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EVIDENCE OF POLLEN AND PLANT MACRO-REMAINS FROM THE SEDIMENTS OF SUBURBAN AREA OF MEDIEVAL TARTU

Pollen and plant macrofossil analyses were carried out in the suburban area of medieval Tartu (Estonia) in connection with archaeological rescue excavations on the building site of Postimaja (Post Office) in 1990–1994. Several soil samples were taken from natural and archaeological layers of the profile 4/i[1] to reconstruct the local environment before and during medieval and early modern habitation of the area. The richest plant micro- and macrofossil material was obtained from the layers dated to the 14th century. Long-term landscape changes are documented by pollen diagram indicating a transformation of the landscape type from natural to urban one. A list comparing and summarizing the pollen and macrofossil taxa is given to see how the plant communities are recorded in the results of different methods.

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Introduction

In 1990–1994 rescue excavations at the building site of Postimaja (Post Office) at 7 Vanemuise Street were carried out in the suburban area of medieval Tartu (Fig. 1) directed by archaeologist Mare Aun (Aun 1994; 1995a; 1995b). In general, treatments of the primary structure of the settlement have been based on the oldest preserved town plans of the 17th century (Mäesalu & Vissak 2002). Although the exact data concerning the formation of southern settlement outside the town wall is not available, it is rather likely that the suburban settlement was already developing by the fourth quarter of the 13th century at the latest (Heinloo 2006).

To engage an archaeobotanist to determine plant macro-remains from the deposits of early town was quite a common practice (Sillasoo 1997; 2005). Besides plant tissues, seeds and fruits, sediments frequently contain plant micro-remains –

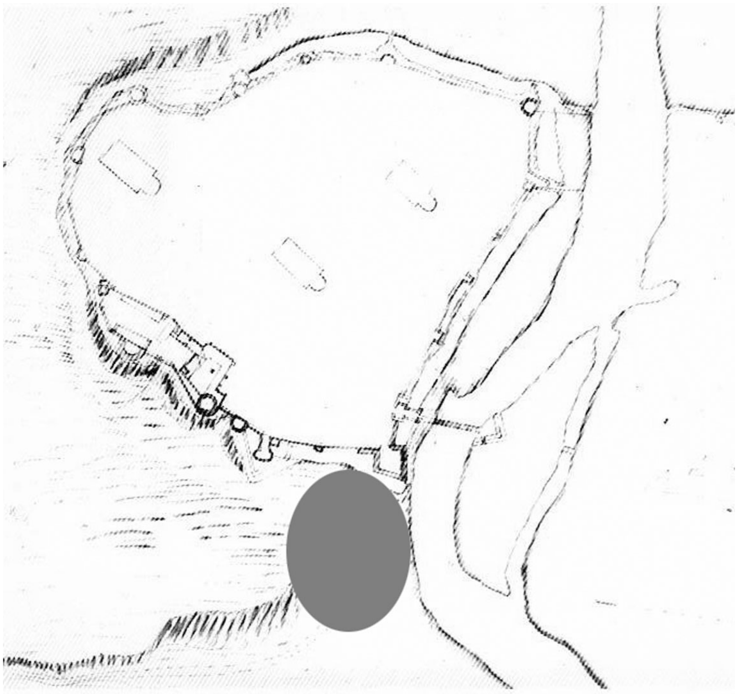

Fig. 1. Town plan of the first half of the 17th century. Location of the southern suburb according to Eero Heinloo (2007).

pollen and spores, providing extra information about the environment, economy and activities of the settlement. Only a few pollen analytical studies of medieval cultural layers were known from Europe at that time (cf. Vuorela & Hiekkanen 1991) as urban archaeology was among the latest fields of palynology. However, several waterlogged habitats from archaeological settings may prove suitable for pollen preservation, such as ditches, moats, wells, lynchets, post holes and sewers (Moore et al. 1991). As pollen and spores survive best in acidic and anoxic conditions, soils receive less attention from palynologists. The soil composition of cultural layers differs from the traditional material (peat, lake sediments and waterlogged sediments) used for pollen analyses. Oxidation and drying of soil lead to pollen corrosion and together with high charcoal dust concentration values it hampers the pollen analyses, so that the identification of taxa is often restricted (Vuorela & Lempiäinen 1993; Vuorela et al. 1996). This has been, for example, the case with material from Tartu Dome Hill, where pollen was not found (Kihno 1994).

Still, not all settlement layers have badly preserved pollen. Archaeobotanical investigations in medieval towns of Finland (Vuorela & Hiekkanen 1991; Vuorela & Lempiäinen 1993; Vuorela 1994), as well as attempts made in this field in the suburban areas of medieval Tallinn (Kihno 1995a), encouraged the archaeologist Mare Aun to involve both an archaeobotanist and a palynologist in the project (Hiie 1995; 2002; Kihno 1995b).

Material and methods

Sampling

Samples for pollen and plant macrofossil analyses were collected by Ülle Sillasoo in May 1994. The sampling point was located in the southern part of the rescue excavations close to Vanemuise Street (Fig. 2). On the site of Postimaja both prehistoric and medieval cultural layers were discernible. Unfortunately neither of them was observed all over the investigated area; in the southern part of the excavation plot a medieval layer was established as the earliest upon the natural layers (Aun 1995b).

About 1 m sample column was taken from the profile 4/i[1] which can be divided into nine complexes (Fig. 3). At the base of the profile light sand crops out. The analysed cross-section begins with 0.18 m of brown peat followed by a 0.12 m

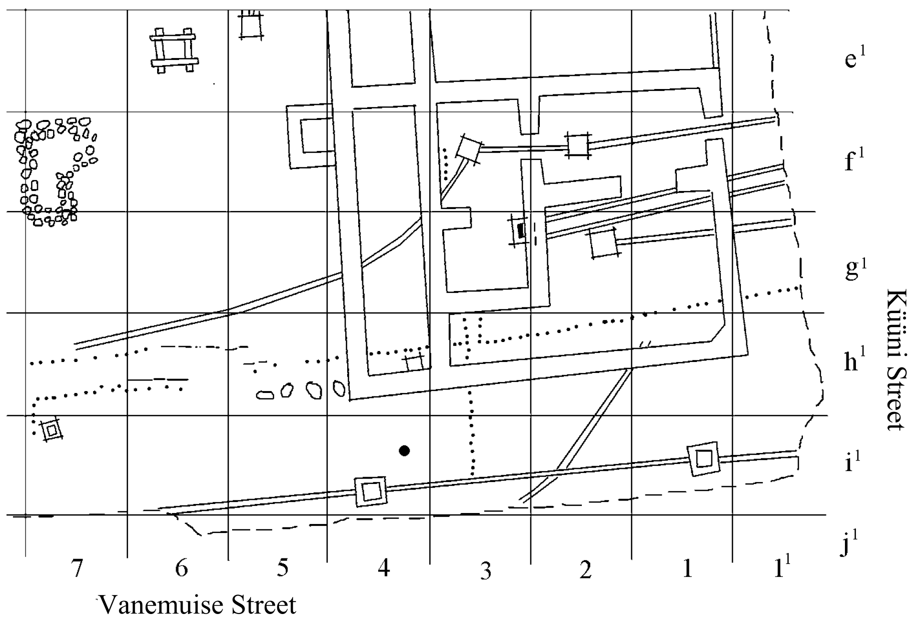

Fig. 2. Location map of building site of Postimaja. ● – location of the profile 4/i[1]. According to Mare Aun (1995b).

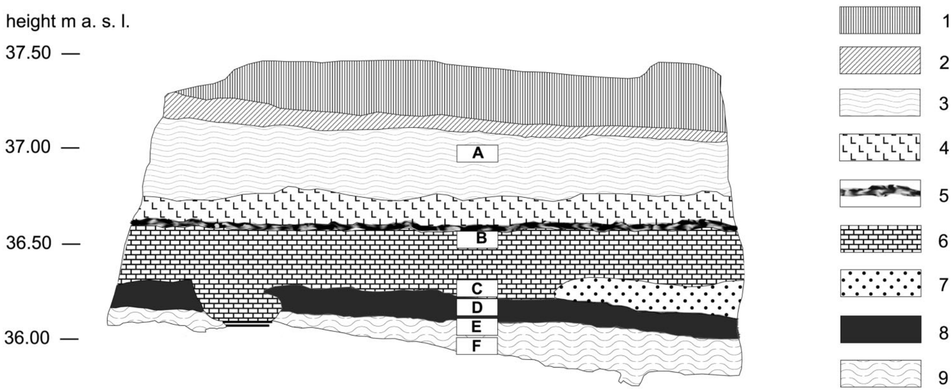

Fig. 3. Stratigraphy of the profile 4/i[1] showing the position of the samples A–F. 1 infill, 2 rubble, 3 clayey sand, 4 sand, 5 sandy soil, 6 soil, 7 disturbed, 8 humus, 9 peat. Drawing by Mare Aun, designed by Kersti Siitan.

well decomposed black layer of humus which is covered by a 0.38 m thick layer of organic-rich soil containing pieces of wood. On top of it, within 0.5 m, layers of sandy soil, fine brown sand rich in charcoal and coarse grey clayey sand with charcoal lay. The upper 0.35 m consists of rubble and infill.

The samples range from the natural layers to the 14th–17th century cultural layers, the dating of which was based on archaeological finds (Aun 1995a). Two pollen and macrofossil sub-samples were analysed from the peat (Table 1), one from the layer of humus and two from the soil. In addition one macrofossil analyse was made from the coarse grey sand containing charcoal, where pollen was not preserved because of high degree of oxidation.

Table 1. The analysed samples

Sample	Depth	Material
F	3592–3595 cm a.s.l.	Peat
E	3600–3610 cm a.s.l.	Peat
D	3615–3620 cm a.s.l.	Humus
C	3620–3630 cm a.s.l.	Soil
B	3650–3660 cm a.s.l.	Soil
A	3690–3700 cm a.s.l.	Sand

Pollen analysis

For pollen analysis macro-remains from the soil samples of 2 cubic centimetres were removed by sieving with a sieve of 0.25 mm. In order to remove humus and cellulose the samples were treated in a laboratory with sodium hydroxide and boiled in a mixture of sulphuric acid and acetic acid following the standard technique of Berglund and Ralska-Jasiewiczowa (1986). Heavy liquid treatment (CdJ_2 and KJ solution with the gravity of 2.2 g/cm^3) was additionally used for samples with high minerogenic matter content (Pokrovskaya 1950).

The samples were inspected microscopically using microscope Jenaval. A magnification of 400x was applied for routine counting. For pollen identification the keys of Faegry and Iversen (1989), Moore et al. (1991), Kuprianova and Aleshina (1972; 1978) as well as pollen reference collection of the laboratory of geoarchaeology and ancient technology at the Institute of History, Tallinn University, was used. More than 1000 land pollen grains from cultural and 500 from natural layer were counted per sample plus identification of aquatics and spores. Pollen diagrams were plotted with the *Tilia*-*Tilia**Graph software (Grimm 1992). Herbs considered to be human impact indicators were grouped following Behre (1981), Berglund and Ralska-Jasiewiczowa (1986) and Hicks (1992).

Plant macrofossil analysis

For the plant macrofossil analyses the samples were prepared according to the method described by Wasylikowa (1979; 1986). The soil samples were washed under tap water through the sieve with a 0.4 mm mesh. More consolidated sediments were dispersed in a 10% KOH solution one day before washing. Plant remains were picked out and identified under the stereomicroscope МБС-10 at the magnification 8–16 times. Most of the investigated plant remains were uncharred. Only carpological finds were identified, vegetative remains of plants were not determined. Identification of seeds and fruits was done using the keys of Katz (Katz et al. 1965; 1977), Rasiņš (1954) and Schoch (Schoch et al. 1988); and the reference collection of seeds and fruits of the laboratory of geoarchaeology and ancient technology at the Institute of History, Tallinn University. The volume of plant macrofossil samples ranged from 400–1100 cm^3, absolute numbers of finds are presented in the table (Table 2).

Results

Macrofossils

80 plant taxa were recorded from the investigated sequence. Table 2 gives a detailed overview of the distribution and grouping of the plant macrofossils

Table 2. Macrofossil plant remains

	Sample volume, ml					
	A, 600	B, 400	C, 800	D, 800	E, 1100	F, 400
CULTURAL PLANTS						
Cannabis sativa			1			
Fagopyrum esculentum			1			
Ficus carica			1			
Papaver somniferum	4		2			
COLLECTED PLANTS						
Corylus avellana		1	3			
Fragaria vesca		4	79			
Humulus lupulus		2	36			
Rubus idaeus				86		
Vaccinium vitis-idaea			1			
Vaccinium sp.			1			
WEEDS AND RUDERALS						
Agrostemma githago frgm.			61			
Anthemis tinctoria			1			
Anthriscus sylvestris			1			
Atriplex prostrata	2	2				
Brassica campestris		5	9			
Capsella bursa-pastoris			1			
Centaurea cyanus		2	3			
Cerastium arvense			3			
Cerastium holosteoides			15			
Chelidonium majus			38	4		
Chenopodium album	69	479	544	27		1
Chenopodium glaucum	7					
Erodium cicutarium			1			
Fallopia convolvulus		8	31			
Fumaria officinalis			2			
Galeopsis ladanum			1			
Galeopsis tetrahit/speciosa		9	25			
Galium aparine			39			
Galium spurium			1			
Geranium pusillum			4			
Lamium album			1			
Lamium purpureum	1					
Lapsana communis			2			
Polygonum aviculare			29			
Polygonum lapathifolium		12	237			
Polygonum sp.			2			
Potentilla anserina			6			
Rumex acetosa		1				
Rumex acetosella		8	35			
Rumex sp.			1			
Scleranthus annuus		2	5			
Setaria sp.			13			

Table 2. *Continued*

	Sample volume, ml					
	A, 600	B, 400	C, 800	D, 800	E, 1100	F, 400
Silene alba		1	1			
Silene vulgaris			7			
Solanum dulcamara	4		1			
Solanum nigrum	1		1			
Spergula arvensis			9			
Stellaria graminea		3	6			
Stellaria media	1	13				
Thlaspi arvense		2	3			
Urtica dioica	3	1	5		6	
Urtica urens	3		4	1		
Viola arvensis		1	1			
MEADOW PLANTS						
Alchemilla sp.		2	2			
Campanula patula			6			
Carex leporina		1	1			
Hieracium sp.					1	
Leontodon autumnalis			2			
Lychnis flos-cuculi		1	5			1
Poaceae		1	60	1		
Potentilla erecta		8	15			
Potentilla argentea			1			
Prunella vulgaris			39			
Ranunculus repens		11	136			
WETLAND PLANTS						
Carex flava		1	1			
Carex pseudocyperus	1					
Carex spp.	6	30	146	5		
Cicuta virosa				3		
Comarum palustre				11		
Cyperaceae			2			
Eleocharis sp.		3	2			
Filipendula ulmaria			3			
Lycopus europaeus		1				
Ranunculus flammula		2	1			
Ranunculus sceleratus			4	183	2	
Stachys palustris					8	6
Typha sp.		1	2			
Viola palustris		2	2			
Viola sp.	1	1	6			
OTHER REMAINS						
Betula sp. fruit and catkin scale			12			
Cenococcum geophilum					42	38
Puparia		8	475			
Fish scales	45	52	29			
Fish vertebra	4	5	3			
Fragments of fish bones		11	25			
Fragments of animal bones	46					

identified. Some other remains like sclerotia of fungus (*Cenococcum geophilum*), fragments of fish and animal bones and puparia of insects are included in the table as well.

Pollen data

Three local pollen assemblage zones (LPAZ) were established for the analysed sediment sequence (Fig. 4) described below, with the earliest zone first.

LPAZ 1 (35.90–36.10 m a.s.l.)

This LPAZ is identified on the basis of two samples in which the proportion of arboreal pollen (AP) is high, up to 96.5% of total land pollen. *Betula* (11 and 17% respectively), *Pinus* (20 and 22%), *Alnus* (8.8 and 20.8%) and *Corylus* (9 and 8%) are supported by enormous amount of broad-leaved tree *Tilia* (34.7 and 31.6%). The sum of other Quercetum Mixtum (*Ulmus, Quercus* and *Fraxinus*) remain at

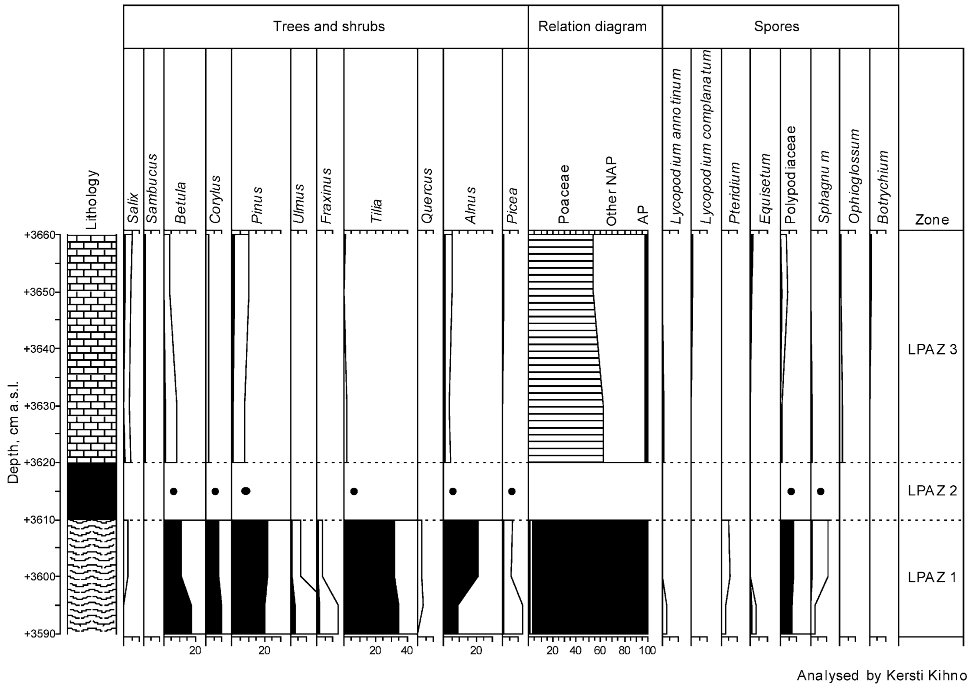

Fig. 4. Percentage pollen diagram for selected pollen taxa with indication of the local pollen assemblage zones (LPAZ). The pollen sum comprises trees, shrubs and terrestrial herbs and grasses (AP + NAP = 100%). The black areas on the diagram show the actual pollen %, while the empty areas show the percentage values multiplied by 10. See Fig. 3 for lithology.

low relative values (4.2–1.2%). *Picea* and *Salix* also occur in this zone. The sum of non-arboreal pollen (NAP) is low. Spores of *Equisetum*, Polypodiaceae[1], *Sphagnum*, *Lycopodium* and *Pteridium* were recorded in LPAZ 1.

LPAZ 2 (36.10–36.20 m a.s.l.)

Only few AP (*Betula, Pinus, Alnus, Picea, Corylus* and *Tilia*) and NAP pollen grains (Poaceae, Cyperaceae, Umbelliferae, Asteraceae, *Viola*) were found in this interval. Spores of Polypodiaceae and *Sphagnum* are present.

LPAZ 3 (36.20–36.60 m a.s.l.)

The uppermost pollen zone in the sequence is established on the basis of the samples in which the pollen concentration of NAP reaches 97%. The high value of NAP is mainly attributable to Poaceae. AP pollen of *Betula, Alnus, Picea, Salix* and *Sambucus* are present as scattered finds.

Discussion

Natural layers

Peat layer (samples F and E) is rather pure by plant species and number of seed finds. Identified plant macro-remains show natural environmental conditions. Wetland species such as celery-leaved buttercup (*Ranunculus sceleratus*) and marsh woundwort (*Stachys palustris*) occur and some seeds of nutrient rich habitants such as nettle (*Urtica dioica*) and fat hen (*Chenopodium album*) were also found. The pollen spectra of peat (LPAZ 1) indicate also natural conditions and most probably reflect the period of climatic optimum. Extremely high lime (*Tilia*) pollen frequencies indicate that lime grew near the site at the time of deposition of the material, as the majority of insect pollinated lime pollen drops to the ground with the flowers. Vegetation in the surroundings was heavily influenced by the differences in hydrological regime and soil. Moist river valley vegetation dominated by birch (*Betula*) forests and alder (*Alnus*) prevail along the riverside. Mixed forest of pine (*Pinus*), spruce (*Picea*) and broad-leaved trees spread on slopes. Presence of spores of light-demanding bracken (*Pteridium*) and pollen of cow-wheat (*Melampyrum*), considered to be indicators of grazed forest suggest an existence of clearings in the forest.

Pollen sample from layer D (LPAZ 2) is different from others with its high concentration of microscopic charcoal particles, so the pure visibility keeps the pollen count under 100 pollen grains. It must be mentioned that the concentration of microscopic charcoal particles was too high to be counted in all samples.

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[1] In the present work the family Polypodiaceae is defined on the basis of *Eesti taimede määraja* (Key of Estonian Plants) (1966).

According to pollen composition, LPAZ 2 is similar to LPAZ 1. Poor preservation of pollen points on low and unstable water level. This hypothesis is supported by macrofossil finds – species of wetland flora are characteristic of this layer. Seeds of *Ranunculus sceleratus* occur most abundantly, which is the pioneer plant in muddy soils and watersides. This plant is often an indicator of grazing in wetland. Other marsh plants such as marsh cinquefoil (*Comarum palustre*), cowbane (*Cicuta virosa*) and sedge (*Carex*) species were also observed. The number of raspberry (*Rubus idaeus*) seeds is remarkable. In this condition they should belong to natural vegetation. Anthropogenic indicators such as *Chenopodium album,* greater celandine (*Chelidonium majus*) and annual nettle (*Urtica urens*) also occur, but they might originate from the uppermost layer, as we do not know the degree of contamination of the layers. If the area was used for grazing, what we can suppose by the great presence of the seeds of *Ranunculus sceleratus*, the settlement weeds might be trampled into this layer by the cattle.

Cultural layers

LPAZ 3 (samples C and B) is rich in pollen which is better preserved than it was in the other samples. Natural mineral soil vegetation is dominated by grasses (Poaceae). The variety of NAP other than Poaceae is high as well reaching up to 50 taxa. In order to study the influence of man a human impact diagram (Fig. 5) was constructed for herbs pollen taxa of cultural layer dated to the 14th century. Pollen dispersal of the family Poaceae is very effective as it consists of wind-pollinated species. To make the traces of human activity more visible against the background of pollen production of Poaceae, the last mentioned taxa was excluded from the calculation sum (NAP-Poaceae = 100%).

Pollen taxa of 18 settlement indicators were recorded. The most dominant are Cerealia and Asteraceae (Liguliflorae pollen type). According to Vuorela (1994) the layers of urban and post-urban period of the Old Town of Helsinki contain many pollen taxa of which Liguliflorae pollen type frequencies dominate, exceeding even those of Poaceae. The relative frequencies of Liguliflorae increase when approaching the edge of the urban cultural layer, thus confirming the importance of this pollen type as one of the essential urban indicators (Vuorela & Lempiäinen 1993). All finds of pollen of cereals are summarized as Cerealia type among which pollen of barley (*Hordeum* type) was more frequent. The rare find is pollen grain of buckwheat (*Fagopyrum esculentum*). Pollen of sorrel/sheep's sorrel (*Rumex acetosa/acetosella* type) and cornflower (*Centaurea cyanus*) is connected with agriculture, settlement weeds are greater/hoary plantain (*Plantago major/media* type) and knotgrass (*Polygonum aviculare*), cabbage family (Brassicaceae), wormwood (*Artemisia*), goosefoot family (Chenopodiaceae). *Melampyrum*, heather (*Calluna vulgaris*) and *Anemone* type refer to the existence of open forest vegetation in the area. Pollen of water- and shore meadow plants (dominated by Cyperaceae) is also present.

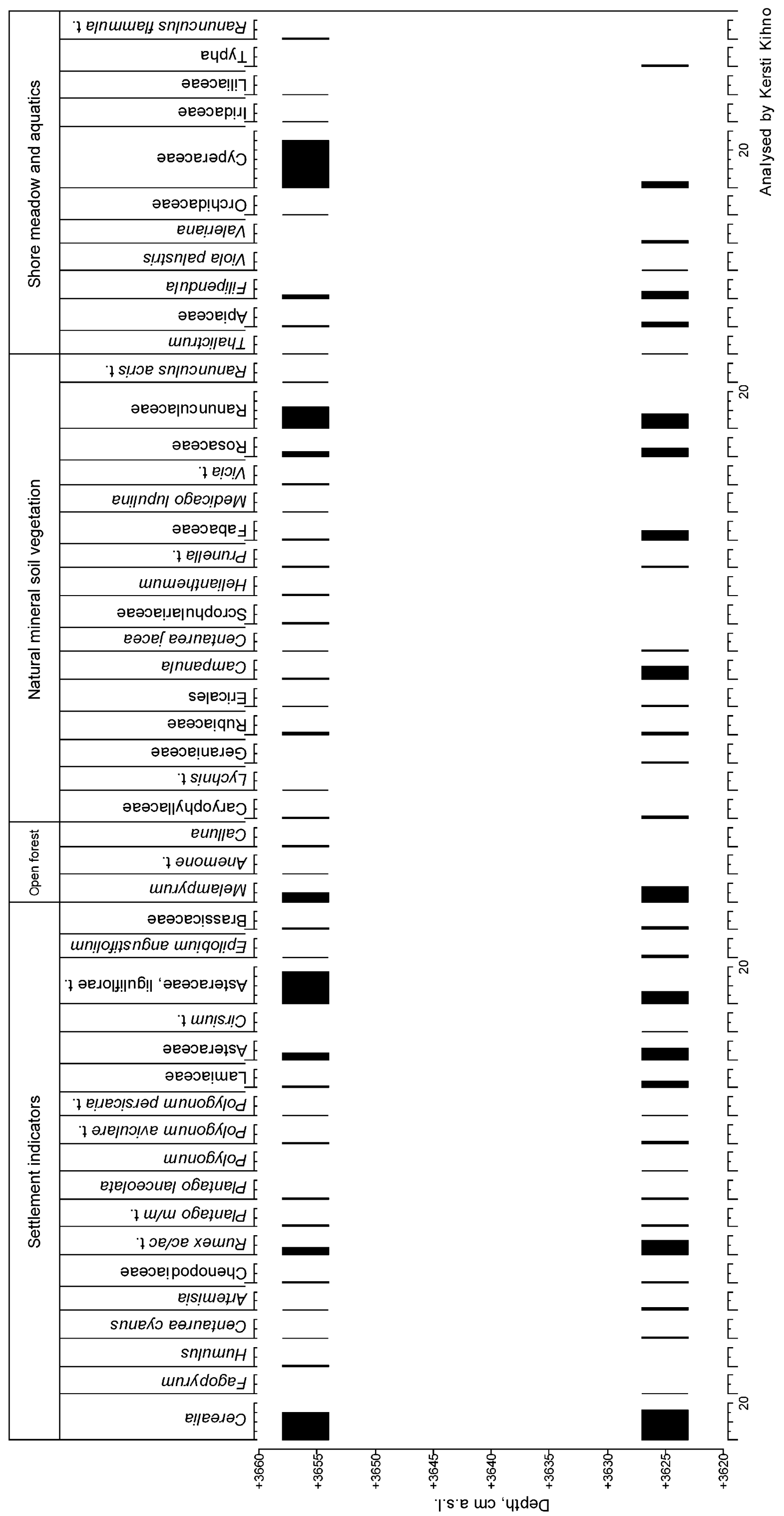


Fig. 5. Percentage pollen diagram for herbs pollen taxa of cultural layer (samples C and B). The calculation sum is NAP-Poaceae = 100%.

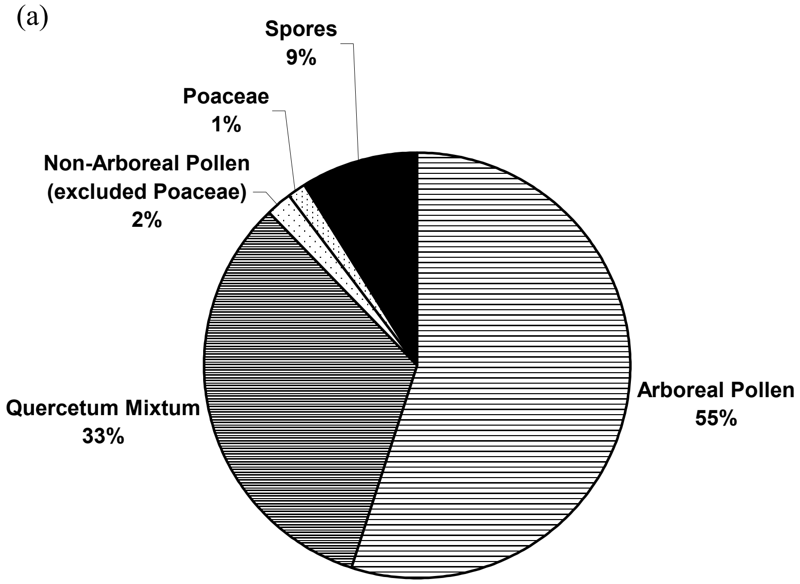
Organic rich deposit (samples C and B) was also richest in macrofossil taxa and seed finds. A few remains of cultural plants were found including one seed of imported fruit – fig (*Ficus carica*), hemp (*Cannabis sativa*), opium poppy (*Papaver somniferum*) and *Fagopyrum esculentum*. The fruit scale and easily distinguished pollen grain of *Fagopyrum esculentum* from the sample C provides evidence of the use of this culture. According to the coin finds the same layer is dated to the 14th century (Aun 1995a). There are several finds of fruit scales of buckwheat from the old town of Tartu from the 14th–15th centuries (Sillasoo & Hiie 2007). Comparing the number of finds of cultural plants to the other analyses made from medieval layers of Tartu, the low presence of cultural plants in our samples could be explained by the content of analysed material. Abundantly finds were obtained mostly from latrines (Tammet 1988; Sillasoo 1995; 1997); our samples were taken from the cultural layer outside the refuse pit.

The wild plants gathered for food were much more numerous. Seeds of wild strawberry (*Fragaria vesca*) and hop (*Humulus lupulus*) were found most frequently. Hop was collected from woods as well as planted in gardens. Some nut fragments of hazel (*Corylus avellana*) and single seed of cowberry (*Vaccinium vitis-idea*) and *Vaccinium* sp. were found. Among the weeds and ruderal plants several field weeds were observed: corn cockle (*Agrostemma githago*), *Centaurea cyanus*, wild turnip (*Brassica campestris*), foxtail (*Setaria* sp.), black bindweed (*Fallopia convolvulus*), pale persicaria (*Polygonum lapathifolium*), cleavers (*Galium aparine*). *Centaurea cyanus* and *Agrostemma githago* are known as weeds in winter crops. The majority of seed finds belong typically to *Chenopodium album*.

The uppermost part of the column (sample A), dated to the 17th century is characterized by anthropogenic species like fat hen (most numerous), oak-leaved goosefoot (*Chenopodium glaucum*), spear-leaved orache (*Atriplex prostrata*), nettles (*Urtica dioica*, *U. urens* and *Lamium album*), common chickweed (*Stellaria media*), bittersweet (*Solanum dulcamara*) and black nightshade (*Solanum nigrum*). All these species are common settlement weeds, which grow near the houses. Some seeds of opium poppy also occur. Because of the sandy soil the preservation of seeds is poor if to compare with the organic rich cultural layer (samples B and C).

It is obvious from Fig. 4 that pollen spectra from peat (LPAZ 1) and archaeological layer (LPAZ 3) are remarkably different. Two pie pollen diagrams were constructed (Fig. 6) to demonstrate more clearly the differences between two complexes. The main contrast lies in the relationship of arboreal pollen to non-arboreal pollen, reflecting development from closed growing conditions to open landscape. The pollen composition found in the lower unit is dominated by arboreal pollen and spores and provides information about the local conditions preceding the urban settlement. In the upper complex the AP/NAP relation is strongly dominated by Poaceae pollen, originated probably from river shore meadow. Relative pollen frequencies of cereals (Cerealia type) exceed 6%.

(a)



(b)

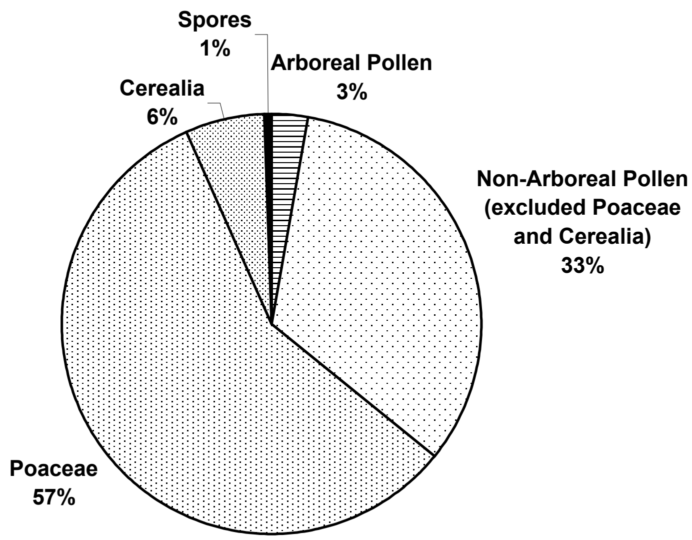


Fig. 6. Pie pollen diagrams showing the percentage of main pollen groups for peat layer (a), and cultural layer (b). The calculations of pie diagrams are based on the sum of all identified land pollen and spores (AP + NAP + Spores = 100%) and show the proportions of arboreal pollen (with Quercetum Mixtum shown separately), non-arboreal pollen (with Poaceae and Cerealia separately) and spores.

Comparison of pollen and macrofossil data

Natural macrofossil assemblages are local and provide information about the vegetation of the nearest area while pollen provides better data from beyond the site. We present a comparison of pollen and plant macro-remains data from the profile 4/i[1] (Tables 3, 4) to see how the plant taxa are recorded in the results of different methods.

In our material the peat layer (Table 3) contains few species of plant macro-remains, as only carpological finds were identified. Cryptogams and trees are altogether missing, even the variety of herbs is larger in pollen records, so only the finds of seeds of *Urtica dioica* and *Ranunculus sceleratus* do not have corresponding pollen taxa. *Urtica dioica* release a lot of pollen. The reason of the total absence of *Urtica* pollen in all samples is probably the quick disintegration of the pollen of delicate exine and partly maybe its poor visibility in soil samples.

Table 3. Comparison of pollen and macrofossil data from natural peat (samples F, E). The plant taxa (see also Table 4) identified at genus or species level are in italic, at family level in bold

Pollen taxa	Macrofossil taxa
Poaceae	
Artemisia	
Cichoriaceae	*Hieracium* sp.
	Lychnis flos-cuculi
Chenopodiaceae	*Chenopodium album*
Rumex Acetosa/acetosella t.	
Lamiaceae	*Stachys palustris*
Rubiaceae	
	Urtica dioica
Rosaceae	
Melampyrum	
Cyperaceae	
	Ranunculus sceleratus
Brassiceae	
Lycopodium	
Pteridium	
Equisetum	
Polypodiaceae	
Sphagnum	
Salix	
Pinus	
Picea	
Tilia	
Ulmus	
Querqus	
Fraxinus	
Corylus avellana	
Betula	
Alnus	

Table 4. Comparison of pollen and macrofossil data from cultural layer of the 14th century (samples C, B)

Pollen taxa	Macrofossil taxa
Poaceae	**Poaceae**
	Setaria sp.
Cerealia	
Hordeum t.	
Secale cereale	
	Ficus carica
	Cannabis sativa
Humulus lupulus	*Humulus lupulus*
Asteraceae	
Artemisia	
Centaurea cyanus	*Centaurea cyanus*
Centaurea jacea	
Cirsium t.	
Cichoriaceae	*Leontodon autumnalis*
	Lapsana communis
	Hieracium sp.
Caryophyllaceae	*Agrostemma githago*
	Cerastium arvense
	Cerastium holosteoides
	Scleranthus annuus
	Silene alba
	Silene vulgaris
	Stellaria graminea
	Stellaria media
	Spergula arvensis
Lychnis	*Lychnis flos-cuculi*
Plantago major/media t.	
Plantaga lanceolata	
Brassicaceae	*Brassica campestris*
	Thlaspi arvense
	Capsella bursa-pastoris
Chenopodiaceae	*Chenopodium album*
	Atriplex prostrata
Polygonum sp.	*Polygonum* sp.
Polygonum persicaria t.	
Polygonum aviculare t.	*Polygonum aviculare*
	Polygonum lapathifolium
	Fallopia convolvulus
Fagopyrum esculentum	*Fagopyrum esculentum*
Geraniaceae	*Geranium pusillum*
Erodium cicutarium	*Erodium cicutarium*
Rumex acetosa/acetosella t.	*Rumex acetosa*
	Rumex acetosella
	Rumex sp.

Table 4. *Continued*

Pollen taxa	Macrofossil taxa
Lamiaceae	*Galeopsis ladanum*
	Galeopsis tetrahit/speciosa
	Stachys palustris
	Lycopus europaeus
	Lamium album
Prunella vulgaris	*Prunella vulgaris*
Rubiaceae	*Galium aparine*
	Galium spurium
Epilobium angustifolium	
	Urtica dioica
	Urtica urens
Apiaceae	*Anthriscus sylvestris*
	Cicuta virosa
Helianthemum nummularium	
Rosaceae	*Potentilla anserina*
	Fragaria vesca
	Comarum palustre
	Potentilla erecta
	Potentilla argentea
	Alchemilla sp.
Filipendula ulmaria	*Filipendula ulmaria*
Ericaceae	
Calluna vulgaris	
	Vaccinum vitis-idaea
	Vaccinum sp.
Fabaceae	
Medicago lupulina	
Vicia t.	
Campanula	*Campanula patula*
Scrophulariaceae	
Melampyrum	
Cyperaceae	**Cyperaceae**
	Eleocharis sp.
	Carex flava
	Carex leporina
	Carex spp.
Ranunculaceae	*Ranunculus repens*
Ranunculus acris t.	
Ranunculus flammula	*Ranunculus flammula*
	Ranunculus sceleratus
Anemone t.	
Thalictrum	
Valeriana	
	Fumaria officinalis
	Papaver somniferum
	Chelidonium majus
	Solanum dulcamara
	Solanum nigrum
	Viola sp.
Viola palustris	*Viola palustris*
	Viola arvensis

Table 4. *Continued*

Pollen taxa	Macrofossil taxa
Orchidaceae	
Liliaceae	
Iridaceae	
Typha	*Typha* sp.
Salix	
Sambucus	
Pinus	
Picea	
Tilia	
Corylus avellana	*Corylus avellana*
Betula	*Betula* sp.
Alnus	
Lycopodium annotinum	
Lycopodium complanatum	
Equisetum	
Polypodiaceae	
Ophioglossum	
Botrychium	
Sphagnum	

The possibilities of pollen analysis are limited concerning the taxonomic level down to which pollen can be identified. Pollen types are sometimes identified only at family or genus level, while macrofossils of anthropogenic plants can be often identified at species level. It is important in the case of cultural layer (Table 4) as it gives more exact information of the activity of people. For example, macro-remains of *Brassica campestris*, *Thlaspi arvense* and *Capsella bursa-pastoris* correspond in pollen record to the family Brassicaceae. *Agrostemma githago*, *Cerastium arvense*, *Cerastium holosteoides*, *Scleranthus annuus*, *Silene vulgaris*, *Stellaria graminea*, *Stellaria media* and *Spergula arvensis* to the pink family (Caryophyllaceae) as use of phase contrast microscopy would be necessary for identification of the mentioned species. Pollen of some self- or insect pollinating species may not get into the sample even if the plants grow nearby. On the other hand, we can find pollen taxa not recorded from macrofossils – *Hordeum* t. and rye *(Secale cereale)* from cultural plants; *Plantago major/media, Plantago lanceolata* t., rosebay willowherb (*Epilobium angustifolium*), thistle (*Cirsium* t.) and *Artemisia* which belong to weeds and ruderals; wetlands taxa as common valerian (*Valeriana officinalis*), Orchidaceae, Liliaceae and Iridaceae. Woody plants species are much better represented in pollen record. Cryptogams exist only in the list of pollen taxa.

Conclusions

The results of our investigation prove that macrofossil data gives different information from pollen data and thus the comparison of two methods allows us to reconstruct local environment in greater detail.

Long-term landscape changes are documented by pollen diagram indicating a transformation of the landscape type from natural to urban. The ratio of arboreal pollen (AP) to non arboreal pollen (NAP) reflects a development to deforestation at least in the 14th century. The proportion of NAP is 5% in lower sub-samples, gaining its maximum values (95%) in the upper samples of the profile 4/i[1] at the level 3620 cm a.s.l. The high value of NAP is mainly attributable to Poaceae (60% of total pollen). The variety of NAP other than Poaceae is high as well, reaching up to 50 taxa. The most dominant settlement indicators are cereals (Cerealia type) and Asteraceae (Liguliflorae pollen type).

The richest plant macrofossil material was obtained from the layers dated to the 14th century. Species composition is typical to medieval towns, although the number of cultivated plants is small. Some remains of buckwheat (*Fagopyrum esculentum)*, hemp (*Cannabis sativa*), fig (*Ficus carica*) and opium poppy (*Papaver somniferum*) were found. The wild plants gathered for food were much more numerous. Hazel (*Corylus avellana*) nuts, raspberry (*Rubus idaeus*), wild strawberry (*Fragaria vesca*), bilberry (*Vaccinium myrtillus*), cowberry (*Vaccinium vitis-idaea*) and hop (*Humulus lupulus*) were found. In addition to typical settlement weeds the seeds of cornflower (*Centaurea cyanus*) and fragments of corn cockle (*Agrostemma githago*), the weeds of winter crop, were found.

The results show that the development of the suburban area is in good correlation with the foundation of the town in the 13th century.

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Kersti Kihno ja Sirje Hiie

ÕIETOLMU JA TAIMSETE MAKROJÄÄNUSTE VÕRDLEV ANALÜÜS KESKAEGSE TARTU EESLINNA ALALT

Resümee

Aastatel 1990–1994 juhatas arheoloog Mare Aun päästekaevamisi keskaegse Tartu eeslinna alale (joon 1) jääval Postimaja ehituskrundil. 1994. aasta mais võttis Ülle Sillasoo kaevamiste käigus paljastunud looduslikust ja kultuurkihist paleobotaanilisi proove asustuse-eelsete loodusolude taastamiseks ning inimtegevusega kaasnevate muutuste leidmiseks. Kui taimsete makrojäänuste analüüs oli tol ajal linnaarheoloogias küllaltki levinud praktika (Sillasoo 1997; 2005), siis õietolmuanalüüsi rakendati väga harva (Kihno 1995a). Seega on käesolev taimsete makro- ja mikrojäänuste võrdlev analüüs Postimaja kaevamiste profiilist 4/i[1] Eestis omas vallas üks esimesi (joon 2).

Profiil 4/i[1] (joon 3) algas liival lasuva pruuni turba ja mustja leiuaineseta pinnasega, millest võeti vastavalt proovid F, E ning D (tabel 1). Looduslikke kihte kattis puutükke sisaldav segatud orgaanikarikas pinnas (proovid C ja B) ning söese liiva kihid (proov A). Profiili ülemise osa moodustasid rusuviirg ja täitekiht.

Taimsete makrojäänuste analüüsil leiti jälgi 80 taksoni esinemisest. Detailne ülevaade makrojäänuste leviku ja rühmitumise kohta on esitatud tabelis 2. Õietolmuanalüüsi andmed on esitatud diagrammina (joon 4), kus on eraldatud kolm kohalikku õietolmutsooni (LPAZ 1, LPAZ 2, LPAZ 3). Loodusliku ja kultuurkihi õietolmuspektrid eristuvad teineteisest selgelt, peegeldades muutust suletud kooslustest avatud kooslusteks. Eri komplekside sektordiagrammidest (joon 6) selgub, et kõige paremini väljendab taimkatte muutusi puude-põõsaste (AP) ja rohttaimede (NAP) õietolmu omavaheline suhe. Kui alumises settekompleksis domineerivad puude õietolm ja sõnajalgtaimede eosed, siis ülemises kompleksis on valdav kõrre-

liste (Poaceae) ning kultuurkõrreliste (tüüp Cerealia) õietolm. Kasvab ka muude rohttaimede õietolmu hulk ja mitmekesisus, ulatudes 50 taksonini (joon 5). Kultuurtaimedest leiti odra (*Hordeum*), rukki (*Secale*) ja hariliku tatra (*Fagopyrum esculentum*) õietolmu. Samast kihist (proov C) leitud tatra viljasoomus annab tunnistust selle kultuuri kasutamisest Tartu eeslinna alal. Arheoloogiliste leidude põhjal 14. sajandiga dateeritud kihist on kõige enam leitud ka taimseid makrojäänuseid: kultuurtaimedest veel harilikku kanepit (*Cannabis sativa*) ja unimagunat (*Papaver somniferum*); imporditavatest viljadest viigimarja (*Ficus carica*) seemneid; korjatavatest taimedest metsmaasika (*Fragaria vesca*), hariliku mustika (*Vaccinium myrtillus*), hariliku vaarika (*Rubus idaeus*) ja hariliku pohla (*Vaccinium vitis-idaea*) seemneid, samuti hariliku sarapuu (*Corylus avellana*) pähkleid ning hariliku humala (*Humulus lupulus*) jäänuseid. Taliviljade umbrohtudest tuleb lisaks rukkilillele (*Centaurea cyanus*) ära märkida hariliku äiaka (*Agrostemma githago*) leid. Umbrohtude ja prahitaimede hulka kuuluvad põld-kapsasrohi (*Brassica campestris*), kukeleib (*Setaria* sp.), põld-konnatatar (*Fallopia convolvulus*), kahar kirburohi (*Polygonum lapathifolium*), roomav madar (*Galium aparine*) ja valge hanemalts (*Chenopodium album*). Inimkaaslejatele liikidele, nagu hapu ja väike oblikas (*Rumex acetosa*, *R. acetosella*) ning erilehine linnurohi (*Polygonum aviculare*), lisanduvad õietolmuleidude alusel suur ja keskmine teeleht (tüüp *Plantago major/media*); puju (*Artemisia*), ristõielised (Brassicaceae) ning korvõieliste (Asteraceae) hulka kuuluv tüüp Liguliflorae. Kanarbiku (*Calluna vulgaris*), härgheina (*Melampyrum*) ja *Anemone* tüüpi õietolmu esinemine viitab ümbruskonna maastike mitmekesisusele.

Läbilõike ülemist, söese liivaga kihti (proov A), iseloomustavad tüüpilised inimkaaslejad umbrohud, nagu hanemalts (*Chenopodium album*), vesihaljas hanemalts (*Chenopodium glaucum*), odalehine malts (*Atriplex prostrata*), kõrvenõges (*Urtica dioica*), raudnõges (*U. urens*), valge iminõges (*Lamium album*), vesihein (*Stellaria media*), harilik maavits (*Solanum dulcamara*) ja must maavits (*S. nigrum*). Esinesid ka mõned unimaguna seemned. Liivase pinnase tõttu oli seemnete säilivus halb ja selles kihis polnud säilinud ka õietolmu.

Meetodite võrdlus näitab, et samadest kihtidest saadud andmed kannavad eri infot ja tulemuste kombineerimine võimaldab paremini rekonstrueerida nii ümbritsevat maastikku ning taimkatet kui ka otsustada toidutaimede (nii kultuur- kui looduslike) kasutuse ja päritolu üle. Sellest tulenevalt on oluline võtta lisaks makrojäänuste analüüsiks vajalikele proovidele ka õietolmuproove, ja seda mitte ainult looduslikest kihtidest, vaid ka hästi säilinud keskaegsetest kihtidest ning jäätmekastidest.