Urbanised Nature in the Past
Site formation and environmental development
in two Swedish towns, AD 1200-1800

Jens Heimdal
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This doctoral thesis has five appendant papers, listed below. They are referenced by their roman numerals in the text. All figures included in the thesis are original illustrations made by the author.

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Paper II
Heimdahl, J.: Urban Sediments as Indicators of Changes in Land use and Building Tradition in two Swedish Towns, AD 1200-1800 in two Swedish Towns. Manuscript

Paper III

Paper IV

Paper V
Heimdahl, J.: Archaeobotanical Evidence of Early Tobacco Cultivation in Norrköping, Sweden. Manuscript accepted by Vegetation History and Archaeobotany
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Abstract

In order to explore site formations and reconstruct environmental development in Medieval and Post-Medieval towns, urban occupational strata in Norrköping and Karlstad were studied according to biostratigraphy, sedimentology and pedology. New field procedures including continuous pilot sampling, parallel archaeological and geological stratigraphic interpretation, and on-site analysis of plant macrofossils were developed and applied at archaeological excavations in both towns. Representation of both disciplines in the field during excavations greatly contributed to more complete field interpretations.

Stratigraphical analyses indicate that geological processes have been active in both towns, and reveal similarities in site formation. The earliest proto-urban phase is represented by the presence of dark earths, formed by the combination of alluvial processes and cattle trampling. Alluvial processes were common in Karlstad due to the flooding of the river delta, and in Norrköping due to the sloping topography. Both situations were enhanced by human activity, which caused drainage problems. A significant change in composition and origin of house foundation fill was also noted. The oldest foundations contained fine-grained material of local origin in contrast to younger foundations, which contained coarser material, sometimes of regional origin. This is interpreted as a professionalisation of the urban building tradition, which in Norrköping occurred during the beginning of the 17th century and in Karlstad during the 18th century. Site formations of urban strata are regulated by three major factors: deposition, post-depositional soil formation and erosion/truncation, which all may occur both culturally and naturally.

Plant macrofossil analyses in Norrköping and Karlstad resulted in a fossil record with a total amount of 203 and 169 different types of plant species and taxa respectively. The records indicate that site formation processes seem to have been inhibited during wintertime. The results also confirm the idea of the early Scandinavian towns as rural, also during the Post-Medieval time. The finds of cultural plants in Karlstad indicate 18th century cultivation of Fragaria moscata and 17th century import of Pimento officinalis. In Norrköping remains of beer additives confirm that the tradition of combining Humulus lupulus and Myrica gale disappeared after the 15th century, but also indicate the use of Filipendula ulmaria as a beer addative. Finds of seeds from Nicotiana rustica suggests that tobacco cultivation occurred in Norrköping 1560-1640, which is some decades earlier than known so far in Sweden.

Keywords: Urban stratigraphy, environmental reconstruction, site formation, geoarchaeology, dark earth, macrofossil analysis
1 Introduction

Towns are often built on older remains called ‘urban occupational deposits’ that contain information about the history of the town. Geological and biological remains are mixed and interbedded with archaeological traces of houses, streets and artefacts (man-made objects). In other words, urban occupational layers do not only contain ancient cultural remains, but also environmental archives from which palaeoenvironmental records can be extracted. Urban nature occurs alongside and intermingled with the cultural life in a town, and adapts to and affects urban cultural expressions. In this way, the study of urban nature results in the knowledge about urban culture, and thus we may find examples throughout history of the reactions and responses in the relation between culture and nature.

Traditionally, the main focus of geological and biological studies have been placed on the ‘undisturbed’ nature – the nature untouched and unaffected by humans. In later decades, with growing concern about the anthropogenic effects on the environment, studies of ‘disturbed’ nature have become more common. Among culturally affected areas, the urban environment can be considered the most extreme. Geological and ecological studies of towns – urbanised nature – is however a young and growing discipline (Gilbert 1989, McDonnell & Pickett 1990, Botkin & Beveridge 1997, McDonnell 1997, Walbridge 1998, Nilon et al. 1999). In this field, studies of the palaeoecological traces in urban occupational layers may contribute new perspectives (e.g., Latalova et al. 2003, Wittig 2004). The term ‘urban’, used in the title of this thesis, has been defined in many different perspectives, for example according to law, history and demography. I use this term to characterize a specific type of environment. The definitions will be more carefully discussed in the chapter “Urban occupational deposits”.

The foundation of palaeoenvironmental studies of urban areas is the interpretation of the urban stratigraphy. It is important to understand the site formation processes of urban occupational deposits, since these deposits derive from both cultural and natural processes. Ideally, archaeologists and Quaternary geologists should perform the field interpretation together. However, the archaeological method of recording and interpreting urban stratigraphy, developed during the last 25 years, has often proven to be difficult and demanding to combine with the methods used by visiting geologists (cf., Lucas 2001).

The present thesis is based on site studies and analyses of samples collected from two urban excavations performed within the frames of so called ‘rescue archaeology’. A rescue excavation is conducted as a controlled form of the destruction of material that is classified as cultural heritage when making room for new constructions. The task of archaeologists is to retrieve, document and interpret the archaeological remains, leaving a description and interpretation in its place. Ideally the description should leave possibilities for researchers in the future to make new interpretations. In Sweden rescue archaeology is financed by those responsible for the exploitation of the ground where ancient remains are present. Economical frameworks defined by the county administrative board limit the excavation time and the analytical work performed after the excavation. It affects also the choice of strata that are to be documented. Generally urban occupational deposits in Sweden that are older than the 18th century are considered to be part of the cultural heritage and are classified as ancient remains that should be preserved. Younger strata are excavated without documentation.

Figure 1: (A-B) location of the investigated towns of Norrköping and Karlstad in southern Sweden.
The sites investigated within this study are situated in Norrköping and Karlstad, middle Sweden (Fig. 1). The main aims are: I) To develop methods for integrated fieldwork between archaeologists and Quaternary geologists/palaeoecologists (Paper I). How can the members of the different disciplines adapt their working procedures to utilize each other's capacity of interpretation? II) To reconstruct site formation and environmental development at two urban sites (Paper II-V).

Reconstructions of site formation and environmental development are performed according to two main perspectives. Site formation is mainly studied by sedimentology and pedology, an approach that I refer to as ‘geoarchaeological’ (Paper II). Environmental development is principally studied from the perspective of biostratigraphy/archaeobotany (Paper III-V). However, the two perspectives of geoarchaeology and archaeobotany are sometimes integrated to confirm or contradict specific results.

This thesis has been written from the perspectives of Quaternary geology and palaeoecology/archaeobotany. The environmental development of Karlstad and Norrköping has been previously studied from the perspectives of archaeology and history, studies which I take into account, and the conclusions of which are compared with the results and conclusions in this thesis. Hence, it is my intention that archaeologists and historians, as well as Quaternary scientists and botanists, should be able to understand, use and scrutinize this research. Accordingly, the different disciplines require an introduction and my basic approach to this interdisciplinary work is presented below.

2 Interdisciplinarity

The description and interpretation of objects and subjects may be facilitated if they are approached from different disciplinary perspectives. Geological deposits may contain biological remains and hence, a biological perspective can contribute to the understanding of the deposit. The objects of the archaeological study are the remains of material culture, which are also possible to study according to the methods of natural sciences, history and social sciences.

These statements and examples may sound trite, but while they are easy to make, they are, however, difficult to implement.

Geology and archaeology

Since the disciplines of geology and archaeology traditionally belong to different faculties, natural sciences and art, this may give an impression that they are fundamentally different. It has been stated that: “...archaeology […] straddles the gulf which separates the arts from the sciences.” (Hodder 1992). But I don’t believe that it is so. I don’t think there is a gulf.

A popular opinion concerning those differences is that natural sciences are based on empirical principles and use quantitative methods while the humanities are based on hermeneutical principles and mainly use qualitative approaches. This is incorrect; the fundamentals of both disciplines rest upon empirical principles and hermeneutics (sensu lato interpretation – not only of text) and use both quantitative and qualitative methods (Kieffer 2005). For example, geological interpretation of stratigraphical sequences is inherently hermeneutic and qualitative. Similarly, the botanical identification of plant remain based on morphology, is qualitative. These studies can be quite subjective, perhaps more so than either discipline would like to admit.

There is currently a debate among Scandinavian archaeologists concerning the question of what may be considered archaeology (Svestad 2004; Wienberg 2004; Cornell 2005; Hegardt 2005; Herschend 2005; Karlsson 2005; Kristiansen 2005; Notelid 2005; Rundqvist 2005). It relates to the criticism of post-processual archaeology, which emphasises the symbolic meaning of material culture, partly as a reaction to positivistic trends, the so-called ‘New Archaeology’ that influenced archaeology in the 60s and 70s and attempted to reform archaeology to become more like the natural sciences. The debate is ongoing and trends are developing in all scientific disciplines but I would like to emphasise that my studies of archaeological material from a perspective of natural science are not to be seen as a contribution to this debate. I will not debate the nature of archaeology, only some of the study objects of archaeology, although from a different perspective.

Some of the differences between humanities and natural sciences fall back on the classic and controversial question of what is considered nature versus culture. One perspective is that humanity exists beside or on the top of nature and that human activity (culture) is considered separate from nature. The contrasting perspective is that humanity is part of nature and that culture should be considered as a part of nature as well.

The controversial aspect of these questions partly derives from the definitions of the terms that apply to societal values. ‘Nature’ is often used as synonymously to positive terms such as ‘normal’, ‘ordinary’,
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‘usual’, ‘regular’ or ‘original’, and to describe something that is ‘good’, ‘harmonious’ or according to a higher or ‘God-given’ purpose. On the other hand, the term ‘culture’ is more complex, referring to a way of life, customs, beliefs, art, identity etc. It may refer to something sophisticated but also something that opposes nature – something ‘unnatural’.

From the perspective of natural science, humanity might also be seen as a part of nature because humans and human culture are observable in the physical world. This does not mean that all aspects of humanity and culture can or should be studied according to the methods of natural science. In fact, most cultural aspects are far too complex for these methods and instead, require methods from the humanities and social sciences. In the following, I will use the term ‘culture’ to describe human activity while ‘nature’ will be used for everything that is not cultural. It is merely a practical use that results from the need to separate human actions from non-human actions, not a moral statement. In this regard, it is also important to note that irregardless of whether we include culture as part of nature or not, nature and culture strongly affect each other and often in such a way that cause and effect are difficult to distinguish. It is not always possible to separate nature and culture, and it is in such cases that interdisciplinarity is put to the test.

**Interdisciplinary urban research**

A multidisciplinary approach is to study an object from the perspective of many different disciplines parallel to each other. This multidisciplinary work becomes interdisciplinary in the dialogue between the different disciplines, and when they thereby affect and influence each other.

In this study the objects consist of the physical remains of towns – urban occupational strata. These strata, and some of the processes that have caused them, may be studied from the perspectives of archaeology and natural sciences. However, some of the causes behind the processes may be of such nature that they only can be understood by the use of historical or sociological methods, even if the physical object itself cannot be explained according to those methods (Fig. 2).

Since the end of the 19th century, urban occupational deposits have been considered part of our cultural heritage and the main responsibility to investigate them has fallen on archaeologists. European towns generally belong to the period defined as ‘historical’ – the period that can be studied through written sources. When archaeologists began to study the material from this period they collaborated with historians. The archaeological branch that studies remains from the historical period is called ‘historical archaeology’, and it has to consider different types of sources of information. The specific study of town remains may be called ‘urban archaeology’. In Sweden urban archaeology includes ‘Medieval’ and ‘Post-Medieval archaeology’, two periods that are separated by the time of reformation of the church defined at AD 1527 by king Gustavus Vasa. Urban archaeology has undertaken many questions that traditionally fall within social sciences and human geography, questions important to the urbanisation process.

Many archaeologists remedy the need for multidisciplinary knowledge by taking supplementary training in Quaternary geology, and there are archaeologists that are also good geologists or geoarchaeologists.
This supplementary knowledge is however not enough to cover the need at all excavations.

Archaeologists and geologists work with different scientific questions, not only because of the differences in the study objects, but also because of the differences in disciplinary background. Archaeologists need not only to determine what process or behaviour has formed a certain record, but must also ask questions about why this process or behaviour occurred and attempt to understand the context of social interaction behind it (cf., McLees et al. 1994, Larsson 2000). Geologists need to ask questions about the mechanisms behind processes but since those processes traditionally do not include human activity, social interactions are not normally considered as a factor. If a geologist works with occupational layers, the processes behind these layers may be caused by social interactions and should therefore be considered. However, since geologists generally lack the necessary knowledge concerning cultural explanations, the interpretation process should be performed in conjunction with archaeologists or/and historians (Fig. 2).

Occupational layers and archaeological stratigraphy

The sediments that compose the stratigraphy in occupational sites may be of natural or cultural origin. Natural deposits that can be formed within, or cover an occupation may be of eolian (wind transported), alluvial (water transported) or colluvial (gravity transported) origin but most common are depositions created by humans. Such deposits are called ‘occupational layers’, ‘occupational deposits’ or sometimes ‘cultural layers’. It is here worth mentioning that the geological terminology concerning occupational deposits is poor. On the maps of Quaternary deposits published by the Geological Survey of Sweden (SGU), urban occupational layers are marked as “Artificial fill: the original ground surface is covered by an alien material” (Persson & Svantesson 1994). The word ‘alien’ may here also serve as an example of how humans sometimes are viewed from the perspective of geology. The archaeological terminology is hence developed independently from geology. A general difference between geological and archaeological stratigraphical methods is that those used by archaeologists, to a greater extent, are focused to describe the surfaces buried within the stratigraphy (contacts between layers called ‘interfaces’). Geological terms and methods are more focused around the layers and sediments themselves and their changes with depth.

Different definitions of ‘occupational layer’ exist, partly because field-terminology varies locally and also because of the methodological development within stratigraphy. Traditionally there has been a need for archaeologists to separate stratigraphical units formed intentionally, like fill used as foundation for houses or other buildings, from units that are formed unintentionally, either by cultural or natural action. Strata formed intentionally may in fact be considered as artefacts (cf. Arrhenius 1996) since humans create them, and their form and placement may reveal information about the people that formed them. On the other hand, strata formed unintentionally, for example as a secondary effect of a cultural activity, may reveal information about this activity also by its content.

Figure 3: Many excavations during the first half of the 20th century were performed according to the ‘Box and baulk system’. The excavations were performed according to a regular system of rectangular areas. The bottom of the pits was always horizontal and often cut through strata that were dipping. Stratigraphic control was poor and stratigraphic interpretation difficult.
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...tation”. Beside those slowly and continuously deposited sediments called ‘accumulations’ (Sw. *avsatta lager*), there were also intentionally created layers called ‘depositions’ (Sw. *påförd lager*), which were not to be considered occupational layers. The idea was that the unintentionally accumulated occupational layers that successively had been growing during occupation (due to the habit of waste handling) would contain more information about the everyday life on the site than the intentionally formed deposits. Järpe *et al.* (1979) also called this type of occupational layers ‘cultural gyttja’ and presented a number of symbols, representing different types of layers, to be used within section drawing (Fig. 4). The type of layers presented in the system were, however, not explained and defined, and even though many of the words used (such as ‘peat’, ‘gyttja’, ‘alluvial layer’ etc.) were of geological origin, it is obvious that the definitions used by the authors were not geological. For a period the paper by Järpe *et al.* and the symbols they presented had a great influence on stratigraphical methods in Sweden (Larsson 2000, Tagesson 2000a) since it contributed a tool to handle stratigraphy in a more interpretative way. It also seems to have corresponded to former ideas about site formation process in Britain (Matthews 1993).

During the 80s Andrén (1985, 1986, 1989a, b) introduced the terms ‘latent’ and ‘manifest’ which aimed to separate deposits formed due to unintentional action from those formed by intentional acts. Since the different deposits are formed according to different degrees of intent, they have to be separated and sometimes interpreted in closed contexts (cf. Andrén 1989a, b). The ideas of different degrees of intent in site formation processes have also been discussed by Florén and Dahlgren (1996) who suggested a separation between ‘acts’ (intentional acts) and ‘behaviour patterns’ (acts according to habits without specified intention).

The need for better stratigraphic control within urban archaeology was emphasised by Beronius-Jörpe-Land (1992) and a broader definition of occupational deposits was suggested. She suggests that all deposits created by humans are to be called ‘occupational deposits’, and stressed the importance of separation between depositional and post-depositional processes.

During the 80s and 90s there was a continuous development of excavation techniques, although they differed locally. The technique of excavating stratigraphically was developed. One stratum at a time was excavated and the extension of the stratum was followed horizontally. By this method it was possible to uncover and separate old ground surfaces, which made the interpretation of the site development easier (e.g., Anund 1995, Ros 1996, Larsson 2000).

A considerable shift in excavation techniques, especially at urban sites, occurred in the beginning of the 21st century. The shift had its prologue in 1993 when the method of so-called Single Context Recording (hence referred to as SCR) was introduced in Sweden after experiences from Norway (Larsson 1993). SCR is a stratigraphic recording method adapted to archaeology that deals with complex stratigraphy. It was developed in Britain by Edward...
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Harris (Harris 1979 and Harris et al. 1991) and was built on the idea of classifying and uniting different stratigraphical units (which are defined as consisting of ‘depositions’ and ‘interfaces’) and artefacts into time dependent contexts. The contexts are in turn connected to groups. The stratigraphical relation between those units, contexts and groups, are illustrated by the drawing of a so-called ‘Harris Matrix’ (Fig. 5). This type of matrix was used earlier, for example at Helgeandsholmen in Stockholm but the excavation only used parts of this method (Broberg & Douglas 1983). In this method both layers, interfaces and “negative” units, such as holes, are given the same treatment. The method has proven to be a powerful and effective tool in order to document and interpret stratigraphical information, and it forces the user to carefully consider all strata and contacts.

SCR has dominated urban excavations in the latest years, for instance at excavations in Lund from 1993 (Larsson 1993, 2000); Norrköping 1998 and 2000 (Hållans et al. 1999, Tagesson 2000b Karlsson et al. in press); Sigtuna 1999-2000 (Fogelberg & Wickström 2003) and Karlstad 2001 (Bäck 2002).

There has been criticism against the weaknesses within the SCR-system, for example the problem of catching the cultural activities within the time-gaps between the stratigraphical units described within the matrix (Fogelberg et al. 2004). Harris (1979) states that occupational layers consist of two components: depositions and interfaces. In the later years, the need for separating the strata into depositions and soil horizons (depositional and post-depositional remains) within the interpretation has been stressed (Heimdahl 2003, 2004). The depositions generally reflect short-term events, while soil horizons developed within the depositions are generated by the effect from a longer sequence of every-day activities.

In later years, the development of digital tools and GIS-techniques have greatly improved urban stratigraphical documentation and new techniques are tested alongside the use of SCR. Extensions of layers and positions of finds and samples are measured, digitalised and registered in GIS-programs (for example Arc-View). Also 3-D visualization of complex urban stratigraphy has been tested, for example in Naantali, Finland (Lehtonen & Uotila 2004).

The extensive redeposition that has occurred in urban occupational deposits sometimes makes it difficult to interpret finds therein. This has led to a need to classify different deposits according to the risk that its content (of for example artefacts) is redeposited. In Britain, a system of classifying finds into ‘primary’ (original) and ‘secondary’ (redeposited) positions has been in use, but was criticised by Roskhams (1992) as being too coarse. He instead suggested a system of four classes, relating the find to chronological, spatial and functional contexts. In Sweden, this system developed into a three-grade scale where the finds are classified as:

- primary deposited – according to original time, space and function contexts, for instance household tools dropped on the floor in the house where it was used.
- secondary deposited – contemporaneous but isolated from original context in function and space, for example waste deposits.
- tertiary deposited – redeposited material, isolated in time, space and function (Larsson & Johansson-Hevren 1998), for example material and artefacts in

Fig. 5: Example of application of Harris matrix (Harris 1979). In the matrix to the left stones are marked with boxes, layers with rings, holes with pentagons, and hole infillings with triangles. In this case, layer (4) is the settling sand for the cobbledstones (3). If this cobbled ground were interpreted as a part of the construction that was held up with posts, e.g. a shed, posthole (2) would also be a part of the shed-context, marked within the dotted line in the matrix. The hole infilling (1) is a later deposition and will not be a part of the context.
layers that are excavated and used as fill in new constructions on another site.

This system was later adapted to account for the depositions themselves (Tagesson 2000a). Tertiary deposits consisting of fill that is redeposited may then have had a primary function, for instance as a foundation for a house.

Clashes in terminology

When discussing terminology, we must assume that terminological use within a discipline often differs between different groups of researchers, both locally and regionally. However in this discussion, I refer to geologists and archaeologists, although simplified, as two homogeneous groups and discuss some similarities and differences that appear to be widespread.

Both geology and archaeology work with the physical material that holds information on past conditions, and both disciplines attempt to gain knowledge through the use of stratigraphic principles. Many of the stratigraphic terms used in archaeology derive from geology (c.f., Larsson 2000). It can therefore be presumed that archaeologists and geologists use the same stratigraphical terminology. This is partly true, especially when it comes to descriptive terms (e.g., ‘deposition’, ‘interface’) and technical terms (e.g., ‘gravel’ or ‘clay’).

However, there are major differences between the uses of terminology in the two disciplines. Archaeologists usually do not apply many terms used in geology. Examples are: ‘autochthonous’/’allochthonous’ and ‘concordance’/’discordance’, which are descriptive terms that probably would be useful also to archaeologists. Although when these terms have been used by archaeologists (e.g., Roslund 1997), other archaeologists have found them complicated (Larson & Johansson-Hervén 1998).

In other cases, archaeologists have developed their own terms to describe stratigraphy. Good examples are the terms referring to SCR and the use of Harris matrix. There are also examples of terms that are used by both disciplines but differ in definition. Some of those differences are necessary and depend on the differences in approach, objects of study and methods.

The different use of terms has led to interdisciplinary misunderstandings and conflicts. Since geologists often have a clearer view of terms associated with sediments and soils, sometimes archaeologists just leave it up to the geologists to classify the material. This can create a false sense that the material is classified according to strict and correct principles. This is perhaps so, but sometimes geological terminology is insufficient to describe the material that occurs in archaeological contexts, and the geologist may lack knowledge of the formation process of “archaeological” strata. Also, terms with common definitions used in archaeology may at times be more appropriate than geological or pedological terms when describing occupational deposits (cf., Heimdahl et al. 2003).

One example is the Swedish word torv, which has two possible translations in English: ‘peat’ and ‘turf’. In Swedish geological terminology torv is defined strictly as ‘peat’ – an autochthonous accumulation of plant remains, for instance vitmosstorv (Sphagnum peat) or starttorv (Carex peat). However, an older meaning of the word, probably of agrarian origin, is the uppermost vegetative zone of soils in grasslands – the root horizon (easy to cut with a spade to sods) of turf. In Sweden as in many other European countries, turf has been used as a building material, for example in ramparts, earthwork and as a cover on house roofs. At some archaeological sites, ground vegetation and root horizons may be covered and become preserved as buried horizons within the stratigraphy, which also may be considered turf. Furthermore different types of peat have been used throughout history. For instance, Sphagnum was used as a packing material, as ‘toilet paper’, as moist buffering material in beds and as litter in stables (Krzywinski et al. 1983, Geraghty 1996, Hansson & Dicksson 1997).

In some cases, when a site is located in a moist area (for instance an alluvial valley), peat may also have accumulated naturally in the urban environment.

It is possible to find both remains of peat and turf in urban occupational layers and of course, it is important to separate these two different types of material since they indicate different environmental origin and cultural use. This does not mean that the Swedish term torv should be applied only in one way but it is of great importance to be aware of the different definitions in order to clarify descriptions.

Another example of confusing terminology is the Swedish term jordart, which may be translated to ‘regolith’ – an unconsolidated deposit. It may have both a genetic definition like ‘till’, ‘glaciofluvium’, ‘littoral sand’, or a descriptive function, for example ‘gravel’, ‘sand’ and ‘clay’. Occupational deposits may also be referred to as a type of jordart. In Scandinavia, deposits of this type are of Quaternary origin but the term is also used to describe weathered material that may be much older in other parts of the world. The geological term jordart should not be confused with the pedological term jordmän, which corresponds to ‘soil’ – the upper part of a regolith that has been affected by post-depositional proc-
esses associated with physical, chemical, biological or cultural factors. The problem is that the English term 'soil' is not only used in the strict pedological definition but also in a more general manner, even by scientists. It does not then refer to a specific type of soil but either to all soils covering the world’s land area (Brady 1990), or at times to the material composing a soil or terrestrial sediment. This use may correspond to the word jord, which lacks a geological definition, but may sometimes refer to what in a geological definition should be considered a regolith (jordart). It may also be added that the term ‘earth’ is not used as a substitute for soil.

Many Swedish archaeologists are not aware of this complexity of definitions and do not notice when a British or American author refers to the pedological definition of soil or merely uses the word in a general, undefined way. For instance, it is common that archaeologists define culturally affected soil horizons as ‘occupational layers’. Since ‘layer’ refers to a deposit, and the culturally affected soil to the main part consisting of the minerogenic sediment that has been there before the occupation, this often leads to misunderstandings.

Torv and jord- (art/mån) are two examples of how problems concerning geoarchaeological terminology may arise. These, and many more examples not mentioned here, reveal the importance of awareness of the differences and similarities between the terminologies used within the two disciplines. Clear and open communication between the disciplines is necessary, not only through an explanation of terms, but also through a sensitive and receptive dialogue.

Stratigraphic terms used in this thesis

The urban occupational layers I have worked with are composed of two main physical units: depositional layers and post-depositional soil horizons. Since it is of great importance to keep these apart, I will use the terms sensu stricto according to the working definitions presented in Table 1.

3 Urban occupational deposits

Urbanisation and towns

Historians, human geographers and archaeologists have mainly performed research on the history of towns during the last 25 years. Before the 1970s, historians dominated the arena of urban science and at that time very few urban archaeological excavations had been performed in Sweden. Exceptions were the towns of Birka, Lund and Gamla Lådöse, where long traditions of urban archaeology existed. Large building projects during the 1970s and 1980s caused a huge expansion in urban archaeology. As a response to the need for information concerning ancient remains in towns, a project called ‘The Medieval Town’ (Sw: Medeltidsstaden) was initiated by the National Heritage Board (RAÄ). The aim of this project was to provide an overview of the urban medieval remains in Sweden, which concerned about 70 towns that were given privileges before the Reformation in 1527 (Forsström 1982, Andersson 2001, Lindeblad 2002).

The history of towns differs according to the definition of ‘town’. In the juridical aspect, a town is an area that has received special privileges to regulate trade. In Scandinavia, this system was first introduced in Denmark (11th century) and Norway (12th century). Therefore, the oldest Swedish towns, according to this definition, are located in areas that previously belonged to those countries. Lund and Helsingborg in the county of Skåne was founded in Denmark during the end of the 11th century. Kungshälla in the county of Bohuslän was founded 1130 in Norway. In Sweden, the system of town privileges was introduced during the early 13th century. Examples of early Swedish towns, according to this definition, are Visby, Söderköping and Sigtuna (Ahlberg & Redin 1994).

Another type of definition of town is social and structural, for example “a dense settlement, where inhabitants form a social unit in economic or/and juridical aspect according to common interests in trade” (Schück 1926). According to this definition, Scandinavian towns are older. Ribe in Denmark seems to have been founded as a central trading place in the early 8th century. Birka in Lake Mälaren (Sweden) existed c. 760-1000 AD, and many of the later medieval towns seem to have been founded upon older occupations, which in many cases may be called towns, for instance Visby and Sigtuna. Within the juridical definition of towns, those types of settlements are sometimes referred to as ‘proto-towns’ (Holmqvist-Olausson 1993).

Definitions related to the environmental aspects of the terms ‘town’ and ‘urban’ are also used among urban ecologists (cf., McIntyre et al. 2000). In urban ecology, the environment is often compared with rural areas along so-called ‘urban – rural gradients’ (e.g., McDonnell & Pickett 1990, McDonnell et al. 1997, Simmons et al. 2002, Moffatt et al. 2004). ‘Urban’ and ‘rural’ are then commonly defined according to population density in specific areas (e.g., McDonnell et al. 1997). Urban palaeoecology often confronts similar gradients, although
occurring chronologically, but there is generally a lack of information concerning population density. The term ‘urban’ is instead used to name a certain type of environment with specific characteristics. Early Scandinavian towns generally had a strong rural character since farms were often situated within the towns. This means that the early urban environments had rural character that eventually decreased and disappeared. Because of this process, the terms ‘urban’ and ‘rural’ are not mutually exclusive (cf., Clark 1992). I will use the term ‘rural’ as referring to an environment dominated by activities occurring in a rural economy (as crop processing and live stock handling), *n.b.* the degree of self-sufficiency not defined. The term ‘urban’ will refer to a densely and permanently populated area that is environmentally characterised by trade, craft and/or industry.

A central issue within urban history is the processes that give rise to the towns – the urbanisation. The causes behind urbanisation are complex. They include geographical, social, historical, economical and physical factors. Ambitions of a central political power often seem to have initiated the process. In Scandinavia, urbanisation occurred irregularly from the late Iron Age (Viking Age) until modern times (Andersson 2001).

**Urban deposits**

The character of urban occupational strata in Scandinavia differs not only between but also within the towns themselves. Compared to geological deposits, an urban stratigraphical unit varies on a smaller scale due to its cultural origin. Of course there are also many urban sites that lack older occupational layers, both because of uneven deposition and as an effect of truncation.

According to my own observations at urban excavations (in Norrköping 2000; Sigtuna 2001; Stockholm 1999, 2001; Lund 2003; Mariestad 2003; Karlstad 2003-2005 and Skänninge 2003-2005), as well as studies of records from older excavations (Börnios-Jörpeland 1992, Larsson 2000), some general features may be recognised.

Urban sites are commonly located close to the water (for instance, rivers, lakes or in coastal areas) since waterways were the natural routes for trade and transport. As a result, many towns have been exposed to flooding and alluvial deposits are often found interbedded within urban deposits. Water-logging of deposits is also common, which leads to anaerobic conditions. This inhibits the decay of uncharred organic material and leads to the preservation of organic material, for example plant remains.

The thickness of urban occupational deposits

<table>
<thead>
<tr>
<th>Term</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact and Interface</td>
<td>The boundary between layers/beds/deposits. Archaeologists most commonly use ‘Interface’ while geologists use ‘contact’.</td>
</tr>
<tr>
<td>Dark earth</td>
<td>A dark, organic rich stratum (generally over 2 dm thick) that commonly pre-dates the well stratified medieval and post-medieval urban occupational deposits in Scandinavia and Europe. Dark earths are more thoroughly discussed in Chapter 3.</td>
</tr>
<tr>
<td>Deposit, layer and bed</td>
<td>The terms are used synonymously for depositional units or sediments of natural or cultural origin. The material in layers and beds may have been deposited during a single event or by successive deposition, for example in water bodies where sedimentation of single beds may take some time. Layers, beds and deposits can be divided into subunits that are also called layers, beds and deposits.</td>
</tr>
<tr>
<td>Facies</td>
<td>A series of specific stratigraphical units developed during similar conditions (cf. Reading &amp; Levell 1996). The stratigraphy at the sites studied here is divided into four different Facies. A Facies may further be divided into subfacies.</td>
</tr>
<tr>
<td>Horizon or soil horizon</td>
<td>A post-depositional feature developed within a deposit/layer/bed by pedogenic processes under the influence of climate, soil chemistry and/or biology. Horizons in urban occupational layers are often developed by trampling by humans and cattle. When horizons are formed through several strata, contacts between layers can be destroyed and older stratigraphical features disappear or become obscured.</td>
</tr>
<tr>
<td>Phase</td>
<td>A term used by archaeologists (based on e.g. different building styles or other cultural habits reflected by artefacts) to separate time dependent units in a stratigraphy</td>
</tr>
<tr>
<td>Sediment</td>
<td>Transported and deposited minerogenic and/or organic material consisting of one or several layers.</td>
</tr>
<tr>
<td>Soil</td>
<td>Not used as a single word in this thesis in order to avoid confusion. It is, however, used to describe post-depositional process or strata e.g., soil horizon, soil process or soil bioturbation.</td>
</tr>
<tr>
<td>Stratum and unit</td>
<td>Refers to an unspecified stratigraphical unit that has not yet been classified as a layer/bed/deposition or a soil horizon or a combination of both.</td>
</tr>
</tbody>
</table>
seems to be dependent on local topographical features and therefore have a levelling effect on the urban topographical landscape, since they tend to fill depressions and become thinner on the top of hills (Fig. 6). In a flat landscape, the thickness of urban deposits is generally even. In Sweden, the thickness of urban deposits is up to 12 meters thick, excluding 19-21st century fills.

In many towns there is a general trend in the degree of stratification according to relative age. Younger units are generally thinner and more distinctly stratified than older units, which are often composed of thick (20-70 cm), dark, homogeneous strata rich in organic matter. Such old strata have proven difficult to interpret through archaeological methods. Internationally they have been called ‘dark earths’ (more thoroughly discussed in the following section). The upper, well-stratified strata are generally easier to interpret since they mainly consist of two main units: remnants of constructions (e.g., fills, houses and streets) and waste.

The material that constitutes urban deposits varies from minerogenic to more or less organic but is mostly a mixture of minerogenic and organic components. Charcoal, fragments of wood and faecal material from both humans and animals often dominate the organic component. Reworking processes were extensive, both due to deliberate actions such as digging and truncation, and unintentional effects of trampling by humans and animals. The material in the deposits is therefore often from different origins.

Dark earths

The term ‘dark earth’ (in some early texts referred to as ‘black earth’) originates from Britain and was coined to describe the thick, homogeneous, poorly stratified, dark soils that often separate the clearly stratified urban deposits of the Roman and Medieval Ages (Fig. 7). The term was traditionally associated with the abandonment and decline of urban environments during the early Middle Ages – the ‘Dark Ages’ c. AD 500-1000 (Norman & Reader 1912). Dark earths were formed as a result of cultural activities that occurred at former urban and proto-urban sites (Macphail et al. 2003). (Note that both ‘dark earth’ and ‘black earth’ are terms also used in the classification of natural Amazonian soils and humid step soils. Those natural soils have nothing to do with the dark earths found in the archaeological contexts discussed here.)

In later decades archaeologists in, for example Italy, Belgium and France (terres noires) have adopted the term. The European use of the term gave rise to a broader definition, and ‘dark earths’ are no longer considered to have been formed during a specific time period, in a specific urban environment, or by a specific human activity. The term is now more generally used to describe dark, thick (often 20-70 cm), poorly stratified stratigraphic, organically rich units that occur at archaeological sites. The genesis of dark earths on different sites is probably diverse. When occurring at urban sites, dark earth is usually associated with some type of urban decline, and the local environment is often interpreted as changing into waste ground or midden (Macphail et al. 2003).

Ideas about the processes that create dark earths have varied. Macphail (1994) showed that dark earth might be formed by natural soil formation due to total abandonment of the area. A ruderal flora may begin to grow in the house debris, giving rise to entisols or inceptisols (developed by earthworm and root bioturbation) in occupational deposits. Cattle grazing (Gebhardt 1997), middening (Macphail 1994), cultivation (Gebhardt 1997), market activities (Reece 1980), ‘backyard activities’ (Gebhardt 1997) and natural flood events (Corty et al. 1989) have all been used to explain the formation of specific dark earths.

In the 1980s and 1990s, a discussion took place in Italy concerning the formation process of dark earth. The question was whether the formation process occurred during a few years or decades, or longer time periods of hundreds of years (Macphail et al. 2003). In later years, it has been obvious that dark earth often reveals a more complex stratigraphy, obscured by the bioturbation (e.g., Sidell 2000).
adapted in this European aspect. The term *svarta jorden* ('black earth') has long been used to describe soils with occupational remnants rich in carbon dust, for example the soils in the area of the Viking Age town Birka on Björkö in Lake Mälaren. Use of this term is documented from 1683, probably as an adaptation to the terminology used locally (Haldorff 1683, Hyenstrand 1992). After this, and since the excavations during the 19th century (e.g., Stolpe 1871-1879), the term ‘black earth’ has been regularly used when referring to the complete stratigraphy of the occupational layers in Birka (c. 1-2 m thick). Also, well-stratified units preserved within the occupational layers at Birka are referred to as belonging to the ‘black earth’. The Swedish term *svarta jorden* is also used to describe the carbon-rich occupational layers of the 12th century town of Kungahälla (Andersson & Carlsson 2001). Engelmark (2002) used the term ‘dark earth’ for the urban occupational layers at Sigtuna, deposited between the 10th and 13th century. Those layers are, however, well-stratified units of urban occupational layers so in this case, the term is used in a different way. In Norway, the term ‘black earth’ has been used to describe the remaining deposits of the Viking Age marketplace Kaupang (Sørensen et al. 2002). The term ‘black/dark earth’ in Scandinavian contexts seems to refer to carbon/organic-rich urban occupational deposits in general.

Thick, poorly stratified, organic-rich strata that predate well-stratified medieval urban units are also commonly found in Scandinavia (Fig. 7). Apparently, they correspond to the European dark earths but have not been referred to as such. In the following, I refer to these Scandinavian units as ‘dark earths’, in the broad, descriptive sense not connected to any specific formation process or human activity. The occurrences of dark earths have also been debated in Scandinavia, but since this area lacks the traces of Roman occupation as on the European continent and on the British Isles, the Scandinavian dark earths have generally been looked upon as indications of a new development – a development that preceded the advanced medieval urban phase, rather than as a decline of an earlier advanced phase. To explain the shift from dark earths to well-stratified urban units, the focus has mainly been placed upon the changes in the thickness of the strata.

The Scandinavian discussion concerning the dark earths has generally been focused on their disappearance. Many Scandinavian authors note that this type of thick occupational strata was formed between the 10th and 14th century (e.g., Andrén 1986). Beronius-Jörpeland (1992) suggested that the high ‘growth-rate’ of deposits, resulting in thick occupational layers, might indicate that settlement expansion was at its height during this period. Runer (1999) noted the difference between urban and agrarian development during Medieval time. While the occurrence of thick urban strata decreases from the 14th century, they seem to remain in many agrarian environments, which are interpreted as an indication of a ‘social integration’ into new hierarchies that occurred within towns but not in rural settings. In Lund and many other towns, the thinning of occupational strata from the 14th to the 17th century has been described as a decrease in ‘growth-rate’ (André 1986). The thick, early occupational strata in Uppsala have been explained as being caused by a ‘semi-agrarian’ economy with large cattle stocks within the town (Ergård 1986). The shift to thinner strata in Visby is explained by the increase in waste control (e.g., Westholm 1990, Nydolf et al. 1992). Also André (1986) refers to the changes in waste handling when explaining this general shift within urban occupational stratigraphy. The increasing use of manure on fields during the 15th century may have decreased the amount of cattle faeces deposited within the urban environment, and the increasing use of pavements.
and permanent plots may have made it easier to keep the town clean. Andrén also suggests that the waste-handling shift may indicate a changed cultural view on waste. This view was supported by Solli (1989) who suggested that the shift in the thickness of urban strata in Norwegian towns was caused by social and political changes. Accordingly, the ‘growth of layers’ may be a measure of a town’s capacity for organisation.

It is interesting to note the differences and similarities between the Scandinavian and European discussions concerning dark earths. One of the main differences is what is considered status quo in the environment where dark earth is formed. At many urban sites where Roman towns preceded Medieval towns, the interlayering dark earth is considered as a break in an urban activity continuum. Apparently pedogenic processes acting on the debris of Roman buildings formed dark earth at some sites. Others have been formed by rural activities (Macphail et al. 2003). In Scandinavia, dark earth seems to indicate new development at a site. Apparently they are formed during the initial phase of the riddling urbanisation process. Naturally, this phase has never been referred to as an ‘abandonment’ or ‘decline’ – rather the opposite – since the preceding environment commonly has been a non-occupied site, even though the later urban phase with its thinner and better-defined stratigraphical units is considered to be formed during a more advanced phase.

The similarities in these discussions are found in the ideas concerning specific activities and processes that may have caused the formation of dark earth. Cultivation, grazing/cattle handling, middening/waste ground use or less intensive occupational activities have been common interpretations in both the European and the Scandinavian debate.

The methodological approach to dark earth and obscured stratigraphy varies between the traditions in the different countries. In England and France micromorphological studies have been used (e.g., Corty et al. 1989, Gebhardt 1997), for example in London (Corty et al. 1989), Worcester (Dalwood 1992) and Paris (Cammas 1997). In Sweden there has been no tradition of incorporating micromorphological studies in archaeology so far. The exception is the studies of soil profiles from cultivated terraces in the counties of Halland and Närke and the occupational strata of Birka (mentioned in Håkansson 1995 and Håkansson 1997). Unfortunately, the results of those studies have not been published thus far.

Measurements of various biological, chemical and physical parameters are applied in geology in order to make stratigraphical interpretations. Some of this multiproxy approach has also been applied to trace the possibly obscured stratigraphy of dark earths. One approach has been to determine vertical or horizontal compositional variations (Sidell 2000). Chemical analysis and measurements of magnetic susceptibility may also be useful when separating dark earths formed in urban and rural environments (Macphail et al. 2000). A clear indication of hidden strata are the remnants of constructions found in situ within the homogeneous stratigraphical unit, resting on a former surface that now invisible in sections.

The stratigraphy of urban constructions

From an archaeological point of view, the most important components in urban occupational layers are the physical remains of the town itself – its buildings, streets and yards. In the discussion concerning what part of the occupational deposits are intentionally or unintentionally created (Järpe et al. 1979; Andrén 1985, 1986), these constructions are considered intentionally created deposits (and may also be referred to as ‘manifest’). It is important to realize that medieval houses, and parts of houses, were often constructed during different time periods (e.g., Eriksdotter 1996) and that old structures rarely have been left untouched by later activities. Therefore, a building remnant may represent building phases that span over several decades.

Parts of buildings preserved in urban strata generally consist of the lower units – the foundation, which in turn may consist of fill, stones, sills, posts/postholes and sometimes floor remains. Foundations or parts of ovens and kilns are also sometimes preserved.

In archaeological studies, the focus is generally placed on documenting the structural proportions of house remains in order to interpret the type of building and its function, and the spatial distribution between different buildings in order to locate backyards, lanes and streets (Augustsson 1992). In order to interpret building techniques, there has been a focus on the parts that most clearly reveal the upper structures of the building, for example the arrangement and styles of sills and postholes (cf. Goodburn 1995). The foundation layers of houses, which generally are the remains that built up the occupational layers, have been studied in terms of their general morphology. Only few, if any, studies have until now focused on the material in those foundations, the fill that composes them. Since they often contain reworked material, finds within the fills are difficult to interpret and relate to time and place dependent contexts and are therefore considered as be-
In some cases, the upper parts of buildings are preserved in the stratigraphy. This is especially evident when buildings have been burned but sometimes also deliberately demolished, generally in order to make space for other constructions. These types of remains are preserved as depositions of house debris consisting of fragments of the former houses and in some cases, their content in the form of charcoal, wood, fragmented bricks, chalk, mortar, glass, stones and pieces of turf. Sometimes it is possible to identify layers of different composition within the house debris, which may make it possible to understand which materials composed the different units of the building.

When dealing with the stratigraphy of collapsed constructions, it is important to consider how the building came down (e.g., Keevill 1995, Robins 2003). Did the building collapse on its foundation, or did it tip over in the process? If the building tipped over, or if its walls fell outwards, the house debris would also be distributed outside its foundations (Fig. 8). The investigation of how a collapse of a building took place may also reveal evidence of the building techniques (Keevill 1995).

When new buildings were constructed in medieval towns, it was common to use debris from older buildings as fill in the new foundations. Augustsson (1992) states that building materials in Swedish towns were limited, which may be reflected in the habit of recycling house debris as fill.

A special valuable type of stratigraphical remains of destructed buildings is the traces of large city fires, which often were well documented in historical records (Fig. 9). Residues of such fires may be preserved as extensive and continuous charcoal horizons that contain building remains and objects affected by fire (melted glass, burned clay etc.). These layers are often possible to identify even if they have been truncated. If such identification is possible (and supported by artefact typology) the dating of the strata can be pinpointed, sometimes down to hours.

Also streets, lanes and yards may be preserved within the stratigraphy, both as depositions and as horizons. When cobble streets and yards are preserved in urban occupational layers, they generally consist of a settling material (commonly sand) into which the cobblestones are pressed. Sometimes the stones have been removed and the settling horizon may then be recognised by its surface morphology, with preserved imprints of the stones. At waterlogged sites, wooden boardwalks are sometimes found. The most common types of streets, lanes and yards in Scan-
Dinavian towns were probably naked, tramped soil without any paving at all. Remains of such surfaces may be recognised by the compacted topsoil or the tramping horizon. Old walking grounds may also be recognised by the orientation of artefacts and other objects that almost exclusively are deposited in horizontal positions.

Finds of former tramping grounds are generally considered as being of high interpretative value. Objects found on those grounds may be considered as primary deposits, and can therefore be connected to a time and space dependent context (Tagesson 2000a).

Another type of urban construction is the large-scale fill that was used to transform ground surfaces within the town. Examples of this are the rearrangements or damming of rivers, filling and foundations of banks or shores, and filling in depressions (Beronius-Jörpeland 1992). In order to transform landforms or prepare an area for building, negative forms such as pits, cavities, hollows and truncations were also created (Yule 1992, Clark 2000, Tagesson 2000a). In geological terms the contact between the truncated material and a later deposition is ‘erosive’ (indication of hiatus). In archaeological terms it is sometimes called a ‘truncation horizon’.

The stratigraphy of waste

‘Waste’ would possibly be the most common answer to the question of what mainly composes urban occupational layers, and probably many archaeologists and geologists would agree on this point. There are many reasons for this.

Waste may be considered a term for unwanted material. What is considered as ‘unwanted’ in a specific situation is, of course, dependent on social conventions. Things that are ‘waste’ in one situation or in a specific social context, may be considered valuable and useful in another. In Scandinavian medieval towns, the things that were interpreted as waste can be classified in different groups: by-products, broken or used objects, and faeces – which also may be considered a type of by-product (Fig. 10).

For instance, by-products (or waste products) may be wooden chips created during carpentry, bones during the cutting of meat, or ash and charcoal from hearths. This type of waste is the material that in one way or another was originally brought into the town from the surroundings. Another type of by-product has its origin within the town itself, for example natural (or cultural) sediments that may be considered as waste when being redistributed by digging. Besides by-products, broken, used or old products will often also be considered waste. It is the waste of past times, the small things forgotten, that in our times will consist the absolute majority of the ‘artefacts’ studied by archaeologists (cf., Deetz 1996). A third type of waste is faeces from humans and animals. Cattle, horses, pigs, sheep, goats, dogs, cats and fowls were kept on the streets during daytime. This is the reason that dung constitutes a major part of the organic compound in many urban occupational layers. Faecal material from animals is often found in urban refuse hips, which indicates that this material was removed from the streets. Human faeces are generally found concentrated in latrines and on dump piles where latrine buckets or chamber pots were emptied.

There are many popular myths concerning waste handling in Medieval and Post-Medieval times and many have a mental picture of the medieval towns as extremely dirty. Numerous authors have described how household waste was dumped directly on the street, which has contributed to the idea of the medieval town as a constantly growing waste pile – an
idea that in turn has been used in order to explain the presence of urban occupational deposits, since they have been interpreted as the actual waste pile.

Archaeologists initially supported this picture since it was impossible to find traces of cleaning and truncation, according to earlier excavation techniques (Larsson 2000). During the latest decade this picture has been adjusted. Partly because of the introduction of SCR, it has been possible to interpret patterns of refuse removal within urban environments. Specific dumping places and dumping pits are often identified, and an organised system of waste dispersal with wooden barrels seems to have been in use in many towns. The systematic cleaning in Medieval and Post-Medieval towns is also supported by written sources (Beronius-Jörpeland 2001).

Urban production of waste during the Medieval and Post-Medieval times was limited compared to later times and the recycling of material was probably common (cf. Drangert & Hallström 2002). Organic by-products from cooking was used to feed pigs, wooden waste was often used as fuel and when things could not be recycled in other ways, they could serve as fill in foundations for new constructions (Beronius-Jörpeland 2001). In many towns there are examples of how waste was used as fill in the construction of extensive land forming, for instance the foundation of new waterfronts in Stockholm during the 14th century (Hansson 1970, Dahlbäck 1982).

Urban pedogene soil processes

Alongside the depositional processes, like construction and waste handling, the urban environment and its associated activities also led to the formation of strata according to post-depositional process and formation of horizons. The soil horizons formed in urban sites can be developed by natural pedogene processes that occur independently of the urban environment and also by processes directly linked to the urban environment. Tramping by humans and domesticated animals, grubbing of pigs and pecking of fowls cause culturally induced bioturbation in the urban topsoil. At the same time horizons may form by natural bioturbation, for instance caused by roots, earthworms and other soil organisms. A majority of the topsoil horizons in towns were probably truncated, but sometimes they were buried and thereby preserved.

In the south Swedish lowland two orders of ‘natural’ pedogene soils dominate: Spodosoles (Sw: podsoler) and a type of Entisoles (sometimes also referred to as Inceptisoles), (Sw: brunjordar). The Entisols are developed in grasslands and broad leaf forests through earthworm bioturbation (Fig. 11). Organic litter on the ground is mixed with the upper part of the minerogenic material that constitutes the sub-soil. This leads to the formation of A- and B-horizons above the unaffected C-horizon: The surface A-horizon is characterised by humified organic matter mixed with

![Figure 10: Deposition of waste occurs through different degrees of awareness. A) By-products, such as wood chip litter, e.g. created through carpentry. They are unintentionally accumulated as litter on the floor or ground and later mixed with the topsoil through post depositional tramping. B) Minerogenic waste created as a by-product from digging. They can be left as unintentionally created waste piles, be dumped intentionally in waste piles or be reused as fill. C) Objects may be dropped accidentally and are then considered waste by mistake. If new protecting layers do not cover the surface, the objects dropped can be either tramped into the ground or cleaned away and deposited in waste pits or piles. D) Waste from e.g. households was commonly and intentionally thrown in waste pits or given to pigs.](image-url)
minerogenic particles and the subsurface minerogenic B-horizon is characterised by the enrichment of organic matter. If an area, for instance, a vacant lot within a town is left untouched, it generally leads to the establishment of ruderal plants and earthworms begin to thrive. After some years this will develop natural A and B-horizons. Such horizons (sometimes partly truncated) are commonly found buried in archaeological sites and indicate old ground surfaces that have been open, and relatively undisturbed, for several years.

Human interaction with soil forming processes is sometimes considered as ‘disturbance’ but soils formed due to anthropogenic activity may also be classified as its own order: Anthrosols (Gilbert 1989) that may include soils affected by ploughing, digging, trampling, or chemical pollution. Individual horizons within soils, affected by ploughing (often rich in phosphate due to fertilizing) may also be called ‘anthropic’ (e.g., Brady 1990). However, the classification of Anthrosols is generally adapted to modern soils (Gilbert 1989) and the letter system of classifying different horizons within soils is not sufficient when classifying horizons in urban archaeological contexts. Instead the individual horizons are referred to by the descriptions of the activity that created them such as: ‘trampling horizon’, ‘earthworm horizon’, ‘root horizon’ or in combination such as ‘trampling horizon, affected by earthworms’.

The two major horizon-types formed due to cultural activities found in urban occupational deposits are trampling horizons (developed by humans and animals) and cultivation horizons (developed through ploughing and digging). Cultivation horizons, or cropmark horizons, are sometimes difficult to separate from horizons developed through cattle trampling. Their content and appearance in cross section may be similar. Both contain a mixture of cattle faeces and minerogenic material, and both may be developed to similar depths (c 10-20 cm). If studied in detail, they may be separated by different features in their contact with the unaffected substratum, for example in cultivation horizons the contact may be impressed by marks from ploughs or shovels (e.g., Pettersson 1999, Hedwall et al. 2000, Karlenby 2002).

Ploughing is a very rough mechanical force that generally destroys remnants of buildings and structures within the affected horizon, and archaeological interpretation in plough horizons is difficult, although possible (Alexander & Armit 1993, Sarnäs 2004). Trampling, on the other hand, may be gentler, and the turbative force is not as large but still has an effect on objects within the affected horizon. Experiments have proven that trampling effects by humans, especially in sand, may cause dispersal effects on artefacts, not only on the horizontal plan but also in their vertical displacement (Stockton 1973, Villa & Courtin 1983). Another soil affecting process may be heating of the ground, for example below hearths or burned buildings (Corty et al. 1989). The effect of earthworms is even smaller than trampling but still these organisms can be capable of moving larger objects, such as bones and stones. The effects of earthworms on artefacts and archaeological sites have been investigated several times (e.g., Armour-Chelu & Andrews 1994; Grave & Kealhofer 1999; Lawson et al. 2000; Davidson 2002).

Traces of earthworms may be found either by the structural analysis of the soil, by macrofossil finds or by worm tracks in the sediment. Earthworms’ faeces are composed of mineral particles and humic material that stick together in aggregates. These aggregates form a structure called ‘crumb microstructure’. Generally they are easy to identify with field observations but sometimes micromorphological studies are required (Corty et al. 1989). A soil that contains crumb microstructures obtains specific properties, for instance it becomes much more resistant to erosion by rain and alluvial runoff (Brady 1990). The cocoons formed on the worms’ clitellum constitute the most common remains of earthworms (Fig 12). They are easy to find and identify during macrofos-
sil analysis, and may reveal the former presence of earthworms even if a crumb microstructure has not been identified. Tunnels burrowed by earthworms are identifiable by characteristic tracks. They are especially easy to identify when the worms have moved from one strata into another since the material from the old strata will occur as tunnel fill in the new strata (Fig. 12). If earthworms occur in and between several strata separated by sharp contacts, these contacts will gradually become obscured. This makes it possible to exclude bioturbation by earthworms between strata whose contacts are sharp and undisturbed.

Another important post-depositional effect is the decomposition of organic material in the deposits. The decomposition occurs through activities by microorganisms, mainly fungi and bacteria. This activity is largely controlled by the access to oxygen, which in turn is controlled by the amount of water in the material. Decomposition activities are therefore low in waterlogged material. The presence of water depends on the ground water table and the capillarity of the material. Richness in organic material increases the fine-grained fraction through humus particles and the water is easily kept within the strata. Preservation in coarse-grained material, like gravel and stones, is generally poor if it is not situated below the groundwater surface. Preservation along roots is generally poorer because the transport of water along the roots also leads to the transport of oxygen. The rate of decomposition can fluctuate through time due to changes in climate and local environment, like nearby excavations. Excavations lead to the drainage of surrounding strata, which then increases decomposition rate. This in turn may lead to the settling of the ground and the destruction of buildings. The processes and effects of decomposition of occupational strata have been studied several times (e.g., Borg 1993, Oxley 1993, Gardelin 2002, Lagerlöf & Nord 2002, Wikström 2003).

4 Urban Plant Ecology

From a perspective of botanical ecology, the urban environment is a mosaic of ecological niches, providing habitats for a multitude of communities characterised by species with different strategies.

The urban environment has changed in many ways since the Medieval and Post-Medieval times. One of the most important changes is the urbanisation of the rural economy. The end of animal husbandry within towns and the disappearance of horse driven transport have decreased the content of nutrients in the systems. The transport of seeds and fruits from meadow and pasture plants by animal faeces and field weeds from crops has almost ceased. Streets and yards are almost exclusively covered with asphalt or stones and few cultivation plots for kitchen plants remain. On the other hand, cultivation for esthetical or recreational purposes has increased since the mid 19th century when public parks were introduced (c.f., Nolin 1999). In those parks, plant communities of cultivated species and weeds co-exist.

There are also examples of urban environments that remain relatively unchanged. Past and present processes of soil exposure are probably similar. Loosely packed and exposed soil provides a niche for r-strategists (cf., Hitchmough et al. 2001) – pioneer plants adapted to quick environmental fluctuations by a rapid reproductive capacity and the capacity to form seed banks (Begon et al. 1996, Crawley 1997). Plants that are resistant to mechanical disturbances, such as trampling, find their niches in both past and present towns on paths and between cobblestones on streets and yards. It is also common to find refugia of natural environments in towns (Gilbert 1989, Botkin & Beveridge 1997). Along cliffs and water lines, it is also common to find a flora dominated by K-strategists – competitive plants with long life cycles.

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Gardens and parks are especially rich in foreign plants, and it happens that imported plants naturalise in vacant ecological niches or take over niches by interspecies competition. Unintentionally introduced plants commonly spread in harbours and places where cargo is unloaded, for instance on market places. The high introduction rate of neophytes provides a stress to the urban ecology in general (Gilbert 1989) and it has been observed that many alien species become a part of the urban seed bank (Kostel-Hughes et al. 1998).

The introduction pattern of alien taxa has changed since the Medieval and Post-Medieval times. Both intentional introduction of cultural plants and unintentional introduction have increased in the last centuries (Lundqvist 2000). Proportionally, the intentional introduction has increased much more than the unintentional introduction because of the large quantities of cultural plants. Although the early towns were probably rich in neophytes and past urban environments should also be suitable to study from this perspective (cf., Preston et al. 2004, Wittig 2004).

Urban fossil floras commonly consist of a mixture of plants derived from different environments (see Chapter 5). This mixture may be analysed through the ecological grouping of those species that can provide important information about both local and regional environments (Latalowa et al. 2003).

Earlier studies of urban archaeobotany in Sweden and neighbouring countries

The material in this study has been compared with the results from other investigations of urban Medieval sites in Sweden, and also from Finland, Norway and Denmark where archaeobotanical methods have been applied (Fig. 13). Some results are unpublished or exist as reports from local museums or university departments. In other nearby countries, such as Germany, Poland and Great Britain, urban biostratigraphical records have been more frequently studied and published than in Scandinavia. Examples are the investigations in Cracow (Wasylkowa 1978), Göttingen (Hellwig 1995), Kiel (Wiethold 1995), Lednicki (Polcyn 1995), York (Kenward & Hall 1995), Wrocław (Kosina 1995), Dublin (Geraghty 1996), London (Giorgi 1997), and Elbag and Kolobrzeg (Latalowa et al. 1998, 2003).

Most archaeobotanical studies in Sweden have focused on prehistorical sites but there are some examples of the studies of plant remains from Medieval and Post-Medieval urban sites. Urban archaeobotanical work has been performed on plant material from 11th – 13th century Lund, 12th-14th century Uppsala (Hjelmqvist 1963, 1991, Regnell in Carelli & Lenntorp 1994, Regnell in Carelli 1995, Pålsson 1983, 1991a, 1991b) and 16th century Gävle (Elwendahl & Pålsson 1991). During the archaeological excavations at Helgeandsholmen in Stockholm, there was a close collaboration between the National Heritage Board (RAÄ) and the Geological Survey of Sweden (SGU). Palaeoecological reconstructions, based on diatom and pollen floras, were performed by Miller and Robertsson (1982) and the plant macrofossils were studied by Griffin (1983) and Berggren (1984). In Stockholm, studies have also been carried out on the material from the Post-Medieval area of ‘Kvasten’ (Heimdahl 1999b) and from the park ‘Humlegården’ (Hansson & Dyhlén-Täckman 1999). Urban archaeobotanical studies in Göteborg have been performed at four Post-Medieval sites ( Larson 1985, 1986). Geoarchaeological studies in a wider sense have been carried out around and in the Viking Age town of Birka (Miller & Clarke 1997 and Risberg et. al 2002), including archaeobotanical analysis (Hansson 1995, 1996, Hansson & Dickson 1997, Heimdahl 1999a). Birka, however, differs from other Swedish urban contexts since the occupational deposits are not waterlogged and the preservation of organic remains is poor. Much of the study has therefore focused on the clay-gyttja deposited offshore, just outside the town. This is similar to the sediments of the former lake Fatburssjön, that represent depositions from the Bronze Age to the 19th century (Robertsson et al. 1995). In addition, earlier analyses of plant macrofossils of samples from the 16th -17th century have been performed in Norrköping (Ran heden 1999). Macrofossils were also sampled in the castle of the Medieval town of Vadstena (Ran heden in Hedvall et al. 2000). Macro remains from the Medieval town of Sigtuna (9th-13th century) were studied by Engelmark (2002).

Urban palaeoenvironmental reconstructions in Finland have been undertaken in the Helsinki area using different biostratigraphical methods (Vuorela & Lempääläinen 1993). In Turku macrofossil analyses were carried out by Aalto (1994) and Lempääläinen (1983, 1988, 1994 &1995). During the reconstruction of the environmental history of Turku, a combination of palaeoecological methods (pollen, diatoms and plant-macrofossils) was used (Vuorela et al. 1996). The Finnish data is probably well suited for comparison with the Swedish sites since Finland was strongly influenced by Sweden during the Medieval and Post-Medieval times as it was under Swedish administration during AD1323-1809.

Extensive geoarchaeological and palaeoecological
work has been carried out in urban medieval contexts in Norway, for example in Bergen (Krzywinski et al. 1983, Krzywinski & Kaland 1983). Investigations specifically focusing on plant macrofossil analysis have been made in Oslo (Griffin 1979, Griffin et al. 1988) and Trondheim (Griffin & Sandvik 1989, Sandvik 1992, 1995).

Denmark has a long tradition of archaeobotanical
investigations of Medieval contexts. However, during the Medieval Time Denmark was heavily influenced by northern continental Europe, and the Medieval Danish archaeobotanical material is more comparable to the German or Polish than to the Scandinavian material. Results from Svendborg (Jensen 1979), København (Moltsen 1999, 2002) and a summary of plant macrofossil data from the Medieval Danish sites (Karg and Robinson 2002) were used as northern European case studies in this investigation.

5 Taphonomy of urban macro remains

The study in this thesis is largely built on the analysis of plant macrofossils. In order to understand a fossil record, both palaeoecological and taphonomic aspects must be considered. Taphonomy of urban material is especially complex, and it is therefore necessary to include it as a background for palaeoecological analyses and interpretation of results.

Taphonomy includes all factors, both natural and cultural, that affect the final setting of a fossil record, including post-depositional processes as well as the sampling and treatment of material in the laboratory. This account will mainly focus on the plant macrofossil material – seeds, fruits and other diaspores. A more extensive taphonomic account of pollen grains can be found in Vuorela (1999). I have chosen to divide the taphonomic factors into seven groups: biology; deposition; human influence; preservation; reworking; sampling, preparation and registration; and personal bias.

1. Biology

Life strategies of plant species vary. K-strategists have a long and less effective reproductive cycle than r-strategists (e.g., Begon et al. 1996, Crawley 1997). K-strategists more commonly form wood tissue and have thicker roots. Differences in seed dispersal and seed production (Howe & Westley 1997) will influence the fossil record. Some plants are dioic (separated sexes of the individuals) and only female, fruit setting plants will be registered through seed or fruit identification. Plants of the same species may act differently from time to time depending on environmental factors. They may produce different amounts of seeds or set fruits in different periods, and thus give signals of varying magnitude in the fossil record.

Since plant macrofossil analysis commonly deals with diaspores (as they are relative to other plant tissue that are both resistant and easier to determine to species), we will come across plants that have been going through seed setting. This also means that male individuals (in the case of dioic plants) will not be found in this fossil record. It is also important to take into account that seed and fruit production varies between different plant species in quantity, season and frequency.

2. Depositional processes and ecology in urban environments

Depositional processes within the urban environment are complex (Fig. 14 and 15) (cf. Thomas 1997). In this discussion, the fossil plant record has been di-
vided into four groups, based on taphonomic origin of the plants: A: the local flora; B: the regional flora; C: plants from pastures and meadows, and D: cultural plants. These groups can in turn be subdivided as discussed below.

A: The local flora

The local flora is considered to include plants, which have grown in the immediate vicinity of the investigated area. The Medieval and Post-Medieval urban environment was characterised by continued spatial rearrangement of buildings and structures, and by the large production and deposition of waste and nutrients. Soils were exposed and covered by new depositions rapidly, both by human activities and large-scale domestic animal bioturbation (e.g., pigs). In this type of environment, alluvial and coluvial processes lead to the exposure of soils. These environmental factors will disturb plant communities, and small-scale migration of plants will occur between patches in the area. The in situ urban flora with ruderal plants and weeds has pioneer strategies with a high capacity of dispersal and low competition ability, according to trade-off effects (e.g., Crawley 1997). This means that these plants often have a rich production of seeds and can form seed-banks or seeds that are easily dispersed (Rees 1997, Howe & Westley 1997). The Medieval urban flora generally developed different biotopes directly connected to the soil types within the site (Gilbert 1989). These biotopes can be divided into eight groups (Fig. 15):

1. Trampling resistant flora on streets and in yards
2. Loose soil flora
3. Nitrophilous flora
4. Turf roof flora
5. Refugal flora on cliffs, etc.
6. Harbour flora, neophytes etc.
7. Weeds in local cultivation plots
8. Flora thriving along walls, etc.

A. Seed dispersal through footwear and wheels
B. Import of (sometimes exotic) seeds
C. Storing and processing of seeds before marketing
D. Export of seeds
E. Cleaning of streets and yards, dumping of waste
F. Cleaning of dung from streets and yards, used as fertilizer
G. Dung from stables
H. Stored and processed crops
I. Processed cereals used within the town or exported

Figure 15: Local urban flora environments (1-8) and transport of material and seeds within the town (A-I).
1. Trampling resistant communities occurring on pathways, backyards and in streets.
2. Loose soil communities growing on loosely packed debris and soil stacks.
3. Nitrophilous communities found near latrines, waste piles, dung heaps and along house walls and ditches, where moisture and nutrients are concentrated in the soil.
4. Turf-roof communities will occur if roofs are overgrown with e.g., grass or plants selected for fire protection (Krzywinski et al. 1983).
5. Remains of the pre-urban natural flora may occur as refugium biotopes, for example river and seashore flora, or plants growing on cliffs or rocks.
6. Harbours where cargo is handled may act as a first environment for neophytes. Floras in harbours and wharves often contain specific species.
7. Weeds and kitchen plants may grow on cultivation plots within the town. Cultivation within and just outside towns is documented in historical sources.
8. The ground adjacent to walls may act as a substrate for weeds. The environmental factors along walls vary according to geographical position, house type, street-type etc.

B: The regional flora

In this study the regional flora is defined as all ruderal and natural plants occurring outside the excavated area, both outside and in the town. The regional flora is mainly represented by plants along roads and in the nearby town blocks. These plants can be spread by wind or by attachment to animals, humans (Clifford 1956) or wheels (Millberg 1991). Seeds transported in this way are, however, difficult to differentiate from seeds grown in situ, since they are often derived from identical biotopes. Sometimes they may also arrive from different environments, such as forests and wetlands.

Many plant species thriving in urban areas can also grow as weeds in cultivated fields. Among the finds from Norrköping and Karlstad, there are also plants that are common in many different environments and thus are hard to correlate to any specific habitat. This is especially relevant for the Chenopodium album-type and also the species Cirsium arvense, Fumaria officinalis, Galeopsis tetrahit/G. bifida, Lithospermum arvense, Solanum dulcamara and Stellaria media. These plants could have been growing in fields, along roads and pathways, in the town or locally within the investigated area. They may be separated if their occurrence is connected to other species that are specific to certain local or regional environments.

C: Plants from pastures and meadows

Grazing by cattle can lead to a concentration of plant remains from pastures and meadows in urban areas by deposition of faeces and hay. This taphonomic factor plays a major role in most Medieval and Post-Medieval urban sites. Cattle sometimes also graze ruderal plants and weeds, and some of the ruderal plants are abundant in pastures as well. If isolated coprolites (in this case, faeces that are distinguished as coming from one individual) are found, it may be possible to determine the species of the animal that produced it by the morphology or species-specific parasites. Plant macrofossils in coprolites can also provide important information on the grazed area, or during which season the grazing or cutting of the hay occurred (Moe 1996, Møltsen 1999, Karlsson 2000).

D: Cultural plants

Cultural plants are referred here as plants that are known to have been regularly used by humans. They could have been collected from a wild or cultivated population and might have been brought into the town for trade, storage and/or processing. If a cultural plant is represented, both in the pollen flora and by macrofossils, it may be an indication of regional cultivation. This is not always the case since pollen grains can also be brought into the town in an artificial way (cf., Faegri and Iversen 1989).

Cultural plants are generally processed in specific ways which may affect the fossil record. For example, harvested cereal crops are processed through different methods of threshing, sieving and cleaning. Fossil records of crops may differ according to which steps have been taken in their handling. (cf., Hansson 1997, Viklund 1998, Hambro Mikkelsen 2003).

3. Human influence

Humans can selectively have affected plant communities due to cultural habits that may be unknown to us. Some species may have been cleaned away or favoured for different reasons, for example due to unpleasant characteristics (like stinging or burning tissues), pleasant characteristics (like beauty), or due to mythical ideas (like luck or misfortune). Small-scale cultivation or the collecting of species, according to religion, tradition, medicine and decoration,
must also be considered (cf., Johnson 1999).

4. Preservation of plant macrofossils

Macrofossils are preserved by water logging and occasionally by carbonisation through heating. Different preservation processes of the same original plant community will lead to different fossil records. Water logging generally leads to a wider and more complete spectra of preserved plant remains but there are exceptions. Cereal grains and wild grasses are more easily preserved by carbonisation, while fruits of e.g., the Apiaceae family are much better preserved by water logging (Gustafsson 2000). Another example is the differences between r- and K-strategists. Since r-strategists often have the capacity to form seed banks, the seeds tend to be bigger and more hard-coated than seeds from K-strategists. This may lead to that seeds from r-strategists are over represented in materials with bad preservation status.

At Norrköping and Karlstad, about 95% of the counted macrofossils were preserved as un-carbonised specimen, since the embedding medium consisted of a dense, fine-grained deposit with high capillarity and low permeability. Only 5% of the material consisted of carbonised diaspores, concentrated mostly on the old surfaces in connection with fireplaces or debris from burnt houses. Samples with carbonised material were generally lacking un-carbonised material and vice versa but in some cases they occurred together. This may indicate different taphonomic origin of the plant material and the two groups were interpreted separately.

5. The reworking processes

The reworking of deposits in urban environments is usually extensive. It may affect the preservation status of the fossil content by mechanical, biological and chemical deterioration. This can lead to the relative concentration of hard macrofossils in the re-deposited material, (given that they also occur during the reworking process or are present in the mixed material). This also makes robust macrofossils less suitable to use for reconstructions since they can be reworked many times and still remain well preserved. For the same reason, we can put more trust in fragile material.

Some samples from ‘Konstantinopel’ were characterised by high concentrations of plant macrofossils with the same size as the medium sand fraction (0.2-0.6 mm). This occurred in well-sorted, water deposited alluvial material, dominated by silt and is probably an effect of sorting by water. Conclusions about the biotopes for plant remains found in this type of deposit must be handled with care.

6. Sampling, preparation and registration

Additional taphonomic factors occur by sampling, storing, processing and finally by analysing the fossil content of the samples. For example, the flotation process is a method that works differently with different sedimentological mediums, and it is a good idea not to handle all samples in the same way (Wright 2005). During wet sieving, the choice of sieve size will have an effect on the composition of the retrieved material, which in turn may affect ecological interpretation (e.g., Birks 2001; Zohar & Belmaker 2005). During analysis, it is also important to have a clear classification and quantification strategy for fragmented material, and for the comparison of the different anatomical features preserved as plant macrofossils. How do we compare leaves with seeds?

7. Personal biases

The final taphonomic factor is connected to the person performing the analysis. It is therefore important to ask the question: what are my personal biases?

It appeared to me that I first observed certain types of fossils. These were usually the most common types of moderate size (1-2 mm) like Chenopodium-types, Carex sp. and Urtica sp. This was probably due to their high abundance within the samples and that they were easily noted with the magnification used (c. ×8-15). But it also may have been a kind of “favouring the expected”. To avoid this, the samples were analysed on a number of occasions to ensure that the more unusual or discrete fossils (e.g., Poaceae-fruits) were identified as well as the more common remains.

The trade-off of favouring the expected is to favour the unexpected. This seemed to happen when I made unusual or exotic findings. This then led to attempts to find more fossils of the same type, which perhaps made me ignorant to the more common findings. Again, to go through the samples repeatedly was my strategy to avoid this bias.

6 Study sites

Norrköping (Paper I, II, IV, V)

Norrköping is situated along the river Motala Ström, between Lake Glan in the west and a bay of the Baltic Sea, Bråviken, in the east (Fig. 16). The excavated
site is located in the centre of the town (Fig. 16).

The bedrock consists of migmatised granites, gneisses and mica schists (Bergström & Kornfält 1973) and is partly exposed in the highland area southwest of the town. In the east, thicker Quaternary deposits cover the bedrock. About one kilometre south of Norrköping, the deposits are generally dominated by different littoral sediments (Fig. 16). The eastern lowland is characterised by flat areas with post-glacial clay and silt underlain by varved glacial clay and silt and southwest of the town, the landscape is hummocky and consists of till and bedrock outcrops. An esker runs straight through the town from northwest to southeast. The investigated site is situated where the river Motala Ström cuts the esker. The glaciofluvial deposits are surrounded by coarse silt and till. The slope within the excavated area is part of the river valley of Motala Ström, and the esker itself does not seem to affect the local topography (cf., Lindgren-Hertz 1999). Downstream, the riversides are dominated by alluvial deposits, from clays to coarse silt rich in organic material. The distribution of this alluvium is poorly known, especially the area along the southern riverside, where the investigated area is situated (Bergström & Kornfält 1973).

The investigation area is situated close to a bay of the Baltic and thus the shore displacement must be considered. Present land uplift in the area is 3.0 mm/yr and according to a relevant shore displacement curve (Persson 1979), the rate has probably not changed significantly during the last 3000 yrs. The altitude of the shoreline of the Baltic Sea during the 13th century can be estimated to be about 2.4 m a.s.l. The present surface of the excavation site is located about 9 m above present sea level and the substratum of the oldest occupation layers is situated about 7 m a.s.l. Since the Medieval times, the site has not been affected by the regressive sea level. The elevation of the earliest medieval ground surface in the excavated area was about 4.5 m a.s.l.

The flat landscape is suitable for cultivation. Humans have been present in the area since the land in the vicinity started to rise above sea level about 2000 years ago. The river Motala Ström, which in this part is characterised by rapids and turbulent water, made the place attractive for salmon fishing and ideal for establishing mills and therefore, it became a place of economic interest (Ljung 1965).

Norrköping was first mentioned as a trade centre in 1283, but it was not given its town privileges until 1384. Written sources indicate that during the Medieval times, Norrköping was an important centre for trade and administration, where both the state and the church had interests (Lindeblad 1997). During the middle of the 16th century, as a result of the reformation under the regiment of Gustavus Vasa, Norrköping became the most important Swedish harbour for the export of iron. The town expanded rapidly and during the 17th century, due to industrialisation, Norrköping became the second largest town in Sweden, next to Stockholm.

The Medieval constructions in Norrköping have so far remained unknown because of the major reconstructions of the city plan during the 16th and 17th centuries, including a major reconstruction and

Figure 16: A) Map over Norrköping. The investigated area is marked with black in the upper left corner of the marked block. The present river Motala ström is shown in dark grey, and the light-shaded area marks the former extension of the stream before the rearrangements after AD 1640. B) Simplified map of Quaternary deposits in the area (After Bergström and Kornfeldt 1973). Till and bedrock are marked with triangles, glaciofluvium with dots, fine grained marine sediments with white, and light grey marks the alluvial deposits of the river (dark grey).
filling of the river Motala Ström, which was made narrower and deeper (Fig. 16). Therefore, the oldest remains normally found during archaeological excavations are from the 16th century or later (Parr 1987, Kjellén 1996, Hållans et al. 1999).

In the excavated area the preserved occupation layers are sloping towards the west and the former river course, which according to the rectified map of 1640 was very close, perhaps only some meters away from the border of the present investigation area (Fig. 1). Due to the sloping substratum, the layers are thicker and better preserved towards the west. The occupation layers disappear about 50 meters upwards from the western edge of the excavated area (Lindgren-Hertz 1998).

Karlstad (Paper II and III)

Karlstad is situated in southwestern Sweden on the river Klarälven delta that fills out a bay on the northern shore of lake Vänern (Fig. 17). The lake was isolated from the sea due to land uplift c. 7000 BC (Fredén 1988). Karlstad is the only town in Scandinavia that is located on an active river delta. Hummocky terrain with exposed and sparsely till-covered bedrock surrounds and partly penetrates the delta plain.

Between 7000 and c. 2500-2000 BC the shoreline of Lake Vänern retreated ca 20 km southwards due to land uplift (Sandegren 1939, Heijkenskiöld 1981, Sundborg & Heikenskiöld 1972 and Fredén 2000) and the delta sedimentation moved southwards to the present area. During the last 2000, years the shoreline of Lake Vänern has remained more or less stable and local changes are mainly due to a continuous built up of the delta. Coring in the delta revealed silty and sandy sediments with a depth between 10 and 20 m (Fredén 2000). The present water level of Lake Vänern is 44.0 m a.s.l. and the water level fluctuates about ±1.3m between low and high water (Heikenskiöld 1981). Heikenskiöld (1981) estimates that the delta situated at the excavation area was built up over the sea level about 700 BC to AD 1. During the beginning of the Roman Iron age, a sandbank dividing the river into two branches was formed. Later the delta mainly grew in the eastern and western branches of the river. By AD 700 the central part of the delta had the same characteristic features as today. From the 13th century the expansion of the delta shifted to the south, and since then the central parts of the delta have remained stable, although certain morphological changes of the spit of Sandgrund was seen during the 19th century.

The hills around the flat delta plain display several Iron Age and Medieval settlements. There seems to have existed a Medieval trade centre located at a place called ‘Tingvalla’. In AD 1290 Tingvalla is mentioned as the centre where markets and juridical processes were held (Nygren 1934), but the exact location and nature of Tingvalla is not known, and no archaeological evidence has so far been found. However, single artefacts from the Middle Ages found within Karlstad indicate nearby activities during this period (Andersson & Schedin 2001).

Karlstad was founded as a strategic iron-shipping town between the mining areas in middle Sweden.
(Bergslagen) and the Swedish west coast. Karlstad was given its town privileges in AD 1584 by King Karl IX and until now, no urban structures pre-dating that year have been found (Lundh et al. 1994, Angeby 1995). The town had its main economical growth during the 18th and 19th centuries.

The accumulation of sand seems to have been a problem in Karlstad for a long time and regular dredging of the river was necessary for the shipping. Flooding in the town centre also occurred regularly, except for the hilly areas of till-covered bedrock that are seen above the flat delta plain (Andersson & Schedin 2001).

The excavated area is located on the flat delta area in the town centre between the till-covered hills of Lagberget in the northeast and Marieberg in the southwest (Fig. 17). The c. 1 m thick occupational layers were deposited directly on, and partly developed as horizons in the flat delta surface and they are evenly distributed over the investigated area.

7 Methods

Field methods and sampling strategies of this project are described in more detail in Paper I. Because of the nature of the urban stratigraphy, continuous sampling was not undertaken in all stratigraphical units. The main method used was plant macrofossil analysis, which was suitable to describe the local environment as well as human activities. The macrofossil content was diagnosed in all stratigraphical units excavated. In remains directly related to human activities, e.g., house debris, the method was limited to the search for indicators of past vegetation and cultural plant use. In these contexts, sampling in each stratigraphical unit became more extensive in order to adapt to the archaeological excavation strategy.

Other biostratigraphical methods used were pollen and diatom analysis. These methods were only applied when more specific questions arose. Pollen analysis was used as a complement to plant macrofossil analysis on the oldest strata because of the lack of cereal grains in these layers. In order to trace the origin of the deposits, diatom analysis was used where the stratigraphy presumably was influenced by alluvial action. Some stratigraphical units were studied more carefully for sedimentological features and in these cases, samples were taken for texture analysis and the determination of organic carbon content. Fabric analysis was carried out when it was difficult to distinguish between dumped filling masses and till.

Field work

Since the geological fieldwork was carried out during the archaeological excavations it had to be adapted to the archaeological framework (Menander & Karlsson 2002, Heimdahl et al. 2003; Paper I). At each site the archaeological excavation was performed according to SCR methodology and the stratigraphy was plotted in a Harris Matrix. The positions of all stratigraphical units, as well as artefacts and samples, were documented three-dimensionally in a database and visualised in the GIS-program Arc View.

A sampling technique for macrofossil analysis was developed and adapted to the single context methodology used at the excavation (Paper I). Pilot sampling was performed in each layer except those that were unfavourable for the preservation of organic remains, for instance deposits including coarse gravel or stones. The samples aimed for macrofossil analyses were collected in cardboard boxes with a plastic inner film. The samples were normally floatated and wet-sieved immediately after sampling, according to the method described by Wasylikowa (1986). The enriched remains were investigated under a dissecting microscope at the site and the plant macrofossil content was qualitatively diagnosed in order to evaluate the need of additional sampling before the layer was totally excavated. After this pilot analysis, the samples were stored in water filled plastic containers.

Stratigraphical cross sections were described and drawn both by the archaeologists and the author. The colour of the strata was classified according to the Munsell Soil Colour Cart (Munsell Colour 2000). In some cases the drawings were dissimilar because of differences in the interpretation of the stratigraphy. In layers where sedimentological structures could be of interest for sampling, metal boxes were pressed into the wall and cut out so that sufficient parts of the strata were preserved intact. The filled boxes were subsequently wrapped in plastic and stored in a cold room before sub-sampling.

In order to minimise contamination by recent vegetation, a survey was made of the seed-producing plants in the present local urban flora. The composition of the modern local flora was also compared with the fossil urban flora investigated. Investigations were carried out on five occasions during each excavation in an area up to 10 metres away from the excavation site. Plants with seeds spread by wind were documented with extra care, even if they were growing a long distance from the excavation site e.g., Betula spp. and Salix spp. The time of seed setting was noted and plants that were about to set fruits close to the site were, if possible, removed.
Macrofossil analysis

In order to facilitate an ecological interpretation of the macrofossil content, between 300-500 diaspores were identified to species level in each sample investigated. Other plant remains which could be identified, such as needles, leaves and bark, were registered but not included in the percentage calculations. The macrofossil samples were, when necessary, wet-sieved for a second time and cleaned in the laboratory according to methods described by Wasylikowa (1986).

After the wet sieving the samples were examined as subsamples of c. 3-5 ml at a time. The microscope used in the laboratory had a magnification of ×8-100. The samples were first described according to their general composition of tissues and biota. The groups used were wood, charcoal, bark, herbacea epigaeic (stems and leaves), herbacea hypogaeic (roots), insects, statoblasts (hibernate-capsules of bryozoans), puparia (pups, eggs, cocoons etc. of lower animals), Ichtyes (bones and scales from fish), Mammalia (bones and hair from mammals) and artefacts, e.g., slag, glass fragments and brick fragments were also included in this description. The amounts of the most frequent components: wood, charcoal and bark was roughly quantified as ‘1’ (single objects), ‘2’ (<5% of the visual field) or ‘3’ (>5%). The diaspores were counted as single units.

Fragmented material was noted as parts of units if the original parts could be reconstructed or the amounts were roughly quantified into separate units. Fragments of a seed taxon, represented by a single element from the original carpum (e.g., a hilum), could be counted as one unit but in contrast, fragments without these special elements were not considered for quantification.

The remains with characteristic cell patterns, such as Poaceae and Juncus fruits, were determined under a light-microscope with higher magnifications (×100-1000). For specimens where identification was of extra importance, further analyses were undertaken with a SEM-microscope (Paper II).

The identification of the seeds was mainly carried out by consulting a reference collection and the works of Korso (1926); Bertsch (1941); Körber-Grohne (1964, 1991); Katz et al. (1965); Berggren (1969, 1981); Beijerink (1976); Tallantire (1976); Jacomet (1987); Schoch et al. (1988); Jacomet et al. (1989); Blidow and Krause (1990); Anderberg (1994) and Krause (1997). After identification, the seeds were stored in distilled H₂O in 5ml plastic containers. A mixture of glycerine, ethanol and thymol was used for storing very fragile material.

Pollen analysis

Pollen analysis was undertaken to investigate the cereal pollen content in the dark earths of Norrköping. Samples designated for pollen analysis were sub-sampled from the sediment collected in the metal boxes. In order to concentrate pollen and spores from the sediment, a standard acetolysis method was used (Erdtman 1936; Berglund & Ralska-Jasiewiczowa 1989). A collection of reference slides and the work of Moore et al. (1991) were used for identification. The cereal type pollen grains were measured and surface structures were studied according to Beug and Firbas (1961) and Andersen (1979).

Diatom analysis

Analysis of diatom composition were undertaken in order to investigate ecological signals of terrestrial or aquatic environments. Samples for diatom analysis were sub-sampled from the metal boxes. Siliceous microfossils were extracted according to the method described by Battarbee (1986). Identification of the diatoms and the interpretation of the ecological conditions were made with the use of Kramer and Lange-Bertalot (1986; 1988; 1991a; 1991b) and Round et al. (1990). The diatoms were grouped according to their habitat, either as terrestrial or aquatic. Only one of the six samples contained significant amounts of diatoms for a quantitative analysis.

Grain size distribution

Textural analysis was performed as a complementary stratigraphical tool in order to reveal obscured stratigraphical changes and in order to trace possible mother material for fills. When sediment is reworked (for example by digging), its structural features will disappear and changes but the texture will remain intact (cf., Paper I). Samples for grain size distribution were taken directly from the open transects and on surfaces where stratigraphical units had been exposed. Texture analyses were performed on gravel and sand particles by dry sieving using sieves with square-formed holes. The silt and clay fractions were determined by hydrometer analysis (Kompendium i jordartsanalys 1995).

Organic carbon and loss on ignition

The analysis of organic carbon content and the loss on ignition (LOI) was performed in order to reveal obscured stratigraphy of the dark earths. It was determined on the dark earths from both Norrköping and Karlstad. Continuous samples, each 1 cm thick
yielding c. 1-2 cm³, were extracted from the dark earth at 3-5 cm intervals. Organic carbon content was determined by a carbon sulphur detector (ELTRA CS 500). The LOI was calculated as percentages from the weight loss of dried samples, which were slowly heated to +550ºC and kept at that temperature for two hours (Kompendium i jordartsanalys 1995).

14C-Dating

Seven plant macrofossil samples (five from Norrköping and two from Karlstad) were AMS dated at the Ångström Laboratory, Uppsala University. The material used was sub-sampled from the macrofossil samples (Table 1), which were stored in distilled H₂O in a cold room at +4ºC, between the summer of 2000 and the autumn of 2001. Fragile seeds from terrestrial plants found in a primary position (e.g., floors, trampling horizons and hearths) were chosen for dating to minimize the risk of using reworked material. The seeds were gently cleaned in distilled H₂O and detritus was washed away with a small nylon brush under a dissecting microscope. This material was first slowly heated at +70ºC for 2h and then dried at +105ºC for 8h and placed in small glass jars with plastic screw lids.

Other dating methods

Dendrochronology and the typology of artefacts and coins were also used for dating purposes. Thomas Bartholin at the National Museum in Copenhagen carried out the dendrochronological work. The archaeologists at the excavation undertook the typological datings. Monica Golabiewski Lannby at the Royal Coin Cabinet in Stockholm performed the identification of coins.

Ecological grouping

The identified plants were grouped according to ecology using the systems described by Grime et al. (1988), Ellenberg et al. (1991) and Mossberg et al. (1992, 2003). The system of Ellenberg et al. is based on Central European data, and groups the plants according to their different requirements (e.g., light, moisture, nutrients and temperature) expressed in numbers. The system is hierarchic and a plant can only be described as thriving either in light or shadow. This compilation covers about 90% of the species found in Norrköping and Karlstad. Grime et al. (1988) describe the biotopes of plants in the British Isles according to where the plants are found and evaluate their degree of abundance with a number (a scale from 1-5). The system is heterarchic, which means that a plant may occur with the same frequency in different habitats. In this way plants with generalist strategies can be separated from plants with special strategies according to their habitat. This system covers about 60% of the plant species found in the investigations. Mossberg et al. (1992, 2003) is a comprehensive flora with descriptions of the ecology and habitats of plants found in the Scandinavian Peninsula. This was mainly used for plants that were not included in the systems of Grime et al. (1988) or Ellenberg et al. (1991) Mossberg et al. (1992, 2003) was also useful for comparing descriptions of plant ecology in order to check if there are differences between the regions.


Biological nomenclature

The Latin names of plant species and taxas are according to the continuously updated species list published on the internet by the Museum of Natural History in Stockholm. The version used here was updated 2004-01-19 (Karlson 2004). The English names are according to Qualtrocchi (2000).

8 Summary of Papers

Paper I

Jens Heimdahl, Hanna Menander and Pär Karlsson,

During excavations of complex urban occupational deposits in Norrköping, new procedures were elaborated in order to combine archaeological, geological and archaeobotanical fieldwork. This fieldwork was also based on parallel work by members of the different disciplines throughout the whole excavation. The archaeological fieldwork was based on SCR. In order to understand the archaeological fieldwork procedures and the basis of interpretation, the geologist (Jens Heimdahl) also spent time excavating with the archaeologists.

The elaborated procedures resulted in continuous pilot sampling and on site preparation and di-
Vial deposits consisted of silt lenses that apparently were of alluvial origin. Many of those alluvial deposits originated from 1400-1660. The occupational deposits at the site in Karlstad are deposited on top of the active delta of river Klarälven. The substratum consists of the top set beds of the delta. The oldest culturally affected deposits at the site is the uppermost dark earth sand in which a 30-40 cm thick dark earth with obscured strata have formed, probably during the 16th century, but it may also contain older units. This dark earth is overlain by 1 m well stratified urban occupational deposits originating from 1400-1660. The occupational layers at the site in Karlstad are deposited on top of the uppermost dark earth during the mid 14th century. Above the boardwalks the stratigraphy is characterised by c. 1 m well-stratified urban occupational deposits originating from 1400-1660.

The site in Norrköping is situated on a slope towards the river Motala ström, and the occupational layers were deposited as slope front fill on a substratum of littoral and alluvial sand. The occupational deposits were 3-4 meters thick downslope and disappeared 10-15 m upslope from the excavation limit. The lowest 1m thick layers consisted of minerogenic sediments, probably of littoral and glaciofluvial origin, dumped partly in the flooded stream during the 13th century. On top of these fill, two dark earth units with obscured strata developed during the 13th to 14th century. Wooden boardwalks were built on top of the uppermost dark earth during the mid 14th century. Above the boardwalks the stratigraphy is characterised by c. 1 m well stratified urban occupational deposits originating from 1400-1660.

All strata were geologically studied according to sedimentological structure and texture, parallel to the archaeological stratigraphical interpretations. These double interpretations resulted in constantly ongoing field discussions. On some occasions the different interpretations confirmed each other, in others they opposed each other. The discussions that followed proved important for the development of a mutual understanding and in some cases led to new, sometimes surprising conclusions.

The geological interpretations revealed that the thick minerogenic strata, located below the dark earths, were fills consisting of reworked glaciofluvium and littoral sand. Without the geological expertise present, they would probably have been interpreted as the natural substratum. The geological field interpretations also revealed new ways to critically treat stratigraphical units as information sources. This especially counted for material that traditionally is considered reworked, like fill. By analysing the fill texture and comparing it with the texture in other local material of natural origin, it was on some occasions possible to determine the source material for the fill. Another way of dealing with the problem of reworking was to look at the degree of fragmentation of fragile organic macro compounds. Finds of large pieces of leaves or fragile seeds may be used to exclude reworking.

Geological field interpretation also resulted in the discovery that the occupational deposits to a large extent were of alluvial origin. Many of those alluvial deposits consisted of silt lenses that apparently had accumulated in water ponds. Some of the water ponds had acted as traps for material from surrounding ground surfaces. Surfaces are important for archaeological interpretation, and since many surfaces had disappeared though truncations or were located outside the excavation area, the macro content of water pond sediments could sometimes be used to reveal cultural activities and environment on those surfaces.

**Paper II**

Jens Heimdahl, 2005: Urban Sediments as Indicators of Changes in Land use and Building Tradition in two Swedish Towns, AD 1200-1800. (Manuscript)

Results and conclusions from sedimentological studies of occupational deposits at the excavations in Norrköping and Karlstad were compared in order to reconstruct urban environmental development and site formation processes.

On some occasions the results revealed the functions of occupational deposits originating from 1400-1660.

The site in Norrköping was excavated two Swedish Towns, AD 1200-1800. (Manuscript)
was trampled into the ground, possibly during wet conditions. There are also several structures revealing that the homogeneous dark earths contain obscured strata. The dark earths are believed to have formed during a combination of repeated alluvial sedimentation and a continuous trampling of cattle, thus successively deepening the horizon and homogenising the individual alluvial deposits. In Karlstad the alluvial deposits originate from regular flood events on the active delta. In Norrköping they are formed by alluvial runoff on the slope. This also explains why the dark earths here are thicker downslope.

The alluvial deposits in Norrköping continued to form during the formation of the well-stratified urban occupational deposits. Silty alluvium accumulated repeatedly in the depressions of the town, mainly in streets and lanes between the houses, and on some occasions, created negative casts of the urban landscape. When alluvial silt filled the streets, new constructions had to be elevated in order to avoid moisture. This habit is thought to have formed a cycle of human response to natural effects thereby inducing each other and resulting in the growth of urban occupational deposits.

At both Norrköping and Karlstad fills used in the foundations for houses were investigated with grain size analyses. The results show that the fill used in the early stages of the urban development was local material of a fine fraction, not suitable for foundations. In the foundations built later, the material was coarser and taken from more distant deposits. This shift is thought to represent a professionalisation of building construction. In Norrköping it seems to have occurred during the beginning of the 17th century. In Karlstad the shift occurs later, during the 18th century.

Paper III


Macrofossil evidences from Karlstad reveal glimpses of environmental development of the urban and regional area, cultivation, trade, and differences between grazed pastures and mowed meadows.

The oldest 14C-dated samples taken in the delta sediments had calibrated ages of 215 (±40) BC and AD 165 (±40). A dense forest vegetation represented by birch and alder formed on the newly built up delta surface. Light demanding plants, for example *Prunus spinosa*, *Rubus idaeus* and *Bidens tripartite*, thrived along channel banks, and different *Juncus* and *Carex* species were growing at the waterline. Submerged plants like *Nitella opaca*, *Isoëtes echinospora* and *Potamogeton* spp. probably grew in the delta channels.

Cattle grazing and the creation of meadows deforested the delta during the time when the black earth was formed, sometime between AD 500 and 1500. An increase of ruderal plants in the uppermost part of the undisturbed delta sediments provides an indication of human occupation predating the formation of the dark earth. The macrofossil concentration in the dark earth is heterogeneous and varies both spatially and vertically. The composition of the flora, however, is homogeneous, and is heavily dominated (up to 90%) by *Juncus* spp., mainly *Juncus bufonius* and other wet meadow plants like *Carex*. The taphonomy of wet meadow plants is interpreted as cattle faeces. Samples taken from fresh cattle faeces at a nearby wet meadow with ungrazed *Juncus* tufts reveal that the faecal material becomes heavily dominated by *Juncus* fruits, due to the grazing of fruits stuck to the surrounding grazed vegetation.

The macrofossil record in the urban occupational deposits is dominated by a species composition that also characterises cattle faeces. This confirms the historical notes from the 16-17th centuries that the town was largely composed of farms. Hay remains were found stuck to the inside of a compressed bucket that was situated on the floor in a burnt down small stable from the early 17th century. The macrofossil composition of the hay, dominated by *Filipendula ulmaria* and *Poa palustris*, differs completely from the composition in the cattle faeces, dominated by *Juncus bufonius*, found on the stable floor (that seems to have been covered by spruce branches). This shows that the cattle kept in this stable had been grazing and was not fed with hay mowed from meadows. Since hay was likely used as winter fodder, this indicates that the stable was not used for winter stabling. An explanation to this may be that it was used specifically for cattle that were to be slaughtered.

The urban cultural layers were also rich in the remains of cultivated, collected and imported plants. The finds of cereal grains were dominated by *Avena sativa* (oat). According to historical sources, this was the most frequently cultivated plant in the county of Värmland at this time, which indicates that locally cultivated crops dominated the urban use of cereals. Macrofossil finds also indicate the cultivation of *Fragaria moschata* (Hatbois strawberry) during 17-18th century, *Rubus* subg. *Rubus* sect. *Rubus* (blackberries), *Pisum sativum* var. *arvense* (field peas) and *Fagopyrum esculentum* (buckwheat). Further, there is botanical evidence of cultivation of *Nicotiana rus-
tica (wild tobacco). This cultivation is historically documented to have been introduced in Karlstad by Gustav Claren during the mid 18th century. Historical documentation and find positions in the debris of a burnt house may contribute to a dating of the destruction of the building to June 8, 1752, when there was a large fire in Karlstad.

The discovery of a fruit from *Pimenta officinalis* (allspice) in a stratum from the latter part of the 17th century indicates the importation of exotic species. Allspice has earlier only been archaeologically found twice, in England and Poland, and this is probably the oldest find in Europe so far. There is also other evidence of long distance trade in the form of rare species specifically known to grow at docking places and in harbours, for example *Erucastrum gallicum* and *Chenopodium murale* / *C. vulvaria*.

**Paper IV**

Jens Heimdahl, 2005: Botanical Evidence of Environmental and Traditional Changes in Norrköping, Sweden, AD 1200-1660 (Manuscript)

During excavations in Medieval and Post-Medieval Norrköping, macrofossil and pollen evidences revealed local and regional floral changes, cultivation of plants, preparation of food and importation of exotic plants.

The oldest macrofossils were found in alluvial deposits underlyng the oldest occupational deposit – a fill from c. AD 1200. The composition indicates that the slope towards the river Motala ström partly contained a wet meadow with tufts of *Juncus* sp. and *Urtica dioica*, and partly a drier sand bank vegetation with for example, *Arenaria serpyllifolia*, *Potentilla argentaea* and *Arabidopsis thaliana*.

The urban phase at the site seems to have started with the dumping of filling masses on the slope towards the river. On these filling masses, a dark earth developed through cattle trampling between AD 1200-1400. Nitrophilous plants with pioneer strategies like *Thlaspi arvense* and *Lamium album* besides species thriving on faeces like *Urtica dioica* and *Chenopodium glaucum/rubrum* seem to have dominated the site together with plants resistant to trampling, for instance *Polygonum aviculare* and *Plantago major*. This combination of plants indicates a rural environment with dung heaps, tramped paths and plants growing along fences and buildings.

Above the dark earths, complex strata of urban occupational layers were deposited between AD 1400 and 1660. The composition in the layers indicate a shift in the local plant ecology since earlier common plants like *Plantago major* and *Lamium album* disappear and are replaced by newcomers like *Aethusa cynapium* and an increase of *Hyoscyamus niger*.

*Centaura cyanus*, *Rumex acetosella* and *Sparganium arvensis* are examples of plants interpreted as regional field weeds. Field weeds especially common in fields with autumn sawed rye, for example *Bromus secalinus* and *Agrostemma githago*, was found. The cattle that were brought into town were probably mainly grazing on wet meadows with different species of *Carex* spp.

*Secale cereale* (rye) dominates among the cereals in the pollen record from the dark earths (1200-1400) and in the cereal macrofossil composition between 1400 and 1550. If this reflects local cultivation, it is partly in line with historical evidences since the area became part of the so called ‘rye belt’ during the 15th century. Of special interest is a burnt find of what is interpreted as threshed remains from a harvested rye crop from 1400-1550. The cereal grains are here mixed with seeds from typical field weeds like *Centaura cyanus* and *Rumex acetocella* but the most common non-cereal plants are *Poa palustris* and *Trifolium hybridum*, which are typical meadow plants common in mowed hay. This may be either a mixture of a crop and hay, or possibly a crop from a field that previously was used as a meadow.

Among the most commonly found cultivated plants were hops (*Humulus lupulus*), well known to have been used for the flavouring of beer. Beer making seems to have been common at the site between the 14th and 16th centuries. In some samples, hops were found together with *Myrica gale*, which was the most commonly used beer flavour in Sweden before hops was introduced. The finds also indicate that a mixture of *H. lupulus* and *M. gale* was used for beer flavouring in 1400-1550. *Filipendula ulmaria* was over-represented in the samples that contained other beer flavours. This plant is earlier known to have been used as a flavouring of mead during the Viking Age. The find in Norrköping may indicate that this tradition survived into the late Middle Ages.

Further, seeds from imported plants like grapes and figs were found. An early find of grape, probably deriving from the 14th century, indicates the presence of a clerical, or upper class, community.

**Paper V**

Jens Heimdahl, 2005: Archaeobotanical Evidence of Early Tobacco Cultivation in Norrköping, Sweden (Manuscript)

Botanical evidence of tobacco cultivation was found...
during the investigations in Norrköping. It is the first archaeological find of tobacco in Sweden. Light microscope and SEM analysis resulted in the identification of the seeds as *Nicotiana rustica* (wild tobacco) and *Nicotiana* spp. (tobacco unspec.) Since finds of fossil tobacco seeds are rare, the seeds are carefully described. No leaf tissue from tobacco was found in the samples containing the seeds. In total, 42 seeds were identified. Although a $^{14}C$-date indicates a younger age, artefacts and stratigraphical information suggests that cultivation occurred sometime during 1560-1660 – possibly the earliest tobacco cultivation in Sweden.

The conclusion that the seeds indicate cultivation in Norrköping is based on several facts. Tobacco for smoking or sniffing was imported as leaves. In order to maximise the size of cultivated tobacco leaves, the flower buds were cut off the plants. The possibility that the seeds derive from imported tobacco leaves is therefore minimal.

So far the oldest known cultivation of tobacco in Sweden took place in the garden of Uppsala castle in 1632. During the 17th century, tobacco cultivation in Sweden was not aimed for large-scale production but for medical use. Tobacco was considered a panacea – a miracle medicine able to cure many types of diseases. Early tobacco cultivation for medical or scientific use is a probable explanation to the find in Norrköping. From written sources, tobacco cultivation for industrial use is known to have occurred in this town between 1720 and 1930.

### 9 Discussion

#### Urban strata, a formation model

From a geological perspective, it is natural to define urban strata as two different types of phenomenon: sediments and soil horizons, meaning strata formed by depositional and post-depositional processes respectively. This classification has earlier been stressed in archaeological contexts by both geologists (Limbrey 1975, Lundqvist 1986, Corty et al. 1989, Carter 1992), and archaeologists (Beronius-Jörpeeland 1992). A third important factor that affects site formation are the negative effects from truncations, erosion (Tagesson 2000a) and decomposition. The processes that controlled the formation of the urban stratigraphy in Norrköping and Karlstad can be divided into three major groups: Depositional, Post-depositional and Truncation/erosion/decomposition processes.

Deposition provides the material, which is redistributed during post-deposition, and the third process, truncation/erosion, removes the material. Truncation/erosion may be also followed by redeposition. Again, each of these groups may contain both natural and cultural elements. One of the major questions archaeologists ask about site formation is which of the units were formed by intentional acts, and which were formed unintentionally (Järpe et al. 1979, Andrén1986, Beronius-Jörpeeland 1992, Larsson 2000). The answer influences the information potential of each stratum. Moving towards a classification of possible site formation causes as being either intentional or unintentional, I would like to add natural processes as a third factor. Table 2 presents how the tree groups of processes, depositional, post-depositional and truncational/erosional, combined with the tree groups of causes, intentional, unintentional and natural, may result in different types of stratigraphic features.

A compilation of processes that affects the formation of urban occupational strata can be combined into a model (Fig. 18). This model combines the geological and archaeological approaches to the stratigraphy. The model is divided in three main steps: causes, cultural actions/natural events and stratigraphic features.

### Table 2: Classification of urban occupational strata

<table>
<thead>
<tr>
<th>Natural</th>
<th>Unintentional</th>
<th>Intentional</th>
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</thead>
<tbody>
<tr>
<td><strong>Depositions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alluvial (water)</td>
<td>Cattle droppings</td>
<td>Constructions</td>
</tr>
<tr>
<td>Colluvial (gravity)</td>
<td>Unintentional waste</td>
<td>Fills</td>
</tr>
<tr>
<td>Eolian (wind)</td>
<td>Tramping horizons (humans and</td>
<td>Waste and dump</td>
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<td>cattle)</td>
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<td></td>
<td>Live stock turbation</td>
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<tr>
<td><strong>Horizons</strong></td>
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<tr>
<td>Earthworm horizons</td>
<td>Plough horizons</td>
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<td>Root horizons</td>
<td>Cultivation horizons</td>
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<tr>
<td><strong>Erosion/truncation/de-</strong></td>
<td>Trampling erosion</td>
<td>Truncations</td>
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<tr>
<td>composition**</td>
<td></td>
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<tr>
<td>Alluvial erosion</td>
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<tr>
<td>Microbiological</td>
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<tr>
<td>decomposition</td>
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</tbody>
</table>

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Urbanised Nature in the Past

The stratigraphic results are in turn divided into: strata formation (depositional and post-depositional) and strata destruction (including truncation/erosion/decomposition) effects. The model illustrates how cultural and natural causes contribute to site formation in both the depositional and the post-depositional phase, and also how the stratigraphic results in turn can act as a trigger mechanism for cultural and natural responses (cf., the cyclic model in Paper II).

All types of processes that bring material to the site are here referred to as depositional. From a geological perspective, they can be considered as ‘sedimentological’ processes. The depositional processes result in accumulations of different layers. The intentional deposits dominate the occupational layers in both Norrköping and Karlstad. The main volume of the deposits consists of minerogenic layers that were transported to the site with specific intentions, mostly to reshape the local landscape, for example to make a terrace on a slope, as in Norrköping, or to construct elevated foundations for buildings. For
these purposes mainly minerogenic material was used. Reworked house debris are also intentional deposits. The destruction of houses may have been unintentional but often the material of destructed houses was truncated and used as fills in new foundations, and the unintentionally created debris is thereby intentionally reworked (cf., Tagesson 2000a). A special type of intentionally deposited material was sand that was spread on icy grounds during wintertime. This sand was deposited with a purpose but when the snow melted in the spring, it became redistributed by alluvial processes and by cleaning. Waste piles, dung heaps and latrines are examples of intentionally created organic deposits but all traces of organic waste piles found in Norrköping and Karlstad contained 40-80% minerogenic material. The fact that cattle faeces were dumped within the town and not brought to the surrounding fields indicates an overproduction, which is also confirmed by written sources (see Paper V).

The second most common depositional factor in Norrköping and Karlstad was natural events (Paper II). The major natural process was alluvial and resulted in the sedimentation of silt and sand in water ponds formed in depressions. In Norrköping there is also an example of small mudflows. Regularly occurring exposure of sandy material in the slope results in erosion during rainfall and snow melt. The alluvial slope runoff in Norrköping probably worked as a trigger mechanism for a certain cultural responses. The concentration of alluvial and mudflow deposits to depressions results in drainage problems in these areas, which led to that buildings had to be elevated by their foundations in order to avoid the moisture, which in turn created new depressions in the streets. Hence, this includes a nature-culture cycle of reactions and responses (cf. Paper II). This is probably one of the reasons why occupational deposits are thicker in depressions. The cycle was inhibited when the foundation materials became coarser, with better permeability and more resistance to alluvial erosion. (In Fig. 18 the bottom arrow that leads from the strata and the erosive contacts back to the cultural and natural causes represent these processes.) A fully natural process dominates the alluvial material in Karlstad – the regular flooding of the river Klarälven and the formation of top set beds on the still active delta.

Examples of unintentional deposits are dropped objects and animal faeces dropped on the ground in the streets and yards. Normally, material deposited on the ground was mixed into the topsoil by post-depositional processes such as trampling and bioturbation by earthworms. To find these types of deposits unaffected by post-depositional processes is extremely rare.

Trampling by humans and animals was probably the most important of the post-depositional processes that occurred in the Medieval and Post-Medieval urban environment. Experiments have proved this process to be able to redistribute objects up to 17 cm in depth (Villa & Cortuin 1983) in sandy material during just one day of tramping. However, with the exception of dark earths, trampling horizons on the sites in this study are 3-10 cm deep. Cobblestones, wooden boardwalks and a compact humic ground inhibited the trampling effect.

Natural soil formation processes occurred parallel to the trampling. There are several examples of strata in both Norrköping and Karlstad where earthworm traces were present. This is indicated both by horizons with crumb microstructure and macroscopic finds of earthworm cocoons. It was quite common to find traces of root horizons together with traces of earthworms. Traces of smaller soil-penetrating organisms like nematodes and Oribateids were also found in many samples.

Examples of intentionally created post-depositional processes are ploughing or digging in order to prepare a soil for cultivation. Soils of this type were not found at any of the sites although a 16th century plough-horizon had earlier been identified in Karlstad, c. 200 m east of the present site (Lund et al. 1994).

The macrofossil record from Karlstad indicates that the development of soil horizons occurred during summer and autumn (cf. Paper III). Due to frozen ground no organic material was mixed into the soils during wintertime. Cattle faeces loaded with fodder plants remnants from mowed meadows (winter signal) are absent in the urban soils and must therefore have been deposited during the grazing season. Since deposition of winter droppings loaded with fodder plants most likely occurred, their absence implies that the droppings were cleaned from the streets before the thawing of the ground. It could have occurred during snow ploughing but since snow is not always present, their absence also implies that the frozen streets were cleaned from dung also when they were snow-free – probably due to a regular habit of cleaning the streets. This is in line with the idea that an organised cleaning occurred in the towns during the Medieval and Post-Medieval times (cf., Beronius-Jörpeland 2001).

Intentional truncation and unintentional/natural erosion created negative features found in Norrköping and Karlstad. These features are revealed by erosive contacts between layers. Truncations may be
recognised by their regular extension that excludes natural or unintentional processes. When a truncation has cut one or several strata, it is sometimes possible to identify and trace the eroded or truncated material that is redeposited as fills nearby. This is possible when the redeposited material contains a mixture that is possible to identify, for instance through recognisable specific pieces or lumps. It is possible to make these observations in the field, although soil micromorphology provides a more powerful tool when dealing with these features (cf., Carter 1993). Erosion by unintentional acts may be, for example, hollowed walking paths or streets that are eroded during snow ploughing. Natural erosion may occur, for example through alluvial processes. In this study erosion has been harder to recognise than truncation, as it occurs on a smaller scale. On the other hand, the material that is eroded and redeposited by alluvial process has been easier to identify.

The formation of dark earth
The dark earths of Norrköping and Karlstad were formed by a combination of depositions by natural events through alluvial processes and the post-depositional unintentional formation of soil horizons by...
cattle trampling (Fig. 19).

The post-depositional processes led to the formation of soil horizons in the exposed ground surfaces. When cattle were present at the site, new organic material in the form of dung was deposited on top of the sand. The mixture of sand and dung occurred by cattle trampling but probably also by other pedogene soil forming processes, such as bioturbation by earthworms and roots. In this way a tramping horizon mainly composed of a dung-and-sand mixture was formed. However, alluvial processes continued to affect the area, and additional sand and silt were deposited on top of the horizon. Since the cattle handling at the site continued, the deposition and mixing of the dung into the tramping horizon also continued. The horizon affected the ground all the way below the contact between the old ground surface and the newly deposited alluvial sand, and erased this contact. This process continued and the result was dark earths that contained several obscured beds of alluvial material and several overlapping obscured tramping horizons (Fig. 19).

The obscured stratigraphy of the dark earths in Norrköping and Karlstad was revealed through the traces within them, such as preserved fragments of minerogenic units, traces of constructions that apparently were built on top of obscured surfaces and the varying organic compound and macrofossil content that differed through depth (Paper II, cf., Sidell 2000).

The reason why the dark earths at the investigated sites ceased to form was probably due to the change in land use when the area was divided into plots in order to raise houses. Even if cattle were still kept within the towns, movements of the animals were restricted to streets and backyards that were partly paved, inhibiting alluvial effects. Tramping horizons of cattle do occur also in the strata above the dark earths but were not developed to the same depth or complexity.

Sediments, soil horizons and culture

The formation of deposits in the urban environment generally occurred during short-term intervals while post-depositional formation of soil horizons normally had a longer duration (Fig. 20). Fills in foundations and terraces were most likely formed during minutes, hours or days. Waste deposits may, as a whole unit, have a longer duration of months or years but parts of the waste heaps can be formed during seconds. Geologically speaking, the urban occupational deposits are extremely rich in hiatuses since no continuous accumulation takes place.

The effective depositional time of the urban layers in Norrköping and Karlstad may be a few days or weeks in total, even though the whole stratigraphy represents a development during several millennia. The pedogene post-depositional soil formation process had a longer duration. The trampling horizons developed in some of the deposits represent units that were formed through ‘the unintentional activities of the daily life’. If the total formation time of these soil horizons are added to the total formation time of the deposits, the result is more likely to represent decades instead of days or weeks but it is still important to remember that we are trying to reconstruct millennia from the fragments of those decades.

Harris’ (1979) statement that a stratigraphic sequence comprises depositions and interfaces is, in my opinion, too generalized. Larsson (2000) may be sociological correct when he states that “the surface is the scene upon which the social interactions occurred” but it may also be stratigraphically misleading. The idea that the surfaces are the most interesting stratigraphical units to the archaeologist (Gardelin et al. 1997, Larsson 2000) may lead to some confusion when trying to understand how the ground was affected by activities. Surfaces are two-dimensional and constantly changing on a substrate and if they are buried, they are extremely difficult to trace through excavation. Surfaces themselves are rarely preserved in a stratigraphy because of truncation and erosion. In fact, most of the contacts/interfaces between the urban deposits of Norrköping and Karlstad are erosive. Instead the traces after those ‘activity surfaces’ have to be searched for in the soil horizons developed as three-dimensional strata in the deposits that constituted the ground at a specific period. The social interaction mainly took place during the post-depositional phase, and it is therefore the post-depositional features – the trampling horizons etc. – that must be studied in order to interpret this daily life activity, and thus the cultural and social complexes.

Still, it has also been proven fruitful to trace social and cultural changes by studying the deposits. Alluvial beds may contain reworked objects from lost surfaces and objects found in minerogenic deposits with known origin may be considered as primary deposited (Paper I). In addition, textural studies of fill have proven rewarding. The shift from locally used material in the fills to material with ‘exotic’ and coarser texture probably reflects a professionalisation of the building tradition (Paper II). Among urban historians such a change has long been known but it has not been known when it occurred, or if it developed at different times in different towns,
and in different blocks within the town (Augustsson 1992). The investigations in Norrköping and Karlstad suggest that this shift occurred at different times in different towns, but it is not known if it occurred simultaneously in all areas within the these towns.

This professionalisation may also have inhibited the further formation of well-stratified urban occupational strata. The use of coarser material led to better drainage and higher resistance to erosion by alluvial processes. This change also resulted in more advanced drainage systems and the paving of streets and backyards become more common. The paving inhibited soil formation by trampling, and the streets became easier to keep clean (cf., Beronius-Jörpeland 2001). It is probably not a coincidence that well stratified urban strata are not found after the reorganisation of building tradition was introduced. The younger urban occupational deposits are coarser, water logging is inhibited and the preservation status of organic material in this material is therefore poor.

Larsson (2000) stated that we might expect a decrease of natural (geological) processes within the urban environment in comparison to a rural environment. The results in this thesis speak in favour of the opposite: The specific urban environmental conditions at Norrköping seem to have enforced geological processes. In Karlstad, the geological, alluvial processes were not affected at all until the control of the river in the beginning of the 20th century. It is also worth mentioning that urban occupational deposits generally are thicker than rural occupational deposits. The comparisons I have made between excavations indicate rather that naturally formed geological deposits are more commonly found interlayered within urban deposits than rural deposits. This also suggests that the urbanisation in Medieval and Post-Medieval towns, with their constant ongoing soil exposure, reworking and land use shifts, increased the activity of local geological processes.

10 Conclusions

- Stratigraphic interpretations are more complete and reliable when archaeologists and geologists carry out excavations together. Possibilities of continuous field discussions enhance the prospects of mutual understanding between the disciplines. Methods connected to Single Context Recording are fully adaptable to a continuous geological fieldwork during archaeological excavation.
- Continuous pilot diagnoses of macro contents in samples during excavation greatly contribute to field interpretations, concerning both interpretation of stratigraphy, functions of structures and past local environments.
- The presence of a geologist during archaeological excavations contributes with knowledge concerning both natural and cultural factors connected to the site formation processes. Naturally formed sediments may be studied to obtain cultural information, for example alluvial sediments may have acted as traps for material on truncated surfaces or areas situated outside the excavation area.
- There is evidence of small changes in the local urban flora through time, probably as an effect of interspecies competition. Marked floral changes occurred according to changes in land use. In Karlstad there is evidence of a neophyte harbour flora with rare species, nowadays limited to sporadic occurrences on the west coast. Many species are found which probably had a more northerly distribution during the 14th–19th centuries than today.
- Botanical evidence combined with historical data suggests that the main consumption of cereals in the towns derived from local crops. Rye dominated in Norrköping and oat dominated in Karlstad. In Norrköping evidence of a transition between a grass-clover meadow and a rye field was found. There are also indications of cultivation of berries, for example Fragaria moschata in Karlstad during the 17th and 18th centuries. In Karlstad and Norrköping evidence of tobacco cultivation was found. In Norrköping tobacco cultivation occurred between 1560-1660, and may be one of the earliest tobacco cultivations in Sweden. In Karlstad it occurred during the 18th century, and by historical sources it is possible to connect to Gustav Clareen’s cultivation of tobacco 1741-1772.
- Comparison between the content of plant macrofossils in mowed hay and cattle dung in Karlstad strongly suggests the use of a specific stable as a slaughterhouse, not used for winter stabling. The floral composition of meadows and pastures differed and there existed several types of meadows that were managed differently. The grazed pastures in the area were characterised by ungrazed tufts of Juncus bufonius. Sampling of recent cattle droppings from a pasture with an ungrazed Juncus community shows that the cattle graze the Juncus fruits that fall on the surrounding vegetation. The composition of diaspires in cattle faeces may therefore also include ungrazed species.
- The formations of dark earths in Sweden are not connected to any specific time period but probably to rural environments. The dark earths found in Norrköping and Karlstad were formed due to a combi-
nation of recurrent alluvial deposition in areas that were used for intense cattle handling. By the trampling of the cattle, humic soil horizons were formed that obscured the contacts between the alluvial sand and silt. In Norrköping the dark earth was formed during the 13th century, in Karlstad up to the 17th century.

- Deposition of urban strata was generally more intense in depressions and at the base of slopes. The causes of this seem partly to have been from a cultural need of levelling the ground due to drainage, and partly because alluvial deposits from rain water, snow melting and flooding were concentrated in depressions. Since alluvial deposits were concentrated to depressions in the town, they may sometimes have created casts of streets and lanes and backyards.

- Development of urban soil horizons was concentrated during spring, summer and autumn, when the ground was not frozen. This is indicated by the macrofossil record originating from cattle dung in Karlstad that consists entirely of species that were grazed at meadows. Remains of mowed winter fodder have not been found within the preserved soils.

- In the occupational deposits of Norrköping and Karlstad there is a significant textural trend of coarsening upwards of the minerogenic material because the local sand and silt was used as fill in the early phases, and more coarse sand and gravel was used in later constructions. (This trend is also observed during field studies in Skänninge and Stockholm, and according to many archaeologists it seems to be common in the occupational deposits of most towns.) The shift was identified to have occurred during the 17th century in Norrköping and during the 18th century in Karlstad. It is probably a reflection of a professionalisation of the urban building procedures that apparently occurred at different times in different towns.

- Waste material does not seem to have been used as a primary filling. Places where the dumping of minerogenic filling material occurred were probably secondarily used as places for waste dumping. The different taphonomy of the urban macrofossil record may be utilized to make interpretations of the composition of mixed and reworked depictions. Macrofossil remains may contribute to model the development of both local and regional environments. Changes in the local urban flora may reflect both environmental changes and interspecies competition. When such changes occur, they can be locally used for indirect dating of strata.

- Formation processes of urban strata are regulated by three major factors: Deposition, post-depositional soil formation and erosion/truncation. All these factors may occur as both natural and cultural. Culturally controlled factors dominate but natural factors are always present and even dominate on some occasions. Intentional and natural depositions seem to have contributed to the main part of the minerogenic material. The main part of the organic material was successively deposited unintentionally and unintentionally mixed into the topsoil through trampling. Past urban environments in Norrköping and Karlstad were geologically active and geological processes contributed to and greatly affected the site formation process.

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**DEN URBANISERADE NATUREN**

De äldre städernas spår

Städer är ofta byggda på resterna av sina forna lämningar. Äldre fylknadsmassor, husgrunder, gator, avfallshögar och enstaka glömda och borttappade föremål utgör s.k. stadskulturlager. Vid sidan av arkeologiska kulturlämningar vittnar geologiska och biologiska spår om den miljö som funnits i och omkring staden under olika perioder. Det är lätt att se 'staden' som en motsats till 'naturen', men miljon i ständer utgör också en ekologisk nisch för växter och djur med särskilda krav. I staden skapas också förutsättningar för vissa geologiska processer. På samma sätt som man kan tala om en "urbaniserad människa/kultur" kan man också tala om en "urbaniserad natur".


Både i Sverige och internationellt har stadskulturlager främst varit studieobjekt för arkeologer, men de senaste decennierna har också naturvetare i såsom biologer (arkeobotaniker) och geologer (geoarkeologer), alltmer kommit att knytas till utgrävningarna. Vanligen är det fråga om tillfälliga, i bästa fall regelbundna, besök i fält, eller analyser av jordprover som skickas in till laboratorier. Samtidigt har praxis inom exploateringsarkeologin (som står för nästan alla utgrävningar i Sverige) varit att fältarbete utfors av arkeologer, vilket innebär att den viktiga fälttolkningen av kulturlagren, som är avgörande för slutresultaten, nästan uteslutande görs av arkeologer. Det kan också uttryckas som så att naturen i stads- och naturvetenskapliga studier av kulturlager ofta saknat en tillfredställande fältfas. En del av detta har berott på uttalad praxis, en annan på uppfattningen att modern arkeologisk grävteknik är knäpp att kombinera med deltagande av naturvetare under fältarbete.


**Utgrävningarna**


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År 1589 grundade Hertig Karl (senare Karl IV) Karlstad, som en strategisk utsekningsplats mot väster. Staden har en möjlig medeltida föregångare som kallas ”Tingvalla”. Den är omnämnt som marknadsplats i området, men har hittills inte lokaliserats arkeologiskt, även om man då och då hittar lösa fynd i området, som visar att människor varit här under medeltiden. Karlstad ligger på Vänerns norra strand, där Klarälven har sitt aktiva delta. Staden är byggd på själva deltaytan, vilket medför att översvämningar har varit regelbundet förekommande i Karlstad genom historien.


Den geologiska undersökningen i Norrköping visar att de äldsta kulturmarken i området bestod av meterjocka fyllnadsmassor av sand och grus, som använts för att någon gång på 1200-talet skapa en terrass på sluttningen, kanske som ett skydd mot översvämningar av Motala ström. Fyllnadsmassorna har delvis blivit dumpade i vatten, antagligen under en översvämning. Utan den geologiska undersökningen hade dessa tidiga fyllnadsmassor antagligen blivit tolkade som naturliga sediment, och inte kommit att ingå i den arkeologiska tolkningen av platsen.

Eftersom analyser av växtmakrofossil (växtrester syntliga för blotta ögat, främst frukter och frön) tillämpades som huvudmetod utvecklades ett system för att kontinuerligt och preliminär analysera alla stratigrafiska enheter och arkeologiska lämningsredan i fält. På så viss kunde provtagningen effektiveras och arkeologerna kunde få svar på vilka växter som fanns i olika lager, innan de var helt utgrävda. Förutom att ge svar på hur den lokala floran i kvarteret såg ut, visade också analyserna t.ex. spår av latrinavfall, kodynga, odlingsväxter och åkergräs, rester av oljekyddor, exotiska (importerade) växter, men också spår av hantverk som t.ex. smidesloppor.

Växterna i Norrköping och Karlstad

Växter som bevarats i stadskulturlager har ett komplext ursprung. För att kunna tolka sammansättningen av växtfossilen, måste man förstå vilka processer som lett till att de hamnat där.

Staden har en lokal flora med växter som trivs i själva stadsmiljön och som kan avslöja hur miljön varit på olika platser, t.ex. vilka områden som betrampats, var avfallsplatser har funnits, och vilka områden som legat i skugga eller sol. Förändringar i lokallfloran kan avslöja förändringar i stadsmiljön. En stor mängd frön och frukter kommer in i staden via djur som betat i hagar eller åtåt vinterfodrar slaget på ångar. Frön och frukter i dynga ger signaler om hur stadens omgivande hag- och ängsfloran sett ut vid olika tider. En tredje viktig fyndgrupp är frön och frukter från odlade och insamlade växter, som förts in i staden för bearbetning, försäljning och konsumtion. Makrofossil som hittas i spiskonstruktioner eller i latrinavfall kan ge indikationer på vilken typ av kost som konsumerats, vilket i sin tur kan ge antydningar om den lokala ekonomiska situationen och klasstillhörighet hos de inneboende i kvarteret.


I Karlstad var det en lokal flora med växter som trivs i själva stadsmiljön och som kan avslöja hur miljön varit på olika platser, t.ex. vilka områden som betrampats, var avfallsplatser har funnits, och vilka områden som legat i skugga eller sol. Förändringar i lokallfloran kan avslöja förändringar i stadsmiljön. En stor mängd frön och frukter kommer in i staden via djur som betat i hagar eller åtåt vinterfodrar slaget på ångar. Frön och frukter i dynga ger signaler om hur stadens omgivande hag- och ängsfloran sett ut vid olika tider. En tredje viktig fyndgrupp är frön och frukter från odlade och insamlade växter, som förts in i staden för bearbetning, försäljning och konsumtion. Makrofossil som hittas i spiskonstruktioner eller i latrinavfall kan ge indikationer på vilken typ av kost som konsumerats, vilket i sin tur kan ge antydningar om den lokala ekonomiska situationen och klasstillhörighet hos de inneboende i kvarteret.


Frihet och fritid


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men vissa förändringar kan dock spåras, i synnerhet kring mitten av 1500-talet då djurhållningen får ge vika för en mer hantverkspråglad miljö. Vissa örter, t.ex. trampört och vitpilister försvinner ur kvarteret, medan andra, t.ex. bolmör och vildpersilja ökar i betydelse. Även rester av beuxnna hustad hittades på platsen. Innehållet i de rikliga resterna av dynga i kulturlagren visar att boskapen betat på fuktiga strandängar dominerade av starr och tågväxter runt Motala ström, utanför självad staden.


 Lagrens och horizonternas tillkomst


Undersökningar av texturen (korristorleksandsättningen) i materialet som använts i husgrunder vid olika tidpunkter i stadens historia, visar liknande tendenser för Norrköping och Karlstad. I det tidiga skedet användes finkornigt material (silt och finsand) som hämtats lokalt (förmodligen inte mer än några meter bort). I senare tid skedde en omsvärgning, först med användning av en kombination av lokalt finkornigt material och grövre material, och sedermera till bruk av grovsand och grus, som i Karlstad måste ha hämtades från mer avlägsna tät. Denna förändring är tolkad som en professionalisering av byggnadet. Från att husbyggarne varit inflyttande bönder, går ansvaret över till ett byggarkår med andra traditioner. Det finkorniga materialet i grundern kan förklaras av att det på landsbygden, där husen mer fritt kunnt placerades på dränerade platser, funnits en tradition av att ha betraktat grundmaterialet främst som köldisolerade, medan de professionella byggarne i städernas främst säg det som ett stabilt infiltrationsbädd. Professionaliseringen av byggnadet sker vid olika tidpunkter i de två städerna, i Norrköping sker den omkring 1600 och i Karlstad omkring 1700. Förändingen leder att de yngre kulturlagen är bättre dränerade vilket gör att organiskt material bevaras sämre än i de äldre lagrene. Det grövre materialet står också emot erosion bättre, varför också förekomsten av vattentransporterade lager minskar.


I syfte att skapa en teoretisk modell över hur stadskulturler bildas kan de två huvudtyperna av stratagrabens med den arkeologiska frågeställningen om vilka enheter som bildats under medvetna och omedvetna processer. För att all lager i stadsstratigrafin skall täckas in krävs att man frågar sig vilka enheter som bildats genom naturliga processer. Modellen, som framträder, är ett nätryck av medvetna, omedvetna och naturliga handlingar, aktiviteter och processer som bidrar till bildning av olika typer av lager och horizonter, men också till deras försvinnande. Modellen möjliggör också en direkt tolkning av de handlingar, händelser och förutsättningar som ligger bakom flertalet stadsstratigrafska
en heter.

Analyserna av makrofossil ger också indikationer på hur kulturlagen och tramphorisonterna bildas. I Karlstad, där det varit möjligt att skilja mellan vinterfoder och sommar/höstbete, är det uppenbart att dyngan bevarad i stadskulturlagen domineras av det senare. Detta tyder på att bildandet av tramphorisonter hämmades vintertid då marken var frusen. Frånvaron av spår av vinterfoder indikerar också att den dynga, som avsatts i staden vintertid, antagligen hunnit städats undan innan marken tinade och den trampades ner i marken. Detta antyder i sin tur på att gatorna i Karlstad städades regelbundet.

Det sammantagna intrycket av bildningen av stads- skulturlager är ett komplext system av kulturella och naturliga processer. De mänskliga aktiviteterna i de äldre städerna skapade förutsättningar för en mängd geologiska processer som i sin tur gav upphov till motåtgärder. Den geologiska miljön i de äldre städerna kan både betraktas som aktiverad och i viss mån kontrollerad av människan, samtidigt som människan i viss mån styrt av geologiska förutsättningar och påverkats av geologiska processer.

TACK!

Som den strikta men förvirrade forskare jag nu kommit att bli, har jag valt att dela in detta tack till olika personer som riktat till olika skaror. Dessa är fem till antalet och individerna inom dem har haft betydelse för avhandlingen på olika sätt.


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J. Heimdahl


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