Cloister, manor and botanic gardens in medieval and early modern Finland and Sweden

– An archaeobotanical approach to garden history

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2017

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Doctoral Programme in Interdisciplinary Environmental Sciences DENVI

University of Helsinki

ACADEMIC DISSERTATION

To be presented for public examination with the permission of the Faculty of Biological and Environmental Sciences of the University of Helsinki in the Nylander hall at Botanical Museum (Unioninkatu 44), Helsinki, on April 21st 2017 at 12 o'clock noon.

HELSINKI 2017

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Kone Foundation has supported the work

ISBN 978-951-51-2985-7 (paperback)
ISBN 978-951-51-2986-4 (PDF)
http://ethesis.helsinki.fi
Unigrafia
Helsinki, 2017

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LIST OF ORIGINAL PUBLICATIONS AND MANUSCRIPTS

This PhD thesis comprises the following publications and manuscripts, which are referred to in the text by their Roman numerals:

I **Alanko, Teija** & Uotila, Kari (accepted for publication 2015) Gardening and consumption of plants in Naantali cloister (SW Finland) before and after the Reformation. *Journal of Nordic Archaeological Science JONAS*

II **Alanko, Teija** (manuscript) Men in gardens – A brief review of the history of Turku Academy and Helsinki Kaisaniemi Gardens in Finland in the 18th – early 19th centuries.

III **Alanko, Teija**, Oinonen, Markku & Schulman, Leif (2015) Plant remains from the early modern garden of the manor of Kumpula, Helsinki, Finland: an alternative sampling method for macrofossil analysis. *Veget Hist Archaeobot* (2015) 24:571–585, DOI 10.1007/s00334-015-0517-z

IV **Alanko, Teija** (manuscript) An archaeobotanical view on the history of the Uppsala Linnaeus Garden and the Garden of the Academy of Turku.

V **Alanko, Teija** (manuscript) Insights to garden cultivation in the Kaisaniemi site in Helsinki, Finland, in the 18th and 19th centuries through archaeobotanical analyses.

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Original idea	TL / KU	**TIA**, HV	**TIA**	**TIA**	**TIA**
Study design	**TIA**, TL	**TIA**	**TIA**, GT, LS	**TIA**, LH	**TIA**, GT, LS
Sampling	TL, **TIA**	—	**TIA**	**TIA**	**TIA**
Macrofossil analysis	**TIA**, TL	—	**TIA**, TL	**TIA**, TL	**TIA**
Other analyses	MO	—	MO	MO, THA	MO, THA
Manuscript preparation	**TIA**, KU	**TIA,** LS, HV	**TIA,** LS, MO	**TIA**, LS	**TIA**, THA

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Cover illustration: *Datura stramonium* (Grotenfelt 1915)

ABSTRACT

Archaeobotany is a field of science that combines botany, archaeology and history, and concentrates on useful plants and the interactions between humans and plants in the past, including horticulture. Garden history has been studied in Finland mainly through historical references, but not much with archaeological or archaeobotanical methods, although the importance of multidisciplinary work has been noted. Archaeobotany should be applied, because written sources available are often not sufficient. Records of plant species probably originating from garden cultivation are known from Finnish macrofossil analyses, but garden soils themselves have not been investigated much. The interpretation of archaeobotanical material, obtained from soil samples, i.e. macrosubfossil plant remains, is connected to archaeological and historical contexts. Excavations are, however, often restricted for practical reasons, therefore determining sites for macrofossil analyses. An alternative sampling method may be one solution to carry out macrofossil studies in sites unlikely to be excavated, such as historical gardens.

The overall goal of this study was to elucidate a part of Finnish and Swedish garden history by means of archaeobotany. A specific aim was to test archaeobotanical sampling in gardens in the absence of excavations with an end-filling open-ended sampler and applying AMS-radiocarbon dating. The research comprises four case studies from five different sites: 1) the former Naantali Cloister and the cloister church, Finland; 2) Kumpula Manor, Helsinki, Finland; 3) Uppsala Linnaeus Garden, Sweden; 4) the former Turku Academy Garden, Finland; and 5) Kaisaniemi Botanic Garden, Helsinki, Finland. These garden sites are partly linked to each other through their historical context, in the period from the 15th century to the 21st century. All of them existed in the period when Finland was part of the Kingdom of Sweden.

Soil samples for macrofossil analyses were collected in Uppsala, Turku and Helsinki with an end-filling open-ended sampler from different levels from narrow pits, one by one in vertical series. The samples of Naantali came from archaeological excavations. The samples were floated and sieved in the laboratory, and macrofossil remains were identified and counted.

Altogether 8,404 macrofossil plant remains belonging to 154 plant taxa were obtained from five different study sites. In total 30 AMS-radiocarbon dates were measured from seeds, charred grains, and pieces of charred wood. Within these dates ^{14}C ages and calibrated calendar years varied widely. The oldest dates were obtained from charred wood (1120–920 cal BC), but seeds and grains also gave quite old results in these garden contexts, from Swedish and Finnish medieval period (cal AD 1420–1475, cal AD 1255–1390, respectively). Younger dates were drawn out to a wide range (e.g. cal AD 1648–present), the youngests being modern.

Macrofossil plant remains included cereals, berries, ornamental and medicinal plant species, and also some garden plants, and cultural or garden weeds. These indicated both consumption and garden cultivation at the sites, as did other soil contents, such as fish scales and chips of wood and charcoal, referring to fertilization and thus gardening. The sampling method proved to work reasonably well, having both benefits and limitations compared to sampling from excavations. Sampling was not dependent on excavated areas and could be done independently, relatively quickly by one person, as a parallel method to the shovel-test-pits, yet aiming on macrofossils only. Sampling did not disturb the plantings and the other use of the areas. On the other hand, the maximum size of a sample was limited, although larger samples could have yielded more macrofossils and different species. The absence of an archaeological context inflicted the necessity of written sources for the background, but in these case studies of historical gardens, the literature gave historical contexts well enough.

It is concluded that garden history can and should be studied with both written sources and archaeological and archaeobotanical methods. Informative macrofossil sampling can be carried out both in connection with archaeological excavations and without them straight from garden soil. Extensive plant lists from sites, when these exist, bring most of the information concerning species grown at the sites, but they do not expose plants consumed or having grown as garden weeds in the areas. However, quite few species of those that were mentioned in

the plant lists were obtained as macrofossils in this study. This is perhaps due to the relatively poor state of preservation of the seeds in garden soil, and the probable scarce accumulation of seeds of cultivated species into the garden soil from the outset. Also, the small areas sampled in the gardens compared to the large areas of the sites may have caused the small assortment of plants compared to all the species grown in the areas. Nevertheless, in sites with no such comprehensive literature of cultivated species, archaeobotany revealed valuable information of plants that could not be gained otherwise. Other remains than plant macrofossils (e.g., fish scales and chips of charred wood), obtained from soil samples, indicated gardening as well. As for the case of Naantali Cloister, it showed the importance of searching remains of garden plants also from structures outside of gardens.

TIIVISTELMÄ

Arkeobotaniikka eli kasviarkeologia on tieteenala, joka yhdistää kasvitieteen, arkeologian ja historian, ja joka keskittyy hyötykasveihin sekä ihmisten ja kasvien vuorovaikutukseen menneisyydessä. Tähän vuorovaikutukseen sisältyy myös puutarhakulttuuri. Suomalaista puutarhahistoriaa on tutkittu pääasiassa historiallisista lähteistä, mutta ei kovinkaan paljon arkeologisten tai arkeobotaanisten menetelmien, kuten makrofossiilianalyysin, avulla, vaikka monitieteisen tutkimuksen tärkeys on tiedostettu. Arkeobotaniikkaa tulisikin soveltaa puutarhahistorian tutkimuksessa, sillä saatavilla olevat kirjalliset lähteet eivät useinkaan ole riittäviä. Suomalaisten makrofossiilianalyysien perusteella on saatu tietoja kasveista, jotka todennäköisesti ovat peräisin puutarhaviljelystä, mutta puutarhojen maaperää on tutkittu arkeobotaanisesti vain vähän. Maanäytteistä saatavan arkeobotaanisen materiaalin eli makrosubfossiilisten kasvijäänteiden tulkinta linkittyy arkeologiseen ja historialliseen kontekstiin. Arkeologisia kaivauksia rajoittavat usein kuitenkin käytännön syyt, mikä vaikuttaa myös niiden kohteiden valintaan, joista voidaan päästä tekemään makrofossiilianalyysejä. Yksi ratkaisu tähän voi olla vaihtoehtoinen menetelmä maanäytteiden keräämiseen. Näin makrofossiilianalyysejä voidaan tehdä myös kohteista, joihin ei todennäköisesti saada arkeologisia kaivauksia, kuten historiallisista puutarhoista.

Tämän tutkimuksen kokonaistavoitteena oli valottaa Suomen ja Ruotsin puutarhahistoriaa arkeobotaniikan avulla. Erityisenä tavoitteena oli testata arkeobotaanista näytteenottomenetelmää, jossa käytettiin ns. lapiokairaa maanäytteiden ottamiseen puutarhoissa ilman arkeologisia kaivauksia, sekä sovellettiin AMS-radiohiiliajoitusmenetelmää. Tutkimus koostuu neljästä tapaustutkimuksesta viideltä eri kohteelta, joita ovat: 1) entinen Naantalin luostari ja luostarikirkko Suomessa; 2) Kumpulan kartano Helsingissä Suomessa; 3) Uppsalan Linnén puutarha Ruotsissa; 4) entinen Turun akatemian puutarha Suomessa; ja 5) Kaisaniemen kasvitieteellinen puutarha Helsingissä Suomessa. Kohteet linkittyvät osittain toisiinsa historiallisten kontekstiensa kautta, ja kattavat ajanjakson 1400-luvulta 2000-luvulle. Kaikki tutkitut kohteet olivat olemassa aikakautena, jolloin Suomi kuului Ruotsin valtakuntaan.

Maanäytteet makrofossiilianalyysejä varten kerättiin Uppsalassa, Turussa ja Helsingissä pohjasta täyttyvällä, päästä avoimella näytteenottimella eli ns. lapiokairalla, siten että kapeista kuopista otettiin näytteitä yksitellen eri kerroksista vertikaalisissa sarjoissa. Naantalissa näytteet kerättiin kirkon arkeologisilta kaivauksilta. Kaikki näytteet kellutettiin ja seulottiin laboratoriossa ja makrofossiiliset kasvi- ja muut jäänteet määritettiin ja laskettiin.

Tutkimuksessa löydettiin viideltä eri tutkimuskohteelta yhteensä 8404 makrofossiilista kasvijäännettä, jotka kuuluivat 154 kasvitaksoniin. Löydetyistä makrofossiilisista siemenistä, hiiltyneistä jyvistä ja pienistä hiiltyneen puun lastuista mitattiin kokonaisuudessaan 30 AMS-radiohiiliajoitusta. Näissä ajoitustuloksissa sekä ^{14}C –iät että kalibroidut kalenterivuodet vaihtelivat laajalti. Vanhin ajoitus saatiin hiiltyneestä puusta (1120–920 cal BC), mutta myös siementen ja jyvien ajoitustulokset näissä puutarhakonteksteissa olivat suhteellisen vanhoja, ruotsalaiselta ja suomalaiselta keskiajalta (cal AD 1420–1475, cal AD 1255–1390, tässä järjestyksessä). Nuorimmat ajoitustulokset venyivät laaja-alaisiksi (esim. cal AD 1648–nykyaika), nuorimpien ollessa moderneja.

Makrofossiilisissa kasvijäänteissä oli viljoja, marjoja, koriste- ja lääkekasvilajeja, sekä joitakin puutarhakasveja ja kulttuuri- tai puutarharikkaruohoja. Nämä löydöt indikoivat sekä kasvien käyttöä, että puutarhaviljelyä tutkituilla kohteilla. Myös muut maanäytteiden sisältämät jäänteet, kuten kalojen suomut ja pienet hiiltymättömän ja hiiltyneen puun lastut, jotka viittasivat maan lannoitukseen, olivat näin ollen osoituksena puutarhanhoidosta alueilla. Näytteen-

ottomenetelmä osoittautui kohtuullisen toimivaksi, vaikka sillä oli etujen lisäksi rajoituksia verrattuna näytteenottoon kaivauksilta. Näytteenotto lapiokairalla ei ollut riippuvaista arkeologisten kaivausten rajaamista alueista ja saatettiin toteuttaa itsenäisesti, suhteellisen lyhyessä ajassa yhden henkilön toimesta, kuten vastaavasti koekuopitus arkeologisena menetelmänä, joskin tässä työssä tavoitteena oli makrofossiilien löytäminen. Näytteenotto ei juurikaan häirinnyt kohteiden istutuksia tai alueiden muuta käyttöä. Toisaalta, näytteiden maksimikoko oli rajoitettu, vaikka suuremmat näytteet olisivat voineet sisältää enemmän sekä makrofossiileja että eri lajeja. Koska arkeologista kontekstia ei ollut käytettävissä, kirjalliset lähteet olivat välttämättömiä kohteiden tutkimuksellisen taustan muodostamiseksi. Näissä historiallisten puutarhojen tapaustutkimuksissa kirjallisuus tarjosi riittävän hyvän historiallisen taustan.

Tutkimuksen johtopäätös on, että puutarhahistoriaa voi ja tulisi tutkia sekä kirjallisista lähteistä että arkeologisilla ja arkeobotaanisilla menetelmillä. Informatiivisen makrofossiilimateriaalin kerääminen voidaan toteuttaa sekä arkeologisten kaivausten yhteydessä, että ilman näitä suoraan puutarhamaasta. Kattavat kasvilajilistat niistä kohteista, joista näitä on saatavilla, antavat suurimman osan kohteilla kasvaneita kasveja koskevasta informaatiosta, mutta eivät paljasta tietoa näillä paikoilla hyödynnetyistä lajeista, tai niistä, jotka ovat kasvaneet alueilla puutarharikkaruohoina. Kuitenkin jokseenkin harvat lajit niistä, jotka mainittiin kasvilistoissa, löydettiin tässä tutkimuksessa makrofossiileina. Tämä johtuu mahdollisesti siementen suhteellisen huonosta säilyvyydestä puutarhamaassa, ja todennäköisesti viljeltyjen lajien siementen niukasta kertymisestä puutarhamaahan alun alkaen. Lisäksi se, että näytteitä kerättiin puutarhoissa pieniltä alueilta verrattuna kohteiden kokonaislaajuuteen, saattaa aiheuttaa suppean kasvilajivalikoiman verrattuna kaikkiin alueilla kasvaneisiin lajeihin. Kuitenkin kohteilla, joista vastaavaa kattavaa kirjallisuutta viljellyistä lajeista ei ollut saatavilla, arkeobotaniikka paljasti kasveista arvokasta tietoa, jota ei olisi muuten saatu. Myös muut maanäytteistä löytyneet jäänteet kasvimakrofossiilien lisäksi indikoivat puutarhanhoitoa. Naantalin luostarin tapaustutkimus puolestaan osoitti, että on tärkeää etsiä puutarhakasvien jäänteitä myös puutarhojen ulkopuolisista rakenteista.

SUMMARY

INTRODUCTION

Definition of a garden

Defining a certain landscape as a garden could be a simple task but at the same time a complicated one. As Humphry Repton (1752–1818), the great English landscape designer put it: 'A garden is a piece of ground fenced off from cattle and appropriated to the use and pleasure of man: it is, or ought to be, cultivated' (Turner 2005). Malek (2013a) describes gardens in wider terms: 'Gardens constitute a specific ecological system demanding constant human monitoring, including interactions between human and nature, implying the very idea of gardening. Gardens are places carefully set apart from surrounding environment; perfected nature according to a specific cultural view.' Jashemski understands a garden extensively as an open, planted and cultivated area, which have been in connection to many parts of people's everyday life; this includes ornamental and pleasure gardens, fruit and vegetable gardens, and vineyards as well (Malek 2013b). More narrow interpretation is needed with kitchen gardens, which have been located close to the settlement and have been used for small-scale cultivation; they are defined as being delimited with boundary and cultivated (Rohde Sloth et al. 2012).

People living in a natural landscape, in more or less permanent dwelling sites, in the past, presumably gradually started to plant selected species on land near their dwellings, which would have resulted in a primitive garden. People in the past managed vegetation surrounding their settlements, and the construction of gardens shaped landscapes of wild and cultural areas. In the beginning of the cultivation of plants people must have founded vegetable gardens near their dwellings (see Jones 2005; van der Veen 2005). Transferring useful plants from nature to settlements might have been possible even before cultivation from seeds, concerning for example edible root and leaf plants. This vegetable cultivation might have preceded cereal cultivation. Still, later on, the difference between a field and a garden could have been unclear. Earlier cereal fields were not as monotypic as today, and as for gardens, not as many species as now were grown. Thus, past fields and gardens may not be distinguished according to the diversity of a cultivated place. However, a garden to a particular culture could have been a field to another, and in general, in a kitchen garden several species were grown, while in a field fewer, or even only a single crop, although it may have had its weeds with it (Rohde Sloth et al. 2012).

Defining a historical garden is another task (see, e.g., The Florence Charter 1981 Historic Gardens, ICOMOS [International Council on Monuments and Sites]; Sinkkilä 1992a, 1992b; Galletti 2013). A garden of hundreds of years old could be considered a living historical monument, although only old trees could be original while other vegetation has changed, but still, plant specimens may be offspring of original ones. A historical garden that has been kept as it originally was designed could be esteemed as a valuable cultural heritage.

Past gardens, as created landscapes, small or large, have not been just plots for useful economical cultivation or sceneries in a landscape. Past gardens have not been only vegetable, spice or fruit gardens for economical use, or only aesthetic constructions for beauty and pleasure. Gardens have been very tiny or grandiose oases combining these elements, in the middle of constructed cultural environment. And yet, gardens have also been much more. They have been reflections of eras, measuring and exhibiting economic situations of certain periods, impacted by different kinds of climatic periods; they have been theatres of political power, and indicators of development of science, botany and medicine; gardens have been signs of journeys of exploration, colonialism and globalisation.

Archaeobotany

Archaeobotany is a field of science that is usually connected directly to archaeology through excavations, and it may be defined as a part of environmental archaeology. A comprehensive review of the development of archaeobotanical research is given by Larsson (2015). The study material of archaeobotanical investigations, macro(sub)fossil plant remains, for example seeds, derive from soil samples that are typically collected from archaeological excavations, but soil samples can be obtained and studied in geological environmental soil sciences as well. Further, e.g. pollen analysis can be included in archaeobotanical methods. Archaeobotany of historical times, as its own field, combines botany, archaeology and history, and it concentrates on the history of useful plants and interactions between humans and plants in the past. The aim is to understand relationships between humans and the environment, past diet, cultivation and horticulture, economy and everyday life (Branch et al. 2005). The interpretation of plant remains is connected to archaeological and historical contexts. In archaeobotanical research concerning gardens and the definition of a garden, kitchen gardens and other small, limited garden areas with fences or other boundaries may be more relevant than large landscape gardens that may not have visible borders, although large elite pleasure gardens may gain from archaeobotanical studies as well.

Research on garden history, garden archaeology and archaeobotany in Finland and Scandinavia

Garden history

Garden history has been studied in Finland mainly through historical references in the fields of history (e.g., Suolahti G. 1912; Melander 1921), art history (Knapas 1988), landscape architecture (Sinisalo 1997), botany (Parvela 1930), dendrology (Väre et al. 2008), and to some extent in horticultural sciences (Lindén et al. 2010). Extensive cross-sections of Finnish gardens and their plants through time have been written according to interpretations of written sources and drawn maps and plans (Häyrynen et al. 2001; Ruoff 2001); e.g., letters of garden owners and users, account books and well-documented design processes of gardens have been studied (Häyrynen 2001; Liski 2001). Landscaping schemes have also provided evidence of past gardens, although they did not necessarily actualise as they were planned (Häyrynen 2001; Häyrynen et al. 2001; Ruoff 2001). Paintings of contemporary artists have provided an insight into past gardens too, but not definitely reliable (e.g., Ruoff 1993). Detailed descriptions of specific places have been published, e.g., the parks and gardens in Louhisaari Manor in southwest Finland (Frondelius 2005), in Fagervik Manor in Uusimaa in southern Finland (Lounatvuori 2004), and in the estate of Monrepos in Vyborg, in former eastern Finland but now belonging to Russia (Ruoff 1993). Written sources from the 17th century onwards include lists of plant species in gardens (Rudbeck 1666; Tillandz 1673; Linné 1748; Mollin 1779; Juel 1919). It is still sometimes difficult to interpret the actual species from these lists, particularly before Carl Linnaeus' time, and different interpretations of species may occur (see e.g., Kerkkonen 1936; Kari 1940; Ruoff 2001; Martinsson & Ryman 2007). The flora of Finnish gardens has been illustrated with lists of plant species in different periods (e.g., Hämet-Ahti 1992; Alanko P. 2001). In addition, an art historical dissertation concerning Finnish garden history in the turn of the 20th century has been published recently (Donner 2015).

Garden archaeology and archaeobotany

Garden-archaeological or archaeobotanical methods have not been involved much in garden history research in Finland, although the importance of multidisciplinary work was noticed in the 1990s. Luppi (2001a, 2001b, 2001c) and Lempiäinen (1997a, 2002a, 2002b) carried out and presented a few Finnish case studies applying garden archaeology including archaeobotany. Häyrynen (1993a, b) and Rosengren (1995) wrote about investigation methods used in other countries that could be applied in Finland too. Hemgård (1992) and Sinkkilä (1992a) noted archaeology as a part of restoration and reconstruction processes of historical gardens.

Scarce garden-archaeological excavations began in Finland in 1996 continuing with six excavated sites by 2005 (Luppi 2001a; Sutinen 2005a, 2005b). These included manor and parsonage gardens from the 15th-18th centuries and a 19th century park; in Uusimaa, Turku, Helsinki and Ostrobothnia (Härö & Piispanen 2001; Karisto 2001; Luppi 2001a, 2001b, 2001c; Niukkanen 1998; Sutinen 2005a; Uotila & Lehtonen 2004). Excavations varied from a small-scale and test pits and ditches to larger excavated areas. Investigations were targeted for example at a kitchen garden plot, a former orangery, a fruit garden and a hop garden. In four of these six garden excavations, macrofossil analyses were carried out too (Lempiäinen 1997; 1998b; 1999a; 1999b; 2002a; 2002b). Some other archaeobotanical analyses of Finnish manor gardens have also been conducted (Lempiäinen 1998a, 2000, 2002c; Rosengren 2001). A more recent case study that revealed a whole garden plot is from large excavations in Lahti from 2013 (Alanko T. & Lempiäinen-Avci forthc.). In contrast, in other countries in Europe than in Finland, garden archaeological or archaeobotanical studies have been more frequent (Currie & Locock 1991; Dickson C 1994; Dickson J. H. & Mill 1994, Moe et al 1994, de Moulins & Weir 1997; Sandvik 2000, Sillasoo 2002, Viklund 2002, Malek 2013c).

Although not targeting precisely Finnish garden history, archaeobotanical research in Finland has revealed macrofossil remains of garden plants from old town areas, indicating cultivation of garden species. For example, a rare find of *Daucus carota* (carrot) was obtained from medieval layers of Turku (the old capital of Finland) (Lempiäinen 2007); *Pastinaca sativa* (parsnip) was found in abundance from the medieval Bishop's Castle in Kuusisto, near Turku (Lempiäinen 1994); both *D. carota* and *P. sativa* were also present in early modern layers in Helsinki City Centre (Alanko T. 2016); remains of *Anethum graveolens* (dill) and *Carum carvi* (caraway) came from the 15th century Turku Castle (Aalto 1994), and *A. graveolens* also from the Kellomäki site near the 16th century Helsinki Old Town (Onnela 2000); and *Levisticum officinale* (lovage) and *Petroselinum crispum* (parsley) have been found in sites in old Turku (Lempiäinen 2007). However, large garden environments have not been widely studied in Finland archaeologically. Hence, garden structures have not been uncovered or soil analyses have not been enabled, which would include macrofossil analyses or other natural-scientific analyses from garden soils.

Archaeobotanical methods – plant macrofossil and pollen analyses from garden soil – can reveal evidence of plants cultivated in a garden or of garden weeds (Murphy & Scaife 1991; Halvorsen 2012). Firstly, on a wider scale, macrofossil plant remains have even revealed a part of the transition in the human past both in the Old World and the New World sites from gathering plants to cultivation and gardening (Horrocks 2013). Research concerning younger subjects and special case studies has exposed macrofossils of garden species, for example in an archaeological investigation in the Ner-Killingberg garden site in Norway (Guldåker 2014a; Heimdahl 2014a). In Finland, macrofossils of garden plants and cultural weeds have been obtained for example in garden sites in Suomenlinna Fortress, Suitia Manor, Roselund parsonage and Fagervik Manor (Lempiäinen 1997, 1999a, 1999b, 2002a, 2002c, respectively). Still, macrofossils of garden plants are not necessarily discovered from spots where they grew, but from excavated household spots where they were used (e.g., Heimdahl & Lindeblad 2014). Gardening has been studied through micro- and macrofossil analyses from pollen and seeds, but mostly remains of garden plants have been searched and found in structures outside of gardens. In a study from medieval St Olof Dominican monastery in Sweden, macrofossils of herbs, medicinal plants, berries and beer additives from a kitchen floor and waste pit storages demonstrated what was consumed, and also most probably cultivated there (Lindeblad 2010; Lindberg & Lindeblad 2013; Menander & Arcini 2013). Lindeblad (2010) has demonstrated the potential of garden archaeology in garden studies in other investigations of cloisters in Sweden too. Further, another noteworthy project was garden archaeological and archaeobotanical groundwork for reconstruction in the garden of Spydeberg's parsonage in Norway (Guldåker 2012; 2014b; Heimdahl 2014b; Eggen 2015). The investigation of Tycho Brahe's garden in the island of Ven in Sweden, included excavations, reasoning and planning, and reconstruction, and illustrated challenges of such initiatives, but also demonstrated the need for interdisciplinary work (Lundquist 2004). The garden history case of the Milde estate in Norway had a starting point of multidisciplinary studies with natural-scientific methods, including archaeobotany and genetics, and it succeeded well in targeting restoration of the garden (Moe et al. 2006). Written sources and maps were used as a background of a kitchen garden laid out in 1681 at Strömsholm Castle in Sweden, in a case study, which was aiming to advance garden archaeology by considering different archaeological methods in order to demonstrate practical assemblages of methods (Frost et al. 2004). Still, garden archaeology is quite a young field both in Finland and in Scandinavia (Andréasson et al. 2014).

Garden history research benefits from archaeology and archaeobotany

Some historical gardens in Finland have been interpreted and restored to what they were in the 18th or 19th centuries, not to what they might have been earlier. This arises from a scarcity of documents or a complete lack of information of some earlier gardens, and the problem could be solved at least partly by archaeological and archaeobotanical investigations (e.g., Härö & Piispanen 2001). Yet, resources for garden archaeological excavations of old gardens have unfortunately usually been too limited (e.g., Härö & Piispanen 2001). It is assumed that medieval gardens existed in Finland, for example in Kuusisto Castle, Naantali Cloister, Louhisaari Manor and Suitia Manor (Härö & Piispanen 2001; Ruoff 2001; Lempiäinen 2003; Uotila et al. 2003; Uotila 2004; Frondelius 2005). However, only few written sources of Finnish medieval gardens exist. The first written document of a garden in Turku Castle is from 1463, when a meeting led by the Swedish King was held in a 'cabbage garden', presumably a proper garden for the King to be seated (Klockars 1979). The garden of Turku Castle is recorded several times in the 16th century, and also a list of medicinal plants cultivated in the castle's herb garden in the late 16th century exists (Peldán 1967; Uotila 1994; Sinisalo 1997; Ruoff 2001). Still, these references do not reveal much of the garden and its plants. No precise descriptions or identified physical remains exist, except the stonewall of the garden (Sinisalo 1997; Häyrynen 2001).

The problem of lacking information may be even bigger concerning assumptions of small gardens in towns and rural sites in Finland, from which documents may be impossible to find. Further, as an issue of defining a garden, some references may ignore kitchen gardens, as being uninteresting and stating that no garden existed, just a plot for cabbage (*Brassica oleracea*) or hop (*Humulus lupulus*) (e.g., Melander 1921). The history of garden art has slightly overlooked small modest garden plots used for consumption purposes, and understandably focused more on garden art, rather than on actual horticulture (see e.g., Knapas 1988). However, these different strands, gardening as a habit and gardening as art, necessity and private pleasure, were not that far from each other in the Middle Ages (Johnson 1990). Kitchen gardens may have been as beautiful and refreshing environments for people living near them as large landscape gardens to their owners and inhabitants. This illustrates the necessity to study archaeologically medieval or even early modern gardens, of which written descriptions do not exist.

Thus, the potential of archaeology and archaeobotany in garden history research is quite evident. In Sweden, archaeobotanical analyses have revealed small garden plots and kitchen gardens, older than were expected on the basis of written sources, and hidden medieval urban gardens too (Heimdahl 2010a; Andréasson et al. 2014; Heimdahl & Lindeblad 2014). Furthermore, the knowledge of garden history has changed through archaeobotany and archaeology in Sweden, for example revealing Viking Age gardening, and thus history has been rewritten (Heimdahl 2010a; Heimdahl & Lindeblad 2014).

Archaeobotanical studies should be included in garden history research, because written sources available are not enough. Although lists of plants exist, e.g., of botanic gardens, these are not always comprehensive, and are available only from some gardens. The important knowledge of specific plant species and gardening, especially in the oldest sites, needs archaeobotany. Archaeobotany is a rather essential part of garden archaeology too, and in most cases, garden research should not be carried out without it, since the history of gardens is definitely in strict connection to plants themselves. Studies combining all research fields would be valuable to create a comprehensive view of past gardens. Gardens are challenging to study because of their on-going change. With remains of plants in soil, some moments in the changing gardens can be caught, and through chronological snapshots, longer phases of gardens may be demonstrated.

AIMS AND RESEARCH QUESTIONS

The overall goal of this thesis is to elucidate a part of Finnish and Swedish garden history, and to search for plants of cloister (Chapter I), manor (III) and botanic (II, IV, V) gardens, in the context of the development of gardens and horticulture, by means of macrofossil analysis and with historical knowledge. The time frame is from the late Finnish Middle Ages to the early modern period (the 15th–19th centuries), mainly at the time when Finland was part of the Kingdom of Sweden.

The aims of this study are to evaluate the advantages of a multidisciplinary approach to garden history and thus the potential of archaeobotany in garden history research, and especially to test archaeobotanical sampling in gardens in the absence of excavations with an end-filling open-ended sampler (III, IV, V) and applying AMS-radiocarbon dating (I, III, IV, V). The possibilities for archaeological research may set limitations on where archaeobotanical investigations can be carried out. Excavations are often restricted for practical reasons, therefore determining the sites for macrofossil analyses. Thus, a sampling method that could be used without excavations is considered in this study as one solution to carry out macrofossil studies in sites unlikely to be excavated, such as historical gardens. In addition, a case study searching for garden plants from excavated site (I) through ordinary sampling and macrofossil analysis was also included in this study as a more conventional method of archaeobotany together with the tested sampling.

Macrofossils were collected in garden sites where no former macrofossil analyses had been carried out, and results were interpreted in the historical contexts of the sites. The flora of the past gardens, and plants that were cultivated or that grew wild and those that were consumed at the study areas were observed. Furthermore, a brief literature review of the Finnish garden history was conducted (II) to form a historical context to some of the study sites.

Research questions are

- What is the role of archaeobotany in garden history research
- In what extent sampling without excavations can reveal macrofossil plant remains in gardens
- Can macrofossil plant remains be found of plants that are known to have been growing in the selected gardens
- In what accuracy AMS-radiocarbon dates of macrofossils can demonstrate the age of plant remains and thus periods of activity in gardens

MATERIAL AND METHODS

Study sites

This thesis comprises four case studies focusing on five different study sites (Fig. 1): Naantali Cloister church in Finland (I), Kumpula Manor in Helsinki, Finland (III), Uppsala Linnaeus Garden in Sweden (IV), the former garden of Turku Academy in Finland (IV) and Kaisaniemi Botanic Garden in Helsinki, Finland (V). These garden sites are partly linked to each other historically and through individuals working in them (II, IV, V). The oldests were founded in the 15th century, and the discussion of the youngest reaches the 19th century in this study. Four of the garden sites are in present-day Finland and one in Sweden, but all of the gardens existed in the period when Finland was part of the Kingdom of Sweden (from approx. 12th century till 1809).

Fig. 1. Five different study sites, one in Turku, one in Naantali and two in Helsinki in Finland, and one in Uppsala in Sweden.

The sites were chosen on the following grounds. Naantali Cloister church (I), the oldest site with an assumed medieval cloister garden, could presumably demonstrate quite early gardening of historical times, and thus was a good starting point to cases of Finnish garden history. In addition, the Naantali case was an example of conventional archaeobotanical sampling from archaeological excavations. Another premise was the history of botanic gardens. The first of them in Finland was the garden of Turku Academy (IV) followed by Kaisaniemi Botanic Garden (V), while the former garden of Uppsala University (IV) was the catalyst for the Turku Garden. Although the history of Kumpula Manor (III) is older than the gardens of Turku and Uppsala, the actual garden in Kumpula is, according to the literature, the youngest of the gardens studied here. In addition, Kumpula Manor Garden served as an example of Finnish manor gardens, which have an important role in Finnish garden history. The five sites are presented below in the order of the history of their existence.

Naantali Cloister church, Finland (I)

The medieval Birgittine cloister of Naantali (Nådendal in Swedish) in southwest Finland (60°28’16”N 22°00’57”E) had a relatively short period of activity, but it still was important in the history of Finnish and Swedish cloisters, and the late medieval Finnish society (Uotila et al. 2003; Fig. 2). The Catholic cloister for both nuns and monks was constructed with the permission and supervision of the Vadstena mother cloister (in Sweden) from 1443 onwards in the period of a warm climate and cultural heyday of southwest Finland (Heino 1983; Uotila 2003, 2011; Salonen 2011). Naantali and Vadstena of the Birgittine Order were cloisters, quite closed communities, while monks of the Dominican and Franciscan Orders in Finland had convents, more open to the society. Convents may have had hospitals for outside people, although there was one such in Naantali Cloister as well. In 1554, in the Reformation period, Naantali Cloister church was turned to Lutheran, but nuns and monks continued the cloister life with an allowance (Suvanto 1976; Knuutila 2009). The last abbess died in 1577

Fig. 2. Naantali Cloister church in 2014. Photograph Teija Alanko.

Fig. 3. Kumpula Manor in 2016. Photograph Teija Alanko.

and the last nun in 1591, and then the Catholic life in the cloister finally ended (Suvanto 1976; Klockars 1979; Knuutila 2009). The cloister most probably had a garden where medicinal and other useful plants were cultivated; the presumption gains support from the existence of a hospital and a burghers' manor house, a nursing home, near the cloister, mentioned in written sources already in 1446 (Masonen 1985; Knuutila 2009, Vilkuna 2011). Another backing for the cloister's garden is a part of an old manuscript, the herbal of Naantali Cloister, which was probably written in Vadstena in the end of the 15th century (Tirri & Tirri 2011; Sigurdson & Zachrisson 2012).

Kumpula Manor in Helsinki, Finland (III)

The Kumpula (Gumtäk in Swedish) farm was established in the late 14th century; the first written reference of Kumpula village is from 1460 (Salminen 2013; Fig. 3). The owner of Kumpula domain was ennobled in 1481, and the manor was officially established (Kerkkonen G. 1965; Salminen 2013). Kumpula village and the manor were located in the vicinity of Helsinki Old Town, which was founded in 1550 at the mouth of the River Vantaanjoki by King Gustav Vasa of Sweden (Heikkinen 1994). The owner families of the manor changed during the centuries. This may be one of the reasons why, according to written sources, a proper, planted park, and an ornamental manor garden was not established until the 19th century (Koivula 2007). In 1893 the city of Helsinki bought the manor and started to rent it out (Schulman 2009). Nowadays the manor is situated in Kumpula Botanic Garden (the location 60°12'08"N 24°57'20"E), which was founded in the area in 1987 and opened to the public in 2009 (Schulman 2009).

Uppsala Linnaeus Garden, Sweden (IV)

In 1655 Olof Rudbeck senior (1630–1702), the professor of medicine and a botanist, established the botanic garden of Uppsala University (59°51'45"N 17°38'04"E; Fig. 4). It was the northernmost botanic garden in the world at the time, and already in 1670 extensive on a European scale (Martinsson & Ryman 2007). Unfortunately gardening suffered from a destructive fire in 1702, at the time when Olof Rudbeck junior (1660–1740) became the director of the garden for the next 39 years (Martinsson & Ryman 2007). In 1741 Carl Linnaeus (1707–1778) became the professor of medicine and the director of the garden and it developed to one of the best of the time (Morton 1999). The garden served at the site until 1802, and is nowadays a reconstruction of Linnaeus' time and called the Linnaeus garden (Martinsson & Ryman 2007).

Fig. 4. Uppsala Linnaeus Garden in 2008. Photograph Teija Alanko.

Turku Academy Garden, Finland (IV)

Students of Carl Linnaeus, Pehr Kalm (1716–1779), the first professor of economy in Turku Academy (Åbo in Swedish), and Johan Leche (1704–1764), professor of medicine, established the garden of Turku Academy in 1757 (the location: 60°27’12”N 22°16’40”E; Fig. 5); in 1778 Carl von Hellens (1745–1820), also a student of Linnaeus, became the director of the garden and worked the number of species in the garden to reach over 2,000 (Kari 1940; Enroth & Kukkonen 1999; Ruoff 2001). The period of utilitarianism in Sweden and Finland influenced gardening strongly in this academic garden (Niemelä 1998). Pehr Kalm cultivated useful plants brought from America, Siberia and the Tartarian area in the academy garden (Kari 1940). Turku Academy Garden operated and served the education in the Academy until the autumn of 1827 when Turku was burnt (Enroth & Kukkonen 1999, Ruoff 2001).

Fig. 5. The site of the former Turku Academy Garden in 2008. Photograph Teija Alanko.

Kaisaniemi Botanic Garden in Helsinki, Finland (V)

In 1763 Hans Henrik Boije, the county governor of provinces Uusimaa (including Helsinki) and Häme (in southern Finland), rented an area of pastureland, later called Kaisaniemi, in Helsinki, for a garden plantation (Pehkonen 1987). Boije established a sizeable economical garden, employing gardener Fredrik Edbom (Hornborg 1950; Arkio 1982; Pehkonen 1987). After Finland had become an autonomous grand duchy of Russia in 1809 and Helsinki the capital of the grand duchy in 1812, the operation of Turku Academy Garden was transferred to Kaisaniemi in 1829 and the new Botanic Garden of the University was established, and officially opened in 1833 (Suolahti 1949; Lemström 1987; Pehkonen 1987; Enroth & Kukkonen 1999). Carl Reinhold Sahlberg had a significant impact on foundation of the new garden (Saalas 1956). The Kaisaniemi Botanic Garden of the Finnish Museum of Natural History still operates at the site (60°10’32”N 24°56’46”E; Fig. 6).

Fig. 6. Kaisaniemi Botanic Garden in 2006. Photograph Teija Alanko.

Natural-scientific analyses

Fieldwork

Soil samples for archaeobotanical macrofossil analyses were collected from five study sites with different methods. From Naantali (I), samples were collected from the archaeological excavations of Naantali church in 1997–98 (Alanko T. 1998). Soil was taken with a spatula from small squares of different layers to small plastic bags, the size of samples differing from 0.2 litre to 7.5 litre (Table 1 and Fig. 7). From Kumpula, Uppsala and Turku (III, IV) samples were collected in 2008, and from Kaisaniemi (V) in 2008 and 2014. In these four sites, no archaeological excavations were carried out, but samples were collected from pits with an end-filling open-ended sampler, 130 cm in length (Fig. 8-13). Sampling for macrofossil analysis without excavations with a sampler, of slightly different kind than here, has been tested in Finland few times before, for example in the park and garden in Suomenlinna Fortress in Helsinki (Lempiäinen 1997; Luppi 2001b). Altogether 174 samples were collected from five different study sites, comprising approximately 188 litres of soil in total (Table 1).

Spots for sampling pits were selected on the basis of old and present-day maps and other source material available. The most untouched and well-preserved places in the areas were chosen. Present sewer, cable and watering systems were avoided. Before using the sampler, all sampling spots were opened with a shovel to remove the very top of the ground.

Soil samples were collected with the sampler one by one, in vertical series from boreholes in the pits, proceeding from the top of the deposit towards the bottom. The samples were taken from 1 to 11 different levels from each pit, varyingly from depths of 8 to 108 cm measured from the ground level. The volume of each sample was approximately 1 litre, which was the size of the sampler's chamber.

In addition, another kind of sampling was tested in Kaisaniemi (V). It became possible to take samples from short (approx. 2m long) test-ditches, opened by an excavator for another purpose in the garden. Samples were collected from the walls of the ditches from two different levels with a small shovel straight to a plastic bag. In Turku (IV), most of the samples were collected with a sampler, but some of the samples were taken with a small shovel straight to a plastic bag.

Table 1. The number of soil samples collected from the five study sites.

Study site	Chapter	Excavation/Sampler	No. of areas/pits	N:o of samples
Naantali	I	Excavation	4 areas	32
Kumpula	III	Sampler	8 pits	38
Uppsala	IV	Sampler	6 pits	34
Turku	IV	Sampler	7 pits	41
Kaisaniemi	V	Sampler	9 pits/ditches	29
Total				174

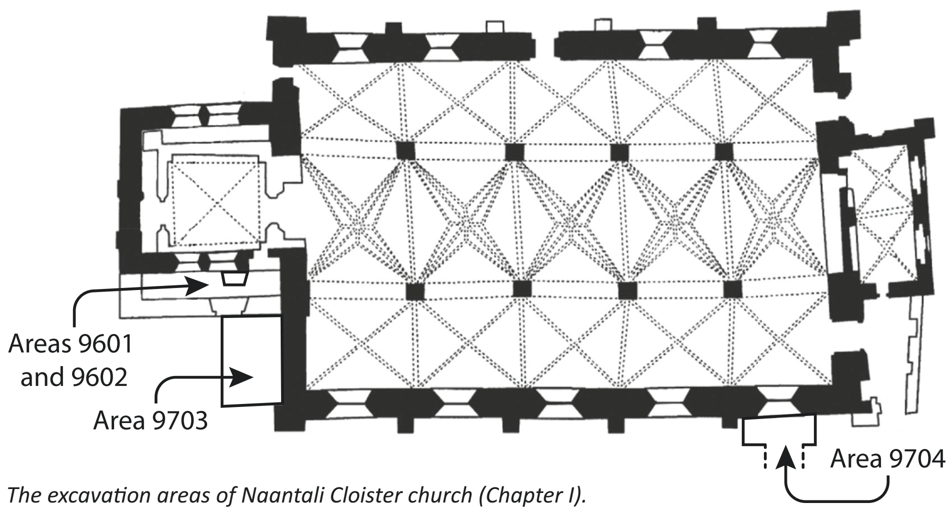

Fig. 7. The excavation areas of Naantali Cloister church (Chapter I).

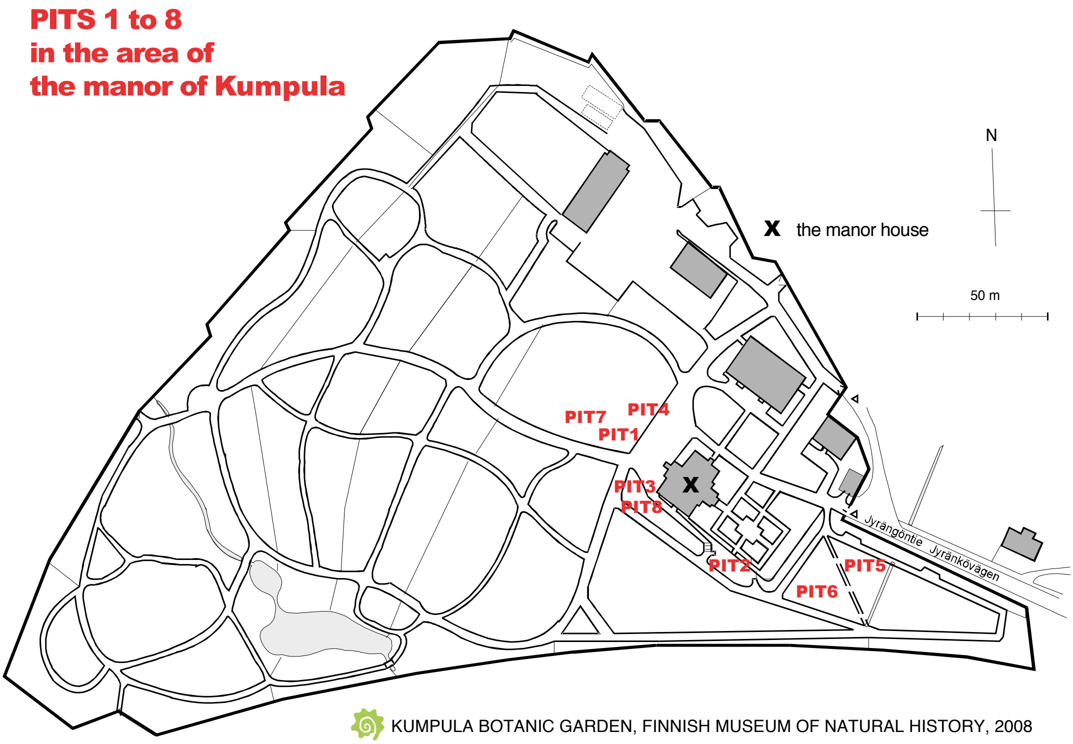

Fig. 8. The sampling pits in Kumpula Manor area (Chapter III).

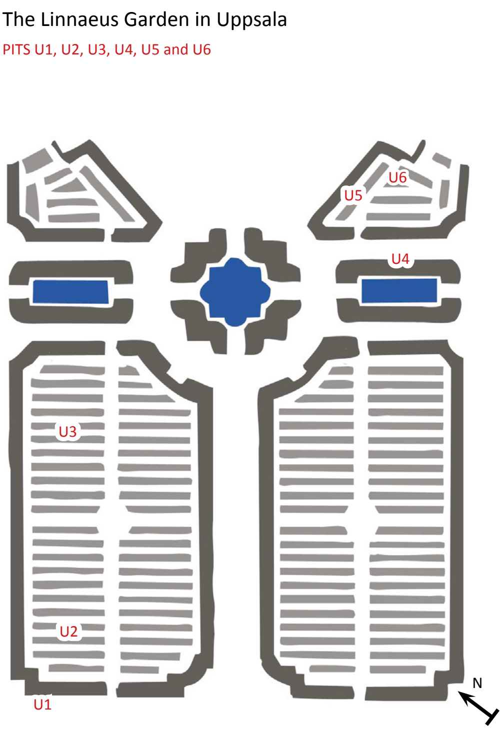

Fig. 9. The sampling pits in Uppsala Linnaeus Garden (Chapter IV).

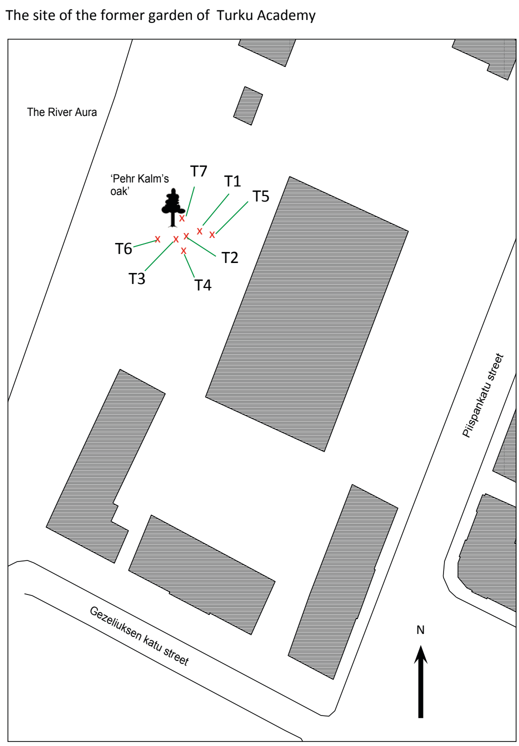

Fig. 10. The sampling pits in the former garden of Turku Academy (Chapter IV).

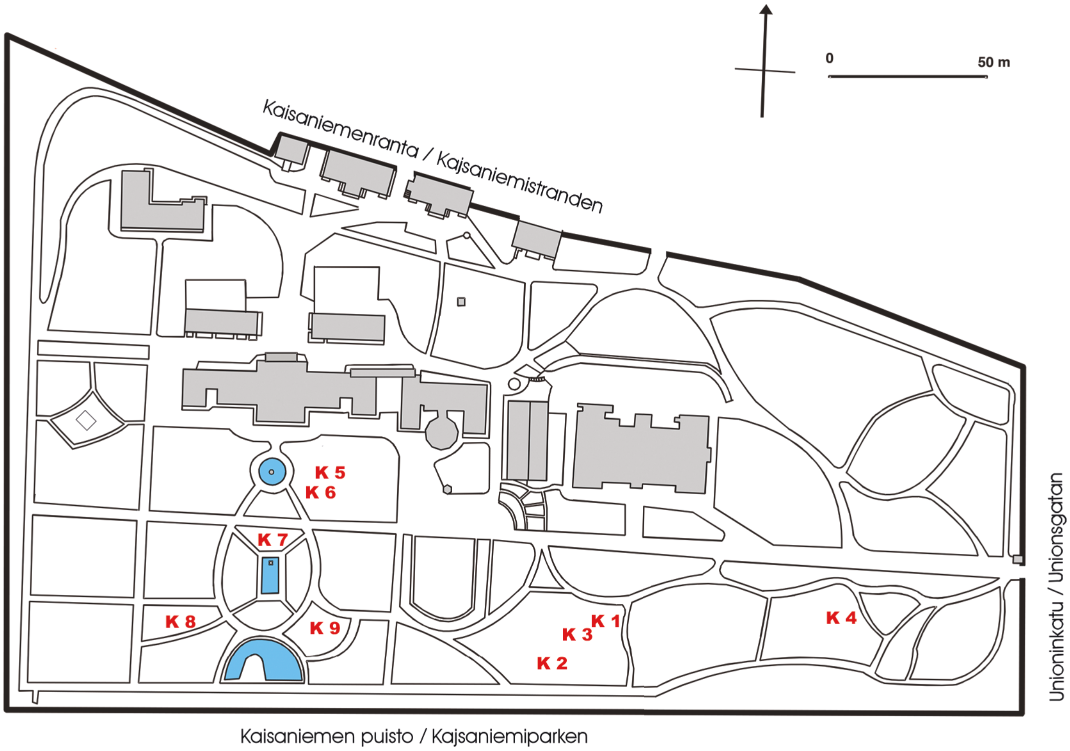

Fig. 11. The sampling pits in Kaisaniemi Botanic Garden (Chapter V).

Laboratory work

Soil samples were floated and washed one by one in a plastic bucket, so that organic material surfaced and was poured into a 0.125 mm or 0.250 mm mesh size sieve and washed under tap water. Part of the samples were floated in saturated NaCl solution (with H^2O:NaCl ratio of 6:1), which has been a custom in Finland (Núnez & Vuorela 1976; e.g., Vanhanen & Koivisto 2014), and the rest in pure tap water, which has appeared to work as well (e.g., Lempiäinen-Avci 2013). Some clayey samples of Naantali were dissolved in KOH-solution first.

Plant remains, mostly seeds, fruits, and their parts, were picked up, identified and counted with the help of a stereomicroscope, seed reference collections (Botanical Museum, the University of Turku; the Finnish Museum of Natural History, the University of Helsinki) and identification literature (Beijerinck 1947; Berggren 1969, 1981; Martin & Barkley 1973; Anderberg 1994; Cappers et al. 2006). In this study the definition 'plant remains' or 'macrofossils' means mainly diaspores, seeds and fruits, and not vegetative parts of plants, with the exception of cone scales and needles of Pinaceae. Thus, and since they were only partly collected and not counted in precise numbers or identified, chips of wood and charred wood are categorized here to other remains, although they actually are macrofossil plant remains. Nomenclature for plant taxa follows Hämet-Ahti et al. (1998, 2005). Some of the plant remains were photographed with a microscope camera or with CT scanning and a systems camera.

Un-charred macrofossils were stored in 50 % ethanol (except those that were AMS-dated, which

Fig. 12. The sampler in Kaisaniemi Garden. Photograph Teija Alanko.

Fig. 13. The Pit 3 in Kumpula Garden, opened and extended with a shovel due to the stones being in the sampler's way. Photograph Teija Alanko.

were stored dry). Charred macrofossils were stored dry. Other remains than plant macrofossils, such as chips of wood and charred wood, insects, sclerotia of Fungi, small animal bones, fish scales and bones, pods of earthworm (*Lumbricus terrestris*) and shells of gastropods were also collected, categorised, partly counted, and stored. Pollen was analysed from 13 subsamples in total from soil samples of Uppsala (IV) and Kaisaniemi (V) gardens by Teija Alenius in Archaeology, the Department of Philosophy, History, Culture and Art Studies in the University of Helsinki. Soil samples that were waiting for laboratory work were stored in a freezer.

AMS-radiocarbon dates

Some of the seeds, charred grains, and chips of charred wood were dated with the accelerator mass spectrometry (AMS) radiocarbon (^{14}C) method in 2013, 2014 and 2015 either by the Laboratory of Chronology in the Finnish Museum of Natural History, the University of Helsinki, or by Poznan Radiocarbon Laboratory.

From Naantali (I), four dates were measured from charred seeds and grains. From Kumpula (III), nine dates were measured from charred grains, un-charred seeds and from chips of charred wood. From Uppsala (IV), three dates were measured from a charred grain, charred seeds and un-charred seeds, and from Turku (IV) three dates from un-charred seeds. From Kaisaniemi (V), 11 dates were measured from un-charred seeds and charred grains.

RESULTS

Plant macrofossils

Altogether 8,404 plant remains and 154 plant taxa were obtained from five different study sites (Fig. 14). The results of five separate macrofossil analyses carried out demonstrate the similarities and differences of the macrofossil finds of the study sites (Table 2). Macrofossil taxa were divided into five different groups according to the use and ecology of plants, since clarifying divisions are common in archaeobotanical studies (see e.g., Karg 2007). The groups are A) garden plants, such as ornamental *Aquilegia vulgaris* (common columbine), useful plants, such as cereals and medicinal *Datura stramonium* (thorn apple), which is also an ornamental garden plant, and collected wild plants, such as *Vaccinium*-species, B) cultural weeds and field weeds, C) trees and shrubs, D) meadow plants, and E) wetlands plants and waterside plants. However, the division is artificial, since many species can belong to many groups, for example cultural weeds, such as *Spergula arvensis* (corn spurrey) and *Stellaria media* (chickweed) could also be collected and useful plants, not only weeds, regarding on the context, and for example *Sambucus*-species, here in the group trees and shrubs, could be in garden plants and useful plants. Some of the identifications of taxa are simplified here in Table 2 (e.g. some uncertain 'cf.' identifications are regarded as certain and counted together with the same taxa without 'cf.'), but all the original identifications in detail are available in the separate papers and manuscripts. In the four case studies, Kumpula, Uppsala, Turku and Kaisaniemi, plant remains found were mainly un-charred, but also some charred seeds and cereal grains were found. In the case study of Naantali, a large share of all macrofossils, 83%, were charred.

From 32 soil samples obtained from Naantali Cloister church (I), 4,561 plant remains were found, comprising 94 different plant taxa. The most dominant species was *Fragaria vesca* (wild strawberry; group A) with 2,416 seeds, 2,266 of them charred. Other taxa from Naantali were for example *Juniperus communis* (juniper; 216 remains; group C), *Empetrum nigrum* (crowberry; 191 seeds; group E), *Sorbus aucuparia* (rowan; 68 seeds; group C), Cerealia (cereals; 32 grains; group A) including *Avena sativa* (oat), *Hordeum vulgare* (barley) and *Secale cereale* (rye), and *Vaccinium* species (50 seeds; group A).

From 38 soil samples obtained from Kumpula Manor garden (III), 2,036 plant macrofossils were found. These comprised 63 different taxa. The most

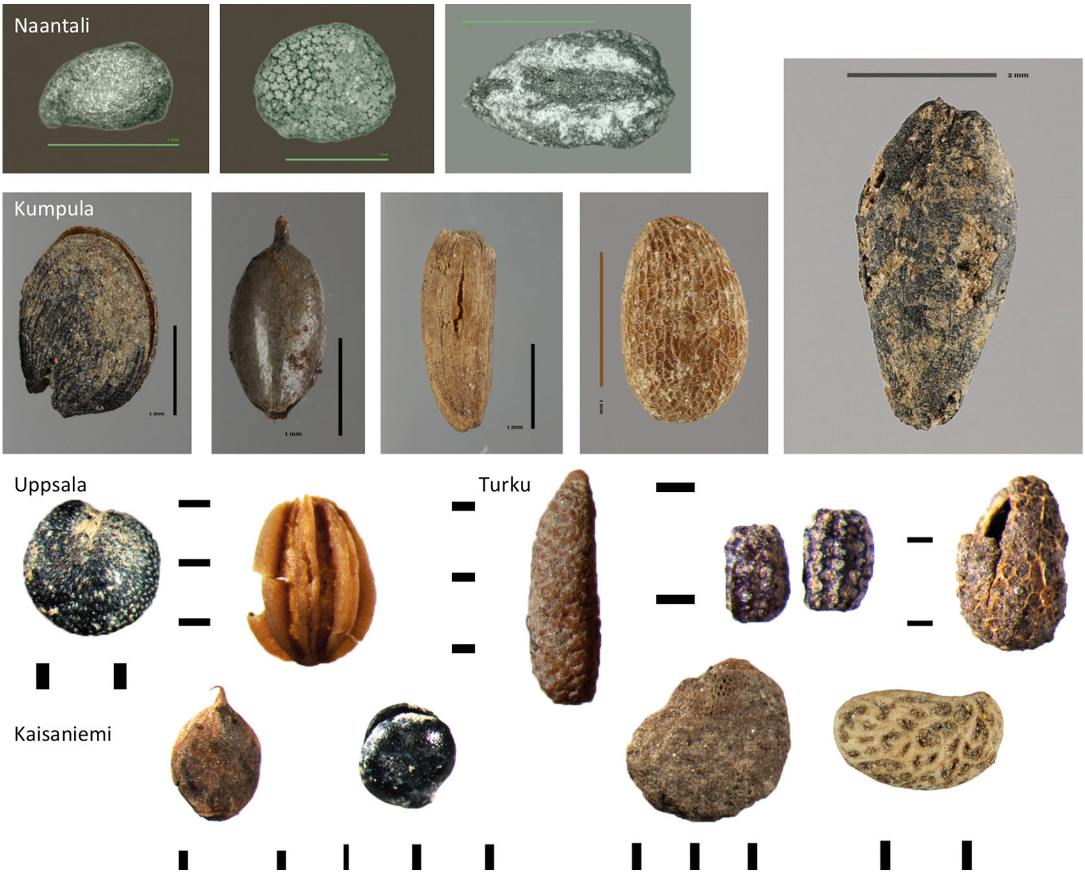

Fig. 14. Photographs of macrofossil plant remains found from the five different study sites: Naantali church (Chapter I) from top left clockwise: Fragaria vesca and Hyoscyamus niger (scale bars 1 mm), and Juniperus communis (scale bar 2 mm); Kumpula Manor (III) from second row left: Thlaspi arvense, Carex ovalis, Carduus cf. crispus, and Chelidonium majus (all scale bars 1 mm), and Secale cereale (scale bar 2 mm); Uppsala Linnaeus Garden (IV) and Turku Academy Garden (IV) from third row left: Chenopodium hybridum, Aethusa cynapium, Sambucus cf. canadensis, Scrophularia cf. auriculata, and Ajuga sp. (scale bars: a gap between each column is always 1 mm); and Kaisaniemi Botanic Garden (V) from bottom row left: Carex sp., Chenopodium album, Datura stramonium, and Rubus idaeus (scale bars: a gap between each column is always 1 mm). Photographs by Teija Alanko, Santeri Vanhanen and Pekka Malinen, image editing by Seppo Alanko.

numerous species was *Chenopodium album* (fat hen; 1233 seeds; groups B), found from 34 different samples. In addition, relatively abundantly seeds were found of *Rubus idaeus* (raspberry; 99 seeds together from 26 samples; group A), *Sambucus racemosa* (red-berried elder; 60 seeds from 21 samples; group C), and *Chelidonium majus* (greater celandine; 28 seeds from 10 samples; group A).

From 34 soil samples obtained from Uppsala Linnaeus Garden (IV), only 322 macrofossils and 36 plant taxa were found. The most abundant species were *Chelidonium majus* (116 seeds) and *Chenopodium hybridum* (sowbane; 47 seeds; group B). From 41 soils samples obtained from the former garden of Turku Academy (IV), 517 macrofossils and 47 different taxa were found. The most numerous species were cultural weeds *Chenopodium album* (58 seeds), *Plantago major* (greater plantain; 51 seeds; group B), *Polygonum aviculare* (swine-grass; 53 seeds; group B), and *Spergula arvensis* (83 seeds).

From 29 soil samples obtained from Kaisaniemi Botanic Garden (V), 968 plant remains and 65 plant taxa were found. The most abundant species were *Chenopodium album* (433 seeds) and *Rubus idaeus* (133 seeds).

Species belonging to group A (garden plants,

Table 2. Table combining all the results from the five different study sites: macrofossil plant remains found in total from Naantali church (Chapter I), Kumpula Manor (III), Uppsala Linnaeus Garden (IV), Turku Academy Garden (IV) and Kaisaniemi Botanic Garden (V).

Macrofossils in total from five study sites: Naantali Cloister church, Kumpula Manor garden, Uppsala Linneaus Garden, Turku Academy Garden and Kaisaniemi Botanic Garden						
Site	**Naantali**	**Kumpula**	**Uppsala**	**Turku**	**Kaisaniemi**	**TOTAL**
Pits		8	6	7	9	
Excavation areas	4					
N:o of soil samples	32	38	34	41	29	174
Litre of soil	46.3	ca 38	ca 34	ca 41	ca 29	ca 188
Samples' depths below ground surface (cm)		15-108	15-100	8-102	36-87	
N:o of AMS-radiocarbon dates	4	9	1.		11	25
Pollen analysis			x		x	
Plant taxa in groups of use and ecology in alphabetical order with number of seeds, fruits, diaspores						
Garden plants, useful plants and collected wild plants						
Aquilegia vulgaris				2	2	
Arctostaphylos uva-ursi	6					
Avena sativa/Avena sp.	7					
Cannabis sativa	4					
Cerealia	3		2			
Chelidonium majus	136	28	116	15	18	
Datura stramonium			5		5	
Fragaria vesca	2416	8	1	4	4	
Fragaria sp./*Potentilla* sp.				1	2	
Hordeum vulgare	10	1			2	
Humulus lupulus	2					
Hyoscyamus niger	68		1	1	2	
Nicandra physalodes			1			
Papaver somniferum					1	
Pisum sp.	1					
Rubus idaeus	48	99	3	1	133	
Rubus sp.			4	1	3	
Salvia sp.				1		
Secale cereale	12	2	1		1	
Syringa sp./*Anemone* sp.					2	
Vaccinium myrtillus	6					
Vaccinium oxycoccos	14					
Vaccinium uliginosum	7					
Vaccinium vitis-idaea	8					
Vaccinium sp.	15					
Cultural weeds and field weeds						
Aethusa cynapium			2	6	10	
Ajuga pyramidalis/reptans/genevensis				2		
Alchemilla sp.	3	3	4		7	
Anthemis cf. *arvensis*					1	
Apiaceae			2	5	2	
Arabis glabra		5				
Arctium tomentosum	1					
Arenaria serpyllifolia	3					
Asteraceae					1	
Atriplex cf. *hortensis*			1			
Atriplex patula	7	2				
Atriplex sp.				1		
Brassicaceae	2	1				
Bromus secalinus	11					
Bromus sp.	1					
Capsella bursa-pastoris		1				
Carduus cf. *crispus*		2				
Centaurea cyanus	4					
Cerastium cf. *arvense*		1				
Cerastium sp.				2		
Chenopodium album	132	1233	13	58	433	
Chenopodium glaucum/rubrum		82		1	42	
Chenopodium hybridum			47	4		
Chenopidium sp.	1	158	39	15	22	
Cirsium arvense	6					
Fallopia convolvulus	9	2		2	1	

Site	Naantali	Kumpula	Uppsala	Turku	Kaisaniemi	
Cultural weeds and field weeds						
Fumaria officinalis	1			2		
Galeopsis speciosa	2			2		
Galeopsis sp./cf. *ladanum/segetum*		2				
Galeopsis sp.	4					
Galium boreale	3					
Galium cf. *spurium*			1			
Galium sp.	19			1	1	
Hypericum cf. *perforatum*		9				
Lamiaceae/*Origanum* cf. *majorana*					1	
Lamium purpureum	1	4				
Lamium sp./*Galeopsis* cf. *ladanum*		2				
Lamium sp.			1	1	4	
Lapsana communis	2					
Myosotis cf. *arvensis/scorpioides*		1				
Persicaria hydropiper	4					
Persicaria lapathifolia	5					
Persicaria maculosa	1					
Persicaria sp.				1	1	
Plantago major	1	21		51	4	
Plantago sp.		4				
Polygonum aviculare	81	2		53		
Polygonum sp.	3					
Potentilla anserina	2	1			2	
Potentilla cf. *intermedia*					4	
Potentilla sp.		1	1	1	1	
Ranunculus repens	2	1	5			
Rubus saxatilis	1					
Rumex acetosella	11					
Rumex sp.	6	5		2	5	
Scleranthus sp. receptacle	3					
Scrophularia cf. *auriculata*			5	29		
Silene dioica					6	
Silene sp.		2			4	
Spergula arvensis	31			83	1	
Stellaria media	48	9	2	13	6	
Stellaria cf. *nemorum*					1	
Stellaria sp.	1					
Taraxacum officinale	1	7				
Taraxacum officinale/Tragopogon pratensis		1				
Thlaspi arvense		7			1	
Trifolium cf. *campestre*			1			
Trifolium repens	15	13		1	3	
Trifolium sp.					2	
Urtica dioica	2	51			6	
Urtica urens					2	
Urtica sp.				4		
Veronica cf. *officinalis*		1				
Veronica cf. *serpyllifolia*					1	
Veronica sp.					2	
Trees and shrubs						
Acer platanoides		1				
Betula nana	1					
Betula pendula	26					
Betula pubescens	45					
Betula pendula/pubescens	5	22	2	1	6	
Corylys avellana	1				1	
Juniperus communis	216				1	
Malus sp.	1					
Picea abies needle	12	19	7	4	13	
Picea abies/Pinus sylvestris	7					
Pinaceae scale of cone		18	2	15	2	
Prunus sp.	1					

Site	**Naantali**	**Kumpula**	**Uppsala**	**Turku**	**Kaisaniemi**	**TOTAL**
Trees and shrubs						
Sambucus racemosa	5	60			7	
Sambucus racemosa /*S. canadensis*				23		
Sorbus aucuparia	68	1				
Meadow plants						
Agrostis sp.	11	1				
Anthriscus sylvestris	1					
Festuca rubra	1					
Galium cf. *palustre*		1				
Hypericum maculatum	1					
Hypericum sp.		2				
Lathyrus sp./*Vicia* sp.		1				
Lithospermum arvense	6					
Lithospermum sp.	1					
Luzula sp.	19					
Myosotis sp.				2	2	
Poa pratensis/trivialis		7				
Poa sp.	17	14		18	3	
Poa sp./*Agrostis* sp.	5					
Poaceae	100	16	10	28	8	
Prunella vulgaris	1		2		2	
Ranunculus acris	1		1			
Rhinanthus sp.	1					
Rumex acetosa	12	1			2	
Stellaria graminea	11			1		
Trifolium pratense	3	2				
Vicia sp.	25	1				
Viola sp./cf. *hirta* /cf. *odorata*			2	2		
Viola sp.	11	6		9		
Wetlands plants and waterside plants						
Alisma plantago-aquatica	1					
Carex nigra	16		1			
Carex ovalis	7	23			2	
Carex sp. distigmatae	196	4	2	4	31	
Carex sp. tristigmatae	62	1	2		25	
Eleocharis palustris	79	1				
Empetrum nigrum	191			1		
Juncus cf. *bufonius*		1				
Juncus sp.	3	55	2	9	63	
Ranunculus flammula	9					
Ranunculus sceleratus		1			8	
Solanum dulcamara		1			1	
Veronica cf. *scutellata*		1				
Veronica cf. *scutellata/officinalis*				2		
Veronica sp.		3				
Indet.	189	26	31	32	39	
Plant remains in total	**4561**	**2036**	**322**	**517**	**968**	**8404**
Number of taxa	**94**	**63**	**36**	**47**	**65**	**154**
cf.=uncertain identification						
Other remains						
Pollen			x		x	
Chips of wood	x	x	x	x	x	
Chips of charred wood	x	x	x	x	x	
Fungi, sclerotium	x	x	x	x	x	
Brick pieces	x	x	x	x	x	
Fish scales and bones	x	x	x	x	x	
Insecta/Hexapoda	x	x	x	x	x	
Lumbricus terrestris pod	x	x	x	x	x	
Small bones	x	x	x	x	x	
Gastropoda	x	x				

useful plants and collected wild plants) were obtained from all of the five study sites, the most from Naantali. Some of the taxa of group A were found in abundance, such as *Fragaria vesca, Rubus idaeus* and *Chelidonium majus*, and others in considerably smaller numbers, such as *Aquilegia vulgaris* (common columbine), *Cannabis sativa* (hemp), *Datura stramonium* (thorn apple) and *Humulus lupulus* (hop).

Other remains

In addition to plant macrofossils (i.e. here mainly seeds and fruits), other remains were obtained from soil samples too. Chips of wood and charred wood, insects, sclerotia of Fungi, small animal bones, fish scales and bones and pods of *Lumbricus terrestris* (earthworm) were found in all of the five study sites. Shells of gastropods were found in Naantali (I) and Kumpula (III). Pollen was obtained from sites where it was looked for and analysed; from Uppsala Garden (IV) with four taxa that had the percentage values of pollen with any relevance: *Pinus* (pine), *Betula* (birch), Poaceae and Cichoriaceae; and from Kaisaniemi Garden (V), where the highest proportion of coniferous trees, broad-leaved trees, grasses and sedges, and herbs of total pollen varied between samples.

Radiocarbon dates

Altogether 30 AMS-radiocarbon dates were measured from five different study sites (Table 3 and Fig. 15). Among them, ^{14}C ages and calibrated calendar years varied widely. The oldest dates were obtained from charred wood (1120–920 cal BC), but seeds and grains also gave quite old results in these garden contexts, from the Swedish and Finnish medieval period (cal AD 1420–1475, cal AD 1255–1390, respectively). Younger dates exhibited a wide range (e.g. cal AD 1648–present, Poz-72237 in Table 3), the youngests being modern (Poz-76626-28).

Dates from Naantali (I) came from three excavation areas, two dates from different layers of the same area. The calibrated dates from Naantali varied from cal AD 1255–1390 to cal AD 1520–1805 (95.4% confidence). Dates from Naantali were revised with archaeological dates, and as a result, according to archaeological interpretations of the layers, the range of dates narrowed.

Of the nine AMS-radiocarbon dates from Kumpula Manor (III), five from charred wood gave results varying from cal 1120–920 BC to cal AD 1680–1930 (95.4% confidence), of which the youngest date (Hela-3342) was interpreted as an outlier, and of the others, older dates came from deeper samples in the pits. Dates that were measured from charred grains of *Secale cereale* and un-charred seeds of *Chenopodium album* varied from cal AD 1450–1640 to cal AD 1640–1930 (95.4% confidence). Thus, charred wood gave much older results than grains and seeds.

The date from *Datura stramonium* in Uppsala (IV) fell in the garden period (cal AD 1645–present, 95.4% confidence). The dates from a charred grain of *Secale cereale* and charred seeds found in Uppsala Garden resulted in cal AD 1455–1640 and cal AD 1420–1475 (95.4% confidence) reaching the time before the garden at the site. Three dates from uncharred seeds of *Sambucus racemosa* in Turku (IV) appeared to be modern.

From Kaisaniemi garden (V), 11 dates were measured, results varying from cal AD 1514–1798 to cal AD 1660–present (95.4% confidence). Within the two dates of *Datura stramonium* from the pit K5 (Poz-72237 and Poz-72223), the older sample originated deeper in the pit indicating intact layers. In the pit K2 dates of relatively young ages (Hela-3546, Hela-3548, Hela-3549) did not show a similarly clear tendency.

Table 3. All AMS-radiocarbon dates from the five different study sites: Naantali church (Chapter I), Kumpula Manor (Gumtäk in Swedish and G in pits; III), Uppsala Linnaeus Garden (IV), Turku Academy Garden (IV) and Kaisaniemi Botanic Garden (V). Calibration data: Intcal13 (Bronk-Ramsey 2009; Reimer et al 2013).

Lab.Code	Site	Area/Pit, sample, below ground depth cm/layer	Material (charred marked with *)	^{14}C age BP	Cal age, 25.4% - 69.4% probability	Cal age, 95.4% probability
Hela-3341	Naantali	A9601, M9626, K108	*Juniperus communis**	696 ± 36	AD 1255-1320 (69.3%)	AD 1255-1390 (95.4%)
Hela-3339	Naantali	A9601, M9641, K113	*Juniperus communis**	384 ± 34	AD 1440-1530 (61.5%)	AD 1440-1635 (95.4%)
Hela-3340	Naantali	A9703, M9701, K303	*Hordeum vulgare** *Secale cereale**	297 ± 33	AD 1520-1590 (49.1%)	AD 1485-1660 (95.4%)

Lab.Code	Site	Area/Pit, sample, below ground depth cm/layer	Material (charred marked with *)	^{14}C age BP	Cal age, 25.4% - 69.4% probability	Cal age, 95.4% probability
Hela-3338	Naantali	A9602, M9609, K202	*Avena* cf. *sativa** *Hordeum vulgare** *Secale cereale**	248 ± 35	AD 1615-1685 (47.4%)	AD 1520-1805 (95.4%)
Hela-3347	Kumpula	G7, G7/3, 26-36 cm	*Chenopodium album*	210 ± 28	AD 1730-1810 (48.4%)	AD 1640-1930 (95.4%)
Hela-3346	Kumpula	G7, G7/3, 26-36 cm	*Secale cereale**	266 ± 28	AD 1520-1670 (68.2%)	AD 1520-1800 (95.4%)
Hela-3345	Kumpula	G7, G7/2, 52-58 cm	*Secale cereale**	258 ± 28	AD 1620-1670 (57.8%)	AD 1520-1940 (95.4%)
Hela-2141	Kumpula	G1, G1/6, 51-60 cm	*Chenopodium album*	353 ± 30	AD 1470-1630 (68.2%)	AD 1450-1635 (95.4%)
Hela-2140	Kumpula	G1, G1/6, 51-60 cm	Wood*	562 ± 30	AD 1320-1415 (68.2%)	AD 1305-1430 (95.4%)
Hela-3343	Kumpula	G3, G3/6, 73-86 cm	Wood*	1,116 ± 29	AD 890-980 (68.2%)	AD 770-1020 (95.4%)
Hela-3344	Kumpula	G3, G3/8, 98-108 cm	Wood*	2,845 ± 32	1050-930 BC (68.2%)	1120-920 BC (95.4%)
Hela-3342	Kumpula	G8, G8/5, 77-87 cm	Wood*	95 ± 26	AD 1800-1930 (69.4%)	AD 1680-1930 (95.4%)
Hela-1963	Kumpula	G8, G8/6, 87-95 cm	Wood*	1,545 ± 35	AD 430-560 (68.2%)	AD 420-590 (95.4%)
Hela-3757	Uppsala	U4, U4/2, 39-45 cm	*Datura stramonium*	209 ± 27	AD 1735-1810 (48.8%)	AD 1645-present (95.4%)
Hela-3515	Uppsala	U4, U4/4, 55-65 cm	*Secale cereale* *	348 ± 40	AD 1480-1635 (68.2%)	AD 1455-1640 (95.4%)
Hela-3755	Uppsala	U3, U3/10, 79-88 cm	Charred seeds *	445 ± 25	AD 1430-1455 (68.2%)	AD 1420-1475 (95.4%)
Poz-76626	Turku	T6, T6/1, 8-13 cm	*Sambucus racemosa*	modern		
Poz-76627	Turku	T6, T6/2, 20-32 cm	*Sambucus racemosa*	modern		
Poz-76628	Turku	T6, T6/3, 32-40 cm	*Sambucus racemosa*	modern		
Poz-72237	Kaisaniemi	K5, K5/1, 40-53 cm	*Datura stramonium*	190 ± 30 BP	AD 1727-1813 (52.7%)	AD 1648-present (95.4%)
Poz-72223	Kaisaniemi	K5, K5/2, 53-61 cm	*Datura stramonium*	275 ± 30 BP	AD 1616-1668 (42.4%)	AD 1514-1798 (95.4%)
Hela-3546	Kaisaniemi	K2, K2/2, 53-65 cm	*Secale cereale* *	113 BP ± 22	AD 1812-1890 (45.7%)	AD 1682-1935 (95.4%)
Hela-3548	Kaisaniemi	K2, K2/3, 65-72 cm	*Rubus idaeus*	98 BP ± 19	AD 1696-1726 (25.4%)	AD 1690-1923 (95.4%)
Hela-3549	Kaisaniemi	K2, K2/4, 72-80 cm	*Rubus idaeus*	167 BP ± 20	AD 1730-1780 (41.2%)	AD 1660-present (95.4%)
Poz-72225	Kaisaniemi	K8, K8/2, 60-75 cm	*Datura stramonium*	245 ± 30 BP	AD 1641-1798 (68.2%)	AD 1523-present (95.4%)
Poz-72226	Kaisaniemi	K8, K8/2, 60-75 cm	*Chenopodium album*	180 ± 30 BP	AD 1726-1815 (51.9%)	AD 1652-present (95.4%)
Poz-72227	Kaisaniemi	K9, K9/2, 65-75 cm	*Datura stramonium*	85 ± 30 BP	AD 1697-1917 (68.2%)	AD 1688-1927 (95.4%)
Hela-3547	Kaisaniemi	K3, K3/4, 66-73 cm	*Hordeum vulgare* *	118 BP ± 20	AD 1833-1882 (36.9%)	AD 1682 – 1936 (95.4%)
Poz-72294	Kaisaniemi	K7, K7/2, 70-85 cm	*Hordeum vulgare* *	220 ± 30 BP	AD 1735-1806 (44.7%)	AD 1642-present (95.4%)
Poz-72224	Kaisaniemi	K7, K7/2, 70-85 cm	*Chenopodium album*	170 ± 30 BP	AD 1721-1818 (50.5%)	AD 1659-present (95.4%)

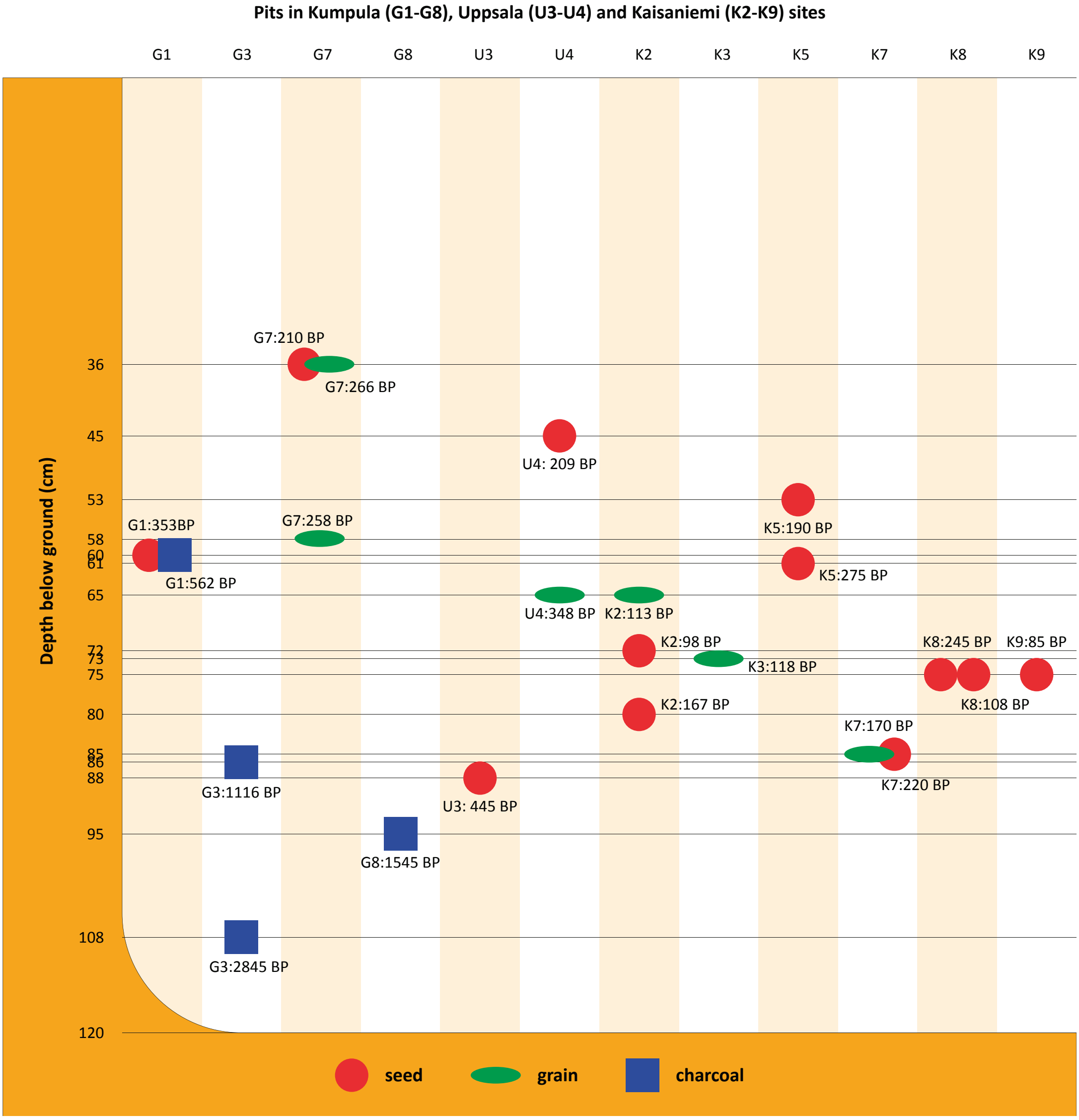

Fig. 15. Radiocarbon dates of macrofossils from three study sites, Kumpula (Chapter III; pits G1-G8), Uppsala (IV; pits U3-U4) and Kaisaniemi (V; pits K2-K9), demonstrated in pits according to the depths below ground where remains were found. The date Hela-3342 (Kumpula; ^{14}C age 95 ± 26 BP; Table 3) was inconsistent with the other dates, indicating that the sample was mixed or pieces of wood dated did not initially belong to this depth (77–87 cm), and thus excluded from this figure. Red circle denotes seed, green oval denotes grain and blue square denotes charcoal. The ages of the remains are shown in ^{14}C years BP. Graphic Seppo Alanko.

DISCUSSION

The historical contexts of the sites and gardening practices

The knowledge of people who established gardens and operated in them in the five study sites varies (II). In the 15th and 16th centuries nuns and/or monks may have worked in the garden of the Naantali Cloister (I). The establishment of the cloister and the gardening practises used there, at least in the beginning, were probably highly influenced by the Swedish mother cloister of Vadstena. At the same time, in the end of the Finnish Middle Ages, Kumpula Manor in Helsinki

(III) started to form, but its ownership and operating persons changed quite often during the decades and coming centuries. In the 17th century, gardening developed in Uppsala University Botanic Garden (IV) by the work of Olof Rudbeck senior. In the same century in Turku, the scientific improvement of horticulture began through medicinal gardens, especially the one of Elias Tillandz (II). In the 18th century Uppsala, Carl Linnaeus had a high impact on the Botanic Garden and on the newly established Turku Academy Garden too (IV). Pehr Kalm advanced economical botany and gardening in Turku in close connection with Linnaeus (II, IV). Contemporarily in Kaisaniemi in Helsinki (II, V), Hans Henrik Boije founded an economical plantation for his own profit. In the next century, Boije's garden turned to a botanic one, when it took the possession of the operation of Turku Academy Garden. Carl Reinhold Sahlberg was a notable person in this shift (II, IV, V). In Uppsala, Turku and Kaisaniemi Gardens, these specific persons were important in the development of the sites. In the sites of Naantali and Kumpula such relevant connection to certain persons could not be demonstrated. An interesting issue is the contemporary operation of Linnaeus, Kalm and Boije, in the Swedish period of utilitarianism, concerning their gardens in different places, both Kalm and Boije concentrating on economical useful plants, the former for scientific and social benefit, the latter for personal advantage.

Tilling and soil improvement as gardening practices in historical times had an impact on garden soils and thus on the archaeological and archaeobotanical evidence that is obtained from these soils. In early modern period, instructions for establishing a garden including soil improvement were given e.g. in Bonsdorff (1804). For a kitchen garden, soil should be dug as deep as 45 cm; if soil was sandy or included small stones it could be turned and tilled, and good clayey fill could be brought to a site; later soil should be fertilized and mixed (Bonsdorff 1804). When a garden is studied, it is important to detect visible elements in garden soil that are the remains of the activity that created the cultivation; the soil was tilled, irrigated and fertilized often with household waste including potsherds, charcoal and manure (Gleason 2013a). The soil of planting beds could have been improved with shells, lime plaster, animal bones and rubbish including pieces of pottery, porcelain and glass (Yentsch & Kratzer 2013). Planting beds may have been lined with bricks and grounded with broken glass bottles or gastropod shells to improve the drainage, leaving these materials in the soil (Kryder-Reid 2013). In archaeological record past gardening can be seen in several ways. One of them is the traces of fertilizers from households, e.g. kitchen and latrine waste; another is chips of wood that are often found mixed into garden soils; and moreover, the traces of garden plants (Heimdahl 2014c). Since old garden soils may be poor environments for the preservation of plant remains, such as seeds, these remains found in soils may represents the latest phase of gardening at a site; and further, seeds that are not eaten may be regarded as traces of cultivation, such as *Datura stramonium*, while e.g. seeds of berries, such as *Rubus idaeus*, may originate from latrine waste mixed into the soil (Heimdahl 2014c). In the results of all these studies (I, III, IV, V), soil improvement was visible as chips of charred wood and other remains, many of them common materials of amelioration. Gardening and soil management may, however, have interfered the stratification of garden soil, so that archaeobotanical plant remains may not have accumulated in clear stratigraphy, and for example earthworms may have caused bioturbation by moving and mixing the soil (Grüger 2013). Nevertheless, soil improvement in gardens has created microenvironments to planting beds, suitable for plants cultivated in them, and these 'changed soils', being less acid than natural soils, have been able to preserve old seeds and pollen; thus, sampling for archaeobotanical remains in historic gardens is worthwhile (Currie 2013). Further, planting beds that have been found in garden archaeological excavations have proved that notwithstanding the management of gardens, old planting beds may survive as well (Currie 2013).

Plants and the development of gardening in the five study sites, and the advantages of a multidisciplinary approach including archaeobotany in garden history research

Macrofossil plant taxa that were common in all of the five case studies, or at least occurred in all of them, out of the total 154 plant taxa found together from five studies, were quite few: *Chelidonium majus* (greater celandine), *Fragaria vesca* (wild strawberry) and *Rubus idaeus* (raspberry) representing useful and collected wild plants; *Chenopodium album* (fat hen) and *Stellaria media* (chickweed) representing cultural weeds; *Picea abies* (spruce) as the only shared tree; Poaceae (grasses), *Carex* sp. (sedges) and *Juncus* sp. (rushes), all representing meadow, wetlands and waterside plants. However, the first three, *C. majus*, *F. vesca* and *R. idaeus,* were apparently common both in gardens and settlements, and show some consistency between gardens through time from the 15th to the 19th century and also from place to place. All these three species, although also growing wild, are classified as garden plants, and have been useful plants as well (Justander 1786; Abel 1994; Tirri & Tirri 2011). The cultural weeds *C. album* and *S. media* can signify garden weeds, and *Carex* and *Juncus* species illustrate moist environments near all study sites.

The development of gardening from the late Middle Ages (the 15th century) to the early modern period in Finland (the 1520s – the early 19th century) is shown in the varying macrofossil data of the garden sites of different ages. In the oldest site, Naantali Cloister (I), the old useful plants were characteristic, e.g., *Cannabis sativa* (hemp) and *Humulus lupulus* (hop), and a wide range of collected plants, e.g., *Vaccinium* species, *Sorbus aucuparia* (rowan), *Arctostaphylos uva-ursi* (bearberry) and *Empetrum nigrum* (crowberry). Although the use of these may have reached the 18th century too, they were rare in the other sites. Still, the distinctions between macrofossil materials of Naantali and the other sites may be due to, for example, the preservation and sampling differences.

If slightly generalized, in the sites of older phases beginning from the 15th century, Naantali and Kumpula (I, III), macrofossil analyses revealed prevalent cultural plant species and old useful plants commonly found in Finnish macrofossil material, such as *Chelidonium majus*, *Fragaria vesca*, *Rubus idaeus*, *Hordeum vulgare* (barley) and *Secale cereale* (rye). In contrast, in the sites with younger phases in the 17th–19th centuries, Uppsala, Turku and Kaisaniemi (IV, V), macrofossil analyses exposed new species introduced from the New World that could not have been found in a medieval context, such as *Datura stramonium* (thorn apple), *Nicandra physalodes* (apple-of-Peru) and probably *Sambucus canadensis* (American elderberry).

The advance in gardening is demonstrated in the new species in the younger gardens. Noteworthy is that *Datura stramonium*, as an example of more modern plants, was found only in Uppsala and Kaisaniemi Gardens (IV, V). The parallel finds in these not so apparently connected gardens may be due to the popularity of the species among cultivators from the mid-17th century onwards, but also to its presumably good ability of preservation in the soil. *Datura stramonium*, native to North America, was growing in Uppsala Garden already in Rudbeck senior's time in 1658, and may have been introduced to Sweden by him (Martinsson & Ryman 2007). AMS-dated macrofossils of *D. stramonium* from Uppsala Garden (IV) suggest cultivation also in later centuries. AMS-dated seeds of the species from Kaisaniemi Garden (V), although showing quite wide a range of calibrated calendar years demonstrate the cultivation in H. H. Boije's or gardener Edbom's period (1763–1773; 1773–1826; respectively). *Datura stramonium* was used in school medicine in Sweden, grown in economical gardens for selling to pharmacies, and mentioned in the Swedish pharmacopoeia from 1775 onwards (Tunón 2005). Macrofossils of *D. stramonium* have been found earlier in Sweden at least in two sites of the 17th century context in Norrköping and Nyköping (Heimdahl 2014d). However, in Finland, no former macrofossil finds of *D. stramonium* exist, seeds from Kaisaniemi Garden thus being the first ones.

Datura stramonium can be found in written sources concerning Kaisaniemi Garden in the mid-19th century, for seeds of *D. stramonium* var. *tatula*, the purple-flowered variety, collected from the botanic garden in Kaisaniemi, were sold in the newspapers in the 1840s as ornamental plants (*Finlands Allmänna Tidning* 1842, 1843). Still, no such earlier written record of the plant in Kaisaniemi or in Helsinki exist that could tell about the mid-18th century cultivation. The cultivation of the species in some other parts of Finland in the late 18th century is recorded (Parvela 1930), and it was grown in Turku Academy Garden in 1768 too (Kerkkonen 1936; Kari 1940), but it was not found in the Turku macrofossil material. This nicely demonstrates the importance of using both the literature and archaeobotanical methods in garden-historical studies.

In total, 23 seeds of *Sambucus racemosa*/*S. canadensis* (red-berried elder/American elderberry) were found in Turku Academy Garden (IV). *Sambucus* species were also obtained from all other study sites, except Uppsala, and the genus was the most numerous in the Kumpula material (III). The identification of macrofossil *Sambucus* seeds found in Finland in general, and in this study, is questionable. *Sambucus racemosa*, *S. nigra* (European elder) and *S. canadensis* may all have been cultivated in Finland in the early modern period, and, excluding the latter one, already in the medieval period. Pehr Kalm brought *S. canadensis* from North America in 1751 (then called *S. Americana*). Kalm reported that he cultivated *S. canadensis* and *S. nigra* in experimental gardens of Turku Academy for medicinal purposes (flowers were used in pharmacies), and although he tried them for hedges too, they did not seem suitable (suffered too much from frost; Kerkkonen 1936). In the end of Kalm's term, three *Sambucus* species were cultivated in Turku Academy Garden, *S. ebulus* (Dane's elder), *S. canadensis* and *S. nigra,* but not *S. racemosa* (Mollin 1779). Comparing to Sweden, *S. nigra* is in the *Hortus Rudbeckianus*, the catalogue listing plants grown in Uppsala Garden by Olof Rudbeck senior in the period of 1655–1702, but *S. racemosa* is not (Martinsson & Ryman 2007). In the *Hortus Linnaeanus,* listing plants cultivated in Uppsala Garden during the Linnean period beginning in 1741, three species are listed: *S. nigra*, *S. racemosa* and *S. canadensis*, two latter ones from 1753 (Juel 1919). Macrofossils of *S. racemosa* from Sweden are quite rare, finds of *S. nigra* being more common (e.g., Heimdahl 2010b, 2012), while macrofossils of *S. racemosa* have been found for example in Estonia (Sillasoo & Hiie 2007). The question is, can macrofossil seeds of these three (or four) different taxa be definitely distinguished and identified. Maybe some of the macrofossil finds from Finland that are regarded as *S. racemosa* are not absolutely certain, but some of them could be *S. nigra* or *S. canadensis*.

The challenge of presenting the development of garden cultivation only through these macrofossil case studies is demonstrated by, for example, finds of a cultural weed *Aethusa cynapium* (fool's parsley). It is regarded as an indicator of old settlements, but was found in the early modern gardens of Uppsala, Turku and Kaisaniemi (IV, V) and not in the older sites of Naantali and Kumpula (I, III). Yet, the plant is nowadays growing as a weed in old gardens too, and may easily be a macrofossil of a garden from younger periods. Another example is an ornamental plant *Aquilegia vulgaris* (common columbine) that was found only from Turku and Kaisaniemi Gardens (IV, V), thus suggesting the cultivation for decorative purposes in later periods. Still, since the species was used as a medicine and in the Catholic period also regarded as a symbol of the Holy Spirit (Ruoff 2001), and is known to been grown in Vadstena Cloister (Sigurdson & Zachrisson 2012), it could have been found in Naantali (I). However, for example the old medicinal plant *Hyoscyamus niger* (henbane), although found in all sites except Kumpula (III), was much more numerous in Naantali (I) than in the other sites, and found in Naantali in the layer dated to the period 1440–1500, referring to its common use in medieval cloisters.

As macrofossils of the species from the New World begin to appear in the materials of the younger garden sites, also the literature shows the alteration of cultivated species, but most of all, the increasing number of species in the gardens. In Elias Tillandz's *Catalogus plantarum*, which lists approximately 500 plants grown in the Turku region in the late 17th century, 188 taxa can be regarded as cultivated or garden plants (Tillandz 1673). Mollin (1779) lists 388 plants that had been cultivated in Turku Academy Garden in Pehr Kalm's period (1757–1779), e.g., *Datura stramonium*, *Nicotiana* species (tobacco) and *Sambucus canadensis*, all from America. In the literature from the late Finnish Middle Ages plant lists are quite short. For example, the medieval herbal of Naantali Cloister, probably written in Vadstena Cloister in the end of the 15th century (Sigurdson & Zachrisson 2012), contains plants that may have been cultivated in Naantali Cloister, but only seven healing herbs and 22 other plant, e.g., *Juniperus communis* (juniper), *Chelidonium majus* (greater celandine) and *Urtica dioica* (nettle) (Tirri & Tirri 2011). Yet, the range of cultivated and consumed plants was definitely wider, as shown in macrofossil material from Naantali Cloister. Still, the lists of plants from later periods grew significantly in numbers of species, in Sweden earlier than in Finland; compare e.g., contemporary Uppsala (Rudbeck 1666; Martinsson & Ryman 2007) and Turku (Tillandz 1673); and again in the 18th century (Linné 1748; Juel 1919 vs. Mollin 1779; Kerkkonen 1936). A comprehensive enumeration of plants cultivated in Uppsala Garden by Olof Rudbeck senior in 1655–1702, the *Hortus Rudbeckianus*, lists plants of approximately 2,500 taxa (approx. 1,500 at species level) (Martinsson & Ryman 2007). The *Hortus Linnaeanus* of cultivated plants in Uppsala Garden in the Linnean period in 1741–1783, including Carl Linnaeus and his son, lists 2,157 species (Juel 1919). Plants of Pehr Kalm's cultivation experiments in Turku Academy Garden, based on Kalm's official planting reports from 1759 and 1768 and his letters, gather together 84 different taxa, which include mainly the plants that Kalm particularly paid attention to of those approximately 400 species of American, Siberian, Swedish, Finnish and other European origin he grew in his garden (Mollin 1779; Kerkkonen 1936; Kari 1940).

Concerning those case studies that had only scarce written sources existing of plants cultivated or used at the sites, Naantali (I), Kumpula (III) and Kaisaniemi (V), macrofossil plant remains obtained in the studies brought new information of plants grown and consumed in these garden sites. Macrofossils found in Naantali Cloister together with the written source, the herbal of Naantali Cloister, suggested gardening and garden plants. Still, although the herbal included plants that were not found in the macrofossil analysis, plant remains revealed many species that were absent in the herbal and could thus not have been discovered without archaeobotany. Only few of the macrofossil taxa were mentioned in the herbal, *Juniperus communis* (juniper), *Chelidonium majus* (greater celandine), *Urtica dioica* (nettle) and *Viola* sp. (violet; Tirri & Tirri 2011), but 90 taxa were not. Hence, it is clear how important a source macrofossils are to demonstrate the plants consumed and also probably cultivated in Naantali Cloister, and more extensively, to create a picture of late medieval and early modern gardening in Finland.

Remains of cultivated and collected plants useful for food, dyeing and medicinal purposes were found in the Naantali Cloister church (I). According to AMS-radiocarbon and archaeological dates, also chronological changes in macrofossil species indicating the changes in food management and usage of medicinal plants were shown. Macrofossils of Naantali included the four taxa mentioned in the herbal, and useful plants mentioned above (*C. sativa, H. lupulus, Vaccinium* species*, S. aucuparia, A. uva-ursi*, *E. nigrum* and *H. niger*). In addition to these, archaeobotany revealed cereals and food plants in different periods varying from 1440–1500 with *F. vesca*, *R. idaeus* and *S. cereale*, 1550–1660 with as a new taxa *H. vulgare*, and to 1550–1790, overlapping with the former, with appearing taxa *Avena sativa* (oat), *Pisum* sp. (pea), *Malus* sp. (apple) and *Corylus avellana* (hazel).

No elaborate plant lists regarding Kumpula Manor Garden (III) exist, thus demonstrating the need of archaeobotanical study. A few species obtained as macrofossils from Kumpula Manor indicated gardening more strongly than others. These were *R. idaeus* and *F. vesca*, which, if cultivated in the garden and not only collected from the wild, could define the function of the manor garden as a kitchen garden. Species like *C. majus* and *Sambucus racemosa* (red-berried elder) could indicate the manor garden as an aesthetic one, if in the younger period *C. majus* was not used as a medicinal plant. Moreover, 31 taxa of cultural weeds were found, these being mainly of the type characteristic to summer crops or root crops, or types growing in soils rich in humus, thus strongly indicating garden soils. Still, plants in this group are rarely mentioned in the literature concerning garden plants, and hence the information of them kept hidden in soil if archaeobotany is not applied. Macrofossil plant remains from Kaisaniemi Garden (V) revealed cereals, berries, and medicinal plant species, which have not been recorded in the literature concerning the earlier phases of gardening in Helsinki. The results of the archaeobotanical analysis thus indicated both consumption at the site and garden cultivation. Remains of a few ornamental garden plants were found in Kaisaniemi too. Regarding those case studies that had extensive lists of species cultivated in the sites, Uppsala and to some extent also Turku (IV), macrofossils found in the sites could not outweigh the knowledge gained from the literature.

Slightly differing from other study sites, one typical species in the Uppsala Garden macrofossil material (IV) was *Chenopodium hybridum* (sowbane) found in addition only in the linking garden of Turku (IV) among the five case studies. *C. hybridum* is in both the *Hortus Rudbeckianus* and the *Hortus Linnaeanus*, as are the other noteworthy species obtained as macrofossils from Uppsala Garden (Juel 1919; Martinsson & Ryman 2007). Since the plant catalogues exist of the former botanic garden of Uppsala University, macrofossil material could not bring big surprises. Still, the plant remains found show which ones can be preserved in garden soil. In addition, according to AMS-dates, the layers preceding the botanic garden were reached, and there are no plant lists from that period.

A good indicator of gardening, soil management and improvement, other than plant macrofossils but one still needing soil sampling, was found quite regularly in many soil samples of all the study sites: chips of wood and charred wood, remains of fish (scales and bones), small animal bones and brick pieces, in abundance, strongly referring to fertilization and soil improvements of the gardens for gardening purposes, with kitchen waste and other components (Ericsson & Guldåker 2015). Thus, although not very many precise garden plant species were found in the archaeobotanical material, the other factors in the soil samples refer to gardening, and hence also demonstrate the importance of archaeobotanical analyses in garden history studies.

Assessment of the sampling method

According to the materials of this study, garden soils appeared to be very challenging for archaeobotanical study without archaeological excavations. Although the sampling itself was quite simple, choosing the sampling spots inside the sites in order to find undisturbed soil layers was tentative. Thus, it was from the beginning a subtle risk to select garden sites of this kind for case studies with this method of sampling from boreholes without excavations, but in the end, it may have been a risk worth taking. It is important that different methods and types of study sites are tested in order to gain the knowledge of divergent opportunities for research for current need, and further, for future studies. The results of methodological testing give material for all researchers, and may open new possibilities for novel methods and various sites to be studied.

Collecting soil samples for macrofossil analyses from boreholes had some benefits in these cases of garden sites compared to the sampling from excavations. Sampling was not dependent on excavated areas or schedules of excavations. Sampling could be done relatively quickly by just one person, and hence considered a parallel method to the shovel-test-pits used in archaeological research, yet the aim in this sampling was focused mainly on archaeobotanical remains. Sampling did not disturb the plantings and the other use of the areas.

The sampling method could also be exploited for various other natural-scientific analyses in garden studies. Chemical analyses of soil (Ca, Mg, P, ash, pH) can be most useful in providing information of fertilization of cultivated garden plots (Currier & Locock 1991; Murphy & Scaife 1991; de Moulins & Weir 1997; Luppi 2001a). Although the number of historic gardens studied worldwide by pollen analysis is relatively small (Grüger 2013), pollen remains, compared to seed macrofossils, could reveal plants that are able to flower, but not to produce fruits or seeds in the northern climate as in Finland, or species that lack their natural pollinator insects and therefore do not produce fruits. The usefulness of pollen is shown in a Norwegian case study, where pollen analysis of garden soil exposed plants that did not appear in the macrofossil data of the site, e.g., garden trees, such as *Aesculus hippocastanum* (horse chestnut), *Juglans* sp. (walnut) and *Syring*a sp. (lilac; Halvorsen 2012). Insect remains could also be analysed from garden soil samples, since they could uncover important horticultural relationships (Larew 2013). Pest insects of certain plants could give information of their hosts (Murphy & Scaife 1991). The sampling method could also be combined with ground radar surveys, which offer reliable information of underground structures and remains, such as broken-down garden walls, garden paths and corridors and edged plantings (Winroth et al. 2011; Andréasson & Pettersson 2014).

One limitation was the maximum size of a sample, approximately one litre, due to the size of the chamber of the sampler. Larger samples could have yielded more macrofossils and more different species. Another restriction was that soil samples were collected somewhat coincidentally without a clear archaeological context, however carefully and systematically the spots for sampling were chosen. Thus, the best spots for macrofossils to be found could have been missed. In addition, stones or roots of trees came in the way in some pits disturbing the sampling.

The absence of archaeological context emphasises the necessity of written sources and historical context for forming a background, in which the research plan is considered, the spots for sampling are chosen, and the plant remains are interpreted. In these case studies of historic gardens, the literature gave historical contexts well enough. Radiocarbon dates are essential with this sampling as well, but they can be quite necessary in excavated sites too. Due to the work without archaeological excavations in four sites (III, IV, V), a clear stratigraphy in the sampled pits could not be detected, which remains a limitation of the method. It was not possible to see distinctly how the soil characters changed within the layers all the way to the bottom of the pits, although from the uppermost samples the possible layers could be seen and photographed (Fig. 13); and still, in several pits distinguishable types were observed from collected samples of which the characters of soil were recorded (Appendix 1). Furthermore, the radiocarbon dates proposed in some pits that the layers may not have been mixed. Moreover, several examples of garden archaeological excavations from different kinds of sites worldwide have shown that distinctive layers of garden soil may have been deposited and preserved untouched, while covered with new soil layers and fills raising the level, but not necessarily mixed, and thus, a clear stratigraphy is possible to be found in old garden sites (Malek 2013c).

The sampling without excavations carried out in four of the study sites (III, IV, V) can be compared to the sampling from excavations in the fifth site, Naantali church (I). The material from Naantali yielded the richest macrofossil data with both more macrofossils and taxa than the materials from the other sites. This was probably because the samples in Naantali were from building structures and presumably partly from a household waste pit, where remains of consumed plants had been accumulated, and remains were, since mainly charred, preserved well. In contrast, the samples from the other sites were from garden soil, where plant remains are spread more widely and thus only part of them can be detected in a one-litre sample from a precise spot. This shows how sampling from excavations can be targeted better on spots where macrofossil density could be higher. However, when sampling from garden soil, the attempt is not to hit such high-density spots but to find plant remains spread out in the soil. Archaeobotanical sampling even with large excavations from garden environments would not necessarily yield numerous macrofossil material, since the garden soil may not contain that many remains especially compared to household layers.

As it has been stated, garden soil would probably not be a very good environment to conserve organic material like seeds, because of its oxygen content and therefore the activity of microorganisms. Garden soil becomes rich in bacteria through intensive tilling and manuring, so that plant remains are usually rapidly destroyed (de Moulins & Weir 1997). Organic macrofossils are usually preserved either by waterlogging or by carbonization. However, in these case studies, excluding Naantali, remains of many species were found from the soil and most of the plant remains were neither carbonised nor properly waterlogged. Still, some of the soil samples were moist and clayey, which supports the preservation. Charred seeds and grains were also found though. The un-charred macrofossils do not have to be presumed recent however, as un-charred material often is, because durable plant material may preserve in relatively young, e.g., 18th century-layers, even if not waterlogged (Gleason 2013b). Some of the AMS-radiocarbon dates of uncharred seeds from these study sites demonstrate this too, for example, *Chenopodium album* from Kumpula Manor Garden (III; Hela-2141), and *Datura stramonium* from Kaisaniemi Botanic Garden (V; Poz-72223) and from Uppsala Linnaeus Garden (IV; Hela-3757). Still, un-charred macrofossils from garden soils were preserved moderately poorly, which made the identification of seeds in many cases more difficult.

A problem with radiocarbon dates from relatively young material, as partly in these case studies, are the wide distributions of calibrated calendar years. Thus, the confidence of the certain ages of the remains, the soil samples, and the usage of the gardens was not very accurate and left quite much space for interpretation. Still, calibrated years of radiocarbon dates from older layers from Naantali Cloister church (I), Uppsala Garden (IV) and Kumpula Manor Garden (III), and even the younger date from Kaisaniemi Garden (V), were more precise, and thus more useful. Still, even if radiocarbon dates from younger periods (the 18th century) cannot give exact answers of the age of the remains, the dating is necessary when sampling without excavations and thus the help of archaeological dates. Radiocarbon dates can give the direction of the age, and most probably exclude the remains being recent ones.

The radiocarbon dates from Naantali church (I) revealed a case where radiocarbon dates alone were not enough to tell the age of the finds and the samples, because the dating of the archaeological contexts changed slightly after the revision with archaeological interpretation and archaeological dates. Thus, the case from Naantali showed that at least occasionally radiocarbon dates alone should not be relied on. In the four other sites, sampled without excavations, comparison to archaeological dates was not possible and radiocarbon dates were the only possibility to demonstrate the age. Radiocarbon dates from different pits from three of the garden sites, Kumpula (III), Uppsala (IV) and Kaisaniemi (V), indicated mostly the trend of unmixed layers in the pits, or thick layers of contemporary soil in gardens (Fig. 15). However, also the drift of a particular macrofossil within unmixed layers must be taken into account. Dated macrofossils of Kumpula pits (G1-G8) demonstrate first of all that all charcoal samples, obtained deeper than other dated remains, were older than seeds and grains, with the exception of one date (Hela-3342) that was inconsistent with the other dates, indicating that the sample was either mixed or charcoal dated did not initially belong to this depth but have drifted from upper layers. As for the deeper and much older date of charcoal in the same pit (Hela-1963), it was consistent with the results of parallel pit (no. 3). In general, charred wood is imperfect material for dating, since the problem of old wood may occur. Since the amounts of macrofossil seeds suitable for dating were small in some pits, charred wood was chosen. Nevertheless, the dates of remains showed some tendency dependent on the depth below ground from where soil samples were obtained: the deeper the sample the older the date, as expected; but due to the wide ranges of calibrated calendar years, many dates overlap. Radiocarbon dates demonstrated the order of layers in pits most clearly in Kumpula Manor Garden.

CONCLUSIONS AND FUTURE PROSPECTS

Garden history can and should be studied with both written sources and archaeological and archaeobotanical methods. Macrofossil sampling that gains informative results can be carried out both in cooperation with archaeological excavations and without them straight from garden soil. Extensive plant lists from sites where these exist bring most of the information concerning species grown at the sites, but they do not expose plants consumed or occurring as garden weeds in the areas. In sites with no comprehensive literature of cultivated species, archaeobotany reveals valuable evidence of plants that could not be gained otherwise.

This study showed that by collecting soil samples with a sampler it is possible to find macrofossils of cultivated and collected useful plants, and wild species of natural vegetation, from historical garden environments, even in the absence of archaeological excavations. Although the sampling method gave relatively scarce results in some of the study sites, it was not necessarily due to the sampling method, but rather the sites, which appeared to be quite difficult to sample and quite poor in macrofossils. Thus, the method may be workable, but sites where it would be used should be chosen carefully. In addition, to maximize the benefit of the sampling, and to obtain the most reliable interpretation of the results, it would be important to measure as many radiocarbon dates from macrofossils as possible. In this study, the options to do so were unfortunately restricted, mostly because enough suitable macrofossil material for dating was not found. Still, AMS-radiocarbon dates from four sites (III, IV, V), where soil samples were collected with the sampler without excavations, were able to show approximately the age of the macrofossils, and with slight uncertainty also the age of the soil samples from where the dated remains were. It could be assumed that the whole samples were of the same age than the dates obtained from them, yet bearing in mind the sources of error. However, since the calibrated calendar years covered mostly quite wide periods, these most probably included the entire samples.

Archaeobotanical sampling without excavations appeared to be profitable and could be recommended in cases when excavations are not achievable. Still, this sampling is coincidental to such an extent that excavating at least shovel-test-pits or test ditches in gardens, when possible, is a more secure method for obtaining informative results. The evaluation of when to use the sampling method alone, and when in combination with other methods, is important. Cooperation with garden archaeological excavations could be the most beneficial way if the sampling method was used outside the excavation area for test pits. Similarly, sampling in the fringe areas of settlement excavations, for example in rural sites, could be advantageous. Borders of settlement areas could perhaps be detected by surveying macrofossils of useful plants and cultural weeds from soil samples of small sampling pits collected systematically around the supposed settlement. Sampling could also find the places of settlement sites from the areas where settlements are assumed to have been located. In excavations, where for example time resources limit how deep a shovel-test-pit or a test ditch can be dug, the depth could be extended and bedrock maybe reached more quickly with the sampler from the bottom of a pit or a ditch.

The sampling method could be used for applications other than macrofossil analysis, when the interest is focused on the soil of a site studied, concerning for example analyses of pollen, insect remains, charcoal particles, animal and fish bones, and chemical characteristics of the soil. Moreover, environmental conditions and nutrient content of soils in gardens and other sites, such as deserted medieval villages and rural sites, could be defined from sampled macrofossils. Furthermore, within larger garden archaeological investigations, some garden structures, such as paths, could be verified from boreholes with a sampler, when a ground radar survey first has given signals of them.

For future studies of historical gardens, collaboration between a garden archaeologist and an archaeobotanist would be most recommendable to gain the best information possible from a site, and to form the best possible interpretation of the results as a whole. If possible, in garden sites, macrofossil analysis should be carried out both from garden soil and from cultural layers of building structures and waste pits of the site, if these exist, since remains of garden plants can be found even more often from the latter ones.

Analyses of plant remains have been carried out in garden sites in Finland, but too often the results have been left aside in overall interpretations of the history of the sites. In future garden-archaeological and garden history studies, the importance of archaeobotany and plant macrofossils should be remembered, since it is particularly a question of plants in gardens. In Finland, there is a need for archaeological and archaeobotanical research at sites connected to gardens without written sources. An interesting task in the future could be to investigate garden sites that are known to have different phases in their history, such as the ones in this study. In sites that have no written sources from the oldest phases of gardens, diverse time layers of gardens could be established through excavations and archaeobotanical analyses. An example of this kind of site could be Suitia Manor, where a garden existed almost five hundred years ago, with differing stages later on (e.g., Härö & Piispanen 2001). As the tendency was shown in this study, especially in the Naantali case, it may be possible to demonstrate chronological changes in vegetation, garden cultivation and plant consumption of sites studied through radiocarbon-dated macrofossils from different excavated layers.

Garden history is such a wide area for research that all different disciplines and perspectives from art history to archaeology and archaeobotany should be involved. Most importantly, the discussion and collaboration between the disciplines should be kept alive. Garden history research is important because it can, in addition to increasing the knowledge of the field, also give information and influence for present and future gardening, landscape management, and garden planning. Awareness of garden history could turn to an important maintenance of present garden vegetation. By means of gardening essential vegetation could be gained into urban environments. By protecting old gardens and parks in cities and their surroundings, and by introducing green roofs, green walls and sheltered roof gardens into cities, gardens could be part of very tight urban architecture. The past horticultural practises can elucidate an attitude towards such gardening where a garden is run for environmental benefit, usefulness, profit, beauty and pleasure at the same time, without excluding one for the other.

NOTES

Parts of the text in introduction and conclusions will be published also in the paper: Alanko, T. & Lempiäinen-Avci, M. (forthcoming) Planted, designed and managed landscapes – A review of Finnish garden archaeology from an archaeobotanical perspective. In: Current research in Finnish landscape archaeology. *MASF* 6 (*Monographs of the Archaeological Society of Finland*), in the part of that paper written by the author of this dissertation. Publishing the text here has the permission of the editor-in-chief of *MASF* Ulla Rajala.

ACKNOWLEDGEMENTS

When I started this PhD work, I did not quite know where it would lead me. I just hopped in with curiosity and began to learn what it would be. It turned out to be a long edifying journey with some bypaths along the way. Fortunately, this journey made possible to meet with many wonderful people, who gave me their time and shared their wisdom.

I am very grateful to Jens Heimdahl for examining my thesis and acting as opponent in the defence. I have followed and admired his work with great interest; he has been an inspiring example of an archaeobotanist in his work. I wish to thank Paula Utigard Sandvik and Sirkku Pihlman for pre-examining my thesis and for giving me valuable comments with which I could finalize my thesis; and Jouko Rikkinen for acting as custos in the defence.

My supervisors Leif Schulman, Terttu Lempiäinen and Teija Alenius guided me through this challenging, instructive, most interesting and occasionally also rocky path from the beginning to the finish. I am very grateful to Terttu Lempiäinen who supervised me to the field of archaeobotany in the first place and continued teaching me the details of the field; to Leif Schulman who, in addition to patient supervision, enabled my working facilities in Finnish Museum of Natural History, and also acted as my co-author and helped me with the preparation of the manuscripts and with the language revisions of them; to Teija Alenius who, in addition to supervision, carried out pollen analyses from Uppsala Linnaeus Garden and Kaisaniemi Botanic Garden, and helped me with the manuscript preparation. I also want to thank the members of my thesis advisory committee, Leena Lindén, who helped me with statistics, and was my mentor with many helpful e-mail-discussions on the way; and Henry Väre, who was my immediate superior in Luomus, who gave me valuable comments and references, and encouraged me to write the Chapter II.

I want to address my grateful compliments to Kone Foundation for the scholarship for this PhD thesis work; and to Finnish Museum of Natural History, and Societas pro Fauna et Flora Fennica for funding the working as well; to City of Helsinki, Maiju and Yrjö Rikala Garden Foundation [Maiju ja Yrjö Rikalan Puutarhasäätiö], Societas pro Fauna et Flora Fennica, and Suomen Biologian Seura Vanamo [Societas Biologica Fennica Vanamo] for funding the AMS-radiocarbon dates; to Kaarlo and Irma Koskimies Fund for a travel grant, which enabled sampling in Uppsala and Turku.

I would like to give appreciative compliments to Veli-Pekka Salonen for counsel, and Department of Geosciences and Geography in Helsinki University for borrowing the sampler. Appreciative compliments also go to Päivi Luppi and Tuuli Timonen who helped me in the beginning with their advice; to Magnus Lidén, Mats Block, Karin Martinsson, Annika Windahl Pontén, and especially to Lena Hansson and the gardeners in the Linnaeus Garden and the Botanic Garden of Uppsala University in 2007–2008 for their kind help; to Länsstyrelsen Uppsala län for the permission to collect samples in the Linnaeus Garden; to Aki Pihlman and Turku Museum Centre for the permission to collect samples from the site of the former Turku Academy Garden; to Markku Heikkinen and Helsinki City Museum for the permission to collect samples from Kumpula Manor area; and to National Board of Antiquities in Finland for the permission to collect samples from both; to Johannes Enroth for helping me through the final practicalities; and to Plant Biology in Department of Biosciences for enabling the position for PhD studies.

I want to address my sincere thanks to my co-author Markku Oinonen for discussions concerning AMS-radiocarbon dates; to my co-author Kari Uotila for being most helpful, encouraging and open-minded with my Naantali studies; to Georg Haggrén, who has taught me so much about historical archaeology; and to everyone else in Archaeology Unit in Helsinki University, who have taught and helped me open-hearted to become almost an archaeologist.

I am both very happy and grateful that during this work I have had the opportunity to get to know many colleagues, who have helped me with my work with fruitful discussions, but also become my friends, especially Mia Lempiäinen-Avci, Nina Edgren-Henrichson, Tytti Juhola, Santeri Vanhanen, and Annemari Tranberg, thank you all. Although I have carried out my everyday work mainly in my own peace, since there are so few archaeobotanists in Finland, I still have been fortunate to join some inspiring groups: Nordic Archaeobotany Group (NAG), which has offered a cheerful, informal society of colleagues and wonderful experiences in the meetings; FORUM för trädgårdshistorisk forskning, which has welcomed me warmly and offered me a wider perspective to the research, especially Aja Guldåker; and Seminar Group of Historical Archaeology in Helsinki University, which has offered me the opportunity to discuss about my unfinished papers, as well as to hear about other on-going studies.

I want to address my thanks to Pertti Uotila, who has patiently shared the too small workroom and a microscope with me; to Marko Hyvärinen and everyone else in the Botany Unit in Luomus, who have helped me and made me feel cosy. Sincere thanks to Terttu Lempiäinen, Santeri Vanhanen and Mia Lempiäinen-Avci for the identification help of macrofossils; to Santeri Vanhanen and Pekka Malinen for photographing the seeds; and to Seppo Alanko for the image editing of the photos, the graphics, and the layout of this book.

I also want to thank my family and my friends. As much as my mother has been encouraging, I know my late father would had been too, also with his example of research, as my sister. My dear friends, Johanna, Minna, Karoliina, Katja, Gabriela, Päivi, Milla, Mia, Maiju, Riina, Piia and Miia, none of them in the field of archaeobotany, but in many different ones, have given me the perspective by showing the lovely variation of paths of life, and gently pushed me forward by asking: when. And finally, my dearest three children, who have kept me down to earth during these years of my studies (with comments: “no offence mom, but that is not the most important thing to do”, but also, however: “I want to be an archaeobotanist too”); and my dear husband Seppo, who has been the most precious support to me, never questioning the reason of my research, but always letting me go my own way.

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Appendix 1. Characters of soil in the soil samples collected from the four garden sites in Kaisaniemi, Kumpula, Uppsala and Turku.

Kaisaniemi 18.-23.4.2008, altogether 23 soil sampels

Collected with sampler = Sa; collected from profile =Pr

Sample	belowground cm	Sa	Pr	Soil type
K1/1	43-49	x		dark brown, sandy, dry, loose, (compost)soil
K1/2	50-57	x		–
K2/1	45-53	x		sandy soil, clayey on the bottom
K2/2	53-65	x		more clayey and moistly than the previous sample
K2/3	65-72	x		more clayey than the previous sample, water seeping into the pit
K2/4	72-80	x		dark brown gyttja, in water
K3/1	46-54	x		loose (compost) soil, ochre, clay
K3/2	54-58	x		big pieces of brick
K3/3	58-66	x		more sand than in the previous sample
K3/4	66-73	x		stone
K4/1	36-40	x		topsoil, stone
K4/2	40-50	x		topsoil
K4/3	50-58	x		clayeye topsaoil/(compost) soil
K4/4	58-65	x		greyish and clayey on the bottom, dry
K4/5	65-70	x		dry clay
K4/6	70-76	x		dry brownish clay
K5/1	40-53	x		loose, dry clayey (top-/compost) soil
K5/2	53-61	x		loose, dry clayey (top-/compost) soil, pieces of crushed brick
K5/3	61-63	x		dryer and less clayey than the previous sample, pieces of brick
K5/4	63-69	x		stone
K6/1	51-63	x		clayey, crusched bricks
K6/2	63-73	x		clayey, dry, piece of brick
K6/3	73-87	x		grey wet clay, pieces of bricks, mortar, water seeping into the pit

Kumpula (Gumtäck) 7.-14.4.2008, altogether 38 soil samples

Sample	belowground cm	Sa	Pr	Soil type
G1/1	15-20		x	clayey soil mixed with sand
G1/2	20-25		x	clayeye topsoil mixed with sand
G1/3	25-30		x	topsoil
G1/4	30-40		x	topsoil
G1/5	40-51	x		topsoil, loose, dry
G1/6	51-60	x		more sandy and clayey than the previous sample
G2/1	62-77	x		light brown sand
G2/2	82-92	x		light brown sand
G2/3	92-104	x		–
G2/4	104-107	x		–
G3/1	43-55	x		topsoil
G3/2	55-63	x		topsoil, crushed bircks
G3/3	63-70	x		–
G3/4b	23-33		x	light brown sand, ochre
G3/5b	33-43		x	light brown sand, ochre
G3/6	73-86	x		–
G3/7	86-98	x		–
G3/8	98-108	x		–
G4/1	36-48	x		greyish brown and orange clayeye soil, wet, sandy
G4/2	48-51	x		light brown gyttja clay
G4/3	58-67	x		light brown gyttja clay, sand, water seeping into the pit
G5/1	25-32		x	topsoil
G5/2	32-38		x	ochre brown sandy soil
G5/3	38-45		x	ochre brown sandy soil
G6/1	25-34		x	–
G6/2		x		–
G6/3	35-43		x	–
G7/1	42-52	x		water seeping into the pit
G7/2	52-58	x		stone, dirty brown clayeye moist sand
G7/3	26-36		x	topsoil
G8/1	40-56	x		tospoil mixed with clay
G8/2	56-62	x		dry tospoil mixed with clay
G8/3	62-71	x		dry tospoil mixed with clay
G8/4	71-77	x		more clayeye and sandy than the previous sample
G8/5	77-87	x		more clayeye and sandy than the previous sample
G8/6	87-95	x		more clayeye, sandy, loose and dryer than the previous sample
G8/7b	22-27		x	grey clay
G8/8b	27-36		x	under the clay layer: light stripe, topsoil stripe and ochre

Uppsala 26.-27.5.2008, altogether 34 soil samples

Sample	belowground cm	Sa	Pr	Soil type
U1/1	27-34	x		dry topsoil, crushed bricks, roots
U2/1	15-24	x		hard, dry, sandy, more soil on the bottom
U2/2	24-32	x		–
U2/3	32-34	x		–
U2/4	34-42	x		–
U2/5	42-52	x		dry sandy (top)soil
U2/6	52-59	x		some clay mixed with the soil
U2/7	59-59	x		stones on the bottom of the sample
U3/1	8 cm-14	x		clayey soil
U3/2	14-21	x		clayey, sandy, dry soil, pieces of brick and mortar
U3/3	21-30	x		more sandy onthe bottom of the sample
U3/4	30-37	x		sand; and under the sand clearly more clayey
U3/5	37-45	x		brown, dry, loose clay
U3/6	45-51	x		stones
U3/7	51-59	x		brown, dry, loose clay
U3/8	59-70	x		on the bottom of the sample the clay turns more light, crushed brick
U3/9	70-79	x		–
U3/10	79-88	x		–
U3/11	88-96	x		–
U4/1	27-39	x		tight clayeye soil, slightly crushed brick
U4/2	39-45	x		–
U4/3	45-55	x		soil mixed with mortar
U4/4	55-65	x		–
U4/5	65-72	x		–
U5/1	40-56	x		clayey, soft, moist (compost) soil, crushed brick
U5/2	56-70	x		brownish grey clay on the bottom
U5/3	70-81	x		–
U5/4	81-90	x		–
U5/5	90-100	x		–
U6/1	37-47	x		loose topsoil
U6/2	47-54	x		–
U6/3	54-62	x		the soil becomes more clayey
U6/4	62-70	x		–
U6/5	70-78	x		–

Turku 28.-29.4.2008, altogether 40 soil samples

Sample	belowground cm	Sa	Pr	Soil type
T1/1	45-56	x		clayey (compost) soil, crushed pieces of brick, dry and loose
T1/2	56-64	x		clayey (compost) soil, crushed pieces of brick, dry and loose
T1/3	64-75	x		clayey (compost) soil, crushed pieces of brick, dry and loose
T1/4	75-81	x		clayey (compost) soil, crushed pieces of brick, dry and loose
T1/5	81-83	x		clayey (compost) soil, crushed pieces of brick, dry and loose
T2/1	22-32		x	clayey (compost) soil, crushed brick and mortar, dry and loose
T3/1	32-40	x		loose, dry soil with mortar, pieces of brick on the bottom
T3/2	40-47	x		loose, dry, more clayey (compost) soil, pieces of brick
T3/3	47-55	x		loose, dry, more clayey than the previous sample, (compost) soil, pieces of brick
T3/4	55-61	x		loose, dry, more clayey (compost) soil, pieces of brick
T3/5	61-68	x		brownish grey dry clay
T3/6	68-74	x		brownish grey dry clay
T3/7	74-82	x		brownish grey dry clay
T3/8	82-90	x		brownish grey dry clay
T4/1a	14-16		x	charcoal
T4/1b	45-57	x		brown loose soil, crushed bricks
T4/2	57-63	x		brown loose soil, crushed bricks, more clayey than the previous sample
T4/3	63-65	x		brown loose soil, crushed bricks, more clayey than the previous sample
T5/1	41-50	x		sandy soil, pieces of brick and mortar
T5/2	50-59	x		sandy soil, pieces of brick and mortar with dry clay
T5/3	59-68	x		sandy soil, pieces of brick and mortar with dry clay
T5/4	68-75	x		sandy soil, pieces of brick and mortar with dry clay
T5/5	75-80	x		dry soil mixed with clay
T5/6	80-86	x		dry soil mixed with clay
T5/7	86-89	x		dry, loose, brownish grey clay
T6/1	8 cm-13		x	dry (compost) soil mixed with clay, charcoal
T6/2	20-32	x		brownish black (compost) topsoil
T6/3	32-40	x		loose topsoil
T6/4	40-47	x		loose topsoil
T6/5	47-52	x		loose topsoil with a little mortar and brick pieces
T6/6	52-57	x		loose topsoil with a little mortar and brick pieces
T6/7	57-62	x		loose topsoil with a little mortar and brick pieces
T7/1	31-36	x		loose, dry sandy (compost) topsoil
T7/2	37-47	x		dry, loose, topsoil mixed with clay
T7/3	47-56	x		dry, loose, topsoil mixed with clay
T7/4	56-64	x		dry, loose, soil mixed with clay, more clayeye than the pervious sample
T7/5	64-73	x		dry, loose, soil mixed with clay, more clayeye than the pervious sample
T7/6	73-81	x		tight brownish grey clay
T7/7	81-91	x		tight brownish grey clay
T7/8	91-102	x		tight brownish grey clay