THE POLLEN DATA OF MÄTÄJÄRVI, TURKU, SW FINLAND

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Abstract

The exceptionally abundant herb pollen flora in the sediments of Mätäjärvi made it possible to investigate the ecological and cultural development in the center of the town of Turku, SW Finland during the period of AD 1200—1700. Based on a pollen sum of 1000 NAP and approx. 33 herb pollen taxa/sample (from among a total set of 72 herb pollen and spore taxa), the changes in the NAP groups of 1) aquatics and hygrophytes, 2) meadow vegetation and 3) primary indicators of human activity (weeds and ruderals) were studied and the indicators of urban settlement determined.

Introduction

As part of an interdisciplinary investigation concerning the early history of the town of Turku, SW Finland, pollen analysis of the sediments of Lake Mätäjärvi was carried out in order to throw light upon the human activity in the growing town community and to study the influence of urbanization on the vegetation.

Even if the herb pollen flora of the lake sediments mainly represents the immediate surroundings of Mätäjärvi, the pollen dispersion from the increasingly settled open area has been fairly effective and the interpretation of the pollen data can be based on human activity in a wider area around the lake.

As can be seen from the map (Fig. 1; based on Kivikoski and Gardberg, 1971) the urban district prior to the 14th century covered an area of approx. 6 hectares. Even if the area was doubled during the 14th century, a zone of more or less natural vegetation still formed a filter preventing much of the indicator pollen originating from the oldest urban areas from reaching the lake sediments. On this inter-area agriculture and grazing were practiced by the habitants of the nearby villages which later became incorporated in the town of Turku. It was not until the 15th century that the urban settlement reached the shores of Mätäjärvi. The areas east of the lake were settled as late as the 16th and the 17th centuries after further drying activities in the area.

In Fig. 1 the circular zones I—III around Mätäjärvi roughly correspond to the division of the herb (NAP) vegetation in the pollen diagrams (Figs. 4—6).

Zone I covers the main area of the aquatics and hygrophytes, that is Mätäjärvi itself and its moist shores. This area was ecologically very uniform up until the 18th century even though the construction of the 'krooppi' channel at the end of the 13th century and the partial infilling of the lake in the 15th century reduced the area of this zone. The pollen data relevant to zone I can easily be compared with the macrofossil results (cf. Lempiäinen, in this volume).

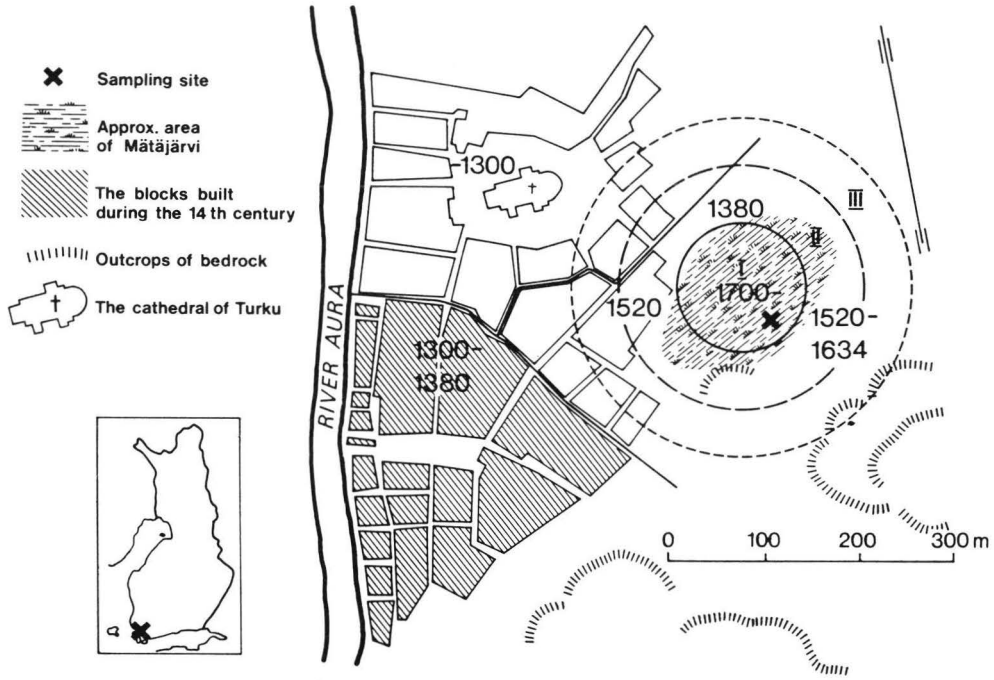

Fig. 1. Map showing the advance of urban settlement in the town of Turku from the end of 13th to 18th centuries. The circular zones around Mätäjärvi roughly correspond to the division of the NAP flora in the diagrams (Figs 4—6) as follows:
I = Mätäjärvi and its moist shores
II = Open meadows around the lake
III = Habitats with strong human impact

Zone II represents the area of meadows around the lake up until the 15th and the 16th centuries when the town grew over it.

The outer limit of zone III is not easily determined. Ecologically this zone was very heterogenous consisting of the early urban areas north-west of the lake, permanent fields east of the lake and rocks in the southern part of the area. A typical feature is, however, the earlier influence of urban settlement on the vegetation compared with those of the previous zones. The distance from the sampling site, however, reduces the reflection of this kind of activity in the present material.

Material and methods

The stratigraphy of the core was as follows (abbreviations cf. Troels-Smith, 1955):

	0—2.5 cm	Soil infill
Dl + Dh, Ga + Gs	2.5—50.0 cm	Sandy coarse detritus gyttja
Dl + Dh, As	50.0—67.5 cm	Mixed gyttja and clay
Dl + Dh	67.5—90.0 cm	Coarse detritus gyttja with wood and plant fragments
Ld	90.0—97.5 cm	Fine detritus gyttja
As	97.5—100.0 cm	Clay

For a more detailed description of the sediments, the ^{14}C-datings and the palaeolimnology of the lake see Salonen and Räsänen, 1983 and Räsänen, Salonen and Terho, in this volume.

The material for pollen analysis was treated with KOH, HF and acetolysis (Faegri and Iversen, 1975). Both the relative and absolute (Stockmarr, 1971) pollen frequencies were determined using 2.5 cm intervals. According to the ^{14}C dates this corresponds to 10—20 y intervals the rate of sedimentation being thus 1.5—2.1 mm/y. If the compression of the material is taken into account this figure is even greater. In determining the pollen influx values a figure of 1.48 was used to correspond to the rate of sedimentation at the 50—85 cm level while the figure for the 10—50 cm level was 2.1.

Because of the fluctuation in the pollen concentration values (Fig. 8) and in the ^{14}C dates which is a result of the heterogenity of the material, the pollen influx values have been calculated only for the ecological groups and the main interpretation of the results has been based on the relative pollen frequencies. The basic sum used for the relative tree pollen frequencies is total arboreal pollen (150—500 AP), and that for the herb pollen curves 1000 NAP.

Tree pollen data

The low relative AP frequencies (Fig. 2) which are consistently below 50 % of total pollen and do not even exceed 15 % of total pollen in the 14th—15th centuries are among the lowest ever met with in Finnish pollen diagrams. The reason for these excep-

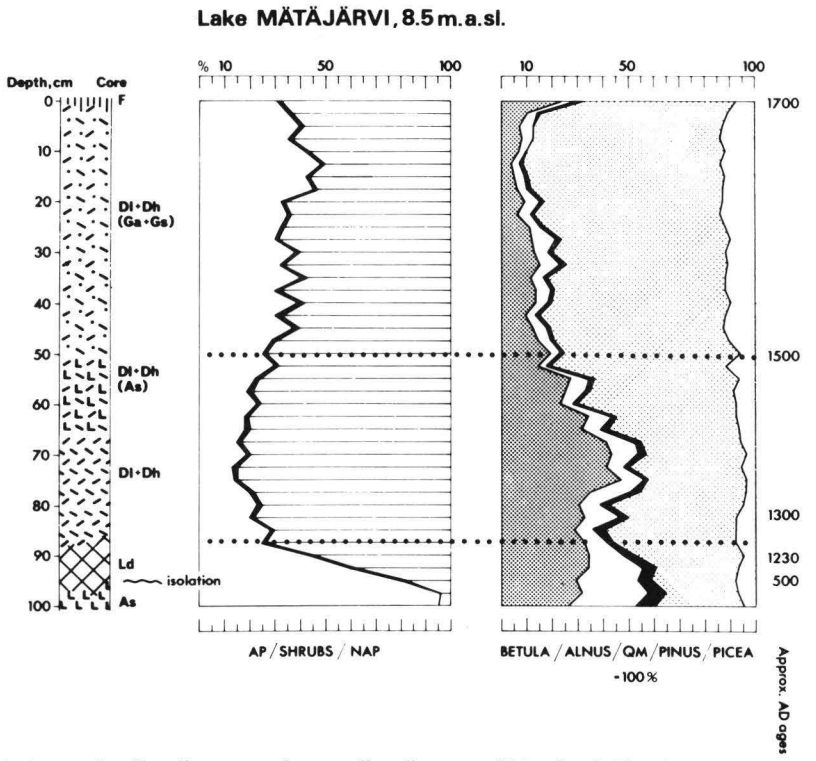

Fig. 2. Relative total pollen diagram and tree pollen diagram of Mätäjärvi. The dotted lines show the level for starting urbanization in the late 13th century and that of the radical constructions in and around Mätäjärvi approx. AD 1500.

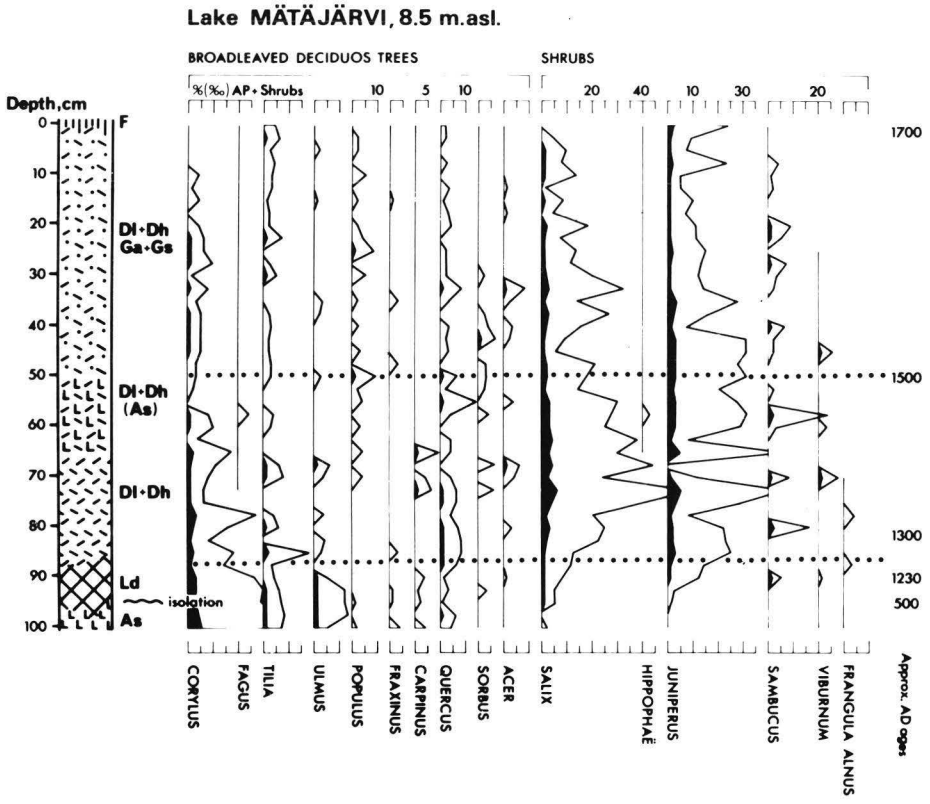

Fig. 3. Relative pollen diagram of broadleaved deciduous trees and shrubs. Dotted lines cf. Fig. 2.

tional figures is not only the open vegetation of the area as early as the 13th century but also the geographical position of Turku on the western coast. The prevailing W and SW winds blow over the sea carrying only small amounts of forest pollen. At a greater distance from the sea a depression of the AP pollen to even 80 % of total pollen has been interpreted as representing open vegetation (Vuorela, 1973; Salonen and Vuorela, 1983) the regional forests at some distance from the sites dominating the results. At Mätäjärvi the relative increase in AP frequencies towards the 17th century cannot be interpreted as the reforestation of the surroundings of the lake. The phenomenon is the result of the urbanization of the meadow-like areas causing a relative, not an absolute increase of the AP pollen derived from a greater distance.

The clear decrease of the deciduous tree pollen frequencies in the 15th century is preceded by an increase in *Betula* pollen particularly at the level of 60—75 cm where the proportion of AP pollen was significantly small. This level is also characterized by a clear decrease in *Corylus* (Fig. 3) and a simultaneous increase of the bushes. These features together with those encountered among the herbs all point to grazing activities around Mätäjärvi, obviously in forested meadows typical of SW Finland and Åland (Cedercreutz, 1927, 1931; Fagerström, 1954) with an open deciduous tree vegetation (for pollen production in this situation see Göransson, 1982) and a rich bush and herb vegetation. Among the latter the following species are represented: *Juniperus, Salix, Sambucus* and *Viburnum* while *Frangula alnus* is found in the formation preceding deforestation.

Herb pollen data

The even representation of the aquatic pollen (Fig. 4) indicates that the site was covered by water up to the 18th century. Shortly before the isolation and at the early stage of the lake the shore vegetation was dominated by Poaceae, mainly *Phragmites australis*. Even though this pollen type was encountered throughout the diagram, in the later stages it was accompanied by pollen types of meadow grasses (cf. Haeggström, 1983).

The constructions carried out at the end of the 15th century caused an increase in *Carex* vegetation around the lake which is reflected at the 50 cm level in the diagram. Among other pollen types typical of the shores the earliest *Filipendula* maximum is connected with the early stage of the lake while the later one at the 60—75 cm level most obviously belongs to the forested meadows *Filipendula ulmaria* being a typical indicator species of this kind of grazing activity. The moist shores of Mätäjärvi are also indicated by *Caltha palustris* and *Sphagnum* whose relative frequencies increase in the 16th century. Depending on the species concerned the *Equisetum* sp. may indicate moist shores and/or cultivated fields.

In addition to the dominating pollen types *Thalictrum, Valeriana, Plantago mari-*

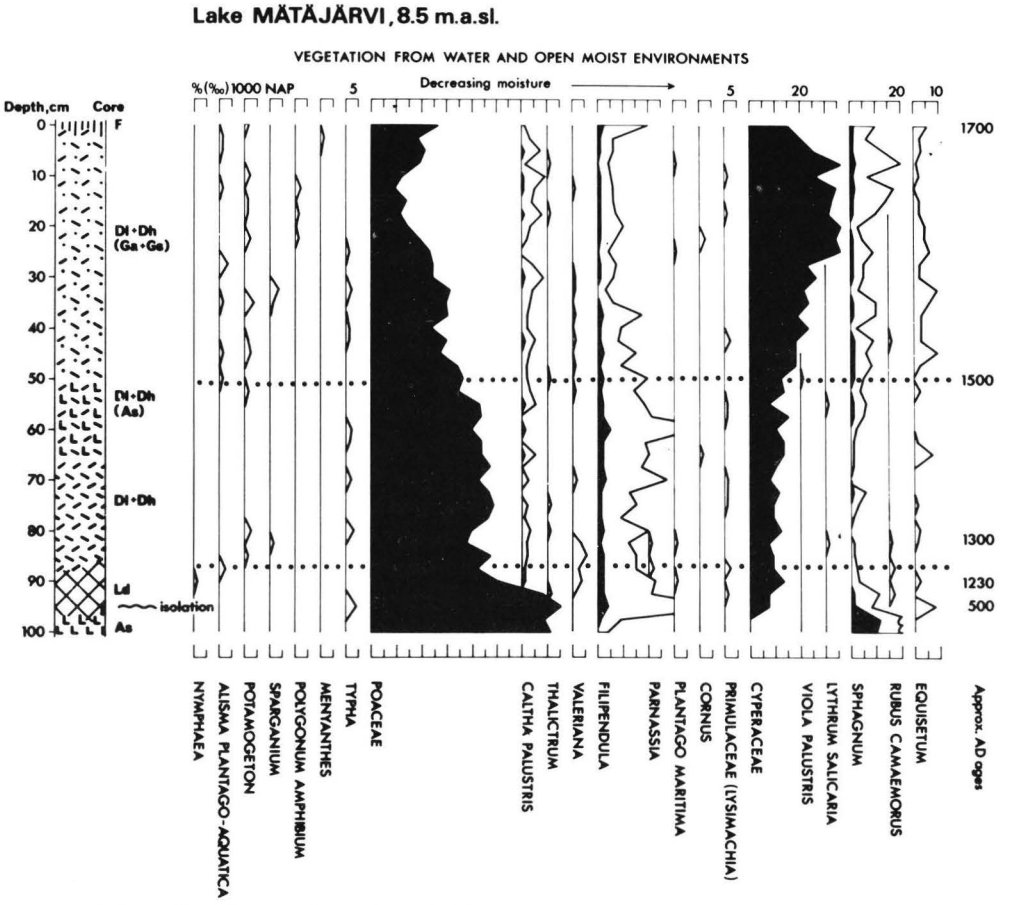

Fig. 4. Relative pollen diagram of aquatics and of the vegetation of open moist environments (% 1000 NAP). Dotted lines cf. Fig. 2.

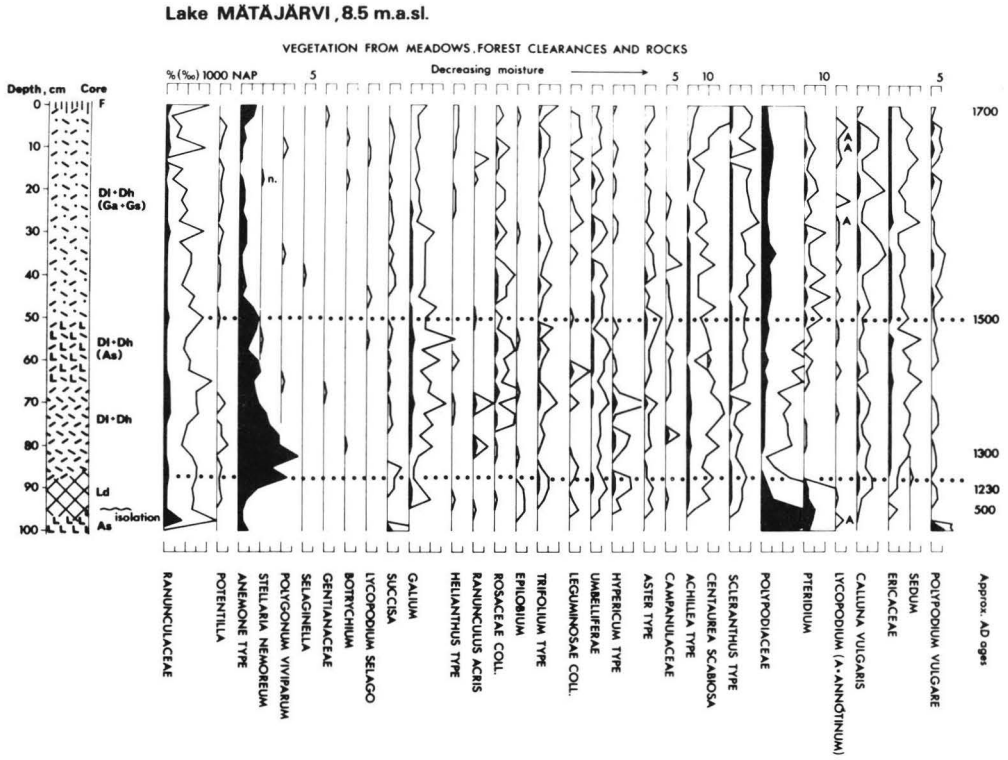

Fig. 5. Relative pollen diagram of vegetation from meadows, forest clearances and rocks (‰ 1000 NAP). Dotted lines cf. Fig. 2.

tima (most obviously derived from the sea shore), *Cornus, Lysimachia, Viola palustris, Lythrum salicaria* and *Rubus chamaemorus* pollen types were found.

The herb pollen types which belong predominantly to zone II in Fig. 1 are represented in the diagram (Fig. 5) in an order which corresponds to the hydrology of the potential species. Since, however, most of the pollen types include ecologically different species and genera the order of the pollen types is no more than a suggestion.

One of the most significant features seen in Fig. 5 is the great number of pollen types in spite of the fact that, with few exceptions, they belong to zoogamous species and genera thus having a very poor pollen production. This points to an exceptionally rich herb vegetation in the vicinity of the sampling site. The greatest relative pollen frequencies in this group are exhibited by the *Anemone* type with a maximum phase in the deciduous forest preceding the deforestation and urbanization of the area and that of *Galium, Trifolium* and Apiaceae pollen types at the 50—80 cm level (for species typical of forested meadows see Palmgren, 1915—1917; Fagerström, 1954; Aronson et al., 1970; Haeggström, 1983). Later, starting in the 16th century the relative frequencies of the dwarf shrubs and the cryptogams increase, the phenomenon being related to that discussed in connection with the tree pollen frequencies and caused by the destruction of the meadows by the urban settlement.

The cultural indicators (hemerophiles; Linkola, 1916; Fig. 6) have been divided into cultivated plants and natural herbs profiting from human activity (weeds and ruderals).

Even if the occurrences of *Secale* pollen need not represent local cultivation they together with earlier pollen evidence (Vuorela, 1982) and historical data (Kivikoski and

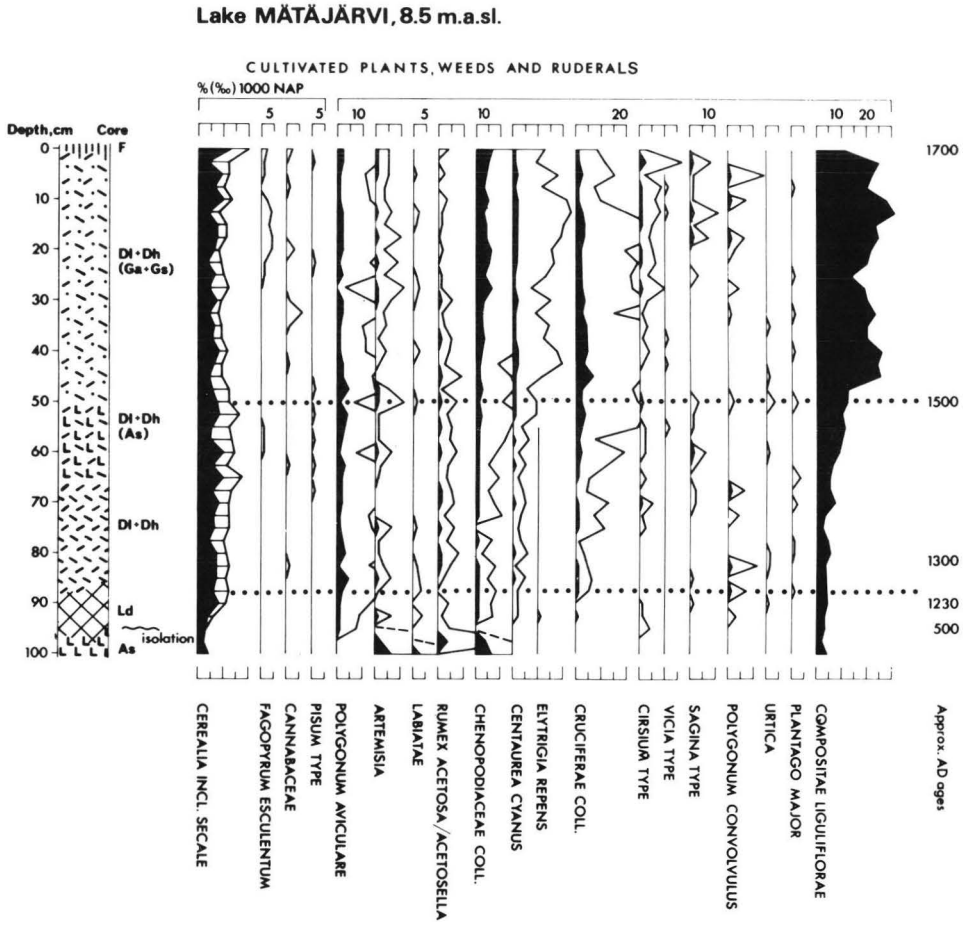

Fig. 6. Relative pollen diagram of cultivated plants, weeds and ruderals (% 1000 NAP). Dotted lines cf. Fig. 2.

Cardberg, 1971) show an early field cultivation in the Turku area preceding the foundation of the town (see also Salonen et al., 1981).

The sum of the *Avena-Hordeum-Triticum* pollen types in the diagram indicates a more local cultivation (Vuorela, 1973) decreasing in the 16th century while the more regional *Secale* pollen (shaded in the diagram) shows an even representation up to the 18th century. According to the present pollen results and those obtained in Paimio (Vuorela, 1983), Perniö (Vuorela, 1985) and Hattula (Vuorela, 1975) the former opinion that *Fagopyrum esculentum* was cultivated only in the eastern parts of S. Finland (Soininen, 1974) has to be changed. The occurrence at the 10—20 cm level in particular obviously represents local cultivation of this species. Considering the sensibility of *Fagopyrum* to frost it is most natural to find it in SW Finland. The Cannabaceae *(Humulus)* pollen type is found throughout the diagram showing that *Humulus lupulus* was cultivated in the gardens around Mätäjärvi throughout all these centuries.

The pollen finds of *Pisum* type at the turn of the 15th/16th centuries could, when one takes into account the poor pollen production of the plant, represent wider cultivation while most of the cultivated plants (e.g. *Brassica* sp.) are not to be found at all in the pollen data.

In the Mätäjärvi material the weeds and ruderals make a most interesting group representing not only tilling and cultivation of the fields and gardens but also an increasing urbanization of the area. The pollen types of *Polygonum aviculare* and *Rumex acetosa/acetosella* are typical of the 14th—15th centuries still representing agricultural settlement around the lake.

From the 16th century onwards the pollen frequencies of Chenopodiaceae, *Centaurea cyanus,* Cruciferae and Compositae liguliflorae increase together with *Artemisia, Cirsium* and *Sagina* (Caryophyllaceae) pollen types. With reference to the macrofossil data (cf. Lempiäinen, in this volume) Chenopodiaceae pollen can be seen to originate from the vicinity of the lake and thus to be an indicator of urban settlement. The exceptionally high Compositae liguliflorae pollen frequencies (earlier encountered by Behre, 1976 and Robertsson and Miller, 1972 for example) which belong to the Cichoriaceae family here represent urban settlement. Most evidently it was *Taraxacum* sp. that was present in the grazed meadows and it increased abruptly with the end of this kind of activity when the area was turned into backyards and courtyards. This has been shown to happen in abandoned hay fields (Jukola-Sulonen, 1983). An other possibility is that the liguliflorae pollen derive from *Sonchus arvensis* which grew as a weed in the former fields.

The high pollen frequencies of *Centaurea cyanus* in the 16th—17th centuries either derive from the vegetation of abandoned fields now changed to courtyards or they possibly represent the cultivated flowers of the gardens. Even if it is evident that the increase of Cruciferae, *Artemisia, Cirsium* and *Sagina* pollen types can also be bound to the urban development of the area, it can not be proved on the basis of the present material.

The pollen groups described above react in different ways to the ecological changes around Mätäjärvi (Fig. 7).

The aquatics and the hygrophytes have a relative dominance throughout the diagram as a result of the close location of this kind of vegetation to the sampling site, the greatest changes being found shortly after the isolation of the lake.

For the vegetation of dry habitats the high number of pollen taxa can also be interpreted as an indication of human influence on the landscape. The sharp decrease in meadow vegetation starts in the 16th century being replaced in the first place by the Cichoriaceae type.

The absolute pollen data

The great fluctuations among the herb pollen concentration values (Fig. 8) result from the heterogenity of the present material. A clear rate of development can, however, be noted. The herb pollen concentration of 110 000/cm^3 in the 13th century diminishes to not more than 20 000—50 000/cm^3 in the upper part of the diagram as a result of destruction of the vegetation and of increasing sedimentation. The corresponding values for the AP concentration are remarkably smaller (around 20 000) and more stabile, as expected.

Even if no pollen influx values for any individual pollen types were determined, the NAP groups demonstrated above reflect the ecological development of the surroundings of Mätäjärvi.

The most distinct decrease of the influx values is noted among the aquatics and the hygrophytes (from 10 000/cm^2/y in the 14th century to as low as 3 000 in the 16th century) while the relative pollen frequencies of this group stayed very uniform. The decrease was due to the constructions in the lake; later the phenomenon gets stronger

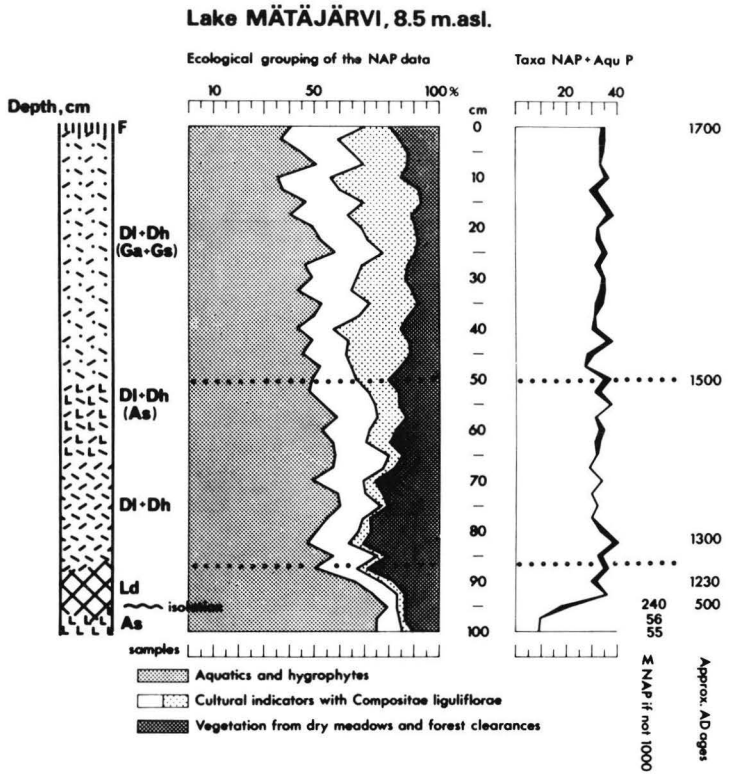

Fig. 7. Relative pollen diagram showing the ecological grouping of the herb pollen data (cf. Figs 4—6).

reflecting the advance of settlement to the SE shores of Mätäjärvi in the 16th century preceded by the partial infilling of the lake. The increasing settlement also affects the influx values of the meadow vegetation which in the early 16th century were only 1/5 of the maximum values (5 000/cm²/y) encountered in the 14th century; later in the 17th century they did not exceed 1/10 of that value. Throughout the diagram the influx values of the total cultural indicators stay very uniform (approx. 4 000/cm²/y). The composition of this group, however, clearly alters at the turn of the 15th/16th centuries when the influx values for the cereals decrease from 2 000 to 600/cm²/y as a result of the end of field cultivation in the vicinity of the lake. The main replacing component in this group was Compositae liguliflorae.

Conclusions

The present results are of great importance from several points of view. In the first place they add to previous knowledge of the settlement history of Turku telling about the sources of livelihood around Mätäjärvi during the first five centuries after the foundation of the town.

The results also have a great pollen analytical value with respect to the exceptionally large herb pollen data which made it possible to base the results on a total of 1000 NAP.

The palaeoecological value of this pollen investigation lies in the fact that previous papers on the cultural indicators and settlement history in Finland have dealt primarily

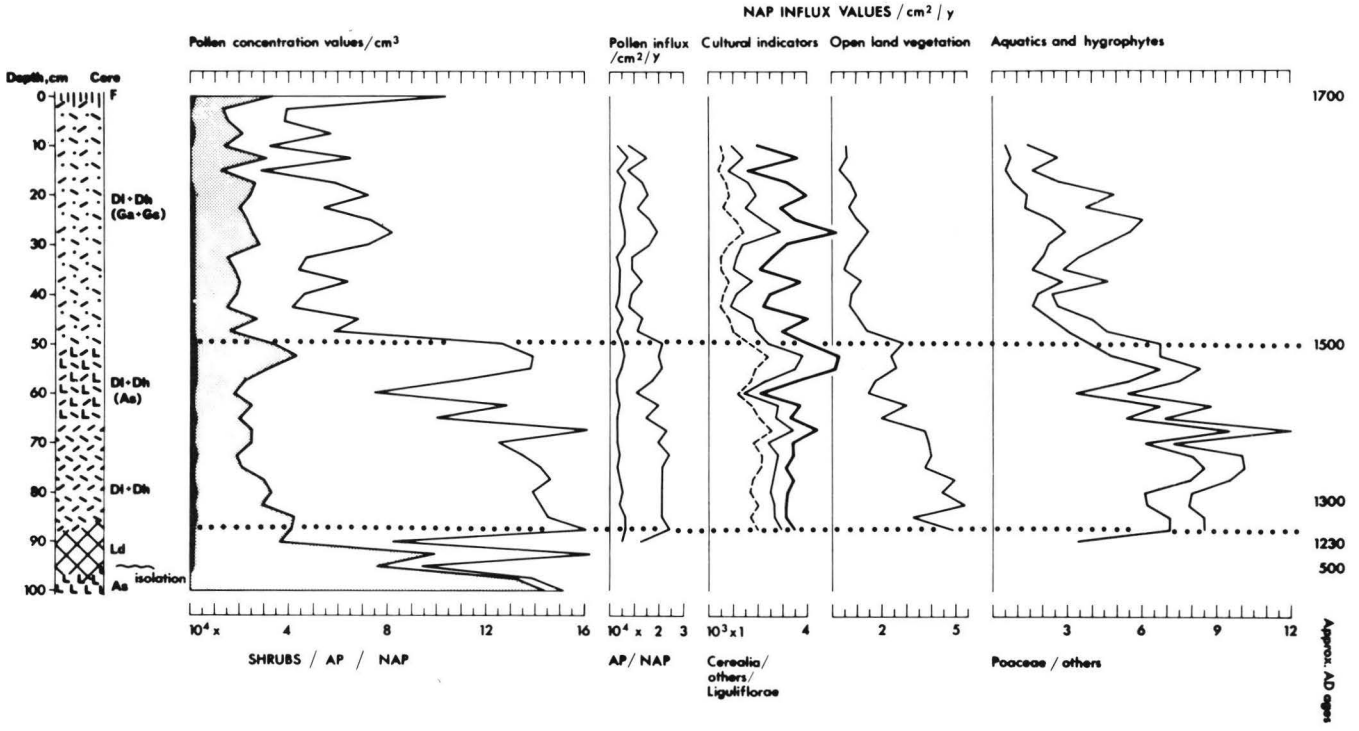

Fig. 8. Pollen concentration values/cm³ and NAP influx values/cm²/y for the ecological herb pollen groups (cf. Figs 4—6).

with early rural settlement history while the Mätäjärvi material defines the indicators of urbanization in the pollen data. Geographically the closest corresponding investigation was carried out in Stockholm, Sweden (Miller and Robertsson, 1982).

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