

**Exchange and surplus production of animals and animal products at  
the Early Medieval settlement of Oegstgeest**



Samira Nagels

**Exchange and surplus production of animals and animal products at  
the Early Medieval settlement of Oegstgeest**

Samira Nagels (s0811785)  
MA thesis Archaeology (1040X3053Y)  
I.M.M. van der Jagt, MA  
Palaeoecology  
University of Leiden, Faculty of Archaeology  
Leiden, 12<sup>th</sup> June 201

## Contents

<b>1. Introduction</b>	5
1.1. Research questions	8
<b>2. Oegstgeest</b>	9
2.1. Oegstgeest Nieuw-Rhijngest Zuid	11
2.2. Geology	12
2.3. The faunal assemblage	12
<b>3. Early Medieval exchange, import and export along the Rhine</b>	13
<b>3.1. The Rhine delta</b>	13
<b>3.2. Oegstgeest and the Rhine exchange network</b>	15
3.2.1. Pottery	15
3.2.2. Coins	15
3.2.3. Stones	15
3.2.4. Wooden well-shafts	16
<b>3.3. Exchange of animals and animal products</b>	16
<b>4. Recognising exchange and surplus production in the archaeozoological record</b>	19
4.1. Presence of exotic species	19
4.2. Metric and non-metric variation	19
4.3. Skeletal element abundance	20
4.4. Differences in rates of tooth wear between animals	20
4.5. aDNA analysis	21
4.6. Stable isotope analysis	22
4.7. Recognising surplus production	22
<b>5. Methodology</b>	24
<b>5.1. Material</b>	24
<b>5.2. Methods</b>	24
5.2.1. Age distribution	25
5.2.2. Sex distribution	26
5.2.2.1. Cattle acetabulae	26
5.2.2.2. Cattle metapodials	27
5.2.2.3. Cattle horncores	28
<b>6. Results</b>	30
6.1. Cattle, pig and sheep/goat	30
6.2. Horses	30

6.3. Dogs and cats	31
6.4. Wild mammals	31
6.5. Birds	33
6.6. Fish	33
6.7. Pathologies	35
6.8. Butchery and other marks	38
<b>6.9. Presence of exotic species</b>	39
<b>6.10. Age distributions</b>	40
6.10.1. Cattle	40
6.10.2. Pigs	43
6.10.3. Sheep/goat	45
<b>6.11. Sex distribution of cattle remains</b>	46
6.11.1. Acetabulae	46
6.11.2. Metapodials	50
6.11.3. Horncores	56
6.11.4. The issue of castration	61
<b>6.12. Skeletal element abundance</b>	62
<b>7. Discussion – Exchange and surplus production at Oegstgeest</b>	67
7.1. Cattle	67
7.2. Pigs	68
7.3. Sheep/goat	68
7.4. Birds	69
7.5. Fish	69
<b>8. Conclusions</b>	70
<b>9. Future research</b>	72
<b>10. Abstract</b>	73
<b>11. Samenvatting</b>	73
<b>References</b>	74
<b>List of figures</b>	81
<b>List of tables</b>	82
<b>Appendix 1. Tooth wear stages of cattle, pig and sheep/goat</b>	84
<b>Appendix 2. Epiphyseal fusion of cattle, pig and sheep/goat</b>	92
<b>Appendix 3. Measurements taken for the purpose of sexing cattle remains</b>	95
<b>Appendix 4. Skeletal element abundance for cattle, pig and sheep/goat</b>	104

## 1. Introduction

Exchange in the Early Medieval period appears to have been organized around central places, also known as *emporium*. These *emporium* have long been the primary focus of research on Early Medieval trade and exchange. However, smaller settlements also played a role. An expanding body of archaeological and numismatic evidence has begun to challenge the notion that such settlements were of no importance in the Early Medieval exchange networks (Pestell and Ulmschneider 2003, 1).

In the Early Medieval period a cluster of settlements was located in the former delta of the Old Rhine. The former settlement of Oegstgeest is located within this cluster (fig. 1). This site has been the subject of archaeological excavations and research since 2004 and has yielded traces from the Merovingian period. The site was inhabited from around 500 AD until about 700 AD (Hemminga and Hamburg 2006). The archaeological finds from this site suggest that it was part of the exchange network that was in place along the Rhine river. Oegstgeest could therefore be considered as an example of a small settlement which played a role in a regional and supra-regional exchange network.

Studies on Early Medieval exchange are generally concerned with various types of goods. Pottery is perhaps the most important, as it is often recovered from archaeological sites in large numbers and can be provenanced through typological studies. Coins are another very important tool in studying exchange networks. Luxury goods such as metal ornaments, antler combs and other, possibly prestige goods, also provide information on exchange. However, some lines of research have remained largely unexplored. Exchange and surplus production of animals and animal products is one example.

The exchange of animals and animal products has been studied in some detail for the Roman period (see for example Stalibrass and Thomas 2008). The subject of Early Medieval exchange and surplus production of animals and animal products, however, has not been touched upon by many archaeologists. Surplus production and exchange are closely linked. In order to be able to participate in exchange a settlement would first need to generate a

surplus. After all, it seems unlikely that people would have exchanged goods which they needed for their own livelihood. The lack of attention for these themes appears to be related to the perceived methodological issues which are encountered when investigating them. It concerns perishable items, such as meat and dairy products, which would leave no visible traces in the archaeological record. Animals could also have been transported on the hoof, meaning direct evidence of surplus production and exchange is removed from the production site (Groot 2008b, 86-87).

To investigate the exchange and surplus production of animals and animal products in the Early Medieval Rhine delta the archaeozoological assemblage from Oegstgeest will be analysed. Up to now, Oegstgeest has been interpreted as a primarily agrarian settlement that was involved in the exchange up and down the Rhine and its various tributaries. Hopefully this research will reveal whether this interpretation is correct or whether it needs to be adjusted.

At Oegstgeest, a large and well-preserved faunal assemblage has been recovered which provides the opportunity to seek out patterns in the archaeological record which might be indicative of exchange and surplus production. Archaeozoological methods of quantification, age and sex determination and osteometry will be employed to discover such patterns and to create a picture of the exchange and surplus production of animals and animal products in small settlements in the Early Medieval period.

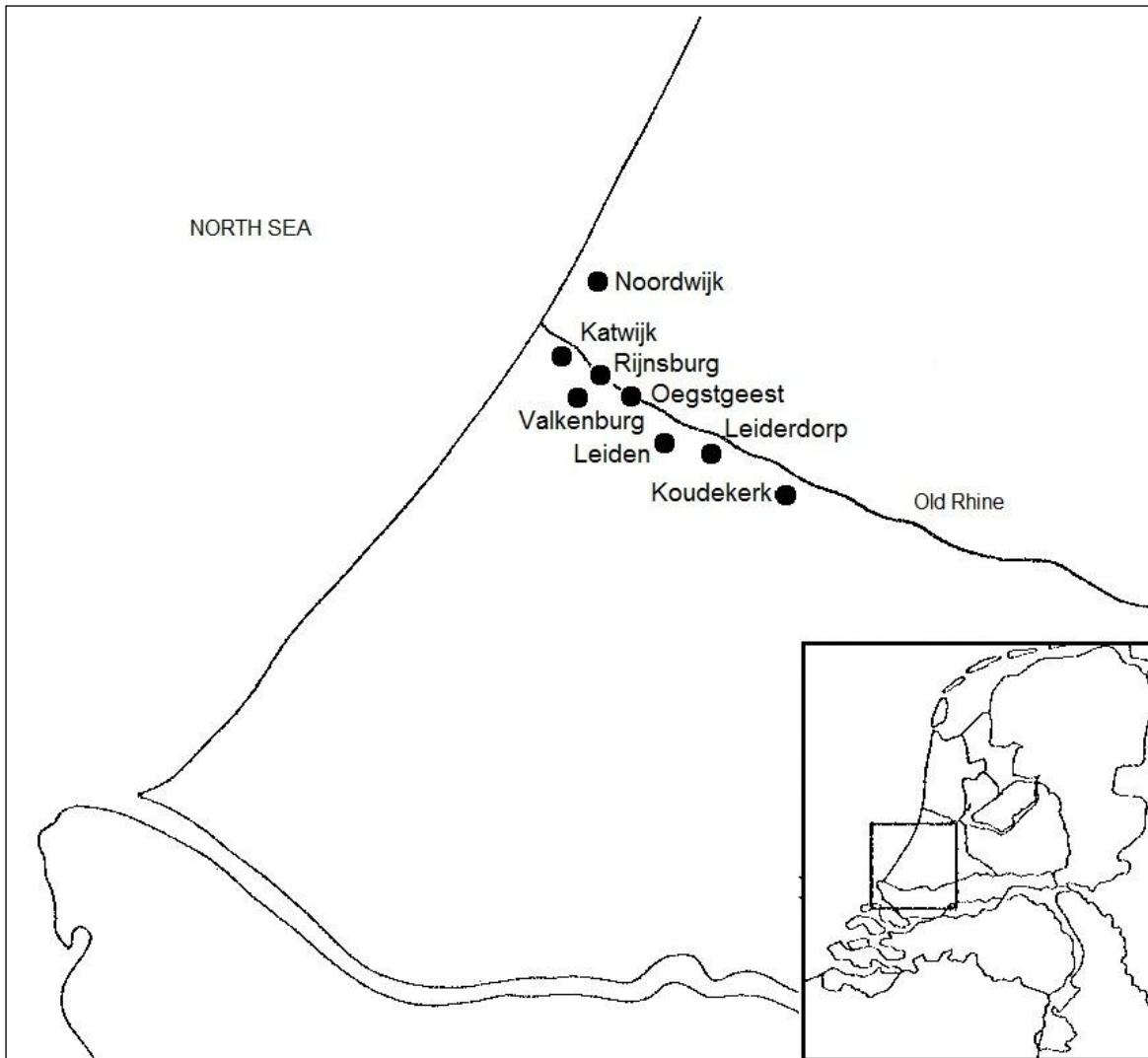


Figure 1. Merovingian settlements in the delta of the Old Rhine (After Bult and Hallewas 1990, 71)  
Although this map dates from 1990, it has been cross-referenced with a more recent map published by  
M. Dijkstra (Dijkstra 2011b, 85).

## 1.1. Research questions

In order to investigate whether the inhabitants of the settlement of Oegstgeest were involved in the exchange and surplus production of animals and animal products, the main aim of this thesis will be to answer the following research questions

- What archaeozoological evidence is indicative of the surplus production and exchange of animals and animal products?
- What archaeozoological methods can be employed to determine the presence of this kind of evidence in the archaeozoological record?
- Does the archaeozoological evidence from Oegstgeest indicate that the population of Oegstgeest was involved in the exchange and surplus production of animals and animal products?
- Does the archaeozoological evidence from Oegstgeest indicate that this settlement may have been part of a large-scale exchange network of animals and animal products along the Rhine river?

**Does the archaeozoological evidence from Oegstgeest indicate the production and exchange of a surplus of animals and animal products?**

## 2. Oegstgeest

The town of Oegstgeest is situated in the western coastal area of the Netherlands, near the city of Leiden (fig. 2). W.A.M. Hessing was the first to perform archaeological research at this location. This small scale excavation was instigated by the discovery of two silver sceatta's (Hessing 1992). During Hessing's campaign, a large amount of soil features were excavated. The pottery from these soil features was dated to the Merovingian period. Other finds from this campaign included fragments from querns, butchery waste and metal slags (Hemminga and Hamburg 2006, 9). In 2004 a second archaeological investigation was started.



Figure 2. Location of the excavation site in Oegstgeest (marked by the star) (Hemminga and Hamburg 2006, 7).

From 2004 onwards several excavations have been carried out at the location of Oegstgeest Nieuw-Rhijngeest Zuid. These excavations have been carried out by archaeological contractors as well as by the University of Leiden and excavations are currently still in progress. Using dates from radiocarbon dating, dendrochronological dating and typological studies on the excavated pottery, the settlement of Oegstgeest has been dated to the Early Medieval period and was inhabited during the sixth and seventh centuries AD (Hemminga and Hamburg 2006, 117-118; Hemminga and Hamburg 2008, 106-107; Jezeer 2011, 116).

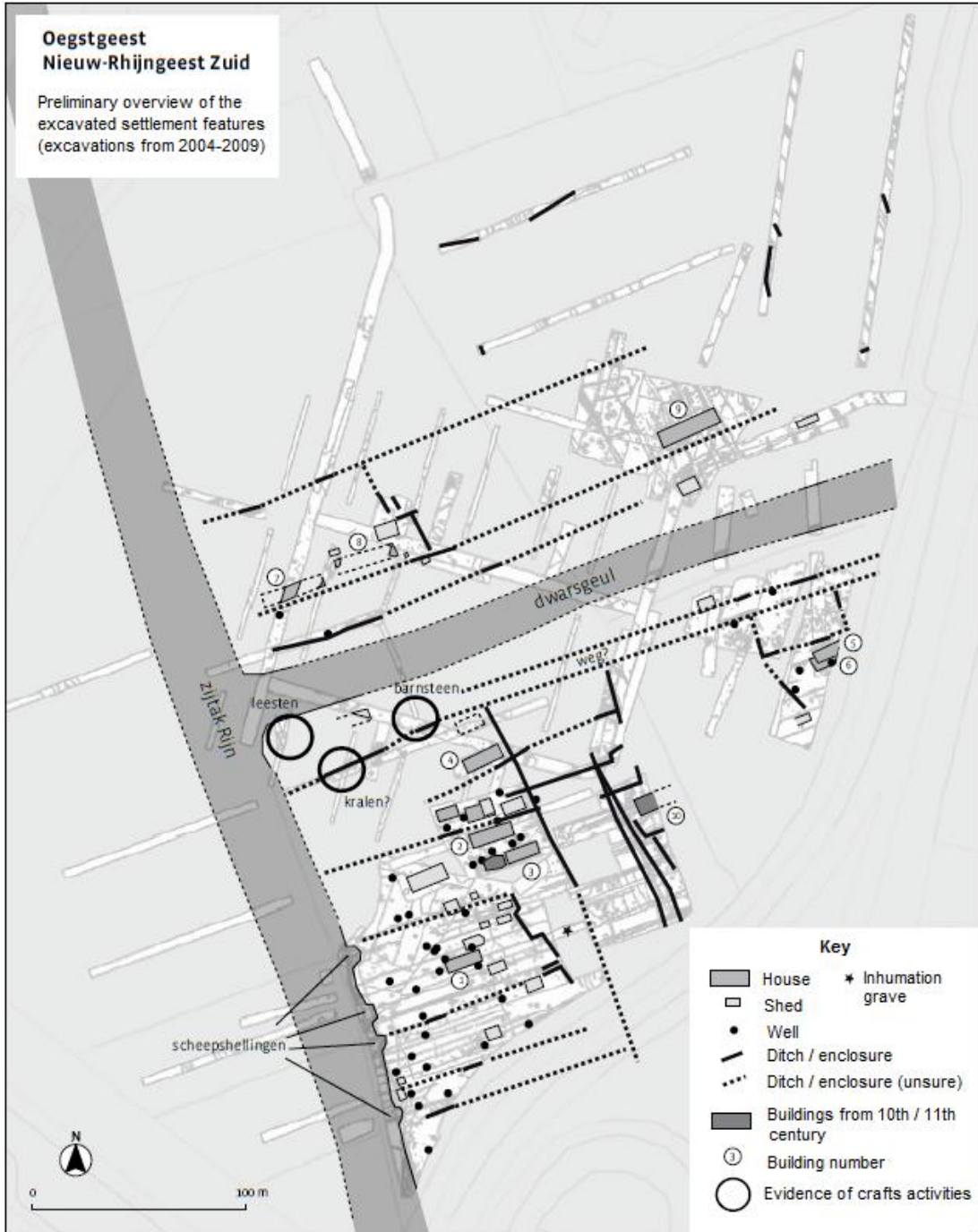


Figure 3. Preliminary overview of the excavated settlement features at Oegstgeest Nieuw-Rhijnegeest Zuid (After Dijkstra 2011b, 135).

### 2.1. Oegstgeest Nieuw-Rhijngeest Zuid

Seven excavated house plans from Oegstgeest have been published so far. Most of these have been dated to the Early Medieval period and have been classified as types Odoorn B and C. One house plan was classified as a type Gasselte B and probably dates from the tenth century AD (Hemminga and Hamburg 2006, 22; Jezeer 2011, 25-27). In addition to house plans a number of small, rectangular plans were excavated, which have been interpreted as sheds of some kind. They may have been used as smaller houses or as storage rooms (fig. 3) (Hemminga and Hamburg 2006, 27-32; Hemminga and Hamburg 2008, 21-24; Jezeer 2011, 28-30). Also, six plans of small storage facilities (*spiekers*) were found (Jezeer 2011, 30-32).

In addition to house plans and other structures, several other kinds of features were uncovered at Nieuw-Rhijngeest Zuid. Among these features are pits, wells, ditches, traces of palisades and traces of a wooden revetment. Among the pits are waste pits, which contain large amounts of charcoal and other waste such as bone material, pottery, burnt clay, metal and rocks. Features which have been termed 'burn pits' were also found. These are pits which have a characteristic fill of a centre consisting of red, burnt clay. Around this a ring of darker, sandy clay can be observed. Such pits have not been recovered on any other sites and their function is unknown. They may have been used as kilns, perhaps for manufacturing pottery. They could also have been used for smoking meat or fish. Long pits with a dark fill of organic sandy clay, accompanied by a second fill consisting of light-brown sand and some organic material were also discovered. These pits may have been used to fertilize vegetable plots. They may also have been pits where flax or hemp was laid to rot to make the fibres of these plants more flexible so that they could be used to make ropes or baskets (Hemminga and Hamburg 2006, 32-50).

The archaeological assemblage from Oegstgeest Nieuw-Rhijngeest Zuid contains a large amount of pottery, most of which seems to be imported Merovingian wheelthrown pottery from the German Mayen region. The assemblage also contains a sizeable amount of stones and rocks, a large amount of animal remains, some human remains, glass finds and botanical remains. (Hemminga and Hamburg 2006). There is also evidence of craftsmanship in the form of worked wooden objects and artefacts made from bone and antler (Hemminga and Hamburg 2008).

## 2.2. *Geology*

The site of Oegstgeest is located on fluvial deposits primarily formed by the Old Rhine. The site Nieuw-Rhijngest Zuid is located approximately 300 metres to the east of the current Rhine and in the Early Medieval period, the settlement was located along one of the tributaries of the Old Rhine. The sediments on which the site is located consist of laminated layers of sand and clay. Long sandbanks were deposited on top of these laminated sediments. These sandbanks are raised above the surrounding landscape, forming excellent locations for habitation (Hemminga and Hamburg 2006, 11; Hemminga and Hamburg 2008, 11). The settlement of Oegstgeest was located in an area with a strong marine influence. There was a strong tidal influence which reached inland and caused high flood levels and an influx of salt water in the area adjacent to the coast. More inland, this marine influence caused a rise in the water level of the Old Rhine, which resulted in the deposition of crevasse sediments in the area around Oegstgeest (Brijker 2011, 17-23).

The excavations have yielded features from the Early Medieval period, but traces from the Iron Age and the Roman period have also been found. All of these traces were located directly beneath the surface, indicating that there has been little disturbance of the archaeological remains at this location (Hemminga and Hamburg 2006, 15).

## 2.3. *The faunal assemblage*

The animal remains recovered from Oegstgeest show little to no signs of weathering. They are, however, highly fragmented. At Rijnfront-Zuid, 75% of all the analysed remains were so badly fragmented that they could not be identified to species level. Cattle remains display the highest degree of fragmentation, followed by pig remains and remains of sheep/goat, which contain a large amount of complete elements (Cavallo 2006, 74-75). At Corpus, 70% of the analysed remains could not be identified to species level (Cavallo 2008, 60). From the remains from the 2009 excavations, about 33% of the mammal remains could not be identified to species level (van der Jagt 2011, 96).

### **3. Early Medieval exchange, import and export along the Rhine**

Exchange, and therefore surplus production, formed an important part of daily life in the Early Medieval period. Items of daily use, such as clothes and food were exchanged, as well as luxury products like objects of metal and glass (Hamburg and Hemminga 2007, 293).

Although the main focus of this thesis is the exchange and surplus production of animal products, it is important to view this in the more general context of Early Medieval exchange. The exchange of animals and their secondary products cannot be viewed as a separate entity; these activities were all part of a larger, more general system of exchange. Archaeological evidence from the Rhine delta sites around Oegstgeest indicates that these settlements were part of a stable, interregional exchange network that reached all the way to Germany and perhaps to regions further away. They also will have formed part of a more local exchange network. The exchange of animals, animal products and other items will have taken place along these local and interregional networks. The purpose of the following overview is to provide the reader with a picture of the Early Medieval exchange network along the Rhine river, of which Oegstgeest formed a part.

#### **3.1. The Rhine delta**

Certain imported goods indicate that the settlements located in the delta of the Old Rhine were involved in a large scale exchange network. An example of a commodity that was imported into the Old Rhine delta is wine. This wine was transported in wooden barrels. After the contents of these barrels had been consumed, they were often recycled as well shafts. Another example of a product that was imported is wood. Though wood was available in the delta region, it may have also been imported from regions like southern-Germany. Metal ore is another product which was possibly imported. Evidence of metal working has been found at many of the settlements in the Rhine delta. It is not clear whether ore was mined locally or whether it was imported. Ore was not available in the delta area itself, but there is evidence that it could be mined in areas nearby, as has been established for the settlement of Frankenslag, a settlement which was located to the south of the Old Rhine Delta in the vicinity of current city The Hague. Such local ore would have been of poor quality, so

it is not unreasonable to assume that some metal ore was also imported from places like Germany, England or the Veluwe. Unfortunately, no definite statements on this subject can yet be made. Some metal objects were also imported. Stones were imported from regions upstream. Types of stones that were imported include tephrite from the Eifel region in Germany, sandstone from the Ardennes and chalk from the Meuse valley (Dijkstra 2011b, 308-309; Hamburg and Hemminga 2007, 306).

Pottery was another product that found its way to the Rhine delta in large quantities. Dijkstra points out that a large percentage of the Merovingian wheelthrown pottery from settlements in the Rhine and Meuse estuaries was imported from German production centres like Mayen, Badorf and Walberberg. No evidence has yet been found that this pottery was produced in the delta region itself. At the settlement of Rijnsburg, 97% of the pottery from the Merovingian period was imported from elsewhere. For the whole Rhine and Meuse area, the percentage of imported Merovingian pottery is between 80 and 100%. These figures can partly be explained by the fact that these settlements were situated at favourable positions along the Rhine and Meuse rivers, meaning this pottery could have been acquired quite easily. Also, this pottery was probably mass-produced and therefore rather cheap. The presence of this pottery in the western coastal area of the Netherlands indicates that the settlements in the Rhine delta were part of a stable supra-regional exchange network which reached all the way to Germany, and perhaps to areas beyond that. It also indicates that these settlements were probably able to generate surpluses which they could have used to pay for these products. Obvious examples would be salt, fish, dairy products and textiles (Dijkstra 2004, 404-405; Dijkstra 2011b, 309-313; Hamburg and Hemminga 2007, 304).

Other products that found their way to the Rhine delta include drinking glasses from the Eifel and the Ardennes, amber, slaves and other luxury products. Glass beads were imported, though they were also produced locally (Dijkstra 2011b, 309, 313-314; Hamburg and Hemminga 2007, 306).

In addition to imported goods, products that were produced in the Rhine delta were also exported. Historical sources indicate that textiles were an important export product. Salt was

also a very important product in this period, because it could be used to preserve foodstuffs. Salt may have been mined in the more coastal regions of the area. There is evidence that sea fish was transported upstream, as salt-water species have been found at Dorestad (Prummel 1983, 110). This stresses the importance of salt as a commodity, as this fish will most likely have been salted before it was exported (Dijkstra 2011b, 314-315).

### **3.2. Oegstgeest and the Rhine exchange network**

Now that the reader has some idea of the scale of the Early Medieval exchange network along the Rhine river, the archaeological evidence from Oegstgeest is examined to give an impression of the role this settlement played in this network.

#### *3.2.1. Pottery*

Research on the pottery found at Oegstgeest shows that the pottery assemblage largely consists of Merovingian wheelthrown pottery. This pottery was imported from pottery production centres which were located upstream along the Rhine river, like the Mayen region in Germany. The favourable position of Oegstgeest along one of the tributaries of the Old Rhine would have enabled the inhabitants of Oegstgeest to acquire this pottery. This indicates that Oegstgeest was involved in a supra-regional exchange network (Dijkstra 2006, 72; Dijkstra 2008, 58; Dijkstra 2011a, 56).

#### *3.2.2. Coins*

Several coins have been found at Oegstgeest. These include a gold Tremissis, which is believed to be an imitation of a Madelinus from Dorestad. Based on its gold-content, the coin was dated to about 650-660 AD. Two sceatta's were also found, one which originates from England and one which was minted somewhere in Frisia or Francia. The English sceatta dates to about 675-750 AD. The second sceatta was probably minted around 695-715 AD (Nooijen 2011, 75, 77).

#### *3.2.3. Stones*

Another indication of exchange at Oegstgeest are the stones. The size and shape of all of

the stones and rocks found at Oegstgeest indicate that they must have been transported there by people. It mainly concerns large pieces of rock which could not have been transported by the Rhine river, seeing as they're too large and display no signs of fluvial transport. Several categories of non-local stones were recovered.

The tufa that has been found at Oegstgeest seems to have originated in the Eifel region in Germany. This, however, does not indicate that this tufa was transported from Germany to Oegstgeest; the people of Oegstgeest probably got this tufa from a nearby Roman settlement.. The same goes for the siltstone and slate that was recovered. Tephrite was also found. Eighty-one fragments were collected, which may all have belonged to one quern. Tephrite was imported from the Mayen region in Germany, where evidence has been found for the production of quernstones. Amber was also found in Oegstgeest. This material can be found in the north of the Netherlands, in the north of Germany and in the Baltic region (Knippenberg 2006, 82-91; Knippenberg 2008, 77; Melkert 2011, 93).

#### *3.2.4. Wooden well-shafts*

A large number of wells has been excavated at Oegstgeest. Several of these wells were equipped with a wooden shaft which was made using wooden barrels. For the manufacture of these barrels, strong wood was used, primarily oak (*Quercus*) and silver fir (*Abies alba*). The latter species is not native to the Netherlands, indicating these barrels were manufactured elsewhere. This means that these barrels were imported into the Netherlands, perhaps as containers for goods such as oil and wine (Kooistra 2011, 62-63; Vermeeren 2008, 94; Vermeeren and van Rijn 2006, 104-105).

### **3.3. Exchange of animals and animal products**

The main purpose of this thesis is to investigate whether the inhabitants of Oegstgeest were involved in the exchange and surplus production of animals and animal products. This section will review results from previous publications to investigate whether this data provides any evidence of exchange and surplus production.

Previous publications have hinted at the possible export of cattle. Age distributions created during previous research show an absence of young adult individuals in the cattle population

from Oegstgeest (Cavallo 2006, 76; Cavallo 2008, 61). This absence of young adult animals has been interpreted as possible evidence of the export of cattle. One of the main goals of this thesis will be to establish whether these assumptions are valid or whether the absence of this age category could be the result of sample size.

Among the animal remains found at Oegstgeest, there seems to be an overrepresentation of the fleshy part of the hind-limbs of pigs. This might be an indication that at least part of the pork consumed at Oegstgeest was imported from elsewhere (van der Jagt 2011, 102).

The sheep remains from Oegstgeest might also provide some indication of the possible exchange of animals. One sheep skull with two horncores and one separate sheep horncore were discovered. The only known variety of sheep in the Netherlands today that has horns is the heath sheep from Drente (*Drentsche heideschaap*) (van der Jagt 2011, 101). Although it is possible that horned sheep were more common in the Netherlands in the past, this find might also be an indication that at least part of the sheep population at Oegstgeest was brought to the settlement from elsewhere.

Horse remains have also been recovered at the settlement. Results of archaeozoological research published so far do not indicate the presence of any juvenile animals; the published data indicates only the presence of adult horses (Cavallo 2006, 79; Cavallo 2008, 65-66; van der Jagt 2011, 103). An absence of juvenile individuals might indicate that the horses were not bred at Oegstgeest and were acquired through exchange (Maltby 1985,61-62).

The cat remains recovered during the excavation of 2009 belong to two incomplete cat skeletons of animals which died at an early age. Research on cat remains from the Danish *emporium* of Haithabu has shown that cats at this settlement died at a relatively early age. This, in combination with the fact that a large amount of cut marks was found on the cat remains, suggests that the cats from Haithabu were killed for their wintercoat (Johansson and Hüster 1987, 40-44). Perhaps this was also the case at Oegstgeest, though this is only indicated by the fact that the cats were rather young when they died; no marks were observed on the remains. At present, there thus seems to be no evidence that these cats were killed for

their winter fur. Evidence for this might be recovered in the future, and it is therefore interesting to briefly speculate about what this might mean in terms of exchange. Winter coats from cats seems to have been quite valuable (Johansson and Hüster 1987). It is therefore possible that these furs were exported from Oegstgeest.

#### **4. Recognising exchange and surplus production in the archaeozoological record**

In order to establish whether the settlement of Oegstgeest was involved in the exchange and surplus production of animals and animal products, it must first be determined how exchange and surplus production can be recognised in the archaeozoological record.

##### *4.1. Presence of exotic species*

Something which is perhaps the most obvious indication of the exchange of animals is the presence of exotic species in an assemblage. In other words, the presence of species of animals which are not indigenous to the area in which they are found. This goes for animal remains in the form of faunal remains in general as well as for animal remains which have been used as raw material for products such as artefacts and textiles (Ashby 2004, 4-6).

The mere presence or absence of species, not necessarily foreign, can also be indicative of exchange. For example, the absence of juvenile remains from a certain species could indicate that these animals, although present in the faunal assemblage, were not bred on site. Sex ratios may also form a clue as to whether animals were exchanged. Over- or under-representation of either male or female individuals in a population may suggest that they were imported or exported (Maltby 1985, 61-62).

##### *4.2. Metric and non-metric variation*

By taking measurements from animal remains, metric variation between regionally distinct types of animals may be discovered. It is important to account for the biological variables which can affect the size of bones. Things to look out for would be strongly polymorphic elements and bones with unfused epiphyses. Environmental factors also affect size; unfortunately, these cannot be systematically excluded from analysis and cannot be controlled either. Some researchers have used dental measurements in order to establish metric variation between animals, claiming that dental growth and development is largely independent of environmental influences. This has, however, not been proven.

Variation in non-metric traits can be studied by looking at several different parts of the skeleton. The absence of the second mandibular premolar in cattle has been mentioned in the literature, but the factors affecting it are not understood. Underdevelopment and absence of

the distal hypoconulid in the lower third molar in cattle may also be useful. Other examples of non-metric variation are the genetic or environmental origins of perforations in the neurocranium and the sagittal profile in cattle, the position of femoral nutrient foramen in sheep and the presence or absence of horns in cattle (Ashby 2004, 4-6; O'Connor 2000, 119-122).

#### *4.3. Skeletal element abundance*

Over- or under-representation of certain skeletal elements may also indicate the exchange of animals, or, more specifically, of joints of meat. If there is an over-representation of skeletal parts that have a high meat yield, this could point to the import of joints of meat from elsewhere. If differences can be observed in the types of butchery marks present on faunal remains, this would mean they might have been processed at different locations. For ungulates like cattle and sheep, it is assumed that the primary butchery waste, like the head, feet and tail, are deposited close to the site where the animals are slaughtered. This creates assemblages which mimic those of hunter-gatherer kill sites (O'Connor 1993; O'Connor 2000, 165-166).

Levitan compared the faunal remains from Exe Bridge and St. Katherine's Priory and found that the two sites each display a distinct pattern in terms of skeletal element abundance. The cattle remains from Exe Bridge consist mainly of horncores. At St. Katherine's Priory girdles and limb-bones predominate. The sheep remains display the same pattern, but more distinct. At both sites, the pig remains are dominated by limb-bones. Levitan concludes that the early levels at Exe Bridge represent waste from tanning and horn working, while the St. Katherine's Priory remains are typical of secondary butchery and domestic waste (Levitan 1987, 69-74).

#### *4.4. Differences in rates of tooth wear between animals*

Differences in the rates of tooth-wear may also be considered as evidence of exchange; tooth-wear would then be influenced by differences in soil conditions in different areas. The method for establishing differences in tooth-wear between animals is described by Bond and O'Connor. This is achieved through noting the wear stage typically reached by a specific tooth in each of a sample of mandibles in which another tooth is at a specific wear stage. This

method uses the wear stages described by Grant, which are then converted to numeric values. Bond and O'Connor applied this method to sheep mandibles from medieval Coppergate and Tanner Row. In the Coppergate sample, a number of mandibles in which the LM1 was at wear stage 'g' was analysed. Then, the wear stages of the LM2 from these mandibles was determined, which were then converted to numerical values. The mean numerical score for the LM2 was 10.32 (SD= 1.57; n=19). This analysis was repeated for a sample of mandibles from Tanner Row, where the mean value for the LM2 was 10.29 (SD= 0.95; n=7). As there is no large difference between the two mean values, there seems to be no difference between the rate of tooth wear for sheep from Coppergate and Tanner Row. A comparison of sheep mandibles from older animals from the two sites in which the LM2 could be assigned wear stage 'g', produced mean values for the LM1 of 13.14 at Coppergate and 14.00 for Tanner Row, a difference which is statistically significant ( $d= 1,87$ ;  $p<0,05$ ). This indicates that the older animals were subject to different rates of tooth wear. Several factors are mentioned to be of influence on the rate of tooth-wear. The ingestion of soil is an important factor. Stocking density is also of influence (densely stocked animals are more likely to graze down to a level where the ingestion of soil becomes more likely). Finally, the soil parent material can affect tooth-wear. Animals grazing on sandy soils are likely to have a faster rate of tooth-wear (Bond and O'Connor 1999, 390-391).

#### 4.5. aDNA analysis

Analysis of aDNA (ancient DNA) is applied more and more frequently in archaeozoology. It is often used in studies on the domestication and movement of animals (see for example Larson *et al.* 2005, Larson *et al.* 2007a and b on the domestication of pigs). aDNA analysis can be used to investigate relationships between animals and between populations of animals (Reitz and Wing 2008, 288-289). This can then help to determine whether animals were brought in from different areas. aDNA analysis would be a good way to investigate if, for instance, an urban settlement was self-sufficient in terms of food production, or whether animals were brought in from different, perhaps more rural areas. It could also be used to establish whether animals with different genetic signatures were present at a settlement, possibly indicating they originated from different areas.

#### 4.6. *Stable isotope analysis*

The analysis of strontium isotopes has proved to be valuable in characterising the mobility of humans and animals in the archaeological record. Strontium isotopes serve as a geochemical signature that can be used to 'source' skeletal remains to a geological area. Strontium isotope signatures are conveyed from eroding geological materials from soils and the food chain into human and animal skeletons. Strontium values from skeletal material can then be analysed and compared to the biologically-available signature from a suspected location of origin (Bentley 2006, 136).

A good example of the application of strontium-isotope analysis in archaeozoology is a study by Viner *et al.* (2010) aimed at investigating the mobility of Late-Neolithic cattle at Durrington Walls, Wiltshire. The strontium isotope values from the enamel of the teeth from cattle recovered from Durrington Walls was compared to strontium values from local vegetation samples, established values from archaeological material and to geological conditions. The results from these analyses showed that only two of the tooth-enamel samples analysed provided a signature that was consistent with the chalkland geology of the area surrounding Durrington Walls. The rest of the samples provided signatures of areas much further away, in some cases at least 100 km, indicating that cattle were being moved over significant distances (Viner *et al.* 2010, 2812, 2816-2819).

#### 4.7. *Recognising surplus production*

Recognising the surplus production of animals and animal products in the archaeozoological record is not a straightforward process. For example, surplus animals were most likely transported on the hoof. This would have been the easiest way to transport meat from one place to the other. For joints of meat to be moved from one settlement to another, they probably had to be salted or smoked to prevent the meat from going bad. They also had to be moved by, for example, a cart or some other means of transportation (Groot 2008a, 75). This requires a large amount of time and effort and it would therefore seem reasonable that people may have preferred to transport meat in the form of live animals. Living animals move themselves and can graze along the way. Unfortunately, this means that the direct evidence of surplus production is removed from the production site (Groot 2008b, 86-87).

If one assumes that the size of animals may have been influenced by market demand, it

becomes possible to study changes in withers height of animals. It can also be worthwhile to study skeletal element representation. In order for this to be useful, animals must have been sold as dressed carcasses, with the primary butchery waste remaining at the production site and the bones that yield most meat to be deposited at the consumption site. Aspects of faunal assemblages that can perhaps provide more useful information on surplus production are the species composition and age distributions. If material from different time periods is available for analysis, this data can provide information on changes in husbandry strategies (Groot 2008b, 87).

## **5. Methodology**

The previous section has presented to the reader several aspects of archaeozoological assemblages that can be studied in order to investigate exchange and surplus production of animals and animal products. This section will describe the studied material and introduce the methods and research strategies that will be applied to answer the research questions put forward at the beginning of this thesis.

### **5.1. Material**

The material that was studied for this thesis has been excavated at Oegstgeest during 2009 and 2010 by Leiden University and belongs to projects ONRZ09 and OSLP10. The studied material has been analysed and recorded by the author and several colleagues. This data will be analysed together with available data from previous publications. The material studied by the author consists of 3542 elements and 8647 fragments.

A large portion of the ONRZ09 and OSLP10 material stored at Leiden University has not been studied yet. From this material elements required for sex determination and metric analyses on cattle remains were selected. These elements were then added to the studied sample. A total number of 198 elements was selected. This sample consists of 31 complete and distal metacarpals, 34 complete and distal metatarsals, 49 horncores, 16 acetabulae and 68 astragali from cattle.

The studied material displays little to no signs of weathering. The material is, however, highly fragmented. This high degree of fragmentation does not seem to be related to post-depositional processes but is the result of butchery practices.

### **5.2. Methods**

The faunal material discussed in this study was identified using the archaeozoological reference collection located at the Faculty of Archaeology at Leiden University. Data on the material was recorded in accordance with the ROB-archaeozoological laboratory protocol (Lauwerier 1997). Measurements were taken *sensu von den Driesch* (1976).

In order to establish whether the settlement at Oegstgeest was involved in the exchange and surplus of animal products, several aspects of the faunal assemblage recovered from this settlement will be analysed.

The emphasis will be on the age distribution and sex ratios of the cattle remains. These will be analysed to create a more detailed picture of the composition of the Oegstgeest cattle population. Also an analysis of metric variation will be carried out for the cattle remains using the measurements that have been recorded for ONRZ09 and OSLP10 material as well as data from previous publications.

Age distributions will also be reconstructed for the other two main domestic species: sheep/goat and pig. This will provide information on the possible exchange and surplus production of these animals and it will provide information on the husbandry strategies that were employed at Oegstgeest.

The species composition of the Oegstgeest faunal assemblage will be discussed. Combining data generated for this thesis with data from previous publications will provide a more detailed picture of the species present in the Oegstgeest assemblage. This will also reveal whether any exotic species indicative of exchange are present among the remains.

Finally, the skeletal element abundance will be analysed to investigate whether any joints of meat were imported or exported.

#### *5.2.1. Age distribution*

In order to create a more detailed picture of the age distributions for cattle, sheep/goat and pig at Oegstgeest, an analysis of tooth eruption and wear and epiphyseal fusion will be carried out for the studied sample. The data from these analyses will be combined with age distribution data from previous publications.

For age determination of the remains based on epiphyseal fusion the data published by Silver (1969) was used. Tooth eruption and wear was recorded using the wear stages published by Grant (1982) and age was then determined using the methods combined by Hambleton (1999).

### 5.2.2. Sex distribution

#### 5.2.2.1. Cattle acetabulae

Morphological differences between male and female cattle can be observed on parts of the pelvis. According to Greenfield (2006), the ilium and pubis regions of the pelvis have several diagnostic features that can be used to distinguish between male and female individuals. The medial wall of the acetabulum, where the ilium and pubis join – the ilio-pubic ridge and the medial border of the acetabulum are very different in female and male cattle (fig. 4). In males, the ilio-pubic ridge is dull and poorly visible. In females, the ilio-pubic ridge is sharp and very visible, and the medial border of the acetabulum is low. In females this wall is low because the pubic bone is thinner in order to facilitate a certain amount of flexibility during reproduction. The acetabulum wall is more robust in males because there is no need for such flexibility (Greenfield 2006, 69).

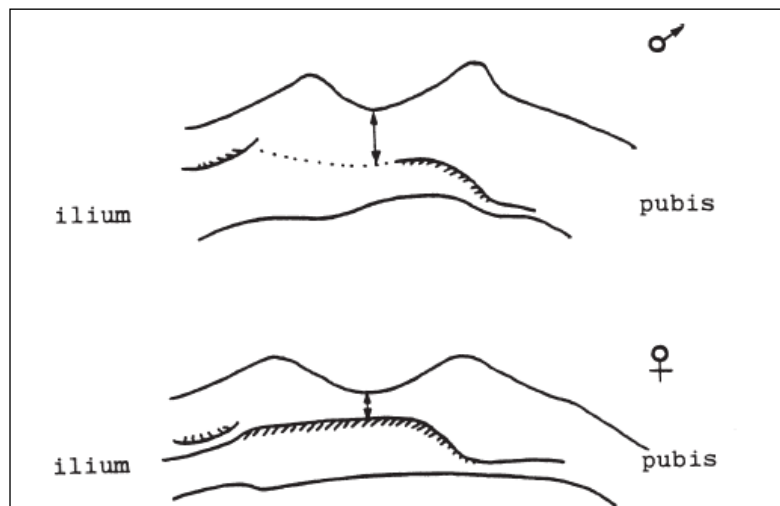


Figure 4. This picture illustrates the differences in morphology between the ilio-pubic ridge of male and female cattle (Greenfield 2006, 71).

In order to use these features to distinguish between male and female pelvic elements, Greenfield tested three series of measurements. The results show that the measurement of the height of the medial acetabular wall (measurement 'H1') (fig. 5) displayed the highest degree of sexual dimorphism in Bovids (Greenfield 2006, 74) (Appendix 3 provides a complete

overview of the measurements taken for creating sex distributions for cattle).

In order to apply this method, measurable acetabulum fragments were selected from the available ONRZ09 and OSLP10 material and for each of these the height of the medial acetabular wall was measured.

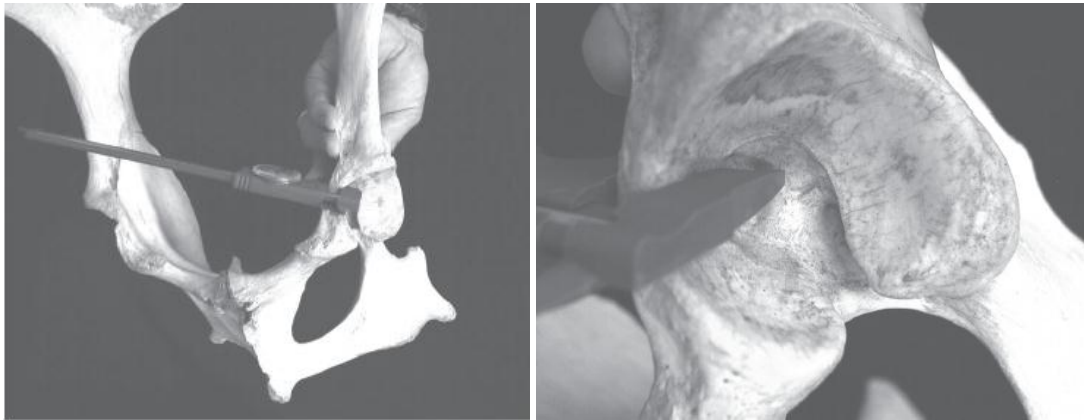


Figure 5. This picture shows how and where to take the 'H1' measurement discussed by Greenfield (After Greenfield 2006, 73).

#### 5.2.2.2. Cattle metapodials

Analyses of the metric attributes of cattle metapodials can be used to establish the ratios of male and female individuals in archaeological assemblages. This subject has been discussed in numerous publications and it is often employed in the analysis of archaeozoological assemblages (See for example Albarella 1997; Boessneck *et al.* 1971; IJzereef 1981; Prummel 1983; Telldahl *et al.* 2011a and b). On average, the metapodials of cows are thought to be short and slender, while those of bulls are believed to be short and wide. There is no significant difference in length between the metapodials of bulls and cows. The metapodials of oxen are thought to be long and slender. The general consensus is that the metacarpus displays more sexual dimorphism than the metatarsus (fig. 6) (Albarella 1997, 38; Boessneck *et al.* 1971, 50; Howard 1963, 92; Thomas 1988, 86). In addition to the morphological differences between male and female cattle metapodials, it is also possible to analyse the metric differences between these elements. The distal width of metapodials, especially that of metacarpals, is often mentioned as being highly indicative of sexual dimorphism (Higham 1969, 64; Prummel 1983, 162; Thomas 1988, 86). Thomas used archaeological as well as

modern cattle metapodials in order to investigate how useful these elements are in determining sex ratios for cattle. After testing a spectrum of 15 measurements, he concluded that measurements on the distal part of metapodials are most indicative of sexual dimorphism, especially the breadth of the medial condyle (Thomas 1988, 86).

For the purpose of this study, complete and distal cattle metapodials were selected. On complete elements the following measurements were taken: Greatest length (GL), smallest breadth of diaphysis (SD), greatest breadth of proximal end (Bp) and greatest breadth of distal end (Bd) sensu von den Driesch 1976. Following the article by Thomas (1988), the breadth of the medial and distal condyles ('mcon' and 'lcon') were also measured. For distal metapodials of which the dexterity could be determined, Bd, 'mcon' and 'lcon' measurements were taken. For distal metapodials of which the dexterity could not be determined with any certainty, only the Bd measurement was taken.

#### 5.2.2.3. *Cattle horncores*

Sex determination using cattle horncores has received a fair amount of attention in the archaeozoological literature (Armitage 1982; Armitage and Clutton-Brock 1976; Grigson 1982; Sykes and Simmons 2007). Armitage and Clutton-Brock set up a classification system to determine sex from cattle horncores (Armitage and Clutton-Brock 1976, 332). Though this classification can be useful, Sykes and Simmons argue that the criteria are rather subjective. They suggest an approach solely based on measurements, specifically those of the basal circumference and minimum basal diameter of horncores, to distinguish between male and female individuals, and possibly also oxen (Sykes and Simmons 2007, 517, 522)

In order to create a sex distribution for cattle horncores, all measurable horncores were selected from Oegstgeest. For complete horncores, the following measurements were taken: Horncore basal circumference (44), greatest diameter of the horncore base (45), least diameter of the horncore base (46) and the length of outer curvature of the horncore (47) sensu von den Driesch (1976) (44 and 47 using a measuring tape, 45 and 46 using calipers). If horncores were incomplete, as many measurements as possible were taken.

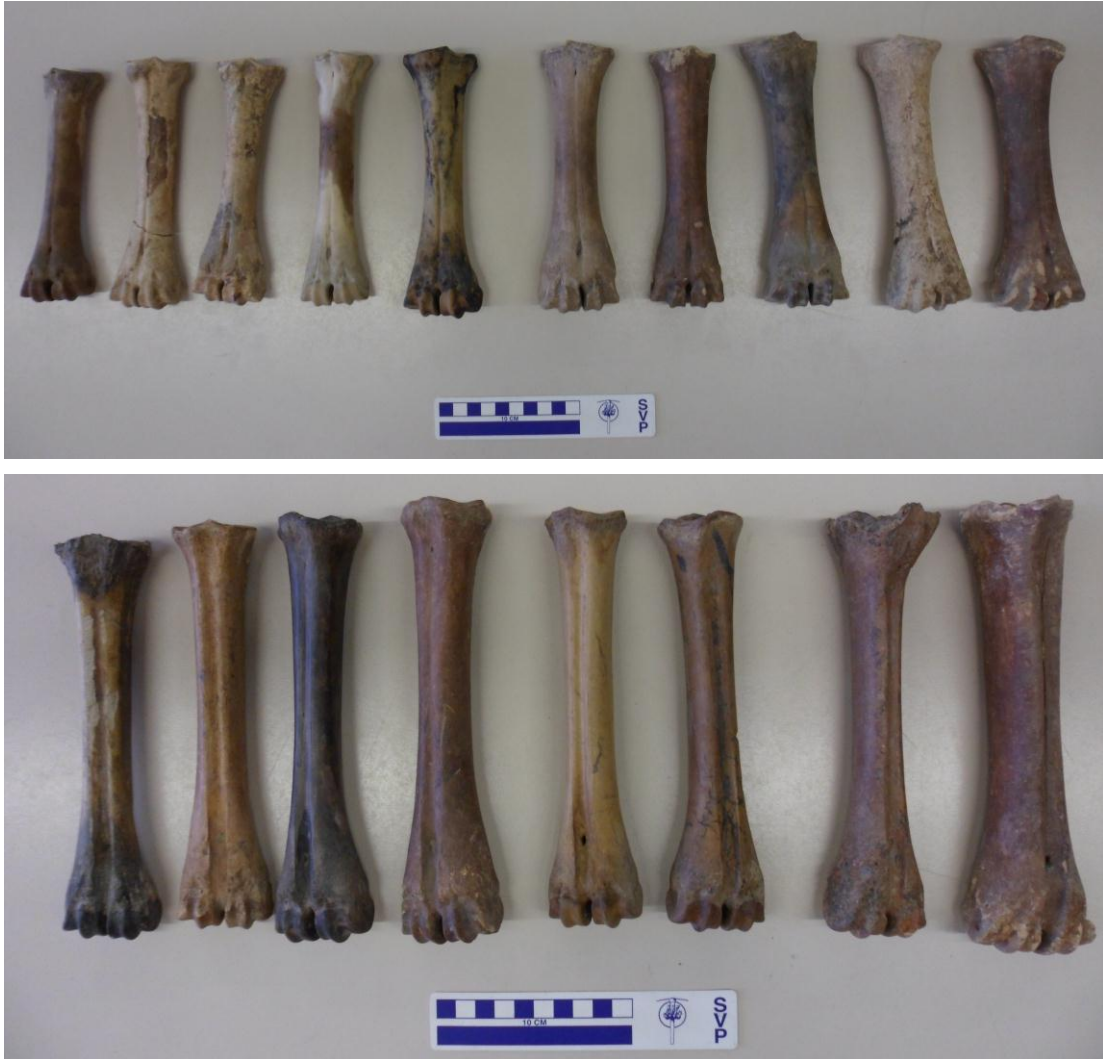


Figure 6. Complete metacarpals (at the top) and metatarsals from Oegstgeest. In order to try and create a picture of sexual dimorphism the metapodials have been arranged according to size and shape with short and slender specimens to the left and broader specimens to the right (Photo's by the author).

## 6. Results

In order to create a picture of the species composition of the Oegstgeest faunal assemblage a species list was created. This list includes data from previous publications (Cavallo 2006; Cavallo 2008; Jagt 2011) as well as the data from the material that was studied by the author.

### 6.1. *Cattle, pig and sheep/goat*

It is clear from tab. 1 that cattle, pig and sheep/goat were the three main domesticates kept at Oegstgeest. Cattle appears to have been kept in the largest numbers. Pigs seem to have been the second most important animal that was kept at Oegstgeest. There is no evidence that goats were kept in large numbers in the Early Medieval period. Assuming that the remains identified as 'sheep/goat' largely belong to sheep, it seems that sheep were also kept at the settlement, though in far smaller numbers than cattle or pigs. The high amount of pig remains stands out. Compared to other Early Medieval settlements in the area, like Valkenburg de Woerd (Sablerolles 1990, 168), Katwijk (Cavallo *et al.* 2008, 356) and Leiderdorp (van Dijk 1995, 95), the amount of pig remains that was found at Oegstgeest seems relatively high. It is difficult to provide an explanation for the high amount of pig remains. Perhaps the inhabitants of Oegstgeest had a preference for pig meat, or perhaps pigs or joints of pork were imported.

### 6.2. *Horses*

The Oegstgeest assemblage contains a small amount of horse remains. This makes it difficult to make any definite statements about the role of horses at Oegstgeest. The remains show that horses were present at the settlement. The fact that horse remains were not found in large amounts could point to the fact that these animals were not very important at Oegstgeest. It is possible that they were used as riding animals or that they were used for carrying heavy loads. Cut and chop marks were observed on a small amount of horse remains. This includes elements with a high meat yield, like the scapula, femur and pelvis, as well as elements that bear little to no meat, like for instance the metacarpus. Because the amount of marks is small, it is difficult to say whether the consumption of horse meat was common practice at Oegstgeest, though it is certainly a possibility. It is also possible that

horse meat was occasionally consumed, for example when an old riding animal died.

### *6.3. Dogs and cats*

Remains of dogs and cats were found. The amount of dog remains is, unfortunately, rather small. It is therefore difficult to say anything about these remains besides the fact that they indicate that dogs were present at Oegstgeest.

Cat remains were found in somewhat larger numbers. Part of these cat remains could be assigned to individual skeletons. This data therefore enables some statements to be made about the age of these cats. One individual cat femur was found with unfused epiphysis. It was determined that this specimen belonged to a juvenile cat with an age of less than eight and a half months (Cavallo 2008, 66). The assemblage also contains 132 cat remains that belong to two partial cat skeletons. Age determination of these remains shows that both cats were about eleven months old when they died (van der Jagt 2011, 104).

### *6.4. Wild mammals*

In addition to domestic mammals, remains of wild mammals were also found at Oegstgeest. These wild mammal remains make up only a small part of the assemblage.

A small amount of red deer remains has been found at Oegstgeest. Most of these remains consist of red deer antler. One metatarsus from a red deer was also found (Cavallo 2008, 66). The antler remains include shed antler as well as antler that was sawn from a red deer skull (Cavallo 2006, 79; Cavallo 2008, 66). This indicates that the inhabitants of Oegstgeest collected shed antler and that they also hunted red deer. The presence of saw marks on red deer antler (Cavallo 2006, 75) indicates that this focus on antler is possibly connected with the production of antler artefacts, like the antler combs that were found at Oegstgeest (Hemminga and Hamburg 2008, 103-104).

Remains of polecat and fox were also found. These could be animals that died of natural causes in or around the settlement. It is also possible that these animals were hunted for their fur or that they were killed because they bothered the livestock. A combination of these two factors is also possible.

Table 1. Species list for the Oegstgeest assemblage. This table was created by combining data from the assemblage studied by the author with the data from previous publications (Cavallo 2006, 74; Cavallo 2008, 60; van der Jagt 2011, 99).

Species			
Mammals	N of elements*	% of elements	weight (gr)
Cattle ( <i>Bos taurus</i> )	1942	22,51	96128,04
Sheep ( <i>Ovis aries</i> )	114	1,32	416,34
Sheep/Goat ( <i>Ovis aries/Capra hircus</i> )	475	5,5	5342,88
Pig ( <i>Sus domesticus</i> )	<sup>1</sup> 992	11,49	19221,63
Horse ( <i>Equus caballus</i> )	<sup>2</sup> 93	1,07	9644,71
Dog ( <i>Canis familiaris</i> )	7	0,08	161,02
Cat ( <i>Felis catus</i> )	<sup>3</sup> 171	1,98	345,84
Red deer ( <i>Cervus elaphus</i> )	16	0,18	946,2
Polecat ( <i>Putorius putorius</i> )	15	0,17	108,6
Fox ( <i>Vulpes vulpes</i> )	1	0,01	5,3
Small rodent	2	0,02	0,8
<b>Total mammal</b>	<b>3828</b>	<b>44,33</b>	<b>132321,36</b>
Large mammal	2091	24,23	29648,4
Medium mammal	789	9,14	3264,42
Small mammal	78	0,9	268,88
Mammal	1706	19,77	8428,31
<b>Total mammal (indet)</b>	<b>4664</b>	<b>54,04</b>	<b>41610,01</b>
<b>Birds</b>			
Fowl ( <i>Gallus gallus domesticus</i> )	18	0,2	64,7
Swan ( <i>Cygnus olor / olor domesticus</i> )	1	0,01	13,3
Wild/Tame Duck ( <i>Anas platyrhynchos/domesticus</i> )	4	0,04	44,3
Greylag / Domestic Goose ( <i>Anser anser/domesticus</i> )	6	0,06	156,9
Goose ( <i>Anser sp.</i> )	13	0,15	42,8
Pink-footed goose ( <i>Anser brachyrhynchus</i> )	1	0,01	33
Crane ( <i>Grus grus</i> )	1	0,01	20
Raven ( <i>Corvus corax</i> )	2	0,02	6,3
White-tailed Eagle ( <i>Haliaeetus albicilla</i> )	1	0,01	9,4
Magpie ( <i>Pica pica</i> )	<sup>4</sup> 18	0,2	5,5
Bird indet.	45	0,52	96,17

<b>Total birds</b>	<b>110</b>	<b>1,23</b>	<b>492,37</b>
<b>Fish</b>			
Sturgeon ( <i>Acipenser sturio</i> )	3	0,03	2
Twait shad ( <i>Alosa fallax</i> )	4	0,04	0
Mullet ( <i>Mugilidae</i> sp.)	2	0,02	0
Cod ( <i>Gadus morhua</i> )	2	0,02	2
Fish indet.	10	0,11	0
<b>Total fish</b>	<b>21</b>	<b>0,24</b>	<b>4</b>
<b>Amphibians</b>			
Frogs/Toads ( <i>Anura</i> )	4	0,04	0,63
<b>Total amphibians</b>	<b>4</b>	<b>0,04</b>	<b>0,63</b>
<b>Total</b>	<b>8627</b>	<b>100</b>	<b>174428,37</b>
<p>* Publications on Rijnfront and Corpus did not specify whether the amount of elements or the amount of fragments was used in the published species lists. It is assumed here that the amount of elements was used. Therefore, the number of elements from van der Jagt 2011 and from the author's own data have been used to create to overall list presented in this table.</p> <p><sup>1</sup> 303 piglet remains were found; these remains have an MNI of 2</p> <p><sup>2</sup> 6 horse remains belong to one horse's leg</p> <p><sup>3</sup> 18 cat remains belong to one individual</p> <p><sup>4</sup> 18 magpie remains belong to one individual</p>			

### 6.5. Birds

Birds are also present in the Oegstgeest assemblage. This includes domestic as well as wild species. Fowl and goose remains make up the largest part of the bird remains that could be identified. These birds were a common source of food in the Early Medieval period and were probably kept as tame animals at the settlement itself (Cavallo 2006, 81). Ducks could also have been kept as domestic animals, though this is less likely (van der Jagt 2011, 105). Remains of raven and magpie were also found. These are probably wild birds that died in or around the settlement. The magpie remains were all identified as belonging to one bird.

### 6.6. Fish

Data on fish remains from Oegstgeest from previously published excavation reports is scant. Research on the Oegstgeest fish remains carried out by F. Kerklaan (2012) provides

more information. Tab. 2 shows that the spectrum includes anadromous, catadromous, sweet and salt water species. Sweet water species seem to predominate in the assemblage. These species could have been caught in the direct vicinity of the settlement. This is also true for anadromous and catadromous species. For the inhabitants of Oegstgeest to be able to acquire fish that lives exclusively in salt water they would have had to venture out to sea. It is also possible that the people of Oegstgeest acquired this fish through exchange.

Table 2. Species list for studied fish remains from Oegstgeest (After Kerklaan 2012, 6-10) . Data on number of elements per species were kindly provided by F. Kerklaan. The habitats presented in this table are very general and are just to provide an indication of where these fish can be found.

Family	Species	English name	N elements	% of total	Habitat
Acipenseridae	<i>Acipenser sturio</i>	sturgeon	1	0,1	salt water (anadromous)
Anguillidae	<i>Anguilla anguilla</i>	eel	81	6,3	sweet water (catadromous)
Clupidae	<i>Clupea harengus</i>	herring	6	0,5	salt water
	<i>Alosa fallax</i>	twait shad	1	0,1	salt water (anadromous)
Cyprinidae	<i>Abramis brama</i>	breem	126	9,8	sweet water
	<i>Abramis spec.</i>	common breem/silver breem	1	0,1	sweet water
	Cyprinidae ind.		304	23,7	
Esocidae	<i>Esoc lucius</i>	pike	5	0,4	sweet water
Salmonidae	<i>Coregonus oxyrinchus</i>	houting	35	2,7	salt water (anadromous)
	<i>Salmo salar</i>	salmon	15	1,2	salt water (anadromous)
	Salmonidae ind.		4	0,3	
Gadidae	<i>Merlangius merlangus</i>	whiting	1	0,1	salt water
Percidae	<i>Perca fluviatilis</i>	perch	168	13,1	sweet water
Mugilidae	<i>Mugil labrosus</i>	thicklip grey mullet	1	0,1	salt water
Pleuronectidae	<i>Pleuronectes platessa</i>	plaice	1	0,1	salt water
	<i>Platichthys flesus</i>	flounder	9	0,7	salt and sweet water
	<i>Limanda limanda</i>	dab	1	0,1	salt water
	Pleuronectidae ind.		521	40,7	
<b>Total</b>			<b>1281</b>	<b>100</b>	

Tab. 3 shows the percentage of anadromous, catadromous, sweet and salt water species for the amount of remains that were identified to species level by F. Kerklaan (flounder was excluded because it seems to occur in sweet as well as salt water). It shows that of the identified remains about 95% belongs to catadromous, anadromous and sweet water fish. All these species could have been caught in the direct vicinity of the settlement. It is important to realize that a large number of remains from the Pleuronectidae family could not be identified to species level because of the strong similarities between species of this family (Kerklaan 2012, 6). The remains of this family that were identified to species level belong to species that occur in salt water. If in future analyses such remains could be identified to species level, the percentage of identified fish remains from species that were not caught in the direct area might become larger.

Table 3. Number of elements and percentages for the fish remains that could be identified to species level by F. Kerklaan. This shows that most of the fish that was identified could have been caught in the direct vicinity of the settlement.

<b>habitat</b>	<b>N</b>	<b>%</b>
salt water (anadromous)	52	11,7
sweet water (catadromous)	81	18,2
sweet	300	67,7
<b>total local</b>	<b>433</b>	<b>97,7</b>
salt	10	2,3
<b>total not local</b>	<b>10</b>	<b>2,3</b>
<b>total</b>	<b>443</b>	<b>100</b>

### 6.7. Pathologies

The Oegstgeest assemblage contains a number of cattle remains that display pathologies. A number of cattle pathologies from the Oegstgeest assemblage have already been described by Van der Jagt (van der Jagt 2011, 106).

Several different types of pathologies were observed on cattle remains. Two femurs display eburnation of the *caput femoris* of the femur. Six pelvic specimens display eburnation on the inside of the acetabulum and exostoses on the outside of the acetabulum (fig. 7). These pathologies are indicative of osteoarthritis of the hip-joint. This condition could have been caused by the use of cattle for traction or it could be the result of old age.

The proximal surface of several metatarsals display what can be described as a degeneration of the bone surface. Some of these specimens also display exotoses on the proximal end of the bone (fig. 8). Some phalanges also display a porous proximal surface and exotoses on the proximal surface. These pathologies are indicative of osteoarthritis of the hock (the joint between the tibia and the tarsal bones, including the metatarsus), also known as spavin (van der Jagt 2011, 106). Spavin is a condition which affects the proximal surfaces of the metapodials and the carpals and tarsals, causing them to fuse together. This condition is painful for the animal until the elements have fused together. After this there is no more pain and the animal can walk, though it may be slightly hampered. Spavin is found in horses as well as cattle. It is not exactly known what causes this condition. Possible causes are genetic factors, an infection of the periosteum, trauma or overloading (Groot 2010, 93-94).



Figure 7. A cattle acetabulum from Oegstgeest showing a pathology (right) shown next to a specimen from the reference collection that does not display any pathologies (Photo by the author).

One distal metacarpus also shows a pathology. One of the condyles (possibly the medial one) is extremely wide. Also, the distal end of this specimen shows thickening and the bone surface is porous (fig. 9). This type of pathology is thought to be indicative of the use of cattle for draught (Bartosiewicz *et al.* 1997; Groot 2005, 55. Also see Cupere *et al.* 2000).



Figure 8. The proximal surface of a metatarsus showing degeneration of the articulation surface and exotoses (Photo by the author).



Figure 9. A distal metacarpus showing extreme widening of one of the distal condyles (Photo by the author).

Several pathologies were also observed on remains from pigs and sheep/goat.

One maxilla from a pig displays an oral pathology. The bone covering the molars and roots is very thin in and in some places the roots of the molars are exposed. One tibia from a pig shows exostoses on the distal end of the bone.

One cranium fragment from sheep/goat displays an irregular cavity that may have been caused by an abscess. One mandibula from sheep/goat shows a bulge around the area of the p4 which may have been caused by an infection.

#### *6.8. Butchery and other marks*

A number of marks was observed on the faunal remains from Oegstgeest. Cut, chop and gnaw marks were observed as well as a small number of burn marks (tab. 4). Cut, chop and gnaw marks were mainly observed on cattle and pig remains. These marks occur less frequently on remains from sheep/goat. This is not surprising as sheep/goat remains are less numerous than remains from cattle and pigs.

Tab. 4 shows only the amount of marks observed on remains of cattle, sheep/goat, pig and horse. The number of marks observed on remains from other species was so small that they were not included in the table. They will be described separately.

A number of marks was observed on remains from birds. Some gnaw marks were observed on bird remains (Cavallo 2008, 61). Two geese bones and one bone from a common crane display cut and chop marks (Cavallo 2006, 80). One bone from a swan shows marks that indicate that an attempt was made to use this bone to create some sort of artefact (van der Jagt 2011, 105).

Marks have also been observed on fish remains. A total of 23 fish remains display cut marks. Traces of burning have been observed on 18 elements and 5 elements show traces of digestion. Most of these traces were observed on elements from the Pleuronectidae family (Kerklaan 2012, 13).

Table 4. Number of marks per species. This table includes data from the material studied by the author as well as data from previous publications (Cavallo 2006, 75; Cavallo 2008, 61).

	cut marks	chop marks	burn marks	gnaw marks
Cattle	134	201	14	133
Sheep/goat	28	13	0	20
Pig	60	33	6	86
Horse	5	8	0	4

### 6.9. Presence of exotic species

The studied assemblage does not contain the remains of species that can be considered 'exotic'. Domestic livestock like cattle, pig and sheep/goat would have been kept at the settlement. The Oegstgeest faunal assemblage provides evidence for the presence of juvenile animals of all these species. Also, all skeletal elements have been found from these species. Horses would also have been kept at the settlement. The assemblage of horse remains has not been studied in enough detail to allow conclusions on whether horses were bred on site. Animals like cats and dogs were also kept at the settlement.

The wild mammal species encountered in the assemblage do not indicate the presence of any exotic animals either. Red deer may have been hunted in the area. Species like fox and polecat could have been caught and killed because they bothered livestock or they may have been hunted for their fur. Small rodents and amphibians probably lived in and around the settlement and died of natural causes.

While scanning the Oegstgeest material for cattle remains that could be sexed, the author came across a fragment of what is assumed to be a whale vertebrae (fig. 10). This specimen is not shown in the species list, as it has not been entered in the database yet. This will be done after it has been determined to what species of whale this vertebrae belongs. This specimen cannot exactly be termed 'exotic'. The settlement of Oegstgeest was located relatively close to the coast. It is possible that the inhabitants found this piece on the beach or that they acquired it from another settlement through exchange. Perhaps stranded whales were exploited for meat, oil and other materials. There is no evidence that the people of Oegstgeest actively hunted whales or other marine mammals. The remains that have been studied so far have not yielded any other remains from whales or other marine mammals and no artefacts associated with whale hunting, such as harpoons, have been found. It therefore does not seem

likely that hunting marine mammals was common practice at Oegstgeest.

## 6.10. Age distributions

The age distributions for cattle, pigs and sheep/goat presented in this section were created using data generated by the author in combination with available data from previous publications (Cavallo 2006; Cavallo 2008; van der Jagt 2011).

### 6.10.1. Cattle

In order to assess for what purposes cattle were kept at Oegstgeest, age distributions for dental- and post-cranial remains from cattle have been created.

Data from previous publications indicates an absence of young adult cattle and a discrepancy between dental and post-cranial data (Cavallo 2006, 76; Cavallo 2008, ; van der Jagt 2011, 99). When reviewing the data presented here, these issues appear to be the result of limited sample size.



Figure10. Fragment of a vertebrae from a marine mammal, possibly a whale (Photo by the author).

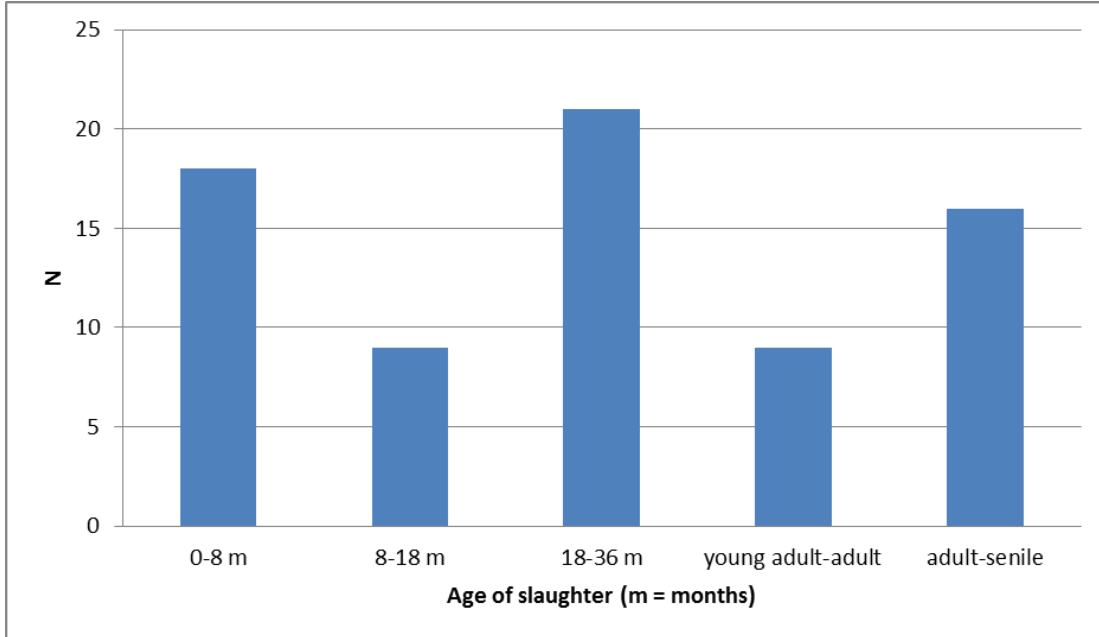


Figure 11. Age distribution created using dental remains from cattle. This diagram was created using data generated by the author in combination with data from previous publications (Cavallo 2006, 76; Cavallo 2008, 63; van der Jagt 2011, table 2).

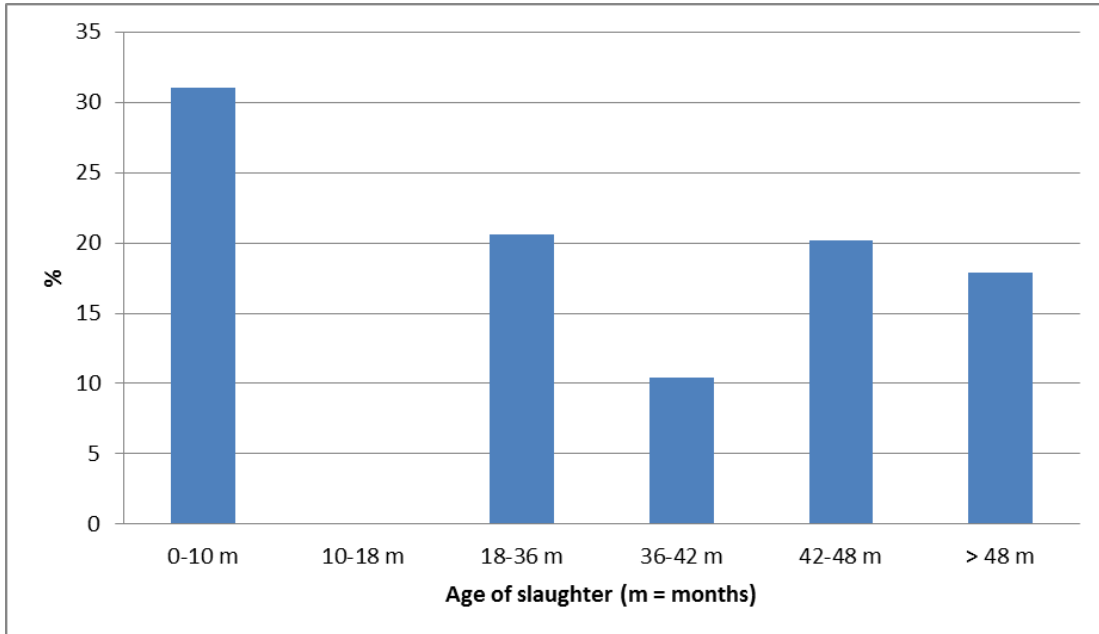


Figure 12. Age distribution created using post-cranial remains from cattle. This diagram was created using data generated by the author in combination with data from previous publications (Cavallo 2008, 62. Data from the 2009 excavation was kindly provided by I. van der Jagt).

The age distribution for dental and post-cranial remains both show a more or less similar age distribution of cattle that was slaughtered. Both fig. 11 and 12 show that a large amount of juvenile cattle was slaughtered. Most animals appear to have been slaughtered before the age of ten months. A fair amount of animals was slaughtered between the ages of 18-36 months. The optimal age of slaughter for Early Medieval cattle is thought to be around 24 months (Prummel 1983). Until Early Medieval cattle reached this age, their growth would have been rapid, meaning a rapid increase in body size. After about 24 months the growth slows down and the increase in body size in relation to the amount of food consumed becomes smaller and smaller until finally the animal stops growing altogether. This optimal slaughter age of 24 months falls in the age category of 18-36 months, indicating a portion of the Oegstgeest cattle population was slaughtered for their meat.

Both diagrams also show that a large amount of older cattle was slaughtered. The categories of 42-48 months and animals older than 48 months as well as the adult and senile categories show high values. These animals could have been cows that were slaughtered because they could no longer produce milk or calves. It is also possible that these animals were used for traction.

Considering both these age distributions it seems that cattle were exploited for multiple purposes at Oegstgeest. Data from dental- as well as post-cranial remains indicates that a large amount of juvenile cattle aged between 0-10 months was slaughtered. This could have two possible explanations. It is possible that the inhabitants of Oegstgeest slaughtered these animals because they consumed a large amount of veal (van Dijk 1995, 96). This, however, seems to be a factor which is more important at urban settlements and not at rural settlements like Oegstgeest (Cavallo 2006, 81). Another explanation is milk production. A large amount of calves was slaughtered so that milk was available for consumption by the inhabitants of Oegstgeest. Because of the rural character of the settlement at Oegstgeest, it is assumed here that slaughter of calves was related to milk production.

Both age distributions show that part of the cattle population at Oegstgeest was killed for their meat. This, in combination with the amount of butchery marks observed on cattle remains, indicates that beef was consumed at the settlement.

It seems that a large amount of old cattle was slaughtered at Oegstgeest. Considering the possibility of milk production, it is possible that these older animals were cows that could no longer produce milk or calves. It is also possible that this category includes traction animals that could no longer be used. Data on pathologies observed on cattle remains indicates that part of the cattle remains display pathologies that could be the result of using these animals for traction. It therefore seems likely that the older cattle that was slaughtered at Oegstgeest consisted mainly of old cows and also included some animals that were used for traction.

#### 6.10.2. Pigs

Age distribution based on dental and post-cranial remains were created for the pig remains from Oegstgeest. Pigs cannot be exploited for secondary products like milk or traction. It is therefore generally assumed that pigs were kept exclusively for their meat (van der Jagt 2011, 102).

The age distributions created using dental remains from pigs shows that most of these animals were slaughtered between the age of 14-27 months (fig. 13 and 14). The age distribution created using post-cranial remains shows that most animals died between the age of 12-24 months. Both diagrams indicate that only a small amount of pigs from the other age categories was slaughtered. The amount of older animals that was slaughtered could have been boars and sows that were kept for breeding purposes.

A large amount of piglet remains was found in a well (WA17; pit 1; feature 18 (*put 1; spoor 18*)). The remains were determined to have an MNI of two. These remains were excluded from the age distribution created using post cranial remains. If these remains had been included in the distribution, the value for the age category 0-12 months would have been very high, which would have been misleading.

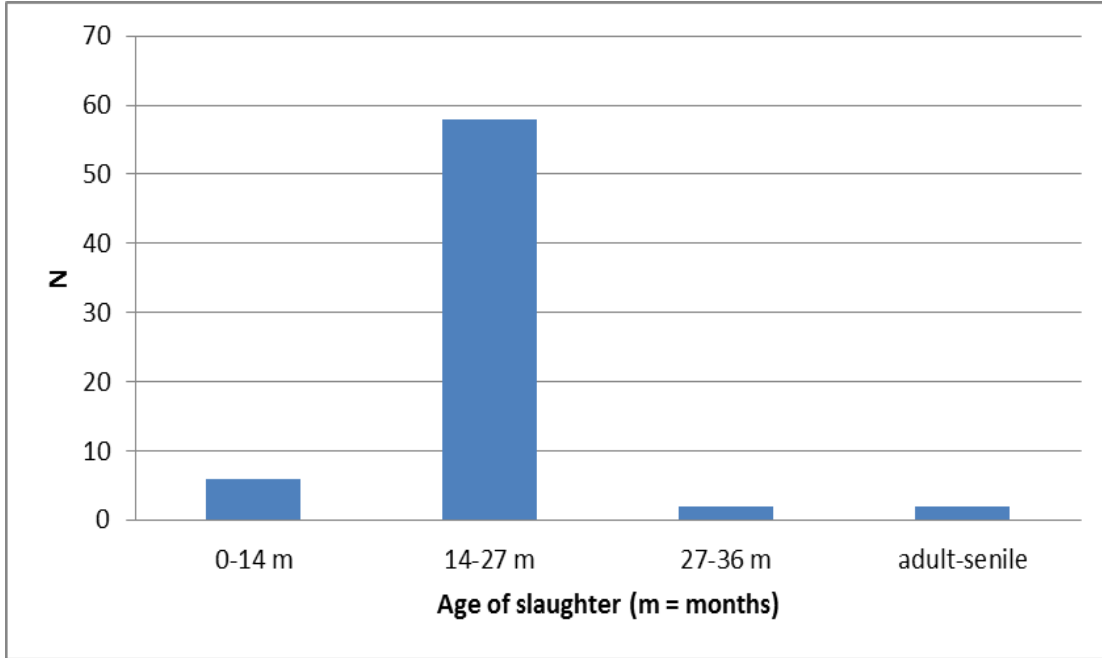


Figure 13. Age distribution created using dental remains from pigs. This diagram was ceated using data generated by the author in combination with data from previous publications (Cavallo 2008, 65; van der Jagt 2011, table 10).



Figure 14. Age distribution created using post-cranial remains from pigs. This diagram was ceated using data generated by the author in combination with data from previous publications (Cavallo 2008, 64; van der Jagt 2011, table 11).

### 6.10.3. Sheep/goat

The amount of dental and post-cranial remains available for creating age distributions for sheep/goat remains is much smaller than the datasets available for cattle and pig remains. Because the amount of available dental remains is rather small, only the age distribution created using post-cranial remains is shown here. Fig. 15 indicates that most animals that were slaughtered were aged between 2-3,5 years. It also shows that a fair amount of animals were older than 3,5 years when they were slaughtered. The emphasis thus seems to be on the slaughter of adult animals. This could indicate that wool production was important at Oegstgeest. However, because of the limited amount of remains available for age reconstruction, it is difficult to make any definite statements.



Figure 15. Age distribution created using post-cranial remains from sheep/goat. This diagram was created using data generated by the author in combination with data from previous publications (van der Jagt 2011, table 7).

## 6.11. Sex distribution of cattle remains

### 6.11.1. Acetabulae

According to Greenfield, the 'H1' (height of the medial acetabular wall) measurements taken from *Bos taurus* acetabulae of known sex yielded clear, non-overlapping ranges for males and females, indicating that the 'H1' measurement can be used to sex fragmentary *Bos* pelvis elements (fig. 16) (Greenfield 2006, 74). Though it is true that the measurements from Greenfield's study provide a non-overlapping range, they did not provide a clear *separation* of the male and female specimens. Fig. 16 shows a steady increase in the values for measurement 'H1'. The values from males as a whole are not significantly higher than those from females. If this diagram had originated from an archaeological sample of cattle acetabulae, it would have been difficult to interpret.

According to the author, the main problem with Greenfield's article is that he does not provide the reader with analytic tools that can be used to apply his method successfully. He states that the measurements for 'H1' from *Bos taurus* provided clear, non-overlapping results. He does not go on to formulate a strategy that can be used to analyse archaeological data. His results would be far more useful to archaeozoologists if he were to suggest, for example, that acetabulae with a 'H1' measurement that falls below the 1,25 cm mark can be interpreted as cows, and acetabulae with values above this mark can be interpreted as males. This conclusion could be drawn when analysing the results presented by Greenfield in fig. 16. Without such a conclusion, it remains difficult to translate Greenfield's research into a workable methodology.

When analysing the selected acetabulae from Oegstgeest, three specimens that display a pathology were excluded from the analysis. These specimens display a pathology of the acetabulum and were excluded because their 'H1' measurements could not be considered representative.

The measurements taken from cattle acetabulae from Oegstgeest have been arranged according to height and then plotted in a histogram. Fig. 17 shows that the Oegstgeest values also show a gradual increase as was observed for the values for *Bos taurus* from Greenfield's

study. It is not possible to distinguish between two separate groups in the diagram, which could represent males and females. Seven values fall well below the 1 cm mark, indicating they probably derive from cows. The next value is well over 1 cm, meaning that the 'gap' between possible male and female values is nearly 20 mm. If this interpretation of the results is correct, the 'H1' values indicate that the sample consists of an equal number of female and male individuals.

Unfortunately, this interpretation may be too simplistic, as it does not take into account the presence of any castrated animals. There were no clear castrates present in Greenfield's sample, meaning the effects of castration are unclear. However, Greenfield states that castration is not expected to have any real influence on the height of the acetabular wall (Greenfield 2006, 75). Considering the presence of castrates at Oegstgeest, a second interpretation of the data is possible. As the bones of oxen are usually thought to be longer and more slender than those of bulls, the separation at around 1 cm could be the transition between females and castrates. The second gap, which is discernible at the right of the diagram might be the transition between castrates and males. This would mean that the sample contains seven females, five castrated animals and one male, which displays a very high value for 'H1'.

In addition to the 'H1' measurement, Greenfield also provides visual criteria that can be used to distinguish between pelvic fragments from male and female individuals. Greenfield states that in males, the ilio-pubic ridge is dull and poorly visible, while in females this feature is sharper and more visible. Using this criterion, the Oegstgeest acetabulae were subjected to a visual examination in order to determine their sex. Based on visual criteria, most of the acetabulae were classified as female (fig. 18). Most of the acetabulae that were classified as female based on the 'H1' measurements were also classified as females using the visual criteria. The group that was presumed to belong to males or oxen based on the 'H1' measurements were also classified as females, except for one acetabulum, which was classified as male. The specimen at the far right of the diagram was also classified as male using the visual criteria. Two specimens were impossible to classify using the visual criteria. This points to a cattle population in which females predominated.

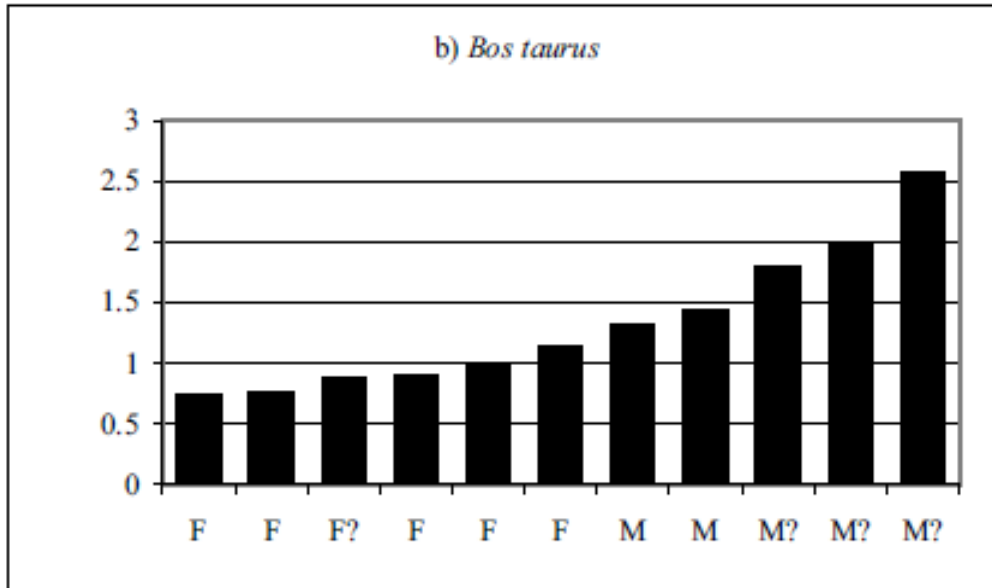


Figure 16. Measurements for 'H1' for Bos Taurus acetabulae as presented by Greenfield (Greenfield 2006, 80).

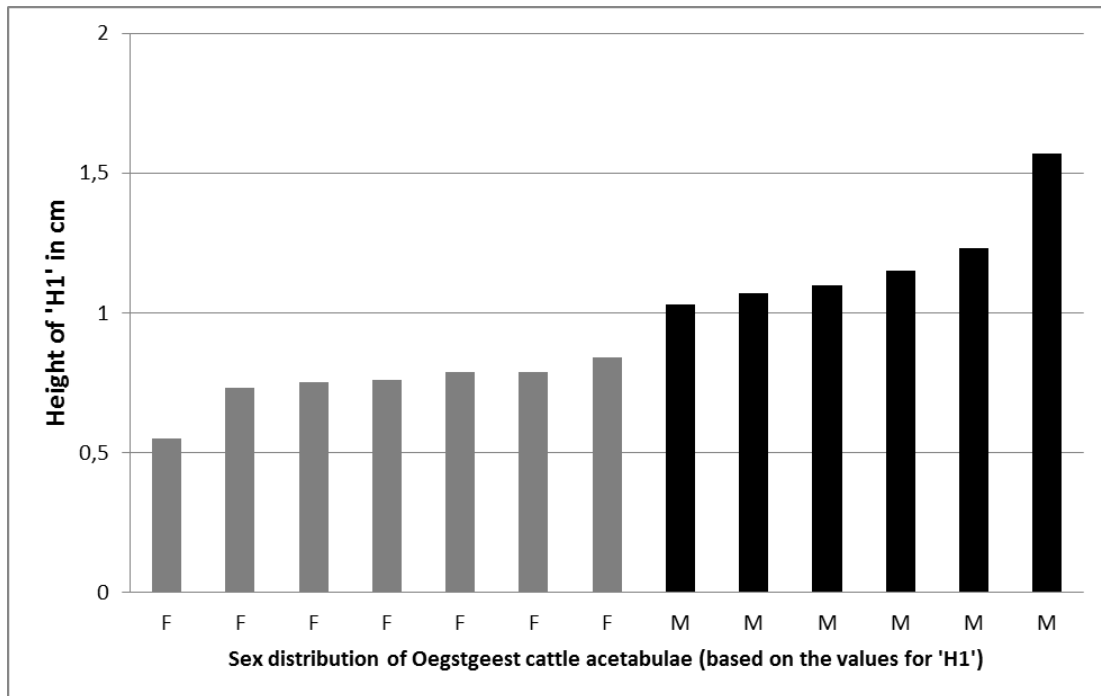


Figure 17. Measurements for 'H1' for the selected Oegstgeest cattle acetabulae. The interpretation of female (F) and male (M) individuals is based on the height of 'H1'.

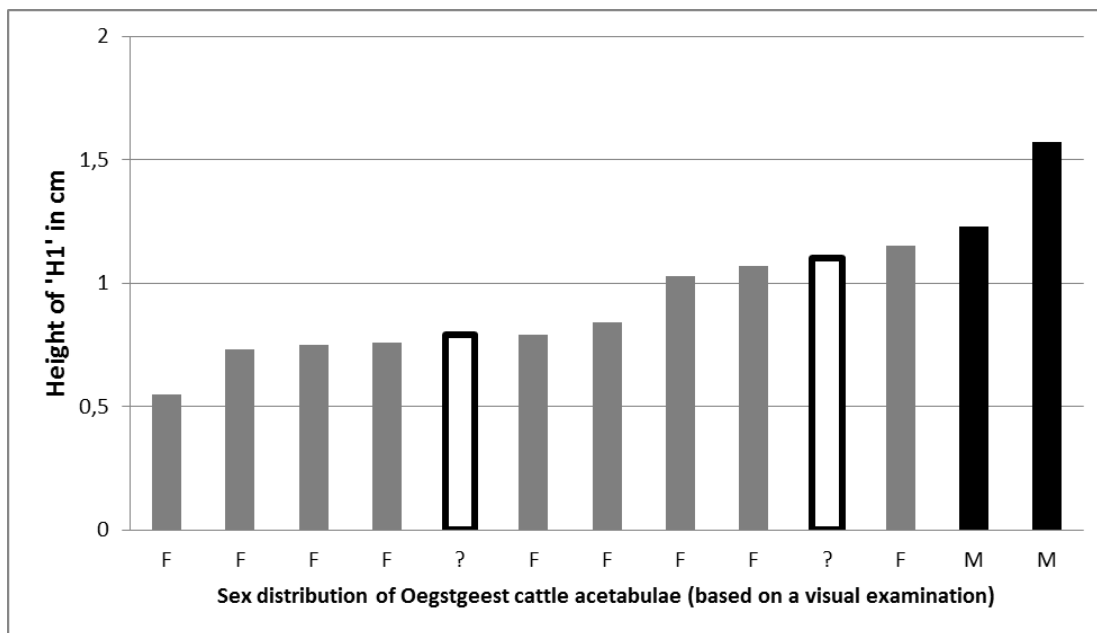


Figure 18. Measurements for 'H1' for the selected Oegstgeest cattle acetabulae. The interpretation of female (F) and male (M) individuals is based on visual criteria. '?' indicates it was impossible to sex a specimen visually.

To sum up, the analysis of the height of the medial wall of the acetabulum of the Oegstgeest acetabulae suggest that an equal number of male (possibly oxen) and female cattle was present at Oegstgeest. Sex determination using visual criteria indicates that the cattle population consisted largely of females. These results are difficult to interpret. If the 'gap' in fig. 17 is discounted, it is possible to interpret it in a similar way as the results from the visual analysis. Only the male specimen at the right of the diagram, which does not display a significantly higher value for 'H1' than the female specimens, would have been wrongly interpreted.

Establishing sex ratios for cattle based solely on the 'H1' measurements proved rather difficult, as neither Greenfield's results, nor the data from Oegstgeest show a clear, visible distinction between the male and female values. Unfortunately, Greenfield's article does not provide any useful way to translate his results into a method that can be successfully applied to archaeological data. This makes it difficult to use his results to sex the Oegstgeest acetabulae.

When considering Greenfield's results together with the data from Oegstgeest, one preliminary conclusion can be drawn. In Greenfield's diagram of the 'H1' values for *Bos taurus*, the transition from females to males seems to occur at around 1,25 cm (fig. 16). When applying this rule to the Oegstgeest acetabulae, together with the interpretation presented in fig. 17, one could put forward the theory that the 1,25 cm mark could be used to separate female from male specimens. It is, however, very important that this theory is tested using a larger dataset before statements can be made on its validity.

### 6.11.2. Metapodials

Many archaeozoologists have observed that the distal width of metapodials is highly indicative of sexual dimorphism in cattle. The Bd measurements from Oegstgeest metapodials have been plotted in a histogram. Assuming that low values indicate females, high values indicate males and intermediate values possibly indicate oxen, the values in fig. 19 seem to indicate that the largest part of the cattle population at Oegstgeest consisted of cows. When comparing the values for metacarpals, metatarsals and the diagram that shows values for both elements, one could argue that the sample also contains some oxen, which are represented by the values which are intermediate between those of cows and bulls (fig. 20). The data does not indicate that a large number of bulls was kept at Oegstgeest.

Boessneck *et al.* 1971 and Boessneck 1956b recommend the following indices to determine sexual dimorphism in cattle metapodials:  $(SD*100)/GL + (Bp*100)/GL$  (Boessneck 1956b, 84-85; Boessneck *et al.* 1971, 45). Though several other indices are used by Boessneck *et al.*, the  $(SD*100)/GL + (Bp*100)/GL$  and  $(Bp*100)/GL + GL$  yield the most comprehensive results. Fig. 21 shows three more or less distinct groups for the plotted metacarpals. One group which has a lower GL and lower values for the  $(Bp*100)/GL$  index, one group which also has low values for the  $(Bp*100)/GL$  index but higher values for GL and finally a group which has higher values for both variables. The first group is interpreted here as belonging to cows. Assuming that metapodials from oxen are longer but similar to those of cows in shape, the second group is interpreted as perhaps belonging to oxen. The two points that show high values for the  $(Bp*100)/GL$  index and GL probably belong to bulls. The results for the metatarsals shown in fig. 22 can be interpreted in more or less the same way.

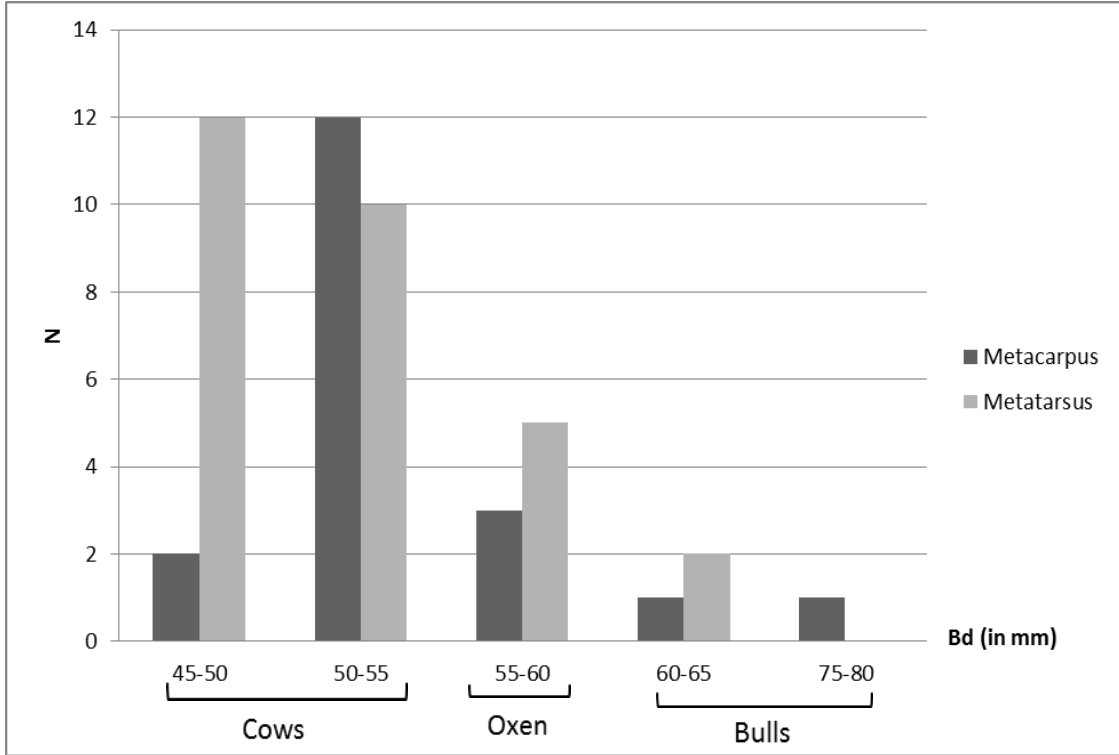


Figure 19. Distal width for metacarpals and metatarsals.

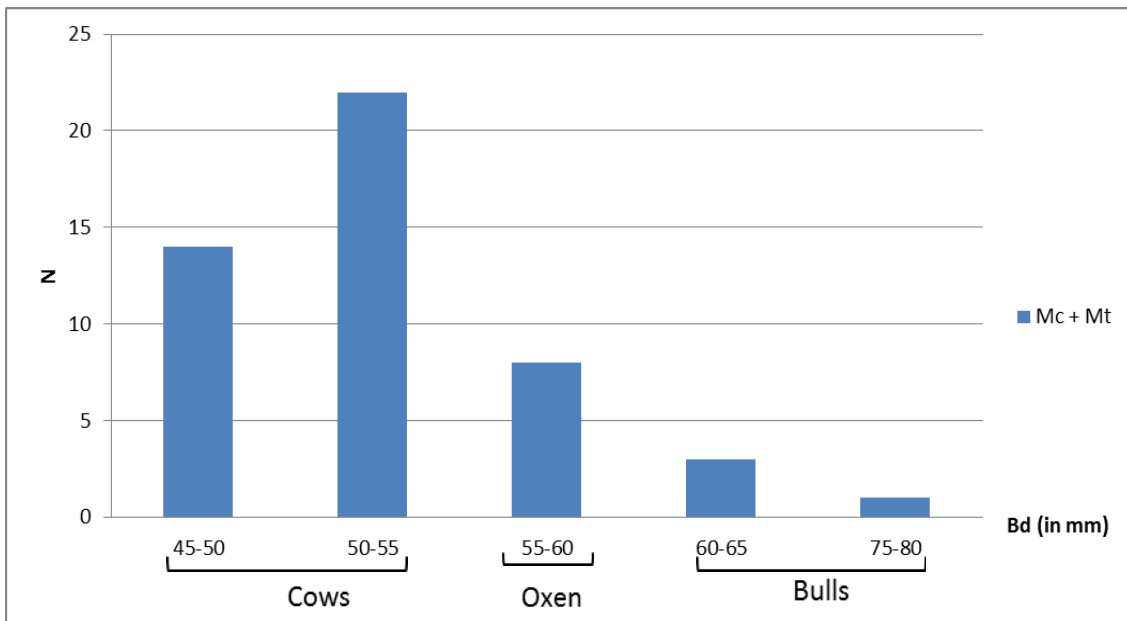


Figure 20. Combined distal widths for metacarpals and metatarsals (Mc = metacarpus, Mt = metatarsus).

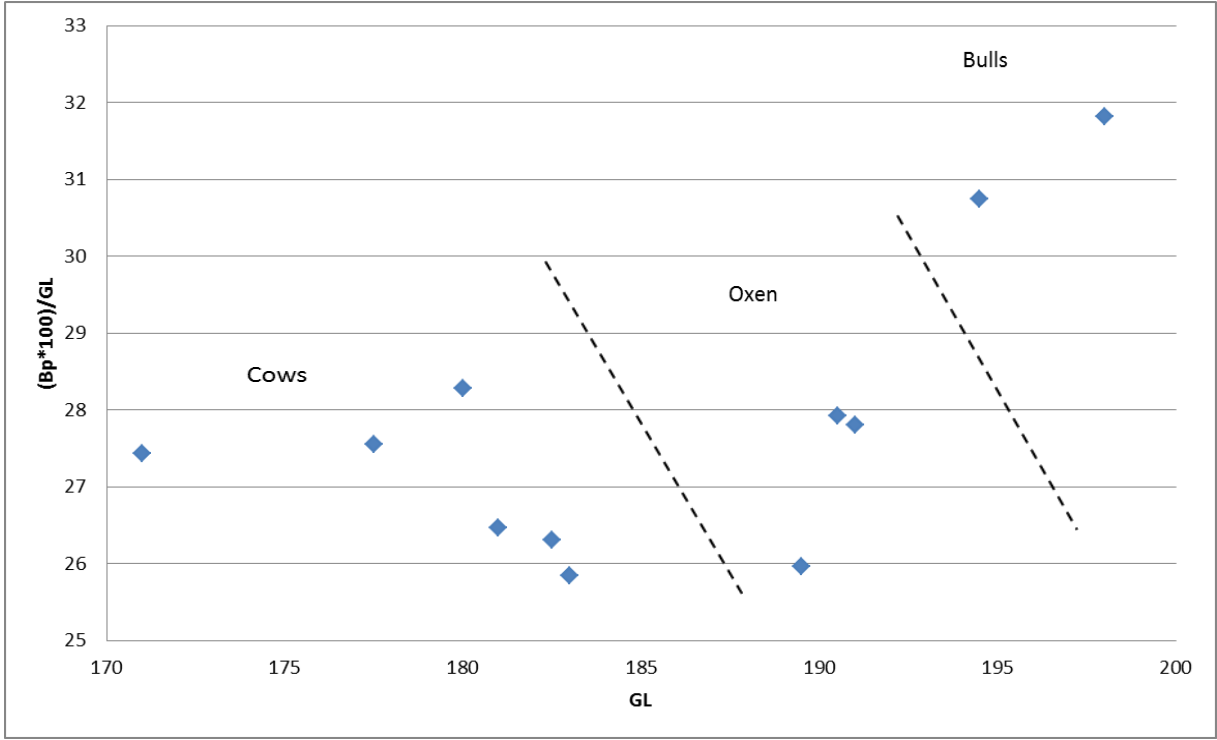


Figure 21.  $GL$  plotted against  $(Bp*100)/GL$  for complete metacarpals.

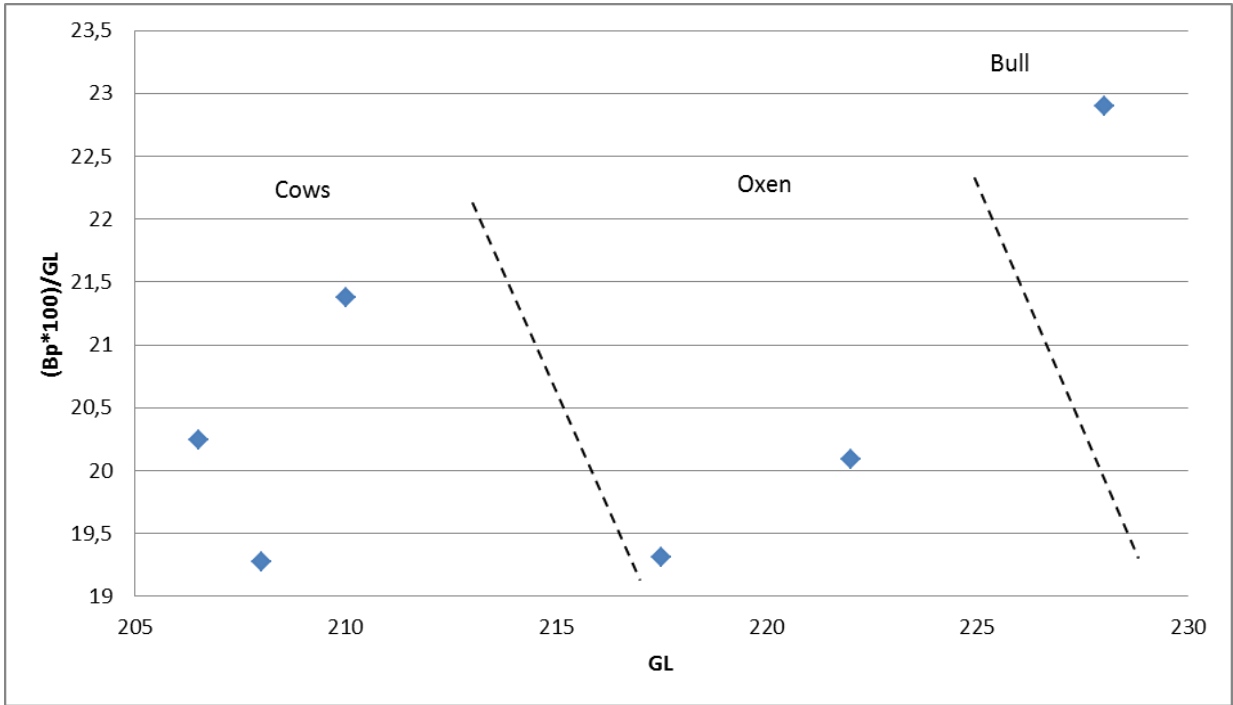


Figure 22.  $GL$  plotted against  $(Bp*100)/GL$  for complete metatarsals.

Following the publication of Thomas (1988) the breadth of the medial and lateral condyles for both metacarpals and metatarsals was measured. The breadth of the lateral condyle was then plotted against the breadth of the medial condyle for both elements. According to Thomas, the specimens clustered to the left side of fig. 23 should belong to females, because, compared to the other specimens, they have low values for the breadth of the lateral and medial condyles. The separation between castrates and bulls is not clearly visible for the Oegstgeest data. Thomas interprets the group that is intermediate between what he labels cows and bulls as castrates. As morphology changes related to castration are strongly dependant on the age at which an animal is castrated, it is possible that the second group visible in fig. 23 is a mix of castrates and bulls. These results point to a cattle population that consisted largely of cows, with a small numbers of males (and/or castrates).

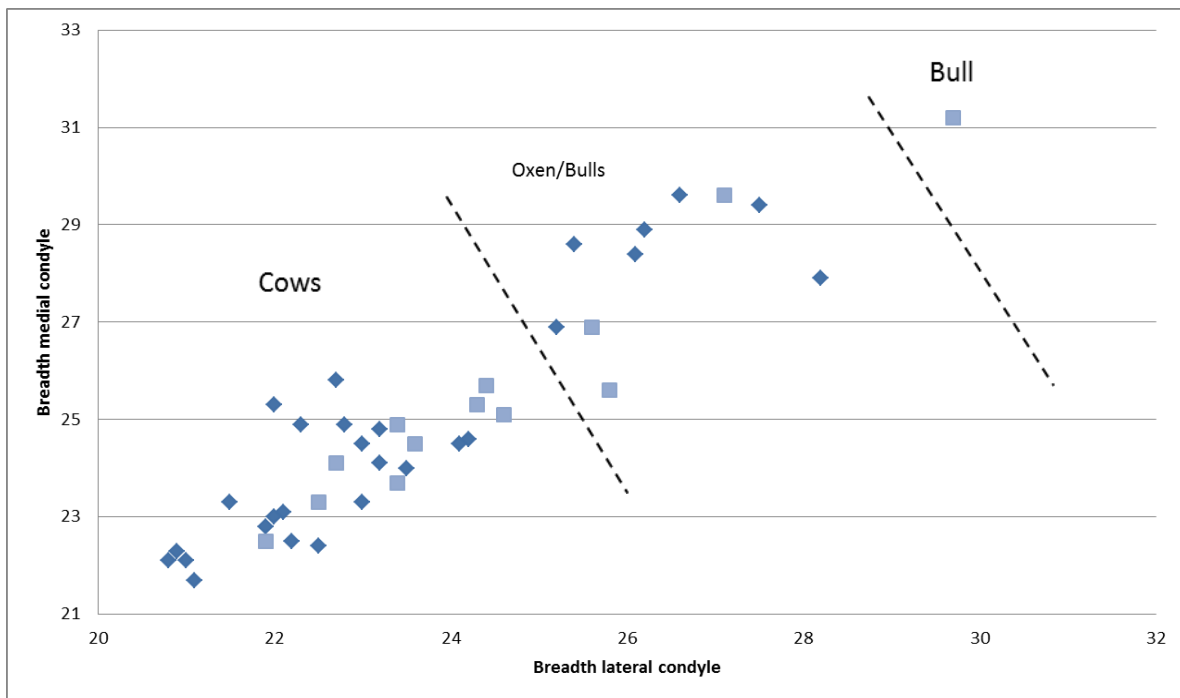


Figure 23. Breadth of lateral condyle plotted against the breadth of the medial condyle for metacarpals (marked as squares) and metatarsals (marked as diamonds).

In order to get an idea of the size of the cattle that was kept at Oegstgeest, withers heights for cattle were calculated using the greatest length of metapodials. A total of 26 measurements of metapodials were available for this analysis. These measurements are

derived from the material studied by the author as well as previous publications on Oegstgeest. Tab. 5 shows 16 metacarpals and 10 metatarsals with their greatest length and calculated withers height. To calculate the withers height of cattle the greatest length of complete metapodials (in mm) must be multiplied with multiplication factors. The multiplication factors suggested by von den Driesch and Boessneck (1974) were used (6.15 for the metacarpus and 5.45 for the metatarsus). The calculated withers heights show a range of 105-125 cm with an average of 115 cm.

To investigate whether these values represent the normal variation of a population that includes males, females and possibly also oxen, or whether they indicate the presence of cattle of very different size classes, the withers heights from Oegstgeest will be compared to those from Dorestad.

In her research on the faunal assemblage from the Early Medieval *emporium* of Dorestad, W. Prummel used the distal width of cattle metacarpals in order to sex them. The results of this analysis allowed her to use separate multiplication factors for the metacarpals from cows, bulls and oxen in order to calculate their withers heights.

The results show that the cows from Dorestad had withers heights ranging from 103 to 118 cm, with an average withers height of about 110 cm (tab. 6). For bulls only two metacarpal measurements were available. These produced withers heights of 121 cm and 124 cm. For oxen, the range in withers height is 110-132 cm with an average of 121 cm. When these ranges and average are compared with the values from Oegstgeest it would seem that the Oegstgeest assemblage contains cows as well as bulls. The range for oxen from Dorestad includes much higher values for the withers height, indicating that oxen from Dorestad were much larger than either cows or bulls. Because the withers heights from Oegstgeest do not include very high values that could be associated with oxen, it does not seem likely that the Oegstgeest cattle population contained a large amount of oxen, or at least not exceptionally large oxen.

The results from the selected Oegstgeest metapodials suggest that the cattle population consisted largely out of female animals. Bulls were also present, but in far smaller numbers. Based on the data from metapodials, no definite statements can be made on the presence of

castrated animals. The calculated withers heights for the Oegstgeest cattle metapodials suggest the presence of cows and bulls. They do not indicate that a large amount of oxen were present at Oegstgeest.

Table 5. Withers height for Oegstgeest cattle. Multiplication factors suggested by von den Driesch and Boessneck (1974) were used: 6.15 for the metacarpus and 5.45 for the metatarsus. (GL = greatest length).

<b>Element</b>	<b>GL in mm</b>	<b>Withers height in cm</b>	<b>(Data from previous publications)</b>
mc	171	105,1	
mc	177,5	109,1	
mc	177	109,5	Cavallo 2008, 63
mc	179	110	Cavallo 2006, 78
mc	180	110,7	
mc	180	110,7	Cavallo 2006, 78
mc	181	111,3	
mc	182,5	112,2	
mc	183	112,5	
mc	185,6	114	van der Jagt 2011, appendix X, table 1
mc	189,5	116,5	
mc	190,5	117,1	
mc	191	117,4	
mc	194,5	119,6	
mc	198	121,7	
mc	197,9	122	van der Jagt 2011, appendix X, table 1
mt	205	111,7	Cavallo 2006, 78
mt	206,5	112,5	
mt	208	113,3	
mt	208	113,3	Cavallo 2008, 63
mt	208,5	113,6	
mt	210	114,4	
mt	217,5	118,5	
mt	222	120,9	
mt	228	124,2	
mt	230	125	van der Jagt 2011, appendix X, table 1

Table 6. Withers heights for cattle from Dorestad (After Prummel 1983, 171). Prummel used multiplication factors suggested by von den Driesch and Boessneck (1974).

element	number	factor	average withers height	range
metacarpus				
cow	27	6	109,6	103-118
ox	21	6,15	120,7	110-132
bull	2	6,3	122,5	121-124
unknown	26	6,15	117,3	108-132
all	*80	6,15	116,3	106-132
metatarsus	64	5,45	115,9	105-127
* Of four metacarpals that were ascribed to bulls the GL could not be measured. These metacarpals were added to the total sum when calculating the average withers height for all metacarpals				

### 6.11.3. *Horncores*

In order to successfully sex the selected horncores from Oegstgeest, their age was determined according to the classification published by Armitage (Armitage 1982, 38-41). Fig. 24 shows that the largest part of the selection consists of adult (adult/old adult) animals. Some young adults were also encountered. These specimens have been marked in the diagrams below. One juvenile horncore was also encountered; this specimen has been excluded from the analysis.

In addition to age determination, part of the selection could also be classified according to horncore length. It is advisable, if possible, to sort horncores according to length in order for an analysis of sex distribution to be as successful as possible (Sykes and Simmons 2007, 520). Sykes and Simmons present a table with an overview of the various horncore length classifications that have been published over the years. The most recent one, published by the authors themselves, has been used to assign the Oegstgeest horncores of which outer curve could be measured to the various proposed categories. Tab. 7 shows that the Oegstgeest horncores fall into two categories; small horned and short horned. These two categories have been analysed separately in order to determine their sex. One horncore was assigned to the medium category and has been excluded from the analysis. The horncores of which the outer curve could not be measured were analysed separately. It is possible that these specimens could also be separated into a small horned and short horned group, but because they could not be measured, and because the difference in length in the measurable

specimens was not very large, it has been decided to analyse the fragmented horncores as one group.

Table 7. Selected Oegstgeest horncores for each size class proposed by Sykes and Simmons (After Sykes and Simmons 2007, table 1).

	Sykes and Simmons (2005)	Selected Oegstgeest horncores for each size class
<b>Small horn</b>	<145 mm	14
<b>Short horn</b>	145-195 mm	8
<b>Medium</b>	195-350 mm	1
<b>Long</b>	>360 mm	0

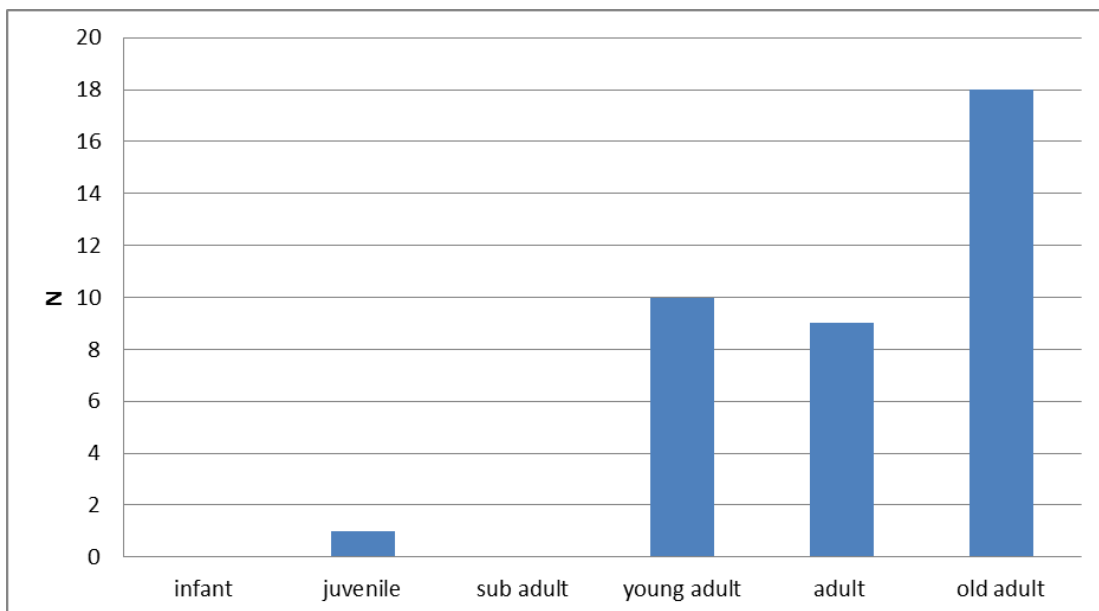


Figure 24. Number of Oegstgeest horncores assigned to each age class (age classes after Armitage 1982, 38-41).

No attempt was made to sex horncores using the criteria published by Armitage and Clutton-Brock (1976, 332) and Armitage (1982, 43-49). These criteria are considered too subjective to be used effectively.

Fig. 25 shows the specimens of which the outer curve could not be measured. In this diagram, the measurements of the basal circumference of the horncores was plotted against

the smallest diameter of the horncore base. These measurements are considered by Sykes and Simmons to display the largest degree of sexual dimorphism (Sykes and Simmons 2007, 519-520). The results indicate that most of the selected horncores belong to female animals, as the density of points is greater at the left side of the diagram. Points to the far right side of the diagram are assumed to be males.

Fig. 26 shows the BB and BC for the horncores that were classified as ‘small-horned’. The diagram contains two clusters of specimens and two single data points. The two clusters to the left of the diagram are assumed to represent females. There is no significant difference between these two clusters in the basal circumference or in the least diameter of the horncore base. The specimen at the far right is assumed to be an ox. It is marked as a young-adult individual and displays high values for both the horncore circumference and diameter. The specimen in the middle of the diagram is assumed to be a female as well.

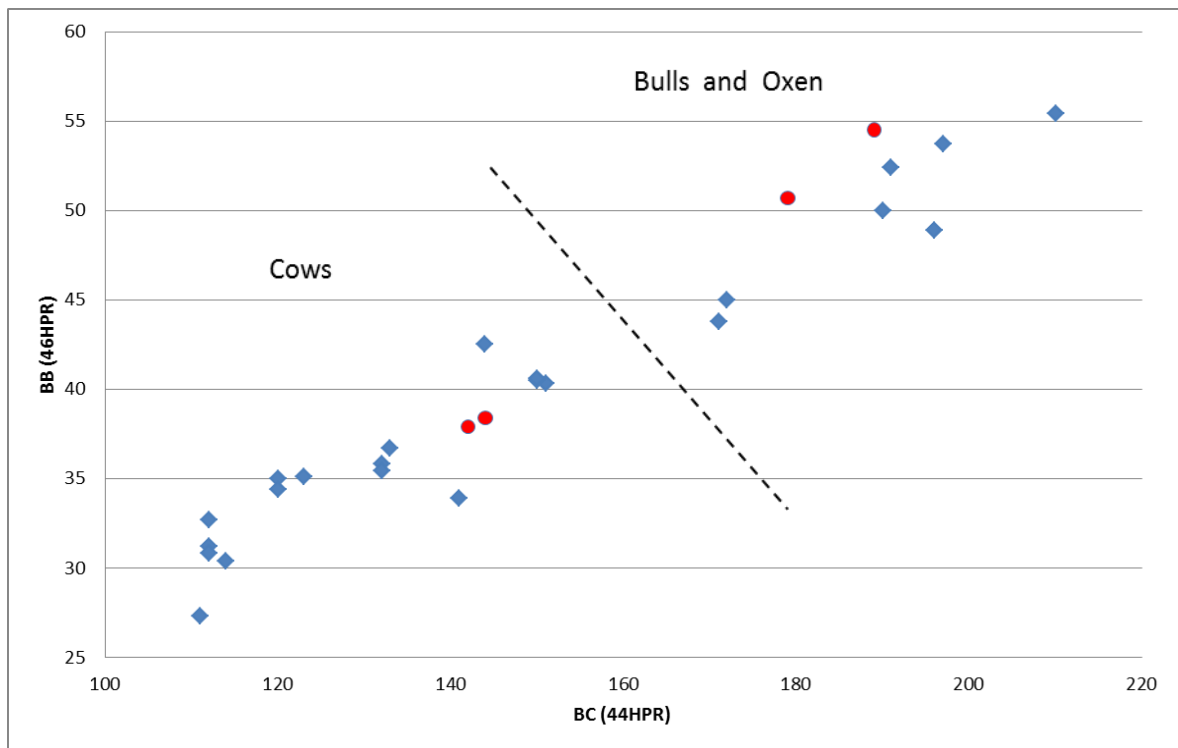


Figure 25. Basal circumference plotted against smallest diameter of the horncore base for horncores of which the outer curve could not be measured (young-adult specimens are marked as red circles).

The diagram for short horned specimens displays three small clusters, each consisting of two points (fig. 27). Because the dataset for this category is rather small, the results are difficult to interpret with any real certainty. Perhaps these three clusters represent females, castrates, and males.

The young-adult specimens are marked in each diagram. In all three diagrams, some young-adult specimens appear to the far right. The fact that they have been classified as young-adults and have high values for the measurements taken on the base of the horncore is probably due to castration, which is known to slow growth and development of cattle. Therefore, these specimens are assumed to represent castrates. In the opinion of the author, Sykes and Simmons do not address the issue of castration in a sufficient manner. Unfortunately, their studied sample only contained two castrated specimens, limiting their results and conclusions to female and male specimens (Sykes and Simmons 2007, 517).

Sykes and Simmons discount the theory that grooving of the horncore could be related to castration. They refer to Luff and Grigson, who have both mentioned grooving of the horncore. They claim that Grigson has suggested that this phenomenon is related to age. This is not true. Grigson states that: “*there seems to be little correlation with age*” (Grigson 1976, 130). Luff states that grooving could be related to castration. She also stresses that: “*grooving is not considered to be a characteristic primarily demonstrated by castrates*” and that “*grooving may be correlated with castration but is not necessarily the result of castration*” (Luff 1994, 182). Luff partly bases her claims on the fact that she observed grooving mainly on young-adult specimens, which, according to her, could be a result of the prolonged growth rate of horncores in castrates (Luff 1994, 181). At Oegstgeest, only adult and old adult horncores display grooves, perhaps indicating that grooving might after all be related to age and not to castration.

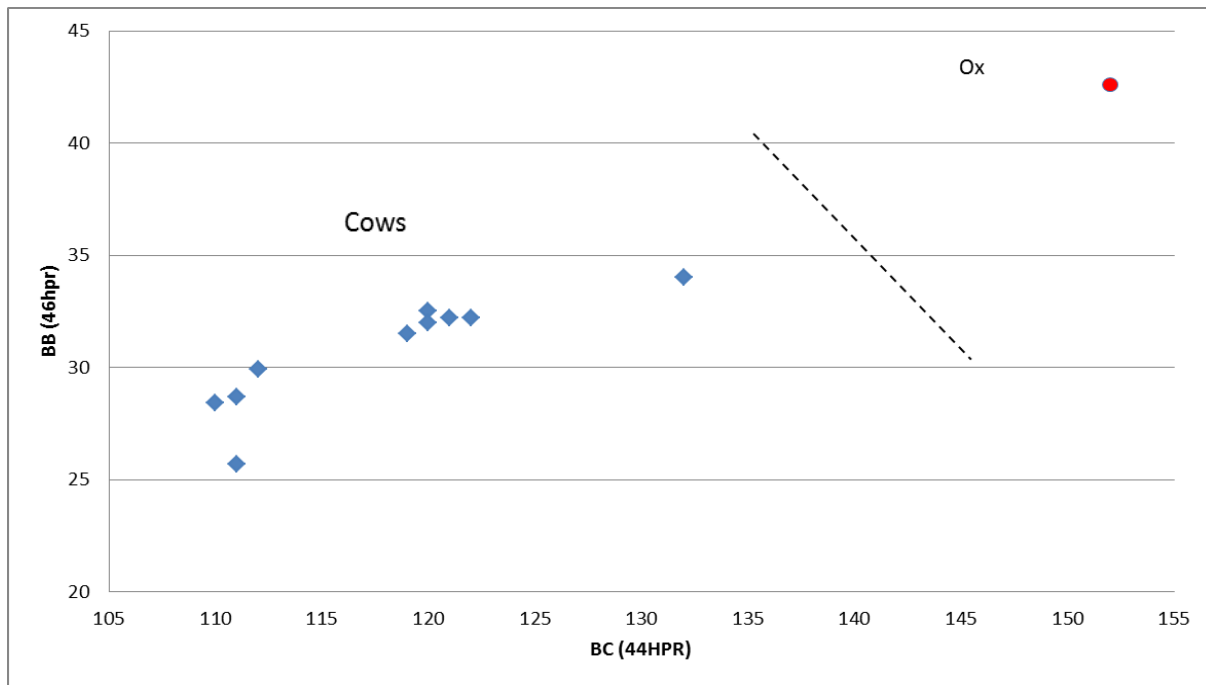


Figure 26. Basal circumference plotted against smallest diameter of the horncore base for specimens that were classified as 'small horned' (one young-adult specimen is marked as a red circle).

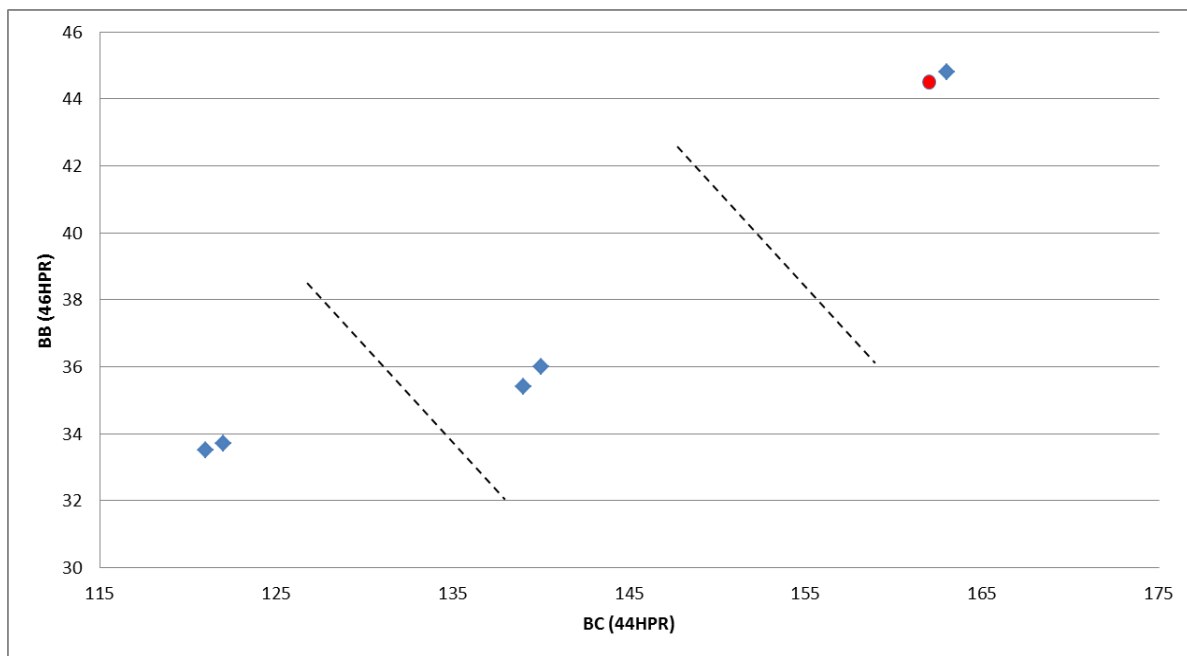


Figure 27. Basal circumference plotted against smallest diameter of the horncore base for specimens that were classified as 'short horned' (one young-adult specimen is marked as a red circle).

The data from fig. 25 indicates that the Oegstgeest cattle population consisted largely of females. The data from figures 26 and 27 do not provide conclusive results due to the fact that they represent much smaller datasets. In contrast to the results obtained from the measured acetabulae and metapodials, the data from horncores is thought to provide evidence for the presence of castrates. These specimens are characterized by high values for measurements taken from the horncore base at young-adult age, which is thought to be indicative of slow growth of the horncore caused by castration.

#### *6.11.4. The issue of castration*

In addition to determining the composition of the Oegstgeest cattle population in terms of male and female animals, it would also be useful to have an idea of the number of castrated cattle or oxen at Oegstgeest. This would provide a more detailed picture of the composition of the cattle population and also give an impression of the husbandry practices at Oegstgeest.

When reviewing the literature to establish ways in which castrates can be identified in the archaeozoological record, several conclusions can be drawn.

It is well known that castration delays epiphyseal fusion. If the epiphyses of bones fuse at a later age, bones continue to grow for a longer time, causing them to be longer than bones from cows and bulls. Castration is also known to result in more slender limb bones (Davis 2000, 374, 386-387; Howard 1961, 256; Pöllath and Peters 2005, 228). Castrated cattle seem to have longer horncores than those of female and male cattle (Armitage and Clutton-Brock 1976, 332; Armitage 1982, 43-44; Bartosiewicz 2006, 304). Using these characteristics, castrates should be relatively easy to detect in archaeological assemblages.

However, it is important to note that the age at which an animal is castrated has a strong influence on the morphology of its skeleton. Animals that are castrated at an early age will develop skeletal elements that fit the generally accepted oxen stereotype; bones that are similar to cows in their morphology but which are longer and more slender than those of bulls. As the age of castration goes up, the influence of this procedure on skeletal morphology diminishes. An animal that is castrated quite late in its life will have bones that resemble those of a bull (Brannang 1966 ; Fitzherbert 1523 in Luff 1994, 182). Osteometric

analysis will only reveal animals that have been castrated at an early age; animals that were castrated when they were older will most likely be interpreted as bulls.

Proving the presence of castrated cattle in the Oegstgeest faunal assemblage has not been straightforward. Because skeletal morphology is highly dependent on the age at which animals were castrated, it has proved impossible to merely interpret long metapodials as belonging to castrates.

The information on the effects of castration on the height of the medial acetabular wall is insufficient, meaning this data cannot be used to draw conclusions on the presence of castrates either.

The supposed increased length of horncores from castrates has not proved very helpful. Though Sykes and Simmons advise to sort horncores according to length before attempting to sex them, they do not comment on the effects of castration on horncore length and on how this would affect any classification. If animals castrated at an early age do have much longer horncores, they might be classified in a different size-category than the rest of a population. Delayed growth rates are also characteristic of castrates. This information has enabled the author to identify several horncores as belonging to castrates. These horncores were larger than other specimens in the sample, even though they were classified as young-adults.

To summarise, establishing the presence of castrates in any archaeozoological assemblage is not straightforward. Only the data from cattle horncores from Oegstgeest has provided some evidence that can be used to determine the presence of oxen at Oegstgeest,. When reviewing this data, it seems that a small number of oxen was present in the Oegstgeest cattle population.

## **6.12. Skeletal element abundance**

In order to determine whether animal products like partial carcasses or joints of meat were imported or exported at Oegstgeest, skeletal element abundance for the three main domestic mammals has been analysed. For the purpose of this analysis, the numbers of skeletal elements for cattle, pig and sheep/goat from previous excavation reports have been added to the numbers from the material analysed for this thesis.

The skeletal element abundance for each species has been presented according to the method published by Spennemann. This method requires the amount for all the elements in the skeleton to be distributed over five classes. The range of these classes is calculated separately for each species (Spennemann 1985).

The amount of vertebrae and ribs are rather low for all species. These elements are hard to identify to species level. Most cattle vertebrae and ribs will have been assigned to the 'large mammal' category, while the majority of vertebrae and ribs from sheep/goat and pig will have been classified as 'medium mammal'. In some cases it was possible to identify a vertebrae or rib to species level.

Fig. 28 indicates that a large number of cranium and mandibular fragments from cattle are present in the assemblage. Mandibular and dental remains are very resistant to degradation and are usually the best preserved elements in an archaeological assemblage. This accounts for their high numbers in the Oegstgeest assemblage. The cranium is an element which is often highly fragmented and it would therefore make sense that that fragments from this element are recovered in high numbers.

Fig. 28 also indicates that a high amount of fragments from the tibia and pelvis were found. This could be an indication that cattle hind limbs were brought into the settlement from elsewhere. When comparing the numbers for elements from the front limb with the numbers for elements from the hind limb (see tab. 17, appendix 4), there does seem to be a significant difference between these numbers, indicating that elements from the hind limb are indeed more abundant. The high amount of tibiae fragments could be explained by the fact that even small fragments from the cattle tibia are often easy to identify due to the shape and exterior morphology of this bone. The abundance of pelvic elements cannot be explained away so easily. It must therefore be concluded that the skeletal element abundance diagram for cattle remains provides a strong indication for the import of beef.

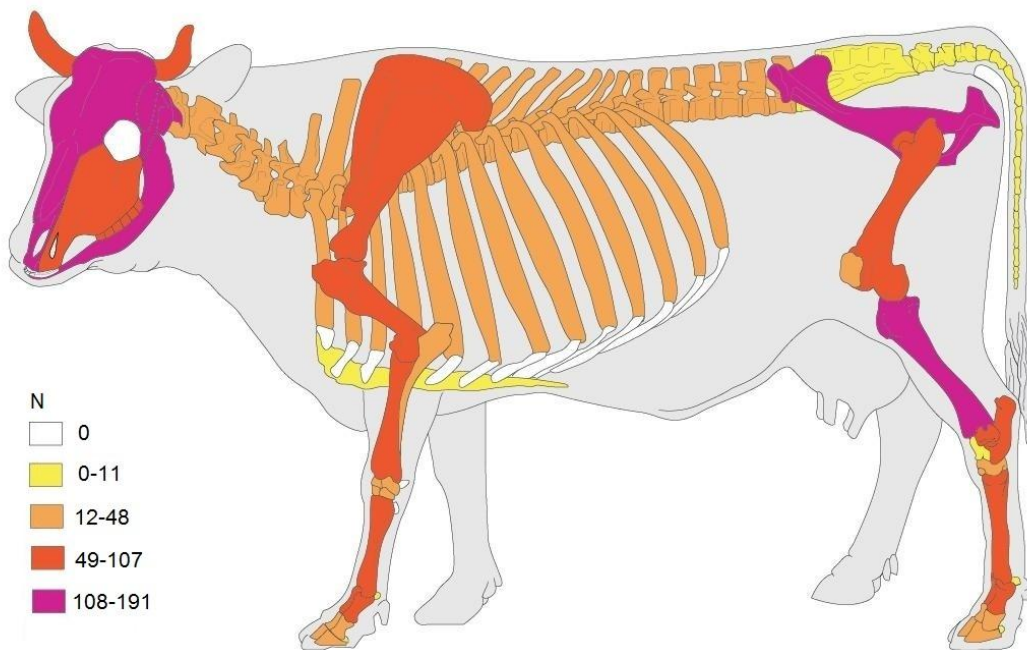


Figure 28. Skeletal element abundance of cattle remains from Oegstgeest presented according to the method developed by Spennemann (1985).

The skeletal element abundance diagram for pig remains indicates that the mandibula and the tibia were found in the highest numbers in the Oegstgeest assemblage (fig. 29). Again, the high number of mandibular fragments can be explained by the fact that the mandibula is an element which is highly resistant to degradation. The abundance of tibia fragments, however, may indicate that joints of pork were brought into the settlement. As mentioned previously, Van der Jagt also encountered a high number of pig tibiae in her studied sample, which she believed could be indication of the import of pork (van der Jagt 2011, 21). The fact that the combined data from Oegstgeest also indicate that pig tibiae are rather numerous in the assemblage is a strong indication that pork was indeed brought to the settlement from elsewhere. This might explain why pig remains in general are far more numerous at Oegstgeest than at any other contemporaneous settlement in the delta of the Old Rhine. Perhaps the people of Oegstgeest had a special preference for pork, or perhaps this pork was imported for some sort of feast.

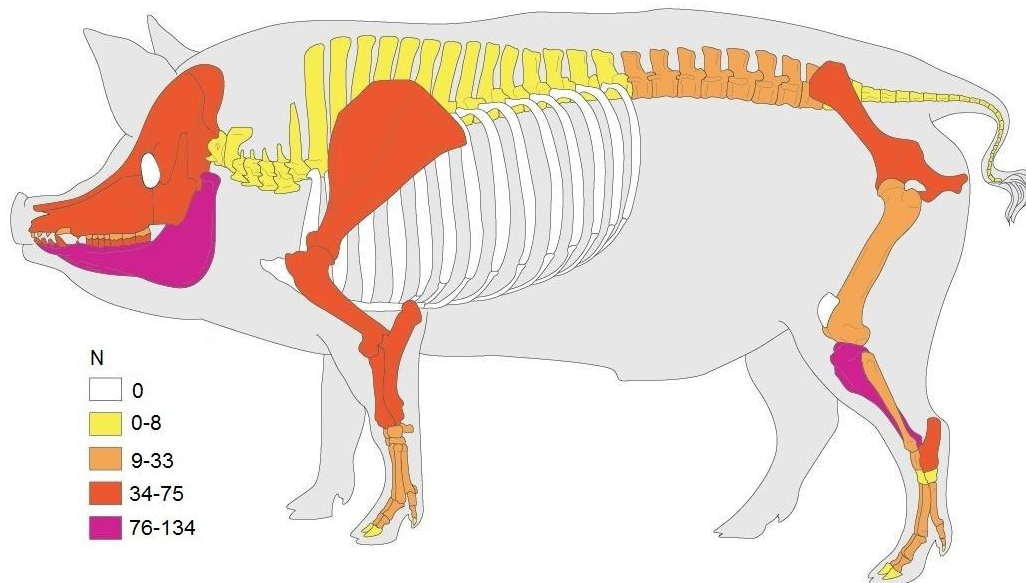


Figure 29. Skeletal element abundance of pig remains from Oegstgeest presented according to the method developed by Spennemann (1985).

Fig. 30 shows the skeletal element abundance for sheep/goat remains. Only the mandibula seems to have been encountered very often and this abundance can be explained by taphonomical factors. Fig. 30 provides no clear indication for either the import or export of mutton. This, in combination with the fact that remains from sheep/goat are far less numerous than those from cattle and pigs, suggests that sheep/goats were kept to provide things like meat, milk and wool for the people of Oegstgeest.

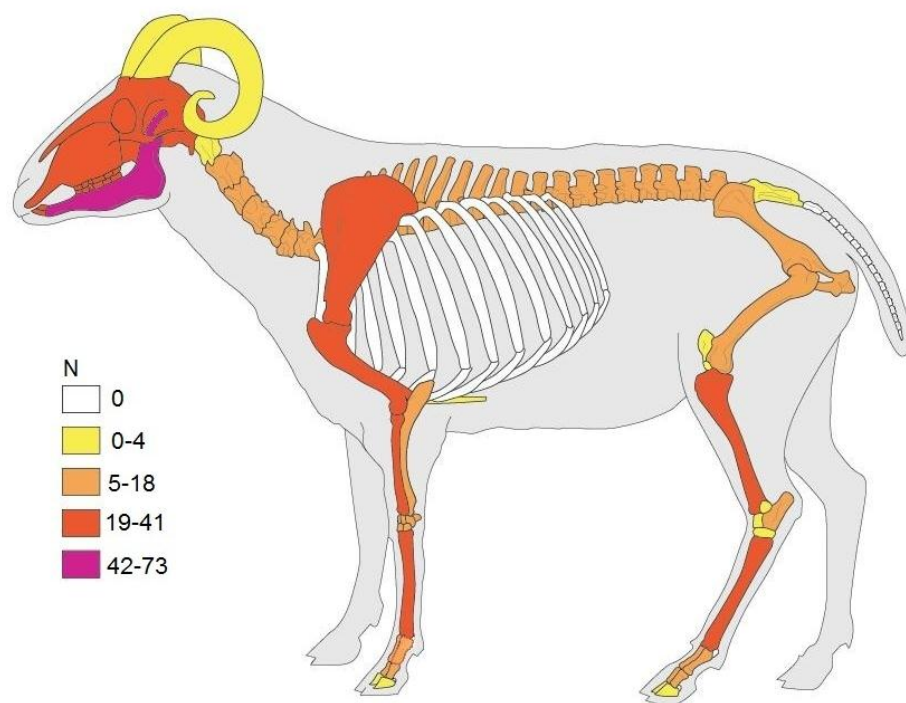


Figure 30. Skeletal element abundance of sheep/goat remains from Oegstgeest presented according to the method developed by Spennemann (1985).

## **7. Discussion – Exchange and surplus production at Oegstgeest**

In order to be able to answer the research questions put forward at the beginning of this thesis, the results of the research conducted will now be reviewed. This will provide the reader with some preliminary conclusions and some reservations which should be kept in mind when moving on to the final conclusions of this thesis. Practised husbandry strategies and possibilities of exchange and surplus production will be reviewed for the various species that have been discussed.

### *7.1. Cattle*

The people of Oegstgeest seemed to have exploited their cattle primarily for milk. The age distributions created for cattle remains indicate that a large amount of juvenile animals was slaughtered, as well as a fair amount of older animals. Especially the slaughter of juvenile animals indicates milk production. Data on the sex ratios of the Oegstgeest cattle remains indicates that the cattle population consisted mainly of females. Bulls and castrates were also present, but in smaller numbers. This supports the theory that milk production was important at Oegstgeest, as a substantial amount of cows would have been important for producing milk. The cattle age distributions also indicate that some beef was consumed at the settlement. When considering both the dental and the post-cranial age distributions (see fig. 11 and 12) as well as the sex ratio of the cattle population, it seems that milk production was more important than rearing cattle for beef.

The cattle age distributions do not indicate that young adults – or any other age category – was exported. The fact that young adults were absent from age distributions discussed in previous publications appears to have been the result of limited sample size. Now that data from previous publications has been combined with data generated for this thesis, the age distributions do not show an absence of young-adult cattle. The previously reported discrepancy between age distribution data from dental and post-cranial remains also seems to have been a result of limited sample size. The age distributions created here using dental and post-cranial remains show similar results. This means that there is no evidence that the people of Oegstgeest were producing a surplus of cattle for export. This is confirmed by data on

skeletal element distribution for cattle remains. These do not indicate the export of joints of beef. The skeletal element abundance for cattle remains does point to the possible import of hind limbs from cattle.

One point of discussion is the transport of cattle on the hoof. If live animals were being moved out of Oegstgeest, this would not be visible in the skeletal element distributions, because whole animals were being removed from the settlement and not specific parts of the skeleton. However, in view of the age distributions this seems unlikely. Animals of optimal slaughter age are abundant in the age distributions. If cattle was exported, one would expect that it would be exactly these animals that would have been exported. It is also possible that older animals that could no longer be used for milk or traction were exported to other settlements. These animals are, however, also abundant in the age distributions. In view of this, it seems safe to conclude that the people of Oegstgeest did not export a large amount of cattle.

### *7.2. Pigs*

Pigs appear to have been abundant at Oegstgeest. Age distributions created for pig remains indicate that these animals were kept to provide pork for the settlement.

The amount of pig remains found at Oegstgeest is rather large compared to the amount of pig remains excavated at other Early Medieval settlements in the area. Data on skeletal element distributions for pig remains indicate that the Oegstgeest assemblage contains a large amount of pig tibiae. This could be an indication that joints of pork were imported at Oegstgeest. If this is true, it would explain the high number of pig remains present in the assemblage.

### *7.3. Sheep/goat*

The amount of remains from sheep/goat is much smaller than the amount of remains from cattle and pigs. This limits the conclusions that can be drawn about why these animals were kept at Oegstgeest. The age distributions created using post-cranial remains from sheep/goat shows that predominantly adult animals were slaughtered. This could indicate that sheep were kept for wool. Perhaps wool production was important at Oegstgeest and part of this

wool was also sold. Unfortunately, this is impossible to prove or disprove as wool does not preserve in the archaeological record.

#### *7.4. Birds*

There is no evidence that birds, wild or domestic, were either imported or exported at Oegstgeest. The assemblage of bird remains consist mainly of remains from chicken and goose, which would have been kept as tame birds at the settlement itself. The bird remains do not contain remains from exotic species that could have been imported into the settlement. It is possible that birds were exported. Unfortunately, sediments were not routinely sieved and the amount of bird remains available for analysis remains is very small. It therefore remains difficult to draw any far reaching conclusions about birds at Oegstgeest.

#### *7.5. Fish*

Research performed by F. Kerklaan on the Oegstgeest fish remains shows a varied spectrum. The assemblage contains remains of anadromous, catadromous, sweet and salt-water species. Analysis of the amount of remains for each identified species indicates that the fish assemblage contains mainly remains from species that could have been caught in the direct vicinity of the settlement. Salt water species could have been caught at sea by the inhabitants of Oegstgeest or they could have been acquired through exchange. The amount of research that has been done on fish remains from Oegstgeest is too limited to enable any definite conclusions.

These results must be viewed as preliminary conclusions. It is important that in the future the fish remains from Oegstgeest are researched in more detail and that more sediments are sieved.

## 8. Conclusions

The main aim of this thesis has been to investigate whether the people of Oegstgeest were involved in the exchange and surplus production of animals and animal products. To establish whether this was the case or not, it was important to first determine how the exchange of animals and animal products can be recognised in the archaeozoological record. This information could then be used to examine the Oegstgeest faunal assemblage for signs of exchange and surplus production.

In order to answer these questions a theoretical framework was created that can be used to recognise the exchange and surplus production of animals and animal products in the archaeozoological record. A number of aspects was identified as being helpful in identifying these activities.

Age distributions can be used to identify exchange and surplus production. They can reveal the over or under-representation of certain age categories. This can be indicative of the import or export of animals. Sex distributions can also be helpful. They can shed light on husbandry strategies and also reveal the possible import or export of male or female animals.

The presence of exotic species in an assemblage is a tell-tale sign of the import of animals or animal products.

Analysis of the metrical and non-metrical attributes of faunal remains can help to establish whether animals from different sizes or breeds are present in an assemblage. Their presence can be indicative of the exchange of animals.

Investigating the skeletal element abundance for the species present in an assemblage can provide information on whether joints of meat were imported or exported.

aDNA and stable isotope analysis can also be used to investigate whether animals with different DNA or isotope signatures are present at a settlement. This can indicate that these animals were brought to the settlement from elsewhere.

After establishing this theoretical framework, it was applied to the faunal assemblage from Oegstgeest in order to determine whether this assemblage shows any signs of the exchange and surplus production of animals and animal products.

There was no surplus production of cattle at Oegstgeest. Cattle were primarily kept for the purpose of milk production. Some animals were slaughtered for consumption but overall, milk seems to have been the most important. Data on skeletal element abundance for cattle remains indicates the possible import of beef.

Pigs were kept to provide meat for the settlement. The high amount of pig remains, and in particular pig tibiae at Oegstgeest, suggest that joints of pork were imported from elsewhere.

Sheep may have been kept for wool production. This is indicated by the fact that mainly adult animals were slaughtered. It is possible that part of the wool produced at Oegstgeest was exported, though this is difficult to establish.

Evidence from the small amount of bird remains from Oegstgeest that have been analysed do not indicate the surplus production or exchange of these animals.

The fish remains from Oegstgeest indicate that salt water species were present at the settlement. This sea fish could have been caught by the inhabitants of Oegstgeest or the people there could have acquired it through exchange.

Overall there are no strong indications that the people of Oegstgeest produced a large surplus of animals or animal products or that they were involved in the large scale exchange of animals or animal products. There is no evidence that any animals or animal products were exported. There is, however, some evidence that pork, beef and sea fish may have been brought into the settlement from elsewhere.

## **9. Future research**

There are several issues that demand additional research. The amount of remains from birds and fish from Oegstgeest that have been available for analysis is small. It is essential that during future excavations sediments are sieved in order to create a larger dataset for analysis. This will provide information on husbandry strategies as well as reveal whether birds and fish were exchanged.

More faunal material from Oegstgeest needs to be identified. This would help to create a clearer picture of the husbandry of species like horse and sheep/goat. The research that has been conducted so far, including the research presented in this thesis, has not enabled any definite conclusions about why these species were kept at Oegstgeest. It is therefore important that more material from these species become available for analysis.

The results from this thesis do not indicate the large scale exchange and surplus production of animals or animal products at Oegstgeest. In the future it may be possible to conduct stable isotope analysis or even aDNA analysis in order to shed more light on this issue. It would be worthwhile to conduct stable isotope analyses on the pig remains from Oegstgeest, as the results presented here indicate that pork may have been imported into the settlement. If possible, such analyses can also be conducted for species such as cattle. This would provide additional data to create a more complete image of the exchange and surplus production at Oegstgeest.

Oegstgeest provides archaeologists and archaeozoologists with the opportunity to conduct extensive research on the exchange and surplus production of animals and animal products in the Early Medieval period; an opportunity which must not be missed.

## **10. Abstract**

Early Medieval exchange and surplus production of animals and animal products has received little attention in the archaeological literature. In order to create a picture of exchange and surplus production of animals and animal products in the Early Medieval period, the animal remains from the Merovingian settlement of Oegstgeest were analysed to determine whether exchange and surplus production took place at this settlement. A theoretical framework was set up in order to determine how exchange and surplus production can be recognised in the archaeozoological record. A number of aspects were deemed important in establishing whether exchange and surplus production took place in the past, including age and sex distributions, metrical- and non-metrical variation, skeletal element abundance and also stable isotope and aDNA analysis. Several of these aspects of the Oegstgeest faunal assemblage were researched. Results show that there was no large scale exchange and surplus production of animals and animal products at Oegstgeest. Results do, however, indicate that pork, beef and sea fish may have been brought into the settlement from elsewhere.

## **11. Samenvatting**

De uitwisseling en surplus productie van dieren en dierlijke producten in de Vroege Middeleeuwen is tot nu toe nog niet uitvoerig besproken in de archeologische literatuur. Om een beeld te schetsen van de vroeg-middeleeuwse uitwisseling en surplus productie van dieren en dierlijke producten is het dierlijk botmateriaal van de Merovingische nederzetting te Oegstgeest onderzocht. Om vast te stellen of de bewoners van Oegstgeest zich bezig hielden met uitwisseling en surplus productie van dieren en dierlijke producten is een theoretisch kader opgezet om te bepalen hoe uitwisseling en surplus productie kan worden herkend in het archeologisch bestand. Een aantal factoren bleek hierbij belangrijk, zoals leeftijdsopbouw en geslachtsverhoudingen, metrische en non-metrische variatie, distributie van skeletelementen alsmede stabiele isotopen analyse en DNA onderzoek. Een aantal van deze aspecten zijn onderzocht voor de dierlijke resten van Oegstgeest. Hieruit is gebleken dat er te Oegstgeest geen sprake was van de uitwisseling en surplus productie van dieren en dierlijke producten op grote schaal. Wel duiden de resultaten van het onderzoek op de mogelijke invoer van varkensvlees, rundvlees en zeevis.

## References

- Albarella, U., 1997. Shape variation of cattle metapodials: age, sex or breed? Some examples from mediaeval and postmediaeval sites. *Anthropozoologica* 25-26, 37-47.
- Armitage, P., 1982. A system for ageing and sexing the horncores from British post-medieval sites (17th to early 18th century) with special reference to unimproved British longhorn cattle. In: B. Wilson, C. Grigson and S. Payne (eds), *Ageing and Sexing Animal Bones from Archaeological Sites*. Oxford: British Archaeological Reports, 37-54 (BAR British series 109).
- Armitage, P.L. and J. Clutton-Brock, 1976. A system for classification and description of the horn cores of cattle from archaeological sites. *Journal of Archaeological Science* 3, 329-348.
- Ashby, S.P., 2004. Understanding Human Movement and Interactions through the Movement of Animals and Animal Products. In: M. Mondini, S. Muñoz and S. Wickler (eds), *Colonisation, Migration and Marginal Areas*. Oxford: Oxbow Books, 4-9 (Proceedings of the 9<sup>th</sup> Conference of the International Council of Archaeozoology, Durham, August 2002).
- Bartosiewicz, L., 2006. Skull formation in long horned cattle: the Hungarian Grey. In: U. Tecchiati and B. Sala (eds), *Studi di archeozoologia : in onore di Alfredo Riedel*. Balzano: Ripartizione Beni Culturali, Ufficio Beni Archeologici, 303-312.
- Bartosiewicz, L., W. van Neer and A. Lentacker, 1997. *Draught cattle: their osteological identification and history*. Tervuren: Koninklijk Museum voor Midden-Afrika (Annalen Zoölogische wetenschappen vol. 281).
- Bentley, R.A., 2006. Strontium isotopes from the Earth to the archaeological skeleton: a review. *Journal of Archaeological Method and Theory* 13(3), 135-187.
- Boessneck, J., 1956b. Ein Beitrag zur Errechnung der Widerristhöhe nach Metapodienmassen bei Rindern. *Zeitschrift für Tierzüchtung und Züchtungsbiologie* 68, 75-90.
- Boessneck, J., A. von den Driesch, U. Meyer-Lempken and E. Wechsler-von Ohlen, 1971. *Die Ausgrabungen in Manching: Die Tierknochenfunde aus dem Oppidum von Manching*. Wiesbaden: Steiner.
- Bond, J.M. and T. O'Connor, 1999. *Bones from Coppergate and Other Medieval sites*. London: Council for British Archaeology (Archaeology of York 15/5).
- Brannang, E., 1966. Studies on monozygous cattle twins, 18. The effect of castration and age of castration on the growth rate, feed conversion and carcass traits of Swedish red and white cattle, part 1. *Lantbruksbogs skolans Annaler* 32, 330-415.
- Brijker, J., 2011. Fysisch geografisch onderzoek. In: W. Jezeer (ed), *Een Merovingische nederzetting aan de monding van de Rijn*. Amersfoort: ADC ArcheoProjecten, 17-23 (ADC

Rapport 2054).

Bult, E.J. and D.P. Hallewas, 1990. Archaeological evidence for the early-medieval settlement around the Meuse and Rhine deltas up to ca AD 1000. In: J.C. Besteman, H.A. Heidinga (eds), *Medieval Archaeology in the Netherlands. Studies presented to H.H. van Regteren Altena*. Assen/Maastricht: van Gorcum, 71-90.

Bult, E.J. and D.P. Hallewas (eds), 1990. *Graven bij Valkenburg III. Het archeologisch onderzoek in 1987 en 1988*. Delft: Eburon.

Cavallo, C., 2006. De dierlijke resten. In: M. Hemminga and T. Hamburg (eds), *Een Merovingische nederzetting op de oever van de Oude Rijn. Opgraving (DO) en Inventariserend Veldonderzoek (IVO) Oegstgeest - Rijnfront zuid 2004*. Leiden: Archol, 73-81 (Archol rapport 69).

Cavallo, C., 2008. De dierlijke resten, in M. Hemminga and T. Hamburg (eds), *Vroeg Middeleeuwse nederzettingssporen te Oegstgeest. Een Inventariserend Veldonderzoek en Opgraving langs de Oude Rijn*. Leiden: Archol, 59-68 (Archol rapport 102).

Cavallo, C., M. van der Heiden and T. van Kolfschoten, 2008. Paleo-ecologie: de dierlijke resten uit de Romeinse tijd en de Vroege-Middeleeuwen in het noordelijke deel. In: H.M. van der Velde (ed), *Cananefaten en Friezen aan de monding van de Rijn : tien jaar archeologisch onderzoek op de Zanderij-Westerbaan te Katwijk (1996-2006)*. Amersfoort: ADC ArcheoProjecten, 353-371 (ADC Monografie 5 / ADC rapport 1456).

Cupere, B. de, A. Lentacker, W. van Neer, M. Waelkens and L. Verslype, 2000. Osteological Evidence for the Draught Exploitation of Cattle: First Applications of a New Methodology. *International Journal of Osteoarchaeology* 10, 254-267.

Davies, J., M. Fabis, I. Mainland, M. Richards and R. Thomas (eds), 2005. *Diet and health in past animal populations*. Oxford: Oxbow Books (Proceedings of the 9<sup>th</sup> Conference of the International Council of Archaeozoology, Durham, August 2002).

Davis, S.J.M., 2000. The Effect of Castration and Age on the Development of the Shetland Sheep Skeleton and a Metric Comparison Between Bones of Males, Females and Castrates. *Journal of Archaeological Science* 27, 373-390.

van Dijk, J., 1995. Zoöarcheologisch onderzoek van vroeg-middeleeuws botmateriaal uit de opgraving Hoogmadeseweg te Leiderdorp. *Westerheem* 44, 95-101.

Dijkstra, M.F.P., 2004. Between Britannia and Francia. The nature of external socio-economic exchange at the Rhine and Meuse estuaries in the Early Middle Ages. *Bodendenkmalpflege in Mecklen- burg-Vorpommern, Jahrbuch* 51, 397-408.

Dijkstra, M.F.P., 2006. Aardewerk. In: M. Hemminga and T. Hamburg (eds), *Een Merovingische nederzetting op de oever van de Oude Rijn. Opgraving (DO) en*

*Inventariserend Veldonderzoek (IVO) Oegstgeest - Rijnfront zuid 2004*. Leiden: Archol, 51-72 (Archol rapport 69).

Dijkstra, M.F.P., 2008. Aardewerk. In: M. Hemminga and T. Hamburg (eds), *Vroeg Middeleeuwse nederzettingssporen te Oegstgeest. Een Inventariserend Veldonderzoek en Opgraving langs de Oude Rijn*. Leiden: Archol, 59-68 (Archol rapport 102).

Dijkstra, M.F.P., 2011a. Aardewerk. In: W. Jezeer (ed), *Een Merovingische nederzetting aan de monding van de Rijn*. Amersfoort: ADC ArcheoProjecten, 45-56 (ADC Rapport 2054).

Dijkstra, M.F.P., 2011b. *Rondom de mondingen van de Rijn en Maas. Landschap en bewoning tussen de 3<sup>e</sup> en 9<sup>e</sup> eeuw in Zuid-Holland , in het bijzonder de Oude Rijnstreek*. Leiden: Sidestone Press.

Driesch, A. von den, 1976. *A guide to the measurement of animal bones from archaeological Sites*. Cambridge: Mass (Peabody Museum Bulletin 1).

Driesch, A. von den and J. Boessneck, 1974. Kritische Anmerkungen zur Widerristhöhenberechnung aus Längenmassen vor- und frühgeschichtlicher Tierknochen. *Säugetierkundliche Mitteilungen* 22, 325-348.

Fitzherbert, J., 1523. *The Book of Husbandry*. Southwark: Peter Treverys.

Grant, A., 1982. The use of tooth wear as a guide to the age of domestic ungulates, in B. Wilson, C. Grigson and S. Payne (eds), *Ageing and Sexing Animal Bones from Archaeological Sites*. Oxford: British Archaeological Reports, 91-108 (BAR British series 109).

Greenfield, H.J., 2006. Sexing fragmentary ungulate acetabulae. In: D. Ruscillo (ed), *Recent Advances in ageing and sexing animal bones*. Oxford: Oxbow Books, 68-86 (Proceedings of the 9<sup>th</sup> Conference of the International Council of Archaeozoology, Durham 2002).

Grigson, C., 1976. The Craniology and Relationships of Four Species of *Bos*. 3. Basic Craniology: *Bos taurus* L. Sagittal Profiles and other Non-measurable Characters. *Journal of Archaeological Science* 3, 115-136.

Grigson, C., 1982. Sexing Neolithic domestic cattle skulls and horncores. In: B. Wilson, C. Grigson and S. Payne (eds), *Ageing and sexing animal bones from archaeological sites*. Oxford: British Archaeological Reports, 25-35 (BAR British series 109).

Groot, M., 2005. Palaeopathological evidence for draught cattle on a Roman site in the Netherlands. In: J. Davies, M. Fabis, I. Mainland, M. Richards and R. Thomas (eds), *Diet and health in past animal populations*. Oxford, Oxbow Books, 52-57 (Proceedings of the 9<sup>th</sup> Conference of the International Council of Archaeozoology, Durham, August 2002).

- Groot, M., 2008a. *Animals in ritual and economy in a Roman frontier community: excavations in Tiel-Passewaaij*. Amsterdam: Amsterdam University Press.
- Groot, M., 2008b. Surplus production of animal products for the Roman army in rural settlement in the Dutch River Area. In: S. Stallibrass and R. Thomas (eds), *Feeding the Roman army. The Archaeology of production and supply in NW Europe*. Oxford: Oxbow Books, 83-98.
- Groot, M., 2010. *Handboek Zoöarcheologie*. Amsterdam: ACVU-HBS.
- Hambleton, E., 1999. *Animal Husbandry Regimes in Iron Age Britain. A comparative study of faunal assemblages from British Iron Age sites*. Oxford: Archaeopress (BAR British Series 282).
- Hamburg, T. and M. Hemminga, 2007. Vroegmiddeleeuwse handel aan de Rijnmonding 550-750 n.Chr. In: R. Jansen & L.P. Louwe Kooijmans (eds), *Van contract tot wetenschap. Tien jaar archeologisch onderzoek door Archol BV, 1997-2007*. Leiden: Archol, 293-308.
- Hemminga, M., T. Hamburg, M. Dijkstra, C. Cavallo, S. Knippenberg, C.C. Bakels, W. Groenman-van Waateringe, M. Hoogland, P. van Rijn, C. Vermeeren en W. van Zijverden 2006. *Een Merovingische nederzetting op de oever van de oude Rijn. Opgraving (DO) en Inventariserend Veldonderzoek (IVO), Oegstgeest-Rijnfront zuid 2004*. Leiden: Archol (Archol rapport 69).
- Hemminga, M., T. Hamburg, M. Dijkstra, C. Cavallo, S. Knippenberg, S.M.E. van Lith, C.C. Bakels en C. Vermeeren 2008. *Vroeg Middeleeuwse nederzettingssporen te Oegstgeest. Een Inventariserend Veldonderzoek en Opgraving langs de Oude Rijn*. Leiden: Archo (Archol rapport 102).
- Hessing, W.A.M., 1992. Bewoningssporen uit de Vroege-Middeleeuwen op de grens van Leiden en Oegstgeest. In: L. Barendregt and H. Suurmond- Van Leeuwen (eds), *Bodemonderzoek in Leiden 13/14*, 102-109.
- Higham, C. F. W., 1969. The metrical attributes of two samples of bovine limb bones. *Journal of Zoology, London* 157, 63-74.
- Howard, M.M., 1961. The early domestication of cattle and the determination of their remains. *Zeitschrift für Tierzüchtung und Züchtungsbiologie* 76, 252-264.
- Howard, M.M., 1963. The metrical determination of the metapodials and skulls of cattle. In: A.E. Mourant and F.E. Zeuner (eds), *Man and cattle: proceedings of a symposium on domestication at the Royal Anthropological Institute, 24-26 May 1960*, London: Royal Anthropological Institute of Great Britain & Ireland, 91-100.
- IJzereef, G.F., 1981. *Bronze Age animal bones from Bovenkarspel: The excavations at Het Valkje*. Amersfoort: ROB (Nederlandse Oudheden 10).

- Jagt, I.M.M. van der, 2011. Archaeozoologisch onderzoek. In: W. Jezeer (ed), *Een Merovingische nederzetting aan de monding van de Rijn*. Amersfoort: ADC ArcheoProjecten, 95-112 (ADC Rapport 2054).
- Jezeer, W. (ed), 2011. *Een Merovingische nederzetting aan de monding van de Rijn*. Amersfoort: ADC Archeoprojecten (ADC Rapport 2054).
- Johansson, F. and H. Hüster, 1987. *Untersuchungen an Skelettresten von Katzen aus Haithabu (Ausgrabung 1966-1969)*. Neumünster: Karl Wachholtz.
- Kerklaan, F., 2012. *De vis van Oegstgeest (OSLP-10 & ONRZ 1255)*. Leiden: (Unpublished internship report University of Leiden).
- Knippenberg, S., 2006. Steenmateriaal. In: M. Hemminga and T. Hamburg (eds), *Een Merovingische nederzetting op de oever van de Oude Rijn. Opgraving (DO) en Inventariserend Veldonderzoek (IVO) Oegstgeest - Rijnfront zuid 2004*. Leiden: Archol, 82-93 (Archol rapport 69).
- Knippenberg, S., 2008. Natuursteen. In: M. Hemminga and T. Hamburg (eds), *Vroeg Middeleeuwse nederzettingssporen te Oegstgeest. Een Inventariserend Veldonderzoek en Opgraving langs de Oude Rijn*. Leiden: Archol, 69-77 (Archol rapport 102).
- Kooistra, L.I., 2011. Hout. In: W. Jezeer (ed), *Een Merovingische nederzetting aan de monding van de Rijn*. Amersfoort: ADC ArcheoProjecten, 57-63 (ADC Rapport 2054).
- Larson, G., K. Dobney, U. Albarella, M. Fang, E. Matisoo-Smith, J. Robins, S. Lowden, H. Finlayson, T. Brand, E. Willerslev, P. Rowley-Conwy, L. Andersson and A. Cooper, 2005. Worldwide phylogeography of wild boar reveals multiple centers of pig domestication. *Science* 307, 1618–1621.
- Larson, G., T. Cucchi, M. Fujita, E. Matisoo-Smith, J. Robins, A. Anderson, B. Rolett, M. Spriggs, G. Dolman, T. Kim, N. Thi Dieu Thuy, E. Randi, M. Doherty, R. Awe Due, R. Bollt, T. Djubiantono, B. Griffin, M. Intoh, E. Keane, P. Kirch, K. Li, M. Morwood, L.M. Pedriña, P.J. Pipers, R.J. Rabett, P. Shooter, G. van den Bergh, E. West, S. Wickler, J. Yuany, A. Cooper, and K. Dobney, 2007. Phylogeny and ancient DNA of *Sus* provides insights into neolithic expansion in Island Southeast Asia and Oceania. *Proceedings of the National Academy of Sciences of the United States of America* 104(12), 4834–4839.
- Larson, G., U. Albarellad, K. Dobney, P. Rowley-Conwy, J. Schibler, Anne Tresset, J. Vigneg, C.J. Edwards, A. Schlumbaum, A. Dinu, A. Bălăçescu, G. Dolman, A. Tagliacozzo, N. Manaseryan, P. Miracle, L. Van Wijngaarden-Bakkero, M. Masseti, D.G. Bradley, and A. Cooper, 2007. Ancient DNA, pig domestication, and the spread of the Neolithic into Europe. *Proceedings of the National Academy of Sciences of the United States of America* 104(39), 15276–15281.

- Lauwerier, R.C.G.M., 1997. *Laboratorium protocol archeozoölogie*. Amersfoort: ROB.
- Levitan, M.B., 1987. Medieval animal husbandry in south-west England: a selective review and suggested approach. In: N.D. Balaam, B. Levitan and V. Straker (eds), *Studies in Palaeoeconomy and environment in South West England*. Oxford, British Archaeological Reports, 51-80 (BAR British series 181).
- Luff, R.M., 1994. The Conundrum of Castration in the Archaeological Record: an Interpretation of Roman Cattle Horn-cores from Chelmsford, Essex. *International Journal of Osteoarchaeology* 4, 171-192.
- Maltby, J.M., 1985. Patterns in Faunal Assemblage Variability. In: G. Barker and C. Gamble (eds), *Beyond domestication in Prehistoric Europe. Investigations in Subsistence Archaeology and Social Complexity*. London: Academic Press, 33-74.
- Melkert, M., 2011. Natuursteen. In: W. Jezeer (ed), *Een Merovingische nederzetting aan de monding van de Rijn*. Amersfoort: ADC ArcheoProjecten, 87-93 (ADC Rapport 2054).
- Nooijen, C., 2011. Metaal. In: W. Jezeer (ed), *Een Merovingische nederzetting aan de monding van de Rijn*. Amersfoort: ADC ArcheoProjecten, 75-77 (ADC Rapport 2054).
- O'Connor, T., 1993. Process and terminology in mammal carcass reduction. *International Journal of Osteoarchaeology* 3, 63-67.
- O'Connor, T., 2000. *The Archaeology of Animal Bones*. Stroud: Sutton.
- Pestell, T. and K. Ulmschneider (eds), 2003. *Markets in Early Medieval Europe. Trading and 'Productive' Sites, 650-850*. Macclesfield: Windgather Press.
- Pöllath, N. and J. Peters, 2005. On the possible use of the LSI scaling technique for stature analysis in cattle. *Revue de Paléobiologie, Genève* 10, 225-235.
- Prummel, W., 1983: *Excavations at Dorestad, Early medieval Dorestad an archaeological Study*. Amersfoort: ROB (Nederlandse Oudheden 11).
- Reitz, E. and E. Wing, 2008. *Zooarchaeology*. Cambridge: Cambridge University Press.
- Sablerolles, Y., 1990. Het dierlijk botmateriaal uit de vroege Middeleeuwen afkomstig van de nederzetting op de Woerd te Valkenburg (Z.H.). Een voorbeschouwing. In: E.J. Bult en D.P. Hallewas (eds), *Graven bij Valkenburg III. Het archeologisch onderzoek in 1987 en 1988*, Delft: Eburon, 167-173.
- Spennemann, D.R., 1985. Vorschlag für ein neues ergänzendes System zur Präsentation zooarchäologischer Daten. *Archäologisches Korrespondenzblatt* 15, 397-403.

- Stalibrass, S. and R. Thomas, 2008. *Feeding the Roman army : the archaeology of production and supply in NW Europe*. Oxford: Oxbow Books.
- Sykes, N. and R. Simmons, 2007. Sexing Cattle Horn-cores: Problems and Progress. *International Journal of Osteoarchaeology* 17, 514-523.
- Telldahl, Y., E.M. Svensson, A. Götherström and J. Storå, 2011a. Osteometric and molecular sexing of cattle metapodia. *Journal of Archaeological Science* 39, 121-127.
- Telldahl, Y., E.M. Svensson, A. Götherström and J. Storå, 2011b. Typing Late Prehistoric Cows and Bulls—Osteology and Genetics of Cattle at the Eketorp Ringfort on the Öland Island in Sweden. *PLoS ONE* 6(6), 1-8.
- Thomas, R. N. W., 1988. A statistical evaluation of criteria used in sexing cattle metapodials. *Archaeozoologia*, II ( I , 2), 83-92.
- Vermeeren, C., 2008. Hout. In: M. Hemminga and T. Hamburg (eds), *Vroeg Middeleeuwse nederzettingssporen te Oegstgeest. Een Inventariserend Veldonderzoek en Opgraving langs de Oude Rijn*. Leiden: Archol, 87-95 (Archol rapport 102).
- Vermeeren, C. and P. van Rijn, 2006. Hout. In: M. Hemminga and T. Hamburg (eds), *Een Merovingische nederzetting op de oever van de Oude Rijn. Opgraving (DO) en Inventariserend Veldonderzoek (IVO) Oegstgeest - Rijnfront zuid 2004*. Leiden: Archol, 96-107 (Archol rapport 69).
- Viner, S., J. Evans, U. Albarella and M. Parker Pearson, 2010. Cattle mobility in prehistoric Britain: strontium isotope analysis of cattle teeth from Durrington Walls (Wiltshire, Britain). *Journal of Archaeological Science* 37, 2812-2820.
- Wilson, B., C. Grigson and S. Payne (eds), 1982. *Ageing and sexing animal bones from archaeological sites*. Oxford. Oxford: British Archaeological Reports (BAR British Series 109).

## List of figures

1. Merovingian settlements in the delta of the Old Rhine (After Bult and Hallewas 1990, 71) Although this map dates from 1990, it has been cross-referenced with a more recent map published by M. Dijkstra (Dijkstra 2011b, 85) (page 7).
2. Location of the excavation site in Oegstgeest (marked by the star) (Hemminga and Hamburg 2006, 7) (page 9).
3. Preliminary overview of the excavated settlement features at Oegstgeest Nieuw-Rhijngest Zuid (After Dijkstra 2011b, 135) (page 10) (page 10).
4. This picture illustrates the differences in morphology between the ilio-pubic ridge of male and female cattle (Greenfield 2006, 71) (page 26).
5. This picture shows how and where to take the 'H1' measurement discussed by Greenfield (After Greenfield 2006, 73) (page 27).
6. Complete metacarpals (at the top) and metatarsals from Oegstgeest. In order to try and create a picture of sexual dimorphism the metapodials have been arranged according to size and shape with short and slender specimens to the left and broader specimens to the right (Photo's by the author) (page 29).
7. A cattle acetabulum from Oegstgeest showing a pathology (right) shown next to a specimen from the reference collection that does not display any pathologies (Photo by the author) (page 36).
8. The proximal surface of a metatarsus showing degeneration of the articulation surface and exotoses (Photo by the author) (page 37).
9. A distal metacarpus showing extreme widening of one of the distal condyles (Photo by the author).
10. Fragment of a vertebrae from a marine mammal, possibly a whale (Photo by the author) (page 40).
11. Age distribution created using dental remains from cattle. This diagram was ceated using data generated by the author in combination with data from previous publications (Cavallo 2006, 76; Cavallo 2008, 63; van der Jagt 2011, table 2) (page 41).
12. Age distribution created using post-cranial remains from cattle. This diagram was created using data generated by the author in combination with data from previous publications (Cavallo 2008, 62. Data from the 2009 excavation was kindly provided by I. van der Jagt) (page 41).
13. Age distribution created using dental remains from pigs. This diagram was ceated using data generated by the author in combination with data from previous publications (Cavallo 2008, 65; van der Jagt 2011, table 10) (page 44).
14. Age distribution created using post-cranial remains from pigs. This diagram was ceated using data generated by the author in combination with data from previous publications (Cavallo 2008, 64; van der Jagt 2011, table 11) (page 44).
15. Age distribution created using post-cranial remains from sheep/goat. This diagram was ceated using data generated by the author in combination with data from previous publications (van der Jagt 2011, table 7) (page 45).
16. Measurements for 'H1' for Bos Taurus acetabulae as presented by Greenfield (Greenfield 2006, 80) (page 48).
17. Measurements for 'H1' for the selected Oegstgeest cattle acetabulae. The interpretation

- of female (F) and male (M) individuals is based on the height of 'H1' (page 48).
18. Measurements for 'H1' for the selected Oegstgeest cattle acetabulae. The interpretation of female (F) and male (M) individuals is based on visual criteria. '?' indicates it was impossible to sex a specimen visually (page 49).
  19. Distal width for metacarpals and metatarsals (page 51).
  20. Combined distal widths for metacarpals and metatarsals (Mc = metacarpus, Mt = metatarsus) (page 51).
  21. GL plotted against  $(Bp*100)/GL$  for complete metacarpals (page 52).
  22. GL plotted against  $(Bp*100)/GL$  for complete metatarsals (page 52).
  23. Breadth of lateral condyle plotted against the breadth of the medial condyle for metacarpals (marked as squares) and metatarsals (marked as diamonds) (page 53).
  24. Number of Oegstgeest horncores assigned to each age class (age classes after Armitage 1982, 38-41) (page 57).
  25. Basal circumference plotted against smallest diameter of the horncore base for horncores of which the outer curve could not be measured (young-adult specimen are marked as red circles) (page 58).
  26. Basal circumference plotted against smallest diameter of the horncore base for specimens that were classified as 'small horned' (one young-adult specimen is marked as a red circle) (page 60).
  27. Basal circumference plotted against smallest diameter of the horncore base for specimens that were classified as 'short horned' (one young-adult specimens is marked as a red circle) (page 60).
  28. Skeletal element abundance of cattle remains from Oegstgeest presented according to the method developed by Spennemann (1985) (page 64).
  29. Skeletal element abundance of pig remains from Oegstgeest presented according to the method developed by Spennemann (1985) (page 65).
  30. Skeletal element abundance of sheep/goat remains from Oegstgeest presented according to the method developed by Spennemann (1985) (page 66).

### **List of tables**

1. Species list for the Oegstgeest assemblage. This table was created by combining data from the assemblage studied by the author with the data from previous publications (Cavallo 2006, 74; Cavallo 2008, 60; van der Jagt 2011, 99) (page 32).
2. Species list for studied fish remains from Oegstgeest (After Kerklaan 2012, 6-10) . Data on number of elements per species were kindly provided by F. Kerklaan. The habitats presented in this table are very general and are just to provide an indication of where these fish can be found (page 34).
3. Number of elements and percentages for the fish remains that could be identified to species level by F. Kerklaan. This shows that most of the fish that was identified could have been caught in the direct vicinity of the settlement (page 35).
4. Number of marks per species. This table includes data from the material studied by the author as well as data from previous publications (Cavallo 2006, 75; Cavallo 2008, 61) (page 39).
5. Withers height for Oegstgeest cattle. Multiplication factors suggested by von den Driesch

and Boessneck (1974) were used: 6.15 for the metacarpus and 5.45 for the metatarsus. (GL = greatest length) (page 55).

6. Withers heights for cattle from Dorestad (After Prummel 1983, 171). Prummel used multiplication factors suggested by von den Driesch and Boessneck (1974) (page 56).

7. Selected Oegstgeest horncores for each size class proposed by Sykes and Simmons (After Sykes and Simmons 2007, table 1) (page 57).