *Humulus* type (cf. Kiimajänkä and Merijänjärvi diagrams). Unfortunately, the level of determination of this type of pollen does not allow a precise definition of *Humulus* and/or *Cannabis*. The discovery of flax *(Linum usitatissimum)* pollen dated to 1630 ± 130 yr BP at Kiimajänkä, is of great interest; the plant being insect pollinated, its pollen grains are only occasionally encountered. Flax was undoubtedly cultivated in Kiimajänkä at the end of the early Metal Age (see HIRVILUOTO, 1975).

The impact of very early man in Pohjanmaa region seems to be linked with the favourable geographical conditions of the Oulu river valley, which have been used as a natural passage between South eastern region and the Baltic coast, allowing the fast spreading of cultures.

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