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Livestock and animal husbandry in early medieval England

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ABSTRACT

Major themes in the zooarchaeological record regarding livestock and animal husbandry in England from the 5th to 11th Centuries AD are reviewed. The 5th–7th centuries, following the end of Roman rule, are particularly challenging, though evidence is emerging of greater continuity of pastoral production than the structural and artefactual record might suggest. The re-emergence of nucleated settlements in the 8th century led to diversification of deposition, especially between monastic and trading sites. Comparing 'Saxon' and 'Danelaw' regions from the late 9th to early 11th centuries shows some hints of differing traditions, but with regional constraints predominating. For the future, new biomolecular research offers great potential, but will need to be driven by archaeological questions, not analytical opportunism.

1. Introduction

Between the 5th and 11th centuries, the region that we now call England underwent a series of historical and cultural changes, some of which materially affected the archaeological record, while others were changes of regime that were more visible historically than archaeologically. At the beginning of that period, England was emerging from four centuries as a province of Rome, and we are in the dark regarding the degree of continuing urban life, economic systems, and the impact on livestock management. By the end of the period, urban life had been reinvented, cash-based economies were flourishing, the rural landscape was planned and productive, and England was worth invading. This paper offers a selective overview of the zooarchaeological record from England for this period, focusing on some of the major cultural changes and shifts of settlement pattern. The aim is not to provide a comprehensive review of all the available evidence, but to pick out several important themes within this period and to explore our current state of knowledge. Fig. 1 locates the sites discussed in this paper.

2. End of *Britannia*?

The classical historical account of the end of Roman hegemony in *Britannia* is agreeably simple. By the beginning of the 5th century, the Western Roman Empire had major internal problems, coupled with increasing incursions from Germanic peoples around the North Sea. In AD410, Honorius issued the famous message to agents of Roman authority in Britain that the region was no longer under the protection of the Empire, and they must fend for themselves. Traditional narratives assert that this rapidly led to the withdrawal of the Roman military, of Romanised elites, Roman currency, cuisine, baths and most other attributes of civilisation, and the collapse of Britain into the pagan squalor of the Dark Ages.

The archaeological record is less clear, with some sites showing clear changes of settlement density from the mid-4th century onwards (Dobney et al., 1998), whilst others continue into the 5th and early 6th centuries (Millett, 1983; Hammon, 2011). None the less, some influential voices have seen the fall of Roman Britain as nothing less than catastrophic (e.g. Wickham, 2005), whilst others, such as John Moreland (2011), see a process of change that began in the 4th century and led to a shift in power from the state to elite individuals situated in their local communities. A similar point is made by Lewit (2009), who sees a general trend away from cattle-raising in western Europe in the 5th–6th centuries as a response to the removal of a taxation system based on cattle and cereals, and an adjustment to local terrain and opportunities. On this model, the extensive restructuring of towns in the later Roman period and the rise of the villa estates reflected an underlying socio-economic trend, with the general abandonment of villas in the 5th century a matter of choice rather than catastrophe. In the forts and *vici* of the military zone of northern *Britannia*, the 5th century evidence from sites such as Binchester has been argued to show a gradual merging of 'Roman' and native identities reflected, for example in the increased use of formerly military areas for carcass-processing activities (Petts, 2013). The cessation of a supply of base-metal

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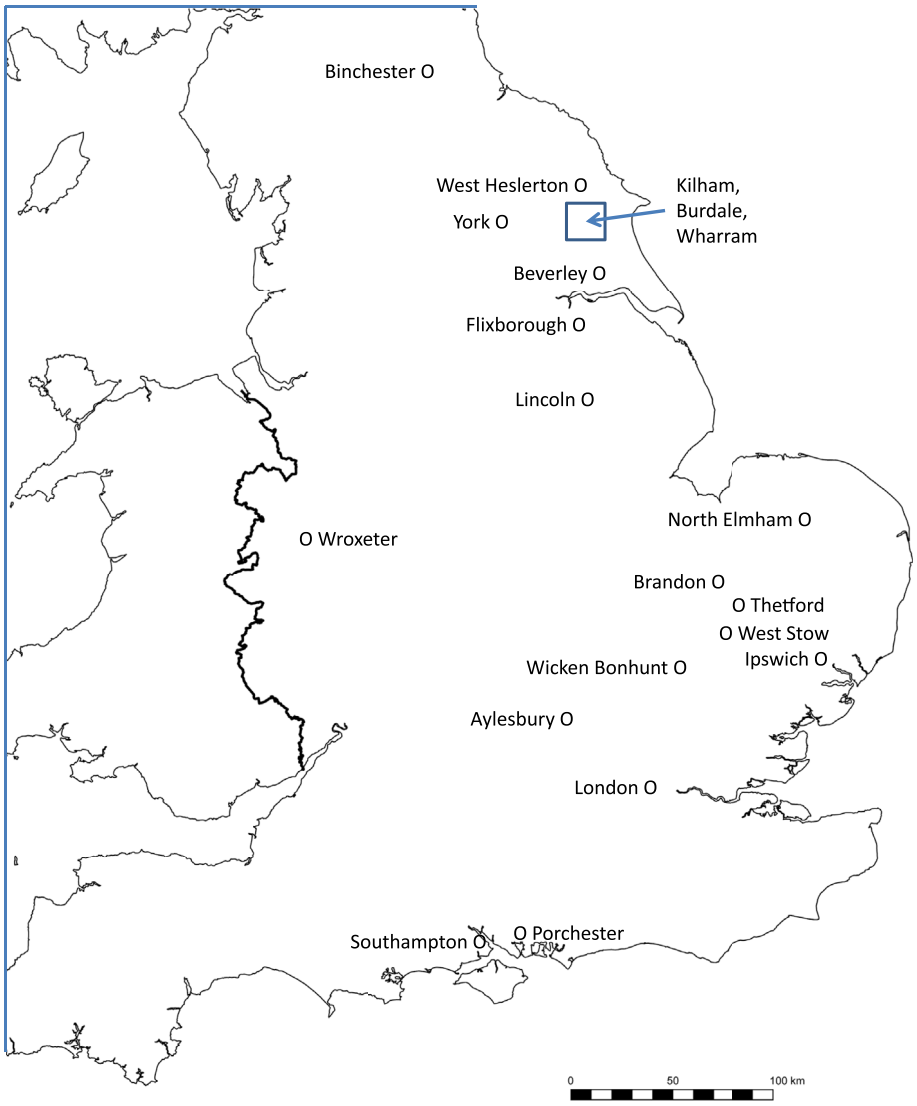

Fig. 1. Map of locations within England referred to in this paper.

coinage required a different socio-economic accommodation, though the magnitude of animal bone deposition clearly shows that cattle were managed and butchered on a large scale.

The archaeology of Roman towns in England is ill-suited to investigation of the 5th and 6th centuries. Typically, deep and complex medieval stratigraphy with good dating evidence back to the 8th–10th centuries overlies and interdigitates with Roman surfaces and structures with firm dating into the 4th century. Somewhere between the two main phases, often in small patches isolated by later down-cutting of pits and ditches and upstanding Roman walls, there will be ambiguous traces of deposition that it is all too easy to attribute to the medieval sequence or, if sufficient redeposited Roman pottery is encountered, to the Roman stratigraphy (Fig. 2). Even if 5th–6th century structures are identified within the Roman layout, there is a tendency to attribute these structures to 'squatters', more or less camping out amongst the ruins of civilization, rather than to urban life continuing in a different building tradition: the legacy of E.T. Leeds persists (Addyman, 1972; Rogers, 2011).

At Wroxeter, Shropshire, Philip Barker's meticulous open-area excavation in the *basilica* area demonstrated the presence of

Fig. 2. Fragmented surviving early post-Roman stratigraphy and structures at Wellington Row, York. Image courtesy of York Archaeological Trust.

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substantial post-Roman buildings, and Hammon (2011) has conducted a zooarchaeological study. The results show little indication that the surrounding landscape underwent major changes, with quantities of the major domestic livestock deposited at Wroxeter, cattle the most abundant. The relative abundance of cattle actually increases during the 6th century, opposite to the trend identified by Lewit (2009). Through the 5th to 7th centuries, there is little evidence of major changes in husbandry: the mortality profiles for cattle, for example, change little through this period, with fully adult animals wholly predominating. It would, of course, be a mistake to regard cattle only in utilitarian terms: early medieval Ireland is a reminder that they were more than just meat (Lucas et al., 1988; McCormick, 2008). However, whether for economic or for more symbolically-embedded reasons, the delivery of adult cattle into Wroxeter continued through the 5th–7th centuries, indicating some consistency in the structure and utilisation of the surrounding countryside. Other trends in the data are quite minor. There is, for example, just a small increase in the relative proportion of wild animals. Comparing the later Roman evidence with the early medieval, Hammon notes a shift from butchery by chopping to butchery by 'filleting'. In all, though, Wroxeter gives the impression that, at least in terms of animal husbandry and supply, life went on.

Wroxeter is exceptional in having a detailed zooarchaeological study of the earliest medieval phases. This is in part a tribute to Barker's remarkable perspicacity in his excavation of the *basilica* and in part because the site was subsequently abandoned to agricultural use, and so lacks intrusive overlying medieval archaeology. In most of the other cities of *Britannia*, we may suspect that there are good 5th–7th centuries bone assemblages to study, but struggle to recognise them amongst the tons of archived animal bones from urban excavations. In York, it has taken years of patient research by Whyman (2001) to disentangle 5th–6th century structures and deposits at the important Wellington Row site. Detailed work has yet to be undertaken on animal bones from the site, though preliminary assessments show continued deposition of animal bones, with no marked departure from the assemblages seen earlier in the Roman period. A post-Roman bone assemblage from excavations beneath York Minster has been the subject of a good deal of speculation. A recent reassessment by Gerrard (2007) concludes that the bones, characterised by an abundance of very young pigs, represent high-status feasting by local elites in the redundant headquarters building of the former legionary fortress. Not squatting amongst the ruins of civilization, then, but celebrating?

3. Early Anglo-Saxon rural settlements

The archaeology of the early Anglo-Saxon period in England (i.e. the later 5th–7th centuries) is best known from the many inhumation and cremation cemeteries (e.g. McKinley, 1994; Parfitt and Anderson, 2012). We know more about the way of death of these first Germanic settlers than we do of their way of life. Animals featured in their funeral rituals (Bond, 1996; Bond and Worley, 2006), with horses sometimes buried in the same grave-cuts as people, or vice versa (Cross, 2011). A few settlement sites of this date have yielded animal bone assemblages, and a picture is gradually emerging of small mixed-farming communities to whom the term 'peasant' is quite applicable.

Probably the best known of the early Anglo-Saxon sites is West Stow, in Suffolk, Variously excavated in 1957–61 and 1965–72, the site yielded an assemblage in excess of 175,000 fragments from pits, ditches, post-holes and Grubenhauser (Crabtree, 1989a, 1989b; 1990, 1994). Table 1 summarises the abundance of the main livestock taxa for West Stow and two contemporary sites in East Yorkshire. West Stow shows a predominance of caprines, probably mostly sheep, though on MNI estimates cattle outnumbered caprines, and probably provided the majority of the red meat consumed at West Stow if the animal bone samples reflect carcass utilisation with fidelity. The two East Yorkshire sites differ a little from West Stow in having a higher proportion of cattle bones and appreciably less pig. West Heslerton (Richardson, 2011) and Kilham (Archer, 2003) were recorded and analysed by different people, so inter-observer effects cannot account for the close similarity between these two sites, and the contrast between them and West Stow. Kilham is located on the chalk hills of the Yorkshire Wolds, and West Heslerton lies at the northern foot of the same hills. The relative dearth of pigs may reflect a lack of, or lack of use of, woodland pannage in East Yorkshire. The high abundance of cattle may indicate that the two Yorkshire sites had more land under the plough than did West Stow.

Table 1
Major livestock taxa from early Anglo-Saxon rural sites.

Sample	Source	Cattle	Caprine	Pig	Total	% Cattle	% Caprine	% Pig
Kilham, Early Saxon	Archer 2003	1199	1253	126	2578	46.5	48.6	4.9
West Heslerton, Anglian	Richardson 2001	10,455	11,187	2112	23,754	44.0	47.1	8.9
West Stow Phase 1	Crabtree 1990	2539	3479	1638	7656	33.2	45.4	21.4
West Stow Phase 2	Crabtree 1990	4811	6944	1912	13,667	35.2	50.8	14.0
West Stow Phase 3	Crabtree 1990	523	725	308	1556	33.6	46.6	19.8

Age-at-death profiles from these early sites are consistent with a mixed-farming and stockbreeding economy (O'Connor, 2010, 370–1). Amongst the cattle from West Stow, Crabtree (1989b, 69–96) noted a peak of young animals, possibly divisible into perinatal deaths and deaths of calves in their first autumn. West Heslerton also has a minor peak of perinatal calves and some deaths during the calves' first winter, just a little later in the year than at West Stow. Kilham, in contrast, had mostly adult cattle, with only a few 2–3 year-olds, albeit in quite a small assemblage. Kilham also lacks young sheep, whereas both West Stow and West Heslerton included lambs that died in the autumn to early winter of their first year, at about 6–8 months old. However, neither site yielded perinatal lambs, so perhaps perinatal deaths were disposed of away from the settlement. If spring lambing took place on designated pastures, perinatal deaths may well have been disposed of at that location. Whether they were buried or left to the crows, those remains are unlikely to have entered the archaeological record. The autumn-winter death of calves and lambs may represent deliberate culling or loss of stock through disease or hardship, or a little of both. If these early settlements were relatively self-sustaining, there may have been a strong case for culling stock in order to match the available winter pasture and fodder, and perhaps to meet projected future needs for replacement stock.

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Crabtree (2012, 14–15) summarises results from a number of smaller Early Saxon sites in eastern England. What they show is appreciable variation between sites in terms of the relative abundance of the major taxa. Although differences in taphonomy and recovery will have affected the results to some degree, the quite distinct differences from site to site probably reflect a rural economy that was not highly integrated in the 6–7th centuries, with the result that local decisions and traditions drove local husbandry strategies.

4. Middle Saxon rebirth of towns

Towards the end of the 7th century, a significant cultural change swept across northern Europe with the re-establishment of nucleated settlements that can be recognised as towns. Although we would now argue for some degree of continuity in the former Roman towns of *Britannia*, the settlement shift and economic reorganisation that marked the end of the 7th century is something quite distinct (Hamerow, 1996). In the archaeological record, a number of what would become England's main medieval towns and cities show an 8th century phase of deposition. Informative bone assemblages have come from, amongst other places, Southampton (Bourdillon and Coy, 1980; Bourdillon, 1994), Ipswich (Jones and Serjeantson, 1983; Crabtree, 2012), Thetford (Jones, 1984), Brandon (Carr et al., 1988), Lincoln (O'Connor, 1982), York (O'Connor, 1989, 1991), Beverley (Armstrong et al., 1991; Scott, 1991) and London (West, 1993a, 1993b). Table 2 summarises the main livestock from these Mid-Saxon sites. Exactly what these assemblages represent in economic terms is open to question: do they represent the consumption part of a market economy or provisioning under a command economy (O'Connor, 2001; Roskams and Saunders, 2001)?

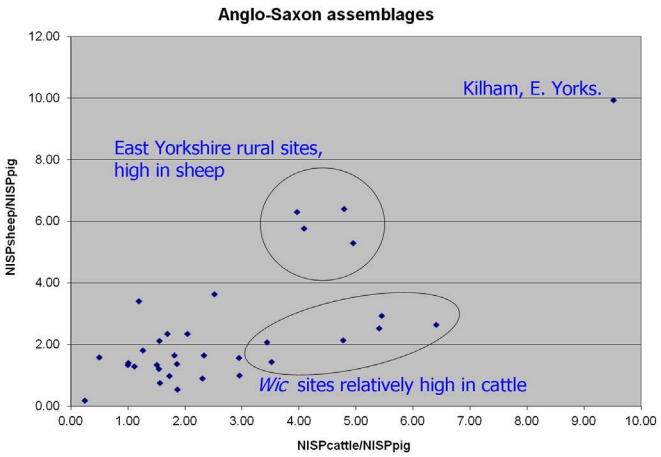

Fig. 3. Anglo-Saxon assemblages distributed in terms of cattle and sheep NISP in relation to pig NISP, showing the tendency to a higher ratio of cattle to pig at *wic* sites.

Second, the age at death distributions of livestock are unlikely to reflect husbandry priorities alone. Although adult cattle predominate, York, Ipswich and Lincoln all show a minor peak of animals killed at around 24–30 months old, as the third molar was forming or just beginning to erupt. These cattle would have been prime stock, reaching adult body size and just coming up to breeding age. It is difficult to explain a cull of such potentially valuable animals in purely husbandry terms. Similarly, a few sites show a minor peak of

Table 2
Major livestock taxa from Saxon 'town' sites

Sample	Source	Cattle	Caprine	Pig	Total	% Cattle	% Caprine	% Pig
Beverley Lurk Lane phase 4	Scott 1991	2162	882	614	3658	59.1	24.1	16.8
Beverley Lurk Lane phase 5	Scott 1991	1921	651	649	3221	59.6	20.2	20.1
Ipswich, Vernon Street	Jones and Serjeantson 1983	3408	1934	1973	7315	46.6	26.4	27.0
Ipswich Middle Saxon	Crabtree 2012	4282	2206	3130	9618	44.5	22.9	32.5
Lincoln Flaxengate Timber Phase 1	O'Connor, 1982	791	425	145	1361	58.1	31.2	10.7
Lincoln Flaxengate Timber Phase 2	O'Connor, 1982	2856	1338	528	4722	60.5	28.3	11.2
Lincoln Flaxengate Timber Phase 3	O'Connor, 1982	1094	489	229	1812	60.4	27.0	12.6
London, Jubilee Line	West 1993a	843	329	365	1537	54.8	21.4	23.7
London, Maiden Lane	West 1993a	2898	850	1547	5295	54.7	16.1	29.2
London, National Gallery Extension	West 1993b	475	661	470	1606	29.6	41.2	29.3
London, Peabody Buildings	West 1993b	2292	1118	1466	4876	47.0	22.9	30.1
Southampton, Melbourne St	Bourdillon and Coy 1980	23,888	14,477	6949	45,314	52.7	31.9	15.3
Thetford	Jones 1984	919	650	394	1963	46.8	33.1	20.1
York, Fishergate Period 3	O'Connor 1991	8296	3421	1295	13,012	63.8	26.3	10.0

The case for indirect provisioning rests on two particular aspects of the faunal data. First, a strikingly consistent feature of Middle Saxon assemblages from these newly-founded 'towns' is their low species diversity (Fig. 3). The three main livestock taxa overwhelmingly predominate, with small amounts of chicken and goose bones, very few mammal or bird bones from species likely to have been hunted, and very few fish. This cannot be attributed to recovery or identification bias, as the low diversity is equally apparent in sieved assemblages, and in material recorded by experienced zooarchaeologists with access to substantial reference collections. The assemblage from Fishergate, York, is typical: 61% of identified specimens were of cattle, and 'wild mammal' specimens were mostly pieces of red deer antler working waste. Only 0.1% was wild birds, and those were mostly corvids and scavengers such as buzzard *Buteo buteo* and red kite *Milvus milvus* (O'Connor, 1991). Corvids are almost the only wild bird taxa represented at the *wic* sites at Ipswich and London (Crabtree, 2012, 24).

young sheep, killed between 6 and 12 months old, or a little older in the material from York (O'Connor, 2010, 370–1). Comparison of dental and epiphysial evidence for pigs from York and London sites shows an interesting anomaly, namely young pigs represented by limb bones but distinctly under-represented by the dental evidence. Given the durability of pig mandibles and teeth, this is the opposite pattern to what one would expect from a bias induced by taphonomic factors. The evidence indicates that carcasses of young pigs came into Middle Saxon York and London as headless, dressed carcasses, rather than as live animals. In the case of York, the dental data show two distinct peaks, representing animals just over one year old and just over two years old. Taking the diversity and mortality evidence together, they are more consistent with the provisioning of settlements by the redistribution of livestock

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acquired in rent and tribute than with a direct producer-consumer market system. The low diversity indicates that the residents of places such as York and London in the 8th century had little means or opportunity to acquire food resources such as wild birds and fish independently of a livestock provisioning system.

These Middle Saxon sites have other attributes in common. They were often established on 'green-field' locations, close to but away from pre-existing centres of settlement. Thus in London, the Middle Saxon settlement is centred along today's Strand, to the West of the Roman city. At York, the 8th century settlement centred around the Fishergate area, South of the Roman fortress. The English sites show connections with their equivalents in Continental Europe, along the coast and major rivers from northern France (e.g. Quentovic) through the Netherlands (e.g. Dorestad) to Jutland (e.g. Ribe), in the form of imported goods such as ceramics and Mayen lava quernstones, and in the distribution of *sceatta* coinage. The English and Continental examples appear to have been busy trading sites, arguably maintained by regional elites as a means of articulating wealth and display (Hill and Cowie, 2001). A number of them have historically-recorded or modern place names that include the element – *wic*, hence the use of '*wic* sites' or 'emporia' as general terms for trading sites of late 7th to early 9th century date around the North Sea. It may be over-generalising to suppose the same economic basis for all of them, or to suppose that indirect provisioning and a market economy are mutually exclusive. Hamerow (2007) examines the economy of these emporia in detail, and concludes that some element of market exchange with the rural hinterland happened at most if not all of them, in parallel with maintenance by aristocratic and/or ecclesiastical elites.

England has other Middle and Late Saxon sites, which do not fall into the '*wic*' template (Table 3). Some represent high-status sites, perhaps the estates of just the elites thought to have maintained the '*wic*' sites. Wicken Bonhunt is a good example, notable for its remarkably high predominance of pig remains. North Elmham and Portchester Castle fall into this category, though without such striking bone assemblages. Flixborough is more problematic. When first under excavation, the Middle Saxon phases resembled what is typically seen at '*wic*' sites, extensive, dense accumulations of refuse including much animal bone, associated with relatively simple structural evidence of rectilinear timber buildings set within enclosures defined by ditches that eventually fill up with the same occupation debris. During post-excavation analysis, and particularly in relation to the later phases, an ecclesiastical and/or monastic association was proposed, and the site may well have changed 'management' over the 8th and 9th centuries (Dobney et al., 2007).

Recently published work from Aylesbury, a market town of medieval origins to the north-west of London, includes an intriguing bone assemblage from a Middle Saxon boundary ditch (Farley and Jones, 2012). It is argued that the ditch is "highly likely" to have been the boundary of an 8th century minster church, largely because of the proximity to the extant St Mary's church, which has pre-Conquest origins. If this ecclesiastical connection is sound, the Aylesbury ditch nicely parallels the situation at Flixborough. The bone assemblage is distinctive, with caprine bones outnumbering those of pigs, and pigs outnumbering cattle, roughly in the ratio 3:2:1. This is unusual amongst the sites considered here, with only phase 1 at Brandon showing similar relative abundance results. Brandon has other parallels with Aylesbury, in its spatial association between intensive Middle Saxon activity and a subsequent church (Crabtree, 2012, 1–3). The Aylesbury assemblage had few bones of other mammals, and the bird bones are predominantly of domestic fowl and goose. Wet-sieving produced a modest assemblage of fish bones, all of them identified as medium-sized eels (*A. anguilla*). The cattle bones include more immature animals than is usual in Middle Saxon assemblages. Epiphysial fusion evidence indicates that half died by the age of 2–2.5 years. The sheep, too, included a number of younger individuals, prompting Jones to suggest "a relatively unintensive use of the sheep flock" (Farley and Jones, 2012, 100).

Despite the possible association with an early church, the Aylesbury assemblage thus has some of the characteristics of those from *wics*, raising some of the same questions as Flixborough. Some previous reviews of Middle Saxon animal bone assemblages, including by this author, have probably been too ready to make a distinction between *wic*- and *non-wic* sites, and we should acknowledge a more porous and shifting boundary between those categories. None the less, if the 'low-diversity' Middle Saxon assemblages are representative of a form of elite-led redistribution, articulated through specific locations of fairs and markets, then subsequent ecclesiastical associations may show either that the church *was* the original controlling elite at that location or that the market location was gifted to the church.

Some apparent regional trends continue into the Middle and Late Saxon periods. The results from Brandon broadly resemble those from nearby, and earlier, West Stow, whilst those from Middle Saxon West Heslerton and Wharram South Manor resemble Early Saxon examples from East Yorkshire in showing a low proportion of pig bones, though with sheep more abundant in the Middle Saxon phases. The assemblage from Burdale, a nearby Yorkshire Wolds site of Middle Saxon date (Fig. 4), shows the same predominance of sheep and scarcity of pigs, though the

Table 3
Major livestock from Saxon sites other than 'towns'.

Sample	Source	Cattle	Caprine	Pig	Total	% Cattle	% Caprine	% Pig
Aylesbury	Farley and Jones 2012	205	610	413	1228	16.7	49.7	33.6
Brandon, Suffolk; Period 1	Crabtree and Campana, 1991; Crabtree, 1996	337	1063	670	2070	16.3	51.4	32.4
Brandon; Period 2	Crabtree and Campana, 1991; Crabtree, 1996	401	1148	336	1885	21.3	60.9	17.8
Brandon; Period 3	Crabtree and Campana, 1991	491	563	240	1294	37.9	43.5	18.5
Burdale, Yorks.	Richardson, 2012	1099	2678	320	4097	26.8	65.4	7.8
Flixborough Phase 2-3a	Dobney et al., 2007	1104	872	716	2692	41.0	32.4	26.6
Flixborough Phase 4-5b	Dobney et al., 2007	2557	3440	2559	8556	29.9	40.2	29.9
Flixborough Phase 6	Dobney et al., 2007	2567	2277	1702	6546	39.2	34.8	26.0
Flixborough Phase 6iii	Dobney et al., 2007	1042	950	574	2566	40.6	37.0	22.4
North Elmham Park; Period 1	Wade-Martins, 1980	2424	2808	2182	7414	32.7	37.9	29.4
North Elmham Park; Period 2	Wade-Martins, 1980	1046	1503	827	3376	31.0	44.5	24.5
Portchester Castle	Grant, 1975	5074	2695	1719	9488	53.5	28.4	18.1
West Heslerton Mid Saxon	Richardson, 2011	3155	4216	658	8029	39.3	52.5	8.2
Wicken Bonhunt	Crabtree, 1996; Wade, 1980	5138	3853	20,954	29,945	17.2	12.9	70.0
Wharram South Manor Phases 2 + 3	Pinter-Bellows, 2000	1170	1863	295	3328	35.2	56.0	8.9
Wharram South Manor Phase 4	Pinter-Bellows, 2000	646	911	158	1715	37.7	53.1	9.2

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Fig. 4. Aerial view of Middle Saxon settlement at Burdale, East Yorkshire, under excavation in 2007. Photograph by Ben Gourley and Pat Gibbs.

relative abundance of domestic fowl is quite high compared with Middle Saxon sites in general. Wharram South Manor is particularly interesting, as the accumulation of middens there resembles the accumulations at Flixborough and some '*wic*' sites, even though Wharram is high on the dry Yorkshire Wolds, at some distance from the coast or a navigable river. Wharram also yielded a deposit of dog and cattle bones that appears to have been a deliberate, perhaps ceremonial emplacement (Stamper and Croft, 2000, 36–7). The subject of 'special' bone deposits on Saxon sites has been reviewed by Hamerow (2006) and reconsidered by Morris and Jervis (2011), who argue for less dualism in our interpretation of 'functional' and 'ritual' assemblages of animal bones.

5. Scandinavian influence in Danelaw?

Through the 9th to early 11th centuries, a historically-significant boundary was established across England, between what we may call the Saxon region to the south and west, and a Scandinavian-influenced Danelaw to the north and east. It is debatable to what extent this boundary was economic or ethnic. Clearly it was linguistic, as the extent of Danelaw can still be mapped within 21st-century England by the distribution of place-names of Danish and Norwegian origin (Higham and Ryan, 2011). However, pre-Conquest England was probably more polyglot than we might suppose, and patches of distinctively Saxon village names persist even in the Yorkshire heart of Danelaw. Did the Scandinavian settlers bring different husbandry practices and objectives to northern England?

The evidence is a little ambiguous. As Fig. 5 shows, in comparisons of the three main livestock taxa, sites from the Danelaw tend to show a higher relative abundance of cattle, especially relative to pigs. However, the two most 'cattle-dominated' assemblages in Fig. 5, although from York, are both too early in date to represent Scandinavian influence. Therefore, although some greater tendency towards cattle husbandry may be inferred for Danelaw sites, it is by no means consistent or characteristic. Most of the Danelaw assemblages in Fig. 5 are from sites in low-lying regions, often on clay-rich soils derived from till or alluvium. In that environment, it would have been necessary to maintain larger plough-teams of oxen than in regions with lighter soils, and that factor alone may account for the distribution seen in Fig. 5. Mortality data for cattle from the Danelaw sites is fairly consistent in showing a predominance of adults, with some animals killed a little younger, probably in their third summer (e.g. see O'Connor, 2010, Table 4). The paucity of young calves is striking, even in well-preserved material recovered with due care, though we should remember that these assemblages are from urban settlements, not from the rural sites where cattle were raised and where casualties from calving and disease are likely to have been buried.

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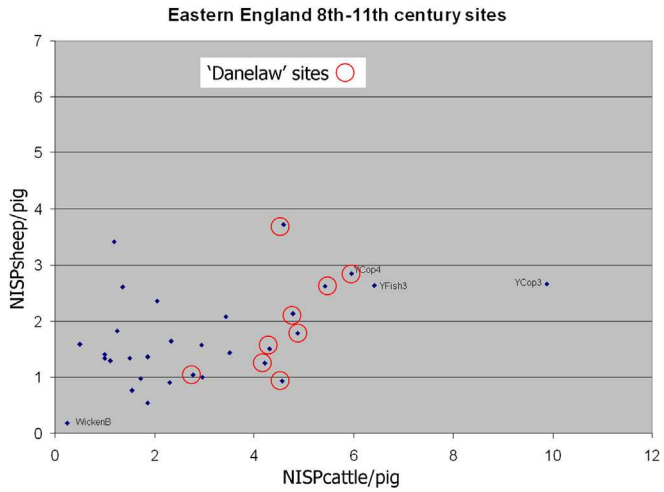

Fig. 5. Cattle and sheep to pig ratios in 8–11th century assemblages, with sites in the Danelaw region denoted.

Broader comparisons across northern Europe put the English evidence in a larger context (O'Connor, 2010). A number of assemblages from Continental Europe stand out by reason of a high relative abundance of pig bones. These 'high pig' sites range from Denmark and southern Sweden across northern Germany and into Poland. More of them are at the eastern end of this distribution than at the western end, and there is a clear correlation between the relative abundance of pigs (relative, that is, to cattle and sheep), and the longitude of the site. Site-by-site discussion therefore has to calibrate the relative abundance against this underlying trend. A few sites stand out as 'high pig' relative to their longitude, notably Birka, Hedeby, late 10th century York, and Fishamble Street, Dublin. Birka, Hedeby and Dublin can be characterised as enclosed port-of-trade sites, looking offshore for their economic relations and, certainly in the case of Dublin, perhaps uneasy about the reliability of supplies from their hinterland. York in the last quarter of the 10th century was back in English hands for a while, but far from secure, and the same uncertainty may have applied here too (O'Connor, 2004). For those settlements and others in similar circumstances, pigs may represent a more secure source of meat supply. Cattle and sheep are more closely integrated with the rural economy, and could not readily be produced as a meat resource on limited areas of land close to settlements. Pigs, on the other hand, have little role other than to produce meat (and more pigs), and may be raised in comparatively small spaces including within the settlement itself. That said, recent stable isotope studies have shown that pigs in post-Norman York were not, as previously thought, mostly kept in backyards and fed on scraps (Hammond and O'Connor, 2013). We need to extend this isotope study to examine pig husbandry in and around the city in the 9th–early 11th centuries.

Perhaps the most obvious contrast between the Danelaw assemblages and their Middle Saxon predecessors in the same region is the greater abundance and diversity of bird and fish bones at the Danelaw sites. Apart from the domestic chickens and geese, a range of wild ducks, geese and wading birds are found in what are clearly domestic contexts. The exceptional preservation in central York has allowed the recovery of considerable quantities of eggshell fragments from 10th–early 11th century deposits. These fragments are too small to allow species identification on morphological grounds. However, an experimental technique that sequences peptide groups in the intracrystalline proteins of the eggshell has shown that most can be attributed to chickens and geese, consistent with the representation of these two species in the bird bone assemblages (Stewart et al., 2013). Two sites within central York, roughly contemporaneous and a few hundred metres apart, differ in that Coppergate has yielded eggshell from ducks, whereas Hungate, more on the fringes of the settlement, has not, and Coppergate also yielded a higher frequency of goose egg-shell (Fig. 6). Whether the Coppergate results represent domestic duck husbandry in this neighbourhood, or simply the collection of wild mallard eggs has yet to be determined. The eggshell proteins do not differentiate these two ecomorphs of *Anas platyrhynchos*. Fishbones from these Anglo-Scandinavian sites show considerable exploitation of eels (*Anguilla anguilla*) and herring (*Clupea harengus*), with a consistent representation of cyprinid river fish. The representation of off-shore marine gadids increases in the early 11th century. In short, 10th–early 11th century assemblages, whether from the Danelaw or from the Saxon region, seem to show that households could acquire a wider range of animal resources than had been the case in the 8th–early 9th centuries, perhaps indicating a shift from provisioning of settlements through a command economy, to something approaching a monetised market economy.

6. Looking to the future

What are the research priorities for the zooarchaeology of early medieval England? The obvious answer is that we are short of good data for many regions and some periods of time. The published record for the Early Anglo-Saxon period consists of Wroxeter and a sample of sites in East Anglia and in East Yorkshire, but little else other than rather specialised sites that tell us little about animal husbandry, or rather small assemblages that tell us very little at all. Wroxeter and West Stow are rarities, and for the rest of these crucial centuries the data will come from small, isolated assemblages. The west and northwest of England are poorly sampled for the whole of the early medieval period, but it is unlikely that the solid and drift geology of the West Midlands and Lancashire, or of Devon and Cornwall, will allow anything more than sparse, very localised preservation of animal bones. Gap-filling aside, there are some research themes that emerge, often because new technical developments have made it possible to address questions that could not have been usefully posed even a decade ago.

Zooarchaeology continues to rely heavily on the interpretation of mortality profiles in order to infer husbandry practices and decisions. This is logical enough, though the techniques that we apply to these analyses mostly developed in the early 1980s, and their resolution is not optimal (O'Connor, 1998). Finer resolution of dental development stages, particularly in the more mature individuals, has seen some progress. Carter (2001) showed that

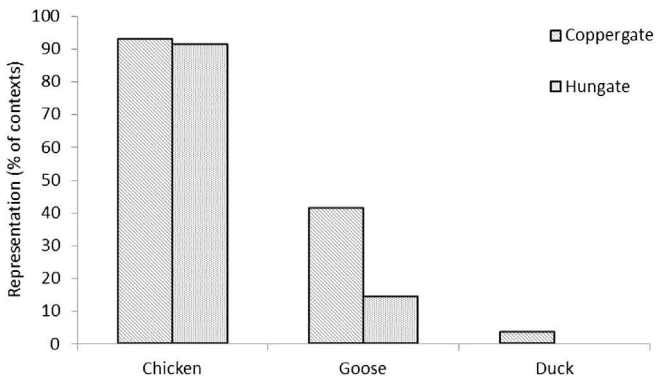

Fig. 6. Identifications of egg-shell from two Anglo-Scandinavian sites in York based on intra-crystalline proteins. Figure by John Stewart.

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radiographic examination of root development in mandibular dentition can give a more confident seriation within a sample of mandibles, although it adds little to the tricky process of adding calendar ages to that seriation (Fig. 7). Jones and Sadler (2012) have published a quantity of useful comparative data from known-age cattle, and have proposed useful procedures for defining tooth wear-stages that are reliably applicable to older cattle. However, even with finer and more confident resolution of age-stages, there remains the challenge of understanding the differential culling of males and females. McGrory et al. (2012) have demonstrated a DNA-based technique that allows cattle mandibles to be individually attributed to age and sex, considerably enhancing the interpretation of husbandry decisions. As extraction and analysis of ancient DNA becomes more routine and less prohibitively expensive, medieval zooarchaeology must be ready to seize the opportunity, developing the research questions and challenging the analysts to find a means of answering them, rather than allowing the analytical advances to drive the research.

One question that aDNA analysis can and must address is that of the population genetics of early medieval cattle. Put simply, the cattle within a given region may have acted as a single population, with appreciable and regular gene-flow between herds as beasts were traded and exchanged. Alternatively, they may have functioned as a metapopulation of relatively isolated demes, small, endogamous herds with little gene-flow between them. This is an important difference. Such a metapopulation would indicate a low degree of direct interaction between livestock producers such as individual farmsteads and villages, and make it more likely that distinctive local varieties would emerge, either through local selection or marked founder effect acting within a small descendant gene-pool. Until recently, this question would have been addressed through biometrical studies, testing for heterogeneity within large assemblages, or local distinctiveness in smaller ones, usually with little satisfactory result There is an urgent need for aDNA studies that directly address this question, probably by testing the homogeneity or otherwise of cattle from an urban site, so as to ensure the quantity and good preservation of samples, and quantifying the diversity of demes that contributed to the 'pooled' urban sample. At the time of writing, a series of cattle specimens from York is under genomic analysis at Trinity College, Dublin, though this project is directed towards detailed genome-building rather than genomic diversity at any one point in time.

Fig. 7. Digital radiographs of ungulate mandibles allow more precise estimation of age at death from root development. Radiograph taken by Sonia O'Connor.

Another area of research that needs development is the study of animal palaeopathology. Although there is increased interest in this topic, recording and interpretation have made few advances in the 30 years since Baker and Brothwell's influential book (Baker and Brothwell, 1980). Lower-limb arthropathies associated with the use of cattle for traction have attracted most research, and there is general acceptance that the stresses applied to the metapodial-phalangeal and inter-phalangeal joints of plough oxen will predispose those animals to develop osteoarthrosis and other strain-related arthropathies (Bartosiewicz et al., 1997; Telldahl, 2005). These are pathologies of the mature animal, reflecting its living environment. Osteochondroses, on the other hand, are pathologies of the growing skeleton, and are probably under-recorded and certainly under-researched (O'Connor, 2008). Within biomolecular archaeology, attention has turned to the potential of mineralized calculus as a repository of information about the genome of the individual animal and of its oral and alimentary biome (e.g. Preus et al., 2011). The skeletal consequences of paradontal and periodontal disease are routinely noted on mandible specimens of cattle and sheep. Now we have the technical capacity to test for associations with specific pathogenic organisms. Underlying all of this new research, however, there must be sound archaeological and historical questions, not least regarding evidence for the care and husbandry of early medieval livestock.

The early medieval zooarchaeological record from England is comparatively rich and diverse, enabling us to undertake detailed studies of some key sites, and to make regional comparisons based on useful numbers of data points. However, the historical richness of the period poses its own considerable challenges. What are we studying in the 5th and 6th centuries? A medievalist view might see this as the period in which a distinctively 'Saxon' cultural package emerged, including all the attributes of livestock husbandry, whereas a broad-minded prehistorian might see it more as the re-emergence of 'native' cultural practices, a sort of Post-Roman Iron Age. Summing up West Stow, Pam Crabtree (1989a,b, 107) points out the continuity of husbandry practices seen in East Anglia from the Iron Age through to Early Saxon times. In terms of animal management, then, the significant cultural shift may have come at the end of the 7th century as towns were established and the economic structuring of the landscape changed. This is also a time at which England clearly re-connected with the rest of Europe. The 5th–7th centuries obviously saw movements of people and goods back and forth, reflected not least by imported ceramics in burials (Huggett, 1988). However, the increase in trade that went on around the North Sea basin in the 8th century must have had its consequences in terms of altered pressures on regional pastoral economies and the introduction of new livestock and new ideas. The Scandinavian presence in the north of England has some zooarchaeological correlates, though no sharp contrasts with the Saxon south, and we should remember that the Danelaw had close connections with Viking Ireland, and thus with a socio-pastoral economy in which cattle assumed a far greater importance than as simple resources (Lucas et al., 1988; McCormick, 1995). The priority for early medieval zooarchaeology in England must be to embrace that cultural complexity and to use it to frame specific questions relating to the trade, movement and husbandry of livestock, making innovative use of the range of new techniques that are now available to us. In short, we need to move beyond the 'bone report' and to adopt a paradigm of targeted research.

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