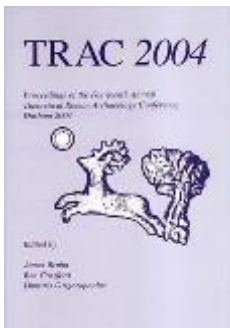

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Interaction and exchange in food production in the Nijmegen Frontier Area during the Early Roman Period

Annemiek Robeerst

Introduction

The subject of this study focuses on the bone material found while excavating the Pre-Flavian settlement of *Oppidum Batavorum,* the predecessor of the civitas capital *Ulpia Noviomagus* that developed in Nijmegen following the Batavian Revolt in 69/70 A.D. For the greatest part of the twentieth century, the Nijmegen region has been the object of intensive study by scientists from several archaeological research institutions (e.g. Bogaers 1979: 18–23; Bloemers 1983, 1989a, 1989b; v. Enckevort and Thijssen 2000, idem 2001; v. Enckevort *et al*. 2000; Lauwerier 1988; Willems 1990: 31–34; Willems *et al*. 1982: 34).

The main research questions archaeozoology deals with for the Roman Period is the impact of the incorporation of the region in the Roman Empire, and changes caused by the process of Romanisation concerning food supply, dietary habits, stock breeding and trade circuits, on regional as well as interregional scales.

Focusing on *Oppidum Batavorum*, the nature and function of the settlement is still rather vague. The present consensus for the settlement is that of a Roman founded civil centre for the newly created *Civitas Batavorum*: the layout, infrastructure, buildings, and pottery are not of native tradition (Bloemers 1990). Analysis of the bone material found in *Oppidum Batavorum* has also indicated that a (Gallo) Roman population, already more 'Romanised' with regard to dietary habits and animal husbandry probably inhabited the settlement (Lauwerier 1988: 21–26, 51). Being one of the earliest Roman settlements in the Nijmegen area, *Oppidum Batavorum* was most likely one of the driving forces responsible for the process of urbanisation that occurred with the creation of the *Civitas Batavorum*. However, indications exist that already from the Augustan phase onwards, the animal husbandry system and the handling of animals in the region had changed which resulted in intensification, interaction, and exchange toward a market orientation of the system. The objective of this research was to see which changes in this early occupation stage could be documented on several issues, such as consumption patterns (section A) and livestock improvements (section B). The results of this study may provide more insight in the regional development of animal husbandry during the incorporation into the Roman Empire.

Method and provenance

The sample derives from the Valkhof area in Nijmegen, known as *Oppidum Batavorum*. The animal bones from most contexts were collected by hand. Several samples were taken and wet-sieved (mesh size 0.5 mm). The preservation of the bones was moderate, probably due to the acidic conditions of the soil. All animal bones derive from the fill of pits, ditches, cellars and wells. The selection of material for the analysis was based on the artefact survey lists and the field drawings maintained by the National Service. In accordance to these lists, several features were selected following a number of criteria. Firstly, datable stamped Terra Sigillata had to be

present. Secondly, the feature had to contain a minimum of five bone specimens. Finally, there need to be an absence of any intrusive objects from other periods. To enlarge the sample, the archaeozoological data of the *Oppidum Batavorum* sample was combined with data from an earlier study from the same area (Lauwerier 1988: 50–51, sample Nijmegen Ib-Ic).

The mammal bones were determined and recorded using the reference collection and the Archaeozoology Laboratory Protocol (Lauwerier 1997) of the National Service for Archaeological Heritage. As the bones from sheep and goats resemble each other in many ways, they were combined into a single sheep/goat category. Given that during the Roman Period not only horses, but also mules and donkeys may be present, and the great similarity between their bones, these animals are referred to in the Table as *Equus sp*., and in the text as 'horse'.

All bones were recorded, weighed, and counted. Fragments that could be designated to one bone element were allocated in the counts, as were all associated elements from a single individual. After adding, the species distribution was determined.

Ages at slaughter were determined using the data on epiphyseal fusion depicted by Habermehl (1975). Wear stages were recorded for all lower molars of cattle, caprines and pig, both isolated and in mandibles. Tooth wear stages follow several methods (Higham 1967; Silver 1969; Grant 1982). For horse, the crown height measurements described by Levine (1982) were used.

Measurements in general follow Von den Driesch (1976), and were supplemented by Johnstone (in prep.). For the calculation of withers heights, several factors for the various complete bones were used for cattle (Von den Driesch and Boessneck 1974; Matolcsi 1970). For horse, the factors described by May (1985) were used.

In order to investigate whether the differences between the species frequencies were caused by accidence, or other factors, in some cases a ^{2} test (without a priori hypothesis, calculated for the 0.05 significance level) was used for determining any degree of significance. To ascertain distinctions and trend increases in withers heights, a one-sided t-test, where

$$t = \frac{\overline{x_1} - \overline{x_2}}{S_{\overline{x_1} - \overline{x_2}}}$$

, based on pooled variance estimates and a 0.05 significance level, was used (Shennan 1997).

Results and discussion

In total, 4045 hand-collected specimens with a weight of 101.73 kg were included in the analysis. From this quantity, 2273 specimens (56.2% in total, equalling 83.7% in bone weight) were identified to taxon level; (see appendix 1). Cattle and pig are by far the most common species recovered in *Oppidum Batavorum*, which corresponds well with sites influenced by the Roman tradition. In addition, the variation in animal consumption of game, birds such as domestic fowl, fish, and seafood also fits the general pattern of "Roman" settlements within the Empire (Benecke 1994; Peters 1998).

Section A: Consumption patterns. The general trend for the animal utilization is an increase in pork consumption in areas and settlements under Roman influence. We shall first zoom in on the species alterations observed within the transition of Ia (0–25 A.D.), Ib (25–50 A.D.) and Ic (50–75 A.D.) time increments in both *Oppidum Batavorum* and nearby *Atuatuca Tungrorum* / Tongres in Belgium (e.g. Ervynck and Vanderhoeven 1992), as is demonstrated in Fig. 1. Secondly, changes that appeared in and around the region after the transition of the Late Iron Age into the following Early Roman period are discussed. An overview of site comparisons is listed in appendix 2 and 3, grouped in sections A-G.

Before comparing general level changes, some remarks on the characteristics of the various site groups must be made. Even within a region, variable species representation values are discernable (see appendix). These differences are probably caused by the dissimilar physical and social circumstances that occur between sites and regions. Also, the moment of incorporation of a region and the intensity of Roman influences is an important factor: *Gallia* was "pacified" in the first Century B.C., the adjacent Germanic territories several decades later. Consequently, when comparing groups of non-homogeneous sites, no absolute statements are possible.

Food preferences and species distribution differences become visible when the sites of *Oppidum Batavorum* and *Atuatuca Tungrorum* / Tongres are compared (see Fig. 1). During the Late Iron Age, the rural settlements in the Nijmegen River Area display the typical Iron Age distribution. For the surrounding rural area of Tongres, the distribution is quite the opposite; this is especially true in the case of the pig values which were almost threefold the value of the River Area. Evidently, this distribution quite fits within the Gallo-Celtic species preference displayed in category B of appendix 2. For *Oppidum Batavorum*, the trend towards more pork and less beef consumption becomes evident during the shift from the Late Iron Age into the Augustan period, and remained high in the Tiberian-Claudian and Neronean phases. For *Atuatuca Tungrorum*, the starting point is different from the situation of *Oppidum Batavorum*, but an alteration in consumption preferences is obvious here as well. During the first half century A.D., the species distributions of *Oppidum Batavorum* and Tongres start to converge, but were still found different at the 0.001 significance level: ($^2 = 32.528$, $\nu = 2$, $\alpha < 0.001$). In both sites, pork consumption increases at the cost of the cattle consumption in *Batavorum*, whereas sheep/goat consumption declines in Tongres. In the Ib-Ic Claudian-Neronian period, the pattern differences no longer appear significant ($^2 = 3.442$, $\nu = 2$, $\alpha > 0.01$). Obviously, the shifts in species preferences can be followed through the separate time-increments in the Pre-Flavian period.

It is possible that a segment of the inhabitants who over time populated both settlements shared many habits and preferences, maybe their origins or roots emanate from the same region in *Gallia Belgica*. However, when the total values for *Oppidum Batavorum* and *Atuatuca Tungrorum* are compared (see appendix 3: E1 and E2), the differences in values appear significant ($^2 = 17.989$, $\nu = 2$, $\alpha < 0.001$), but this significance is mostly caused by the major difference of 4% for sheep/goat. The consumption value for pig is in these two northern urban sites almost twice as high as in the surrounding rural river area sites.

To assess the consumption patterns in the Pre-Flavian period, general species distributions between the Late Iron Age sites in the Dutch River Area in *Germania* (appendix 2 section A), and *Gallia Belgica* (appendix 2 section B) were established. Unlike *Germania*, in *Gallia* the local circumstances and preferences clearly favour more pork consumption in the Late Iron Age. With the transition into the Early Roman period, apparently, no changes in the

consumption patterns of rural settlements (G) were observed, but this may be deceptive (as argued in a later section). However, with the establishment of Roman settlements, other patterns seem to appear. The diversification in pork consumption appears consistent to the degree of Romanisation, status and wealth of the settlement: from top down the range are military sites (C), civil towns (E), villae (F) and *vici* (D). The rural sites (G) have yielded the lowest pig values.

The higher level of pork consumption in the civil/urban centres as is shown in *Oppidum Batavorum* (E1) may be due to several factors. Firstly, it can be associated with archaeological indicators of high status or wealth, probably because of the development of the settlement within a trade and exchange network (Grant 2002: 18). Located near the Waal river and several miles behind the Limes, *Oppidum Batavorum* lay at a cross point of a waterway and roads, connecting the town with settlements like Trier, Tongres and Xanten, and the western Limes towards *Britannia*. Finds of Type Dressel 2-5 wine- and olive oil amphorae sherds (Bloemers 1990) indicate *Oppidum Batavorum* used a supply network reaching as far as the western Mediterranean region that was spreading north since the late first century B.C. onwards.

Obviously, the inhabitants of *Oppidum Batavorum* and other towns alike could afford a more luxurious diet that greatly differs to that of the local tribes that shows a pig percentage of less than 11% in general. The same depiction is shown in the neighbouring area of *Gallia Belgica*: some of the highest proportions of pig bones for the Late Iron Age are found at settlements whose material remains suggest participation in extensive trade networks: the oppida of Variscourt and Villeneuve St. Germain (B) both show pig values which exceed 60%. A similar pattern was registered in *Britannia*, where the oppida at Silchester (Hampshire) and Skeleton Green (Essex) demonstrated a wide range of imported materials, and higher pig bone proportions than found in contemporary sites within their regions (Grant 2002). These proportions sharply contrast with the values for their surrounding rural sites, which stay below 39% for pig remains. Secondly, the possibility of a food preference must be considered here, which is also expressed in regional diversity.

Linking this urban preference of pork to a local supply and market system for *Oppidum Batavorum* based on species representation alone is somewhat problematic due to the limited number of available rural sites in the region. Since any surplus commodity generally moves away from the production sites to be sold at the town markets, any increase in pig breeding in rural sites is difficult to ascertain, as the bones are found in the consumption sites, not the production sites. However, an increasing demand in nearby urban centres creates opportunities for local farmers, to increase their pig breeding facilities with relatively little effort. Columella (VII.9.4) mentions two different regimes, a single farrowing one for farms in out-of-the-way districts, and a second farrowing one for the *fundus suburbanus*, with its close proximity to the city market. The aim for these farmers is to turn a second litter in one year into cash on the market (White 1970). Since the majority of the pigs probably came from the surrounding areas, the forthcoming pig slaughter ages from rural sites will help to answer this question. Other signs for second farrowing regimes like dental hypoplasia on pig teeth, which mark food shortages in the pigs' first winter and thus the birth season (Dobney *et al*. 2002), may provide indications on breeding intensification for a trade or market system, which may even have had frequent trading contacts with nearby *Gallia* (Robeerst in prep.). When combined with data on stock improvements, interaction and exchange between the urban sites and the rural settlements may become more explicit.

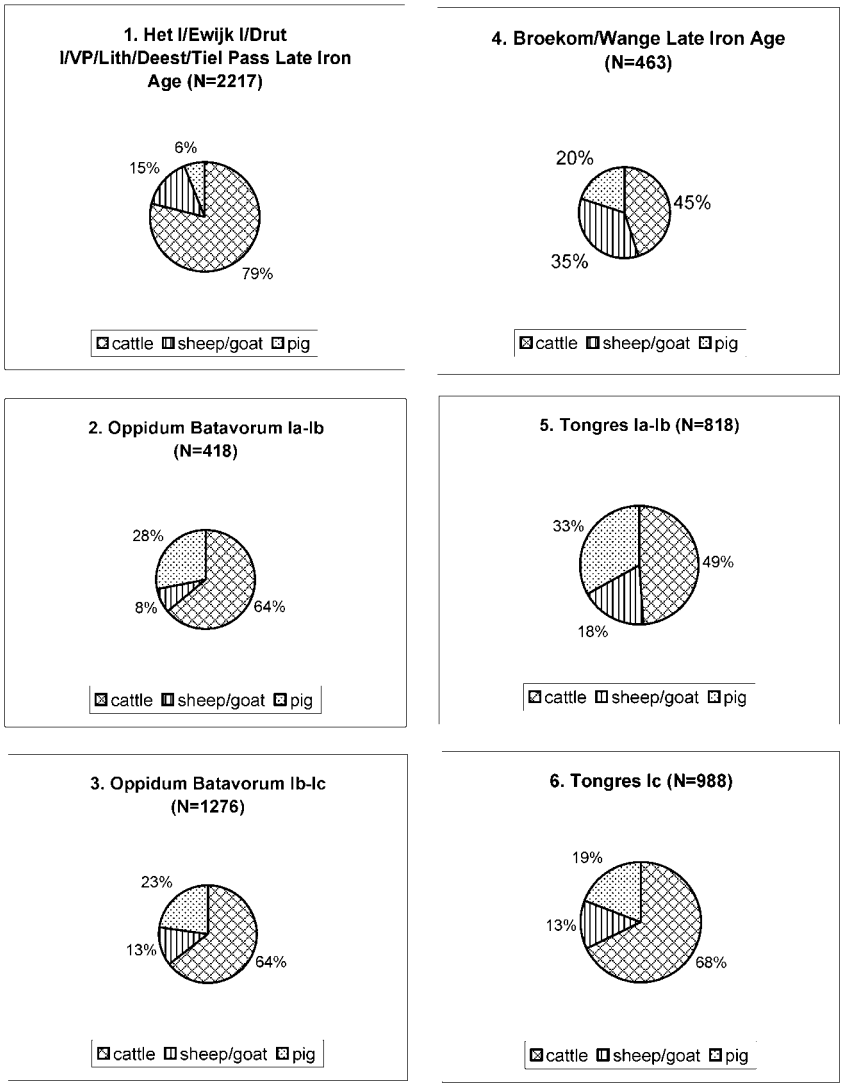

Fig. 1: Oppidum Batavorum and Tongres species distribution comparisons. For site indications, see captions of appendix 2 and 3. After: Robeerst (in prep.)

Section B: Livestock improvements. The estimated calculation of an animals' withers height provides an indication of body size. The use of a multiplying factor provides only an *estimated* body height, but since we are interested in average withers height alterations between groups or populations, the potential error that results from using a multiplying factor is neutralised. The increase in average body sizes of farm animals in the Roman period is probably caused by the introduction of improved stockbreeding practices by the Romans, as generally described in the agrarian works of several classical authors (c.f. Columella; Varro;

Pliny). This aspect has therefore in general been regarded as an effect of Romanisation (Benecke 1994: 188–193; Lauwerier 1988, 1999b; Lauwerier and Robeerst 2001; Peters 1998: 48–59, 150–153). The reason for using withers heights to establish livestock improvements instead of other measurements (e.g. distal metapodial breadth) is that this estimation is less sex related. The distal breadth of a metapodial bone is relatively more directly influenced by the heavier body mass of a male animal than the length of the bone. The length ratio of the metapodials within the limbs is more related to species than to sex, which makes this a better indicator for possible cattle improvements.

For the estimation of the withers heights for cattle, most available bones in the sample consisted of several metapodials, four tibiae, and one radius. The results were combined with the measurements from Lauwerier (1988); which comprised three metatarsals from Nijmegen Ib-Ic, thus resulting in 42 measured specimens. Additionally, the results of the measurements from several other sites were listed for comparison, including sites from the Late Iron Age. In total, the sample contained 406 measured specimens; the distribution is listed in Fig. 2. The total summed values of the *Oppidum Batavorum* Ia, Ia–Ib, Ib–Ic and Ia–Ic time increment sections are listed in Total Nijmegen 0–70 AD.

After the Late Iron Age, both range and mean in withers height of cattle tend to increase considerably in *Gallia Belgica* and the *Germania* territory. In *Gallia Belgica*, especially the range values have increased to such an extent, that the variances of the two populations from the Late Iron Age (2) and the Pre-Flavian period (9) are not equal ($F = 1.777$, $p \approx 1.650$) for the 0.05 level of significance.

The mean value of 117 cm for the sample of *Oppidum Batavorum* (6) has increased even more significantly when compared with Late Iron Age *Germania* (1) value of 106.9 cm ($t = 10.97285$, df = 58, $\alpha < 0.0005$, $F = 1.145695$, $p = 2.90$). Moreover, the increase of withers height displayed in *Oppidum Batavorum* Ia in the first two decades A.D., is also visible in the minimum values for the early military complexes (Ia Traianusplein, Kops Plateau/Oberaden), and even *Oppidum Batavorum* Ia–Ib. It is noteworthy that all slaughtered animals stood at least 110 cm, smaller indigenous animals of 93–110 cm are lacking up to this point. In contrast, these smaller animals are present in the civilian towns of Tongres, Xanten, Magdalensberg and the more general phase of *Oppidum Batavorum* Ia–Ic. Two possible explanations may elucidate this anomaly in withers height. On the one hand, these sites may have purchased a negative selection for animals considered too small for adequate meat purveyance during the first stages of occupation. On the other hand, due to the limited number of finds, the category of smaller animals may just be absent. This also explains why a smaller animal of 103.6 cm is present in Valkenburg, while again this group is lacking in the rural sites of Wijk bij Duurstede and Tiel Passewaaij. To summarize, it was demonstrated that mean cattle sizes in both *Gallia Belgica* and *Germania* increased in the Early Roman period. In addition, the mean cattle size in *Gallia* exceeds that of the values for Germanic cattle. Cattle found in military settlements and *Oppidum Batavorum* are also larger than cattle found in Late Iron Age *Germania*, and rural sites; but in the region the overall size increase of almost 10 cm starts from the first decades of the first century A.D. onwards. Also, the specimens from the Pre-Flavian rural sites are larger than the average found in Iron Age rural sites. Though the mean cattle size of *Oppidum Batavorum* surpasses the cattle from Xanten, it is interesting to see that the mean size equals the cattle values found in Tongres. One possible explanation may be that some import of

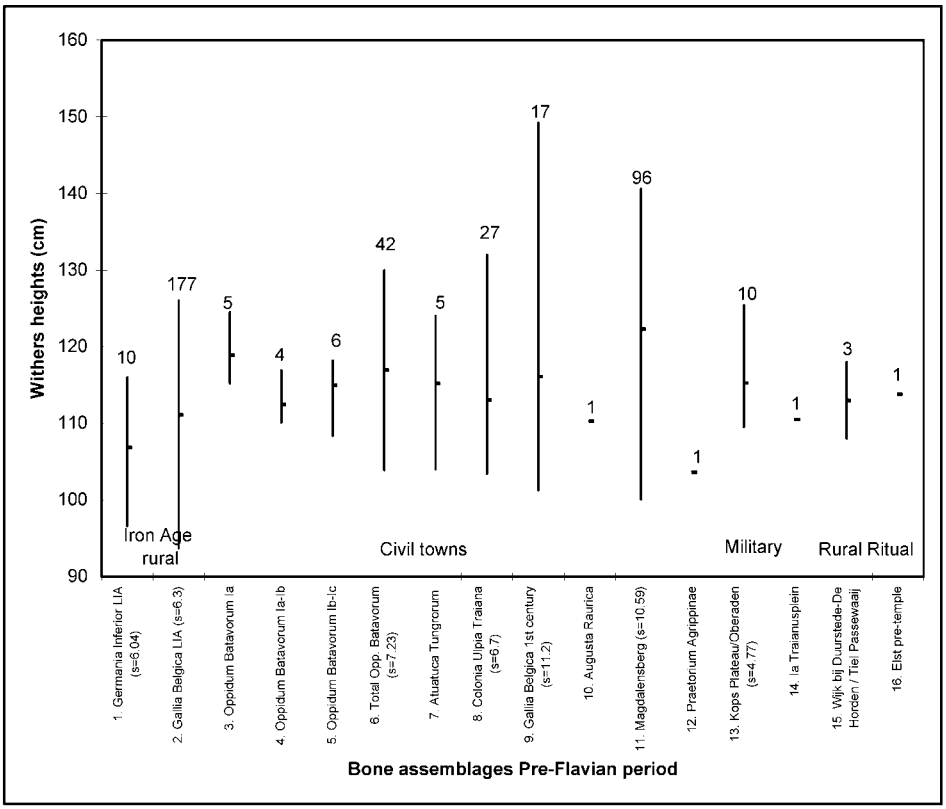

Fig. 2: Cattle estimated withers heights per bone assemblage, Pre-Flavian Period. Note: the bone assemblages are grouped by nature of the site (rural, civil, military, ritual), and numbered for text indication. Indicated are: min, max, mean and standard deviation. After: Robeerst (in prep.) Site information: Late Iron Age Germania Inferior: Laarman 1996, 343–356, 369–376: Houten-Tiellandt, Wijk bij Duurstede-De Horden; Lauwerier 1988, 90–92, 95–111: Heteren I, Druten I; Berke 1999, 98–104: Aldenhovener Platte sites Eschweiler-Laurenzberg, Eschweiler-Lohn, Aldenhoven-Siersdorf; Prummel 1989, 235-265: Voorne-Putten site 17–36; Roymans, Lith North-Brabant (unpublished report); Whittaker 2003, 172–177: Deest. Late Iron Age Gallia Belgica: Lepetz 1996, 39 table LXI. Early Roman Period: Lauwerier 1988, 166–169: Nijmegen, Ib–Ic; Vanderhoeven et. al. 1992, 107–133: Atuatuca Tungrorum; Waldmann 1967, Schwarz 1989: Colonia Ulpia Traiana; Breuer et. al. 1999, 207–228: Augusta Raurica; Hildebrandt 1966, Hornberger 1970: Magdalensberg; Prummel 1974: Valkenburg (Praetorium Agrippinae); Whittaker 2003 unpublished report, 133–152: Kops Plateau; Lanser 1992, 279–294: Oberaden; Lauwerier 1988, 122–173: Nijmegen Ia Traianusplein; Laarman 1996, 369–376: Wijk bij Duurstede–De Horden; Groot 1999: Tiel Passewaaij. Gallia Belgica 1st century: Lepetz 1996, 39 table LXI; Robeerst (in prep.): Elst pre-temple.

breeding stock from the Tongres area into the Nijmegen area had occurred to improve the local breeds.

For the estimation of the horses' height at withers, two metatarsals, and metacarpals were available from the *Oppidum Batavorum* complex. These results were grouped with the three measurements on a metatarsus, metacarpus and radius taken by Lauwerier (1988: 166–169), dating from his Nijmegen Ib-Ic sample, resulting in seven measured specimens. Additionally, the results of the measurements from several other sites were listed for comparison, including sites from the Late Iron Age. In total, the sample contained 527 measured specimens; the distribution is presented in figure 3. Though the sample for *Oppidum Batavorum* is rather small, it is possible to establish whether the sample fits in with the average trend for withers height in this period.

Compared with the Iron Age, in the Pre-Flavian Period the general ranges and mean withers height of both *Germania* (6) (min. 128 cm, max. 143 cm, mean 137 cm), and *Gallia Belgica* first-century (16) (min. 124 cm, max. 144,3 cm, mean 132 cm) populations have increased with 15 cm and 7 cm, respectively. They exceed the pattern of *Oppidum Batavorum* (9) (min. 124,6 cm, max. 136,8 cm, mean 131,9 cm), which in contrast, hardly shows any change compared to the mean value of the Dutch River Area horse population in the previous Late Iron Age period (1). In order to verify this deduction, it was tested but no significance was found ($t = 0.267$, df = 16, $\alpha \leq 0.4$, $F = 1.42$, $p = 4.06$). Taken as a whole this could be due to the small *Oppidum Batavorum* sample (N = 7), which shows a bias towards the maximum values of the floating bar. Larger animals have been found in rural Nijmegen during this period, like some specimens from Wijk bij Duurstede/De Horden (Laarman 1996: 369–376. Range: min. 138 cm, max. 149 cm, mean 145,5 cm, N=4, s=4,5). On the other hand, no increase in mean values for Oppidum Batavorum is indeed a possibility that has to be considered as well. The mean value is almost similar to that of the population of *Gallia Belgica* in the first-century A.D. (16) ($t = 0.081875$, df = 13, $\alpha > 0.1$, $F = 1.2323$, $p = 4.207$). Future research will reveal whether the *Oppidum Batavorum* sample showed a bias for the larger animals, or if no increase in the mean withers height has occurred. However, the chart clearly displays a bias in animals less than 125 cm at withers for the Pre-Flavian period: even in rural sites, smaller animals are absent.

The higher means displayed by the civilian towns of Tongres (10), Xanten (11), and Magdalensberg (12) may be due to the presence of imported or improved horses, which fits in the general pattern (Lauwerier and Robeerst 2001: 278). However, as the samples remain very limited up to this point, some caution is justified; more values will be needed to confirm if this deduction is correct (see also Vanderhoeven *et al*. 1992: 117). The same pattern is found for the military site at the Kops Plateau (13), and the *Germania* population (6). The samples from Osterhofen-Haardorf (14), Tongres (10), and rural populations near Nijmegen like e.g. Oosterhout/Tiel (8) are very small, but a trend is visible. Possibly, stock improvements to increase withers height had started in the region by means of negative selection of the local smallest animals, as the import of improved breeding material from other regions was only in its starting phase; more important military and civil settlements like Tongres and Xanten were supplied somewhat earlier. Maybe in the Nijmegen area cattle breeding improvements were of higher priority.

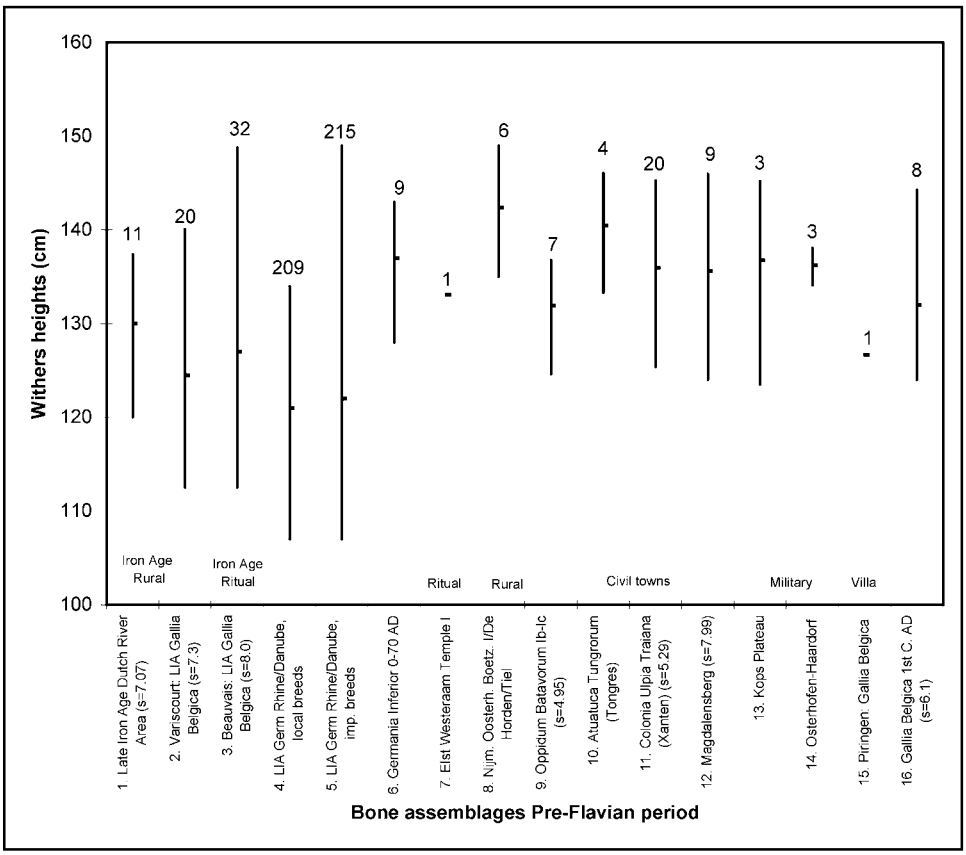

Fig. 3: Horse estimated withers heights per bone assemblage, Pre-Flavian Period. Note: the bone assemblages are grouped by nature of the site (rural, civil, military, ritual), and numbered for text indication. Indicated are: min, max, mean and standard deviation. After Robeerst (in prep.). Site information, Late Iron Age Dutch River Area: Laarman 1996: 343–356, 369–376; Houten-Tiellandt, Wijk bij Duurstede-De Horden; Lauwerier 1988: 90–92, 95–111; Heteren I, Druten I; Prummel 1989: 235–265: Voorne-Putten site 17–36; Roymans: Lith North-Brabant (unpublished report); Whittaker 2003: 172–177; Deest; Peters 1998: 152, table 19: Late Iron Age Germania Rhine/Danube area, local and imported stock. Late Iron Age Gallia Belgica: Meniel 1984: 32 table 15; Variscourt, Beauvais. Germania Inferior Early Roman Period: Peters 1998: 152, table 19. Early Roman period: Robeerst, this volume: Elst Westeraam Temple I; Whittaker 2003: 153–173, 133–152; Nijmegen/Oosterhout Van Boetselaerstraat I, Kops Plateau; Lauwerier 1988: 50-51; Nijmegen Ib-Ic; Vanderhoeven et. al. 1992: 107–133: Atuatuca Tungrorum; Waldmann 1967; Schwarz 1989; Colonia Ulpia Traiana; Hildebrandt 1966; Hornberger 1970; Magdalensberg; Peters & Pöllath 1999; Osterhofen-Haardorf. Gallia Belgica 1st century: Van Neer 1990; Piringen; Lepetz 199: 57 table LXVIII.

Discussion

The analysis of consumption patterns and stockbreeding improvements indicates that the animal husbandry system and the handling of animals changed to some degree from the start of the Early Roman Period.

The general trend for the animal utilization is an increase in pork consumption, which can be observed in Oppidum *Batavorum* as well as *Atuatuca Tungrorum* and *pre-Colonia* Xanten from the Augustan/Tiberian period onwards. Compared with the rural river area settlements, where cattle values remain at a high level after the Late Iron Age, in *Oppidum Batavorum* the decrease of beef consumption is counterbalanced by the increase in pork consumption. In addition, more variation in animal consumption was observed, which is also common in Romanised settlements; game, birds such as domestic fowl, and fish were on the menu.

Stockbreeding improvements were mostly focused on cattle; indications of out breeding (breeding imported bulls with indigenous cows) or other breeding enhancements were visible in the increase of the withers height as early as the Augustan/Tiberian period. There are indications that the surrounding native settlements were incorporated in this cattle improvement-breeding programme as well.

The picture for the increase of the horse mean withers height is more complicated due to the small sample. Although the horse population found in Oppidum Batavorum displays no significant increase in withers height when compared with the Late Iron Age, specimens found in Tongres, Xanten, and rural Wijk bij Duurstede/De Horden indicate a trend for a withers height increase for this period as well. The sample from Oppidum Batavorum may display a bias for larger animals; maybe the larger animals were in the Nijmegen region reserved for the military sites. In addition, a bias for animals less than 125 cm at withers for the Pre-Flavian period was determined; even in rural sites, smaller animals are absent. The animals from the rural sites from Nijmegen Oosterhout, Wijk bij Duurstede and De Horden near Tiel indicate that stock improvements to increase withers height had started in the region; possibly by means of negative selection of the local smallest animals, as the import of improved breeding material from other regions was only in its starting phase. It is possible that in the Nijmegen area cattle breeding improvements were of higher priority to the Romans. Nonetheless, it is strongly recommended that additional samples should be taken to enlarge the reliance of the analysis.

The findings of this study provide evidence that changes in dietary patterns, and stock breeding intensification have occurred in the region from the Early Roman Period. These events were probably initiated by the presence of both military and civil Roman settlements, which started off a market system for their demand of provisions. The region probably supplied most animal products; the more luxurious items were imported from areas as far as the western Mediterranean. Although more research is needed, the analysis of species distribution and withers height may provide some useful tools for apprehending the various Romanisation processes, which emanate from the incorporation of the Nijmegen Frontier Zone in the Roman Empire.

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appendix 1: Number of identified specimens (NISP) by taxon (hand-collected) from Oppidum Batavorum (A) and Nijmegen Ib-Ic (B) samples.

Date: 0-70 AD	**Total Nijmegen Oppidum Batavorum**											
Species	**Total Opp, Bat.**	**%**	**Weight**	**%**	**Total Nijm. Ib-Ic**	**%**	**Weight**	**%**	**Total A+B**	**%**	**Weight**	**%**
Human (*Homo sapiens sapiens*)	1	0,1	37,3	0,1					1		37,3	
Domestic Mammals												
Cattle (*Bos taurus*)	712	50,2	39723,8	72,6	592	69,3	24138,0	79,3	1304	57,4	63861,8	75,0
Sheep/Goat (*Ovis aries / Capra hircus*)	109	7,7	1402,3	2,6	93	10,9	1019,0	3,3	202	8,9	2421,3	2,8
Sheep (*Ovis aries*)	13	0,9	208,1	0,4	2	0,2	134,0	0,4	15	0,7	342,1	0,4
Goat (*Capra hircus*)	1	0,1	29,4	0,1	1	0,1	19,0	0,1	2	0,1	48,4	0,1
Pig (*Sus domesticus*)	435	30,7	7864,2	14,4	126	14,8	2085,0	6,8	561	24,7	9949,2	11,7
Equids (*Equus* sp.)	33	2,3	4178,7	7,6	28	3,3	2643,0	8,7	61	2,7	6821,7	8,0
Horse (*Equus caballus*)	3	0,2	249,9	0,5					3	0,1	249,9	0,3
Dog (*Canis familiaris*)	5	0,4	99,2	0,2	10	1,2	183,0	0,6	15	0,7	282,2	0,3
Wild Mammals												
Aurochs (*Bos primigenius*)	2	0,1	311,8	0,6					2	0,1	311,8	0,4
Red deer (*Cervus elaphus*)	3	0,2	237,1	0,4	2	0,2	235,0	0,8	5	0,2	472,1	0,6
Roe deer (*Capreolus capreolus*)	3	0,2	47,3	0,1					3	0,1	47,3	0,1
Hare (*Lepus europaeus*)	2	0,1	14,3						2	0,1	14,3	
Birds (Aves)												
Domestic fowl (*Gallus g. domesticus*)	52	3,7	136,4	0,2					52	2,3	136,4	0,2
Greylag goose *(Anser anser / A. dom.*)	3	0,2	15,1						3	0,1	15,1	
Bean goose (*Anser fabalis*)	1	0,1	3,1						1		3,1	
Goose (*Anser* sp.)	16	1,1	55,2	0,1					16	0,7	55,2	0,1
Mallard (*Anas plat. / A .plat. dom*)	2	0,1	2,2						2	0,1	2,2	
Duck (Anatinae)	12	0,8	11,0						12	0,5	11,0	
White Tailed Eagle (*Haliaeëtus albicilla*)	1	0,1	5,5						1		5,5	
Fish (Pisces)												
European catfish (*Siluris glanis*)	2	0,1	7,4						2	0,1	7,4	
Pike (*Esox lucius*)	2	0,1	4,7						2	0,1	4,7	
Common sturgeon (*Acipenser sturio*)	3	0,2	20,6						3	0,1	20,6	
Silver orfe (*Leuciscus idus*)	1	0,1	1,4						1		1,4	
Tench (*Tinca tinca*)	1	0,1	2,2						1		2,2	
Mollusca												
Oyster (*Ostrea edulis*)	1	0,1	22,6						1		22,6	
Total identified	1419	*57,2*	54690,8	*87,0*	854	54,6	30456,0	78,4	2273	56,2	85146,8	83,7
Unidentified												
Large mammal	541	51,0	6247,6	76,3	637	89,6	8145,0	97,1	1178	66,5	14392,6	86,8
Medium mammal	405	38,2	1739,3	21,2	49	6,9	179,0	2,1	454	25,6	1918,3	11,6
Small mammals	9	0,8	6,1	0,1					9	0,5	6,1	
Unidentified mammals	96	9,0	190,5	2,3	25	3,5	68,0	0,8	121	6,8	258,5	1,6
Birds	10	0,9	6,5	0,1					10	0,6	6,5	
Total unidentified	1061	*42,8*	8190,0	*13,0*	711	*45,4*	8392,0	*21,6*	1772	*43,8*	16582,0	*16,3*
Total	2480		62880,8		1565,0		38848,0		4045		101728,8	

After: Robeerst (Section Oppidum Batavorum, in prep.); Lauwerier (1988:50, Table 9: Nijmegen Ib-Ic). Note: Percentages calculated for 100% for Total Identified and Total Unidentified. Associated elements were counted as one individual. Lauweriers' data for 'Horse' have been assigned to 'Equids', 'sheep-pig size' to 'medium mammals', and 'cattle-horse size' to 'large mammals'.

appendix 2: Germania Late Iron Age / La Tène D / Augustan Period (100 BC–16 AD) site comparisons.

A. Dutch River Area and adjacent Germania	Location	Nature	Cattle	%	Pig	%	S/G	%	Total
Lith	Netherlands	rural	181	66	18	7	74	27	273
Ewijk I	Netherlands	rural	837	85	41	4	106	11	984
Deest	Netherlands	rural	195	85	20	9	15	7	230
Heteren I	Netherlands	rural	175	82	11	5	28	13	214
Druten I	Netherlands	rural	134	67	17	9	48	24	199
Wijk bij Duurstede-De Horden	Netherlands	rural	162	78	24	11	23	11	209
Houten-Tiellandt	Netherlands	rural	129	74	13	7	32	18	174
Tiel-Passewaaij	Netherlands	rural	156	67	24	10	54	23	234
Voorne-Putten	Netherlands	rural	66	80	2	2	15	18	83
Aldenhovener Platte	Germany	rural	161	90	7	4	11	6	179

B. Gallia Belgica	Location	Nature	Cattle	%	Pig	%	S/G	%	Total
Broekom	Belgium	rural	50	41	25	21	46	38	121
Wange	Belgium	rural	55	31	47	27	75	42	177
Meldert	Belgium	rural	105	64	20	12	40	24	165
Variscourt "L'Oppidum du Vieux Reims"	France	civil town	2576	20	7895	60	2646	20	13117
Villeneuve St. Germain "Les Grandes Grèves"	France	civil town	320	20	1061	65	251	15	1632
Baron: Buisson-Saint-Cyr	France	rural	158	37	165	39	105	25	428

Based on NISP and calculated frequencies (%). After: Robeerst (in prep.) Site information: For Germania: Laarman 1996a, 343–356, 1996b: 369–376: Houten-Tiellandt, Wijk bij Duurstede-De Horden; Lauwerier 1988, 90–92, 95–111: Heteren I, Druten I; Berke 1999, 98–104: Aldenhovener Platte sites Eschweiler-Laurenzberg, Eschweiler-Lohn, Aldenhoven-Siersdorf; Prummel 1989, 235–265: Voorne-Putten site 17–36; Roymans, Lith North-Brabant (unpublished report); Whittaker 2003, 172–177: Deest; Groot 1999, Tiel Passewaaij. For Gallia Belgica: Van Neer 1988, 37–42: Broekom; Van Neer and Lodewijckx 1992, 55–64: Wange; Ervynck 1991, 79–84: Meldert; Méniel 1984, 14: Variscourt and Villeneuve St. Germain (after Classen 1977); Lepetz 1996, 22–23, table XXXI: Baron Buisson-Saint-Cyr.

appendix 3: Pre-Flavian Period (0–70 AD) site comparisons. Based on NISP and calculated frequencies.

C. Military	Location	Nature	Cattle	%	Pig	%	S/G	%	Total
Nijmegen	Netherlands	castra	257	32	476	60	66	8	799
Praetorium Agrippinae/ Valkenburg forts I, II, III	Netherlands	castellum	468	65	188	26	62	9	718
Velsen	Netherlands	castellum	130	66	5	3	61	31	196
Asciburgium/ Moers-Asberg	Germany	castellum	185	82	32	14	9	4	226
Oberaden	Germany	castra	13	14	79	84	2	2	94
Dangstetten	Germany	castellum	4116	25	10821	65	1792	11	16729
Rödgen	Germany	castellum	12	18	34	50	22	32	68
Augusta Raurica / Augst-Kaiseraugst	Switserland	castellum	90	25	124	34	150	41	364
Tenedo / Zurzach	Switserland	castellum	1151	26	2133	47	1219	27	4503
Osterhofen-Haardorf	Germany	castellum	283	33	461	53	124	14	868

D. Vici	Location	Nature	Cattle	%	Pig	%	S/G	%	Total
Saint Mard I	Belgium	vicus	10	42	9	38	5	21	24
Velzeke I	Belgium	vicus	27	42	11	17	26	41	64
Beaumont-sur-Oise "La Blanche-Voye"	France	vicus	1841	53	355	10	1306	37	3502
Vitudurum /Oberwinterthur I früh, I spät	Switserland	vicus	7688	53	4726	32	2153	15	14567
Tenedo /Zurzach	Switserland	vicus	629	55	287	25	225	20	1141

E. Civil towns	Location	Nature	Cattle	%	Pig	%	S/G	%	Total
Oppidum Batavorum / Nijmegen	Netherlands	civil town	1304	63	561	27	219	10	2084
Atuatuca Tungrorum/ Tongres	Belgium	civil town	1063	59	465	26	274	15	1802
Nemetacum/ Arras	France	civil town	251	29	572	66	47	5	870
Aug. Viromanduorum / St. Quentin "L'Hotel de Ville"	France	civil town	106	26	219	54	82	20	407
Augustomagus / Senlis "Impasse du Courtillet"	France	civil town	360	42	379	44	117	14	856
Colonia Ulpia Traiana / Xanten	Germany	civil town	13489	75	2876	16	1721	10	18086
Magdalensberg	Switserland	civil town	20565	36	20050	36	15742	28	56357
Augusta Raurica/ Augst-Kaiseraugst	Switserland	civil town	4479	42	3731	35	2464	23	10674

F. Villae	Location	Nature	Cattle	%	Pig	%	S/G	%	Total
Piringen	Belgium	villa	49	40	33	27	40	33	122
Baron: Buisson-Saint-Cyr	France	villa	152	36	104	25	168	40	424
Hamblain-lès-Près: Les Bonnettes	France	villa	128	24	228	43	174	33	530
Arras "Le Mont Saint Vaast"	France	villa	33	43	34	45	9	12	76
Rémy "Les Neuf"	France	villa	51	22	131	56	51	22	233
Verneuil-en-Halatte "Le Bufosse"	France	villa	514	36	658	46	261	18	1433

G. Rural sites	Location	Nature	Cattle	%	Pig	%	S/G	%	Total
Wijk bij Duurstede-De Horden	Netherlands	rural	253	81	10	3	49	16	312
Voorne-Putten	Netherlands	rural	696	83	139	17	2	0	837
Tiel-Passewaaij	Netherlands	rural	460	49	101	11	379	40	940

After: Robeerst (in prep.). Site information: Military sites: Koopmans 1996, 17; Thijssen 1988, 24: Nijmegen Augustan Castra; Prummel 1974; Verhagen 1982: Praetorium Agrippinae / Valkenburg; Clason 1977 in Luff 1982: Velsen I; Lanser 1992, 279–294: Oberaden; Requate 1962 in Luff 1982:

Asciburgium / Moers-Asberg; Habermehl 1962, 46–53: Rödgen; Uerpmann 1977 in Luff 1982: Dangstetten; Schibler-Furger 1988; Deschler-Erb 1991a, 1991b; Breuer 1992: Augusta Raurica / Augst-Kaiseraugst; Morel 1994, 395–411: Tenedo / Zurzach; Peters and Pöllath 1999, 179–165: Osterhofen-Haardorf. For Vici: Gautier 1970, 1994, 117–125: Saint Mard; Ervynck et al. 1999, 96–102: Velzeke; Lepetz 1996, 20 Table XX: Beaumont-sur-Oise; Fünfschilling et al. 1985, 160–166; Morel 1991, period I früh / period I spät, 88: Vitudurum/Oberwinterthur. For Civilian sites: Robeerst (in prep.): Oppidum Batavorum / Nijmegen; Dräger 1964; Ehret 1964; Luhmann 1965; Fruth 1966; Hildebrandt 1966; Hornberger 1970: Magdalensberg; Waldmann 1967; Müller 1989; Schwarz 1989: Colonia Ulpia Traiana / Xanten; Schibler-Furger 1988; Deschler-Erb 1991a; 1991b; Breuer 1992: Augusta Raurica / Augst-Kaiseraugst; Gautier 1975, 53–54; Ervynck and Vanderhoeven 1992, 107–133; Ervynck, Vanderhoeven, Van Dierendonck, Van Heesch and Van Neer 1993, 127–205; Ervynck and Vanderhoeven 1997, 457–464; Van Neer 1994, 28–37: Atuatuca Tungrorum / Tongres; Lepetz 1996: 18 Table XIII, after Durand 1993; Lepetz 1993: Senlis "Impasse du Courtillet"; Lepetz 1996, 15 Table I: Nemetacum / Arras; idem: 18 Table XI: Saint-Quentin. For Villae: Van Neer 1990: Piringen; Lepetz 1996, 22–23, Table XXXII: Baron Buisson-Saint-Cyr; idem: 23 Table XXXV, after Jacques and Tuffreau-Libre 1984: Hamblain-lès-Près; idem: 24 Table XXXVI: Arras Le Mont Vaast; idem: 25 Table XLI: Rèmy "Les Neuf"; idem: 25 Table XLIII, after Collart 1991: Verneuil-en-Halatte. For rural/agrarian sites: see caption appendix 2.