Counting Roman Chickens: Multidisciplinary Approaches to Human-Chicken Interactions in Roman Britain

Mark Maltby[a], Martyn Allen[b], Julia Best[a], B. Tyr Fothergill[c], Beatrice Demarchi[d,e]

[a]Department of Archaeology, Anthropology and Forensic Science, Bournemouth University, Talbot Campus, Poole

[b] Department of Archaeology, School of Archaeology, Geography and Environmental Science, University of Reading

[c] Department of Archaeology and Ancient History, University of Leicester

[d] Department of Archaeology, University of York

[e] Department of Life Sciences and Systems Biology, University of Turin, Italy

Corresponding author: Julia Best bestj@bournemouth.ac.uk; juliabest.zooarch@gmail.com

Keywords: Zooarchaeology; Chickens; Roman Britain; Eggshell; Medullary bone; Pathology

Abstract: This paper discusses some of the approaches and results from two multi-disciplinary projects. The first is the AHRC-funded 'Cultural and Scientific Perceptions of Human-Chicken Interactions' Project, which investigates the history of the exploitation of chickens in Europe. The second is the Leverhulme Trust-funded 'Rural Settlement of Roman Britain' Project, which has collated evidence from excavation reports from thousands of sites. This paper updates the evidence for the exploitation of chickens in Roman Britain, showing that there were significant variations in the abundance of chicken bones found on different types of settlement. There was also a modest increase in their abundance during the Roman period, suggesting chickens became slightly more frequent contributors to the diet, albeit still only a rare commodity. However, they continued to be frequently represented in graves, shrines and other ritual deposits. The paper also discusses evidence of egg production and avian osteopetrosis, demonstrating that when traditional zooarchaeological research is integrated with scientific analyses, a deeper understanding of past human diet (and other avian-human interactions) can be acquired.

1. Introduction

The history of the domestication and westward spread of the chicken or domestic fowl (*Gallus gallus domesticus*) out of Asia is currently the focus of much debate (Xiang et al. 2014; 2015; Perry-Gal et al. 2015; Peters et al. 2015; Eda et al. 2016; Pitt et al. 2016).

However, the species does not appear to have spread across Europe prior to the late prehistoric period (Best et al. in prep.(b)). The earliest confirmed record for the presence of chickens in Britain is currently from the site of White Horse Stone in Kent where a femur provided a radiocarbon date of 770–390 cal BC with modelled dates of 560–390 cal BC (Kitch 2006). However, chicken bones are rare finds in the pre-Roman period in Britain, being recorded in only around 30% of the Iron Age faunal assemblages from southern England, nearly always in very small numbers (Hambleton 2008). Only on a few Late Iron Age (c. 100BC–AD43) sites in the south-east of England, where continental contact was more evident, did chickens appear in larger numbers (Maltby 1997; Hambleton 2008), despite the fact that images of chickens were depicted on coins minted in two areas of southern England during that period (Best et al 2016; Feider 2017). Indeed, the regular occurrence of partial or complete skeletons of chickens along with Julius Caesar's frequently quoted, albeit enigmatic, observation from *De Bello Gallico* (book 5, ch.12) that the Britons kept chickens but did not eat them, has led to the very plausible contention that chickens were initially valued for some of their other qualities (such as exoticism, display of status, sport or deity association) rather than for food (Sykes 2012).

Despite their recent introduction and continued presence in contexts associated with human burials and other ritual sites (King 2005), chickens are often summarily dismissed in zooarchaeological reports of Romano-British assemblages merely as an unremarkable addition to the diet. A previous survey (Maltby 1997) indicated that there is some evidence to suggest that chickens became more abundant during the Romano-British period but the potential complexity of production, distribution and consumption of chickens and their products in the diet was not fully explored. This potentially undervalues their impact, and their dismissal limits our understanding of their multiple roles. Two recent large multi-disciplinary research projects have provided opportunities to review the evidence for human-chicken relationships in more depth. The Arts and Humanities Research Council-funded 'Cultural and Scientific Perceptions of Human-Chicken Interactions' Project has brought together over 20 researchers from six universities to examine the social, cultural and environmental impact of chickens in Europe. This research has included the collation of zooarchaeological data from both published works and unpublished archives from all periods including the Roman era. In addition, innovative research has been carried out (inter alia) in analyses of metrical data, pathology, ancient DNA, stable isotopes, pottery residues, eggshells, ecology, material culture and anthropology associated with chickens. Meanwhile, the Leverhulme Trust-funded ‘Rural Settlement of Roman Britain’ Project has collated evidence from over 2,500 excavated rural settlements in England and Wales, enabling a comprehensive reassessment of the countryside of Roman Britain (Smith et al 2016). Over 1,600 sites have produced animal bones, and counts of the bones of chickens and other species can be accessed via the wide-ranging online resource created by the project (Allen et al 2016). A separate analysis of these data has also been undertaken to examine the economic significance of chickens amongst other domestic livestock in Late Iron Age and Roman Britain (Allen 2017 in press).

This paper will examine the evidence for an increase in importance of chickens as a source of food in Roman Britain, and whether there are variations in its abundance at different types of site and over time. It will also consider some other analyses that can be used to study the evolving relationships between humans and chickens in the western provinces of the Roman Empire.

2. Chicken abundance in Romano-British zooarchaeological samples

An initial survey into variability in the abundance of chickens from Romano-British archaeological sites was carried out by Maltby (1997). The sample consisted of 123 assemblages from 68 sites and compared data from military sites, major towns, nucleated settlements, villas and other rural settlements. Results suggested that chickens tended to be more common in assemblages from military sites and major towns, but the numbers of assemblages from some types of site rendered these conclusions tentative and precluded investigation of possible chronological variations. During the last 25 years, the number of assemblages has increased enormously, principally due to the considerable expansion of developer-funded archaeology in England and Wales since 1990, both on rural (Allen 2017 in press) and urban sites (Maltby 2015), thus enabling a much more comprehensive survey to be undertaken.

2.1 Materials and methods

This survey will focus on comparing the abundance of chicken bones with those of sheep/goat. Some comparisons with the abundance of pigs will also be made. Whilst not the focus of this specific paper, wider comparison of the faunal dataset, including cattle, can be found in Table 1. Inter-site comparisons of species abundance are faced with a series of well-known challenges concerning differential identification, retrieval, preservation, quantification and deposition. With particular regard to chickens, it is not possible to distinguish all chicken bones from those of other galliforms such as pheasant (*Phasianus colchius*) and guineafowl (*Numida melagris*) via morphological and metrical analysis, but in Roman assemblages where such distinctions have been made, nearly all the diagnostic bones have been positively identified as chicken. It is therefore assumed that the vast majority, if not all, of the galliform bones recorded on these sites belonged to chickens.

Retrieval and preservation biases have long been recognised, and bones from small birds have a greater likelihood of being destroyed or overlooked during hand-excavation than the generally larger and more robust bones of mammal species. Unfortunately, many reports do not separate or list the bones recovered by sieving, or specify whether sieving has been undertaken at all. However, the great majority of the assemblages discussed here were derived entirely or predominantly from hand-collection and, with caution, can be compared. Where known, exceptions are noted in text below to acknowledge the potential bias towards increased numbers of bones from smaller animals at sites where environmental sampling has been undertaken. It is impossible, however, to fully assess whether all hand-collected assemblages were recovered with the same level of efficiency. Obviously, sheep and pigs are larger than chickens and there will still inevitably be some bias in recovery standards, but these will not be as marked as they would be in comparisons with larger mammals such as cattle and horse.

Quantification methods used by zooarchaeologists also vary. Most counts are derived from the total number of identified specimens (NISP). However, what constitutes a NISP count varies significantly. Some counts include vertebrae and ribs, whilst others do not; some zooarchaeologists count all identifiable limb bone fragments; others count only a selected suite of diagnostic elements. Another issue concerns the inclusion or exclusion of bones from partial or complete skeletons in the counts. Where known in this survey, counts exclude associated groups of bones but this was not feasible in every case. It is also quite common for urban sites, in particular, to include assemblages dominated by waste accumulated by the large-scale butchery of cattle (Hesse 2011; Maltby 2015), which is another reason why cattle have been excluded from this survey. To minimise problems created by small samples, a minimum NISP count of 50 sheep/goat and chicken elements for an assemblage was set.

Data for the rural settlements, including nucleated sites, were obtained from the Roman Rural Settlement project database (Allen et al 2016). While the majority of assemblages from Roman rural settlements derive from comparatively recent developer-funded excavations, many of which having fairly standardised excavation and recovery techniques, the dataset also includes assemblages from research-based excavations and rescue excavations undertaken prior to 1990. It is beyond the scope of this paper to explore detailed temporal variations; however further details on specific assemblages and chronology can be found at: http://archaeologydataservice.ac.uk/archives/view/romangl/. Data for the assemblages from the major urban sites were obtained from Maltby (2010a, 276) and supplemented by data obtained from more recently reported assemblages. Data from military sites were gathered from unpublished and published reports.

2.2 Farmsteads and Villages

Rural settlements were split into categories of farmsteads, villages, villas and roadside settlements based on the definitions set out by the Roman Rural Settlement Project (Allen and Smith 2016). Many of the farmsteads could be further subdivided into unenclosed, enclosed or complex categories. As can be seen in Table 1, when all the assemblage NISPs for farmsteads and villages are combined, chickens account for only 0.5% of the key domestic food animals (cattle, sheep/goat, pig and chicken), and on average form just 1.8% of the combined chicken and sheep/goat NISPs. Breaking this down further, over 67% of the 436 assemblages from farmsteads produced either no chicken bones at all or <1% of the total number of sheep/goat and chicken elements (Figure 1). A further 26% had <5% chicken. Of the few assemblages with unusually high percentages of chicken (>15%), most had specific reasons to explain why they were so well represented (Table 2). In several cases, most or all of the chicken bones accompanied human burials; in others, they were derived from single contexts and were probably part of associated bone groups (ABGs) (Morris 2010). In one case, they came from a site (Langdale Hale, Cambridgeshire) with evidence of industrial processing and specialist butchery – 'Romanised' traits more often encountered on larger nucleated sites where chicken bones have often been more commonly recovered.

Table 1: Combined NISP figures by site type for civilian assemblages considered in this study (dark grey); species shown as a % of total NISP of these species (mid grey); chicken as a percentage of the combined chicken and cattle NISP, chicken and sheep/goat NISP, and chicken and pig NISP respectively (pale grey). Section (A) shows percentages calculated

from the total NISP values of all sites combined. Section (B) shows the average percentages when calculated for each site individually.

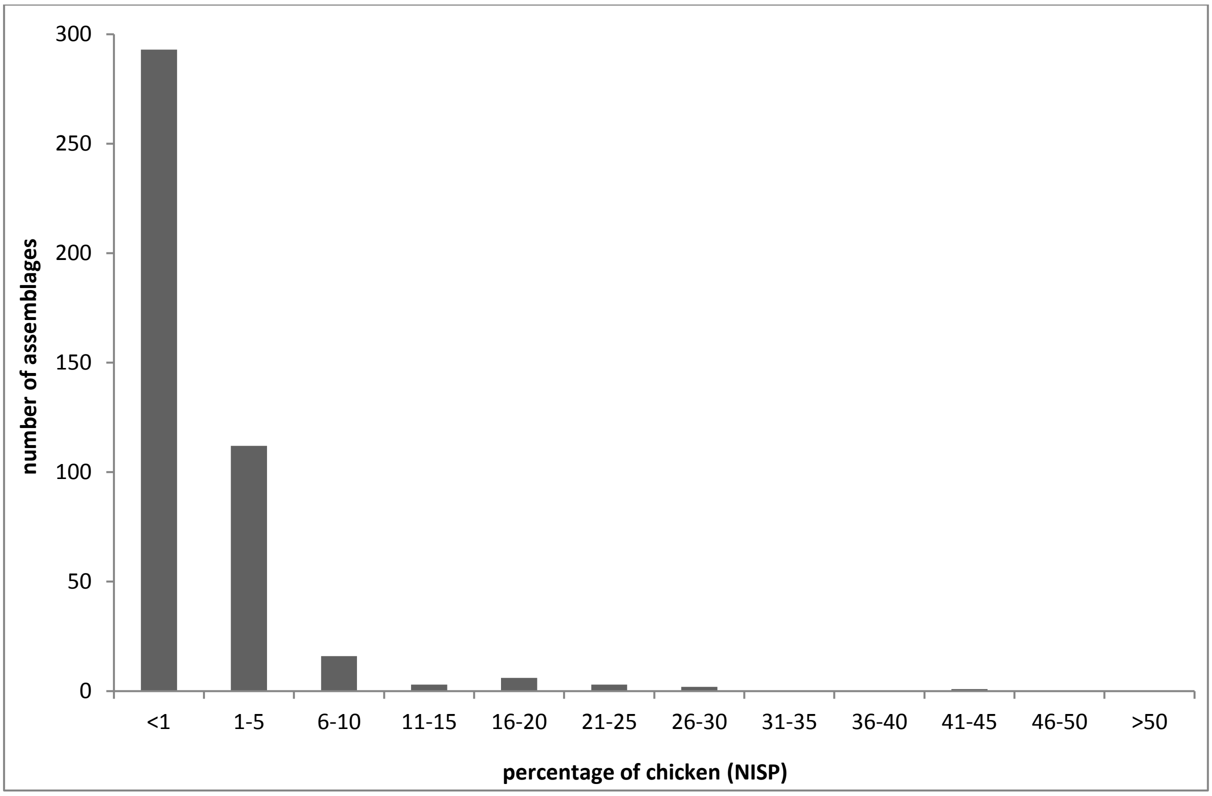


Figure 1: Percentage of chicken of total sheep/goat and chicken NISP counts from farmsteads (n=436)

Table 2: Rural assemblages with high percentages of chicken bones. Data derived from Allen et al. (2016)

Thirty-two assemblages came from sites categorised by the Roman Rural Settlement Project as villages—these sites are defined as nucleated rural settlements not associated with a major road (Allen and Smith 2016). Of these, 18 (56%) contained <1% chicken and 10 (31%) 1%–5% chicken of the total sheep/goat and chicken NISP counts. Three contained between 6% and 10% chicken and only one, a very small assemblage from Abingdon, Oxfordshire, produced an assemblage with over 15% chicken (Table 2). Generally, however, chicken bones were very uncommon components of faunal assemblages from all types of farmsteads and villages.

2.3 Villas

Overall, chickens account for 2.1% of the key food species in villas (Table 1), but they form a higher proportion of the total chicken and sheep/goat remains than at farmstead and village sites, with an average of 6.2%. There is some notable inter-site variation, and many assemblages from villas produced few chicken bones. In 33% of the 79 assemblages, chickens contributed <1% of the total number of sheep/goat and chicken elements (Figure 2). However, chicken bones did quite commonly form higher percentages in villa assemblages, providing 1%–5% of sheep/goat and chicken elements in 34% of the assemblages and between 6%–10% in a further 18%. However, in only six cases did chickens provide over 20% of the sheep/goat and chicken elements (Table 2). Unsurprisingly, these included an assemblage from the spectacular Fishbourne Palace in West Sussex, a site which also produced exceptionally high percentages in the earlier Late Iron Age and Flavian deposits and continued to produce quite large quantities in the later Roman period (Allen 2011). At Bancroft, Buckinghamshire, and Yarford, Somerset, percentages of chicken bones increased significantly from assemblages that accumulated prior to the construction of the villas. The Castle Copse (Wiltshire) assemblage was the only one to produce more chicken than sheep/goat bones. This was partly due to their increased abundance in sieved deposits, but the assemblage was also remarkable for the dominance of pig bones, indicating a different faunal profile (Payne 1997). None of these six assemblages had evidence for biases created by the presence of associated bone groups. There is therefore some evidence that chickens made a significantly greater contribution to the diet at some high-status villa sites.

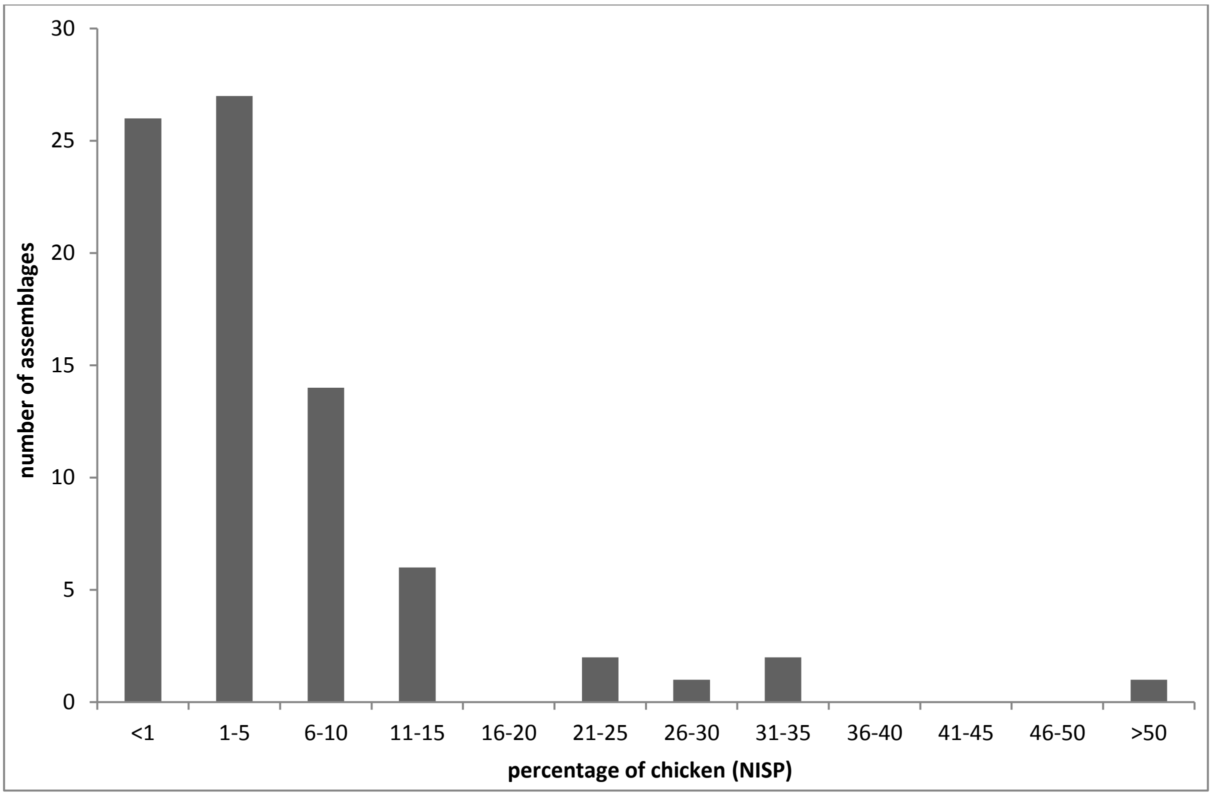


Figure 2: Percentage of chicken of total sheep/goat and chicken NISP counts from villas (n=79)

2.4 Roadside settlements

Chickens only account for 1.3% of the key food species found at roadside settlements (Table 1) and on average form 3.8% of the combined chicken and sheep/goat NISP. These sites produced results similar to those obtained from villas (Figure 3). In 40% of the 115 assemblages, chickens provided <1% of the total number of sheep/goat and chicken elements, and in a further 37% of the assemblages this figure lay between 1% and 5%. Chicken bones contributed 6%–10% in a further 11% of the assemblages. In only six assemblages did chickens provide over 15% of the sheep/goat and chicken elements (Table 2). Of these, the assemblage from Skeleton Green, Hertfordshire (Ashdown and Evans 1981) is better characterised as a Late Iron Age oppidum displaying significant evidence of continental influence. It also produced unusually large percentages of pig bones (Maltby 1997; Hambleton 2008). The two assemblages from Staines, Surrey, are from a site where several excavations have revealed evidence that indicates that the settlement had many urban characteristics, including dumps of specialist butchery waste (Chapman 1984; 2010). The same case could be argued for the settlements of Elms Farm, Heybridge, Essex (Johnstone and Albarella 2002; 2015) and Shadwell, Greater London (Douglas et al. 2011).

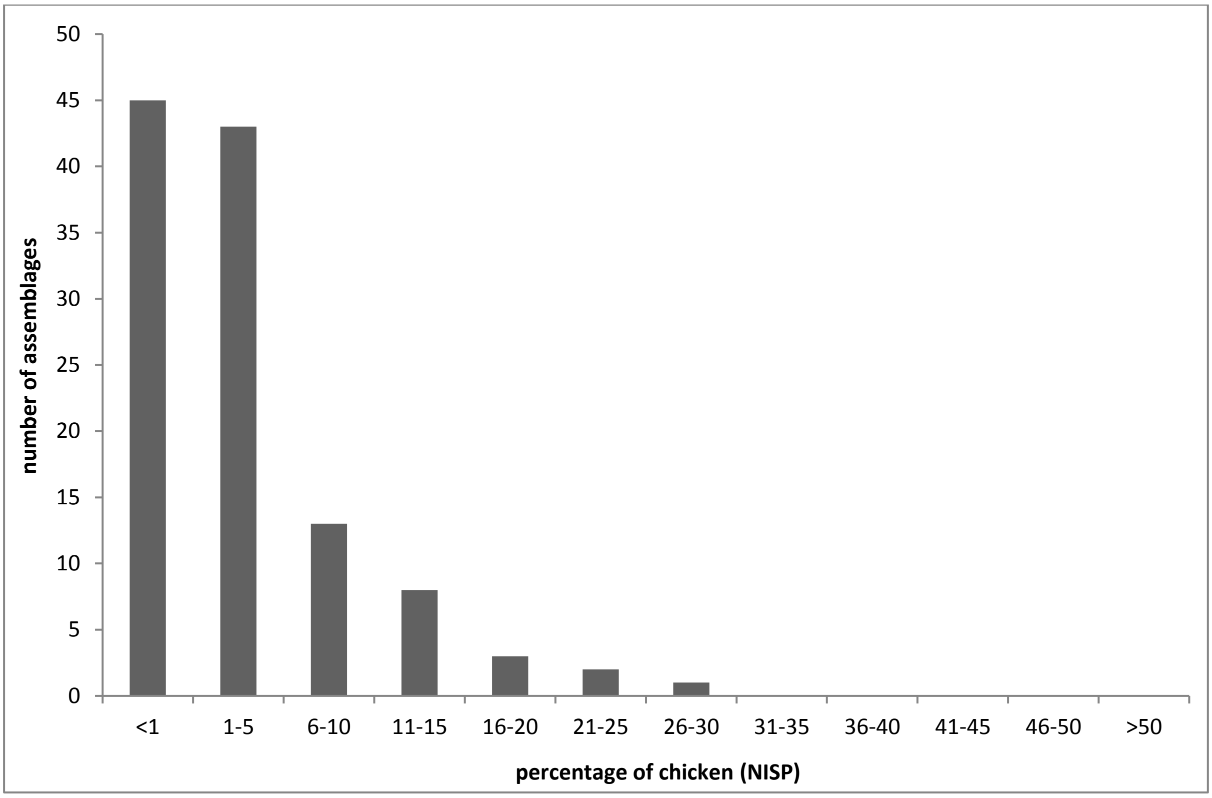


Figure 3: Percentage of chicken of total sheep/goat and chicken NISP counts from roadside settlements (n=115)

2.5. Chronological Variations.

Rural assemblages were sub-divided where possible (n=587 of 662) into five broad periods ranging from the Late Iron Age through to the Late Roman period (Figure 4). These confirmed that the great majority had <1% chicken in the total sheep/goat NISP counts. However, the percentage of assemblages in this category fell in each period from >90% in the Late Iron Age down to 43% in the Late Roman period. Assemblages with 1%-5% chicken increased from 7% in the Late Iron Age sample to over 30% in the Early Roman and later periods. Assemblages with 6%-10% chicken bones formed over 8% of the Early Roman sample, rising to over 13% in the assemblages from the Late Roman period. Chickens gradually became a more consistent, albeit still minor component, of rural assemblages.

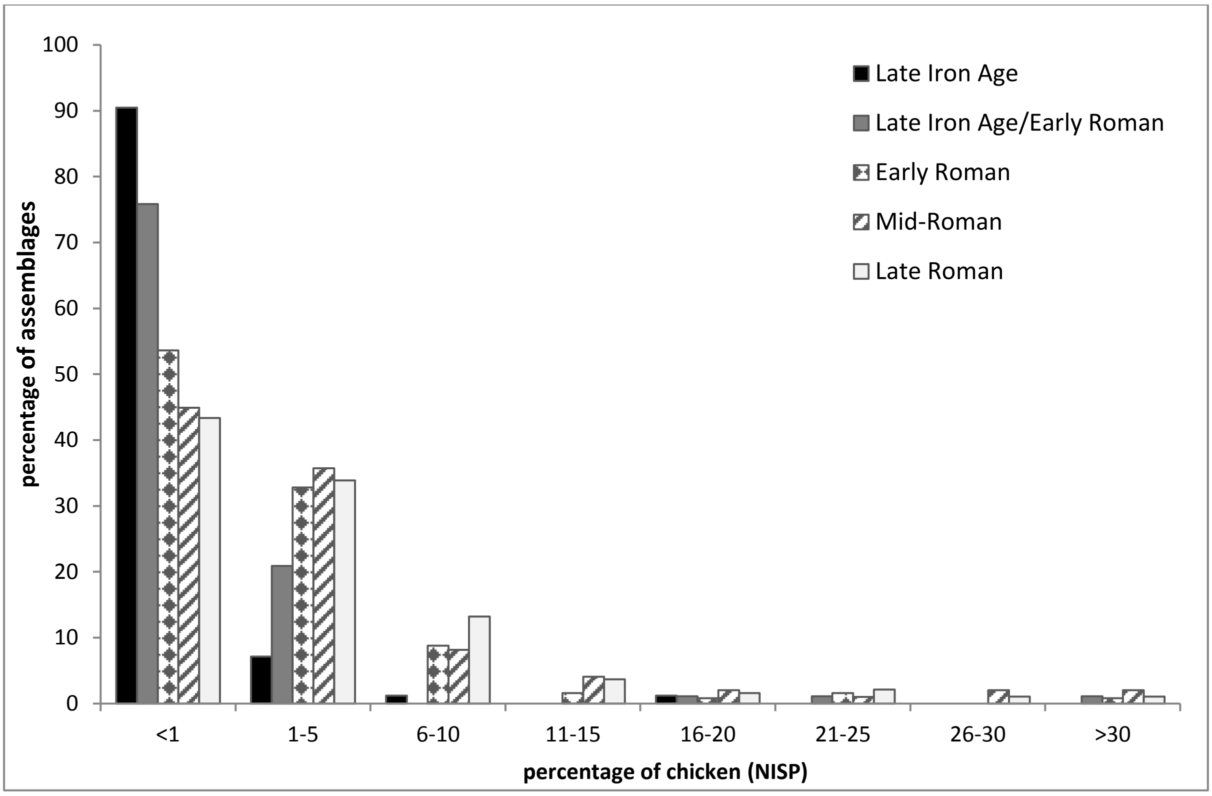


Figure 4: Percentage of chicken of total sheep/goat and chicken NISP counts from rural settlements by period (n=587)

2.6. Urban assemblages

A total of 91 assemblages were obtained from 16 *civitas* capitals and *colonia* from Britain. These showed a marked contrast with those from rural settlements (Figure 5). Chickens form a comparably large proportion of the faunal assemblage accounting for 5.6% of the overall NISP, and on average make up a high 19.2% of the combined chicken and sheep/goat bones (Table 1). Chickens also on average account for 13.8% of the combined chicken and cattle bones, demonstrating that even when sites with large accumulations of cattle butchery waste are included, chickens still form a much higher proportion of the key domestic food animals than at other site types (Table 1). None of the assemblages produced <1% chicken of the total sheep/goat and chicken NISP counts and only 13% fell into the second lowest category (1%-5%). In contrast, 58% of the assemblages included >15% chicken and the mode (21%) lay between 16%–20% chicken. Most of these counts excluded bones in associated bone groups and bones from sieved assemblages were not included. Although urban sites tend to produce better-preserved assemblages than those from rural settlements, it is very unlikely that this could account for all of the urban-rural contrasts. Put simply, people living in towns were much more likely to eat chickens than those living in the countryside. There is abundant butchery evidence (Figure 6) that supports the increased use of chickens for meat in urban contexts, such as Exeter (e.g. Coles in press). Similar evidence has been found on some rural sites including Fishbourne (Allen 2011, 223) and Shefford, Bedfordshire (Maltby 2010b).

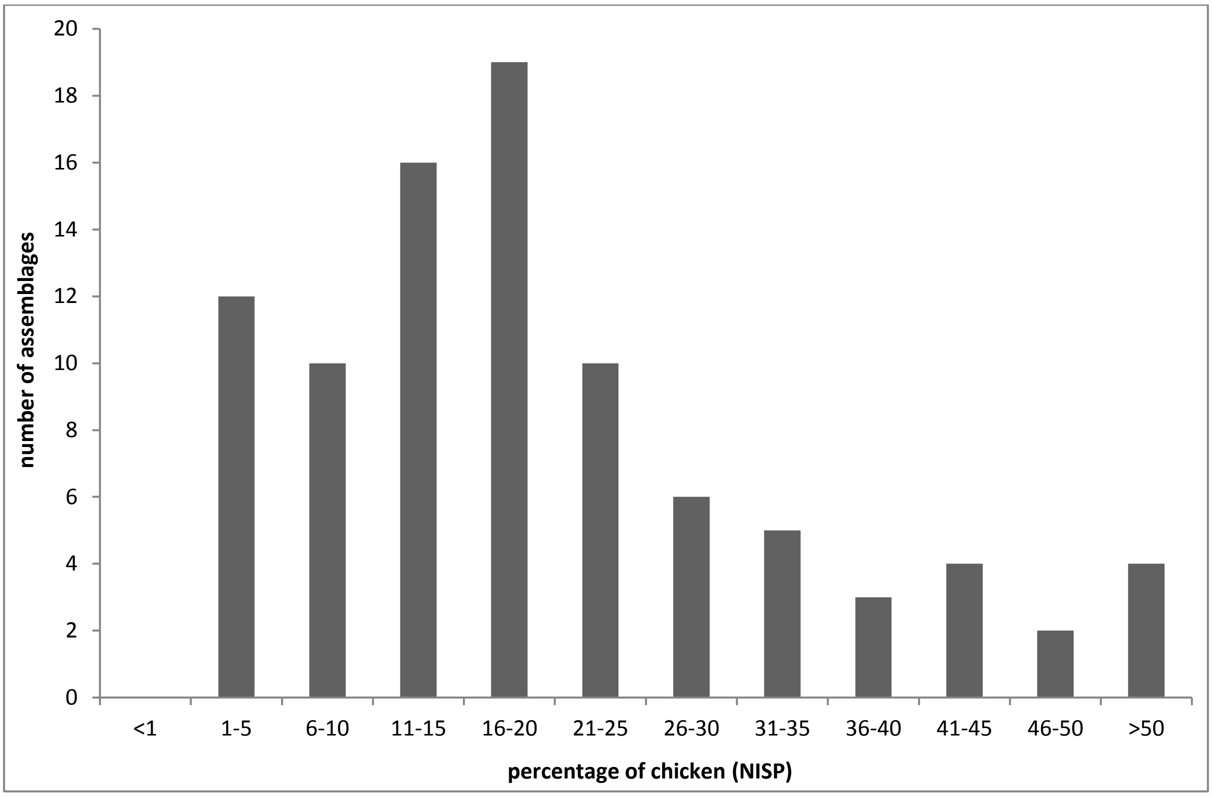


Figure 5: Percentage of chicken of total sheep/goat and chicken NISP counts from urban settlements (n=91)

Figure 6: Chicken tibiotarsus from Princesshay, Exeter showing diagonal knife-cuts on the distal condyles characteristic of disarticulating the lower leg (Photo J. Best).

The contrast between urban and rural chicken abundance can be seen at a regional level, as demonstrated by comparing sites from within the *civitas* capital of Cirencester and rural sites in the local hinterland (Figure 7). This is not to say that the pattern is totally consistent. Sites from Winchester have consistently produced assemblages in the 1%–5% chicken category, whereas those from Dorchester, Exeter and Caerwent have nearly all produced over 15% chickens (Maltby 2010a). The fact that most of the Winchester assemblages are from extra-mural sites, whereas most of the assemblages from the other towns are from sites from central areas of the towns may be significant, perhaps reflecting socio-cultural variations of diet in different areas of the towns.

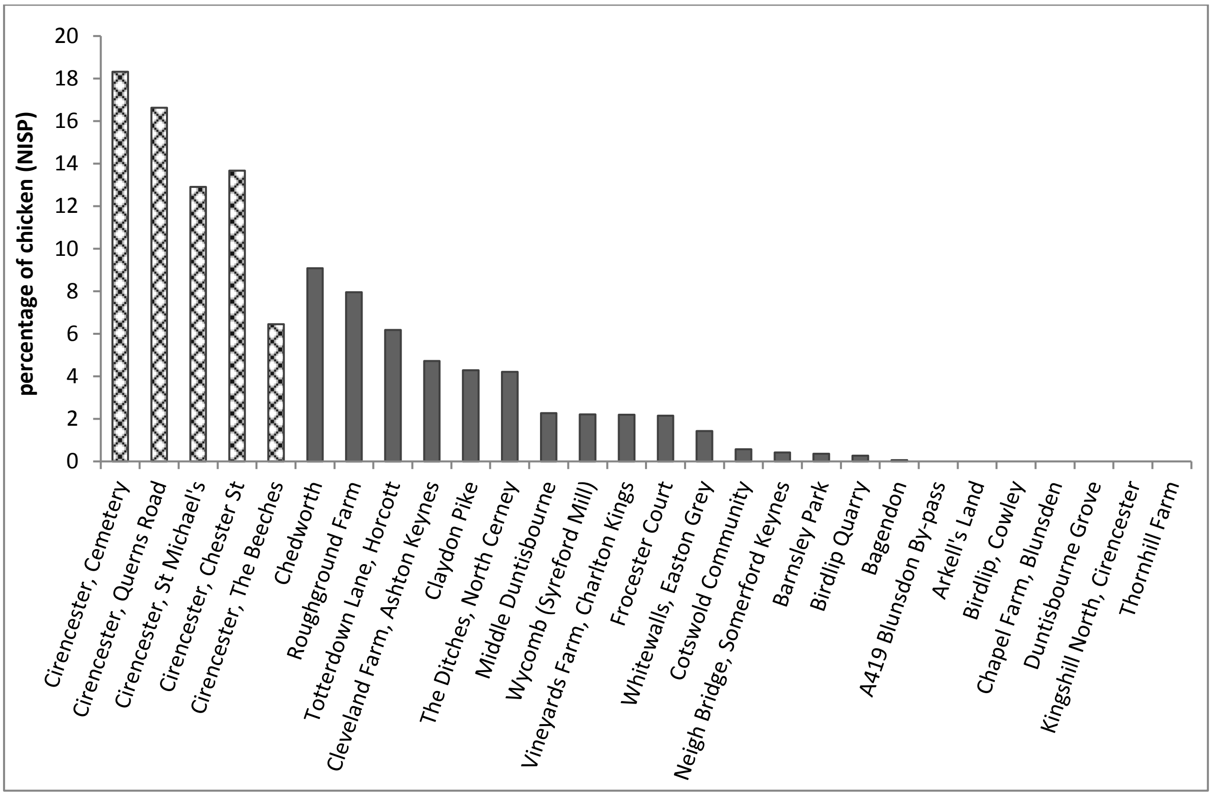


Figure 7: Percentage of chicken of total sheep/goat and chicken NISP counts from sites in Cirencester (checked pattern) and its hinterland (grey)

King (1984) observed that pigs often are more prominent in more Romanised settlements in Britain. This updated review generally supports this interpretation, with assemblages from both villas and towns that had higher percentages of chickens to sheep/goat also having higher percentages of pig in relation to sheep/goat, although there is substantial variation (Figure 8).

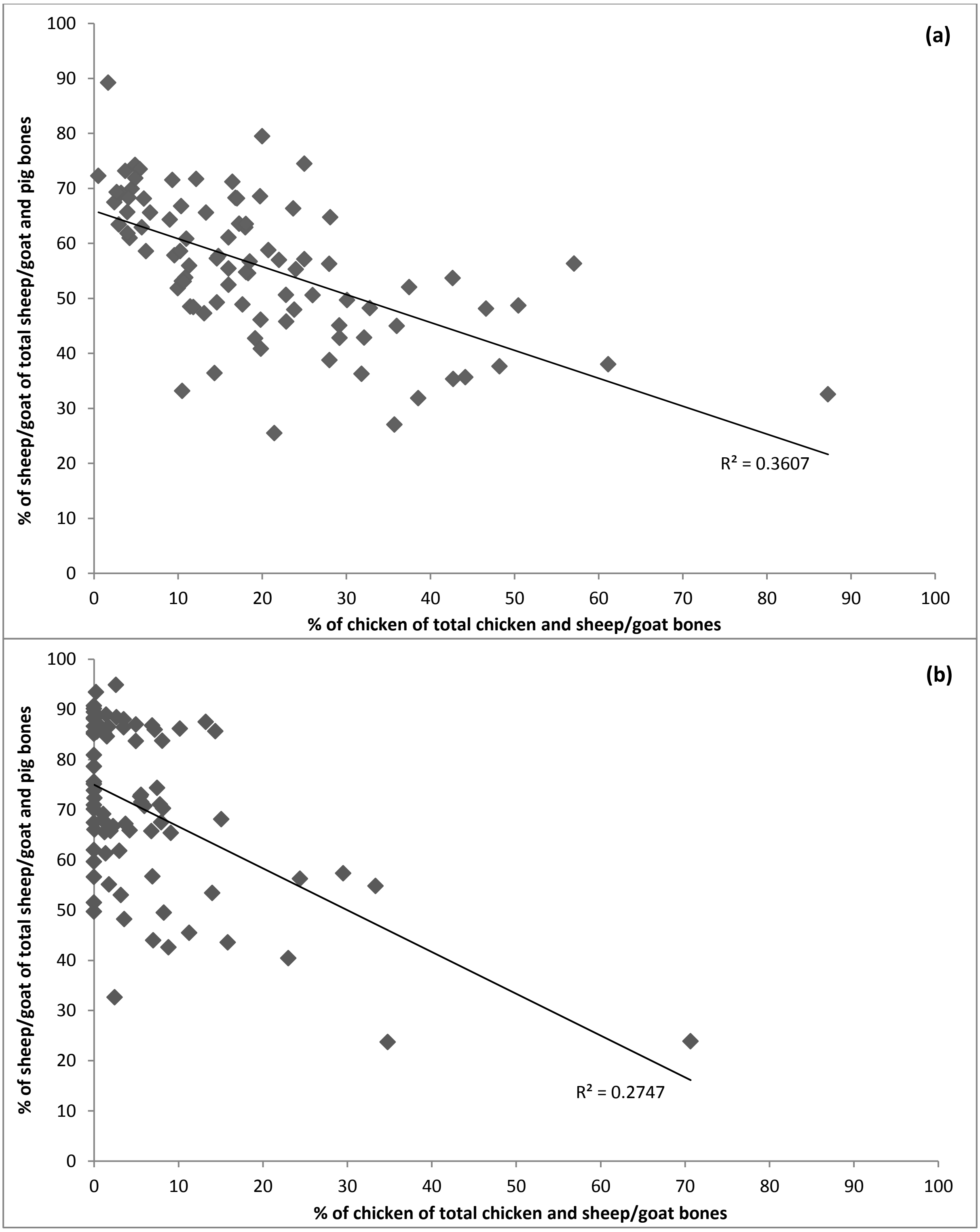


Figure 8: Comparisons of chicken/sheep and pig/sheep ratios in (a) urban (n=91) and (b) villa (n=79) assemblages in Britain

2.7 Military Sites

Excluding vici, 30 assemblages from military sites were considered (Figure 9). Nine (30%) of these fell within the 1%-5% chicken bracket but a similar number produced >15% chicken.

Considerable variability is to be expected as this category covers a wide range of sites, from large fortresses to small auxiliary forts in different areas and periods in Roman Britain. However, the tendency was for chickens to be better represented than on rural settlements, but not as consistently as well represented as in towns. There are also indications that chicken meat may have been more available to high-ranking officers at the supply fort at South Shields (Stokes 2000) and the legionary fortress in Caerleon (Hamilton-Dyer 1993). At the latter, chicken bones were particularly prominent in the drains of the baths (O'Connor 1986), indicating that chickens were commonly eaten by the bathers.

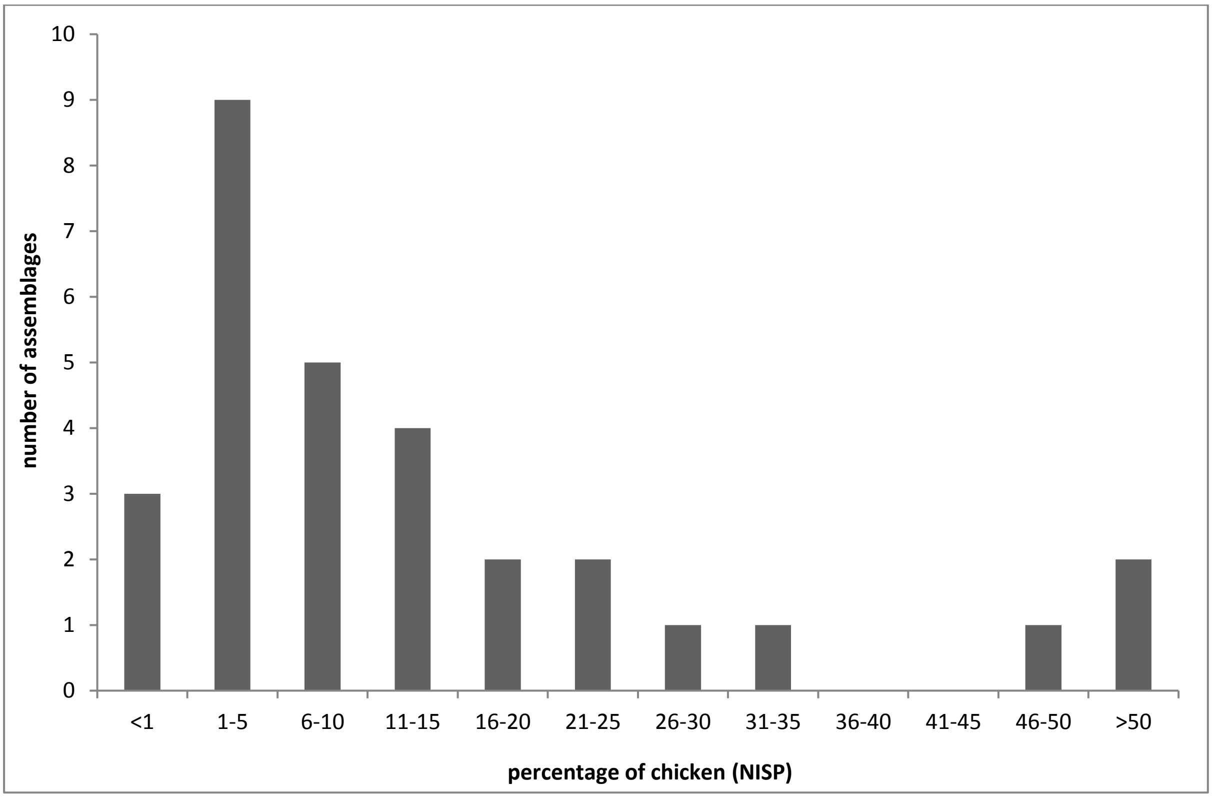


Figure 9: Percentage of chicken of total sheep/goat and chicken NISP counts from military sites (n=30)

2.8 Religious and Burial Sites and other Depositions

King (2005) demonstrated that chickens were sometimes very well represented at temples and shrines in Roman Britain. The best known example comes from Uley, Gloucestershire, where goats and chickens were sacrificed in large numbers at a temple dedicated to Mercury (Levitan 1993; Brothwell 1997). Substantial amounts of chicken bones have also been reported from other temple sites at Brigstock, Northamptonshire, and Folly Lane, St Albans, Hertfordshire (King 2005). The highest percentage of chickens (87%) from the 91 urban assemblages discussed above came from near the Temple of Mithras in London (Macready and Sidell 1998). Continental examples are also well known, including amongst many others, the temple associated with Mithras at Tienen, Belgium (Lentacker et al. 2003a; 2003b) and the temple at Carnuntum–Mühläcker, Austria dedicated to Jupiter (Gál and Kunst 2010). It should be noted, however, that by no means every temple and shrine has evidence of votive offerings of chickens, even where the sacrifice of other animals is prominent (King 2005). On the other hand, in Roman Britain, chicken bones have quite commonly been found in association with inhumations and cremations in both urban and rural cemeteries, showing that they had multiple roles, including food for the dead and votive offerings (Morris 2011).

3. The exploitation of chicken eggs

When considering chickens in Roman diet, it is also important to recognise the secondary products that they can provide, particularly eggs. Chicken eggs become increasingly prominent as food items in Roman and Roman-influenced contexts, and their presence also serves to indicate an increase in on-site husbandry and breeding. Their production and use can be traced by integrating multiple lines of evidence and analytical techniques including historical sources, archaeological eggshell, and medullary bone.

3.1 Documentary evidence

Documentary sources can provide information on more ephemeral chicken products and give insights into productivity, use and trade. On Hadrian's Wall, tablets from the fort of Vindolanda written in the 1st and 2nd centuries AD indicate that as well as live chickens or meat, eggs were also valued items:

"... bruised beans, two modii, **chickens, twenty**, a hundred apples, if you can find nice ones, **a hundred or two hundred eggs, if they are for sale there at a fair price**. ... 8 sextarii of fish-sauce ... a modius of olives ... (Back) To ... slave (?) of Verecundus" (Tablet 302, Translation: Bowman and Thomas 1983).

This particular statement does not indicate specifically that these were chicken eggs, but given the reference to chickens in the same list, it is a fair assumption to make. The quantity requested also suggests that the eggs were probably being acquired from chickens rather than wild sources or domestic geese/ducks. No eggshell has yet been recovered from excavations at Vindolanda, and whilst this may result from recovery or preservation biases, it could be that eggs were not locally available. The desire to obtain them as a special order probably reflects their high value.

Columella's *De Re Rustica* is one of several agricultural works that provide instructions for the care of egg-laying chickens, including housing requirements and modifying feed to make hens lay sooner, more often, and with larger eggs (*De Re Rustica*, book 8, ch.3, s.1-8; book 8, ch.5, s.1-2). He also describes aspects of productivity and preservation, such as transferring eggs for hatching to capable broody hens, and using chaff, bran and salt for egg storage (*De Re Rustica*, book 8, ch.6, s.1-2). Columella and other ancient authors, such as Varro, even suggest that certain types of chicken, including those with five toes, were the best for egg-laying and brooding (*De Re Rustica*, book 8, ch.2, s.8).

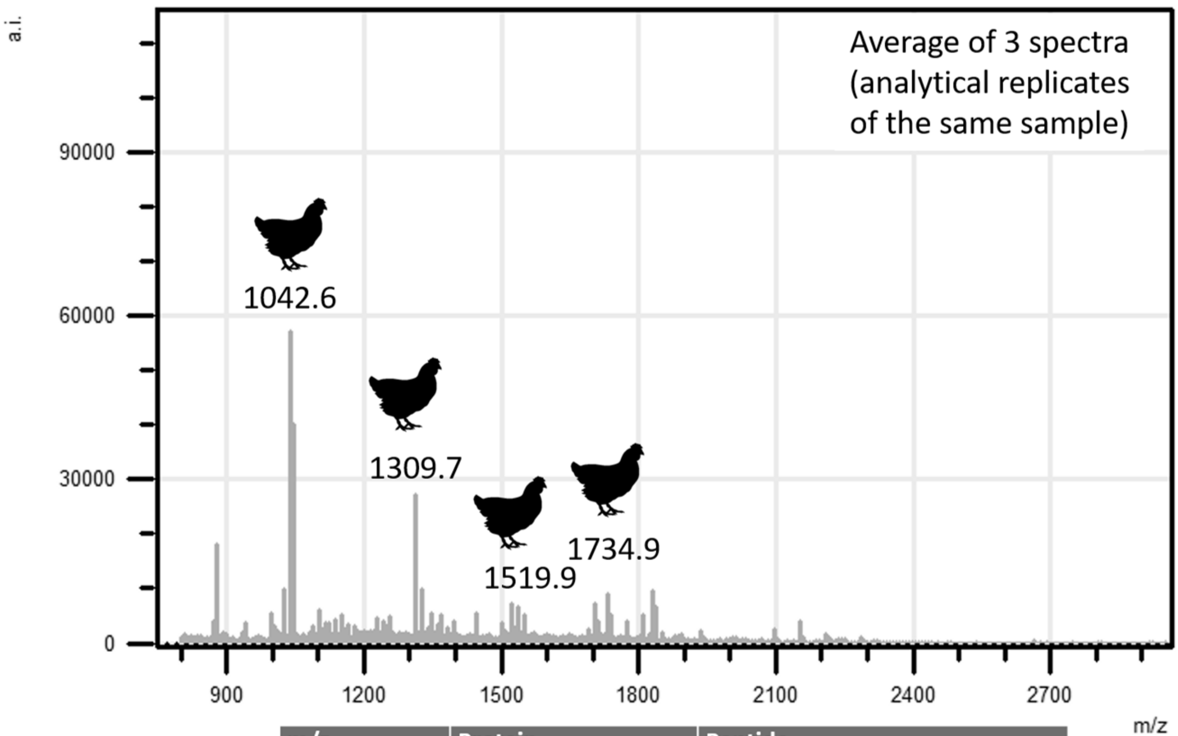
Although rare, recipes can demonstrate how eggs could contribute to diet. Apicius' *De Re Coquinaria*, a collection of recipes compiled in the late 4th or early 5th century AD, shows that they had a wide range of culinary uses, including clarifying muddy wine, and as an ingredient in brain sausages and many sauces (*De Re Coquinaria*, book 6, ch.248, s.2-3). Of course, it is unknown how widespread these recipes and agricultural guides were practised in and beyond Italy, as documentary sources are often limited in applicability by being restricted in period and place.

3.2 Eggshell

Eggshell has been found on different types of Romano-British sites, although thorough soil processing is generally needed for its recovery. Eggshells were recorded on 38 sites collated by the Romano-British rural settlement project (Allen et al. 2016), although rarely were the eggshells further identified. Eggshell can be identified to species via microscopy (Sidell 1993), although this has significant limitations (Best et al. in prep.(a)), and more recently by ZooMS (Zooarchaeology by Mass Spectrometry) which identifies taxa-specific peptide mass markers (Demarchi et al. 2016; Presslee 2015; Presslee et al. in prep.; Stewart et al. 2013). These two methods can be combined: using ZooMS for species identification and microscopy to identify the stage of chick development within the egg (since the developing chick takes calcium from the eggshell to aid bone formation, causing changes to the interior surface of the eggshell) (Beacham and Durand 2007; Best et al. in prep.(a)).

One of the first archaeological eggshell assemblages to be analysed using both techniques came from the military amphitheatre at Chester, Cheshire, where substantial amounts of eggshell were found. The bulk of this material came from two deposits: a well-stratified early assemblage from AD70–80, which correlates with the first phase of amphitheatre use, and a second dating to AD100 from substantial deposits underneath the seating banks (Wilmott pers. comm.). The ZooMS results indicate that all analysed fragments were from chicken eggs (a representative ZooMS spectrum is shown in Figure 10). Microscopy revealed that *c*.90% of the analysed fragments from the AD100 deposits showed no signs of reabsorption associated with chick development. Therefore almost all of the eggs were freshly laid, halted early in their incubation sequence, or infertile. In this instance, the assemblage appears to represent food consumed by spectators watching events at the amphitheatre. Such snack foods may have been on sale outside the amphitheatre, as appears to be depicted in a fresco of the Pompeii amphitheatre (Ellis 2004). This evidence suggests that chicken eggs were traded from a relatively early period of Roman occupation in Britain, at least on military and associated sites.

The eggshells from the AD70–80 phase at the Chester amphitheatre, whilst all identified as chickens, had more varied stages of development, potentially indicating that not all of the eggs were consumed fresh.



m/z	Protein	Peptide
1042.6	Clusterin	EAFVPPVQR
1309.7	Ovocleidin-116	GSTVAGGFAHLHR
1519.9	Ovocleidin-116	VWPGAAP(+15.99)APGVVGVAR
1734.9	Ovocleidin-116	LGQAARPEVAPAPSTGGR

Figure 10: Representative mass spectrum (ZooMS) of chicken eggshell from Chester Amphitheatre, context 625 dating to AD70–80. The identified taxonomic markers are highlighted (following Presslee 2015; Presslee et al. in prep.).

3.3 Medullary Bone

The analysis of medullary bone, a calcium deposit for egg production laid down on the endosteal surface of the medullary cavity, is a useful method for identifying the presence of laying hens in the archaeological record (van Neer et al. 2002, 129–132). It can be used to give an indirect insight into breeding and egg production on sites where eggshell is not recovered. It can be identified by macroscopic assessment of fragmented bones. However, by employing non-destructive x-ray analysis its presence or absence can also be determined for complete bones. This combined approach allows broad sex profiles to be identified for whole assemblages (Best in prep.). For example, no eggshell was available for identification at Fishbourne Palace, but observations of medullary bone in the fragmented bone assemblage indicated that laying hens were present at the site (Allen 2011), either as live birds or dead meat resources. The femur is the best element for examining medullary bone in chickens since the fill is most substantial and enduring in this bone. X-ray analysis of the Fishbourne assemblage increased the overall recorded occurrence of medullary bone from 17% to 28% of the femora (Fothergill et al. 2017). The majority of the deposits only occupied a small proportion of the bone cavity, perhaps indicating that these birds were killed for meat when they failed to lay (which can mark the end of their reproductive life or occur temporarily as a result of moulting, illness, or dietary deficiencies). This suggests that these birds were kept for egg production, with meat being a secondary consideration. The hens at Fishbourne may have been kept on site, but the possibility that some were traded in from elsewhere, such as the nearby town of Chichester, should not be ruled out.

Absence of medullary bone can also be valuable for profiling the birds that were contributing to diet and social/religious life. Bones without medullary deposits can belong to males, but also to females not in lay, or with no deposit in that specific skeletal element. At the temple site of Uley, medullary bone was scarce. When combined with spur evidence and metrics, these data support the interpretation that a large proportion of the birds sacrificed were male (Brothwell 1997; Fothergill et al. 2017). These birds would probably have been consumed in multiple ways: as meat, but also psychologically and metaphorically as spiritual offerings. A similar pattern can also be seen on the continent at sites such as Tienen in Belgium where over 7,600 chicken bones were found, representing at least 238 individuals (155 adults and 83 subadults) which were deposited in a pit after what appears to have been a single large feasting event (Lentacker et al. 2004a, 77–81; 2004b). This site was associated with the god Mithras, who in turn was often associated with the cockerel. Again, several lines of evidence indicate that these birds were primarily males and no medullary bone was identified in the fragmented material or in x-rayed whole bones. This demonstrates that ritual consumption of chickens can be found in many areas of the Roman world.

4. Pathology

One palaeopathological hallmark of Roman-era avian bone assemblages is the presence of avian osteopetrosis, a pathology which is routinely identified in material from sites across Europe. These lesions are caused by a range of avian leucosis viruses, spread through contact as well as from hen to chick and through genomic transmission (Pruková et al. 2007). Avian osteopetrosis lesions are distinctive in appearance, consisting of hypermineralised endosteal and periosteal new bone formation in the diaphyses of affected elements (Figure 11), which can be differentially diagnosed through radiography (O'Connor and O'Connor 2005). Avian leucosis viruses affect various species of domestic poultry and cause a number of detrimental physical and behavioural symptoms which negatively impact vivacity, egg-laying, and weight gain (Holmes 1961; Payne 1992; Uzunova et al. 2014; Vogt 1977).

Figure 11: Tibiotarsus with avian osteopetrosis lesions from Uley, shown with a modern comparative element

Although it is possible that avian leucosis viruses affected poultry flocks in earlier periods (particularly as infection does not always result in bony lesion formation), the earliest archaeological evidence of avian osteopetrosis originates from Tiberian contexts at Roman military sites: the fort and naval base at Velsen in the Netherlands and the fort at Aulnay in France (Prummel 1987; Lignereux and Peters 1997). The 1st century AD assemblage from Carlisle (Old Grapes Lane) also contained two elements described as osteopetrotic (Allison 2010). The proportional frequency of avian osteopetrosis lesions identified in archaeological assemblages increases in the 1st and 2nd centuries AD, and the initial geographic spread of avian leucosis viruses is likely to be linked to the movement of people and their animals around the Empire (Fothergill in press). Since animal husbandry plays a key role in pathogenesis, it is possible that Roman chicken-keeping methods and the environments in which these birds were kept fostered the transmission of avian leucosis viruses. These husbandry techniques have a direct link to human diet in terms of the quantity and quality of chicken resources available. These data also provide insights into how the diet-related cycle of production, distribution and consumption affected many aspects of animal health and avian-human interactions.

5. Discussion

Although there is evidence that the consumption of chicken meat and eggs increased during the Romano-British period, they were still nevertheless a rare commodity. The zooarchaeological data has shown that meat supply was heavily dependent upon the provision of beef, particularly in towns (Hesse 2011; King 1999; Maltby 2015). This is supported by lipid residue analysis. In Silchester, for example, most residues were composed of ruminant fats (Marshall et al 2008; Colonese et al. in press). In Britain, chicken meat and eggs would have been regarded as luxury foods obtained from an exotic, recently introduced, species. It is no surprise that they were consumed more readily on settlements where Roman and other continental influences were more prominent, reflecting the greater cultural and culinary diversity of the inhabitants. The greater dominance of chicken in Romano-British urban deposits is mirrored in other parts of the western Roman Empire, including northern France (Lepetz 1996) and Switzerland (Groot and Deschler-Erb 2015), as well as across much of North Africa (Fothergill and Sterry in press; Fothergill et al. in press). Given their special status combined with their convenient small size, it is understandable that chickens continued to be sacrificed as votive offerings, linked with a number of deities and buried with humans even on settlements where they were probably rarely eaten. The supply of chickens may sometimes have been challenging, as indicated by the Vindolanda tablets and this challenge would have been heightened by the need to supply birds for sacrifice at some temple sites. It is also likely that many chickens were raised in towns, where there was, at least initially, a greater demand for their products. Bones of very young chicks have been found in Winchester, Hampshire indicating at least some of the birds were being bred in the town (Maltby 2010a). The appearance of avian osteopetrosis lesions may also be linked to keeping chickens in more confined environments (Fothergill in press).

However, whilst all the strands of evidence examined here indicate that the Roman period in Britain saw an increase in the use of chicken meat and eggs for food, these animals continued to hold several other roles within society and culture; from deity companions to luxury goods. Therefore, whilst frequently the archaeology of chickens, and particularly their zooarchaeological record, is seen primarily in terms of diet, this is not the only avian-human interaction that needs to be considered. As such, this integrated approach, incorporating traditional zooarchaeological methods alongside historical sources and a suite of scientific analyses, shows that the investigation of avian demography can provide insights into their complex relationships with humans and resultantly inform upon and beyond human diet.

Acknowledgements:

This work was supported by the Arts and Humanities Research Council as part of the project "Cultural and Scientific Perspectives of Human-Chicken Interactions" (Grant No AH/L006979/1) and by the Leverhulme Trust as part of the project "The Rural Settlement of Roman Britain". The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The authors also wish to thank the following people for their help and collaboration: Tony Wilmott, Alice Forward, Rob Symmons, the Intergemeentelijke Archeologische Dienst PORTIVA, Anton Ervynck, An Lentacker, Wim van Neer and Charlotte Coles. We are very grateful to Samantha Presslee and Matthew Collins for providing information and discussion in relation to ZooMS.

References:

Allen, M., 2006. The animal bones from Yarford Villa, Somerset. University of Winchester: Unpublished report to the Southern Quantocks Archaeological Survey.

Allen, M., 2011. Animalscapes and Empire: New Perspectives on the Iron Age/Romano-British Transition. University of Nottingham (Unpublished PhD Thesis).

Allen, M., 2017 (in press). Pastoral farming. In M. Allen, L. Lodwick, T. Brindle, M. Fulford and A. Smith, *New Visions of the Countryside of Roman Britain, Vol. 2: The Rural Economy of Roman Britain*. London: Britannia Monograph Series 30.

Allen, M., Brick, N., Brindle, T., Fulford, M., Holbrook, N., Richards, J.D., and Smith, A., 2016. *The Rural Settlement of Roman Britain: an Online Resource.* [data-set]. York: Archaeology Data Service [distributor] https://doi.org/10.5284/1030449

Allen, M. and Smith, A., 2016. Rural settlement in Roman Britain: morphological classifications and overview. In A. Smith, M., Allen, T., Brindle, and M., Fulford, 2016. *New Visions of the Countryside of Roman Britain, Vol. 1: The Rural Settlement of Roman Britain*. London: Britannia Monograph 29.

Allison, E.P., 2010. The bird bones. In M. McCarthy (ed.), *The South Lanes, Carlisle: Specialist Fascicules.* (Oxford Archaeology North/English Heritage) York: Archaeology Data Service [distributor], Fascicule 1, 161-162. https://doi.org/10.5284/1000182

Apicius 1936. *De Re Coquinaria*. Translation by W.M. Hill. http://penelope.uchicago.edu/Thayer/E/Roman/Texts/Apicius/6*.html.

Ashdown, R., and Evans, C., 1981. The animal bones. In C. Partridge, *Skeleton Green: a Late Iron Age and Romano-British Site*. London: Britannia Monograph 2, 205–237.

Atkins, A., Popescu, E., Rees, G., and Stansbie, D. 2014. *Broughton, Milton Keynes, Buckinghamshire: The Evolution of a South Midlands Landscape.* Oxford: Archaeology Monograph 22.

Barker, B., Luke, M. and Wells, J., 2006. *A421 Improvements: M1 Junction 13 to Bedford. Archaeological Field Evaluation*. Bedford: Albion Archaeology https://doi.org/10.5284/1010377

Beacham, E.B. and Durand, S.R., 2007 Eggshell and the archaeological record: new insights into turkey husbandry in the American Southwest. *Journal of Archaeological Science*, 34: 1610–1621. https://dx.doi.org/10.1016/j.jas.2006.11.015

Best, J., In prep. Non-destructive medullary bone analysis: exploring advantages and limitations of x-ray analysis.

Best, J., Demarchi, B., Presslee, S., Collins, M., and Maltby, M. In prep(a). Integrated application of ZooMS and microscopy in the study of archaeological eggshell.

Best, J., Lebrasseur, O., Larson, G., Sykes, N., Peters, J., Boev, Z., Trentacoste, A., Seigle, M., Miller, H., Hamilton-Dyer, S., Hamilton, H., Cunliffe, B., Mepham, L., Allen, D., Armit, I., Buster, L., Pitt, J., Higham, T. and Maltby, M. In prep(b). Radiocarbon dating early chicken bones from Europe: refining a chronology of introduction.

Best, J., Fieder, M. and Pitts, J., 2016. Introducing chickens - arrival, uptake and use in prehistoric Britain. *Past: the Newsletter of the Prehistoric Society* 84, 1-3.

Bowman, A.K. and Thomas J.D. 1983. *Vindolanda: the Latin writing-tablets*. London: Britannia Monograph 4.

Branigan, K., 1971. *The Roman Villa at Latimer*. Chess Valley Archaeology and History Society.

Brothwell. D., 1997, Interpreting the immature chicken bones from the Romano-British ritual complex on West Hill, Uley. *International Journal of Osteoarchaeology* 4, 330–332.

Bullock, A., and Allen, M., 1997. Animal bones (Flagstones). In R. Smith, F. Healy, M. Allen, E. Morris, I. Barnes and P. Woodward, *Excavations along the Route of the Dorchester By-pass, Dorset, 1986-8.* Salisbury: Wessex Archaeology Monograph 11, 191–193.

Caesar, J. 1917. *De Bello Gallico/ The Gallic Wars*. Loeb Classical Library 72. Translation by H.J. Edwards. Harvard: Harvard University Press.

Chapman, J., 1984. Animal and human bone. In K. Crouch and S. Shanks, *Excavations at Staines 1975-76: The Friends' Burial Ground Site.* London: London and Middlesex Archaeological Society /Sussex Archaeological Society Joint Publication No 2, 115–123.

Chapman, J., 2010. Animal bone, In P. Jones, *Roman and Medieval Staines. The Development of the Town*. Woking: SpoilHeap Monograph 2, 169–171.

Colonese, A.C., Lucquin, A., Timby, J. and Craig, O., In press. Organic residue analysis of ceramic vessels. In M. Fulford, A Clarke, E. Durham and N. Pankhurst, *Late Iron Age Calleva: the Pre-conquest Occupation at Silchester Insula IX*. London: Society for the Promotion of Roman Studies Britannia Monograph.

Coles, C. In press. The Animal Bones of Roman Princesshay. In J. Allan Roman archaeology of Princesshay, Exeter. *Devon Archaeological Society Proceedings*.

Columella, 1954-1955. *De Re Rustica*. Loeb Classical Library Translation by E. S. Forster and E. Heffner. Harvard: Harvard University Press.

Demarchi, B., Hall, S., Roncal-Herrero, T., Freeman, C.L., Woolley, J., Crisp, M.K., Wilson, J., Fotakis, A., Fischer, R., Kessler, B.M., Rakownikow Jersie-Christensen, R., Olsen, J.V., Haile, J., Thomas, J., Marean, C.W., Parkington, J., Presslee, S., Lee-Thorp, J., Ditchfield, P., Hamilton, J.F., Ward, M.W., Wang, C.M., Shaw, M.D., Harrison, T., Domínguez-Rodrigo, M., MacPhee, R.D.E., Kwekason, A., Ecker, M., Kolska Horwitz, L., Chazan, M., Kröger, R., Thomas-Oates, J., Harding, J.H., Cappellini, E., Penkman, K., and Collins, M.J. 2016. Protein sequences bound to mineral surfaces persist into deep time. *eLife* [online] 5, e17092. https://dx.doi.org/10.7554/eLife.17092

Dobney, K. and Jaques, S.D., 1996. Animal bones. In R. J. Williams, P.J. Hart and A.T.L. Williams, *Wavendon Gate. A Late Iron Age and Roman Settlement in Milton Keynes.* Buckinghamshire Archaeological Society Monograph Series 10, 203-230.

Douglas, A., Gerrard, J., and Sudds, B., 2011. *A Roman Settlement and Bath House at Shadwell: Excavations at Tobacco Dock and Babe Ruth Restaurant, The Highway, London.* London: Pre-Construct Archaeology Monograph 12.

Eda, M., Lu, P., Kikuchi, H., Li, Z., Li, F. and Yuan, J., 2016. Reevaluation of early Holocene chicken domestication in northern China. *Journal of Archaeological Science* 67, 25-31.

Ellis, S., 2004. The distribution of bars at Pompeii: archaeological, spatial and viewshed analyses. *Journal of Roman Studies* 17, 371-384.

Feider, M., 2017. *Chickens in the Archaeological Material Culture of Roman Britain, France, and Belgium*. Bournemouth University (Unpublished PhD Thesis).

Fothergill, B.T., 2017. Human-aided movement of viral disease and the archaeology of avian osteopetrosis. *International Journal of Osteoarchaeology*. DOI: 10.1002/oa.2599

Fothergill, B.T., Linseele, V., and Valenzuela-Lamas, S., In Press. Movement and Management of Animals in the North and West of Africa from 1000 BC to AD 1000. In D.J. Mattingly, A. Cuenod and C. Duckworth, eds. *Trans-Saharans: Mobile Technologies.* Cambridge University Press.

Fothergill, B.T., and Sterry, M., In Press. Poulíography and "Poultrymen" in North Africa. In Proceedings of XIe Colloque international Histoire et Archéologie de l'Afrique du Nord, *Hommes et animaux au Maghreb, de la Préhistoire au Moyen Age: explorations d'une relation complexe*. Marseille et Aix-en-Provence.

Fothergill, B.T., Best, J., Foster, A. and Demarchi, B. 2017. Hens, Health and Husbandry: Integrated Approaches to Past Poultry-keeping in England. *Open Quaternary* 3(1) DOI: http://doi.org/10.5334/oq.34

Gál, E., and Kunst, G., 2010. Offered to gods, eaten by people: bird bones from the Sanctuary of Jupiter Heliopolitanus in Carnuntum–Mühläcker (Austria). *International Journal of Osteoarchaeology* 24, 336-346.

Groot, M., and Deschler-Erb, S., 2015. Market strategies in the Roman provinces: different animal husbandry systems explored by a comparative regional approach. *Journal of Archaeological Science Reports* 4, 447–460.

Hambleton E., 2008. *Review of middle Bronze Age - late Iron Age Faunal Assemblages from Southern Britain*. Portsmouth: English Heritage Research Department Report Series number 71-2008.

Hamilton, J., 2000. Animal bones. In: B. Cunliffe and C. Poole (eds.), *The Danebury Environs Programme: the Prehistory of a Wessex Landscape. Vol. 2, Part 6, Houghton Down, Stockbridge, Hants, 1994*. Oxford: University of Oxford, Committee for Archaeology, 67–73.

Hamilton-Dyer, S., 1993. The animal bones, in V. Zienkiewicz, Excavations in the *Scamnum Tribunorum* at Caerleon. *Britannia* 24, 132–136.

Hamilton-Dyer, S., 2008. The animal bones. In G. Anelay, Liss Roman Villa, Liss, Hampshire: Report on the Archaeological Excavations. Unpublished report, Liss Archaeological Group.

Harman M., 1994. Mammal and bird bones. In R.S. Leary (ed.), *Excavations at the Romano-British Settlement at Pasture Lodge Farm, Long Bennington, Lincolnshire, 1975–77 by H.M. Wheeler*. Nottingham: Occasional Papers in Lincolnshire History and Archaeology 10 (Nottingham, Trent and Peak Archaeological Trust), 49–53.

Halkon, P., Millett, M., and Woodhouse, H., 2015. *Hayton, East Yorkshire: Archaeological Studies of the Iron Age and Roman Landscapes Volumes 1–2.* Yorkshire Archaeological Report 7. Leeds: Yorkshire Archaeological Society.

Hesse, R., 2011. Reconsidering animal husbandry and diet in the northwest provinces, *Journal of Roman Archaeology* 24, 215–248.

Higbee, L. 2004. Mammal, bird and fish bone. In R. Regan, C. Evans and L. Webley, *The camp Ground Excavations: Colne Fen, Earith Assessment Report.* Cambridge: Cambridge Archaeological Unit Report 164, 160–200. https://doi.org/10.5284/1021819

Holmes, J.R., 1961. Postmortem findings in avian osteopetrosis. *Journal of Comparative Pathology and Therapeutics* 71, 20–27.

Horton, W., Lucas, G., and Wait, G.A., 1994, Excavation of a Roman site near Wimpole, Cambs., 1989. *The Proceedings of the Cambridge Antiquarian Society* 83, 31–74

Johnstone, C., and Albarella, U., 2002, The Late Iron Age and Romano-British Mammal and Bird Bones Assemblage from Elms Farm, Heybridge, Essex. Portsmouth: English Heritage Ancient Monuments Laboratory Report 45/02.

Johnstone, C., and Albarella, U., 2015. The Late Iron Age and Romano-British mammal and bird bone assemblage from Elms Farm, Heybridge, Essex. In M. Atkinson and S.J. Preston *Heybridge: A Late Iron Age and Roman Settlement, Excavations at Elms Farm 1993-5*, Internet Archaeology 40. http://dx.doi.org/10.11141/ia.40.1.albarella

King, A., 1984. Animal bones and the dietary identity of military and civilian groups in Roman Britain, Germany and Gaul. In T. Blagg and A. King (eds.), *Military and Civilian in Roman Britain: Cultural Relationships in a Frontier Province*. Oxford: British Archaeological Reports (British Series) 136, 187–218.

King, A., 1999. Diet in the Roman world: a regional inter-site comparison of the animal bones. *Journal of Roman Studies* 12, 168–202.

King, A., 2005. Animal remains from temples in Roman Britain. *Britannia* 36, 329–369.

Kitch, J., 2006. Animal Bone from White Horse Stone, Aylesford, Kent. CTRL Specialist Report Series.

Lentacker A., Ervynck, A., and Van Neer, W., 2004a. Gastronomy or religion? The animal remains from the Mithraeum at Tienen (Belgium). In S. O'Day, W. Van Neer and A. Ervycnk (eds.), *Behaviour Behind Bones: The zooarchaeology of ritual, religion,status and identity.* Oxford: Oxbow, 77–94.

Lentacker, A., Ervynck, A., and Van Neer, W., 2004b. The symbolic meaning of the cock. The animal remains from the Mithraeum at Tienen (Belgium). In M. Martens and G. De Boe (eds.), *Roman Mithraism: the Evidence of the Small Finds*. Brussels: Archeologie in Vlaanderen Monografie 4, 57–80.

Lepetz, S., 1996. L'animal dans la société gallo-romaine de la France du nord. *Revue archéologique de Picardie* Numéro spécial 12.

Levitan, B., 1993. The vertebrate remains. In A. Woodward and P. Leach, *The Uley Shrines: Excavation of a Ritual Complex on West Hill, Uley, Gloucestershire*. London: English Heritage Archaeological Report 17, 257–345.

Levitan, B. 1994. Vertebrate remains from the villa. In R.J. Williams and R. Zeepvat (eds.), *Bancroft: A late Bronze Age/Iron Age Settlement, Roman Villa and Temple-Mausoleum: Volume II, Finds and Environmental Evidence*. Aylesbury: Buckinghamshire Archaeology Monograph Series 7, 515–536.

Lignereux, Y., Peters, J., Tassaux, F., and Tronche, P., 1997. Viandes, volailles et fruits de mer a la table des légions Romaines d'Aunedonnacum, 20–30 après Jésus-Christ (Aulnay-de-Saintonge, Charente-Maritime). *Revue de Médecine Vétérinaire* 148 (5), 399–412.

Macready, S., and Sidell, J., 1998. *The animal bones.* In J. Shepherd, *The Temple of Mithras, London: Excavations by W.F. Grimes and A. Williams at the Walbrook,* London: English Heritage Archaeological Report 12, 208–215.

Magilton, J., 2006. A Romano-Celtic temple and settlement at Grimstock Hill, Coleshill, Warwickshire. *Birmingham and Warwickshire Archaeological Society Transactions* 110, 1–236.

Maltby, M., 1997. Domestic fowl on Romano-British sites: inter-site comparisons of abundance. *International Journal of Osteoarchaeology* 7, 402–414.

Maltby, M., 2010a. *Feeding a Roman Town: Environmental Evidence from Excavations in Winchester, 1972–1985.* Winchester: Winchester Museums Service.

Maltby, M., 2010b. Animal bone. In M. Luke, T. Preece and J. Wells, A Romano-British aisled building and associated settlement south of Ampthill Road, Shefford. *Bedfordshire Archaeology* 26, 317–320.

Maltby, M., 2015. Commercial archaeology, zooarchaeology and the study of Romano-British towns. In M. Fulford and N. Holbrook (eds.), *The Towns of Roman Britain: the Contribution of Commercial Archaeology since 1990*. London: Britannia Monograph, 175–193.

Marshall, L.-J., Cook, S.R., Almond, M.J., and Fulford, M.G., 2008. Roman diet and trade: evidence from organic residues on pottery sherds recovered at the Roman town of Calleva Atrebatum (Silchester, Hants.). *Britannia* 39, 245–254.

Maynard, D., Cleary, R., Moore, R., Brooks, I., and Price. J., 1997. Excavations at Foxton, Cambridgeshire 1994. In J. Price and D. Maynard (eds.), *The Archaeology of the St Neots to Duxford Gas Pipeline 1995* (British Archaeological Reports (British Series) 255). Oxford: Archaeopress, 21–39.

Morris, J., 2010. Associated bone groups; beyond the Iron Age. In J. Morris and M. Maltby (eds.), *Integrating Social and Environmental Archaeologies; Reconsidering Deposition*. (British Archaeological Reports (International Series) 2077) Oxford: Archaeopress, 12–23.

Morris, J., 2011. *Investigating Animal Burials: Ritual, Mundane and Beyond*. British Archaeological Reports 535. Oxford: Archaeopress.

Morrison, A., 2000. The animal bone. In N. Cooper (ed.), *The Archaeology of Rutland Water: Excavations at Empingham in the Gwash Valley, Rutland, 1967–73 and 1990.* Leicester: Leicester Archaeology Monographs 6, 132–136.

O'Connor, T. 1986. The animal bones. In J. D. Zienkiewicz, *The Legionary Fortress Baths at Caerleon: Volume II. The Finds.* Cardiff: National Museum of Wales/CADW, 225–248.

O'Connor, T., and O'Connor, S., 2005. Digitising and image-processing radiographs to enhance interpretation in avian palaeopathology. In G. Grupe and J. Peters (eds.), *Documenta Archaeobiologiae 3: Feathers, Grit and Symbolism. Birds and Humans in the Ancient Old and New Worlds*. Rahden: Verlag Marie Leidorf GmbH, 69–82.

Payne, L.N., 1992. Biology of avian retroviruses. In J.A. Levy (ed.), *The Retroviridae, Vol. 1*. New York: Plenum Press, 299–404.

Payne, S., 1997. Animal remains. In E. Hostetter and T. Howe (eds.), *The Romano-British Villa at Castle Copse, Great Bedwyn.* Indianopolis: Indiana University Press, 322–330.

Perry-Gal, L., Erlich, A., Gilboa, A., and Bar-Oz, G., 2015. Earliest economic exploitation of chicken outside East Asia: Evidence from the Hellenistic Southern Levant. *Proceedings of the National Academy of Sciences* 112 (32), 9849–9854.

Peters, J., Lebrasseur, O., Best, J., Miller, H., Fothergill, T., Dobney, K., Thomas, R., Maltby, M., Sykes, N., Hanotte, O., O'Connor, T., Collins, M., and Larson, G., 2015. Questioning new answers regarding Holocene chicken domestication in China. *Proceedings of the National Academy of Sciences* 112 (19), E2415–E2415.

Pitt, J., Gillingham, P., Maltby, M., and Stewart. J., 2016. New perspectives on the ecology of early domestic fowl: an interdisciplinary approach. *Journal of Archaeological Science 74, 1–10*.

Presslee, S., 2015. *Using ancient proteomics to identify the exploitation of bird eggs in archaeological contexts*. University of York (Unpublished MSc Thesis).

Presslee, S., Wilson J., Russell D., Fischer, R., Kessler, B., Best, J., Radini, A., Collins, M., and Demarchi, B., In Review. Identifying taxon-specific peptide markers for archaeological eggshell: a new proteomics approach. *Science and Technology of Archaeological Research.*

Pruková, D., Vernerová, Z., Pilcík, T., Stepanets, V., Indrová, M., Geryk, J., Plachý, J., Hejnar, J., and Svoboda, J., 2007. Differences in pathogenicity among strains of the same or different avian leukosis virus subgroups. *Avian Pathology* 36 (1), 15–27.

Prummel, W., 1987. Poultry and fowling at the roman castellum Velsen I. *Palaeohistoria 29*, 183–201.

Sidell, J., 1993.*A Methodology for the Identification of Archaeological Eggshell.* Philadelphia, PA: The University Museum of Archaeology and Anthropology.

Smith, A., Allen, M., Brindle, T., and Fulford, M., 2016. *New Visions of the Countryside of Roman Britain, Vol. 1: The Rural Settlement of Roman Britain*. London: Britannia Monograph 29.

Stokes, P., 2000. A cut above the rest? Officers and men at South Shields Roman fort. In P. Rowley-Conwy (ed.), *Animal Bones, Human Societies.* Oxford: Oxbow, 146–151.

Stewart, J.R.M., Allen, R.B., Jones, A.K.G., Penkman, K.E.H., Collins, M.J., 2013. ZooMS: making eggshell visible in the archaeological record. *Journal of Archaeological Science* 40, 1797–1804.

Sykes, N., 2012. A social perspective on the introduction of exotic animals: the case of the chicken. *World Archaeology* 44 (1), 158–169.

Uzunova, K., Stamatova-Yovcheva, K., Dimova, V., Yovchev, D., and Halil, M., 2014. Anatomical and ethological changes in poultry affected by osteopetrosis. *Scientific Papers on Animal Science and Biotechnologies* 47 (1), 188–191.

Vogt. P.K., 1977. Genetics of RNA tumor viruses. In H. Fraenkel-Conrat and R.R. Wagner (eds.), *Comprehensive Virology, Vol. 9: Regulation and Genetics, Genetics of Animal Viruses*. New York and London: Plenum Press, 341–455.

Wilson, B., 1993. The animal bones. In Anon, *Abingdon Vineyard Area 3. Summary Report of Excavations and Statement of Potential.* Oxford: Oxford Archaeological Unit, 12–13. https://doi.org/10.5284/1028217

Wood, M., 2006. *Archaeological Assessment Report on Land at Wygate Park, Spalding, Lincolnshire. Volume 2.* Sleaford: Archaeological Project Services. https://doi.org/10.5284/1013596

Xiang, H., Gao, J., Yu, B., Hofreiter, M. and Zhao, X., 2015. Reply to Peters et al.: further discussions confirm early Holocene chicken domestication in northern China. *Proceedings of the National Academy of Sciences* 112 (19), E2416–E2416.

Xiang, H., Gao, J., Yu, B., Zhou, H., Cai, D., Zhang, Y., Chen, X., Wang, X., Hofreiter, M. and Zhao, X., 2014. Early Holocene chicken domestication in northern China. *Proceedings of the National Academy of Sciences* 111 (49), 17564–17569.

van Neer, W, Noyen, K and de Cupere, B 2002. On the use of endosteal layers and medullary bone from domestic fowl in archaeozoological studies. *Journal of Archaeological Science* 29(2), 123–134. https://doi.org/10.1006/jasc.2001.0696

Highlights

1) In Roman Britain, chickens became a slightly more frequent addition to human diet
2) They still formed a relatively small proportion of the Romano-British food animals
3) Chickens account for a much higher proportion of the animal remains in urban sites
4) The production and consumption of chicken eggs increases in quantity & regularity
5) Avian osteopetrosis has been identified at Roman sites in Britain

(A)	**NISPs**					**Species shown as % of total NISP**				**% chicken for each species**		
Site type	*Cattle*	*S/G*	*Pig*	*Chicken*	*Total NISP*	*%Cattle*	*%S/G*	*%Pig*	*%Chicken*	*%Ch:Cattle*	*%Ch:S/G*	*%Ch:Pig*
Farmsteads & villages	173192	161260	39326	1941	375719	46.1	42.9	10.5	0.5	1.1	1.2	4.7
Villas	59553	43116	19264	2569	124502	47.8	34.6	15.5	2.1	4.1	5.6	11.8
Roadside settlements	61600	46614	12686	1552	122452	50.3	38.1	10.4	1.3	2.5	3.2	10.9
Major towns	97586	51474	38501	11152	198713	49.1	25.9	19.4	5.6	10.3	17.8	22.5
(B)	**NISPs**					**Species shown as % of total NISP**				**% chicken for each species**		
Site type	*Cattle*	*S/G*	*Pig*	*Chicken*	*Total NISP*	*%Cattle*	*%S/G*	*%Pig*	*%Chicken*	*%Ch:Cattle*	*%Ch:S/G*	*%Ch:Pig*
Farmsteads & villages	173192	161260	39326	1941	375719	47.6	42.8	8.9	0.7	1.7	1.8	7.4
Villas	59553	43116	19264	2569	124502	49.7	33.3	14.7	2.3	5.4	6.2	11.3
Roadside settlements	61600	46614	12686	1552	122452	47.7	40.8	10.2	1.4	3.1	3.8	12.9
Major towns	97586	51474	38501	11152	198713	49.3	24.8	19.3	6.5	13.8	19.2	21.2

Table 1: Combined NISP figures by site type for civilian assemblages considered in this study (dark grey); species shown as a % of total NISP of these species (mid grey); chicken as a percentage of the combined chicken and cattle NISP, chicken and sheep/goat NISP, and chicken and pig NISP respectively (pale grey). Section (A) shows percentages calculated from the total NISP values of all sites combined. Section (B) shows the average percentages when calculated for each site individually.

Region	Site	Type	Assemblage Date	NISP	S/G	Chicken	%Chicken	Comments and original source
Central Belt	Broughton Manor Farm	unenclosed farmstead	1st C BC-mid 1st C AD	97	78	19	19.59	Chicken bones from cremations (Atkins et al 2014)
Central Belt	Wavendon Gate, Milton Keynes	enclosed farmstead	1st C BC/AD	209	171	38	18.18	Chicken bones from cremations (Dobney and Jaques 1996)
Central Belt	Pasture Lodge Farm, Long Bennington	farmstead (unclassified)	3rd-4th C AD	412	342	70	16.99	Includes chicken ABG (Harman 1994)
Central Belt	Woolram Wygate, Spalding	farmstead (unclassified)	3rd-4th C AD	72	55	17	23.61	Includes chicken ABG (Wood 2006)
South	Maiden Castle Road	farmstead (unclassified)	1st-4th C AD	224	186	38	16.96	Chicken bones from inhumation (Bullock and Allen 1997)
East Anglia	Foxton	complex farmstead	1st-4th C AD	366	297	69	18.85	Chicken bones from inhumation (Maynard et al 1997)
Central Belt	Empingham	enclosed farmstead	3rd-4th C AD	273	221	52	19.05	Most chicken bones from a well (Morrison 2000)
South	St Georges Road, Dorchester By-pass	field system	3rd-4th C AD	135	106	29	21.48	Chicken bones all from one pit (Bullock and Allen 1997)
Central Belt	Brogborough Hill (A421 Site 2)	complex farmstead	2nd-3rd C AD	60	34	26	43.33	All chicken bones from one oven (Barker et al 2006)
Central Belt	Langdale Hale, Earith, Colne Fen	complex farmstead	2nd-3rd C AD	250	182	68	27.20	Site includes specialist butchery deposits (Higbee 2004)
West Midlands	Grimstock Hill, Coleshill	enclosed farmstead	1st-2nd C AD	84	64	20	23.81	All chicken bones from one context (Magilton 2006)
North-East	Burnby Lane, Hayton	farmstead (unclassified)	3rd-4th C AD	185	131	54	29.19	Many bones from well (Halkon et al. 2017)
Central Belt	Abingdon, The Vineyard	village	1st-4th C AD	50	42	8	16.00	(Wilson 1993)
South	Fishbourne	palace	1st-2nd C AD	1035	797	238	23.00	34% in 1st C BC/AD deposits; 15% n 3rd-4th C AD (Allen 2011)
Central Belt	Latimer	villa	2nd-3rd C AD	61	43	18	29.51	(Branigan 1971)
Central Belt	Bancroft	villa	2nd-3rd C AD	111	74	37	33.33	1% in 1st-2nd C AD; 5% in 3rd-4th C AD (Levitan 1994)
South	Liss	villa	3rd-4th C AD	115	75	40	34.78	(Hamilton-Dyer 2008)
Central Belt	Yarford, Kingston St Mary	villa	3rd-4th C AD	291	220	71	24.40	7% in 1st C BC/AD farmstead (Allen 2006)
Central Belt	Castle Copse, Great Bedwyn	villa	3rd-4th C AD	1251	367	884	70.66	Very high % of pig; sieved (Payne 1997)
East Anglia	Braughing, Skeleton Green	roadside settlement	Late 1st C BC-mid 1st C AD	586	449	137	23.38	LIA oppidum (Ashdown and Evans 1981)
South	Heybridge, Elms Farm	roadside settlement	2nd-3rd C AD	302	247	55	18.21	2% in 1st-2nd C AD; 7% in 3rd-4th C AD (Johnstone & Alberella 2002)
South	Staines, Friends' Burial Ground site	roadside settlement	2nd-3rd C AD	432	342	90	20.83	9% in 1st-2nd C AD; 0% in 3rd-4th C AD (Chapman 1984)
South	Staines, Elmsleigh Centre 1975-78	roadside settlement	3rd-4th C AD	318	260	58	18.24	5% in 1st-2nd C AD (Chapman 2010)
Central Belt	Wimpole	roadside settlement	3rd-4th C AD	92	70	22	23.91	(Horton et al 1994)
South	Shadwell, Tobacco Dock	roadside settlement	3rd-4th C AD	292	211	81	27.74	Sieved; dominated by cattle (Douglas et al. 2011)