

Zooarchaeology, Improvement and the British Agricultural Revolution¹

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This paper seeks to revisit the debate concerning the nature and timing of the British Agricultural Revolution. Specifically, it considers how zooarchaeological evidence can be employed to investigate later-medieval and post-medieval “improvements” in animal husbandry. Previous studies of animal bone assemblages have indicated that the size of many domestic species in England increases from the fifteenth century—an observation that has been used to support the writings of those historians that have argued that the Agricultural Revolution occurred several centuries prior to the traditionally ascribed date of 1760–1840. Here, zooarchaeological data are presented which suggest that the size of cattle, sheep, pig and domestic fowl were increasing from as early as the fourteenth century. However, it is argued that the description of these changes as revolutionary is misleading and disguises the interplay of factors that influenced agricultural practice in the post-Black Death period. This paper concludes with a plea for greater awareness of the value of collecting and analysing faunal data from the eighteenth and nineteenth centuries to enable the historically attested productivity increases of the traditionally dated Agricultural Revolution to be examined archaeologically.

KEY WORDS: zooarchaeology; improvement; Agricultural Revolution; animal husbandry; England.

INTRODUCTION

Understanding “improvement” in agriculture has been a central element of historical studies of the feudal/capitalist transition. The British Agricultural Revolution, in particular, has engendered a massive amount of debate in the

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literature, concerning its nature, timing and even existence. The principal focus of historical studies in this topic has tended to be land management and crop husbandry, partly reflecting the unsuitability of livestock data. As Albarella (1997), Davis (1997) and Davis and Beckett (1999) have demonstrated, however, archaeological animal bone assemblages have the potential to investigate this issue, since they enable long-term changes in animal husbandry to be charted.

In this paper, a review of previous historical and zooarchaeological debates concerning the nature of and timing of the Agricultural Revolution is outlined. This is followed by the presentation of faunal evidence from two recently studied sites, which challenge current perceptions of the nature of improvements in animal husbandry in later-medieval and post-medieval England. These data provide the opportunity to re-consider the conceptual validity of the Agricultural Revolution.

HISTORIOGRAPHY OF THE “AGRICULTURAL REVOLUTION”

The Agricultural Revolution has long been described as a widespread technological change in British farming practice that facilitated a sustainable increase in agricultural productivity. From the early twentieth century until the 1960s there was little doubt in the minds of historians that this occurred between about 1760 and 1840 in a movement intimately associated with the Industrial Revolution (e.g. Beckett, 1990, p. 1; Ernle, 1912). This was a phenomenon that enabled the farming community to feed a population that had grown by ca. 20 million in this period (Kerridge, 1967; Mingay, 1969; Turner *et al.*, 2001, p. 211). Some of the traditional features perceived to have led to this increase in productivity included:

- parliamentary enclosure of land;
- introduction of new farming technology (e.g. the seed drill);
- new crops and crop rotations;
- improvement in livestock breeding (Beckett, 1990, p. ix; Overton, 1984, p. 119).

These developments were viewed by historians as being largely facilitated by a small number of key innovators. Robert Bakewell, for example, became famed for selectively breeding and improving domestic animals in Leicestershire; his “New Leicester” breed of sheep fattened quicker and had a greater proportion of saleable meat, and his “New Longhorn” cattle carried a larger amount of fat (Beckett, 1990, pp. 24–25).

While Marc Bloch recognised, as early as 1931, that the term “Agricultural Revolution” was the consequence of a “slow process lasting from the late Middle Ages to the eighteenth century” (Verhulst, 1990, p. 17), it was not until the 1960s that many of Lord Ernle’s ideas, and the evidence upon which they were based, were more convincingly challenged; Eric Kerridge was perhaps the most

influential opponent in this regard. Kerridge (1967) forcefully argued that many of the innovations or practices that were viewed as constituting an eighteenth-century revolution in agriculture, did not occur at all, were insignificant, or occurred much earlier (Overton, 1984, p. 121). Indeed, he sought to argue that the Agricultural Revolution occurred in the sixteenth and seventh centuries and only received “finishing touches” from the likes of Bakewell (Kerridge, 1967, 1969). While Kerridge’s interpretation of the evidence was not unquestionably accepted (see, for example, Mingay, 1969), by the 1970s the period encompassed by the Agricultural Revolution was generally considered to range from 1560 to 1880, occurring in anywhere up to five stages and “varying considerably in its timing across different farming regions” (Beckett, 1990, pp. x, 9; Overton, 1996a).

More recent historical studies have *broadly* divided the study of this subject into two camps. One school contends that the change in agricultural practice, previously termed “the Agricultural Revolution,” was not revolutionary at all, but was rather a long and gradual process, which may have comprised various stages of significant development that varied considerably in space and time (Allen, 1991; Beckett, 1990; Thirsk, 1987). The other school has maintained that the concept of an Agricultural Revolution is valid and asserts that while earlier improvements in agricultural practice did occur, only the eighteenth and nineteenth centuries are deserving of that appellation because of the *magnitude* of change (Campbell and Overton, 1993; Mingay, 1989; Overton, 1996a, 1996b; Turner *et al.*, 2001).

Archaeology is well placed to contribute to this field of contention since it provides a line of enquiry that is independent of the historical crop and livestock data upon which the noted interpretations have largely been constructed. Indeed, a recent archaeological study has led to the formulation of an alternative understanding of agricultural “improvements,” arguing that not just one revolution occurred in the eighteenth and nineteenth centuries but many, with different regions following their own unique trajectories (Williamson, 2002, pp. 158–159). As both Overton (1984, p. 131; 1996a, p. 12) and Williamson (2002, p. 165) note, one of the key problems in the analysis of historical data has been that animal output and improvements in livestock are difficult to measure. Crucially, zooarchaeological evidence has the potential to redress this problem.

THE ZOOARCHAEOLOGY OF “IMPROVEMENT”

From a methodological standpoint, there are two principal means by which zooarchaeological data can be used to explore the issue of “improvement”: through the examination of changes in the conformation (size and shape) of animals, as established through the measurement of particular skeletal elements, and through the analysis of mortality profiles.

As Reitz and Ruff (1994, p. 699) note, animal body size is controlled by the complex interplay of both genotypic (genetic) and phenotypic (environmental)

factors. In domestic animals, for example, previous archaeological studies have shown how the conformation of animals can be influenced by environmental adaptation and geographical origin (e.g. Cossette and Horad-Herbin, 2003; Reitz and Ruff, 1994) and husbandry strategies (e.g. Higham and Message, 1969). Analysis of medieval and post-medieval fauna from Britain has also demonstrated that size and shape change can provide a proxy indicator of deliberate attempts to “improve” animal productivity (Albarella, 1997; Davis, 1997; Davis and Beckett, 1999). In the latter context, biometrical analyses can provide indications of the causes of change since tooth size is largely dictated by genotype and is less affected by environmental conditions during development, while the size of the post-cranial skeleton can be influenced by both genotypic and phenotypic factors. In effect, an increase in the size of skeletal elements, in the absence of a size change in teeth, might signify an “improvement” in nutritional intake, while any change in the size of teeth could be a consequence of selective breeding or the introduction of new stock.

Analyses of ageing data also have the potential to identify animal “improvement” since animals that fattened quicker may have been slaughtered at an earlier age—a development that would have facilitated an increased supply in meat. Such an interpretation requires the assumption that skeletal maturation (i.e. epiphyseal closure and dental eruption) was decoupled from flesh growth rates through selective breeding. While historical evidence indicates that this had occurred by the eighteenth century, with Bakewell’s new breeds of sheep being slaughtered at 2 years of age (Beckett, 1990, p. 25; Chambers and Mingay, 1966, p. 67), Daniel Defoe, who published a three-volume travel guidebook to Britain in the 1720s, noted that bullocks and sheep fattened very slowly (around 4 years of age) (Chambers and Mingay, 1966, p. 67). Thus, if the historical evidence is reliable, it seems unlikely that the separation of skeletal development and soft-tissue mass occurred prior to the eighteenth century. Moreover, while changes in mortality profiles are identifiable through the analysis of epiphyseal closure and tooth eruption and wear data, these may be affected by a range of other husbandry decisions, such as increasing consumer demand for tender meat; the emergence of more specialised farming (such as dairying and veal production); or changing emphasis on particular products (such as those required for the wool and cloth trade).

A supplementary means by which selective breeding might be identifiable is through the presence of certain congenital traits, such as the absent hypoconulid (third pillar) in cattle and sheep lower third molars (Miles and Grigson, 1990), or the congenital absence of the second premolar (Andrews and Noddle, 1975). Although it is hypothesised that these conditions might provide indications of gene flow, the full potential of this technique is yet to be fully realised (O’Connor, 2000, p. 122).

While the benefits of these approaches are clear, such data must not be interpreted uncritically. Firstly, we have to question the extent to which a change in the

conformation of domestic animals in later-medieval and post-medieval Britain is a marker of increased productivity. If we consider the statement made by Gervase Markham (a late sixteenth-/early seventeenth-century writer and poet) that “the larger that every cow is, the better she is” (cited in Davis and Beckett, 1999, p. 13), then such an assumption would appear valid. Furthermore, by the sixteenth century, substantially built Dutch cows were being imported into various parts of England for breeding (Trow-Smith, 1957, p. 203). However, we must consider the evidence presented by Kerridge (1967, pp. 313–314) who, in discussing the new stock associated with the Agricultural Revolution, noted that while the Midland Plain pasture sheep produced large quantities of mutton and wool, the animals had shorter legs. It is equally possible that other “improvements” may have had no discernible impact on the conformation of the skeleton, but resulted in developments of other desired characteristics, such as increased milk production, or finer quality meat or wool. Finally, it should be noted that “improvement” in one commodity might have resulted in deterioration of other aspects of the animal. For example, while Bakewell’s New Longhorn cattle were more fatty, they produced less milk and, despite their superior growth rate, his New Leicester sheep were unsuited to exposed environments (Beckett, 1990, p. 24).

Clearly, the zooarchaeological data are not unproblematic, but integrated with other lines of evidence they provide a potentially valuable source of information regarding “improvements” in animal husbandry in medieval and post-medieval Britain. In the following sections previous and new approaches to this theme of investigation are considered.

Previous Research

In the late 1990s, a number of zooarchaeological studies were published regarding the timing and nature of improvements in animal husbandry in later-medieval and post-medieval England. By plotting histograms of measurements of specific bones, an increase in the size of cattle and sheep between the fifteenth and seventeenth centuries was observed on a number of sites (Davis and Beckett, 1999, Table II). The size increase in cattle appears to have been rather sudden, for sheep it was a much more gradual phenomenon, while “improvements” in pig and domestic fowl were not observed before the seventeenth century (Albarella, 1997, p. 21). For the most part, this evidence consisted of post-cranial bone data, however, evidence from Launceston Castle, Cornwall (Albarella and Davis, 1996) and Castle Mall, Norwich (Albarella *et al.*, 1997) (Fig. 1), also revealed an increase in the size of cattle and sheep teeth. Thus, it was argued that the variation was at least partly a consequence of the introduction of new stock or artificial selection. This evidence was initially used to support the argument of historians such as Kerridge, that the Agricultural Revolution occurred earlier than originally supposed (e.g. Davis, 1997, p. 413), although a later reinterpretation

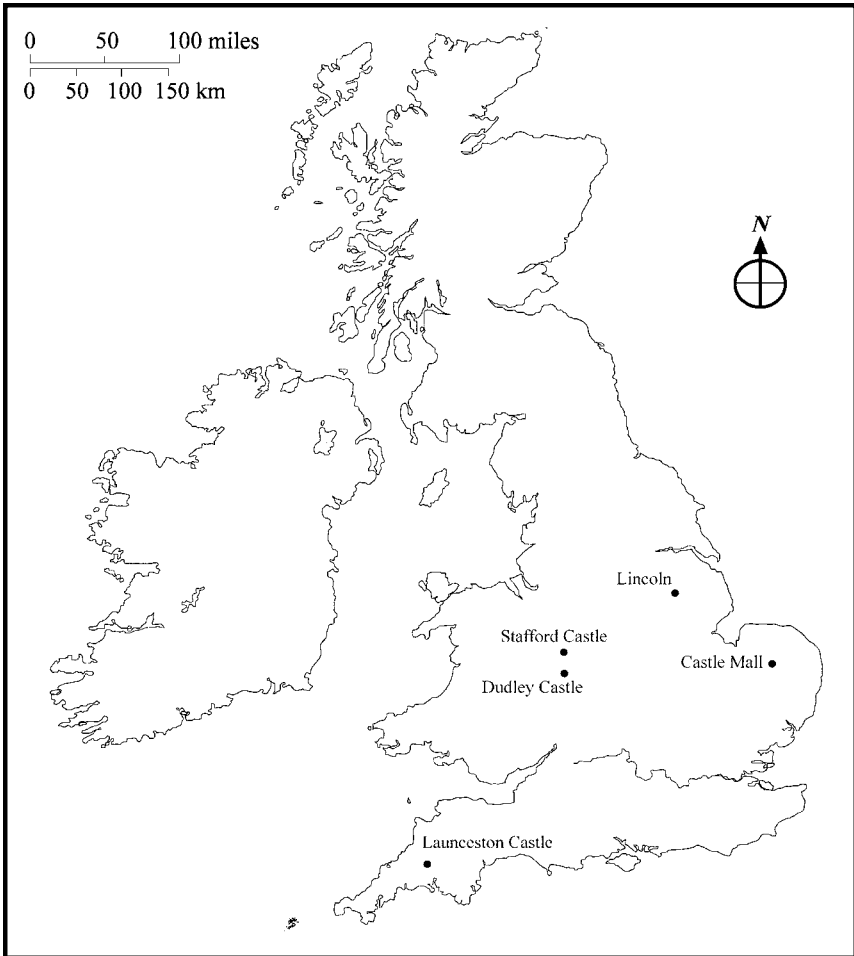


Fig. 1. Map of archaeological sites referred to in the text.

resulted in a more tempered perspective: “agricultural improvements were already underway in the 15th and 16th centuries, and . . . improvement in animal husbandry should be viewed more as a long term and gradual development . . . rather than a revolutionary one” (Davis and Beckett, 1999, p. 14).

New Evidence

We can turn now, however, to a sizeable body of faunal material, which has the scope to expand some of this earlier work and raise further questions concerning

the timing and nature of improvements in animal husbandry. Specifically, we can examine the large assemblage of animal bones from Dudley Castle, West Midlands (see Fig. 1).

The medieval market town of Dudley is situated 15 km north-west of Birmingham. Excavations were carried out at the castle there between 1983 and 1993 after growing concern that modern pollution, together with natural weathering, had left many of the friable sandstone structures of the castle in danger of collapse (Boland, 1984). During the excavation 10 phases of activity were identified stretching from the eleventh to the eighteenth centuries (Thomas, 2002, 2005). The faunal assemblage totalled over 15,000 fragments of bones recorded using a “one zone per bone” strategy (Davis, 1992). While the animal bones were largely dominated by domestic taxa, the high proportions of wild mammals, particularly deer, and wild birds, testify to the high status nature of consumption at the site (Thomas, 2002, 2005).

Figures 2–5 illustrate some of the biometrical data from this site for cattle, sheep, and pig and domestic fowl. The log ratio method has been partly employed

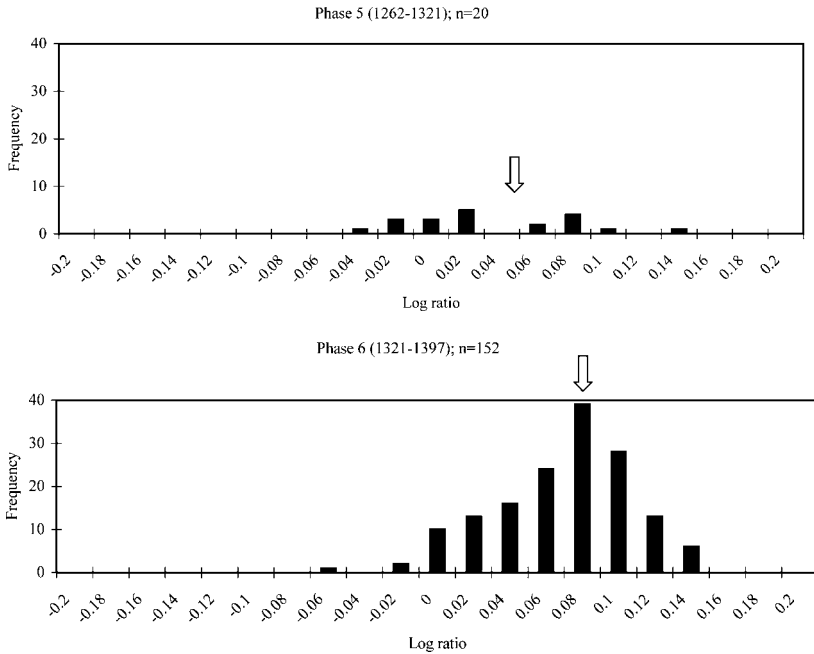


Fig. 2. Log ratios of cattle width measurements at Dudley Castle by phase. The standard is derived from measurements taken on fifteenth-century cattle bones from Launceston Castle (Albarella and Davis, 1996). An arrow indicates the mean of each dataset. Measurements included: tibia Bd; astragalus GL1, Bd, DI; (after von den Driesch, 1976); humerus BT, HTC (after Bull and Payne, 1988); metapodial GL, SD, Bd, a, b, 1, 3, 4 (after Davis, 1992).

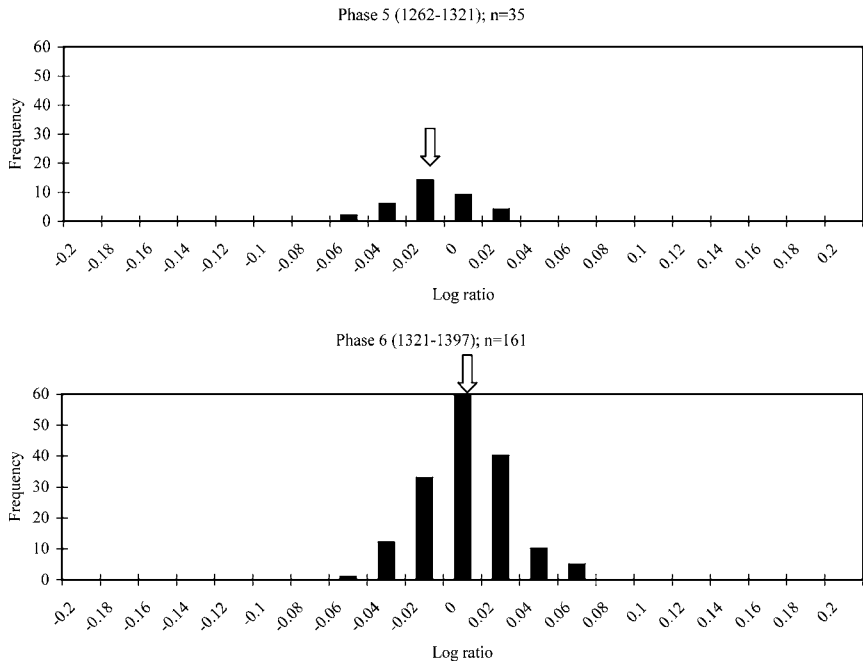


Fig. 3. Log ratios of sheep post-cranial measurements at Dudley Castle by phase. The standard is derived from a modern flock of Shetland sheep (Davis, 1996). An arrow indicates the mean of each dataset. Measurements included: humerus GLC, SD; radius GL, SD; tibia GL, SD, Bd; femur GLC, SD; calcaneum Gl; astragalus GL1, Bd, DI (after von den Driesch, 1976); humerus BT, HTC (after Bull and Payne, 1988); metapodial GL, SD, Bd, a, b, 1, 3, 4 (after Davis, 1992).

in this analysis because it permits the combination of different measurements of the same species onto the same axis, thus increasing the size of biometrical datasets (Albarella, 2002; Meadow, 1999). In essence, the technique involves converting all measurements to logarithms. A single specimen, or group of specimens, is then chosen as a standard for comparison; in this study, however, it is the relationship between the data from different phases of the site, rather than the comparison of the data values against the standard, that is of interest. The log ratio is calculated by subtracting the log of each measurement from the log of the standard. A log ratio of zero implies the measurement is the same size as the standard, a positive value implies that it is larger and a negative value that it is smaller. Measurements from bones and teeth were not combined because, as Albarella (2002, p. 54) notes, teeth respond differently than post-cranial bones to environmental conditions, sex and age. Where the sample sizes permitted, measurements taken along the same plane, i.e. lengths, widths and depths, were also considered together, because biometrical studies have demonstrated that these are highly correlated (see, for example,

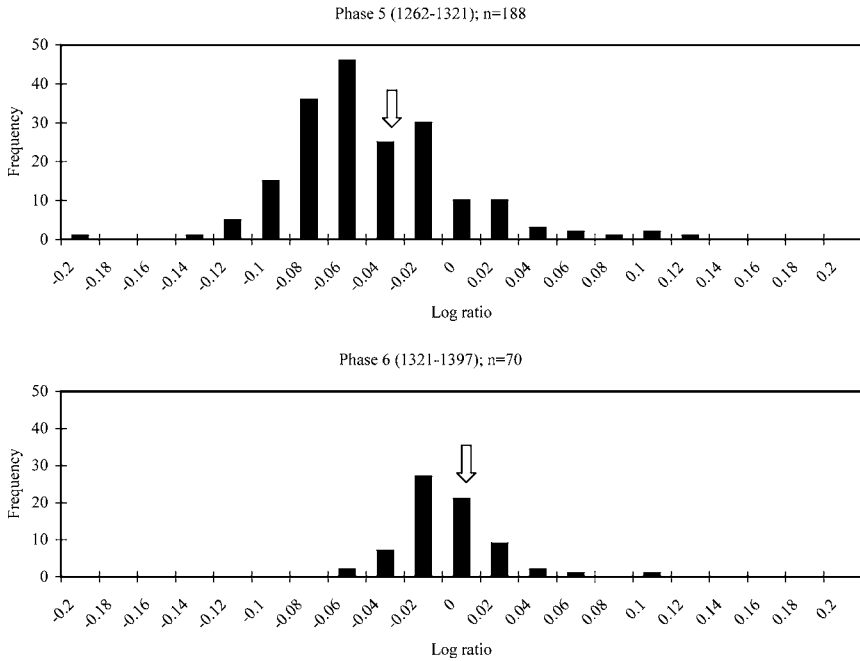


Fig. 4. Log ratio histograms of pig tooth width measurements at Dudley Castle by phase. The standard is based on a Neolithic population of pigs from Durrington Walls (Albarella and Payne, 2005). An arrow indicates the mean of each dataset.

Davis, 1996). For sheep (see Fig. 3), all measurements have been combined on the same axis because of the small sample sizes. All measurements were taken on adult bones using Vernier calipers, following the standards published by von den Driesch (1976), Bull and Payne (1988) and Davis (1992).

Scrutiny of these diagrams reveals that a substantial, and statistically significant, increase in the size of cattle, sheep, pig and domestic fowl, occurred sometime around the middle of the fourteenth century (see Figs. 2–6 and Table I). More detailed analysis of the biometrical data from Dudley Castle (Thomas, 2002, 2005) has revealed that for cattle and domestic fowl, the size change affected all three anatomical planes (height, width and depth). Consequently, for these species at least, it is not possible to link the change in conformation to any shift in the sexual composition of the stock; no change in the relative proportion of males, females or castrates, would result in an increase in all dimensions (e.g. Fock, 1966; Higham, 1969; Thomas, 1988). The unfortunate paucity of measurable sheep and cattle teeth from the site (Thomas, 2002) makes it difficult to determine whether the size change only affected post-cranial bones. In pigs, however, it is clear that the size increase is at least partly genetically controlled (see Fig. 4). In later

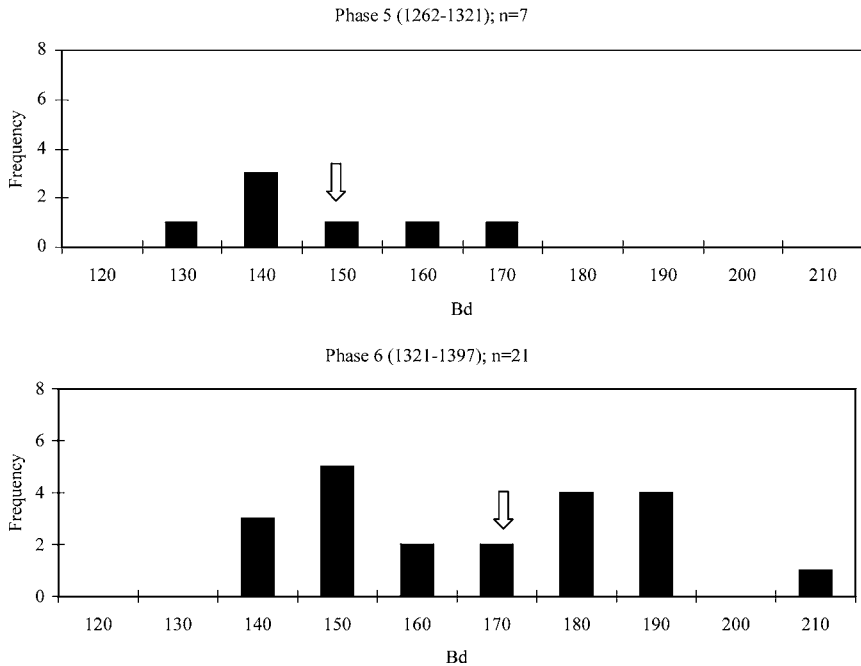


Fig. 5. Histograms of domestic fowl femur Bd measurements at Dudley Castle by phase. An arrow indicates the mean of each dataset.

post-medieval phases at the site, there was virtually no other biometrical variation (Thomas, 2002, 2005).

At face value, this evidence would suggest that the “improvement” of most domestic livestock was occurring, at least at this one site, from as early as the middle of the fourteenth century. While the temptation exists to associate these quite dramatic changes with an earlier incarnation of the Agricultural Revolution (*sensu* Davis, 1997), which became manifest at other sites at a slightly later date (Davis and Beckett, 1999, Table II), the data for later post-medieval sites require consideration, since the observations noted at Dudley Castle may instead reflect entirely different phenomena. Unfortunately, there is a marked paucity of excavated and published faunal assemblages dating from the later eighteenth and nineteenth centuries—the period when historical sources inform us that productivity expanded quickly and sustainably.

Later post-medieval (i.e. seventeenth to nineteenth century) assemblages of animal bones have often been neglected. Not only are they often sacrificed at the expense of the “more interesting” earlier periods but they are also frequently truncated by later development and affected by problems of residuality (Thomas, 1999, p. 342). As Davis and Beckett (1999, p. 6) note, we also have to contend

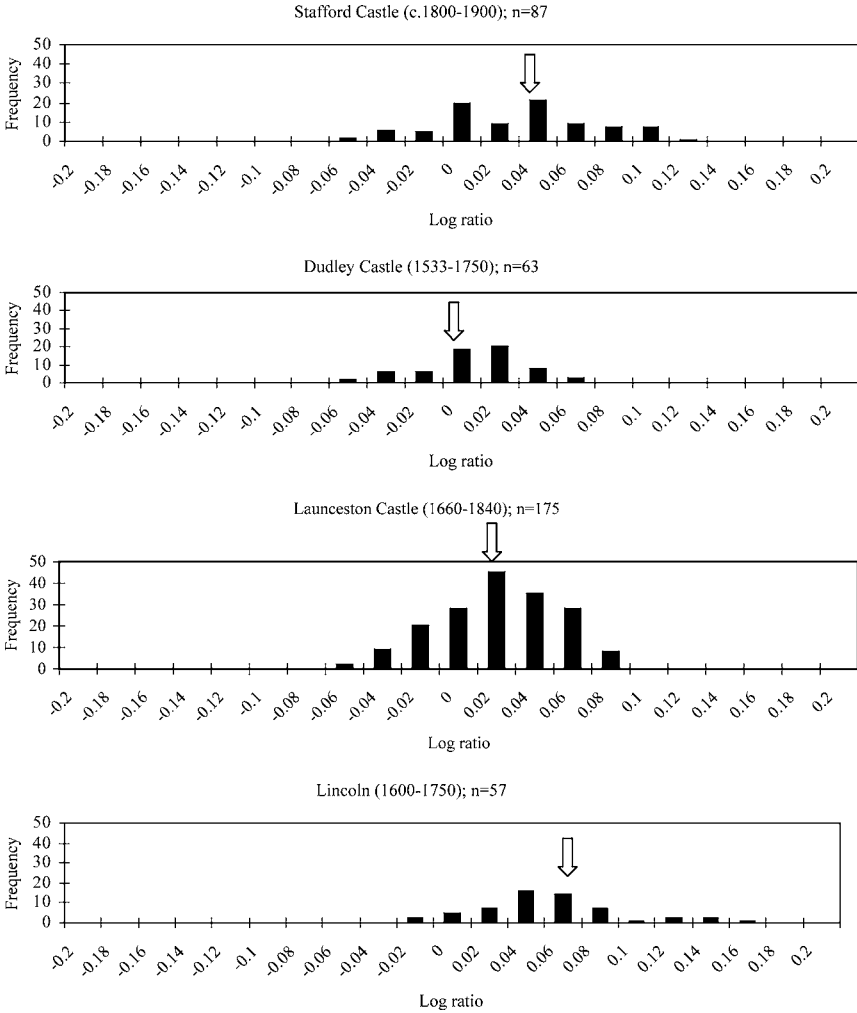


Fig. 6. Log ratio diagrams of sheep post-cranial bones from a range of post-medieval sites. The standard is derived from a modern flock of Shetland sheep (Davis, 1996). An arrow indicates the mean of each dataset. Measurements included: tibia Bd; calcaneum GI; astragalus GL1, Bd, DI (after von den Driesch, 1976); humerus BT, HTC (after Bull and Payne, 1988).

with the fact that waste management was much more effective in this period. Indeed, comparison of the percentage of gnawed bones (which can provide a proxy indicator of redeposition) from nineteenth-century deposits at Stafford Castle (2%) with earlier dated deposits at Dudley Castle (11–37%) provides some support for this interpretation (Thomas, 2002, 2003). Sample sizes from these later sites also

Table I. Student *t*-test Analyses of Data Presented in Figs. 2–6

	<i>t</i> -stat	Probability
Cattle width measurements [Dudley Castle (1262–1321)–(1321–1397)]	–3.6743	0.0003**
Sheep post-cranial bone measurements [Dudley Castle (1262–1321)–(1321–1397)]	–4.1222	0.0001**
Pig tooth width measurements [Dudley Castle (1262–1321)–(1321–1397)]	–9.1814	0.0000**
Domestic fowl femur measurements [Dudley Castle (1262–1321)–(1321–1397)]	–2.3564	0.0263*
Sheep post-cranial bones [Stafford Castle (c.1800–1900)–Dudley Castle (1533–1750)]	5.77	0.0000**
Sheep post-cranial bones [Stafford Castle (c.1800–1900)–Launceston Castle (1660–1840)]	2.89	0.0041**
Sheep post-cranial bones [Stafford Castle (c.1800–1900)–Lincoln (1700–1850)]	–2.40	0.0177*

*Statistically significant ($p < 0.05$); **statistically highly significant ($p < 0.01$).

tend to be small, although the application of scaling techniques for biometrical analysis (Albarella, 2002; Meadow, 1999) can be used to overcome such problems.

A recent study of the animal bones from nineteenth- and twentieth-century deposits at Stafford Castle was undertaken to attempt to redress this gap (Thomas, 2003). This site is particularly useful since it is located only 40 km from Dudley Castle (see Fig. 1). Unfortunately, only sheep provided a sufficiently large dataset for detailed biometrical analysis. However, examination of these data demonstrate that the nineteenth-century sheep were somewhat larger on average than those from slightly earlier dating deposits at Dudley Castle (Thomas, 2002, 2005) and Launceston Castle (Albarella and Davis, 1996), although those from Lincoln (Dobney *et al.*, 1996.) were marginally bigger (see Fig. 6 and Table I). The fact that the sheep from Lincoln were larger may reflect regional variation—a phenomenon that has its origins in the early post-medieval period (e.g. Albarella, 1997). However, the fact that the Stafford Castle sheep were larger than the sheep from Dudley Castle might suggest that new breeds of sheep were introduced into the region, or that existing sheep were improved, sometime in the later eighteenth or nineteenth century.

DISCUSSION

A slowly growing body of zooarchaeological evidence indicates that agricultural practice was changing from the fourteenth century onwards, although there was some regional variation, with outlying sites generally experiencing later developments than more central localities (Davis, 1997; Davis and Beckett, 1999). Moreover, in some places (such as Dudley Castle), the change in size seemingly

occurs over a short period of time, while at other sites it is a much more gradual affair, such as Launceston Castle, Cornwall (Albarella and Davis, 1996).

Clearly, the data from Dudley Castle reveal a fairly dramatic change in animal size in the fourteenth century, but does this represent an earlier incarnation of the “Agricultural Revolution”? As noted above, this term was coined to describe a period (1760–1830) which saw “the agricultural sector of the economy [move] to a new level of productivity, which it was able to sustain” (Beckett, 1990, p. ix). It affected the whole of farming, not just one particular sector (Beckett, 1990, p. ix). Overton (1996a, p. 3) outlines three criteria by which revolutions in agricultural practice might be identifiable:

- a variety of changes in farming techniques, including the introduction of new crops, new husbandry techniques, and the improvement of livestock;
- the ability to feed a growing population;
- an increase in productivity.

The increase in the size of the principal domesticates may be a fairly good indicator of the introduction of “improved” livestock. However, this by no means satisfies the three criteria outlined above, particularly since the fourteenth century was anything but a period of population growth. As Mingay (1989, p. 481) notes, at best “the time period involved stretches the term ‘Agricultural Revolution’ to little more than a convenient label.” Rather than try and associate the changes evident in the zooarchaeological assemblage at Dudley Castle with any particular “revolution,” it is more valuable to view the changes that occurred in the nature of animal husbandry in the light of existing historical evidence for the period (Thirsk, 1987, pp. 57–58).

The most plausible hypothesis to account for the pattern witnessed at Dudley Castle is that it reflects changes in agricultural and tenorial organisation in the post-Black Death period, coupled with change in the environmental landscape. Following the demographic decline in the wake of a host of disasters in fourteenth-century England, there is some evidence to suggest that agricultural improvement became a more pressing issue. In the earlier medieval period, the rising population had led to an expansion of arable farming and forced sheep and cattle to graze on more marginal lands. However, following the Black Death (caused by Bubonic Plague spread by rat-borne infected fleas initially in 1348–1350) the demand to feed an expanding population had dissipated and the market in grain crashed. Animal husbandry thus became a more viable alternative and, while much more land intensive, it was much less labour intensive, thus suiting the prevailing socio-economic conditions (Hopcraft, 1994, p. 1576). It is for this reason that a dramatic rise in the conversion of arable to pasture (and thus the movement of animals off more marginal land to which they had been previously restricted) occurred in this period which, alongside increased land-holdings and an expansion in enclosure, allowed greater control to be exercised over the food intake

of animals and breeding (Dyer, 1981; Hopcraft, 1994; Williamson, 2002). With respect to pigs, a widespread decline in numbers on archaeological sites, together with the greater consumption of neonatal animals, and the increase in size (enabled through greater control over breeding and nutrition) appears to be characteristic of a move towards sty farming (Thomas, 2002, 2005). In the early medieval period, it would have been possible to keep large herds of pigs within woodland, in a semi-feral state, inter-breeding with local populations of wild boar. Following extensive woodland clearance, particularly in the twelfth to fourteenth centuries (e.g. Rackham, 1986, p. 88), however, the keeping of such large populations of pigs would have been a less viable option. After the Black Death, there would have also been more underused waste land on which pigs could root which, together with a decline in woodland management, may have further accelerated the move towards sty-feeding (Chris Dyer, personal communication).

Following the events of the mid- to the late-fourteenth century, there was also an increasing move away from direct management, towards leasing for cash rents, as landlords sought to minimise economic loss. A consequence of this, coupled with increasing wage demands in this period, was a downward social distribution of access to land (Dyer, 1981). Since these new landowners were leasing for cash rent, they may have been more interested in enhancing the profitability of their stock, which may in turn have led to improvements in animal husbandry. As Dyer (1997, p. 306) notes, “in some circumstances lords could have acted as a drag on change.” Moreover, peasants who became landowners in this period are likely to have been in more “intimate contact” with the animals and better able to take “technological initiatives” (Dyer, 1997, p. 308; see also Allen, 1991, p. 252). Why, in either case, the evidence for similar changes in animal husbandry practice in the same period has not been identified elsewhere is curious, particularly since the communal grazing of the open field system in the Midlands is more likely to have inhibited stock breeding (Hopcraft, 1994, p. 1581). The possibility exists, however, that landowners in this region were pioneering technological advances, which may have taken centuries to become established in other areas (Thomas, 2005).

From the fifteenth century onwards a greater number of factors were influencing the development of animal husbandry. These included:

- increasing population;
- freeing up of cattle as traction animals with the increased use of horses for ploughing;
- increasing agricultural specialisation (veal and dairy production);
- expansion and contraction of the wool and cloth industries (Albarella, 1997).

By the eighteenth and nineteenth centuries the need to feed a rapidly expanding and industrialised population must have exerted further pressures on animal

resources. Overton (1996a, p. 75) indeed suggests that there was an increase in meat production of the order of 150% and of 250% for dairy produce in this period. Moreover, Turner *et al.* (2001, pp. 174–207) demonstrate that a significant increase in carcass weights occurred in the nineteenth century. This might partly reflect selective breeding, but the period also witnessed the emergence of better housing for animals and the more widespread use of different fodder—e.g. oil-cakes, clover and turnips—as well as well drained pasture (Williamson, 2002, p. 166). Unfortunately, the extent to which these historically attested productivity increases are visible in the zooarchaeological record is precluded by a paucity of evidence. Tentative evidence from Stafford Castle, noted above, would suggest that, at least in some regions, this “improvement” was reflected in the skeletons of certain animals. However, the increase in size appears to reflect a continuum of development from the fourteenth century rather than any particular “revolution.”

CONCLUSION

The debate regarding the existence, timing and nature of animal improvements in the later-medieval and post-medieval periods is ongoing. While it is difficult to be certain that an increase in the size of animals is a sufficiently good marker of improvement, agriculture was certainly not static in the later-medieval and post-medieval periods. The animal bone data would tend to support Beckett (1990), that particular regions followed their own trajectories of development, and that change in animal husbandry was a much more diverse and gradual process, thus calling the “grand historical narrative” into further question (e.g. Johnson, 1996, p. 5). At Dudley Castle, “improvements” in animal husbandry appear to have been occurring from at least the later fourteenth century as a consequence of the changing agricultural and tenorial landscape. Such changes are not currently archaeologically visible elsewhere until the fifteenth and sixteenth centuries, although it is likely that the stimulus for improvement at any site would have reflected a combination of local, regional and national environmental and socio-economic conditions. This evidence provides some support for the nineteenth-century writings of John Burke, who defines the period during the reign of Edward III (1326–1377) as the “dawn of general agricultural improvement,” and contended that these changes continued through the fifteenth and seventeenth centuries (Davis, 1997, p. 414). The data from Stafford Castle would suggest that improvements in animal husbandry did indeed occur in the nineteenth century. However, the extent to which these can be called “revolutionary” is difficult to establish, given the paucity of animal bone assemblages from this crucial period across Britain. Without the collection, analysis and publication of much more raw biometrical and ageing data from later post-medieval sites this issue will remain frustratingly unresolved. Only with of a sufficiently large dataset from this period, will it be possible to critically examine the archaeological visibility of the

historically attested productivity increases associated with the traditionally dated Agricultural Revolution.

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