A comparative study of faunal assemblages from British iron age sites

Hambleton, Ellen

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A COMPARATIVE STUDY OF FAUNAL ASSEMBLAGES FROM BRITISH IRON AGE SITES

Ellen Hambleton

Thesis submitted for the degree of Doctor of Philosophy

Department of Archaeology
University of Durham
1998

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ABSTRACT

A Comparative Study of Faunal Assemblages from British Iron Age Sites

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The broad aim of this thesis is to further understanding of British Iron Age animal husbandry regimes by undertaking a comparative study of faunal assemblages. More specifically, this involves development of a uniform methodology for comparing published faunal data in order to recognise inter and intra-regional patterns of animal husbandry. Lack of uniformity in methods of recording and presenting faunal data, together with variation in the quality and quantity of information published in reports, serves as a barrier to systematic quantitative comparison. This thesis therefore seeks to develop methods of comparison which utilise the most commonly available forms of faunal data, or convert different forms of data into a single comparable format, in order that inter and intra-regional analyses of the widest possible dataset can be undertaken.

To ensure viable comparisons unaffected by small sample bias, only those sites with total cattle, sheep and pig assemblages of NISP≥300 or MNI≥30 are included in this study. Analyses concentrate on the three main domestic species (cattle, sheep, and pig) which comprise the bulk of all faunal remains recovered from excavations of British Iron Age sites, and utilise three main types of information: Firstly, representation of different skeletal elements is examined in order to recognise the effects of taphonomic and human alteration on each assemblage. Secondly, quantification data for cattle, sheep, and pig is compared, using tripolar graphs to establish the relative importance of different species in each assemblage. Thirdly, mandibular tooth wear data is used for the composition of mortality profiles to compare herd management strategies.

Both species proportions and mortality profiles from different faunal assemblages are compared, and examined for any inter and intra-regional similarities. Subsequently assemblages are examined for relationships between patterns of species proportions and/or mortality profiles and particular site characteristics (topographical location, underlying geology, settlement type, and date). Finally, using the results of these analyses, suggestions are made as to the nature of animal husbandry regimes in different regions, and the factors influencing choice of husbandry strategy in Iron Age Britain.

"So I prophesied as I was commanded: and as I prophesied there was a noise, and behold a shaking, and the bones came together"

Ezekiel 37:7

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Chapter 1

Introduction

This thesis is the product of research funded by the Natural Environmental Research Council, carried out at the Department of Archaeology, University of Durham.

An understanding of animal husbandry is fundamental to an understanding of Iron Age society in Britain due to the central importance of agriculture throughout the period (c. 750 BC - AD 50). The broad aim of this study is to further our understanding of Iron Age animal husbandry regimes in Britain by undertaking a comparative study of faunal assemblages. More specifically, this will involve the development of a uniform methodology for comparing existing faunal data in order to recognise inter- and intra-regional patterns of Iron Age animal husbandry in Britain.

In Britain the first millennium BC is recognised as a period in which many aspects of society, including settlement pattern, social organisation, technology, and the economy, changed and developed. Much of the evidence from this period (Late Bronze Age and Iron Age) appears to be associated with changes in land use and agriculture (Haselgrove forthcoming). Settlement, structural, artefactual, climatic and environmental evidence all indicate changes occurring throughout the later prehistoric period in Britain, particularly during the Mid-Late Bronze Age transition (c.1500-1150 BC) and the Late pre-Roman Iron Age (c.50BC-50AD).

Iron Age settlement archaeology and agriculture

Settlements

The Iron Age provides a wealth and diversity of settlement evidence. In earlier periods the archaeological record in Britain is characterised by monumental, ceremonial and funerary evidence, but from the Mid-Late Bronze Age onwards archaeological record consists primarily of settlement sites, usually those of rural farming communities. Settlement archaeology has provided a ready source of evidence relating to agricultural production and consumption, much more so than the ceremonial and funerary archaeology of earlier periods which are less directly linked with the day to day aspects of the agricultural economy. The Late Bronze Age shows a marked increase in the enclosure of permanent settlements which continues into the British Iron Age. The tendency to enclose sites might be one reason for the wealth of settlement data, as the enclosing of a settlement by ramparts, ditches or palisades improves their archaeological visibility either as standing monuments or crop marks.

The differing forms of settlement may have links with agricultural activity and thus provide insights into certain aspects of husbandry. The enclosing of settlements has been related to the importance of land use and land ownership within British Iron Age societies (Thomas 1997), which in turn implies an increase in the importance of agriculture when compared with earlier periods. Conversely, Van der Veen's (1992) study of crop remains in northern England, and supported by pollen evidence, suggests that intensification of arable production was at least partly linked to a shift from enclosed to open settlements in the later prehistoric period. Changes in settlement forms have also been taken as having agricultural implications in the Late Iron Age in Britain when there are changes in settlement patterns, and different types of settlement appear. A particular example of this is the appearance in the south east of England of "oppida", whose high status and "urban" features are often thought to be partly a product of encroaching Roman influence from the continent. This "Romanisation" of aspects of British Iron Age society may result in some Late Iron Age sites exhibiting associated changes in arable and pastoral production and consumption.

The distinctive shape of the so-called Banjo enclosures, found across Britain but particularly in central southern England, has been interpreted as having particular functional links with agriculture; Perry (1972) suggested that some banjo enclosures may have served as specialised stock corrals within larger settlement complexes, while Hingley (1984) argues that the function of the Banjo form was to enclose settlement and divide arable from pastoral land. Functional links between settlement form and agricultural activity have also been made by Fox (1961) for the wide spaced ramparts of Iron Age settlements in the south west of Britain, and by Cunliffe (1991) for similar sites in northern Britain. Other features associated with settlements may also provide evidence of Iron Age agricultural activity. Linear earthworks associated with a number of settlements such as Danebury, and patchwork "Celtic" field systems found throughout Britain are seen as means of dividing up the Iron Age landscape for agricultural purposes.

Structures

There is evidence of internal structures associated with the agricultural economy at Little Woodbury, and at the majority of other excavated Iron Age settlements. There is unfortunately little structural evidence that can be directly associated with animal husbandry. It is possible that some of the structures found on Iron Age sites may have been for keeping animals. Pryor (1996) has reinterpreted the Bronze Age field systems around Flag Fen as stockyards, although as yet there is little definite evidence of byres or paddocks until the late Iron Age (Hill 1995a).

Widespread over much of Britain are internal structures for the storage of arable produce, usually four or six post-hole structures commonly interpreted as granaries (Gent 1983). Other features also thought to be grain stores are the large storage pits common throughout southern Britain. The function of both post structures and pits has been discussed at length in the recent Danebury report (Cunliffe 1995), taking into account the massive amount of new data recovered during the 20 year program of excavation at this site. These phenomena are widespread over all types of site and provide visible evidence of the universal importance of agricultural activity throughout Iron Age Britain. The existence of some sites with potentially massive storage capacity, e.g. Danebury, has been used to argue the importance of agricultural surplus in the maintenance of social control and reproduction (Cunliffe 1984, Sharples 1991).

Artefacts

The artefactual evidence from the British Iron Age is ubiquitous, both for agricultural production (e.g. hoes, plough shares) and processing (e.g. quern stones, spindle whorls, loom weights). The use of iron in agricultural implements is an innovation in tool technology that may have aided the expansion of arable production in the Iron Age. Technological developments in agricultural processing during the Iron Age are also evident in Britain, for example the development of quern stones from saddle to rotary and beehive forms in the Middle and Late Iron Age.

It is not just surviving earthworks and crop marks of settlements and field systems that provide evidence of Iron Age agricultural activity; excavations of settlement sites have also provided a wealth of structural, artefactual and environmental information concerning the importance of agriculture, and different agricultural husbandry regimes. Little Woodbury in Wiltshire (Bersu 1940, Brailsford 1948 & 1949) is probably the earliest example of the combined use of all these types of evidence to build up a detailed picture of the agricultural economy, although there was only limited use of animal bone as a source of direct evidence of animal husbandry, and more emphasis was placed on determining the nature of arable production and consumption.

Climate and crops

The climatic evidence from Britain shows the Iron Age as a period of change. During the Late Bronze Age and early Iron Age the evidence points to a deterioration into colder and wetter conditions which then improved in the Late Iron Age period (Turner 1981). Variation in climatic conditions is likely to have affected choice of agricultural husbandry strategy and may also have had repercussions for other aspects of Iron Age society. The environmental evidence recovered from British Iron Age sites also indicates changing agricultural practices. There appears to be a chronological trend whereby the cereal economy, dominated by emmer wheat in earlier samples, moves towards later domination of spelt wheat. The adoption of spelt wheats, which tend to be hardier and more tolerant of a range of different soil conditions that emmer wheats, is thought to have enabled the expansion of arable cultivation onto marginal land, a change that is apparent in the Iron Age settlement record (Jones 1981, 1984a, 1996). Hulled barley was also grown extensively, and in some regions was evidently the main cereal crop. Although many areas of Britain had already experienced heavy woodland clearance, pollen evidence indicates intensification and extension of permanent woodland clearance in many areas during the Iron Age period which would suggest an increase in agricultural activity (Bell 1996).

Our understanding of Iron Age arable economy in Britain has benefited greatly from systematic analysis of the botanical evidence recovered from Iron Age sites which is usually in the form of carbonised plant remains, particularly seeds, and also glumes and chaff. Analysis of such remains has provided a detailed insight into arable production and processing strategies at the individual site level. Furthermore, standardised methods of recovery, quantification and analysis have resulted in consistent reliable comparison of botanical assemblages at intra- and inter-regional levels. The use of absolute radiocarbon dates of crop remains (e.g. van der Veen 1992) has enabled accurate analyses of changes in husbandry strategy through time. The result has been that significant chronological and regional trends have been identified throughout the British Iron Age (Jones 1981, 1984a, and 1996). It has also proved possible to recognise important variations in patterns of arable production and consumption between different classes of site within and between regions (e.g. Van der Veen 1992).

The changing nature of the Iron Age agricultural economy in Britain is of direct relevance to studies of all aspects of Iron Age society. In order to further our knowledge of the agricultural economy as a whole it is essential to have an understanding of both arable and pastoral strategies. There is a particular need within the British Iron Age to increase our understanding of the faunal material as its full potential as a source of direct evidence for animal husbandry has yet to be realised.

Justification and aims of research

Faunal remains have been recovered throughout Britain from many different classes of Iron Age site. Since the 1950's animal bones have been used more and more as a direct source of evidence for animal husbandry. The ubiquitous nature of faunal evidence suggests some degree of domestic animal husbandry occurred at the majority of Iron Age sites throughout Britain. Detailed analysis of animal bones has revealed the nature of Iron Age animal husbandry at individual sites and also has the potential to show broader regional and chronological trends in husbandry throughout this period in Britain (Maltby 1981a, 1996).

Given the wealth of Iron Age faunal material from Britain there should be the potential to achieve a similar level of understanding of animal husbandry to that already achieved for crop husbandry. However, while there have been extensive detailed examinations of the mass of faunal remains from individual sites across Britain, e.g. in the Upper Thames Valley (Wilson 1978, 1979, 1984, 1993), Wessex (Maltby 1981b, 1985, 1995a, 1995b; Grant 1984a, 1991), and North East England (Rackham 1987, forthcoming), our understanding of broader patterns of animal husbandry is more limited. Knowledge of the broader trends in animal husbandry regimes is limited mainly because there have been very few attempts at inter- and intra-regional comparison of faunal assemblages, and British Iron Age faunal studies have tended to focus on individual sites. Chapter 2 reviews the main comparative studies of British Iron Age faunal assemblages that have been undertaken.

The lack of comparative studies is partly because the methods of faunal analysis and reporting used are diverse, so data are not always in directly comparable formats. Even where the methods in use are broadly similar there is often variation in the data due to differences in the application of these methods by different analysts. The absence of universally applied uniform methodologies for recovery, recording, analysis, and presentation of faunal data means systematic comparison of faunal assemblages is very difficult; those few attempts at intra- and inter-regional analysis of animal husbandry strategies tend to be very generalised blanket interpretations often based on secondary evidence rather than primary bone data. It is apparent that there is a need for systematic comparison of the existing Iron Age faunal dataset from Britain in order to improve our knowledge of the agricultural economy and our understanding of Iron Age societies.

The aim of this study is to remedy this deficiency and to develop a reliable methodology for the comparison of published faunal data. This will allow recognition of intra- and inter-regional patterns among faunal assemblages, thus contributing to the understanding of animal husbandry in the British Iron Age, and how this varied chronologically and geographically during the period.

Chapter 2

Comparative Regional Investigations Of Iron Age Animal Husbandry: A Review Of The Literature

This chapter will provide an overview of previous regional and comparative studies of animal husbandry in Iron Age Britain. The approaches and content of earlier inter-regional and intra-regional studies will be summarised, highlighting their limitations and suggesting ways in which this study may improve upon them.

Previous analyses of the Iron Age pastoral economy have mainly been at the level of individual site reports; there are very few nation wide or region wide systematic comparisons of faunal data. A number of individual site bone reports have in the past included comparable data from other bone assemblages (e.g. Whitehouse 1974, Wilson 1993) in order to place the faunal information in a wider context, but such comparisons do not constitute a detailed regional comparative study. Those inter-regional and intra-regional studies which do exist are seldom based on quantitative comparison of faunal material. Studies of animal husbandry on a regional level can be found in the literature but are often brief, lack depth, and place too little emphasis on the actual faunal evidence itself, tending to infer animal husbandry practices from other types of archaeological evidence.

Brief discussion of the nature of the agricultural economy in different regions can be found within more general summaries of the British Iron Age (e.g. Hill 1995a, Haselgrove 1989, forthcoming). Lengthier discussions concerning the pastoral economy can be found in complete papers and chapters devoted to the subject (e.g. Cunliffe 1991 chapter 15, Maltby 1995, Piggott 1958); however these tend to be collations of existing interpretations of individual sites, often based on non-faunal evidence, rather than direct comparisons of the faunal material. Similarly, studies of varying quality and detail can be found for the animal husbandry practices of specific regions such as Wessex (Maltby 1994), the Upper Thames Valley (Lambrick 1992), East Anglia (Crabtree 1994), the Nene and Great Ouse Basins (Knight 1984) and Northern England (Huntley & Stallibrass 1995).

Most studies use evidence of pastoral activity together with arable, viewing the agricultural economy as a whole. J D Hill (1995a) argues that it is unrealistic to artificially compartmentalise the arable and pastoral aspects of the agricultural economy. While this is a valid point it must be weighed against the fact that extracting the maximum information from the archaeological evidence normally requires separate specialist consideration of the faunal and botanical material. Consideration of the agricultural economy as a whole is desirable, however before this is done the details of its separate elements should be systematically considered.

These existing studies utilise a number of different approaches in order to consider animal husbandry from a regional perspective. Approaches include qualitative and quantitative comparisons of faunal assemblages, analyses of other related archaeological evidence such as botanical, structural and artefactual remains, and predictive models based on climate and topography. Although discussed separately below, the majority of investigations utilise several of these approaches at once.

Previous approaches

Quantitative

Quantitative studies can be a powerful tools when examining regional trends in animal husbandry as they provide an objective record of the similarities and differences between faunal assemblages, although these 'objective' results are as open to subjective interpretation as any other source of evidence. Systematic quantitative comparison is probably one of the most reliable means of identifying patterns in the composition of faunal assemblages indicative of intra- and inter-regional patterns of animal husbandry. Despite this, quantitative studies comparing British Iron Age faunal data, with the aim of highlighting similarities and differences within and between the faunal assemblages from different regions, are rare.

The main problems of adopting a quantitative approach to studying Iron Age animal husbandry across regions is the limits of the faunal data set itself. Given that many areas of Britain have failed to preserve faunal remains adequately, the scope of a quantitative study of faunal data is limited. A quantitative study cannot hope to consider all regions of Britain as not all regions of Britain can provide sufficient quantities of faunal data, although this does not prevent valuable inter- and intra-regional studies of the pastoral economy in those areas where sizeable bone assemblages are preserved. Indeed quantitative comparative studies carried out by King (1978, 1984) have provided useful insights into the pastoral economy of Britain in the Roman period despite an almost complete lack of faunal assemblages from areas such as North West England. Where possible this study will attempt to utilise small faunal assemblages in order that regions where few large faunal assemblages have been recovered are not excluded, thus extending our understanding of Iron Age animal husbandry based directly on faunal evidence into areas not covered by previous quantitative studies.

It is necessary for a reliable quantitative study that the faunal data be directly comparable. This is not the case for all Iron Age assemblages as different methods of recording and analysis mean faunal data is not always in a comparable format. This study will aim to maximise the amount of comparable data where possible by converting data into similar formats.

Qualitative

Qualitative studies considering only faunal material are found in the Iron Age literature. These tend to collate the interpretations and conclusions from site bone reports and comparing them to build up a picture of animal husbandry in the region. Often qualitative studies use other sources of evidence in addition to the faunal remains and tend to consider the arable as well as the pastoral side to the agricultural economy. Some studies (e.g. Piggott 1958) can be discursive and speculative with only a very generalised picture of the animal economy, using broad terms such as "mixed farming" to describe husbandry practices, and failing to recognise differences within a region. Other qualitative studies (e.g. Lambrick 1992) manage to consider the agricultural economy of a region as a whole without losing sight of the differences in animal husbandry regimes of individual sites.

Although subjective, a qualitative approach is of use when combining several very different types of evidence. For the purposes of this study a qualitative approach is used in conjunction with quantitative analysis where the available data is not of sufficient quantity or quality to be used in statistical tests, and instead analysis relies on the visual identification of patterns and trends within the data.

Secondary evidence

In addition to bones, the primary source of evidence for animal husbandry regimes, secondary sources of evidence can be considered. Secondary sources of evidence for animal husbandry come in the form of archaeological structures and artefacts that have been interpreted as having functions associated with animal husbandry or the products of animal husbandry. Thus the presence of structures interpreted as paddocks or byres, or artefacts associated with wool spinning, leather working, and processing of dairy products may be used to imply certain husbandry activities or aspects of herd management. Evidence of this sort is used where there is a lack of well preserved faunal assemblages as a substitute for primary evidence, as well as in conjunction with faunal remains to provide additional information about husbandry practices.

Although this approach is undoubtedly useful, especially in regions where there is a dearth of faunal material, on its own it can provide only tentative conclusions concerning the animal husbandry of a region as it relies on an interpretative relationship with the animal economy, unlike the faunal remains which have a direct link. This approach is not used in the following comparative study, instead analysis focuses on the faunal material, although different site characteristics are considered in the interpretation of animal husbandry regimes from the faunal evidence.

Literary evidence

One highly dubious source of information concerning Iron Age British farming practices is Classical literature, particularly the writings of Caesar. Although seldom considered as a definitive source of information literary sources have in the past been used, together with other approaches, in regional studies of the Iron Age agricultural economy in Britain. Caesar's assertion that the Britons "do not, for the most part, cultivate grain" (*Gallic Wars,* V, 14), and Dio's description of the Scots as "having neither walls nor towns nor tilth, but living by pasturage and the chase" (Dio, LXXVI, 12) while not accepted by Piggott (1958) for the South of Britain is certainly a visible influence on his interpretation of the North: "The Celtic cow-boys and shepherds, footloose and unpredictable, moving with their animals over rough pasture and moorland, could never adopt the Roman way of life in the manner of the settled farmers of the South." (ibid, 25).

Earlier regional studies of Iron Age agriculture lacked the techniques and datasets available to more recent studies, and thus rely more heavily on the classical literary evidence. The faunal and botanical studies of data from Iron Age sites over the last twenty years have provided evidence, such as that for arable cultivation in the north of England (Van der Veen 1992), that questions the validity of the literature. However, even without the benefit of direct faunal and botanical evidence to the contrary the assertions of classical writings should have been considered unreliable given the problems of interpretation and mistranslation. Certain passages concerning native animals immediately inspire caution, such as Caesar's rather fanciful notion that elk have no joints in their legs and are best hunted by felling the trees which they must lean against to sleep (*Gallic Wars,* VI, 27).

Relation to arable economy

Both the arable and pastoral sides of the agricultural economy are closely related and, as part of an approach that considers the agricultural economy as a whole, evidence for arable production is often used as a secondary source of evidence for pastoral strategies. As with other forms of secondary evidence a knowledge of the arable strategies in connection with the faunal evidence provides a fuller picture of the role of animal husbandry in the economy, but cannot be considered a substitute for primary faunal evidence. Knowledge of arable strategies can add depth to interpretations of the role of domestic animals, for example evidence for intense arable production in conjunction with a predominantly sheep based faunal assemblage might imply that sheep were important as a source of fertiliser. Problems arise with this approach when speculative interpretations based on arable evidence contradict independent conclusions based on the faunal remains. This study utilises only faunal evidence, but it is recognised that any interpretations of animal husbandry regimes should considered as part of broader agricultural and economic strategies.

Blanket interpretation

Often a particular site or assemblage is deemed to have features characteristic of many or all sites in a region and this "type site" is then taken as being representative of all sites and assemblages within that region. This approach can be useful in summarising general trends within or between regions, however it can obscure intra-regional differences; a type site may have particular traits seen in all sites or assemblages across the region but this does not mean they share all characteristics. This blanket application of a specific set of attributes to all sites can obscure inter-site differences and thus limit our understanding of animal economies.

A blanket approach can obscure local and regional differences in animal husbandry regimes, particularly if the defining characteristics of a type site are concerned with the arable rather than the pastoral economic strategies. This is illustrated in the blanket interpretation used by Piggott (1958) describing a "Woodbury type" economy for the whole of South East Britain, and a "Stanwick type" for the whole of North West Britain. The use of blanket interpretations of the Iron Age animal economy in certain regions of Britain may partly be the result of preservation biases that leave large areas of the country without archaeological faunal remains; thus, in the absence of any other data to contradict the assumption, one faunal assemblage is used to describe the pastoral economy of an entire region. By considering as many separate faunal assemblages as possible from each region, this study enables not only identification of key unifying trends that are characteristic of all sites from a region, but also recognition of the diversity of faunal assemblages and therefore husbandry strategies that occur within what have previously been considered homogeneous regional groups.

Environmental determinism

Environmental determinism involves the formation of predictive models of agricultural regimes based on factors such as climate and topography. Environmentally determined models rely on the assumption that particular economic strategies are best suited to particular environmental conditions, thus where those environmental conditions occur so does the associated economic strategy. Prevalent in studies of prehistoric Britain is the notion made popular by Fox (1938) of the "Highland" and "Lowland" zones (fig. 1) (Haselgrove forthcoming, Hill 1995a). These are environmental distinctions based on climate and topography, the Highland zone being characterised by a high, rugged landscape with a very wet climate and the Lowland zone characterised by dryer, lower lying land. Once again Piggott's (1958) model provides a good example of the use of this approach in British Iron Age studies; the distribution of the two types of agricultural economy described by Piggott (fig. 2) is closely related to Fox's zones.

There are three main problems with the adoption of environmentally determined models. Firstly, within a broad environmental zone there is often considerable localised variation. This means that within a large environmental zone there are smaller micro environments that would suit agricultural strategies different to those predicted for the broader region; indeed, often such areas are favoured precisely because they allow diversification. Therefore the predicted models are not uniformly applicable across regions without obscuring intra-regional variation.

Secondly, in the case of Iron Age Britain we are dealing with domestic species in both the pastoral and arable economy; domestication is itself an alteration of the natural order (a number of Iron Age domesticates are not naturally indigenous to Britain) which causes difficulties when trying to apply a model of agriculture based on natural environmental constraints. Humans can alter the environment, for example by irrigation or drainage, or by providing livestock with shelter from the elements, and in doing so can extend the environmental tolerance of domestic species beyond the range of natural limiting factors. Where such environmental alteration has occurred predictive models based on natural environmental constraints would not be applicable.

Finally, even without human intervention, the environmental constraints that determine whether or not a particular husbandry strategy is viable are often broad enough to encompass a number of possible regimes, so there is no way of predicting the details of husbandry regimes such as the degree of specialisation or intensification.

Environmental determinism is of limited use in regional studies of the British Iron Age agricultural economy, especially when using as predictive tools broad environmental factors such as climate and topography which may not be consistent throughout a region. Knowledge of environmental conditions is still helpful in explaining observed patterns of animal husbandry (Grant 1984b). Variables such as underlying geology and topographical location are considered by this study when attempting to explain intra- and inter-regional similarities and differences observed between faunal assemblages.

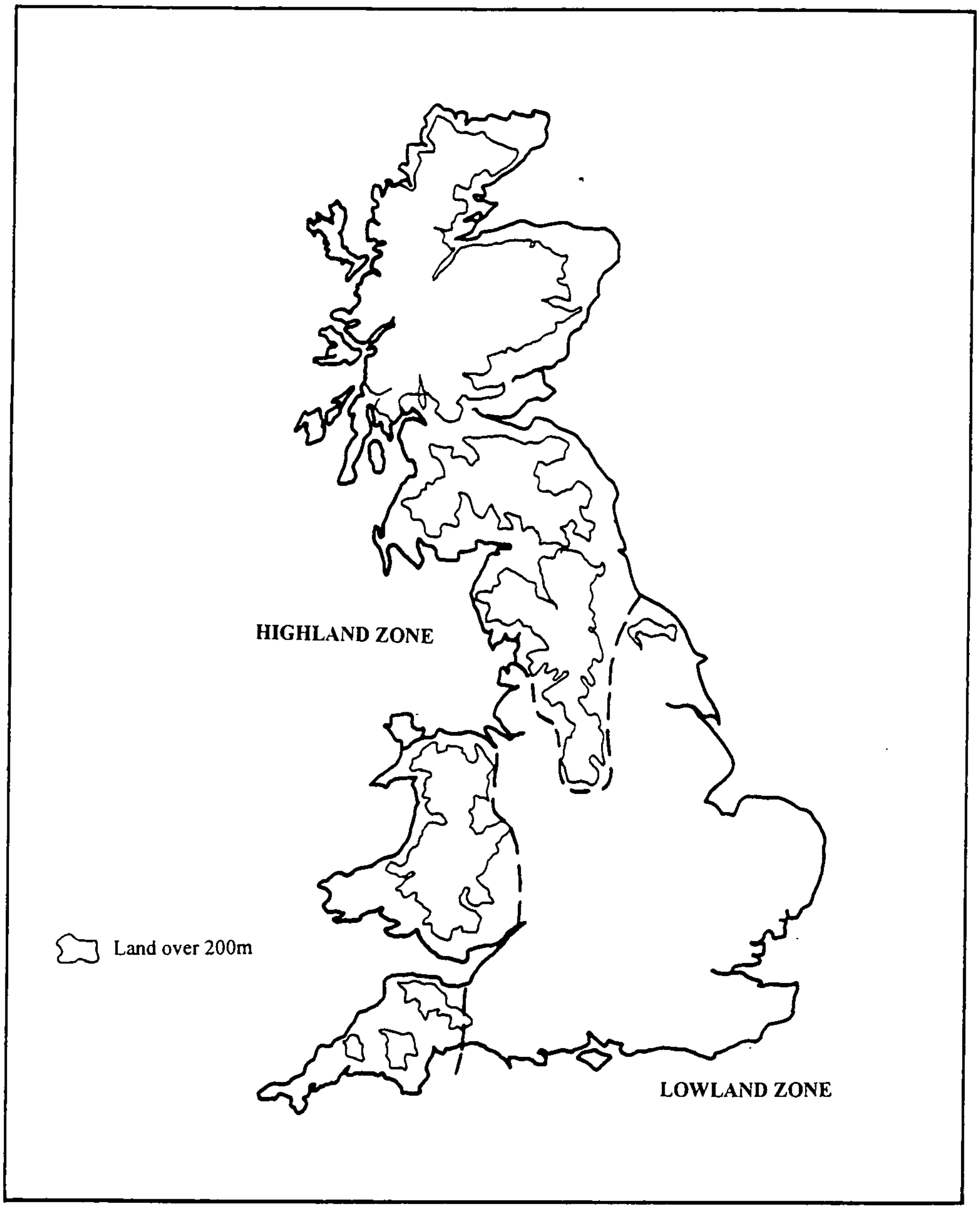

Figure 1: Map of Britain depicting Fox's (1938) 'Highland' and 'Lowland' zones.

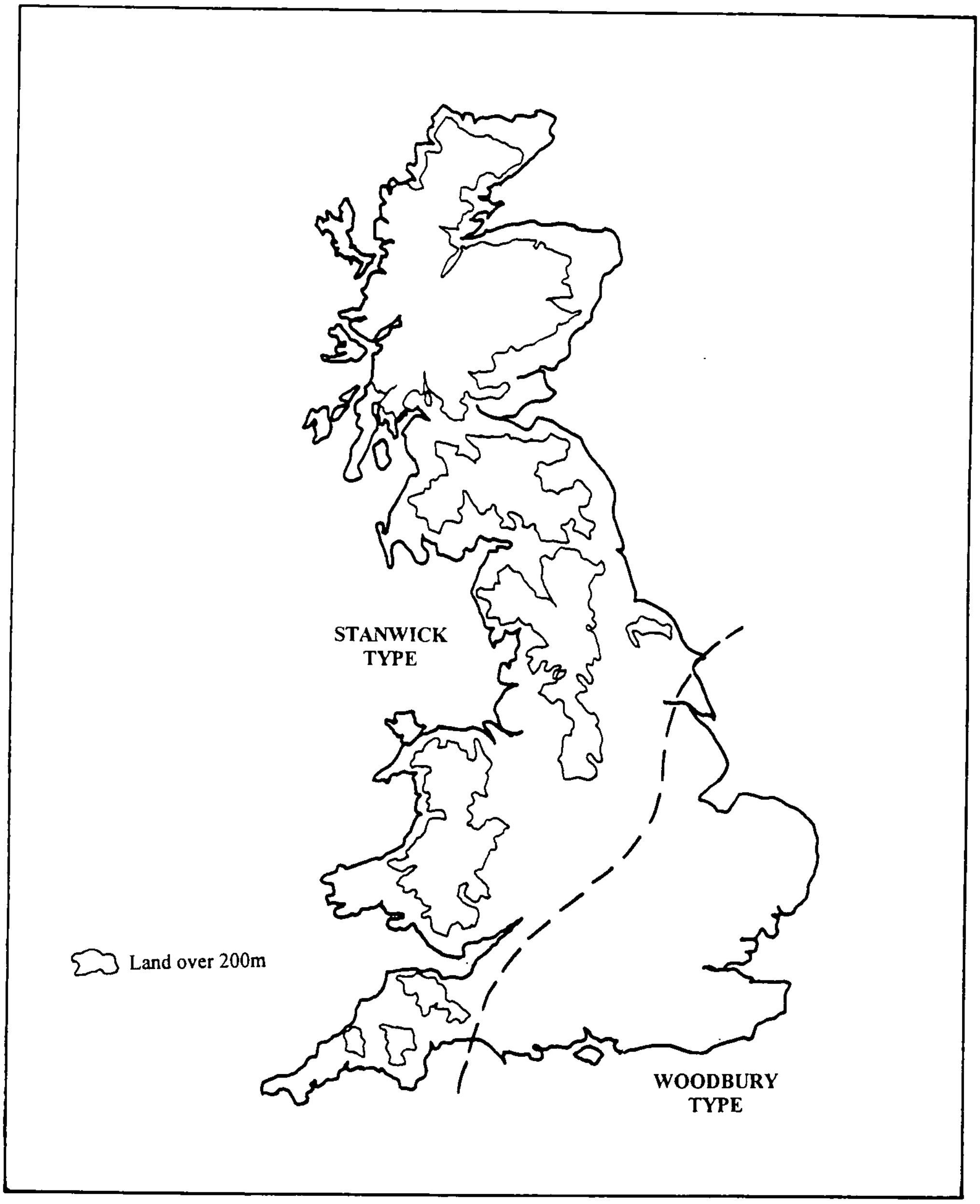

Figure 2: Map of Britain depicting Regions covered by Piggott's (1958) 'Stanwick' and 'Woodbury' cultures.

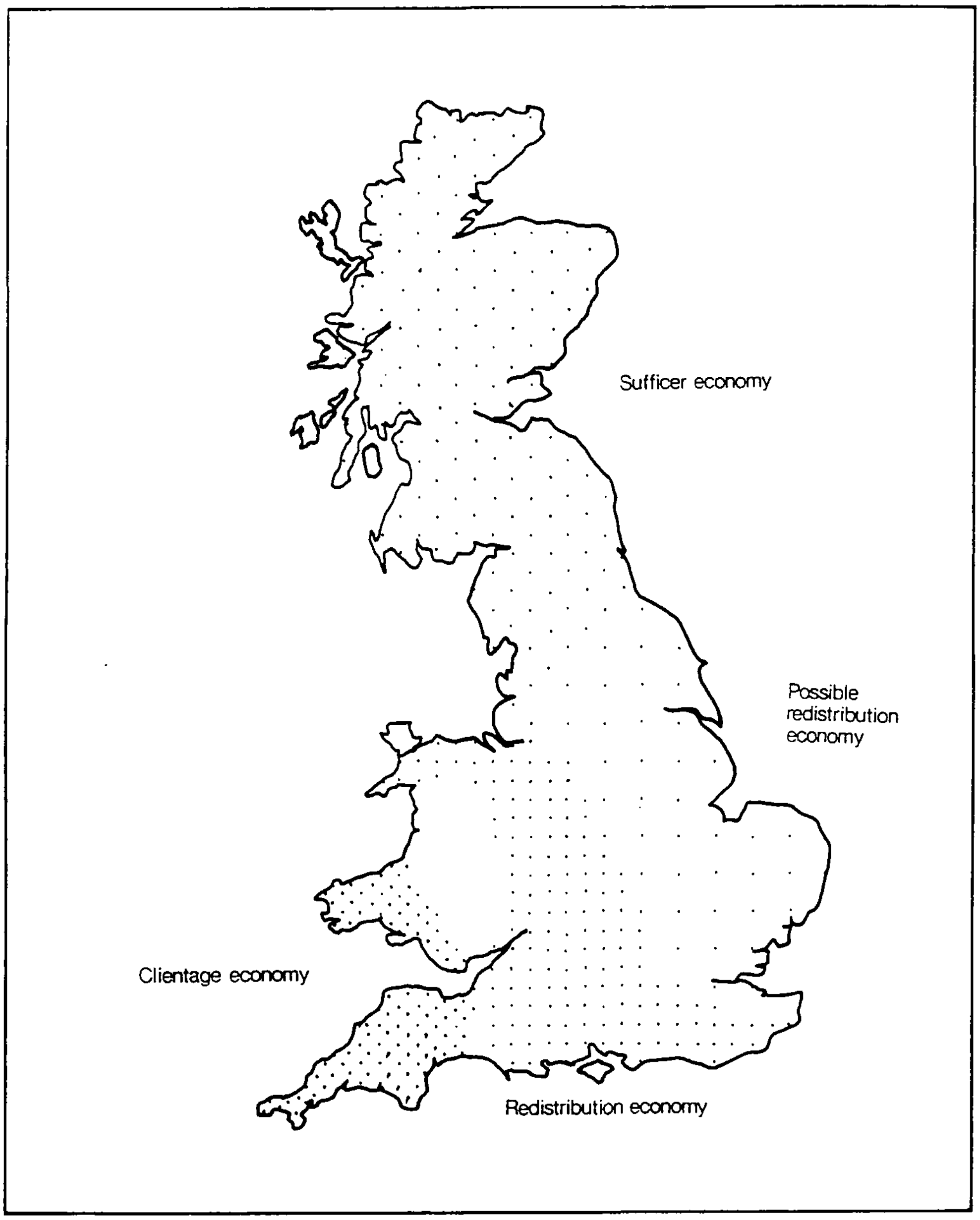

Figure 3: Map of Britain depicting Cunliffe's (1991) model of the distribution of different Iron Age agricultural economies.

Previous Studies

The following section will review a number of different regional studies of Iron Age animal husbandry. The studies reviewed consider animal husbandry regimes either alone or as part of the overall agricultural economy; they come in the form of inter-regional studies looking at trends across the whole of Britain or smaller scale studies looking at intra-regional patterns. The approaches taken by the various studies will be summarised together with their findings. As shown above, there are a number of means of approaching investigations of animal husbandry at a regional level. Most of the studies referred to in this chapter utilise a combination of different practical methodologies and theoretical approaches.

Inter-regional studies

Piggott's (1958) interpretation of native agricultural economies in Iron Age Britain utilises many of the approaches discussed above. The qualitative assessment of the faunal, botanical, structural and artefactual remains that were then available, together with a consideration of literary evidence and environmentally determinist principles results in the recognition of two main types of agricultural economy. Piggott recognised two type sites; Little Woodbury, which characterises the economy of the South and East of Britain, and Stanwick, which characterises the North and West. The model proposed by Piggott was that of two different economic strategies, a "Woodbury type" where there was mixed farming but the pastoral economy was secondary to the arable cultivation, and a "Stanwick type" which represented an almost entirely pastoral based economy with probable elements of limited nomadism.

Cunliffe (1991, chapter 15), like Piggott considers both arable and pastoral sides of the agricultural economy together, he also uses a variety of sources of evidence together with a consideration of the technological and environmental constraints imposed on British Iron Age populations. However Cunliffe divides Britain up into smaller regions, allowing a more detailed consideration of agricultural strategies across Britain. The island is divided up into the following regions: Central-southern Britain, the Midlands, the South-west, Wales, Northern Britain, and Northwest Scotland and the Isles. The detail of discussion of animal husbandry practices differs between regions mainly in relation to the amount of faunal evidence available. The nature of the pastoral economy is discussed in most detail for the south of England, Cunliffe suggests similar agricultural economies for Wessex and the Upper Thames Valley involving the exploitation of sheep mainly for secondary products such as wool and manure, and the presence of cattle primarily as a sign of status and wealth. The main concern of Cunliffe's study is not with the details of animal husbandry strategies but with the overall productivity of the agricultural economy and how this relates to social structure. Fig. 3 shows the different economic types attributed to different regions of Britain in Cunliffe's model of Iron Age agricultural strategies.

The study of animal exploitation in Iron Age Britain carried out by Maltby (1996) differs from those of Piggott and Cunliffe in that it considers only the evidence from archaeological faunal assemblages. There is very little discussion of regional variation other than a discussion of the differences in availability and quality of faunal assemblages. The study is mainly geared towards a qualitative summary of the data available, the relative importance of different species to the pastoral economy, and the contributions of intra-site studies of faunal material. Maltby provides a summary assessment of the faunal evidence rather than an interpretation of it, no neat regional models of pastoral economies are given but there is a good assessment of the available faunal information and the problems inherent in using it to examine the regional aspects of Iron Age animal husbandry in Britain.

The inter-regional approach taken by this investigation of Iron Age animal husbandry uses six regions similar in size and location to those utilised by Cunliffe, but like Maltby's study it concentrates purely on the available faunal material. The following study aims to move beyond a qualitative summary of the available faunal material to provide detailed quantitative comparisons of the different regional groups of faunal assemblages. As well as inter-regional comparisons of faunal material the investigation will be sufficiently detailed at the individual assemblage level to enable investigation of patterns of animal husbandry within regions.

Intra-regional studies

The Upper Thames Valley and Wessex are considered as one region in Grant's (1984b) quantitative comparison of the faunal assemblages from the area. There is an assessment of the quality and size of faunal assemblages from the region and a comparison of the proportions and age profiles of the main domestic species in the different assemblages. Grant seeks to explain the observed trends in the faunal assemblages in terms of topography. A pattern is observed within the region whereby the chalk downland sites, above 76 m OD, exhibit a greater emphasis on sheep while the lowland sites, below 76 m OD, appear to have a pastoral economy based more on cattle husbandry. This study is one of the better intra-regional analyses of animal husbandry in Iron Age Britain, and is the only one to provide a successful quantitative comparison of faunal assemblages.

The Upper Thames Valley is the subject of a detailed study of later prehistoric and Roman agriculture by Lambrick (1992). The study utilises a variety of evidence including faunal, botanical, climatic, topographic, and settlement information in order to build up a picture of animal husbandry practices alongside other aspects of the agricultural economy. Lambrick considers chronological trends as well as intra-regional differences, and concludes that there is an increase in production from the Early Iron Age and that in the Middle Iron Age there is increased intensification of pastoral and arable farming which continues into the Late Iron Age. The Middle Iron Age intensification results in intra-regional variation in animal husbandry regimes as there appears to be the development of specialised pastoral farming, the most extreme form of specialised pastoralism using a strategy of seasonal transhumance to exploit the summer pastures of the flood plain. There is no quantitative analysis of the faunal assemblages but this does not appear to have prevented detailed and independent consideration of the pastoral economy as well as its relation to the arable economy.

A recent review of the faunal material from Wessex (Maltby 1994) summarises the proportions and age profiles of the main domestic species. The study concludes that in general sheep and cattle appear to have been used to provide secondary products, wool and manure from sheep and dairy products and traction from cows, but there is no evidence for specialised regimes of animal husbandry. This is a brief article that summarises only the most general aspects of Wessex animal husbandry, and itself suggests the need for a more detailed inter-site analysis of the faunal assemblages.

Two other regional assessments of Iron Age animal husbandry are Knight's (1984) analysis of the Nene and Great Ouse basins, and Crabtree's (1994) study of some East Anglian Iron Age faunal assemblages. Knight's quantitative comparison of the region's faunal assemblages meets with little success, mainly because of the lack of sizeable published faunal assemblages from the region. The tentative conclusions that Knight does draw (a mixed economy with probable later expansion and intensification of stock rearing and, for sheep, a possible increase in the emphasis on secondary products) are for the most part based on artefact and structural evidence. Crabtree's study involves quantitative comparison of the Iron Age faunal material in terms of species proportions, kill patterns, and measurements. Unfortunately for those of us interested in the Iron Age pastoral economic strategies of the region, the study concentrates on the Anglo-Saxon pastoral economy the Iron Age material being compared with the Anglo-Saxon to illustrate chronological continuity. Thus the study provides a source of comparative faunal information for the Iron Age period but does not provide any detailed intra-regional assessment of animal husbandry regimes.

Huntley and Stallibrass' (1995) review of plant and vertebrate remains from Northern England is worth mentioning as it provides a detailed summary of the faunal evidence from the region, although it is not an attempt to analyse the Iron Age animal husbandry strategies of the region. The aim of the review is to provide a summary of the available faunal data together with suggestions for future directions of research, and as such it is a useful tool for anyone attempting to study Iron Age (or other period) animal husbandry regimes in the region. Recently a similar series of regional reviews of environmental data from prehistoric and historic periods have been commissioned by English Heritage. These other English Heritage reviews will cover much of the same Iron Age material for each region included in this study and will undoubtedly encounter similar problems of quality, availability and comparability of published faunal data.

Quantitative analysis such as the comparison of species proportions used in Grant's comparative study of the Wessex and Upper Thames Valley faunal assemblages will be adapted for use in this study, and extended to include other characteristics such as mortality patterns and skeletal element representation. The use of site characteristics to help explain similarities and differences in the composition of faunal assemblages is another of Grant's approaches that will be adopted; however, rather than just a single variable such as site height, other factors including underlying geology, settlement type, and date will also be considered. As well as providing a clear summary of the available faunal evidence for each region, similar to many of those described above, the systematic comparative approach taken in this study should allow a detailed analysis not only of broad regional patterns of animal husbandry, and internal variations within a region, but also variations that extend across more than one region.

Summary

Having discussed the approaches taken in previous comparative regional studies of Iron Age animal husbandry strategies it is apparent that although consideration of the agricultural economy as a whole is desirable, it is also important to examine the faunal material independently in order to gain a detailed understanding of the pastoral economy. The usefulness of a quantitative comparison of faunal assemblages is shown by Grant's (1984b) study of Wessex and the Upper Thames Valley and supports the approach taken by this thesis. The lack of similar detailed inter-regional and intra-regional studies of animal husbandry practices based on quantitative comparisons of faunal assemblages justifies the need for a study of this sort. There is a tendency in the literature towards generalised blanket inter-regional interpretations and a lack of detail in intra-regional studies. However, despite a lack of detail previous comparative inter- and intra-regional studies have provided a number of models of British Iron Age animal husbandry strategies against which the results of this thesis may be compared.

Chapter 3

The Iron Age Dataset And Introduction To Methods Of Analysis

The Iron Age faunal dataset encompasses a broad diversity of animal bone assemblages. Differences in sample size, state of preservation and species composition are primarily the results of past human activity and taphonomy, although these and other differences may also be due to the actions of archaeologists and faunal analysts. Other differences in the dataset include the quality of faunal analyses and the ways in which data is made available. Methods will be suggested that aim to provide reliable systematic comparisons of Iron Age faunal assemblages from Britain despite the varied quality and format of the available data.

Problems in faunal analysis

Relationship between recovered and deposited assemblages

The size, duration of occupation and level of activity that occurred at any archaeological site will dictate the potential size and composition of the faunal assemblage entering the archaeological record, while taphonomic factors will determine the size and composition of the assemblage surviving in the ground. However it is the actions of the archaeologists that determine size and composition of the recovered sample; the extent of the excavations (i.e. whether the whole or just a percentage of the site is excavated) will determine the size of the assemblage, as will the quality of recovery, the composition of the assemblage may also be influenced by the quality of recovery as well as by the choice of contexts excavated. The decisions made by the faunal analyst to examine the whole assemblage or smaller sub-samples, together with the choice of which fragments to record and the individual ability to identify fragments also influence the final size and composition of a faunal sample. The effect of all these influences on the amount of faunal information available is shown in figure 4.

The alteration of assemblage size and composition by pre-depositional and post-depositional factors occurs in all archaeological faunal samples. Any analysis of animal husbandry using archaeological faunal data must rely on the assumption that the recovered faunal sample is in some way representative of the original death assemblage which in turn can be related to the original living population. This is not an unreasonable assumption; however, the difficulties of faunal analysis lie in determining how directly the recovered sample represents the original death assemblage. It is possible to recognise the effects of some taphonomic factors on a recovered sample, and this information could be used to estimate how the recovered sample differs in composition from the original death assemblage. Thus any method of faunal analysis, and therefore any comparative studies of faunal assemblages, should attempt to establish taphonomic histories to extrapolate from the recovered sample the probable composition of the original death assemblage.

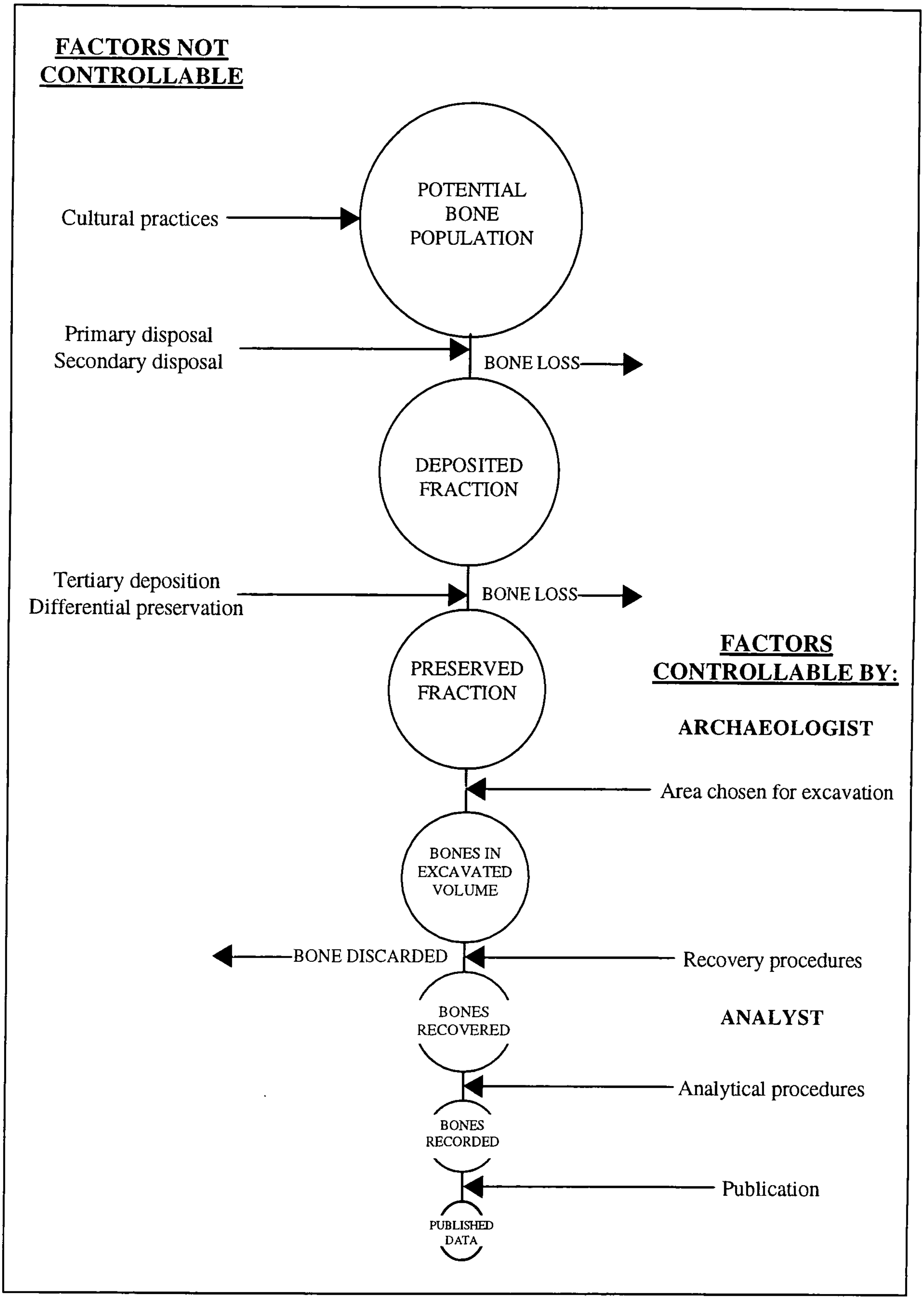

Figure 4: Model of the taphonomic history of a faunal assemblage (after Meadow 1981). The decreasing size of the circle (from top to bottom) denotes the loss of information through taphonomic time.

Structured deposition

Ritual or structured deposition of faunal material is seen as one of the main barriers to reliable reconstruction of the archaeological animal economy of Iron Age Britain. It is believed by some archaeologists (e.g. Hill 1995a) that where faunal material has been deposited as part of a periodic ritual rather than as daily refuse, those remains are outside the sphere of the economy and cannot be used to help reconstruct animal husbandry regimes. To a certain extent this may be true as deliberate deposition of particular species or particular age cohorts in certain contexts may bias the composition of the recovered sample away from that of the original death assemblage. This is thought to be of particular relevance to the British Iron Age faunal material as many sites exhibit some incidence of structured deposition in the form of complete or partial articulated burials particularly in pits and ditch terminals (Grant 1984c, Cunliffe 1992, Hill 1995b). When quantifying faunal material the preservation of complete or partial articulated skeletons can result in over-representation of the species and age groups involved, biasing the overall composition of the recovered assemblage. Problems of this sort do not seriously reduce the reliability of economic reconstruction from faunal remains, as it is possible to avoid significant over-representation of articulated remains by recording them as a single unit rather than as multiple occurrences of separate skeletal elements, a strategy frequently used by faunal analysts studying British Iron Age assemblages.

Hill (1995a) maintains that the bulk of faunal material deposited on Iron Age sites should be considered the results of "structural deposition", and that the composition of recovered faunal assemblages are too much the product of deliberate human activity to be representative of the original composition. The representation of different species in an assemblage may be affected by ritual or cultural factors that result in differential deposition of different species. For example low incidence of pig in many assemblages may result from differential deposition of pig remains away from the settlement in areas which are unlikely to be the focus of archaeological excavation.

It is acknowledged that the importance of domestic animals to British Iron Age societies went beyond that of simply a subsistence resource, but suggesting that this is a barrier to our understanding of the animal economy seems to be an unnecessary compartmentalisation of the ritual, ceremonial and spiritual role of domestic animals and their economic functions. To consider ritual deposits of faunal material as separate from the animal economy is to study ritual activity *out of context*. Faunal analysis can attempt to recognise and take into account the biasing effects of structured deposition in the same way as other taphonomic factors. Also, the level of structured deposition on many British Iron Age sites may have been overestimated. Wilson's (1996) spatial analysis of distribution of faunal remains on archaeological sites suggests that many of the differences in species and age composition between different types of context and different areas of a site, previously interpreted as ritual human activity, may actually be explained by carcass processing combined with the effects of carnivore attrition.

The faunal dataset

Sources of data

The faunal assemblages selected for use in this study are restricted to those recovered from sites which, subsequent to excavation, have been interpreted as Iron Age settlements. As the majority of British Iron Age sites have been interpreted as rural farming settlements this does not reduce significantly the faunal dataset. Those sites interpreted as ritual centres, e.g. Hayling Island (Downey et al 1979) and Harlow Temple (France & Gobel 1985, Legge & Dorrington 1985), are excluded from the dataset as it is unlikely that the faunal assemblages from such sites include any of the day to day refuse of animal processing and consumption which can be used to infer animal husbandry strategies. It should be pointed out that often there is no clear distinction between settlement and ritual centres, and it is not unusual for areas of ritual significance to occur inside settlements, as is the case with Danebury (Cunliffe 1984). As a result of these potential palimpsests of ritual and domestic faunal assemblages, it is important to be cautious when using entire site assemblages to infer animal husbandry strategies. For this reason only broad interpretations of economic strategy should be made, unless the proportion of non-domestic refuse in an animal assemblage can be proven to be negligible.

The decision was also made to use existing published data, where available, to compare faunal assemblages. Published reports on individual faunal assemblages provide a readily accessible source of data for use in comparing the British Iron Age material. Using published material meant the largest possible number of assemblages from around Britain could be compared in the time available, as the alternatives of collecting fresh or archived data were much more time consuming and probably would have resulted in the use of a smaller dataset. Another reason for attempting to use published data was to see whether or not is was possible to do so; the purpose of publishing data is to enable reinterpretation and further evaluation of the faunal material, and it is important to assess to what extent this is possible under the current conventions of British Iron Age faunal publications.

Ideally a comparative study of faunal assemblages from different sites would use fresh faunal data collected by direct analysis of the bones themselves. This would ensure the use of a consistent methodology and cut out any variation due to the idiosyncrasies of different faunal analysts. Unfortunately this was not a realistic proposition for the purposes of this study as collection of fresh data from the majority of existing British Iron Age faunal assemblages would have been too time consuming. There are other logistical problems involved with the collection of fresh data, in particular the problems of reassessment of old assemblages. Loss of material, including loss of complete assemblages, is not uncommon and many assemblages have suffered additional mixing and breakage which mean they are no longer in the same state as when examined originally. There are also problems of gaining access to existing faunal collections that may further reduce the available dataset.

Archive material was also considered as a possible source of data for use in this study on the assumption that use of archive reports would enable access to data unavailable in the published sources while being less time consuming than collection of fresh data. In actual fact the archive material proved to be of surprisingly limited use to this sort of comparative study. A pilot study using the archive faunal reports and catalogues from six Iron Age Upper Thames Valley sites revealed that although there were some potentially useful intermediate forms of data, on the whole there was little information in the archives, in terms of quantification of species, skeletal element representation and ageing data, that was not available in the published reports. Also, archive material often suffers the same problems of loss, incompleteness, and poor access as the bone assemblages themselves.

The most suitable source of faunal data for use in this systematic comparative study of Iron Age faunal assemblages from across Britain was thus the existing published dataset. In a few cases, regions lacking sufficient published data were supplemented, where available, by archive and fresh data. For example the dataset from northern Britain (the region covering the north of England from South Yorkshire to the southern Scottish borders and Lothian) includes as yet unpublished data from Stanwick, and fresh data obtained from direct analysis of the Port Seton faunal assemblage. All sites included in this study and all those mentioned in the text are fully referenced in the bibliography.

Those faunal samples considered for use in this study were all excavated and published after 1950, as prior to this date faunal studies invariably contain insufficient information in a suitable format. Suitable assemblages were found by consulting British regional archaeological journals for Iron Age sites (post 1970), and consulting the bibliographies of books and papers providing overviews of the British Iron Age, primarily Cunliffe's (1991) *Iron Age Communities in Britain.* Several hundred Iron Age site reports were examined for usable faunal assemblages.

Many faunal assemblages could be instantly rejected as the quality of analysis was too poor and none of the required data had been recorded. References were found to a number of large and potentially important faunal assemblages of which there was no attempt at analysis, in particular the assemblage from Staple Howe (Brewster 1963). It was not uncommon, particularly in earlier reports, to read that no attempt had been made to analyse the faunal remains, and that recovered bones were often discarded. It was also apparent that many samples were too small to be able to provide a reliable indication of the composition of the archaeological assemblage, and therefore could not be used in this comparative study. Details of those British Iron Age faunal samples which were large enough and produced sufficient data for use in this study are given in appendix 1 and 2.

Species

This comparative study is concerned only with the three main British Iron Age domesticates: cow, sheep and pig. These three species comprise the bulk of all British Iron Age faunal samples, and while the exploitation of other species is of interest it is apparent from the dominance of these three species in the archaeological record that the majority of Iron Age animal economies were based almost exclusively on the products of cattle, sheep and pig. This also appears to be true of much of the northern French Iron Age assemblages (Lepetz 1996) and Romano-British Assemblages (King 1978). Compared to most modern domestic breeds, Iron Age cattle, sheep and pig must be considered small; small breeds such as Soay sheep and Dexter cattle appear to provide the best modern analogy to the British Iron Age breeds, exhibiting similar size and skeletal morphology (Reynolds 1979).

Other domestic species commonly found at British Iron Age sites include horse and dog. Dog remains are seldom present in large numbers, and rarely constitute more than 1 or 2 % of the identified faunal assemblage. At some sites horse remains are present in greater quantities than pig, e.g. Mingies Ditch (Wilson 1993), suggesting a greater economic importance, and a number of sites, e.g. Danebury (Grant 1984a,1991) also show a relative increase in the importance of horse at the very end of the Iron Age. In overall terms, however, pig remains occur at a greater percentage of Iron Age sites and are the third most abundant species more consistently than horse. The role of horse in the Iron Age economy is open to debate; while it is accepted that horses were probably used as mounts or pack animals, the butchery evidence is ambiguous with some sites showing evidence that horses were used as a source of meat and others not. The role of horse in the British Iron Age is a subject that warrants further research, however the inclusion of pig in this study as one of the three most common domesticates, rather than horse, is justified by the overall abundance of pig on Iron Age sites.

Goats also occur in the faunal assemblages but often sheep and goat remains are not easily distinguished as separate species. The general consensus among the published Iron Age faunal analyses is that the majority of ovicaprid remains are those of sheep rather than goat, and there is little evidence to suggest any significant difference in the treatment of the two species. Thus for the purposes of this study sheep, goat and indeterminate sheep/goat remains are all included under the term "sheep".

There is a very low incidence of wild species in most British Iron Age faunal assemblages. Deer, hare and wild boar appear to have been the most commonly hunted species. Wild boar, where identified separately, have not been included in the counts of pig, although it is possible that some reports have counted wild boar remains among those of domestic pig. Nevertheless, the consistently low occurrence of wild boar in Iron Age samples, where it is separately identified, suggests that the relative importance of pig would not be significantly increased in samples where wild and domestic remains were grouped.

There are a few instances where faunal assemblages do include a larger percentage of wild species, indicating the importance of exploitation of wild resources to the local economy. For example, the East Anglian fenland sites of Haddenham and Market Deeping exhibit high incidences of beaver remains, and it is thought that the exploitation of beaver was of great importance to the inhabitants of these sites (Evans and Serjeantson 1988, Albarella 1997). These are exceptions, and the overall impression from the majority of British Iron Age faunal assemblages is one of an animal economy based almost exclusively on domestic species with minimal utilisation of wild species. The concentration on domestic animals is apparent even where wild resources are abundant and easily accessible such as at the Scottish coastal sites of Port Seton, where there is little or no evidence that marine resources were exploited (Hambleton & Stallibrass forthcoming), and Broxmouth, where it appears marine resources were exploited only as an emergency resource (Sloan forthcoming). An overview of the British Iron Age animal economy, and details of intra- and inter-regional patterns of husbandry strategy, may therefore be obtained by undertaking a comparative analysis of the main component of the Iron Age faunal dataset, namely the assemblages of domestic cow, sheep and pig.

Site characteristics

In order to attempt to understand the reasons for the differences in assemblage composition and, consequently, animal husbandry strategies observed in the British Iron Age faunal dataset it was decided to examine the patterns of species composition and mortality profile for relationships with a variety of different site characteristics. The following sections give details of these various characteristics.

Regions

The faunal samples were separated into six regional groups covering England, Wales and Southern Scotland (the northern Scottish mainland was excluded due to the paucity of available Iron Age faunal evidence) and were examined for any corresponding similarities in assemblage composition. The chosen regions (figure 5) reflect broad areas of shared cultural and geographical traits. These form cohesive units despite inevitable environmental diversity and local variation in the archaeological evidence, for example differences in pottery decoration (Cunliffe 1991).

Wessex and Central Southern England: Including the main Wessex counties of Wiltshire, Hampshire and Dorset together with Somerset, Avon, Berkshire and south Sussex, this region, with the exception of the Somerset Levels, is mainly comprised of reasonably low lying

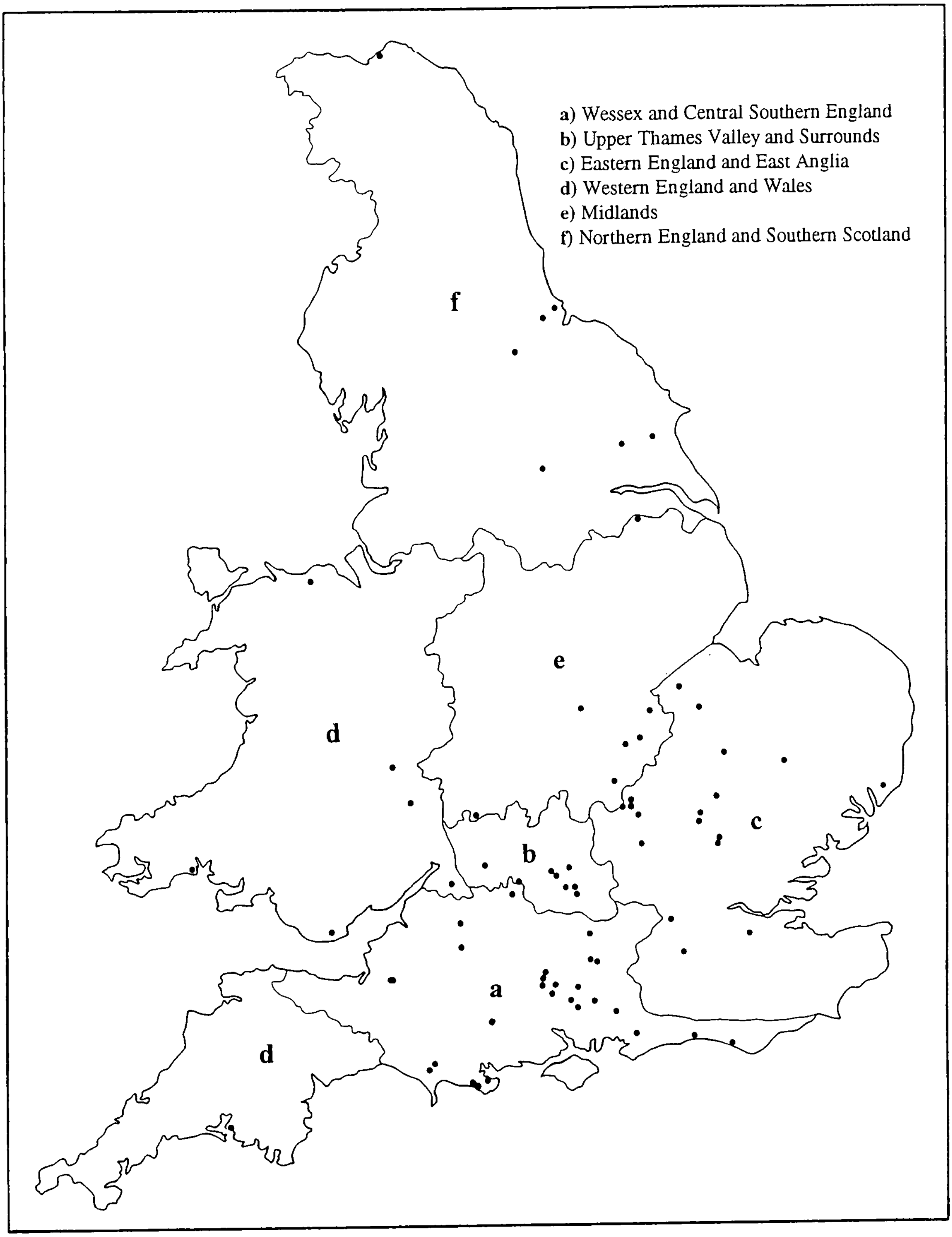

Figure 5: Map of Britain depicting geographical regions and location of sites used in this study.

undulating chalk downland. It forms the southern half of the hillfort-dominated zone which is characterised by the "developed" multivallate hillfort (Cunliffe 1984). The non-hillfort sites tend to be relatively small enclosed domestic farmsteads such as Gussage all Saints, and banjo enclosures such as Micheldever Wood. Central southern England has been the main focus of many Iron Age studies, having had a long history of archaeological investigation which accounts for the large faunal dataset available from this region.

Upper Thames Valley and Surrounds: This region covers Oxfordshire and Gloucestershire, the counties that contain the upper reaches of the Thames and its tributaries. Settlement on the upland chalk areas is in the form of widely spaced enclosed sites, while on the low lying alluvial flood plains and gravel terraces of the river valleys more closely spaced open settlements predominate (Hingley 1984). Compared to the other regions, this covers a very small geographical area. However, intensive archaeological survey and a long program of rescue excavation has provided sufficient numbers of faunal samples to allow this area to be examined as a region in itself.

Eastern England and East Anglia: This is a large area stretching from the Lincolnshire fens and covering the whole of East Anglia and most of south east England, including Cambridgeshire, Bedfordshire and Buckinghamshire to the west and at its southernmost reaches Kent and north Sussex. Cunliffe (1982) maintains that Kent and north Sussex should be considered part of Eastern England because they share cultural and geographical similarities with the region centred around the Thames and East Anglian rivers flowing into the North Sea. There is a certain amount of geographical diversity ranging from the reasonably high ground of the Chiltern Hills and the Weald to the fenlands lying only a little above sea level. Settlements tend to be open and the enclosing of sites tends to be a later occurrence. There are few hillforts, and those that do occur in the region appear mainly in the Late Iron Age.

Western England and Wales: This is a broad geographical area comprising the south west of England, Wales, and the border counties of the Welsh Marches. Geographically diverse, the region includes the mountainous areas of central and northern Wales, the coastal environments of the south west and Welsh coasts, and the mixed topography of the more temperate Marches. One shared feature is that much of the region has acid soils that do not favour bone preservation, a feature which may account for the small size of the available dataset. The Marches and north Wales comprise the other half of the hillfort-dominated zone. In this part of the zone there are fewer of the "developed" hillfort type and the non-hillfort sites are mainly isolated enclosed farmsteads. The rest of the region may be considered part of the Atlantic tradition and shares similar traits such as the occurrence of small settlements with large enclosing earthworks called raths in Wales and rounds in south west England. Another settlement feature of the region is the occurrence of hillforts with wide spaced ramparts (Fox 1961). Even though it may well encompass more than one distinct Iron Age cultural tradition, it is necessary to group together faunal samples from such a broad region in order to obtain sufficient samples for viable inter- and intra-regional comparison.

Midlands: The midlands region includes the counties of central England as far west as the Welsh Marches and as far east as Northamptonshire and Lincolnshire north of the fens. This region falls outside the hillfort-dominated zone and exhibits a diverse range of settlement types including enclosed, open, and agglomerated settlements. Hillforts occur in low density, and the few that have been excavated appear to be of Early Iron Age origin, e.g. Hunsbury (Fell 1937, Jackson 1993) and Mam Tor (Coombs 1976).

Northern England and Southern Scotland: As with the western region, this is a large and diverse geographical area with a high incidence of acidic soils. Bone preservation is generally poor, although there are exceptions. The region encompasses the north of England counties from South Yorkshire through to the Scottish counties south of the Forth. The main variation in geography is between the east and the west; to the west the ground is higher and the climate wetter, while to the east the region is more temperate and lower lying. The settlement pattern is also varied and includes both open and enclosed sites. There are a few large hillforts throughout the region, but the majority of univallate and multivallate sites termed "hillforts", most dense in north east England and south east Scotland, are not on the same scale as those of Wessex and the Welsh Marches and are best described as enclosed settlements or defended enclosures (Ferrell 1997).

The regions defined for use in this study are consistent with the important aspects of those used in previous surveys of Iron Age Britain. Hence Fox's (1938) Highland zone can be equated to the 'Northern' and 'Western' regions described above, while his Lowland zone is roughly equivalent to the environmental parameters of the remaining four regions[1]. The northern and western regions also represent the survey areas which. given the high incidence of acid soils, are most likely to have suffered the detrimental effects of natural environmental conditions on assemblage preservation.

In terms of the archaeological evidence the regions reflect broad variations in settlement patterns across Britain as described by Cunliffe (1991). The core, periphery, and outer zones used to model the spread of Late Iron Age developments such as the adoption of coinage and Roman styles of material culture (Haselgrove 1982) can also be identified in the

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[1] The clear division of Highland/Lowland environments described by Fox (1938) was in place by the Iron Age. In earlier periods the differences were less acute but were exacerbated by Neolithic and Bronze Age agriculture (Jones 1986); thus Fox's Highland/Lowland zones are not an appropriate frame of reference for similar studies of earlier periods.

regions chosen. The core area is largely included within the eastern region; the Wessex, Upper Thames, and Midlands regions correspond to the peripheral zone, and the western and northern regions provide a fair approximation of the outer zone.

The use of established geographical and cultural regions will enable the interpretations of animal husbandry strategy provided by this study to be placed within what are perceived to be the important socio-political and environmental divisions within Iron Age Britain.

Settlement types

The categories of site, hillfort, banjo enclosure, enclosed settlement, and open settlement, are all terms in common use in the literature concerning Iron Age Britain. Many are broad blanket terms that could well encompass a variety of different types of site. However it is not the purpose of this study to debate Iron Age terminology and the categories used do appear to include sites with enough generally similar features to be considered a coherent group. It is not uncommon for settlements to change form through time, for example Thorpe Thewles in Cleveland has both an enclosed and a later open phase (Heslop 1987). Assigning faunal assemblages to particular site categories is quite difficult in this situation and can only be resolved if the faunal assemblage has been divided into sub-samples corresponding to the different phases of settlement type.

Hillforts: The term hillfort is generally applied to large univallate or multivallate hilltop enclosures such as those prevalent throughout Wessex and the Welsh Marches. Most hillforts appear to have arisen during the Early Iron Age, but this varies and in eastern Britain hillforts are generally a later Iron Age phenomenon. Hillfort sites range from small, densely occupied and well fortified settlements to large enclosures with little evidence of occupation; as well as varying geographically, hillfort forms also vary through time (Cunliffe 1991). Generally the term seems to infer some sort of special status which differentiates hillforts from other enclosed settlements, although in the past the term has also been used indiscriminately for enclosed settlements whose only real difference from other surrounding sites is their location on a hill.

Banjo enclosures: Supposedly shaped like a banjo, these are small circular enclosures which have leading from them a characteristic long narrow entrance of parallel ditches that splay out at the end. Although occurring throughout Britain they appear most commonly in central southern England. Banjos could be included under the umbrella term of enclosed settlement, however they are a quite clearly defined group which allows them to be treated as a separate category. Also, the banjo form has been interpreted as having some functional association with agriculture such as livestock keeping, and because of this is worthy of separate attention in a study concerned with agricultural strategies.

Enclosed settlements: This includes all other sites with a definite boundary surrounding the whole settlement. For the most part sites in this category are small single household farmsteads which differ across Britain mainly in terms of shape and can be circular, rectilinear, D-shaped or irregular. Size can vary, as can the boundary itself which may be in the form of simple boundary ditches, palisades, or more substantial earthworks or stone ramparts.

Open settlements: This is probably the broadest category and includes any settlement without a clear enclosing boundary. They range in size from individual roundhouses to aggregations of households covering several hectares. Although having no single enclosing boundary many open settlements do exhibit some enclosed features, for example the site of Dalton Parlours consists of multiple interlocking small enclosures. The nature of agglomerated settlements differs from planned "villages" such as Ower (Woodward 1987), to looser sprawls (e.g. Ashville, Parrington 1978) that represent the shift of settlement through time. This category also includes *oppida* and related sites[2]. Characteristically these are large, low lying sites, often defined by linear dykes but not wholly enclosed, which developed on the latter half of the first century BC. They typically exhibit strong links with the continent and have been interpreted as high status sites and political foci (Darvill 1996).

As well as their prevalence in the literature, the choice of categories has been influenced to a limited extent by their significance to the potential characteristics of faunal assemblages. Open and enclosed sites are considered as separate categories as the presence or absence of a clear boundary may influence the completeness of recovery of the site faunal assemblage and - because of differential spatial distribution between species - the relative proportions of species (Wilson 1996). Previous studies linking particular agricultural strategies or functions with particular types of site have also influenced the choice of categories. Comparing the faunal assemblages from different types of site can help test these assumptions. Comparison of similarities and differences of faunal assemblages both within and between different categories of site can help fuel debates over whether similarities in site form are related to similarities in site function.

Date

The date divisions are those in current use throughout British Iron Age studies: Early Iron Age, Middle Iron Age, and Late Iron Age. A fourth category, Late Iron Age and Early Romano-British, is also used as many samples continue into the Roman period and it is useful to

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[2] These include the so-called *territorial oppida* of south east England (Cunliffe 1991), such as Colchester, St Albans, and Silchester (none of which unfortunately yielded faunal samples that could be used in this analysis), and other major nucleated settlements, with or without smaller defended enclosures. The latter group includes Baldock and Puckeridge-Braughing/Skeleton Green. The site of Stanwick, North Yorkshire, is also commonly included as one of the *oppida*, but is distinguished by its geographical location in the north of England.

examine these sites separately for possible differences linked with the spread of Roman influence and the adoption of Roman culture. Dating in the Iron Age is a contentious issue as a plateau in the radio-carbon curve between 800 and 400 BC hinders accurate absolute dating of assemblages for the first half of the Iron Age (Cunliffe 1991). This means dating of sites, and consequently faunal assemblages, has relied heavily on relative dating based on artefact and settlement types which results in variation of the start dates and duration of Iron Age periods assigned for different areas in Britain. Despite these inconsistencies there are generally agreed dates for the Different Iron Age periods in Britain. For the purposes of this study the following dates are used: EIA c.750-400 BC; MIA c.400-100 BC; LIA c.100BC - AD50. The LIA-ERB category refers to assemblages beginning during the Late Iron Age period but with a substantial proportion of faunal remains representing the second half of the first century AD. These are necessarily broad categories but it is hoped they may highlight some interesting chronological variations in animal husbandry strategy throughout Iron Age Britain.

Geography

Certain aspects of a site's geographical location can determine the range of different agricultural strategies most appropriate for its inhabitants. This study considers differences in topographical location and underlying geology with reference to the composition of faunal assemblages.

Underlying geology: The categories chosen are the six most common found among the sites used in this study and include, Alluvium, Boulder Clays, Chalk, Gravel, Limestone, and Peat. Underlying geology, as the parent material, provides a broad indication of the soil types at each site, and is more commonly noted in the published site reports than the soil types themselves.

Topographical location: The categories are height ranges of 0-25m OD, 26-75m OD, 76-150m OD, 150-225m OD, and above 225m OD. These divisions distinguish between very low-lying sites in wetland areas or river floodplains which may have been subject to seasonal flooding, and higher areas of different pasture types with variable access to water sources and suitability to arable cultivation. The divisions are also suited to testing associations of different site heights with particular faunal assemblage compositions proposed in previous studies (e.g. Grant 1984b).

Methods of analysis

The use of existing published faunal data influences the choice of methods used to compare assemblages. The simplest way to ensure comparable data would have been to use established methodologies already in frequent use in British Iron Age faunal studies. This way the faunal data used would be in the same format and can provide a reliable comparison of different assemblages. Unfortunately the variety of different methods of recording and presenting data used in analyses of British Iron Age faunal assemblages means data from different sites are often not directly comparable. Where this is the case techniques must be developed to convert existing data into a single comparable format. The majority of methods of recording and presenting faunal data used in British Iron Age analyses reflect those commonly used in studies of French Iron Age material, and Romano-British material, as well as in many other faunal assemblages from different locations and of different date. Any comparative methods developed here for use with the British Iron Age dataset are therefore likely to be of future use in comparative studies of faunal remains from other periods and regions where similar types of data are available.

Another feature of the methods required for this study is that they should provide a quick and straightforward outline of the main characteristics of a faunal assemblages while enabling easy identification of intra- and inter-regional trends and the presence outlying samples.

Approaches: Body part representation, species proportions, and mortality patterns

The approach used to compare faunal assemblages in this study involves three main methods. Assemblages are characterised by the relative proportions of the three main domestic species in the sample, the age profile of each species, and the representation of different body parts among these species. The main principles behind the choice of these methods are given below while the details of each of these methods are given in **chapter 4** - Skeletal Element Representation, **chapters 5 & 6** - .Quantification, and **chapters 7, 8 & 9** - Ageing.

One method intended for use in this study was the comparative analysis of *skeletal element representation* in the three main domesticates. Where suitable data were available results were presented graphically to allow visual comparison of different site assemblages, and different species within an assemblage. The purpose of analysing the representation of different elements of the skeleton was to recognise the effects of different taphonomic biases on each assemblage, and to use these broad taphonomic histories to clarify the validity of the different species compositions and mortality profiles exhibited in each assemblage. Unfortunately it was not possible to implement this method fully for the comparative study of Iron Age faunal assemblages from Britain.

Comparative analysis of *quantification* data was undertaken to establish the relative importance of cattle sheep and pig in different Iron Age faunal assemblages. All published faunal analyses make some attempt to quantify of the faunal remains according to different species, and most use similar units of quantification that can be easily compared by converting these numbers into percentages. Where similar units of quantification were used in reports, assemblages were compared in terms of species composition. The relative abundance of cattle, sheep and pig remains were expressed as percentages of the total abundance of those three species in each assemblage. The relative percentage of cattle sheep and pig in each assemblage were plotted on tripolar graphs, which provided a means of visually comparing the species composition of different assemblages, allowing recognition of patterns of intra- and inter-regional similarities and differences. For each faunal sample plotted on the tripolar axes, different site characteristics could be clearly labelled enabling easy recognition of relationships between observed trends in the species composition and particular properties of the sites from which the faunal assemblages were recovered. The main purpose of comparing the relative abundance of different species was to gain an understanding of the relative importance together with the treatment and utilisation of the different species at each site and their potential contribution to the Iron Age economy. Triplots have been used extensively in comparative faunal studies elsewhere, e.g. by King (1978, 1984) and by French archaeozoologists e.g. Lepetz (1996).

Finally, a*geing* data from analysis of mandibular tooth wear was also compared. As with quantification, most published reports provide some relevant data although, unlike units of quantification, ageing data from British Iron Age assemblages is not always presented in a similar format. The method for comparing age data involved the development of a technique for converting different types of tooth wear data into a single comparable format. A visual comparison of age at death for each species was possible by presenting data in the form of mortality curves which could be plotted on the same axes allowing visual recognition of similarities and differences both within and between regions. Analysis of mortality profiles was undertaken because it enables different strategies of herd management to be recognised. This in turn provides some indication of the level of exploitation of each species for different primary products, such as meat and hide, and secondary resources, such as milk, wool, manure, and muscle power as draught and pack animals.

The possibility of providing details of the taphonomic histories of each assemblage by comparing skeletal element representations is limited by the availability of useful data. However, comparative analyses of both quantification and ageing data do successfully enable analysis of intra- and inter-regional patterns in the relative economic importance of each different species, and the relative importance of different animal products throughout the British Iron Age.

Statistical or visual analysis?

It is important to be able to examine data to see if any patterns may be explained by factors other than simple chance or the vagaries of separate analysts and their methodologies. For the purposes of this study visual methods of examining patterns of similarities and differences among the faunal assemblages are used rather than statistical analyses. Ideally statistical tests would be used to determine whether or not the observed trends were due to chance and whether the relationships between assemblage composition and certain site characteristics were real. In this instance it did not seem appropriate to use statistical tests to assess the validity of the observations, because the archaeological data used were not of sufficiently high quality to warrant the use of precise mathematics, or because there were no statistical techniques suited to testing this sort of data.

As mentioned previously, the relationship between a recovered archaeological faunal assemblage and the original living population is a hazy one. In order for results to be considered reliable, most statistics would require that the test population (the recovered faunal assemblage) is a representative sample of the whole population (the complete archaeological assemblage, the original death assemblage, or the original living population) (Shennan 1988). As we have seen this requirement is unlikely to be met by individual faunal assemblages given the unquantifiable taphonomic alterations that occur prior to deposition, during burial, and during excavation. Comparative analyses are also hindered by the variation among the taphonomic histories of archaeological assemblages from different sites. In addition, the variation resulting from differences in treatment of material and data by different analysts constitutes a degree of human error that renders the data too crude for use with many statistical techniques.

Small sample size is also a limit to the application of statistical tests as many of the assemblages used in this study are too small to be considered statistically viable even though in practise it is still possible to observe samples of all sizes fall into visibly cohesive groups. for example, Shennan (1988) suggests that a sample of forty aged mandibles is required for each mortality curve before their similarities can be assessed using the Kolmogorov-Smirnov test. Less than 40% of British Iron Age cattle, sheep, and pig mandible samples included in this study can provide sufficient quantities of tooth wear data to meet this criteria, which means for the majority of faunal samples the use of statistical tests to compare mortality profiles is inappropriate. In addition to the problems of sample size, there is the strong possibility that many of the visible patterns in the faunal data would not be registered as statistically significant as the ranges of similar groups are broad and often overlap with the ranges of samples interpreted as belonging to different groups. This is the case with this study of species proportions, where the ranges of percentage of a species overlap between samples seen as belonging to distinct regional, chronological, or other groups.

It is difficult to find appropriate methods of statistical analysis that are suited to testing the hypotheses generated by comparative studies of archaeological faunal assemblages. Multivariate Analysis, used to great effect on plant remains, is of potential use when comparing archaeofaunas as it is a statistical technique that is *deductive* and describes the sample as it stands rather than other *inductive* techniques that assume the archaeological sample is directly representative of, and can generate conclusions concerning, the original assemblage (Madsen 1988). Multivariate techniques allow the consideration of numerous variables in the analysis of an assemblage; however this is of no use in describing and comparing samples if the importance or weight of each variable is not known (ibid.). The extent to which each taphonomic factor has transformed the different faunal assemblages and the relative importance of each taphonomic variable cannot be quantified which means multivariate analysis is unsuited to comparative archaeofaunal studies, even before the problems of the small sample sizes of British Iron Age faunal assemblages are taken into account.

Statistical analysis of data is a valid and useful approach to many aspects of faunal archaeology. However, given the small size of many of the samples involved, and the problems of unquantifiable variation due to taphonomic alteration, human error, and inconsistent methodology, the data available for use in this study is not of sufficient quality for the application of statistical techniques to be considered a viable option. Also many trends that may be picked out by visual comparison of the data are unlikely to be considered statistically significant, although the fact that they form visibly cohesive groups would suggest that the majority of observed trends are real. Certain principles of statistical analysis are kept, such as acquiring the largest possible dataset in order to achieve repeated observation of a trend, even though the available British Iron Age faunal data is not suited to rigorous statistical testing. Despite being subjective, visual analysis rather than statistical is the more suitable means of comparing the available published faunal data.

It is believed that the approaches taken in this study will provide reliable comparisons of faunal assemblages that will increase understanding of the intra- and inter-regional patterns of animal husbandry throughout the Iron Age in Britain.

Chapter 4

The Representation Of Skeletal Elements In Iron Age Faunal Assemblages

The representation of different parts of the skeleton in an archaeological faunal assemblage invariably deviates from that which would be expected if only complete skeletons were recovered. It may be assumed that all elements of the skeleton will be present in an animal at the moment of its death, thus any deviation from this expected representation of skeletal elements in the recovered archaeological assemblage must be due to post-mortem influences on the carcass. A variety of taphonomic factors may alter the skeletal element representation away from the norm; survivability of the different elements in response to differential transport of parts of the carcass, pre-depositional destruction (weathering, trampling, carnivore activity, human processing), post-depositional destruction (physical and chemical weathering in the soil), and biases in retrieval and identification of different elements.

The various processes by which the representation of skeletal elements can be altered from their original anatomical proportions have been examined in a number of studies over the past twenty years (e.g. Isaac 1967, Payne 1972, Binford & Bertram 1977, Binford 1978, Brain 1981, Lyman 1985 & 1993). The main purpose of such studies is to establish the distorting effect that individual taphonomic factors will have on the representation of different skeletal elements with the aim of recognising similar patterns in archaeological assemblages. By recognising patterns of skeletal element depletion associated with particular processes it should in theory be possible to establish the different taphonomic histories of faunal assemblages. Establishing which taphonomic processes have been acting on an assemblage is of particular importance when making inter-site comparisons, as similarities and differences visible in separate archaeological site faunal assemblages may be as much the result of taphonomic influences as the composition of the original death assemblages.

The potential of skeletal element representation as a source of archaeological information

There is great potential for the use of predictive models of skeletal element representation based on ethnographic and experimental data to explain patterns observed in archaeological faunal assemblages. *Preservation models* based primarily on the survivability of elements according to their bone density, and their resistance to attrition and weathering (e.g. Brain 1981, Lyman 1984) and transportation models based on the general utility of elements in terms of meat, marrow, and grease content (e.g. Binford 1978) are perhaps the most common themes in archaeological studies of skeletal element representation. However in addition to differential preservation and transportation of skeletal elements, archaeological faunal studies of skeletal element representation have also been used to highlight the effects of recovery bias (e.g. Payne 1972), and to recognise different activity areas within a site e.g. butchery, cooking, craft/industrial, waste disposal, ritual deposition (Lyman 1994).

Brain's study of the effects of dog gnawing on different skeletal elements is a classic example of the use of a predictive model of preservation based on bone densities to explain the skeletal element frequencies observed in an archaeological faunal sample. He examined a sample of goat bones from the Kuiseb River Hottentot villages in South-west Africa, known to have been subject to extensive gnawing by dogs. An analysis of the structure of the bones revealed, *"a clear and direct relationship between the specific gravity of the end of a long bone and its percentage survival"* (Brain 1981:21). The percentage survival (see below for details of method) of different skeletal elements in the Kuiseb River goat sample was then compared with that of the Plio-Pleistocene bovid assemblage from Makapansgat in South Africa (fig. 6). Brain concluded that the similar survival of skeletal elements seen in both assemblages indicated both samples had been subject to similar destructive processes, namely carnivore attrition.

Binford's (1978) study of differential transport of skeletal elements from kill sites, like Brain's, used both experimental and observed ethnographic data to create a predictive model of skeletal element representation. Binford argued that the likelihood of a bone being removed from a kill site once a carcass had been butchered would be related to the usefulness of that bone in terms of meat, marrow, and grease. The usefulness of different skeletal elements of caribou was calculated by Binford by measuring the amount of meat, marrow, and grease available, and these figures used to construct a "general utility index" (GUI). The tendency for certain low utility elements to be transported along with high utility elements as a result of butchery and transportation practices was taken into account in the "modified general utility index" (MGUI). Binford used this MGUI to explain the skeletal element representation he observed at a number of Nunamiut base camps, hunting camps, and kill sites. These observed patterns of skeletal element representation, and the revised utility indices developed by Metcalfe and Jones (1988), have been used as predictive models of the suite of elements one would expect to find at archaeological hunting camps, base camps or kill sites.

The study of the large mammal bones from Star Carr by Legge and Rowley-Conwy (1988) is an example of how Binford's differential transport models have been used to explain the skeletal part representation observed at an archaeological site. A comparison of the skeletal element representation in the Star Carr red deer assemblage with the various Nunamiut caribou

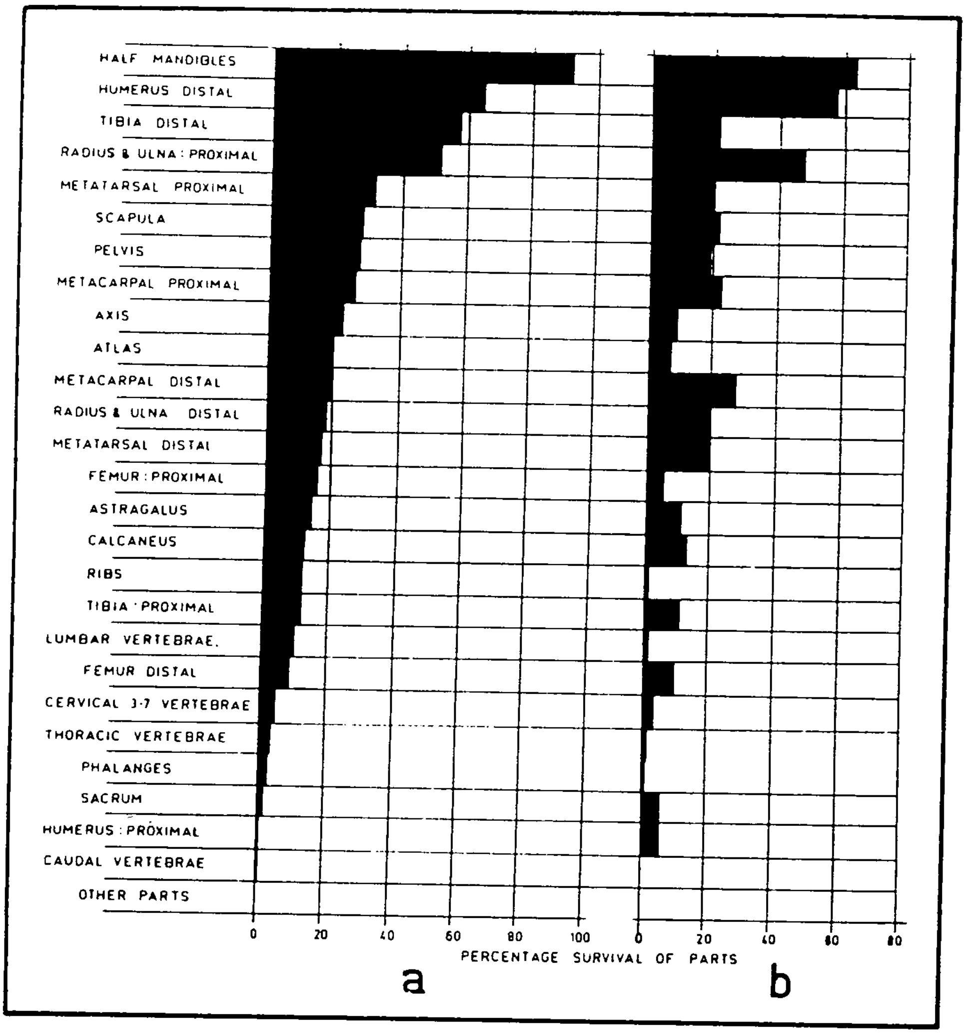


Figure 6: a) Percentage survival of parts of goat skeletons from the Kuiseb River villages **b)** Percentage survival of parts of bovid skeletons from Makapansgat. (reproduced from Brain 1981)

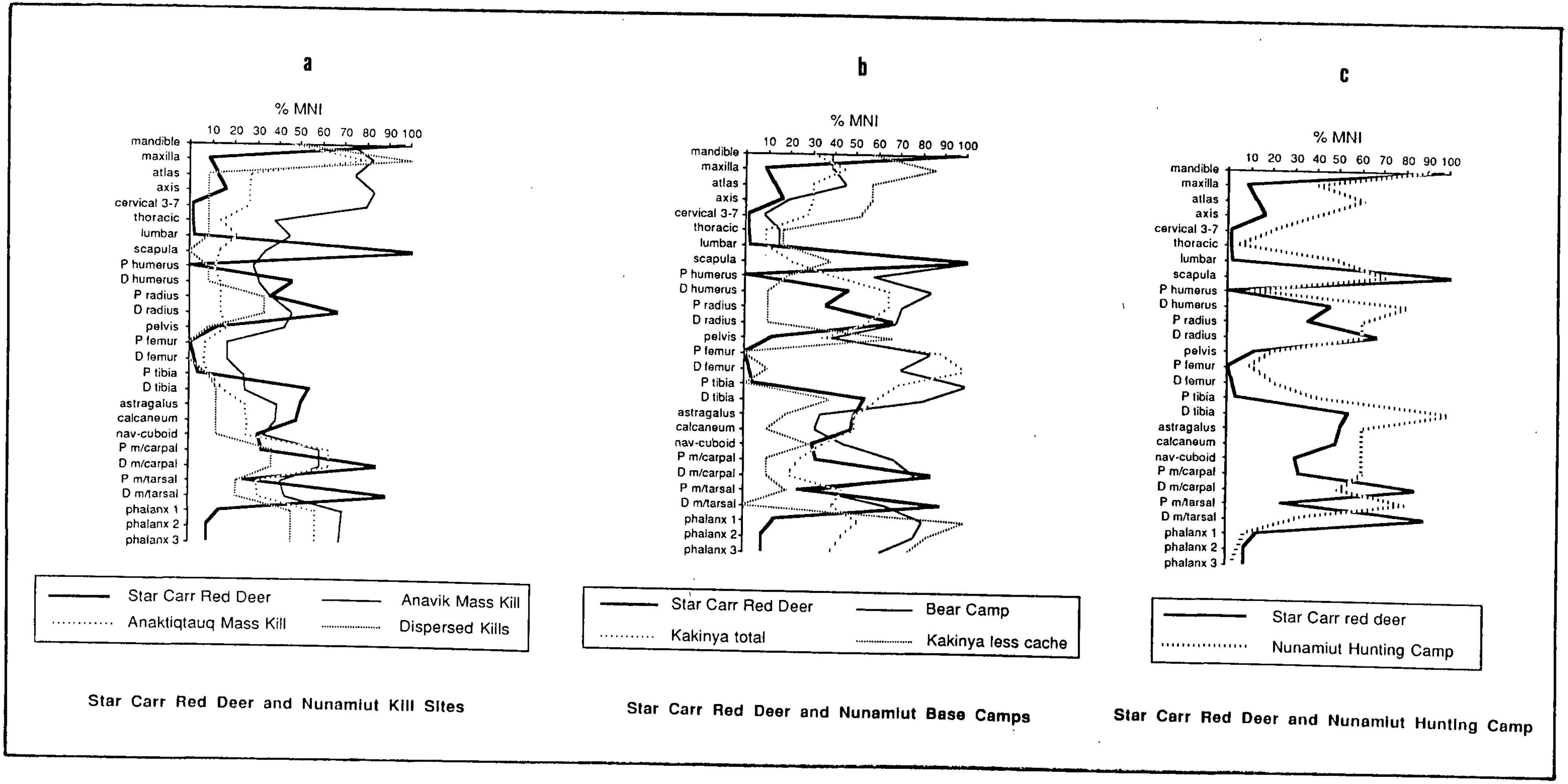


Figure 7: Percent MNI of the Star Carr red deer compared with caribou from three types of Nunamiut Eskimo sites: **a)** Kill-butchery sites **b)** Residential base camps **c)** Hunting camp. (reproduced from Legge & Rowley-Conwy 1988)

assemblages revealed a strong similarity to the Nunamiut hunting camp (fig. 7). Thus Star Carr may be interpreted as a hunting camp, the suite of skeletal elements represented having been transported from a separate kill site, with other elements further removed to the base camp.

It may be argued that this type of study is of limited potential as the identification of separate kill sites and hunting camps is of little use in the study of faunal assemblages from non-hunting based economies, such as the domestic farmsteads of Iron Age Britain. However the principles of differential element utility and transport are applicable to the study of archaeological producer/consumer economies. Import and export of meat products between producer and consumer sites would have been most likely to involve high utility meat joints, resulting in recognisable patterns of skeletal element representation; low occurrence of high utility elements at producer sites, and high occurrence of high utility elements at consumer sites. The potential of skeletal element representation for indicating import and export of meat products is limited to instances where meat was transported in the form of butchered joints; where meat was transported on the hoof (live animals) or filleted, the proportions of different skeletal elements in an assemblage would remain unmodified by the import/export process. When considering differential transport of skeletal elements it is important to remember that the utility of an element in terms of meat, grease, and marrow need not be the only factor influencing its desirability as an import/export item. Similar principles have been applied to the analysis of crop processing remains on British Iron Age sites (e.g. Jones 1984b, Van der Veen 1992).

The skeletal element representation of deer in British Iron Age faunal assemblages illustrates the point that Binford's notion of utility is not always the main factor determining the desirability of a body part. Where deer remains are present they often contribute only a very small proportion of the Iron Age faunal assemblage and exhibit a high incidence of antler and a low incidence of other skeletal elements (Grant 1981). In Binford's MGUI for caribou antler is considered a low utility element, thus one might interpret the high incidence of antler in Iron Age deer assemblages as low utility, kill site/primary butchery waste with high utility elements transported away from the site. However, when the cultural importance of antler as a raw material for tool and other artefact manufacture is taken into account it becomes apparent that antler is of high "utility" and that the skeletal element representation seen in many Iron Age deer assemblages is actually indicative of the selective transportation of high utility elements on to the settlement. This example illustrates the ambiguous nature of skeletal element representation patterns. The potential information obtainable from studies of skeletal element representation is limited by the degree of understanding and recognition of the cultural contexts within which such patterns were generated.

The above example also serves to illustrate the potential of studying skeletal element representation as a means of identifying industrial and craft activity at an archaeological site. The high incidence in an assemblage of particular elements may well be associated with a particular industrial process, for example the clusters of cattle horn cores from Roman towns such as Colchester, Exeter, London and Silchester interpreted as waste from horn working (Wilson 1996).

It is not just industrial activity which can be recognised from studying the occurrence of different skeletal elements; if the intra-site variability of skeletal elements is examined there is the potential for recognising characteristic suites of elements from many different activities. The different patterns of skeletal element representation discussed above, when seen in different areas or contexts within a site, may indicate specific areas of activity. Recognisable patterns of skeletal element representation associated with particular activities can often be found on Iron Age, and other, archaeological sites, providing material has not been mixed up and redeposited elsewhere. Activities that may be inferred from particular groups of elements include primary butchery areas (represented by elements of low utility, and those easily removed by butchery - similar to a kill site assemblage); deposits of kitchen waste; areas of craft and industrial activity such as horn and antler working; "special" deposits of complete skeletons or particular elements such as skulls.

In addition to activity areas the differential effects of other taphonomic processes may be recognised. Intra-site variability in the abundance of elements of differing density may indicate areas of low carnivore attrition, perhaps inferring enclosed areas where dogs had no access such as houses or pens. Alternatively it may be possible to identify areas of heavy trampling, areas of swift deposition, or areas of differing soil conditions and degrees of chemical weathering. Recovery bias can also influence the abundance of different elements within a sample, this may be recognised by a low incidence of the smaller elements such as phalanges and loose teeth (Payne 1972). Recent work by Bob Wilson (1996) has established spatial patterns in the intra-site distribution of faunal assemblages which may largely be explained by the effects of scavenger activity. Wilson recognises a tendency for larger bone fragments to be located to the periphery of Iron Age settlements and smaller fragments to be more central to where they were originally dumped. This spatial variability could well be visible in skeletal element representation analysis of different contexts across a site.

Problems in the study of skeletal element representation

The previous section has shown that there is a great deal of potential information to be obtained from analyses of skeletal element representation in archaeological faunal assemblages. This is as true for the Iron Age in Britain as for any other period or location. Such analyses are not without their limitations however. As explained above, models of differential transport are not immediately applicable to Iron Age assemblages because of the domestic farming (non-hunting) economy and the multi-purpose (no single specific activity) nature of the settlements. Interpretation of different element abundance is also confused by differing cultural concepts of what makes a particular element useful or desirable.

Intra-site variability can also limit the extraction of useful information. In assemblages where there is a great deal of intra-site variability it is important that skeletal element counts from different areas are examined separately. It is unfortunate that once subdivided into context or context type in order to assess intra-site variation, faunal samples are often too small to provide useful or significant information. Lumping together samples from different contexts to create a numerically viable sample will fail to solve the problem as the resulting representation of skeletal elements will be a palimpsest of different processes, impossible to identify separately.

The problems of multiple taphonomic processes being represented in the pattern of skeletal element representation are not limited to avoidable scenarios such as the lumping of data from an internally variable site. Archaeological faunal assemblages will have been invariably subject to several taphonomic variables, thus none of the observed patterns of skeletal element representation can be explained in terms of a single process. Often there is one factor that influences the composition of an assemblage more than the others and it is these major influencing factors that may be identified by analysis of the skeletal element representation. Studies of this sort cannot hope to establish a full history of the taphonomic processes that have been at work, they can merely give an indication of those factors that have had the most marked effect on an assemblage.

Skeletal element studies are also subject to the problem of equifinality, whereby several different taphonomic processes cause the same pattern of element representation. This is partly the result of certain taphonomic processes being dependant on the same properties of bone, for example in instances if both trampling and carnivore attrition the pattern of element survival is a result of differential bone density. Lyman (1985) has shown that even processes dependant on different properties of bone such as utility and density may be confused. Lyman established that there was a correlation of bone density with MGUI, thus element patterns previously interpreted as differential transport of high and low utility elements may actually be the result of differential destruction of low and high density bone. Finally, an observed pattern of element representation that is recognisable as the effect of a particular process may actually be an artefact resulting from the combined effect of several different processes.

Skeletal element representation reflects the effects of taphonomic processes, it does not provide definite proof of which particular factor is responsible for the alteration of an assemblage. Other evidence should be used in conjunction with skeletal element representation to support conclusions drawn. For instance a pattern of skeletal element representation exhibiting low incidence of low bone density elements may be the result of dog gnawing, but it may also be indicative of other different destructive processes; dog gnawing can only be supported as a conclusion with the additional evidence of a high frequency of characteristic gnaw marks on the bones.

Studies of skeletal element representation have been used to great effect in determining the taphonomic processes shaping particular archaeological faunal assemblages, and are best used in conjunction with other sources of evidence. The potential for establishing the taphonomic histories of Iron Age faunal assemblages is limited by problems of interpretation, sample size, intra-site variability, multiple taphonomic processes and equifinality. Despite the problems mentioned above, it is believed that a study of skeletal element representation in different Iron Age faunal assemblages has the potential to provide useful information concerning the factors influencing assemblage composition. Although a potentially good source of information, the usefulness of this study will ultimately depend on the availability of sufficient Iron Age data in an appropriate format.

Methods of analysing skeletal element representation

Before discussing the various ways in which skeletal element representation has been calculated and may be calculated from the data published in reports of British Iron Age sites it would be sensible to outline some of the methods that can be used on fresh data. The most reliable methods use minimum numbers rather than counting total fragments in order to get a true picture of the survival of each element. Results are most frequently presented in the form of a graph expressing the abundance of each element as a percentage of the most frequent element to indicate the differential levels of survival between elements. The advantages and limitations of the different methods are discussed below. Other, less ideal methods are also considered because of their prevalent use in published Iron Age faunal reports.

Minimum Number of Individuals method

This is the method developed by Binford (1978). A separate "minimum number" count is made for each element using the MNE quantification method described in chapter 5. Binford terms these "minimum number" counts for each element "MNI"s. Binford counters the effects of natural differences in abundance of skeletal elements by using a correction factor, which involves dividing the minimum number recorded for each element by the number of that element in a complete skeleton. Corrections of this sort ensure the occurrence of elements in an assemblage is comparable not only within a species but also between different species. The corrected MNI counts for each element are used to produce a graphical representation of the skeletal element representation. This is done by presenting the MNI for each element as a percentage of the MNI for the most commonly occurring element, and plotting the % MNI on a line graph such as figure 7. (NB. In an assemblage consisting only of complete skeletons the % MNI for each element would be 100%).

Proximal and distal long bones are considered separately as different elements. For Binford this allowed consideration of the different MGUI of proximal and distal epiphyses of the same bone, but the separate treatment of proximal and distal elements is of further use when considering any taphonomic process that effects different parts of the same bone to differing degrees.

There are a number of variations on Binford's original methodology which may be used; slight differences in the counting methods such as the counting of specific "anatomical zones", the use of different correction factors, presenting the results either graphically or numerically, or the use of a smaller suite of elements. The main principles of this technique remain unchanged: the use of corrected MNI counts to avoid the effects of differential fragmentation and natural differences in skeletal abundance of elements, and a comparison of the occurrence of the different elements in relation to the most common element.

Percent Survival method

This method is that put forward by Brain (1981:19-21). A minimum number count is made of all elements taking into account side. The MNI is taken as the highest number counted for either a right hand or left hand side element. The number of each element in a complete skeleton is multiplied by the MNI of the most common element to give a value that is the number of elements that should be present in an unaltered assemblage. The observed number of each element is then expressed as a percentage of the expected number of that element, giving a "% survival" value. For example: if the most common element in an assemblage is the left mandible, with an MNI of 25 the expected number of mandibles in the assemblage would be 50 as there are two mandibles in every skeleton, a right and a left. If the actual observed number of mandibles is 25 right and 20 left, in fact only 45 mandibles were observed out of an expected 50 so the % survival of mandible in the assemblage is 90%.

As with the Minimum Number of Individuals method, the results are presented as a bar graph (see fig. 6). Both Binford and Brain's methods are based on the same principles (corrected MNI values compared for each element) and the use of both methods on the Star Carr assemblage shows, *"comparable but not identical results"* (Legge & Rowley-Conwy 1988:69). For use with fresh data there is little to choose between the MNI and % survival methods, except that Brain's method involves identifying elements to right or left hand side which can be unnecessarily time consuming.

NISP method

This method is the most common of those used in British Iron Age faunal studies. In this method the NISP (total number of identified fragments) is counted for each element (see chapter 5 for details of this method of quantification). The NISP count for each element then may or may not be corrected for the natural differences in abundance of separate skeletal elements. Also there may be variations in the suite of elements which different analysts choose to record. The counts are often simply listed in a table, but can be expressed as a percentage of the NISP of the most commonly occurring element and presented in a bar or line graph showing % occurrence of each element similar to those presenting % MNI or % survival in Binford's and Brain's methodologies.

As a method of expressing skeletal element representation this shares many of the problems that limit the reliability of NISP as a method of species quantification. A high level of fragmentation at a site will increase the NISP count, making NISP counts not comparable between sites with different levels of fragmentation. The inaccuracy of a NISP count is furthered by differential fragmentation between species, the bones of some species being more resistant to fragmentation than others. Even more importantly there may be differential fragmentation between different elements; larger bones may fragment more than smaller more compact elements such as the phalanges and thus cause over representation of the larger fragmented bones. Correction for the different numbers of elements in a complete skeleton in this instance would further compound the problem by reducing the phalanges count, increasing the disparity between those and the larger more fragmented elements.

Differences in the level of fragmentation between elements are likely to mask patterns of element representation that might have been visible using MNI or Percent Survival methods. The effects of fragmentation could be borne in mind when considering the skeletal element representation, reducing the likelihood of misinterpreting the results, however the fragmentation bias cannot be reliably corrected for, other than by using an MNI count, so any conclusions based on the NISP method will remain vague and unreliable.

Treatment of skeletal element representation in Iron Age faunal reports

Obtaining skeletal element data from published British Iron Age faunal reports is difficult as the necessary information is seldom present. Those reports that do present skeletal element data often do so in different formats which makes a comparative study virtually impossible. Also, skeletal element data is seldom analysed using the most ideal methods; of all the reports examined only three utilised Binford's MNI method (Cat's Water, Biddick 1984; Meare, Backway 1986; Port Seton, Hambleton & Stallibrass forthcoming). An additional six sites provide data that allow the use of Binford's MNI method, but only considering whole bone elements rather than separate proximal and distal long bone epiphyses. Skeletal element representation was most frequently expressed using NISP. Some thirty five sites listed NISP counts for separate elements, most presented in tables, a few represented graphically using the method described above. The limitations of the Iron Age data is immediately apparent; all the aforementioned problems of the NISP method apply to its use in Iron Age faunal studies. Even the use of more reliable (i.e. MNI) methods at a number of sites effectively limits a comparative study as MNI data is not comparable to NISP.

In addition to the prevalent use of the NISP, rather than other more suitable methods, there are a variety of other problems with much of the Iron Age skeletal element information presented in reports. Collection of useful information concerning skeletal element representation is often prevented by a lack of detailed information about all the main skeletal elements. If sufficient detail is lacking from the initial recording and identification of bone material this will be reflected in the skeletal element analysis where elements not recorded cannot be considered.

Due to problems with identification to species level, ribs and vertebrae are often not counted for separate species but are attributed to loose categories such as "cow size" or "sheep size". In some instances ribs and vertebrae are not recorded at all. The "rapid method for recording information about mammal bones from archaeological sites" proposed by Davis (1992) has been used for some Iron Age bone assemblages (e.g. Albarella 1997, and Pinter-Bellows 1996). This technique records a very restricted suite of elements, it excludes all ribs and most vertebrae, and of the major limb bones only one end (usually distal) is recorded. Such omissions limit the usefulness of studying the representation of those elements that have been recorded. For instance, high or low representation of parts of the axial skeleton may indicate post-mortem influences such as differential transport/butchery. However, if ribs and vertebrae are not recorded then there will be no indication of this sort of activity in the skeletal element representation.

Further information is lost when parts of the skeleton are not considered in sufficient detail in a study of skeletal element representation, even if the information was recorded initially. Whole bones may be considered as single elements even though survivability of different parts of a bone may differ under the same conditions. This is particularly true of the upper limb bones where the proximal and distal ends of the same bone often differ in how they resist destructive taphonomic processes, and in how they survive the effects of processing by humans. Very few of the Iron Age bone reports that consider skeletal element representation treat the proximal and distal long bone ends as discrete elements, in fact out of all the reports that use the NISP method only the Danebury (Grant 1984a,1991) and Mount Batten (Grant 1988) reports consider the proximal and distal epiphyses separately.

There are a number of Iron Age bone reports, in particular those by Wilson for the Upper Thames valley sites (see for e.g. Wilson et al 1978), that consider the representation of only broad groups of elements such as "head", "body", and "foot". While such broad categories enable a quick and easy indication of intra-site variability in skeletal element representation between contexts (something many of the other Iron Age reports fail to examine), they provide very little information about the taphonomic history of the assemblage. Broad body part groupings can generate only coarse indications of human processing of carcasses, and lose all details of processing methods, the precise parts of the carcass utilised, and any indication of the effects of preservation or retrieval bias.

Thus the skeletal element information available from published British Iron Age bone reports is severely limited. The most common method of analysis (NISP) is certainly not the best method of analysis, and frequently the potential use of such studies is drastically reduced as only part of the skeleton is considered. There is no possibility of establishing or reliably comparing detailed taphonomic histories of the Iron Age sites using the available published data.

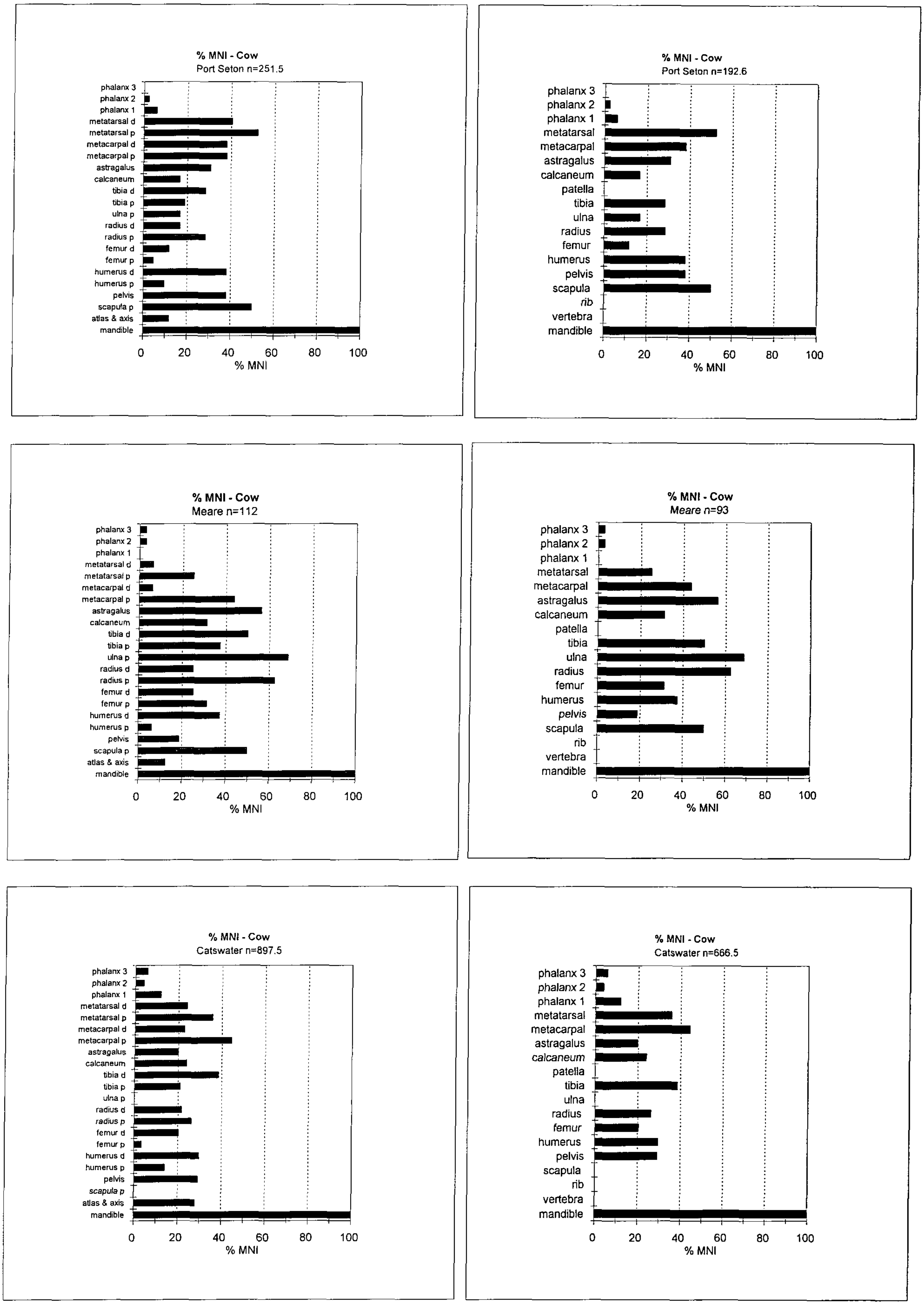
Analysis of the Iron Age data

It was hoped that an analysis of the skeletal element representation would provide a great deal of information concerning the taphonomic processes influencing the composition of the Iron Age faunal assemblages studied. Unfortunately it is apparent that the available taphonomic information is severely limited by the poor quality of the published data. At its best a comparative study of skeletal element representation can provide a great deal of useful information. At its worst, as is the case with much of the available Iron Age data, few or no reliable conclusions can be drawn. The skeletal element data available from published Iron Age reports is of poor quality and quantity and therefore unsuited to a reliable systematic comparative study; however an attempt was made to establish what use, if any, could be made of the data in order to improve understanding of the treatment of Iron Age domesticates at both local and regional level.

The most reliable studies of skeletal element representation were those using the MNI method, in particular those which included ribs and vertebrae and treated proximal and distal long bone epiphyses as separate elements. However, because of the number of site reports employing this method was so small they proved to be of little use to a study intending to compare large numbers of Iron Age assemblages. A few more sites provided MNI data but with whole bone elements, thus limiting the taphonomic information obtainable. Again, the number of sites was too small to allow an extensive comparative study. MNI studies giving proximal and distal information can be converted to an equivalent whole bone study, this was done for the sites that gave proximal and distal MNI data. It is apparent from comparing the two types of MNI data for each site (fig. 8) that although the details are lost, the overall pattern of skeletal element representation remains very similar.

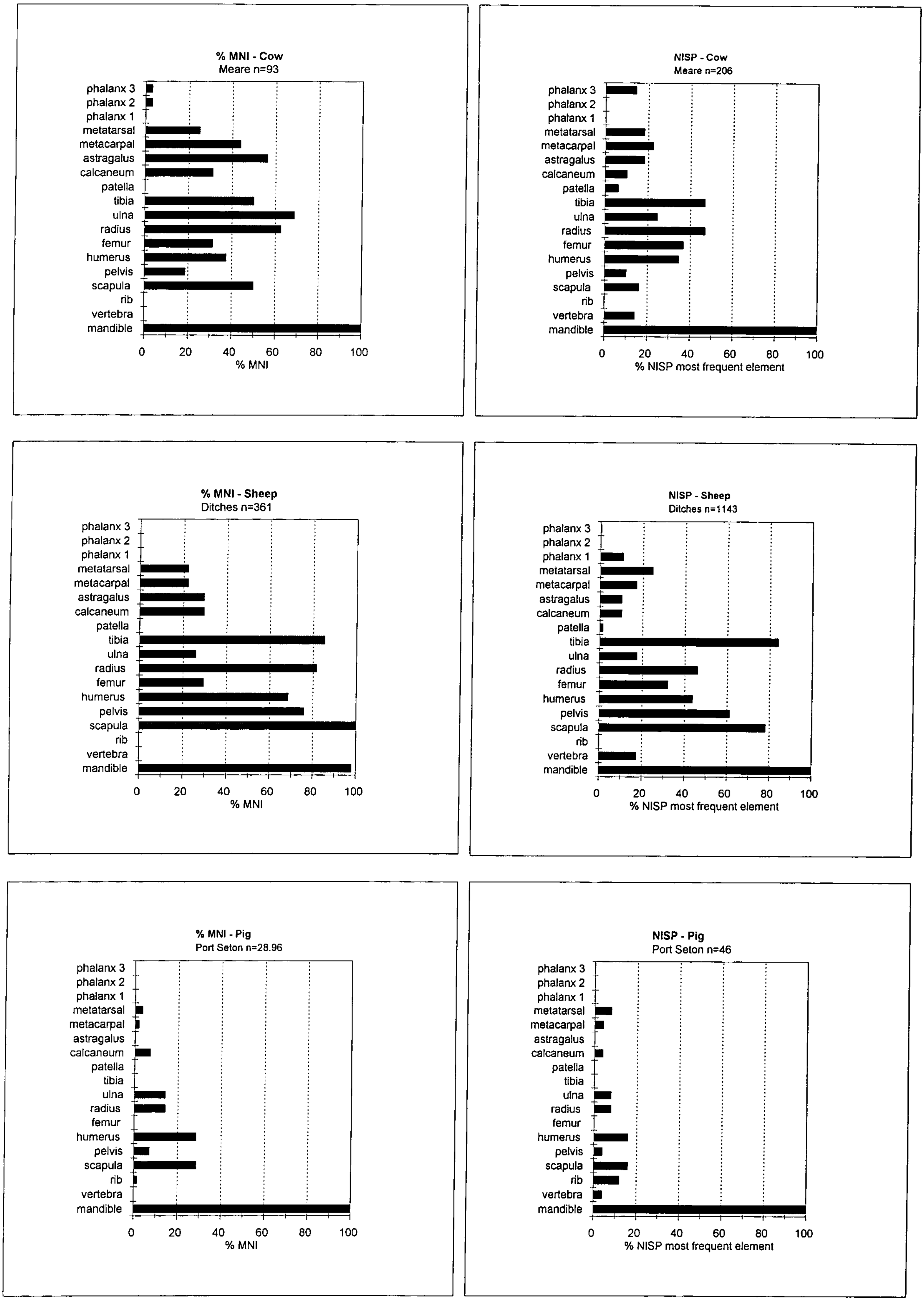
Only six sites provided both MNI and NISP skeletal element counts for sheep and cow, and five of these also provided data for pig. A comparison of both techniques showed that for all three species, use of the NISP method resulted in roughly similar patterns of skeletal element representation to those generated by the %MNI method (fig. 9). While the pattern of skeletal element representation appears similar with regards to the relative abundance of skeletal elements (i.e. which are the most common elements, and which are the least, and whether a particular element is more or less abundant than another), it is not always similar in terms of overall abundance (i.e. whether the mean % occurrence or % MNI of all elements is high or low). Figure 10 shows examples of MNI and NISP analyses of assemblages that exhibit similar patterns of relative skeletal element abundance, but differences in overall abundance.

Overall skeletal element abundance may provide a tentative indication of the general level of preservation of an assemblage. Bearing in mind that in an assemblage of perfectly preserved complete skeletons the % occurrence of each element would be 100%, it (perhaps) should follow that better preserved assemblages should exhibit a higher overall % occurrence than a less well preserved assemblage. If this is the case then the Iron Age NISP data may be used to provide information that allows a comparison of the general state of preservation of different assemblages. If overall abundance were a true indicator of preservation then the differences in overall abundance between site assemblages should show similar patterns using both MNI and NISP methods. Unfortunately this is not the case. In figure 10 the overall



a **b**

Figure 8: Patterns of skeletal element representation in three Iron Age cattle assemblages using MNI method: **a)** with separate proximal and distal long bone elements **b)** with whole bone elements



a **b**

Figure 9: Representation of skeletal elements from different Iron Age cattle, sheep, and pig assemblages: **a)** using MNI method **b)** using NISP method.

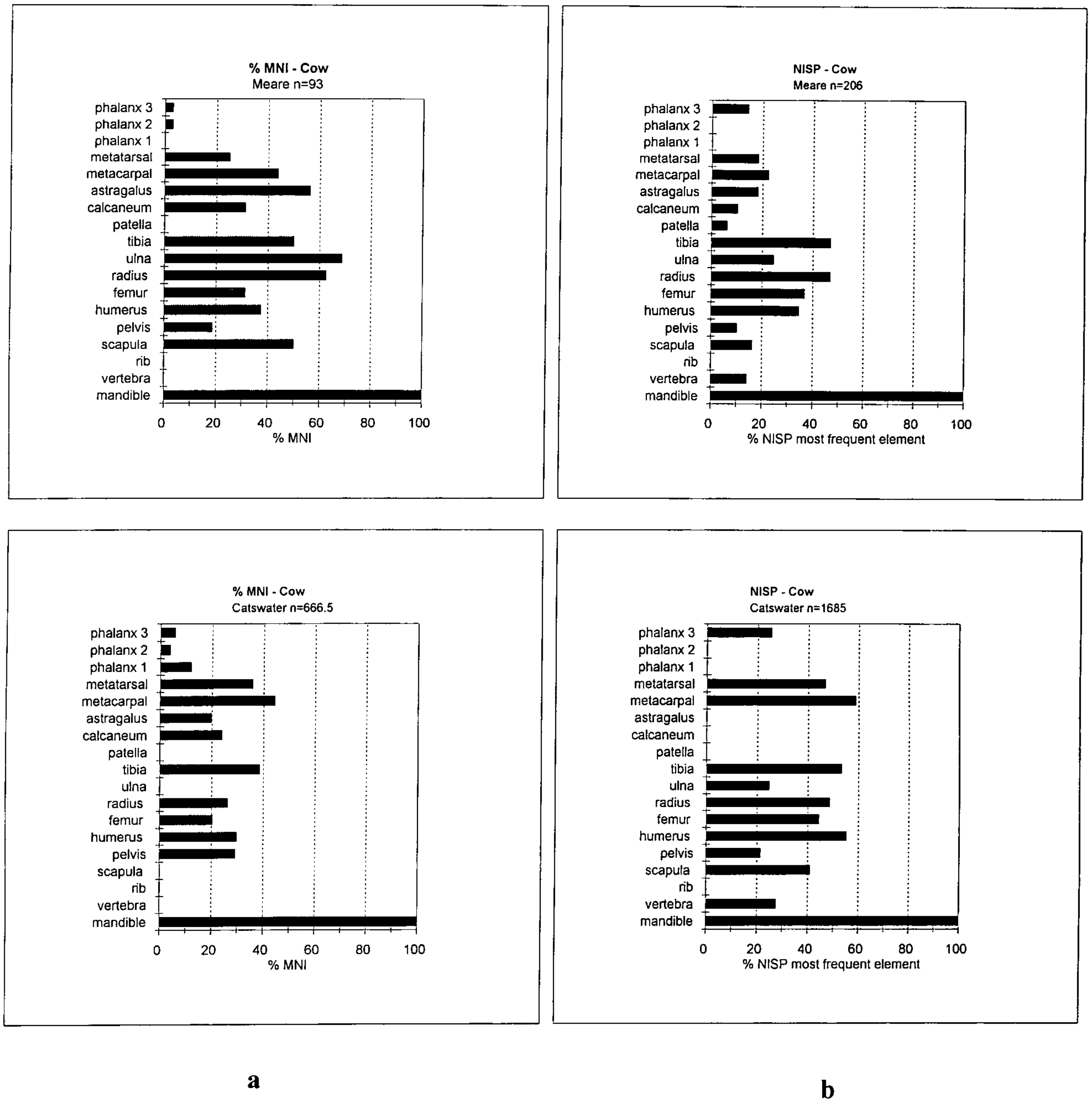


Figure 10: Representation of skeletal elements in two Iron Age cattle assemblages illustrating the differences in overall % occurrence of all elements between **a)** MNI method, and **b)** NISP method.

abundance of elements appears greater in the Meare cow assemblage than in the Cat's Water cow assemblage when using %MNI but the situation is reversed when using NISP data. This suggests that the relationship between overall abundance of elements and preservation is not straightforward and that there is no reliable means of using NISP results to compare the overall level of preservation of different assemblages.

It would seem the potential information available from the published Iron Age data is extremely limited. The only useful information appears to be the relative abundance of different skeletal elements, and this is only available for a minority Iron Age faunal assemblages. A knowledge of the skeletal elements present and their relative abundance should provide some indication of whether or not whole carcasses were present at the site, giving some indication of differential transport and import/export of certain parts of the carcass. Differential levels of fragmentation between elements and sites may obscure this information where the NISP method is used; however the fact that the NISP and MNI methods showed similar patterns of skeletal element representation suggests that this need not always be the case. One by-product of the use of NISP data in Iron Age bone studies is that in many cases it provides an indication of which elements were and were not counted in the initial recording of the material, something that many analysts fail to mention when presenting NISP counts of species abundance.

This comparative study of skeletal element representation has failed to provide any significant contribution to the understanding of Iron Age faunal assemblages from around Britain, primarily because of the lack of comparable data available in the published reports. The Iron Age skeletal element data which is available is not in a format that allows predicted taphonomic changes to be recognised. However if trends can be recognised in the skeletal element patterns within or between species, it may be possible to attempt to explain them retrospectively having examined other aspects of the site assemblage.

The available NISP and MNI skeletal element data for each Iron Age faunal assemblage is presented in appendix 3. Although any rigorous statistical analysis of skeletal element representation has proved impossible due to lack of samples and poor quality of data, it is still possible to gain an overall impression of the general trends from a visual inspection of the Iron Age dataset. A brief comparison of the data failed to observe any trends specific to regions, however there were some patterns noticeable both within and between species throughout the Iron Age material. It must be stated that all trends observed are tentative and by no means universal throughout every Iron Age assemblage.

The following trends in skeletal element representation were observed:

Overall occurrence of elements

- All species (cow, sheep and pig) tend to be represented by elements from all parts of the carcass. Where an element is completely absent it would appear mainly to be the result of small sample size. This is particularly noticeable with pigs which tend to have the smallest samples and the most absent elements.
- Cow and sheep exhibit reasonably similar overall element occurrence at each site, while the pig bones from the same site tend to have a much lower overall occurrence of elements.

Relative occurrence of elements

- Pig: In most assemblages the mandible is the most abundant element, with the other elements being substantially less well represented in the assemblage. There is also a tendency for upper limb bones to be comparatively more abundant than lower limb bones.
- Cow: Mandibles tend to be the most common element, but perhaps less regularly than is the case for pig. The remaining elements usually have comparatively similar levels of abundance to one another, although there may be a very slight tendency for upper limb bones to be better represented than lower limb bones.
- Sheep: Mandibles are not always the most common element in an assemblage, tibia and radius also have very high abundance at many sites. There are often quite extreme differences in the relative abundance of different elements within an assemblage, with some elements represented by very high occurrence and others by very low occurrence.

Differences in the overall skeletal element abundance of cow, sheep and pig may be a manifestation of the commonly observed phenomenon that the pig post-cranial skeleton seldom survives as well as the post-cranial skeletons of other domestic mammals (Peter Rowley-Conwy pers. comm.). The tendency for pig bones to be less well preserved than those of other domestic species can be explained by the fact that pigs tend to be killed while immature, and the unfused juvenile bone has a lower survivability than the harder adult bones, while populations of other species tend to have larger proportions of adults. This phenomenon does seem to hold good for the Iron Age and might go some way to explaining the difference in overall skeletal abundance observed between species.

The patterns of relative skeletal abundance observed are probably most easily explained in terms of the combined effects of fragmentation and retrieval bias. The high incidence of mandibles is usually explained as being the result of the robust nature of this element, which means it is more likely to survive destructive taphonomic processes and thus survive in the archaeological record. In a fragmented assemblage, where most single elements are represented by several fragments, the robust mandibles often survive intact; despite other skeletal elements being represented by more fragments, the mandible may still be the most numerous element in a NISP count because the fragments of other elements often lack identifiable features and so remain unrecorded. Added to this is the fact that the characteristics of the mandible (the presence of teeth, and alveoli) mean that even very small fragments can be identified to element and, because of the distinctive teeth, to species. The consistent abundance of mandibles may be explained by the high survivability of that element and, in a fragmented assemblage, by its easy identification.

The tendency observed in pigs, and to a lesser extent cows, for upper limb bones to be more abundant than lower limb bones may be explained by differential fragmentation and retrieval bias. A NISP count will tend to over-emphasise the abundance of the more fragmented elements, and as the larger upper limb bones tend to be more susceptible to fragmentation than the lower limb bones which are smaller and more compact, the NISP count for upper limb bones will be greater. In addition to the effects of fragmentation a retrieval bias acting against smaller bones such as phalanges, tarsals and pig metapodials (i.e. the lower limb bones) may also account for a lower representation of the lower limbs. The less noticeable differentiation between upper and lower limbs in cow can be explained by the fact that cow bones are larger than pig bones and so are less affected by retrieval bias against small elements.

The slightly different patterns observed in skeletal element representation among sheep may also be explained in similar terms. The highly abundant elements such as mandible, tibia and radius tend to be very hard and have a high level of resistance to fragmentation (this is true for distal tibia, although not for proximal). Although one might expect there to be a greater abundance of fragmented elements, as seen with pig and cow, the fragmented remains are subject to retrieval bias; sheep bones are small, and fragmented sheep bones even smaller. Thus the hard unfragmented elements remain intact and of a size that will be retrieved while many identifiable pieces of the fragmented elements are not recovered in an unsieved assemblage. The differences in patterns of skeletal element representation observed between Iron Age cow, sheep and pig assemblages may be explained by the action of the same taphonomic influences.

As previously mentioned, the observed trends are by no means universal. However, some of the more noticeable oddities observed may be explained by the method of recording elements rather than particular taphonomic processes. The extremely high abundance of phalanges compared to other elements in the Dalton Parlours cow, sheep, and pig assemblages

(Bery 1990), for example, is mainly the result of the analyst grouping together first, second and third phalanges together.

Iron Age skeletal element representation: conclusions and recommendations

The available Iron Age data concerning skeletal element representation are extremely poor, greatly limiting the potential retrievable information. The NISP method, though far from ideal, does have the potential to generate certain information, and a comparison of the skeletal element representation of Iron Age sites did generate some results upon which were based the following (tentative) conclusions.

- There were no absences of skeletal elements which could not be explained as the result of small sample size, suggesting the presence of whole carcasses at most sites. There was no obvious abundance or absence of particular body parts to suggest the import or export of joints of meat at any site; however this does not exclude the possibility of transport of primary products in other forms between Iron Age sites.
- The observed patterns of overall and relative abundance of skeletal elements differed between species suggesting different responses to taphonomic processes between species, or different taphonomic processes acting on different species.
- The observed patterns of relative skeletal abundance illustrated the effects of fragmentation and retrieval bias. These processes were seen to affect cow, sheep and pig differently. These findings may be of use when comparing NISP counts of relative species abundance in Iron Age faunal assemblages.

The full potential of skeletal element representation analysis has yet to be reached in the majority of Iron Age faunal studies. The poor methodology and inconsistent recording of skeletal element representation seen in many Iron Age studies prohibits both the retrieval of taphonomic information and reliable comparison of faunal assemblages. In order to establish the taphonomic history of a faunal assemblage, a detailed and reliable analysis of skeletal element representation is essential. Comparative studies of Iron Age faunal assemblages should take into account the effects of taphonomy on the composition of different bone assemblages; it is important to determine whether similarities and differences of faunal assemblages are the result of taphonomy or true differences in husbandry regime and herd management.

Future Iron Age bone reports will need to take more care to examine skeletal element representation, using reliable and uniform techniques such as Binford's MNI method. Full consideration should be given to intra-site variability, and proximal and distal long bones considered as separate elements. Where possible all the main parts of the body should be considered, including the ribs and vertebrae. The above recommendations should enhance the amount of information retrieved about the taphonomic history of any Iron Age faunal assemblage, and serve to further our understanding of the comparability of different assemblages. Recognition of taphonomic processes altering the composition of an assemblage, such as retrieval bias reducing the numbers of smaller elements, or canine attrition depleting numbers of elements of low bone density, may help explain differences in species proportions, and age profiles within and between faunal assemblages.

In addition to natural processes, differences in the effects of human activity such as butchery, importing and exporting of carcasses, and ritual deposition may also be identified within and between different species and sites, providing insights into the treatment of animal carcasses by humans and the role of different animals in the Iron Age economy. This would be of great importance to both individual site studies and inter-site comparisons . The use of a reliable method of studying skeletal element representation data will allow the optimum information to be retrieved, while the consistent use of a single reliable method for all Iron Age sites will facilitate reliable and valid comparison of that information.

Chapter 5

Quantification Of Faunal Remains

In order to analyse and compare faunal assemblages it is essential to find ways of summarising and describing the composition of the skeletal material. Quantification of the bones and the different species present, either by straightforward counting or by more complex methods, is the most common way of describing an assemblage. Quantification of a faunal assemblage may involve the entire assemblage or more restricted sub-samples, such as a random sample of the overall assemblage, the remains from particular contexts or periods, or only those bones which are identifiable to species. This chapter aims to highlight some of the uses of quantifying faunal remains, and to describe a number of the more common methods of quantification of faunal remains identifiable to species while discussing their potential for application in comparative archaeozoological studies. In addition to the theoretical advantages and disadvantages of these methods, the practicalities (availability, comparability and sample size) of utilising them for a comparative study of the British Iron Age faunal material will be considered.

Uses of quantified faunal data

There is a number of possible uses for quantified archaeofaunal data. Whatever the method used, the main purpose of quantifying faunal remains is to establish the relative proportions of the different species present in an archaeological assemblage in order to extrapolate their relative importance within the original animal economy. The relative proportions of species obtained from the quantification of identifiable remains cannot provide a direct indication of the contribution of different species to the economy. However once the initial quantification of different species has been done this information may be used to provide a more "real" estimation of a species' economic importance. For example, sheep and cow may represent equal proportions of an archaeological assemblage but by taking into account the difference in size and therefore "meat weight" of these species it becomes apparent that the larger cows potentially contributed much more meat to the economy.

Meat weight calculations are a useful tool when attempting to estimate the potential economic contribution of different species, but it must be remembered that they are just that: a *potential* contribution, and that the actual contribution of a species may be influenced by any number of factors other than just meat weight. It cannot be assumed that all animals provided a meat contribution to the economy or that it was the main or sole contribution; contributions to the economy in the form of secondary products such as milk, wool, and traction should not be ignored. Also, there is the possibility that social influences such as food taboos may have prohibited meat contribution from certain species or body parts, or that the prestige associated with the ownership of a certain animal, and therefore its worth, may not have been related to its potential meat contribution. Any attempts to determine the nature of animal economies from archaeofaunal data will be severely limited if the economic potential of a species is measured only by its capacity to provide meat.

Methods of quantification

The units of quantification most commonly used in analyses of Iron Age faunal assemblages are the NISP (Number of Identified Specimens), and the MNI (Minimum Number of Individuals). A few more recent Iron Age faunal studies (Albarella 1997, Hambleton & Stallibrass forthcoming, Rackham forthcoming) have also used MNE (Minimum Number of Elements) counts. All three methods have been defined and discussed in detail previously in the faunal literature (e.g. Grayson 1984, Klein & Cruz-Uribe 1984, Lyman 1994), in particular Lyman (ibid. 100-104) gives a comprehensive, detailed definition of NISP, MNI and MNE. Given the presence of general discussions of NISP, MNI, and MNE elsewhere, this volume will limit definitions and discussions to aspects of relevance to the theoretical and practical application of these methods of quantification to comparative studies of British Iron Age faunal assemblages. Although this discussion is primarily concerned with the methods of quantification applied to Iron Age assemblages it should be stressed that none of the techniques mentioned are period specific and, moreover, neither are the problems associated with their application.

NISP

The NISP is "the number of identified specimens per taxon" (Lyman 1994: 100). In the majority of Iron Age studies the taxon is species, and a specimen is considered *identified* if it is possible to tell which skeletal element it is part of and what species it belongs to. A *specimen* is a complete skeletal element or any fragment of a skeletal element. An *element* is a single complete defined anatomical unit, usually a whole bone or tooth (e.g. mandible, astragalus, maxillary M3) but occasionally a partial bone (e.g. proximal humerus, distal tibia). Thus a NISP count records the number of specimens that are of known skeletal element and of known species, be they complete bones or minute fragments.

This method may be seen used in faunal reports in various guises; "Number of Identified Fragments", "Total Identified Fragments", "Bone Number", "Total Fragments Count". Provided a definition similar to the one above is given in the report, the quantification method can be considered to be NISP regardless of any other name the analyst may have chosen. It is important however, to clarify the precise method of quantification used as "Bone Number" and "Total Fragments Count" are ambiguous phrases and could refer to a quantitative technique completely different to NISP, perhaps one that includes unidentified specimens.

The NISP method is probably the simplest of those discussed and requires only a count of the NISP for each species, which may then be expressed as a percentage of the total NISP in order to establish the relative proportions of different species within an assemblage. Despite its simplicity, this method has several disadvantages; although it records the composition of the assemblage it is unlikely to provide a reliable indication of the relative proportions of the different species. Firstly, different species may have different numbers of bones in their skeletons, so a NISP count may over-represent species with more bones. For example, pigs have more bones in their feet than sheep so there is a possibility that pigs, by having more skeletal elements and therefore a higher potential NISP, will be over-represented compared with sheep in an actual NISP count. Secondly, species which are more prone to fragmentation will be over-represented as a single element that is fragmented into many identifiable pieces will contribute more to a NISP count than the same unfragmented element. Finally, differential degrees of fragmentation do not only affect the reliability of NISP counts of different species at an intra-site level. When attempting inter-site comparisons of faunal assemblages NISP counts are of limited value as the degree of fragmentation or preservation would have to be identical at the different sites for there to be any realistic comparison of relative frequency of species.

With particular reference to Iron Age comparative studies there is a further problem with using NISP counts. Despite the widespread adoption of NISP counts as a method of quantification throughout Iron Age faunal studies, it is apparent upon closer inspection that not all published NISP counts are produced using identical methodologies, a fact which limits their inter-site comparability. In many reports the exact methods used to produce NISP counts are not given at all. As well as the minimal differences in the number of specimens that different analysts are *able* to identify, there are more noticeable differences in the number of specimens that different analysts *choose* to identify. For instance, rapid methods of recording such as that of Davis (1992) which only identify a restricted suite of elements will result in lower NISPs than would be generated if there were a more thorough attempt to identify all remains.

The problems of inter-site comparability of NISPs resulting from variation in the levels of fragmentation, or identification may be partially solved by the use of percentage frequencies rather than absolute frequencies of NISP. Provided the fragmentation or identification levels vary only between sites and not within sites between species, variations in absolute NISP are unimportant and the %NISP frequencies will be comparable. Unfortunately intra-site variation in fragmentation between species remains a problem, although different levels of identification between species are unlikely to occur intentionally, and any unintentional identification bias would be minimal.

The NISP method, along with most other quantification methods, also falls down in the presence of complete or partial articulated skeletons. With most mammal skeletons containing well over two hundred bones, the presence of as few as one or two complete burials can raise the NISP of a species quite dramatically, especially if the overall sample size is relatively small. The presence of complete, or virtually complete, skeletons can result in gross over representation of species which would otherwise comprise only a very small proportion of the fragmented, disarticulated sample. This is a particular problem for British Iron Age faunal assemblages where "special deposits" of whole or part articulated burials are common and recurring phenomena. The convention followed by most analysts for dealing with NISP counts involving complete or partial skeletons is to treat articulated bone groups as a single specimen. Provided this method is used consistently then there is no further reduction in inter- or intra-site comparability of NISP counts. The NISP counts included in this study follow this convention wherever possible, although where a report fails to acknowledge the presence of articulated remains it is impossible to know if the convention has been followed, or if all the articulated bones have been included in the NISP count or simply excluded altogether.

MNI

The MNI is the Minimum Number of Individual animals that can account for all the elements represented in an assemblage. As with NISP an element is a pre-defined anatomical unit that may be a complete or partial bone or tooth. In the case of Iron Age studies most MNIs are calculated using whole bone elements. Unlike the NISP count not all identified specimens are counted, only those which represent a non-repeatable element, i.e. only those fragments that cannot possibly have come from the same bone.

The MNI is taken as the number of the most abundant element, once the natural skeletal abundance has been accounted for; thus in the case of sheep there are four times as many phalanges as there are each long bone so the minimum number of phalanges counted must be divided by four before it can be considered the minimum number of individuals represented by the phalanges. The majority of MNI counts take into account the side of each element represented and count right and left hand side elements separately so that an individual cannot be counted twice. Some analysts consider it unlikely that both right and left hand elements of an individual will be recovered in a disarticulated archaeological faunal sample so do not distinguish between left and right elements, but simply divide the number of each element by two in order to keep the MNI at a similar order of magnitude to those MNIs that are side specific. Other variations on the MNI method take into account age, sex, size or on-site location of an element to determine whether or not fragments specimens could represent the same individual.

All these variations in methodology have no differential effect on the different species counted so providing %MNI frequency and not absolute MNI frequency is used, inter-site comparability of relative species proportions should be possible. The complexity of the methodology allows a number of possible variations in the way MNI is calculated. This methodological variation does mean that often the MNI figures from one site are not derived in the same way as the MNI figures from a different site. All indications are that the methodological variations have very little effect on the comparability of MNI from different sites, however it is still important to remember that one is not always comparing like with like. Given the number of different analysts producing Iron Age bone reports in Britain there is a capacity for many variations in MNI methodology, something that must be borne in mind in a comparative study.

MNI has some advantages over NISP for the purposes of comparative studies. The correction for the natural skeletal abundance of an element prevents the over representation of species that have greater numbers of bones in their skeleton. The problems of different levels of fragmentation between species and between sites are substantially reduced as with an MNI count no matter how fragmented an element is it should only be counted once. Despite these advantages MNI can still be very unreliable in providing a reasonable indication of the relative frequency of different species as it tends to over emphasise the importance of the less abundant species in an assemblage (Casteel 1977). Over stressing of the importance of the rarer species is a problem that increases with decreased sample size, this is a very real problem in Iron Age faunal studies where sample sizes are often small.

MNE

The MNE is the Minimum Number of Elements that can account for all the identified specimens in an assemblage. Identified specimens are as defined for NISP (see above), and elements are as defined for NISP and MNI. In MNE counts elements are usually a combination of complete and partial bones, usually long bones are partial with proximal and distal ends considered as separate elements. The MNE is determined for each bone in a similar way to

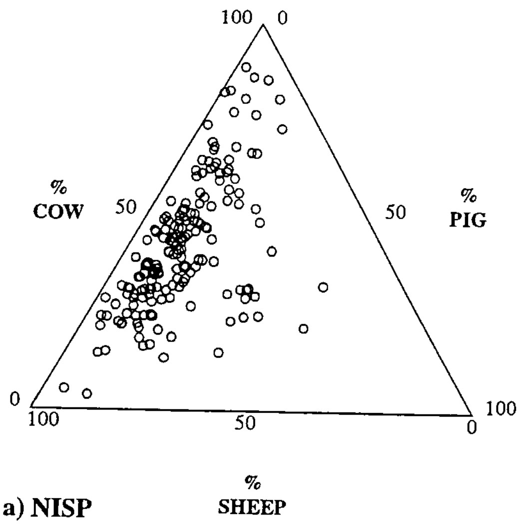
MNI; only those specimens that are a non-repeatable part of an element are counted, and the count for each element is corrected to take into account the natural skeletal abundance of that element. As with MNI there are the possibilities of taking into account side, age, sex, and size, and these provide the main areas of methodological variation. The minimum number of each element is summed with the other element counts to produce a total MNE. This method of quantification is also referred to as a Minimum Animal Units (MAU) count (e.g. Binford & Bertram 1977).

MNE counts are most commonly used to examine the representation of different skeletal elements, an important aspect of determining the effects of taphonomic biases acting on an assemblage (this is discussed in chapter 4 above). In addition to this, MNE counts have a number of advantages of direct relevance to comparative quantitative analyses of species proportions. The MNE method counteracts many of the problems of the NISP and MNI counts. The MNE count overcomes the problems of both differential fragmentation and differences in skeletal element abundance between species, and by including more of the faunal remains in the count MNE is much less likely to over estimate the importance of the rarer species. As with MNI there is the risk that variable methodologies may produce results that are not perfectly comparable, but for the most part MNE appears to be both a useful and reliable unit of quantification for use in comparative studies of Iron Age faunal assemblages.

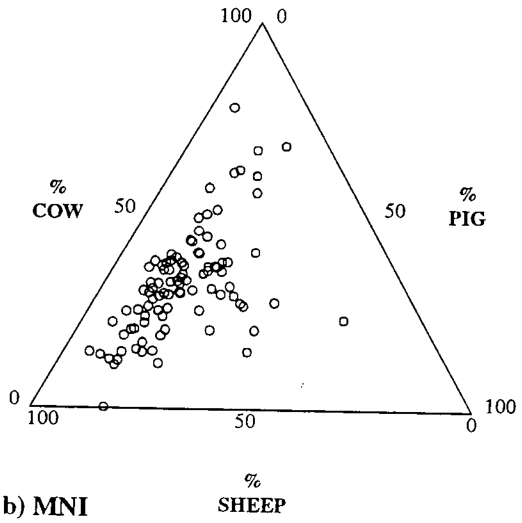
Theoretically MNE would appear to be the best choice of quantitative unit by which to compare the relative abundance of different species in British Iron Age faunal assemblages. Unfortunately in practice MNE is the least useful method of quantification for this study. The use of MNE is severely limited by the lack of available published data in an appropriate format. Preparation of an MNE count for those sites that do not provide appropriate published data would involve returning to the original bone catalogue, and in many cases the original raw material, to undertake fresh MNE counts. This course of action was not possible within the scope of this research project, so the availability of published NISP and MNI data may over ride the theoretical advantages of MNE data.

Availability of NISP, MNI and MNE data

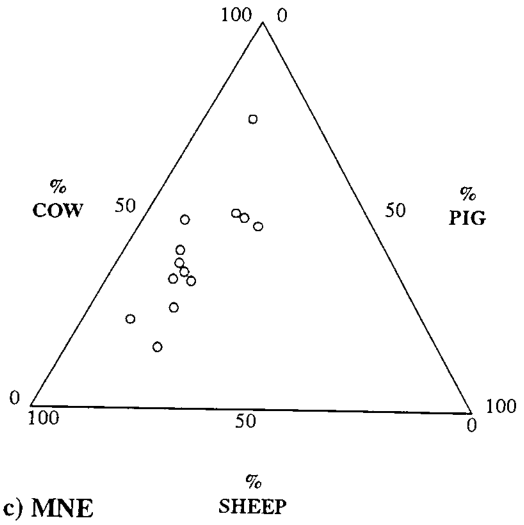
Comparing the number of Iron Age faunal samples that provided MNE data with those that provide MNI and NISP data it is immediately apparent that the scope of a comparative study using MNE data would be severely limited in terms of the number of sites that could be included (fig. 11. NB for instructions on reading tripolar graphs see appendix 5). NISP is the most frequently used form of quantitative data and is available for 184 British Iron Age faunal samples. MNI data is available for 99 faunal samples. However, MNE



a) NISP



b) MNI



c) MNE

Figure 11: Relative percentages of the three main domesticates from British Iron Age faunal assemblages using **a)** NISP **b)** MNI **c)** MNE.

could be calculated for only 13 samples. Despite theoretical advantages, the use of MNE is severely limited by the lack of available data in an appropriate format. In practise, given the wealth of available data, the best quantitative unit to use in a comparative study of British Iron Age faunal assemblages is NISP.

Comparability of NISP, MNI and MNE data

In order to maximise the number of samples that may be compared in a study of relative species proportions it would be desirable if the different methods of quantification produced compatible and comparable results. Thus samples that provide data in one format might be directly compared with samples that are quantified using a different method. A comparison of the relative proportions of the three main domesticates in twelve faunal samples using NISP, MNI and MNE data (fig. 12) reveals that the results of these three methods are not directly comparable. The species proportions generated by NISP and MNE are the most alike, and although not interchangeable it is likely that the results of comparative studies using NISP or MNE would be similar. The MNI results show a similar degree of diversity to the NISP and MNE methods, however the relative species proportions themselves appear noticeably different and tend toward higher incidences of sheep, and to a lesser extent pig. This would suggest that the results of a comparative study of Iron Age remains using MNI data would differ noticeably from a similar study using NISP.

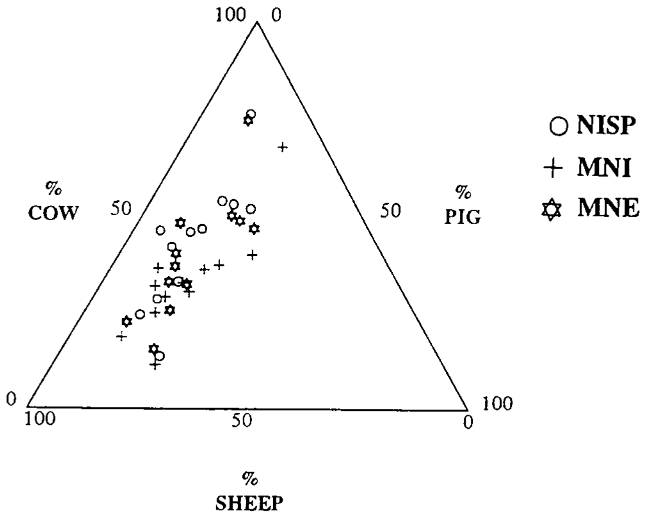
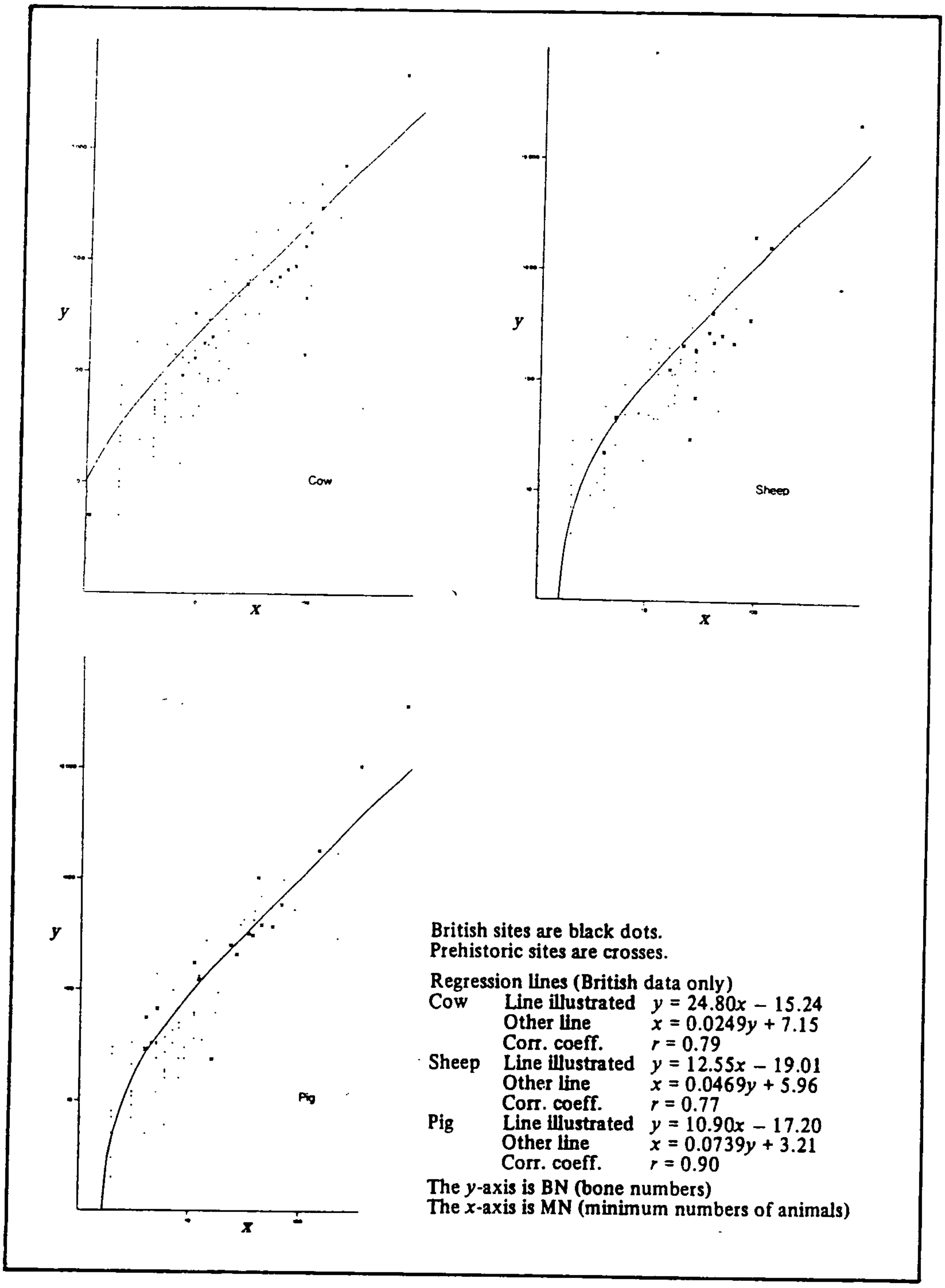


Figure 12: Relative percentages of the three main domesticates from several assemblages using three different methods of quantification for each faunal sample.

It is possible that NISP counts favour cow, and other large species, which would account for the discrepancies between the NISP and MNI species proportions seen in the triangular diagrams (fig. 11a & b). The bones from larger species will break into fragments which will tend to be large enough to be easily visible and therefore recovered during archaeological excavation, whereas the bones from smaller species when fragmented may be too small to be noticed and therefore not recovered. This would result in a higher proportion of fragments from a single bone being recovered for larger species, thus raising the NISP count. In an MNI count where a bone is only counted once, regardless of the number of fragments into which it has been broken, there is less likelihood of the larger species being over-represented, so the relative proportions of the smaller species appear greater than in the NISP count for the same sample.

Although NISP and MNI give different species abundance for the same faunal sample, the two sets of results are not completely unrelated. That there is a relationship between MNI and NISP is apparent from the triangular diagrams in fig. 11; the majority of MNI results come from the same samples as the NISP results, and despite differences in actual species percentages the MNI and NISP results exhibit remarkably similar patterns of spread, grouping, and outlying. NISP and MNI results are not compatible, but if the relationship between the two quantitative units can be established it may be possible to directly compare them. In his comparative survey of bone assemblages from Roman sites in Britain, King (1978) demonstrates the relationship between NISP and MNI by plotting the two against each other on a logarithmic scale and determining the regression line and the correlation coefficient (fig. 13). King's analysis demonstrates a "quasi-linear characteristic" (ibid: 208) in the relationship between MNI and NISP.

The relationship between NISP and MNI would appear to be a cross-cultural and cross-regional phenomenon, which King suggests is associated with sample size. King's study includes a number of prehistoric European samples that conform to the pattern of his Romano-British samples, and it is also mentioned that the results match the pattern seen in Ducos' (1968) study of Palestinian bones. Applying King's method to British Iron Age faunal samples produces similar patterns (fig. 14), and illustrates that the NISP/MNI relationship also holds true for the dataset used in this study. The linear pattern cannot be used as a predictive tool to determine MNI from NISP or vice versa. However any patterns of spread, grouping, or outlying values observed in a comparative study of relative species proportions using one quantitative method (NISP), if not an artefact of that method, should also be observable in a study using the other method (MNI). Thus having established that there is a relationship between the two quantitative units the results of one method may be used as a control for the other.



British sites are black dots.
Prehistoric sites are crosses.

Regression lines (British data only)

Cow	Line illustrated	$y = 24.80x - 15.24$
	Other line	$x = 0.0249y + 7.15$
	Corr. coeff.	$r = 0.79$
Sheep	Line illustrated	$y = 12.55x - 19.01$
	Other line	$x = 0.0469y + 5.96$
	Corr. coeff.	$r = 0.77$
Pig	Line illustrated	$y = 10.90x - 17.20$
	Other line	$x = 0.0739y + 3.21$
	Corr. coeff.	$r = 0.90$

The y-axis is BN (bone numbers)
The x-axis is MN (minimum numbers of animals)

Figure 13: Relationship between NISP (BN) and MNI (MN) on a logarithmic scale for Romano-British and prehistoric European faunal samples. (reproduced from King 1978)

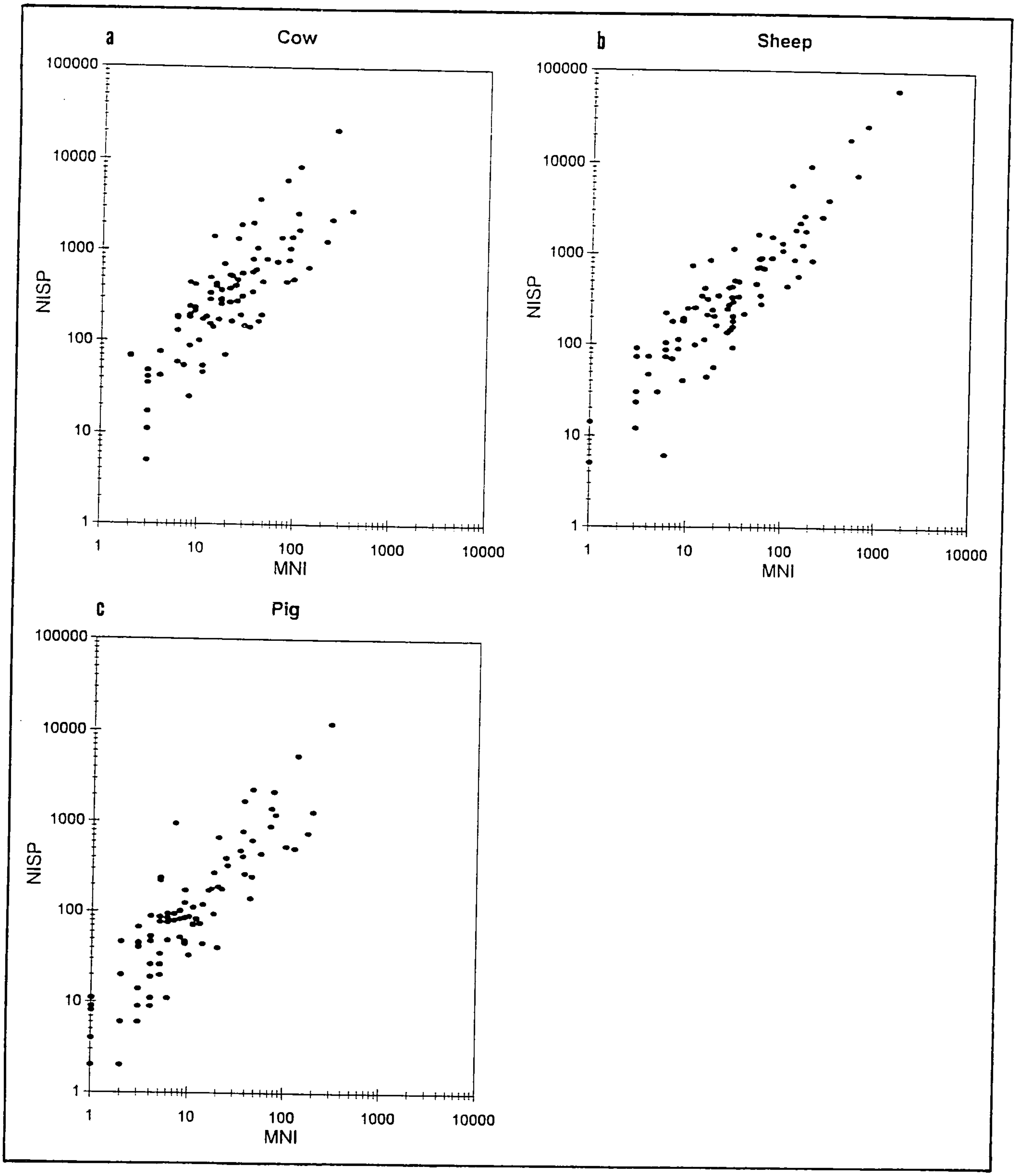


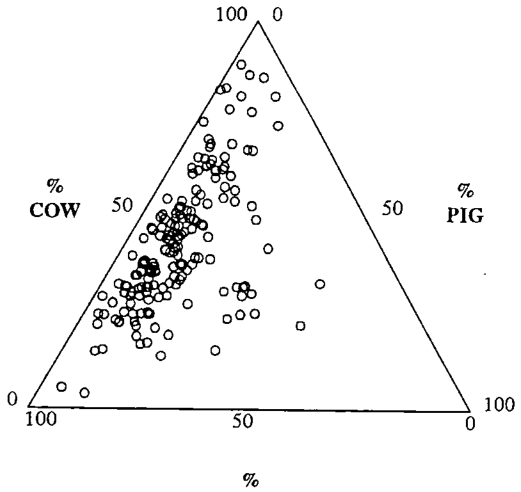
Figure 14: Relationship between NISP and MNI on a logarithmic scale for **a)** Cow **b)** Sheep and **c)** Pig from British Iron Age faunal samples.

Sample size

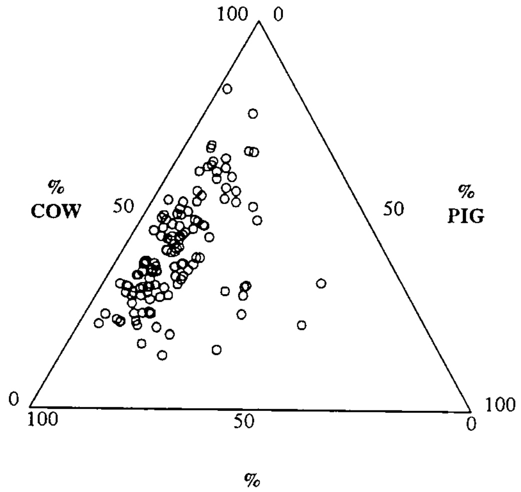
Many of the published British Iron Age faunal assemblages examined while undertaking this research were of very small sample size. Total cow, sheep and pig NISP from assemblages ranged from less than 50 (e.g. Norbury Hillfort, Levitan 1983) to approximately 100,000 (Danebury, Grant 1991). It is a well known and accepted fact that small sample sizes provide unreliable results that may bias a study, and the simplest way to deal with this problem is to exclude small samples. The problem that then arises is determining what size sample can be considered reliable, and what is the cut-off point below which samples have to be discounted as being too small. Figures 15a and 16a contain the NISP and MNI data respectively for all available Iron Age faunal samples. In both triangular diagrams, the NISP one in particular, there are a number of outlying points with proportions of sheep, cow or pig higher than in the majority of samples; these may indicate specialised husbandry regimes, but could equally be the result of small biased samples. It is therefore important to eliminate unreliably small samples from the study in order that true outliers can be recognised.

The results of King's analysis of the relationship between MNI and NISP in his comparative study of Romano-British faunal assemblages can be used to help determine what may be considered a reliable sample size for a comparative study of species proportions using NISP or MNI. It can be seen in figure 13 that the relationship between MNI and NISP breaks down below a certain sample size for each species, suggesting that below that sample size quantification will cease to be reliable. For the three main domestic species (cow, sheep, and pig) included in King's study it appears that above sample sizes of 100 for NISP and 10 for MNI faunal samples conform to the NISP/MNI relationship apparent in the graph. This would seem to indicate that for a comparative study of the relative proportions of cattle sheep and pig a reliable sample size would be NISP>300 or MNI>30 for all three species (average sample size for each species of NISP>100 and MNI>10).

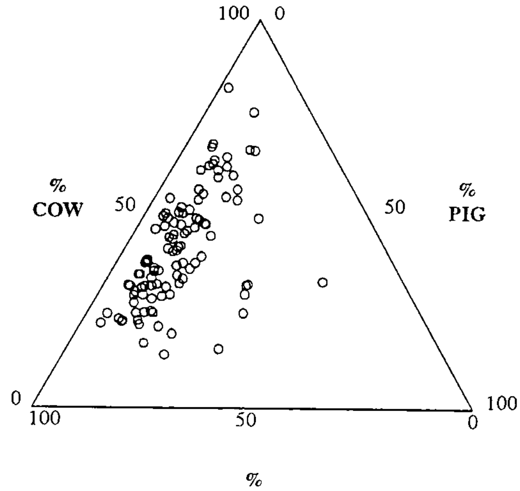
The results of excluding all samples below 300 NISP or 30 MNI are shown in figures 15b and 16b respectively. The exclusion of small samples appears to have eliminated the majority of outliers with high proportions of sheep or cow, especially for NISP, which would suggest that excluding samples below 300 NISP or 30 MNI successfully removes many of the problems of small sample bias. Some of the outlying samples with high proportions of pig still remain; this may be because they are genuine outliers or because the cut-off point for what is a reliable sample size is still too low. Total NISP>300 or MNI>30 may be an under estimation of reliable sample size. This is because, although on average the NISP/MNI is greater than 100/10 for each species, in actual fact the three species are not equally represented; therefore in a NISP/MNI sample of 300/30 at least one species will have a sample size of substantially less



a) All NISP values

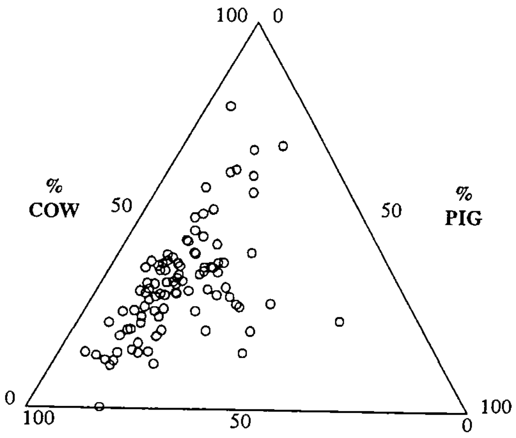


b) NISP>300

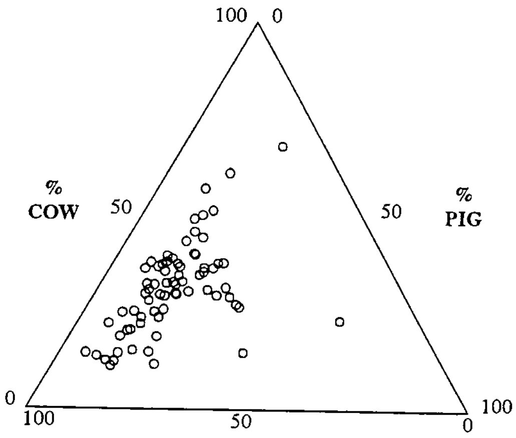


c) NISP>500

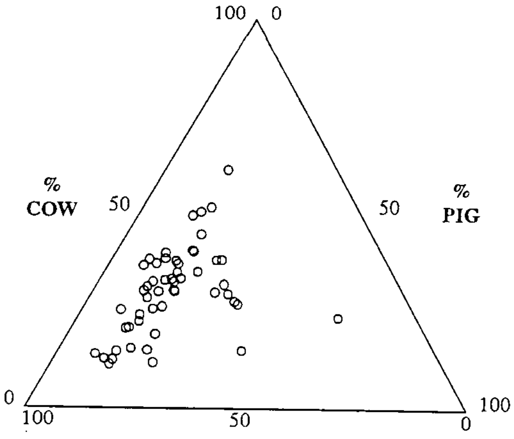
Figure 15: Relative percentages of the three main domesticates in Iron Age samples with **a)** all NISP values **b)** NISP>300 **c)** NISP>500.



a) All MNI values



b) MNI>30



c) MNI>50

Figure 16: Relative percentages of the three main domesticates in Iron Age samples with **a)** all MNI values **b)** MNI>30 **c)** MNI>50.

than 100/10. A total NISP or MNI sample size of 500 or 50 respectively should solve this problem, bringing the sample size of the least well represented species up to around NISP>100 or MNI>10.

The results of excluding all samples below 500 NISP or 50 MNI are shown in figures 15c and 16c; almost no further outliers are excluded than is the case with a NISP/MNI cut-off point of 300/30. This would imply that the worst of small sample bias is removed by excluding samples of total cow, sheep and pig NISP<300 or MNI<30 and that a higher cut-off point of NISP=500 or MNI=50, while not significantly reducing the chance of small sample bias, would reduce drastically the number of samples available for comparative study.

While in theory a comparative study of relative species abundance in Iron Age faunal assemblages would ideally use MNE as the unit of quantification, in reality the availability of appropriate data make NISP and MNI the best methods to use. The situation is similar when deciding which samples to include in the study on the basis of size; there has to be a trade off between excluding small samples and maintaining a large comparative dataset. In practice the optimum sample size for a comparative study of species proportions in British Iron Age faunal assemblages would appear to be a total NISP for cow, sheep, and pig, greater than 300 or an MNI greater than 30.

Chapter 6

Species Proportions In Iron Age Faunal Assemblages

Introduction

A comparative study of relative proportions of cow, sheep, and pig in Iron Age faunal samples was undertaken. Any observable groupings, outliers, or general trends in the species proportions were noted and the results examined for relationships between relative proportions of cow, sheep and pig and the region, geology, topographical location, site type, and date of the samples. Only those Iron Age samples with the total NISP for cow, sheep and pig greater than 300, and MNI greater than 30 were used in this study. This resulted in 125 samples with NISP data available for comparison, and 71 samples with MNI data. Details of the methods used, and the results and interpretation are given below.

Methods

The NISP and MNI were calculated or taken directly from published reports for as many Iron Age faunal samples as possible. For those samples exceeding the minimum size (NISP>300 or MNI>30) the NISP or MNI of each of the three main domesticates (cow, sheep and pig) were expressed as a percentage and plotted on tripolar graphs. The tripolar graphs were used to enable a visual assessment of the results and recognition of groups and trends in the data. Initially the whole dataset was plotted and observations made concerning the general spread and any particular clustering of samples. The dataset was then examined for any observable relationship between species proportions and a number of different factors (region, geology, topographical location, site type, and date). Plotted samples were labelled according to the characteristic under examination and the results noted.

Having carried out NISP and MNI analyses of all samples the dataset was then subdivided into regional groups in order to examine in more detail the relationship between the aforementioned criteria and the relative proportions of cow sheep and pig. The analysis of the regional groups used only NISP data as there were insufficient numbers of samples with MNI data in many of the regional groups to allow viable comparisons. Details of the characteristics examined for a relationship with species proportions are given below.

Region

A relationship between region and species proportions in faunal samples may occur for a number of reasons. Specific husbandry regimes may be reflected in the species proportions; thus any regional trends in farming and subsistence practices may show up in an analysis of species proportions. The adoption of a particular husbandry regime in a particular region may be due to the local climate or habitat being suited to a particular strategy, or it may be the cultural choice of a society that is regionally grouped for some other reason. Similarities and differences in species proportions may not always be an indication of different husbandry regimes; often different conditions of preservation may significantly effect the representation of different species in a recovered archaeological sample.

Regional analysis of species proportions is a useful tool for recognising trends and groups among faunal samples. However, in order to provide an explanation for any observed trends, other characteristics of sites and faunal samples should be considered. Each site that produced a faunal assemblage utilised in this study was assigned to a region, and the samples labelled accordingly on the tripolar graphs. The regional grouping of samples, even if failing to exhibit any definite trends, still provide a basis by which the dataset may be subdivided in order to examine the samples in more detail. The regions used are those described in Chapter 3. The number of samples from each region is given in Table 1.

Table 1. Number of faunal samples within each region with NISP>300 or MNI>30.

Region	Number of samples (NISP)	Number of samples (MNI)
Wessex and Central Southern England	n = 55	n = 18
Upper Thames Valley and surrounds	n = 12	n = 10
Eastern England and East Anglia	n = 18	n = 14
Western England and Wales	n = 11	n = 8
Midlands	n = 13	n = 13
Northern England and Southern Scotland	n = 16	n = 8

It is unlikely that any useful results will be obtained from those regions that contain only a small number of samples as even if all exhibited similar species proportions there may be too few to constitute a definite trend. Also regions that cover large or varied geographical areas have the potential to include several disparate intra-regional groups which, unless the number of samples is large enough, may just appear as a scatter of dissimilar samples. Despite these limitations there are sufficient numbers of samples in most regions to reliably determine both regional and intra-regional trends.

Geology

Underlying geology and soil type may be related to species proportions either by influencing husbandry strategy or by affecting the preservation of faunal material from different species. Underlying geology and soil type is most likely to influence choice of animal husbandry strategy as a knock-on effect of its influence in the choice of arable strategy. Although there is a tendency in archaeological studies to consider the arable and pastoral aspects of an economy separately, in order to work efficiently they are usually closely linked. Thus where geology and soil type effects the arable strategy it may also influence animal husbandry regimes. The nature and extent of the arable economy in the Iron Age would have been very closely linked to the need for different animal products such as manure and traction, as well as the amount of meat in the diet, and this would influence the proportions of different species husbanded.

Geology and soil type are closely linked to the amount of chemical weathering to which an archaeological faunal assemblage is subjected. The differential levels of survivability between species mean that where preservation conditions are poor there may be under representation of those species with lower survivability. Thus geology and soil type may be related to species proportions both directly, through their effects on preservation conditions, and indirectly, through their influence on arable strategy.

Where possible, the categories used in this study refer to the underlying geology at the site where the samples were recovered. Information concerning underlying geology was more frequently available from the published site reports than details of soil type. For this reason it was decided to analyse species proportions according to underlying geology rather than soil type, although in some cases soil type was the only information available and has been used as a category. Soil type may have more of a direct influence on the localised preservation environment of faunal material and as a result the relative species proportions in an assemblage, however such detail is only of real use in a study of intra-site variation. For a broader inter-site comparison underlying geology is probably more appropriate as it is more often uniform across the site, and therefore uniform throughout the sample. Also the underlying geology usually constitutes the parent material of any overlying soil types so this study still allows some consideration of the soil conditions.

The categories used are; Alluvium, Boulder Clay, Chalk, Gravel, Limestone, and Peat. For the intra-regional analysis two other categories are included; Unknown (where the information is not supplied in the report), and Other (includes samples that are the sole example of a particular geological type, or samples from areas with a mixture of geological and soil types).

Topographical location

Species proportions may be related to topographical location in terms of height as certain species are more suited to hill or valley environments and because of this the height of a site may well influence husbandry strategy. Cattle require good quality pasture and ready access to water and this makes them well suited to low lying valley areas and much less well suited to higher arid hillside areas. Sheep on the other hand can cope very well on poorer quality pasture, and susceptibility to foot-rot and liver-fluke means they are more suited to higher, well drained land than lower lying damp valley areas.

Grant's (1984b) comparison of some of the Wessex and Upper Thames Valley faunal assemblages revealed a relationship between the species proportions and the height of the site from which the assemblage was recovered. Those sites situated over 76m Ordnance Datum exhibited higher percentages of sheep, whereas those below 76m OD exhibited higher percentages of cattle suggesting a relationship between topographical location and species proportions. No definite conclusions could be drawn from Grant's study, however, as the lowland sites (<76m) were mainly situated on the Upper Thames Valley gravels, and the highland sites were mainly situated on the Wessex chalk downs. The differences in species proportions could therefore be related as much to regional/social grouping of sites, or underlying geology, as to topographical location.

By including a large number of samples from elsewhere in Britain as well as Wessex and the Upper Thames Valley this study will be able to clarify the results of Grant's study and determine whether there is a relationship between height and species proportions, or whether the results she observed are due to a different relationship. This study examines variation in height in more detail than Grant's by using more categories than just above or below 76m Ordnance Datum. The categories used are; 0-25m OD, 26-75m OD, 76-150m OD, 151-225m OD, and 225+m OD. Most reports provide only an approximate height, however in order to assign samples into categories these heights were treated as absolute. Where a range of height was given for a site that fell into more than one of the above categories the central value was taken as the absolute height and assigned to the appropriate category. Also included is the "Unknown" category where height is not given in the site report.

Site type

It is important to consider the nature of the site from which faunal samples are recovered as it is possible that the type of site may have some bearing on its function, and if that function is associated with animal husbandry there may be a relationship between the site type and the relative proportions of different species. An example of this might be the so called "Banjo" enclosures which have been suggested as having a function associated with stock keeping and as such may exhibit different species proportions than are seen in hillforts which have been suggested, depending on the author, as having functions associated with storage, craft production, military defence, temporary refuge, elite residence, and redistribution, to name but a few! To be related to proportions of species the site type need not be directly, functionally associated with animal husbandry strategy. It is possible that particular types of site have specific social/cultural associations and that a social/cultural link with particular husbandry strategies may result in a visible relationship between site type and species proportions. It is also possible that the prevalence of different types of feature, such as pits and ditches, on particular types of sites may influence the species proportions as different feature types often exhibit different species proportions either as a result of different preservation environments, or the effects of human activity.

The categories of site used in this study are; Hillfort, Banjo, Enclosed Settlement, and Open Settlement. The intra-regional analysis also includes sites categorised as "Other", this includes sites which are of unknown type or are ill defined in the site report (as a result this category may include some non-settlement sites) also included in this category are samples that encompass more than one phase of different settlement type.

Date

Relationships between species proportions and date should be tested for as they may be indicative of changing husbandry strategies. Changes in animal husbandry strategy, and therefore relative species proportions, over time may be related to changes in climate/environmental conditions or social/cultural developments. There are two particular hypotheses that may be tested by a study of changes in relative proportions of different species in Iron Age faunal samples through time.

Firstly, the notion of Late Iron Age agricultural intensification will be examined. This could be revealed by differences in species proportions between the Middle and Late Iron Age samples, perhaps with some LIA samples exhibiting a particularly high proportion of one species suggesting a move to a more specialised animal economy. Needless to say there are many other aspects of agricultural intensification that would be unlikely to be recognisable by a change in species proportions, however it is still something that should be considered when examining chronological patterns in species proportions. The second hypothesis that may be testable by studying species proportions is that of Late Iron Age "Romanisation". Romanisation, adoption of certain aspects of Roman culture, may take the form of changes in preferred diet and agricultural strategy and such changes are likely to show up as changes in species proportions, particularly an increase in the importance of cow and pig.

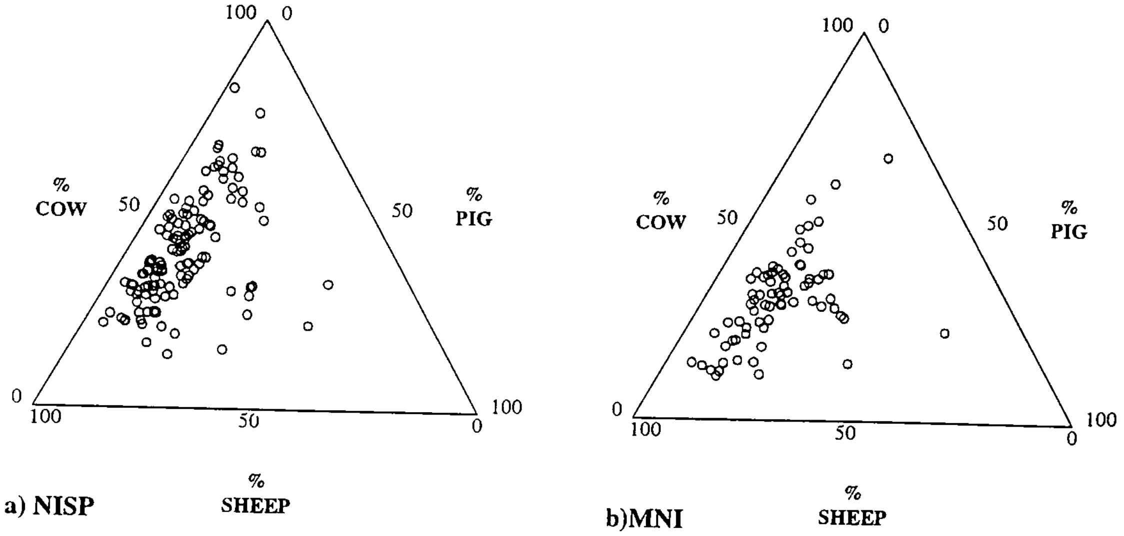
Ideally samples would be dated precisely and accurately assigned to Early, Middle, or Late Iron Age date; however many samples cannot be accurately dated, or span more than one period. The categories used in this study are as follows; EIA, MIA, LIA, LIA-ERB, and general IA. Where the date range of a sample spans more than one period (e.g. EIA-MIA) the sample is included in the later date category unless it is known that the majority of faunal material in the sample comes from the earlier period. The general IA category includes samples of date range broader than two periods, samples that are summed totals of sub-samples of different periods, and samples of no definite known date.

It should be stressed that the points on the tripolar graphs represent Iron Age faunal "samples" not "sites"; while some samples do represent the complete faunal assemblage from a site, others samples may represent smaller subsets of the complete site assemblage. Where there are several faunal samples from the same site they are usually separated by date, but in a small number of cases they represent the faunal assemblages collected from different areas of a site, or from different seasons of excavation. All samples, even if a sub-division of a larger sample, used in this study have a total cow, sheep and pig NISP of >300. A result of this use of separate samples can be that there are clusters of several points with similar species proportions. Such clusters may be misinterpreted as representing several different sites with similar species proportions when in fact the clustered samples all come from the same site.

Misinterpretations of this sort can be prevented by checking the provenance of clustered samples, and by considering the overall spread of points, and the differences between samples rather than just concentrating on identifying clusters of similar points. Separate samples from a single site do not always cluster and exhibit similar species proportions; the composition of an assemblage may vary significantly between periods, or area excavated and an analysis of this sort should attempt to recognise and explain these differences. Averaging the results of different samples from the same site in order to create a single result for each site would produce meaningless data and obscure potentially useful information.

British Iron Age species proportions

The relative proportions of cow, sheep and pig in the Iron Age faunal samples are presented in the tripolar graphs below (fig. 17). The results are analysed for trends throughout the whole Iron Age dataset and within smaller regional groupings.



a) NISP

b)MNI

Figure 17: Percentage of Cow, Sheep, and Pig in British Iron Age faunal samples a) NISP >300 b) MNI >30.

Both the NISP data (fig. 17a) and the MNI data (fig. 17b) show similar trends in the Iron Age faunal samples. There is a clustering of samples indicating that the majority of Iron Age assemblages are comprised mainly of sheep and cow in roughly equal proportions with a low incidence of pig. The NISP data shows a slightly higher concentration of samples with a greater percentage of sheep than cow, although there are still large numbers of samples with more cow than sheep. The NISP data also includes a few samples that appear to be outliers of the main sheep/cow dominated group, having noticeably higher percentages of pig remains. The MNI data exhibit similar groupings to those seen with NISP, the majority of samples having more sheep than cow, and a few outlying samples with high percentages of pig. There is a tendency throughout the MNI data for slightly higher percentages of sheep and pig than are seen in the spread of NISP data, but this difference is expected and explainable (see Chapter 5 above).

The similar pattern of NISP and MNI species proportions throughout the Iron Age dataset is also apparent at the inter- and intra-regional level. The clearest regional patterns of species proportions and trends related to certain site characteristics observed in the NISP data are also apparent in the MNI data. Thus, to avoid repetition, only the results of the analysis of species proportions using NISP data will be presented.

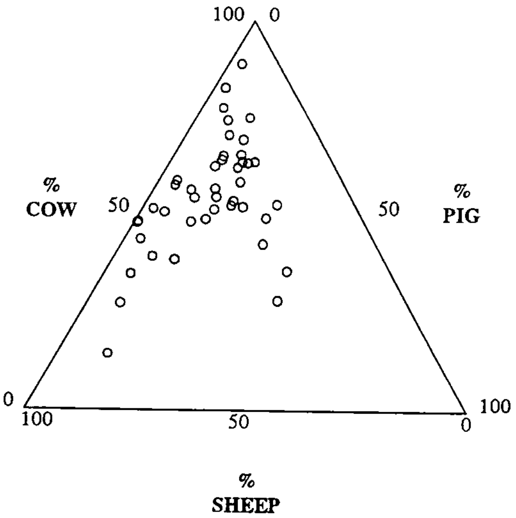


Figure 18: Percentages of Cow Sheep and pig in Romano-British faunal samples. NISP>300. (after King, 1978)

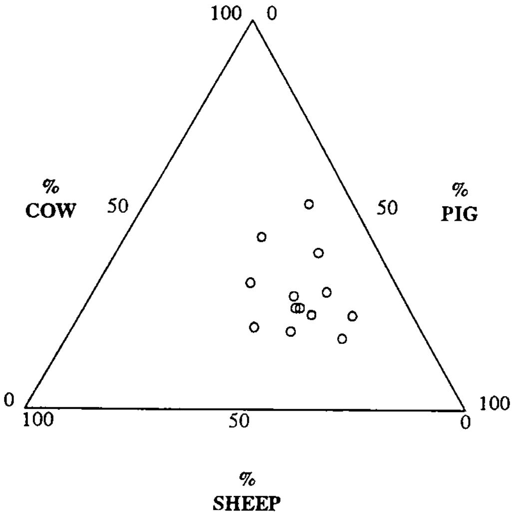


Figure 19: Percentages of Cow Sheep and pig in northern French Iron Age faunal samples. NISP>300. (after Méniel, 1987 & 1990)

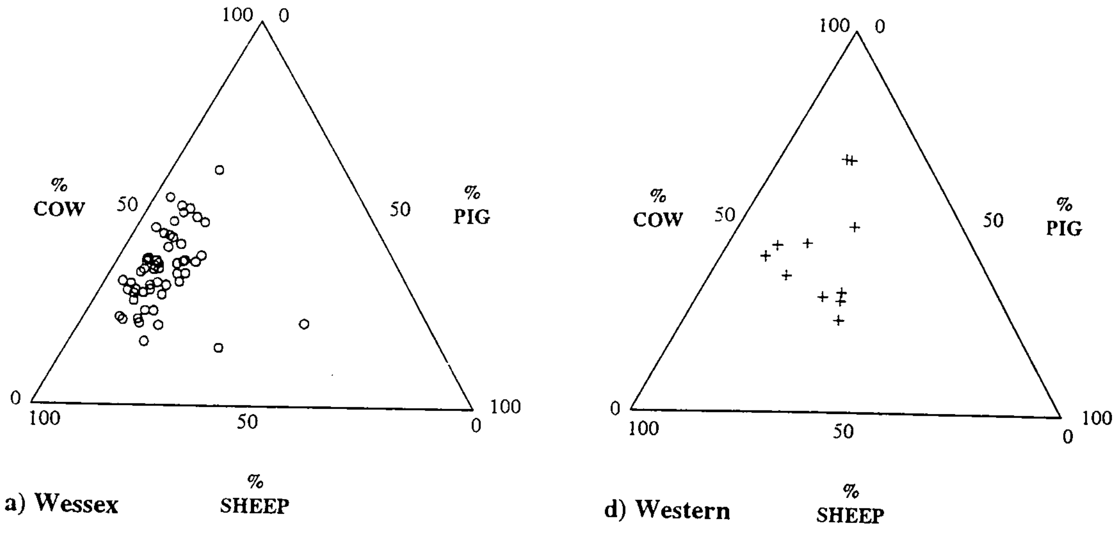
A comparison of the range of species proportions exhibited by British Iron Age faunal samples with those from Roman Britain (fig. 18, after King, 1978), and from a selection of Late Iron Age sites in Northern France (fig. 19, after Méniel, 1987 & 1990) reveals significant differences between the three datasets. While there is some overlap between the Iron Age and Roman datasets from Britain, the bulk of samples from each dataset are distinct with very different ranges of species proportions. Unlike the British Iron Age samples, the majority of Roman assemblages exhibit high percentages of cow; also the percentages of pig tend to be higher than in the British Iron Age samples. These differences in species proportions imply changes in husbandry regimes from the Iron Age to Roman period in Britain. It is possible that an analysis of the date of samples in the British Iron Age dataset may reveal a tendency toward species proportions more in keeping with the Romano-British dataset in samples from the later Iron Age periods, particularly in those regions where the material culture has been argued to show "romanisation" (e.g. Cunliffe's (1991) "core zone").

The Late Iron Age French material also forms a distinct group of samples with ranges of species proportions very different to those seen in the British Iron Age samples. Among the French samples, pig exhibits the highest percentages of the three main domesticates and cow and sheep have similar, but slightly lower percentage ranges. Assuming there are no major taphonomic differences, it is immediately apparent from observing the ranges of species proportions that the animal husbandry strategies of these Northern French sites were very different to those practised by their British contemporaries. More recent studies of French Iron Age and Roman faunal assemblages by Lepetz (1996) reveal a broader range of species proportions than those seen in Meniel's select group, but although there is some overlap with the British Iron Age dataset for the most part the British and French faunal assemblages show clear differentiation in terms of relative cattle, sheep and pig proportions.

This brief comparison of the British Iron Age faunal samples with their Gaulish counterparts, and their Roman successors, shows them to be a spatially and chronologically distinct group. A more detailed analysis of the British faunal samples may reveal spatial, chronological and cultural distinctions within the dataset, in the same way that this brief comparison has revealed distinctions between the LIA French, Romano-British, and British Iron Age faunal samples.

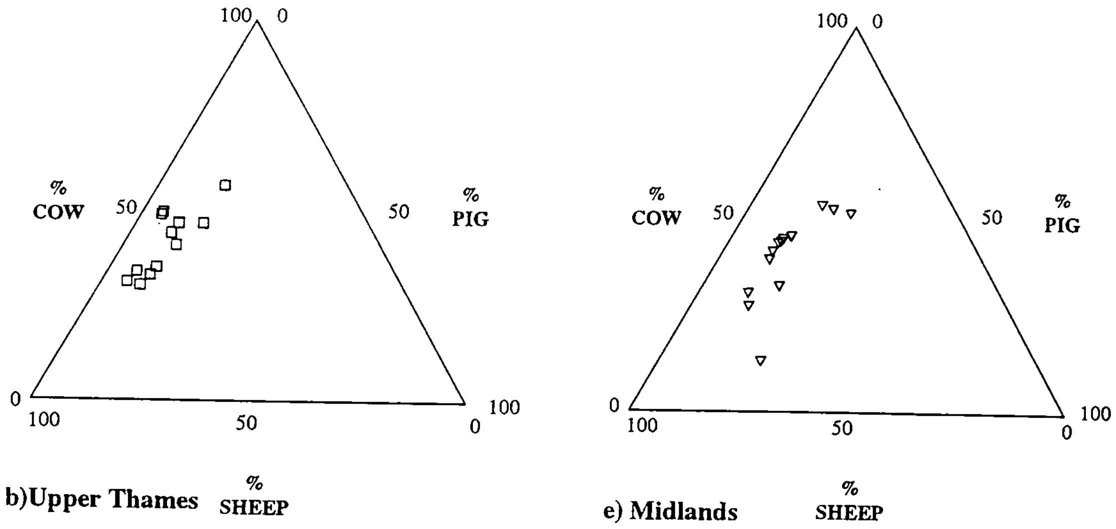
Region

There is a substantial amount of overlap in the species proportions of samples from different regions, but despite this overlap a number of regional traits are immediately apparent. There is a predominance of sheep among the Wessex samples, while the samples from Eastern England and East Anglia exhibit higher proportions of cow. The Western England and Wales samples contain higher percentages of pig than are seen in the main cluster of Iron Age faunal samples. Plotting the results on separate graphs for each region gives a clear picture of any regional patterning in relative species proportions. The patterns of relative species proportions for each region are discussed below.



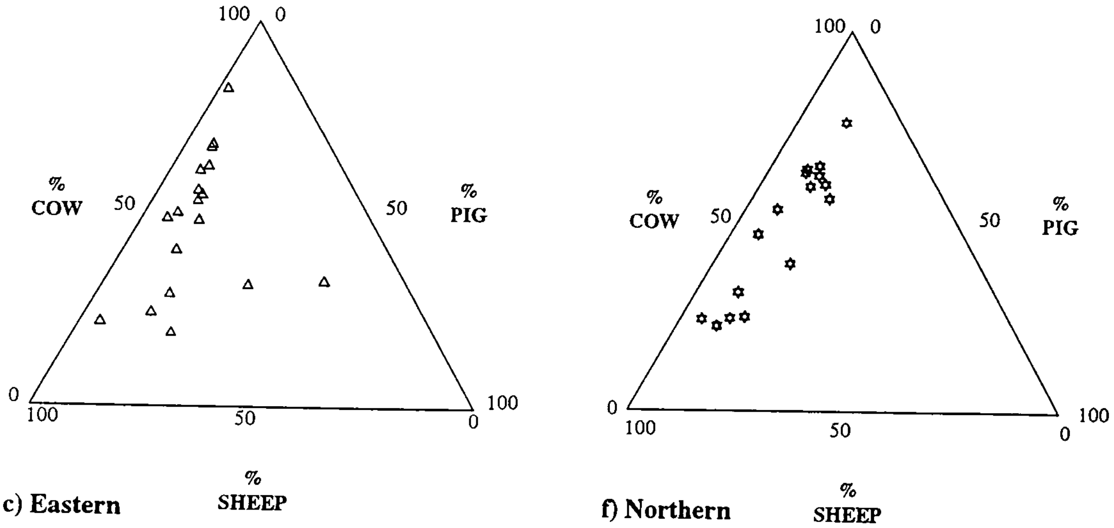
a) Wessex

d) Western



b)Upper Thames

e) Midlands



c) Eastern

f) Northern

Figure 20: Percentage of Cow, Sheep and Pig NISP in Iron Age faunal samples from separate regional groups.

Wessex and Central Southern England (fig. 20a)

Within the overall spread of Iron Age faunal samples the Wessex samples form a distinct and fairly tight group. The majority of Wessex samples form a group with high percentages of sheep ranging from c. 40-70%, slightly fewer cows (c.20-50%), and low percentages of pig (c.0-20%). Compared to the overall range of Iron Age faunal samples the Wessex group occupies the upper end of the range of percentages for sheep, and the lower end of the range for cow. Outside the main group of Wessex samples there are two samples with significantly higher incidences of Pig (Groundwell Farm and Ower, Dorset). The LIA-ERB sample from Owslebury, Hampshire, also exhibits a slightly higher percentage of cow compared to the majority of Wessex samples.

These results are in keeping with Cunliffe's (1991) model of predominantly sheep based animal economies helping to maintain large scale arable production throughout central southern Britain during the Iron Age. The good symbiotic relationship between sheep and fertile arable land is undisputed. However, even in such high percentages sheep may well have been less important than cattle in terms of their economic contribution; the meat weight of one cow being equivalent to that of several sheep, and in addition to providing manure cows may also be used for traction. The emphasis of sheep in the Wessex animal economy may be as much a product of the region's topography as it is a product of arable strategy.

It should be noted that within the Wessex group there still remains a reasonably broad range of different species proportions. Although within the overall Iron Age dataset the species proportions in the Wessex samples appear similar, there are differences within the region and there is the possibility of several smaller intra-regional groups being represented within the general spread of Wessex samples.

Upper Thames Valley and surrounds (fig. 20b)

The Upper Thames Valley sites also exhibit similar species proportions in the majority of samples. Falling well within the range of the bulk of Iron Age samples, the samples from this region tend to have fairly equal percentages of cow and sheep remains (both with a range of c.30-60%)and a low percentage of pig (0-20%). There is one sample, from Appleford, Oxfordshire, with a slightly higher percentage of cow than most samples from this region; however this difference is slight and the sample cannot be considered a notable outlier.

In keeping with Grant's (1984b) observations, the Upper Thames Valley samples examined in this study do not exhibit the very high percentages of sheep seen in many of the Wessex samples. It would however be erroneous to conclude that the Upper Thames Valley samples represent a different strategy of animal husbandry to that occurring in Wessex in the Iron Age; the majority of Upper Thames Valley samples being well within the range of species proportions seen among the Wessex samples. The species percentages suggest that cattle were the main contributors to the Upper Thames Valley animal economies given their greater size, although in terms of herd numbers sheep and cattle were probably of similar importance. The absence of any extreme emphasis on sheep does not discount the possibility that the animal economy had a major symbiotic relationship with the arable economy; topographic location or other factors may have caused concentration on sheep to be a less viable option than was the case in Wessex.

Of all the regional groups in this study the Upper Thames Valley covers the smallest geographical area; it also exhibits the tightest clustering of samples in terms of relative species proportions. Despite this apparent uniformity in the species proportions, there is still sufficient variation to suggest a degree of intra-regional difference among the Upper Thames Valley faunal samples worthy of further exploration.

Eastern England and East Anglia (fig. 20c)

The samples from Eastern England and East Anglia exhibit a broad range of species proportions throughout the whole group. There are a sub-set of quite closely grouped samples that share certain similarities; the percentages of cow, although a broad range, are generally high (c.40-80%), while the sheep percentages, also a broad range, are generally low (c.10-50). The majority of samples also have the usual Iron Age characteristic of low percentages of pig (c.0-20%). The high percentages of cow are certainly indicative of an animal economy concentrating mainly on cattle. There are also four samples with a high incidence of sheep (50-80%) more in keeping with the assemblages from Wessex and Central Southern England. There is a notable amount of intra-region variation in species proportions within the Eastern samples, particularly with regards to the relative importance of sheep and cattle. There are two notable outliers from the main spread, samples from the Puckeridge-Braughing/Skeleton Green settlement complex in Hertfordshire, both of which have higher percentages of pig.

A number of the East Anglian samples are from wetland sites (Cat's Water and Haddenham, Cambridgeshire). Cat's Water has roughly equal percentages of cattle and sheep, while the samples from Haddenham exhibit the highest percentages of sheep seen among the assemblages from this region. Similarly, the Somerset Levels wetland samples from Meare in the Wessex region exhibit some of the highest percentages of sheep in that group. Given the high groundwater levels and possibility of seasonal flooding at these sites, one might have expected to see a low incidence of sheep, which tend to be better suited to drier environments. However, the wetland conditions need not be considered to be the determining factors of domestic species proportions at these sites as Cat's Water shares similar species proportions to several other, non wetland, samples throughout the Eastern region suggesting there is probably another factor influencing choice of husbandry strategy.

Western England and Wales (fig. 20d)

As with other regions the range of species proportions indicates a certain amount of intra-regional diversity, which is unsurprising given the size and diversity of the geographical region. The samples from Western England and Wales do appear to form a clear group. The range of species proportions from this region are noticeably different from the bulk of the Iron Age material, having generally higher percentages of pig. The samples have roughly equal proportions of cow, sheep and pig remains (all three species c.20-50%). There are two outlying samples, both from Coygan Camp, Carmarthenshire, which have higher percentages of cow and lower percentages of sheep than the main group.

The species proportions in this region are interesting as they not only show the presence of a regional group among the Iron Age material, they also exhibit a deviation from what might be considered the norm for Iron Age samples by having high proportions of pig. This is an important observation as the bulk of Iron Age faunal samples come from Southern and Eastern Britain (the result of more profuse excavation, and more favourable preservation conditions). This notable difference in species proportions in faunal samples from westerly sites opens up the intriguing possibility that high percentages of cow/sheep and low percentages of pig is not the norm for Iron Age Britain, merely the norm for Southern and Eastern Britain, and that far from being oddities the samples from this region are examples of the norm for Western England. Obviously without additional evidence from Western Britain this is pure speculation, but it should be remembered that the catchment of British Iron Age faunal material presently available is far from comprehensive.

Midlands (fig. 20e)

The samples in this region show a spread of generally similar species proportions. Cow and sheep have similar percentages (c.30-60%)and pig is present in lower numbers (c.10-30%). Within the parameters of this regional group there is a cluster of six very similar samples which come from a variety of sites. This may constitute and intra-regional group; however given the relatively small dataset this is at best a tentative suggestion. Further analysis of different sample characteristics such as date or site type may help to clarify the situation. Possible outliers include one of the samples from Weekley, Northamptonshire, which has a high percentage of sheep, although the other Weekley samples fall well within the main group, and three samples from Grove Farm, Leicestershire, which have slightly higher percentages of cow. At this stage of analysis there is very little that can be said about the relative species proportions, and animal husbandry strategy in the Midlands region other than that the samples fall within the range of species proportions seen in the majority of Iron Age samples.

Northern England and Southern Scotland (fig. 20f)

The samples from this region, as with the Eastern assemblages, exhibit a very broad range of species proportions; pig is consistently poorly represented (c.0-20%) while cow and sheep percentages vary greatly for both species (c.20-70%). The region encompasses a large geographical area which may increase the chance of such diversity. Although broad, the range of species proportions is unremarkable in terms of the general spread of Iron Age samples used in this study. The broad range of husbandry strategies suggested by these results is contrary to Piggott's notion of "Celtic cowboys" (Piggott, 1958: 25) and economies based primarily on cattle pastoralism throughout the North of Britain during the Iron Age. Even though Piggott's model of agricultural strategy for the Iron Age in Northern Britain has already been discredited due to the widespread evidence of arable cultivation in the region (Van der Veen 1992, Huntley and Stallibrass 1995), it is useful to obtain further confirmation from the faunal data.

The spread of samples suggests there is little evidence to support the notion of a particular regional trend in animal husbandry strategy. There are two slight clusters, a group of five samples with high percentages of sheep, and another group of seven samples with high percentages of cow. At first glance these clusters may suggest the presence of two separate groups. However, the clusters represent several samples from the same sites; four of the five sheep dominated samples coming from Garton Slack, East Yorkshire, and the cow dominated cluster containing multiple samples from Stanwick, North Yorkshire, and Thorpe Thewles, Cleveland.

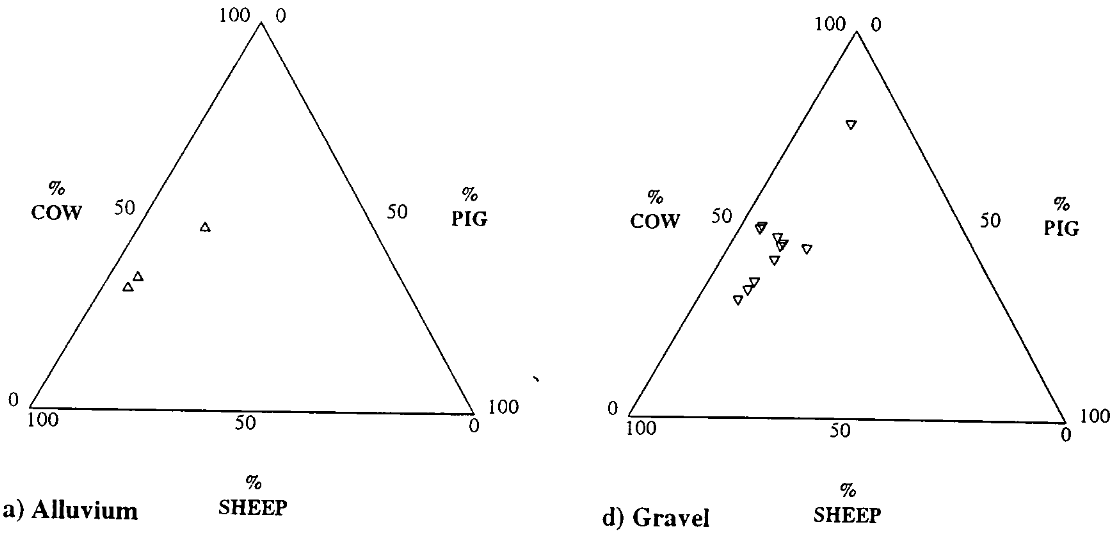
The outlying sample with the high percentage of cow (c.85%) comes from Port Seton, East Lothian, and is worth mentioning as it is a known example of recovery bias. Although the hand recovered faunal sample from this site exhibits a high incidence of cow, the ratio of cow : sheep is almost completely reversed in the sieved sample from this site (Hambleton & Stallibrass, forthcoming). The interpretation of the species proportions as they appear on the tripolar graph would be one of an animal economy specialising almost exclusively on cattle; however when the recovery bias is taken into account the interpretation is very different. The Port Seton animal economy most probably comprised similar numbers of sheep and cow, with cow contributing most to the economy but not to the exclusion of all else. This example highlights the problem of unknown retrieval bias; although recovery bias is unlikely to account for consistent trends across a region, there is always the possibility that interpretations of individual site assemblages may be unreliable due to the effects of an unknown bias effecting the relative proportions of different species.

It has been demonstrated that there are regional trends in the range of species proportions observed in the NISP data from Iron Age faunal samples. The regions with the most noticeable grouping of samples are Wessex and Central Southern England, the Upper Thames Valley and surrounds, and Wales and Western England. Further examination of the regional datasets for relationships with properties of archaeological sites, such as date or height OD, may help explain these regional groupings, as well as the presence of certain outlying samples.

Geology

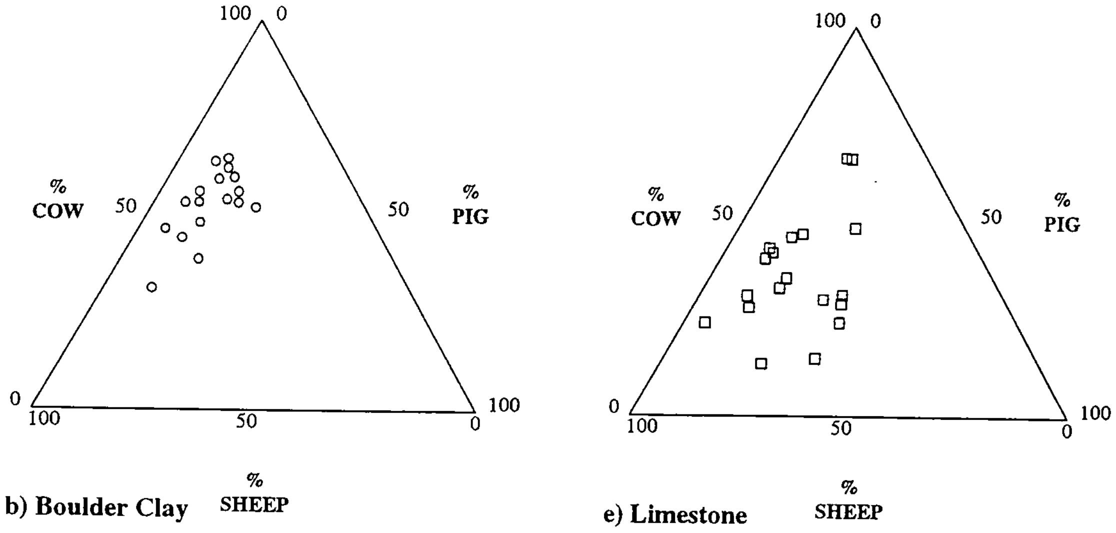
It is difficult to determine whether or not there is a strong relationship between the proportions of different species in faunal samples and the underlying geology of the sites from which they were recovered (fig. 21). Some categories of underlying geology do appear to share a relationship with species proportions, but other categories (e.g. alluvium and peat) contain too few samples upon which to base any conclusions. There is some separation between the range of species proportions exhibited by the samples from chalk and those from boulder clays. Those samples from boulder clays tend to have higher percentages of cattle than sheep, while those from chalk tend towards higher percentages of sheep than cattle. The samples from limestone areas cover a broad range of species proportions but seem to include many of the Iron Age samples with the highest percentages of pig. The majority of faunal samples appear to be from sites located on Chalk or Limestone. This is probably due to the alkaline nature of these soils providing an environment conducive to bone preservation.

It is hard to distinguish between cause and effect in the apparent relationship between species proportions and certain categories of underlying geology. Underlying geology is closely related to other aspects of the environment that may influence choice of husbandry strategy, and therefore species proportions. The samples from alluvium and those from gravels share similar species proportions; these similarities may be more closely related to the river valley environments commonly associated with these types of underlying geology, rather than a direct relationship with the geology itself. It is not uncommon for a particular category of underlying geology to be prevalent in a particular region, as a result of this it is equally possible that some of the apparent relationships between species proportions and geology result from regional characteristics other than the prevailing geology. This association of regions with particular categories of underlying geology is seen in the Upper Thames Valley samples which are predominantly from gravels, the Wessex samples which are predominantly from chalk, and the



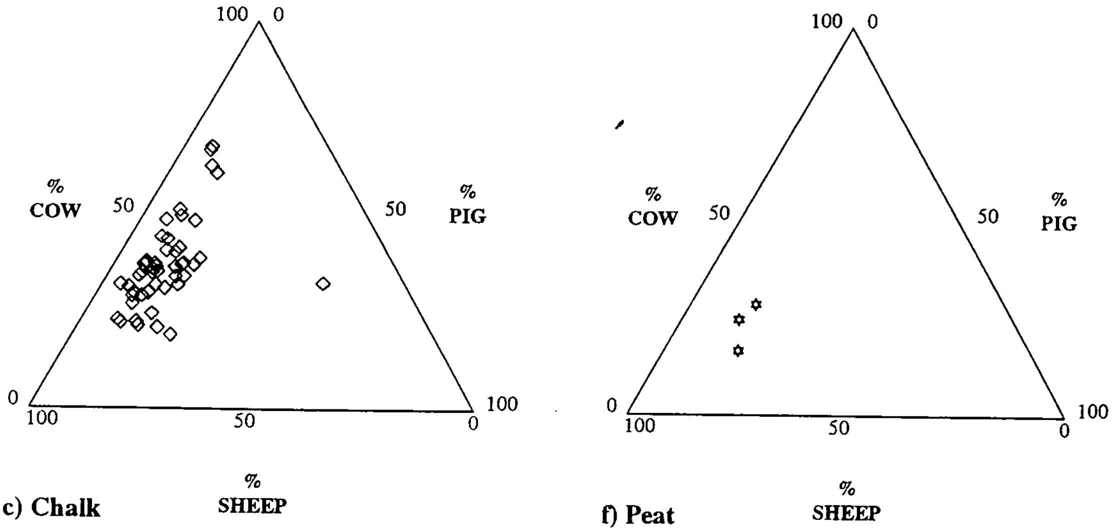
a) Alluvium

d) Gravel



b) Boulder Clay

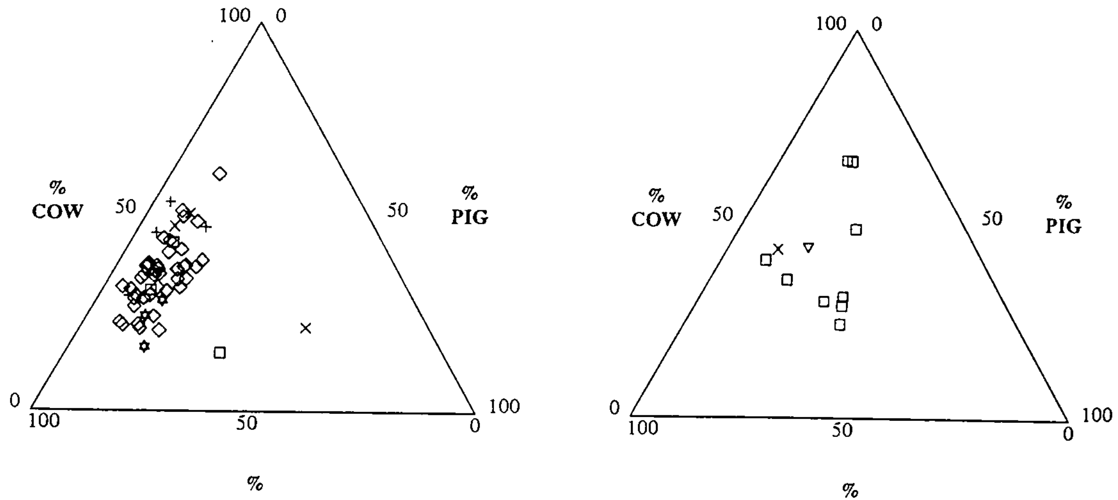
e) Limestone



c) Chalk

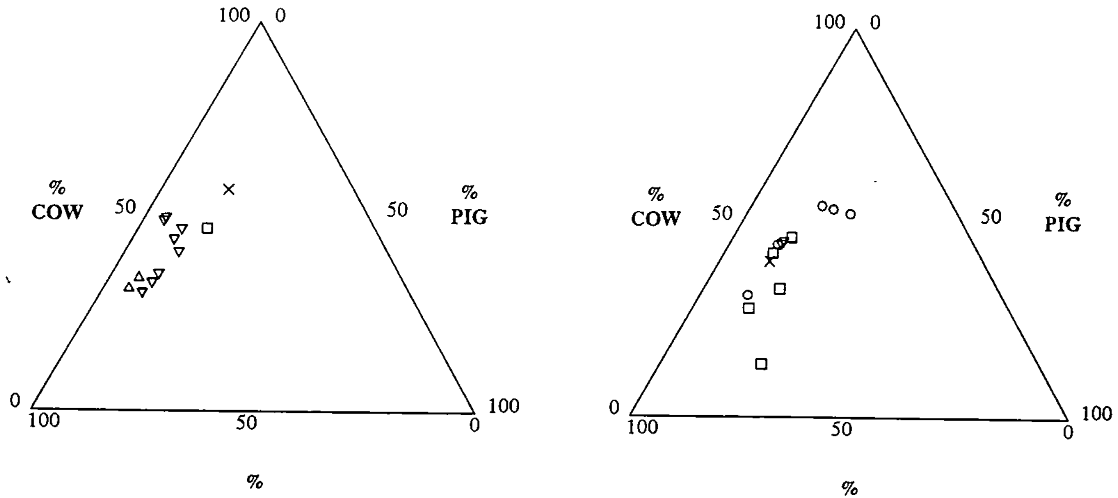
f) Peat

Figure 21: Percentage of Cow, Sheep and Pig NISP in faunal samples from Iron Age sites and their underlying geology



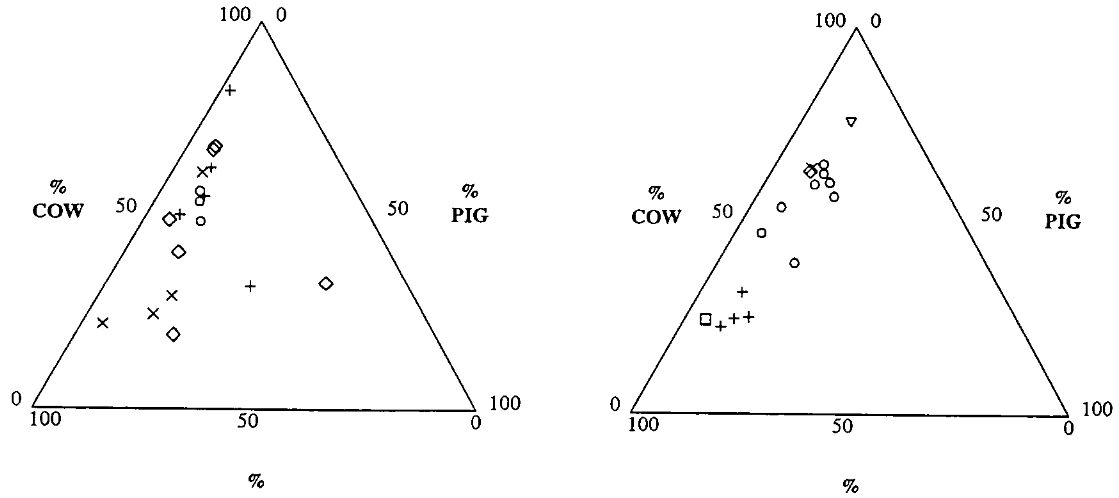
a) Wessex

d) Western



b)Upper Thames

e) Midlands



c) Eastern

f) Northern

Key: △ Alluvium ○ Boulder Clay ◇ Chalk ▽ Gravel □ Limestone ✡ Peat + Other × Unknown

Figure 22: Percentage of Cow, Sheep and Pig NISP in faunal samples from Iron Age sites and their underlying geology in separate regional groups.

Wales and Western England samples which are mainly from limestone areas. More details concerning the relationship between geology and species proportions may be gained from examining the samples at a regional level.

Wessex and Central Southern England (fig. 22a)

The Wessex faunal samples come from sites located almost exclusively on chalk. The samples located on peat are among those with very high percentages of sheep, however they are well within the range of chalkland samples and there does not appear to be any clear link between species proportions and underlying geology in this regional group. The favourable bone preservation conditions associated with chalk may partially account for the large dataset from this region, although the large number of samples is also the result of a long and continuing tradition of active archaeology in this area of Britain.

Upper Thames Valley and surrounds (fig. 22b)

The samples from this region are mainly from gravel sites and there is no indication to suggest that the geology of the area has any direct bearing on the species proportions of faunal samples. If geology were a significant influence on species proportions, samples with different geology might be expected to show dissimilar species proportions; however, those samples from sites with geology other than gravel still fit well into the main spread of species proportions. Although falling within the spread of Wessex samples, the Upper Thames Valley samples have very different geology, which justifies the consideration of Wessex and the Upper Thames Valley as separate regional groups.

Eastern England and East Anglia (fig. 22c)

There are no obvious patterns of geological categories to explain the different species proportions in the Eastern region. The outliers with high percentages of pig, and those samples with high percentages of sheep cannot be accounted for by different geology as the same geological categories are also seen among samples with high percentages of cattle.

Western England and Wales (fig. 22d)

All but one of the sites of known geology from this region are situated on limestone. This may account for the presence of preserved bone at these particular sites, as elsewhere in Western Britain the soils are generally too acidic to allow bone preservation. The single sample from gravel has a relatively low incidence of pig, but this is also true of some samples from limestone areas so there is no evidence to suggest a relationship between underlying geology and species proportions in this instance. There are insufficient samples from different geological categories to determine whether or not the regional phenomenon of high incidence of pig remains is related to the underlying geology of the region.

Midlands (fig. 22e)

The samples from boulder clays exhibit the highest percentages of cow in the region, and the samples from limestone exhibit the highest percentages of sheep. There is substantial overlap between the boulder clay and limestone samples, however, so it is unlikely that geology plays a significant part in influencing the choice of arable strategy in this region. The tight cluster of samples at the centre of this group exhibit a variety of geological categories, it is therefore unlikely that geology is the factor determining their similarity.

Northern England and Southern Scotland (fig. 22f)

There does appear to be some intra-regional separation of faunal samples into different geological categories. The northern faunal samples are in keeping with the general trend of higher percentages of cattle than sheep in samples from the boulder clay category. In addition to this the mixed geology at Garton Slack does include chalk, and the cluster of samples with high percentages of sheep from this site are similar in species proportions to the majority of other chalkland samples. There is some ambiguity in the relationship between species proportions; the presence of a single chalkland site exhibiting similar species proportions to the cluster of boulder clay samples suggests that geology is not the only factor influencing species proportions in this region. As mentioned previously, any apparent clusters are due to samples coming from the same site on chalk which may mean that intra-regional grouping of samples according to geological category might be overemphasised in the triplot. Having said this, the diversity of underlying geology within the region may go some way to explaining the broad range of different species proportions in the northern sample.

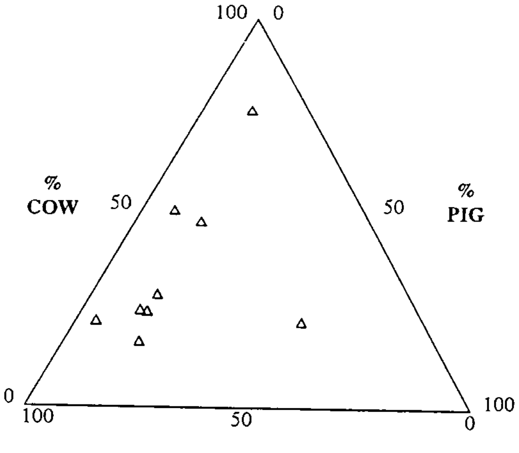
Analysis of the relative proportions of species in Iron Age faunal assemblages with relation to underlying geology has provided ambiguous results. There is a close relationship between underlying geology and region which makes it difficult to determine whether underlying geology has a significant influence on species proportions or whether the apparent inter-regional groupings of species proportions by geological category is the result of other regional characteristics. Those regions with samples from several different types of underlying geology exhibit no clear intra-regional grouping according to geological category, which would suggest that there is no relationship between the two variables. There is a tendency for faunal samples to come from sites located on chalk as the alkaline environment usually associated with chalky soils favours bone preservation. Although geology may influence the overall preservation of faunal assemblages, the results of this study would suggest that site geology does not significantly effect the proportions of species within a sample, and the regional patterns of species proportions seen in the Iron Age faunal data are not directly related to underlying geology.

Topographical Location

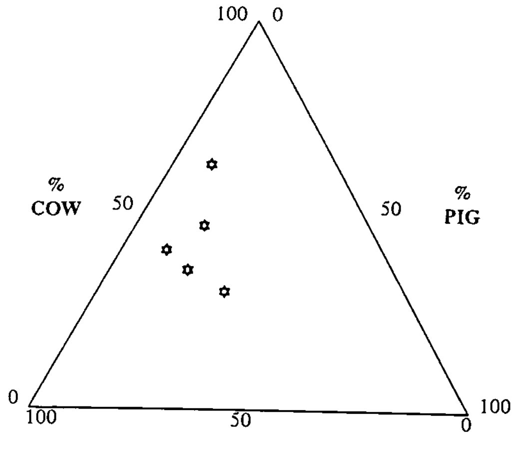
There does not appear to be a clear relationship between species proportions and height OD among the British Iron Age faunal samples (fig. 23). The use of smaller intervals for height categories might, in principle, have provided a clearer indication of any relationship between height and species proportions, but in practise this would have resulted in the number of samples in each category being too small to enable viable comparisons. The samples from the 26-75m category have a tendency for higher percentages of cattle, while the 76-150m category includes samples with high percentages of sheep. This could possibly give some credence to Grant's (1984b) observation of a relationship between height and species proportions in Iron Age faunal assemblages from Wessex and the Upper Thames Valley, whereby those sites above 76m OD have higher percentages of sheep while those sites below 76m have a higher incidence of cow. This slight division at the 76m mark is only apparent in the middle height range for the dataset used in this study; the 0-25m OD category has a very broad range of species proportions and includes samples with among the highest percentages of sheep, cattle and pig. The samples from 151-225m and over 225m also fail to show any definite trend in species proportions related to the topographical location of the sites from which they were recovered. Further examination of samples at a regional level may provide more information.

Wessex and Central Southern England (fig. 24a)

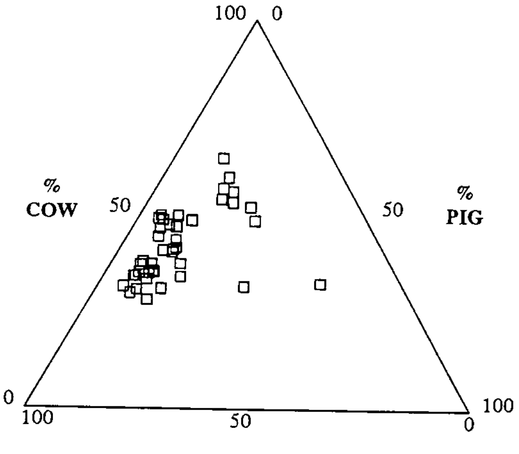
There is a slight intra-regional patterning of species proportions according to topographical location in that the samples from sites located at 26-75m OD do not have high percentages of sheep, while the range of species proportions from the 76-150m category does include high percentages of sheep. These results might be considered to be in keeping with Grant's (1984b) observations, and to support the notion that the choice of husbandry strategy is influenced by the suitability of species to the local environment whereby sheep tend to be the preferred species for high ground, and cattle for lower. This tentative relationship does not hold for all the samples from this region; the samples from Meare, situated on very low ground in a wetland environment that would theoretically be better suited to cattle husbandry, exhibit some of the highest percentages of sheep among the Wessex samples. Although there may be some links between



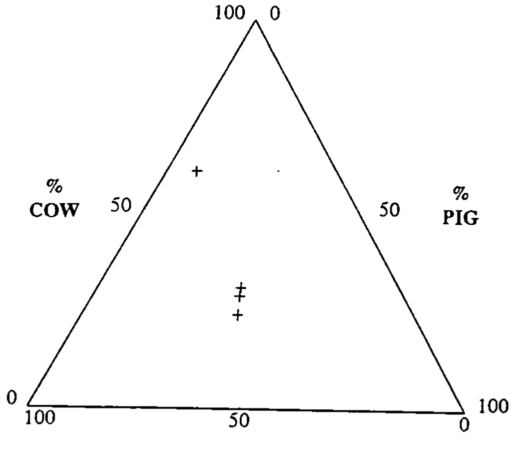
a) 0-25m



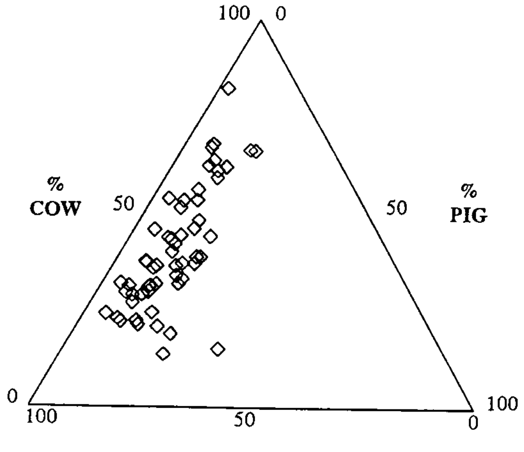
d) 151-225m



b) 26-75m

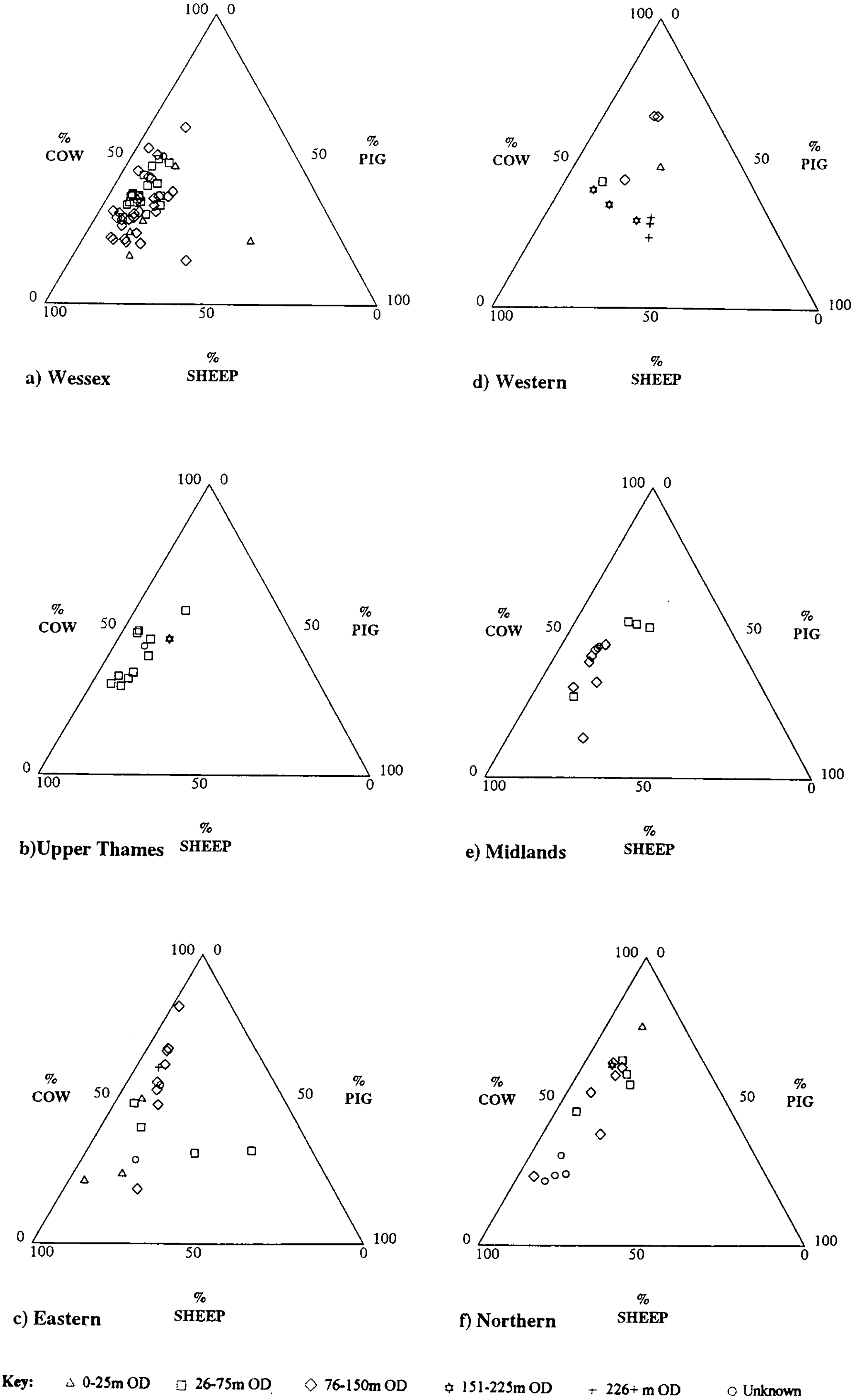


e) 226+ m



c) 76-150m

Figure 23: Percentage of Cow, Sheep and Pig NISP in faunal samples from Iron Age sites and their height in meters OD.


a) Wessex

b)Upper Thames

c) Eastern

d) Western

e) Midlands

f) Northern

Figure 24: Percentage of Cow, Sheep and Pig NISP in faunal samples from Iron Age sites and their height in meters OD in separate regional groups.

species proportions and topographical location in this region there is no evidence of a strong relationship. The intra-regional variation in species proportions cannot be fully explained by differences in site location, nor can it account for the presence of outliers.

Upper Thames Valley and surrounds (fig. 24b)

The majority of samples from this region are from sites located between 26m and 75m OD. As with the geology it is difficult to determine whether the similar topographical location accounts for the similarity in species proportions in the regions faunal assemblages, or whether the similarities in height are merely coincidental or secondary to another factor. The fact that the sample from a site with a much higher (151-225m) location falls well within the main sample group, would indicate that topographical location is not a major factor influencing species proportions. With regards to Grant's argument for a relationship between height and proportions of cattle and sheep, it is apparent that the majority of Upper Thames samples do come from lower lying ground and exhibit lower percentages of sheep than many of the higher Wessex samples. However, in the absence of contrasting higher level samples from within the same region the results of the Upper Thames Valley samples neither support nor refute Grant's model.

Eastern England and East Anglia (fig. 24c)

All but one of the sites of known height from this region are located below 150m, the majority of samples come from 76-150m and the others are mostly from 26-75m. Despite differences in height there is a substantial overlap in associated species proportions, suggesting there is no discernible relationship between height and animal husbandry strategy in this region. The two main outliers both belong to the same height category (26-75m), but this category also includes samples from the main group which fall well within the range of species proportions exhibited by the samples from other height categories. Thus topographical location is unlikely to account for the different species proportions of the outlying samples.

Western England and Wales (fig. 24d)

The samples from Western England and Wales exhibit great differences in height; some samples come from sites located at 0-25m OD, others from sites located at over 225m OD, and from a range of heights in between. The samples still form a cohesive group, despite this extreme variation in site location. There is no evidence to suggest a relationship between site height and species proportions in this region.

Midlands (fig. 24e)

All samples of known height from this region come from sites located between 26m and 150m OD. There can be no conclusions made concerning the relationship between height and species proportions. While some samples from 26-75m have high percentages of cow and some samples from 76-150m have higher percentages of sheep, there are no clear groups and there is an overlap in the range of species proportions from each height category. Also there are really too few samples from different sites to consider any apparent trends as evidence of a relationship between topographical location and species proportions.

Northern England and Southern Scotland (fig. 24f)

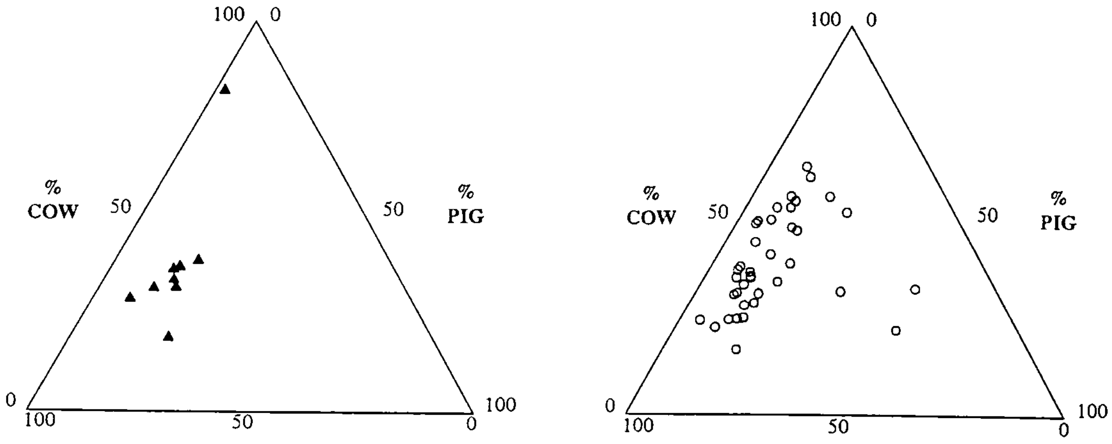
Again, there are no obvious trends to suggest that the topographical location of the site significantly influences species proportions, or animal husbandry strategy.

On the whole this study has produced little evidence to suggest a strong relationship between topographical location and species proportions in Iron Age faunal assemblages. Grant's observation for the Wessex and Upper Thames Valley faunal assemblages that sites above 76m OD favour higher percentages of sheep and those below 76m favour higher percentages of cow does not hold true for the whole of Britain as samples from other regions show no such pattern. With regards to Wessex and the Upper Thames Valley, those samples exhibiting high percentages of sheep compared to cow do tend to be from sites above 76m OD, although the very lowest sites from the region also share this characteristic. Of the lower sites (26-75m OD) few have high percentages of sheep. Thus it may be seen for the Wessex and Upper Thames Valley regions that while most sites from below 76m do not have high percentages of sheep this does not hold true for the very low lying samples. Also many of the higher sites above 76m are indistinguishable from the lower sites in terms of species proportions.

It must be concluded that while there may be some slight trends in species proportions related to topographical location there are no patterns of any great significance that would help explain inter- and intra-regional differences in Iron Age animal husbandry strategies. This does not mean that animal husbandry strategies at different sites were not influenced by the suitability of the local environment, it simply means that for the British Iron Age faunal samples this is not the major factor determining species proportions.

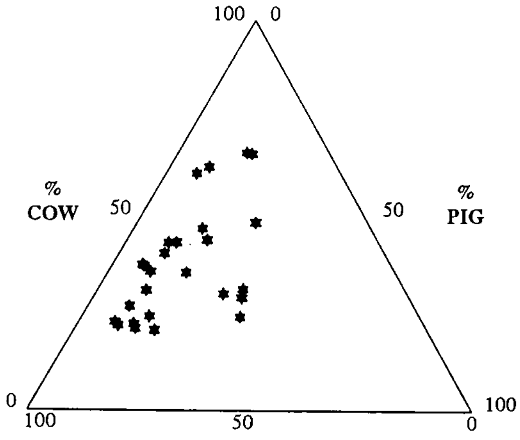
Site Type

Of the four categories of site type used to classify samples in this study only the Banjo enclosures exhibit any clear evidence of a relationship with species proportions (fig. 25). With the exception

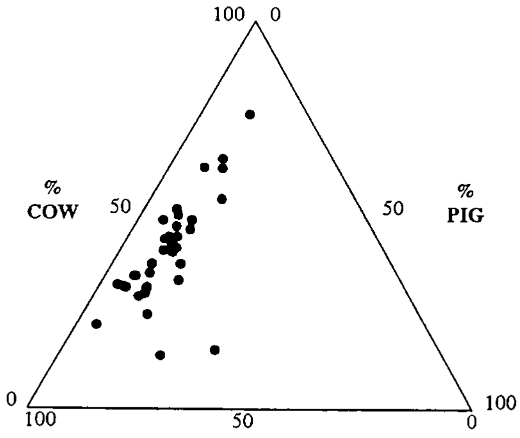


a) Banjo

d) Open

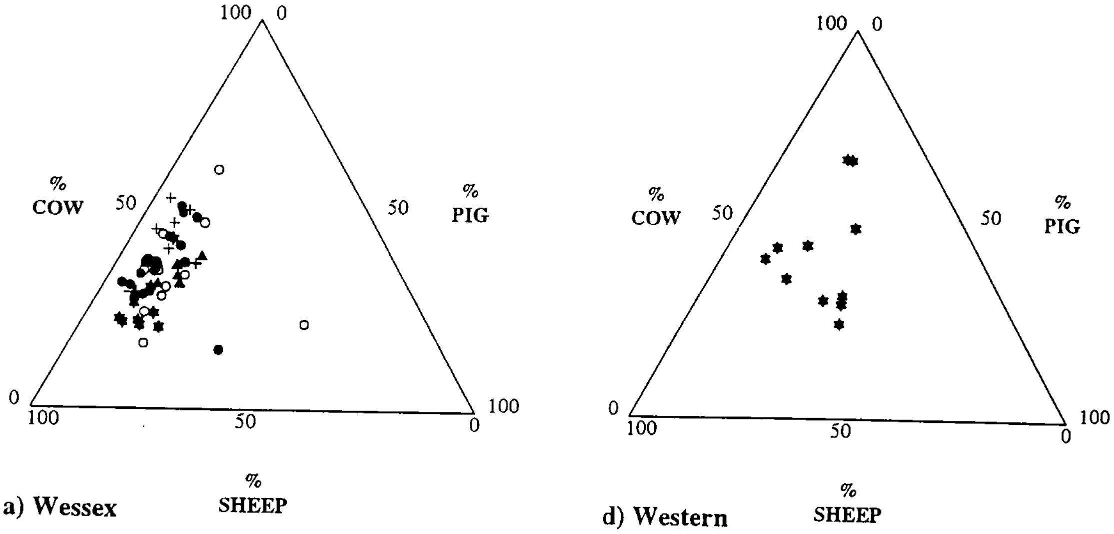


b) Hillfort



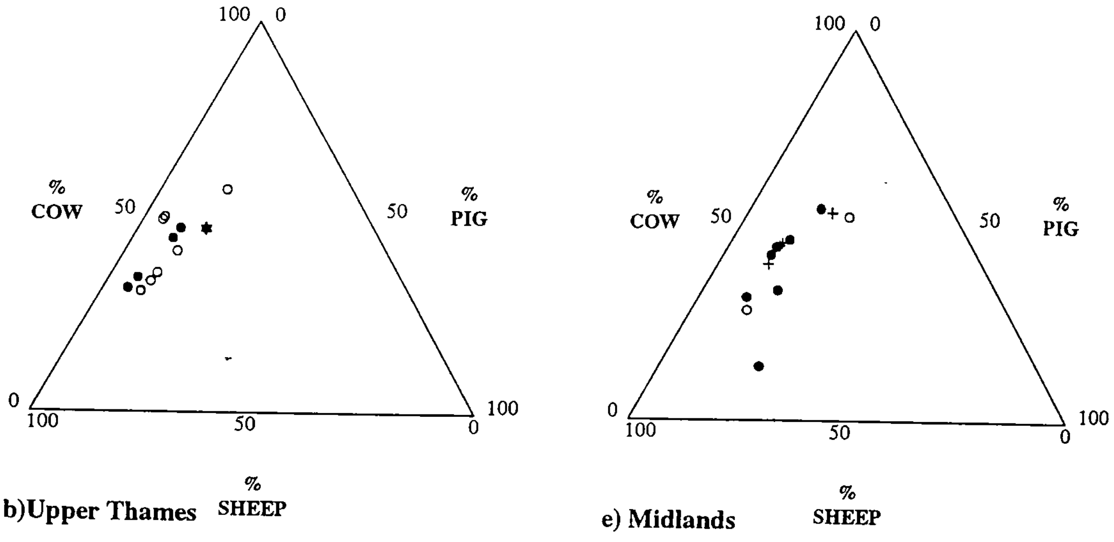
c) Enclosed

Figure 25: Percentage of Cow, Sheep and Pig NISP in faunal samples from different types of Iron Age site.



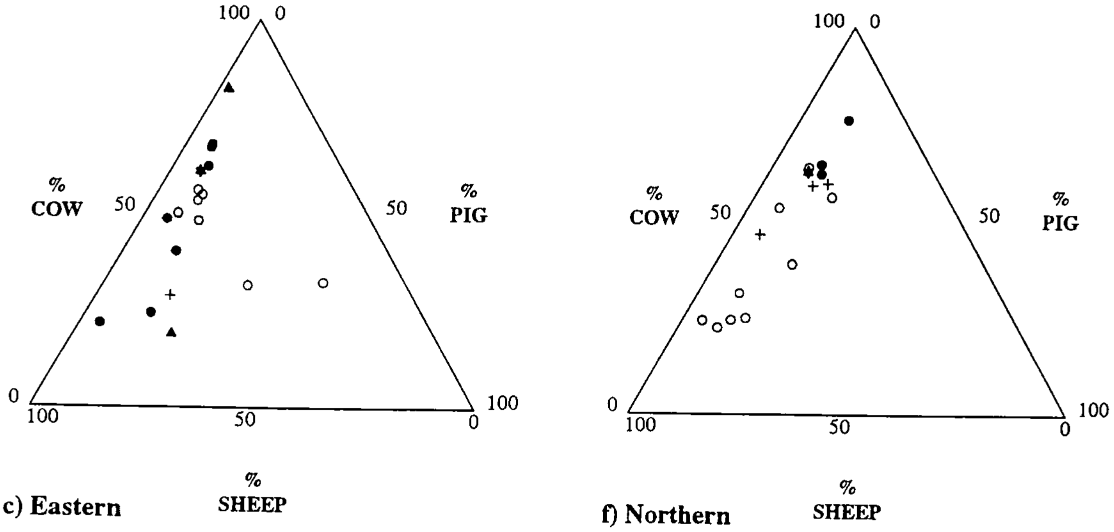
a) Wessex

d) Western



b)Upper Thames

e) Midlands



c) Eastern

f) Northern

Key: ▲ Banjo Enclosure ✱ Hillfort ● Enclosed settlement ○ Open settlement + Other

Figure 26: Percentage of Cow, Sheep and Pig NISP in faunal samples from different types of Iron Age site in separate regional groups.

of one outlier all the Banjos have high percentages of sheep (c.40-70%) and low percentages of cow (c.20-40%). The other categories of site type (Hillfort, Enclosed settlement, and Open settlement) all show a very broad range of species proportions. This is unsurprising as apart from Banjos, which are a quite clearly defined group, the categories encompass a broad diversity of site types from around Britain. For the most part all site types are well represented throughout the full range of species proportions in the Iron Age samples, although there may be some clustering that may be clarified by examining separate regional groups.

Wessex and Central Southern England (fig. 26a)

There do appear to be a number of discernible intra-regional groups of samples within the Wessex dataset that can be related to site type. The most noticeable trend is that of hillfort samples having higher percentages of sheep than the majority of other site types. The banjo enclosures also form a recognisable cluster of samples, exhibiting lower percentages of sheep than the bulk of the hillfort samples but slightly higher percentages of pig than the other enclosed settlements. The open and enclosed settlement categories encompass a much broader range of species proportions than the more tightly clustered samples from Banjo enclosures and Hillforts. It is fair to say that there is some relationship between site type and species proportions, particularly in the case of hillforts and banjo enclosures.

The association of particular types of site with different ranges of species proportions may be indicative of sites having specific animal husbandry related functions. Alternatively the observed relationships between species proportions and site type might be explained as a cultural phenomenon; the different species proportions of separate types of site perhaps reflecting the different animal husbandry strategies or dietary patterns of different socio-cultural groups of people.

Upper Thames Valley and surrounds (fig. 26b)

The majority of samples fall into the enclosed settlement, and open settlement categories. The open settlement samples do appear to have slightly higher percentages of pig than the enclosed settlement samples, however the difference are so small as to be insignificant. There does not appear to be any intra-regional variation within this group of samples that can be related to site type.

Eastern England and East Anglia (fig. 26c)

On the whole the Eastern samples exhibit no clearly discernible relationship between site type and species proportions. With regards to any evidence of inter-regional trends, one of the banjo samples (Wavendon Gate, Buckinghamshire) from this region has very different species proportions to those seen in Wessex banjo enclosures. This may call into question the accuracy of the banjo classification for this particular site, or it may suggest that other factors have a stronger influence than site type on faunal assemblage composition in this region.

One notable feature is that the two outliers with high percentages of pig, although included in the open settlement category are samples from the major LIA settlement complex of Puckeridge-Braughing/Skeleton Green. Although the relationship between settlements of this type and high percentages of pig is at best tenuous, there are a number of possible explanations for these two outlying samples. As examples of Iron Age sites with a more "urban" nature than others, oppida and other major LIA nucleated settlements may well have had consumer rather than producer economies; without the added requirements of manure and traction the emphasis on sheep and cattle could have been reduced, leaving pig to play a greater role in the diet. In addition, it has been suggested that British oppida show more evidence of Roman influences than the majority of contemporary rural sites (Cunliffe 1991), and such romanisation may be reflected in the faunal assemblages from these sites. There is also the possibility that the higher incidence of pig in the assemblages from oppida reflect the high social status of these sites within the region (King 1988). King (ibid.) highlights the similarity of species proportions from Puckeridge-Braughing and Skeleton Green faunal samples, the two outliers mentioned above, to those seen in samples from other high status LIA sites from Southeast England.

Western England and Wales (fig. 26d)

All the samples in this group come from hillforts, reflecting a bias in the archaeological exploration of this region. There are arguments to suggest that British hillforts were "high status" sites (Cunliffe 1984), or gathering places associated with feasting (Hill 1995c, Stopford 1987), both of which would be in keeping with the high incidence of pig in the faunal assemblages from this region. However, without other non-hillfort faunal assemblages to provide a comparison, there is no evidence to suggest that this pattern of species proportions is in any way indicative of a relationship with site type.

The range of species proportions in these hillforts differs substantially from the range seen in the Wessex hillfort samples. This would indicate that there are no inter-regional similarities in species proportions among the Iron Age hillfort samples. It should be remembered that "Hillfort" is a blanket term encompassing a diversity of sites, as are the terms "Open settlement", and "Enclosed settlement". Although possessing broad similarities, such site categories could well exhibit both inter- and intra-regional variation, and it is therefore unsurprising that trends observed in one region do not hold true in others.

Midlands (fig. 26e)

The results from this region fail to indicate any relationship between the species proportions of faunal samples and the type of site from which they were recovered.

Northern England and Southern Scotland (fig. 26f)

The Northern samples also fail to provide conclusive evidence of a relationship between site type and species proportions. There is a slight tendency for the samples from enclosed settlements along with the one hillfort to have high percentages of cow, but there is no clear division between these and the samples from open settlements which exhibit a broad range of species proportions.

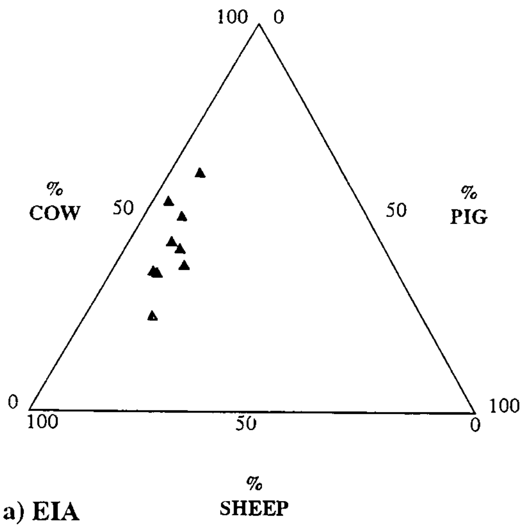
There is no predictive relationship between site type and species proportions throughout the Iron Age faunal samples. However the results of this analysis suggest that within certain regional groups there is a relationship between site type and species proportions and, possibly, animal husbandry strategy. This is particularly true of Wessex, where hillforts and banjo enclosures exhibit definite intra-regional grouping. There are by no means such strong relationships in other regions, however the outlying LIA settlement complexes in the east Anglian sample may provide another example of a relationship between species proportions and site type.

Date

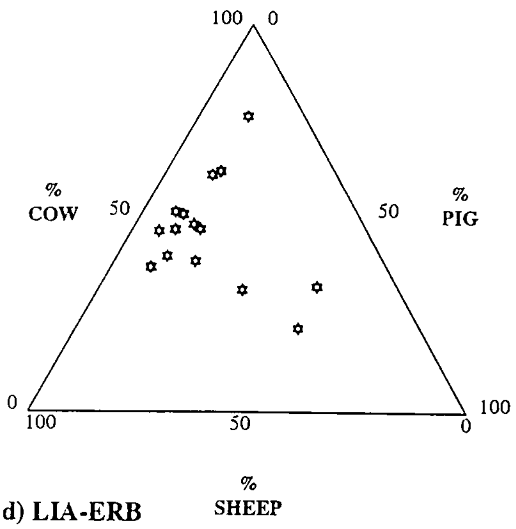
In general the faunal samples exhibit little variation in the range of species proportions from different periods of the Iron Age in Britain (fig. 27). The EIA samples have low percentages of pig and roughly equal proportions of sheep and cattle remains. The MIA and LIA samples also share these characteristics but with a slightly broader range of species proportions, some with high percentages of sheep or cow. The notable exception is the LIA-ERB dataset which exhibits a range of species proportions with markedly lower percentages of sheep than earlier periods (sheep <60% in all LIA-ERB samples), and a number of LIA-ERB samples also have relatively high percentages of pig. This pattern is in keeping with King's (1988) observations of Late Iron Age high status sites and may be a reflection of the effects of romanising influence on Late Iron Age diet and husbandry strategies. It is possible that analysis of the different regional groups may reveal further distinct chronological trends in species proportions.

Wessex and Central Southern England (fig. 27a)

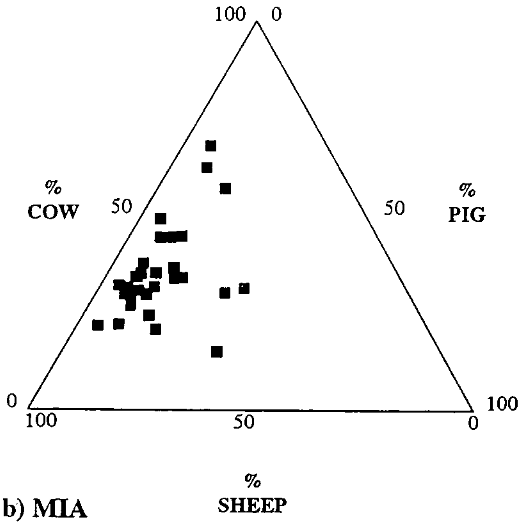
Despite a certain degree of overlap, there does appear to be a relationship between sample date and species proportions within the Wessex group. The samples show a progressive increase in



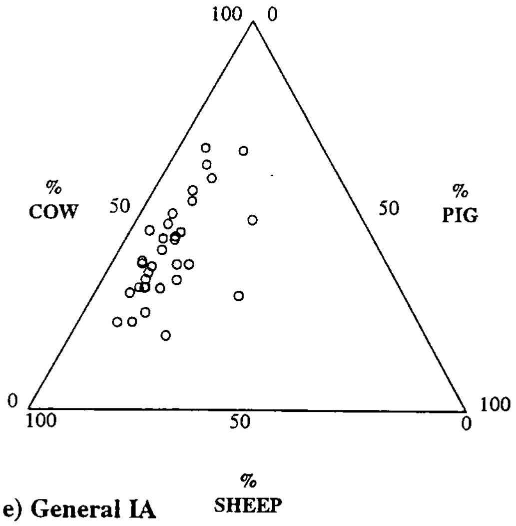
a) EIA



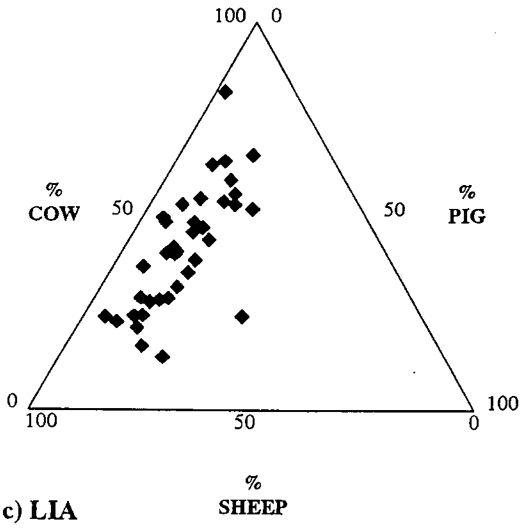
d) LIA-ERB



b) MIA

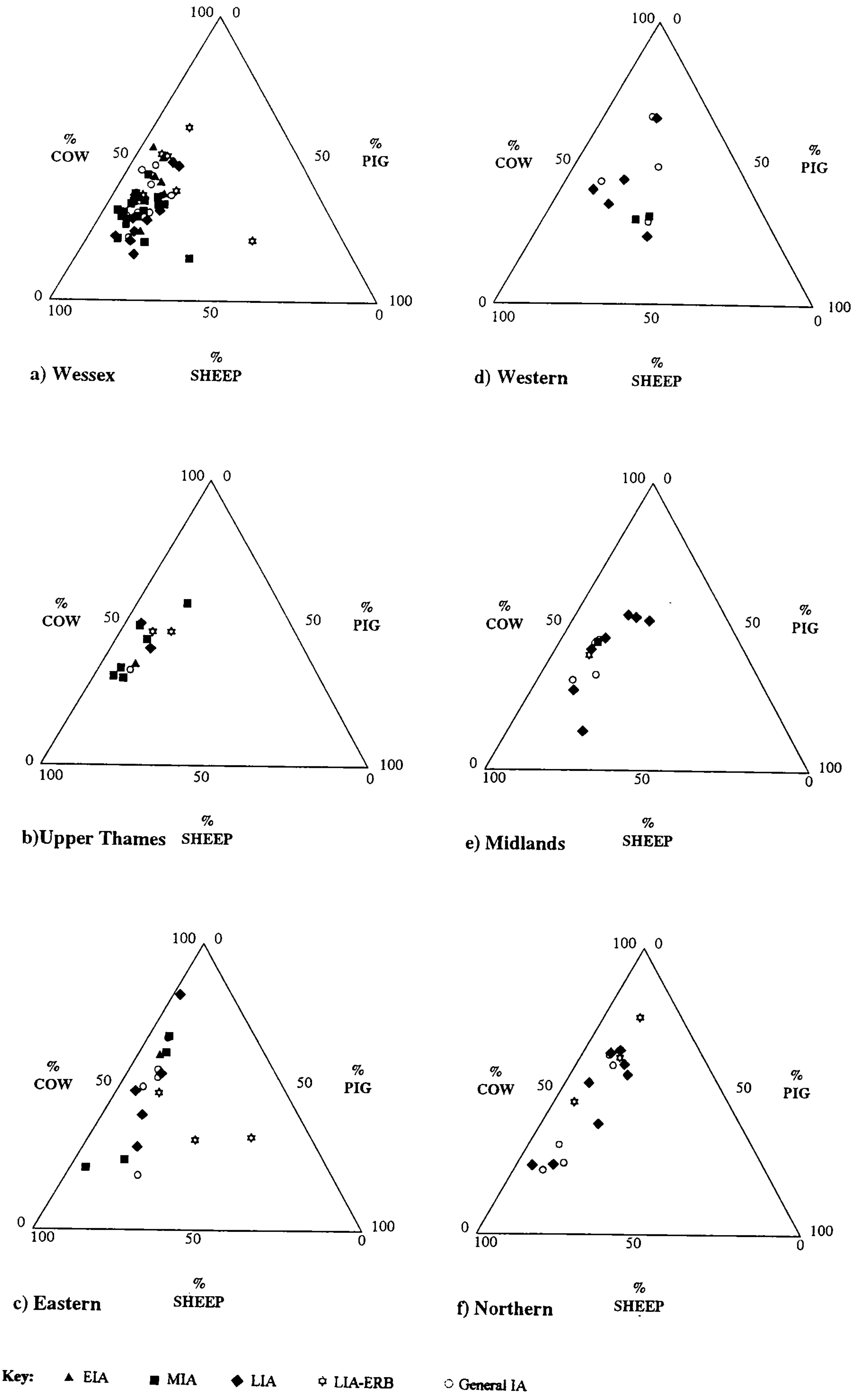


e) General IA



c) LIA

Figure 26: Percentage of Cow, Sheep and Pig NISP in Iron Age faunal samples of different dates.


a) Wessex

b)Upper Thames

c) Eastern

d) Western

e) Midlands

f) Northern

Figure 27: Percentage of Cow, Sheep and Pig NISP in Iron Age faunal samples of different dates in separate regional groups.

the percentage of sheep from the Early Iron Age, where percentages of cattle and sheep are roughly equal, through to the Late Iron Age, where samples have the highest percentages of sheep. This trend does not continue into the Late Iron Age/Early Romano-British period, in fact the LIA-ERB samples exhibit percentages of cow similar to, or higher than, those seen in the EIA samples. The outlier with the highest percentage of pig in this region is also a LIA-ERB sample.

This increase in the percentages of sheep through to the LIA may be indicative of intensification of farming and the move to more specialised economic strategies. In the Wessex samples this could be interpreted as the result of specialisation in sheep products, perhaps for trade, such as wool, or the development of an animal economy suited to more intensive arable production requiring sheep for stubble clearance and manure to increase soil fertility and productivity. Cattle are also suited to intensive arable production as they can provide both manure and traction. The difference in species proportions between the LIA and LIA-ERB samples suggests a radical change in the local animal husbandry strategy in the later period, perhaps as a result of increasing Roman influence. The LIA-ERB samples are certainly more in keeping with the higher percentages of cow and pig seen in Romano-British faunal assemblages (fig. 18) than are the earlier Iron Age samples. These explanations for the observed changes in species proportions are only tentative; however it can be concluded that there is a strong relationship between the date and species proportions of samples throughout the Iron Age in Wessex.

Upper Thames Valley and surrounds (fig. 28b)

Most of the samples from this region date to the Middle Iron Age. It is therefore difficult to examine the regional group for chronological variations in species proportions, as in the absence of samples from different periods it is impossible to tell whether similarities in species proportions are the result of similarities in date or not. It is possibly significant that the two LIA-ERB samples are at the upper end of the range for percentage of cow, in keeping with the trend seen among the Wessex samples. The observed chronological variation in species proportion in this region may be explained by a change in husbandry strategy in the Late Iron Age, perhaps the result of romanisation, or the effects of other cultural influences. However, the differences in species proportions are so slight that it must be concluded that the Upper Thames Valley samples show no evidence of a relationship between date and species proportions.

The similarities of species proportions within the Middle Iron Age samples does not immediately support Lambrick's (1992) study of farming on the Upper Thames gravels, where he argues that Middle Iron Age intensification of farming practices occurred involving the development of specialised pastoral farming, and resulting in intra-regional variation in husbandry strategies. Before Lambrick's model can be dismissed it must be pointed out that the Upper Thames Valley dataset used in this study is quite small and therefore may not be large enough to illustrate intra-regional variation. A number of faunal samples have been excluded from this study due to their small size, one of these being the site of Farmoor, Oxfordshire, which it has been previously argued illustrates a specialised pastoral farming strategy (Lambrick and Robinson 1979). It must also be remembered that different specialised farming strategies need not differ substantially in the proportions of species, but may rather differ in the particular methods of management and exploitation of the different species. Although this study can provide no definite evidence to support Lambrick's theory of intra-regional variation in species proportions within the Middle Iron Age, neither does it refute the possibility. Similarly there is no definite evidence to suggest a relationship between date and species proportions in samples from this region, but neither is there sufficient evidence to reject the possibility of such a relationship.

Eastern England and East Anglia (fig. 28c)

Within the main group of Eastern samples there is no clear reflection of the Wessex trend; there are samples with higher percentages of cow in the Middle Iron Age and higher percentages of sheep in the Late Iron Age, but there are also samples of MIA and LIA date that exhibit the reverse trend. The two outliers in this region have been categorised LIA-ERB and exhibit high percentages of pig which could be related to their date should high incidence of pig be interpreted as a Roman trait. Even if the high percentage of pig is not taken as evidence of "romanisation" the difference in species proportions exhibited by the two LIA-ERB samples may still be indicative of a significant change in animal husbandry strategy away from those practised in earlier periods in this region.

Western England and Wales (fig. 28d)

All the samples of known date come from the Middle or Late Iron Age in this region, and there is no intra-regional grouping according to date. In the absence of any EIA or LIA-ERB samples it is impossible to fully analyse the effects of date on species proportions. However, it is interesting that there are high percentages of pig among the samples even though none are of LIA-ERB date, as this shows that there are explanations other than those involving Roman influence that may account for high incidence of pig in faunal samples.

Midlands (fig. 28e)

The Midlands samples exhibit a wide range of species proportions but there is no evidence to suggest a relationship between date and species proportions. The small cluster of three LIA samples with the highest percentages of cattle all come from the same site so cannot be taken as an intra-regional grouping. The tight central cluster of samples represents a variety of different categories, implying that their similar species proportions cannot be explained as a chronological relationship.

Northern England and Southern Scotland (fig. 28f)

There is a broad scatter of both species proportions and dates among the Northern samples. There are no discernible trends to indicate a relationship between husbandry strategy and date in the faunal samples from this region.

There is by no means a Britain-wide relationship between date and species proportions in the Iron Age faunal samples, but within certain regions there are discernible date-related trends. The presence of LIA-ERB outliers in several regions is suggestive of radical changes in patterns of local husbandry at that time. Within the Wessex dataset there are observable intra-regional groupings that suggest chronological trends in animal husbandry regimes. The samples from the Wessex region illustrate the phenomena of increasing importance of sheep throughout the Iron Age, and changes in animal husbandry strategy coinciding with increasing Roman influences in the region

Conclusions

It has been demonstrated that an analysis of species proportions can provide useful information concerning inter- and intra-regional trends in animal husbandry strategy. This study has highlighted the presence of a number of distinct regional groups within the Iron Age faunal dataset, and has gone some way to explaining these groupings by examining the relationship between species proportions and a number of different site characteristics.

The most definite intra-regional trends are observed among the samples from Wessex; there are apparent relationships between species proportions and both site type and date. These, and other factors, are likely to be inter-related making it difficult to establish the main influence on husbandry strategy. For example, it is difficult to establish whether date or site type is the main factor influencing the MIA and Banjo groupings seen in the Wessex samples as Banjos are Middle Iron Age phenomena, so in this instance site type and date are inter-linked. This is likely to be the case with other site types and date categories throughout the British Iron Age, such as the LIA-ERB major settlement complex samples from Eastern England.

In all probability, the clearest trends are visible among the Wessex samples because this is the largest regional dataset. Given the small number of samples from many regions it is unlikely that, once subdivided into the various different categories, there would be sufficient samples in any category to constitute a definite regional group. This problem of small sample size, coupled with the diverse range of species proportions seen within many regional groups, make it unlikely that any but the largest regional datasets with the narrowest range of species proportions (i.e. Wessex) are likely to exhibit any reliable intra-regional groupings.

This method of analysis was never intended to provide explanations of the species proportions observed in each individual faunal sample, nor should it be. Rather this type of study was intended to compare multiple faunal samples in order to highlight the presence of inter- and intra-regional trends in species proportions, and to attempt to relate these trends to characteristics of archaeological sites (underlying geology, height OD, site type, and date). This study has succeeded in establishing the presence of inter- and intra-regional groups among British Iron Age faunal samples, relating these groups to specific characteristics, and explaining the implications for Iron Age animal husbandry strategies.

Chapter 7

Ageing Of Iron Age Domesticates

The majority of archaeological faunal reports make some attempt to consider the age of animals represented in the assemblage. There are a variety of possible methods of ageing faunal remains; this study will concentrate on ageing techniques based on the eruption and wear of the mandibular cheek teeth. The main purpose of determining the age at death of animals is to examine the age structure of the archaeological populations of different species; these mortality profiles may provide some indication of the husbandry strategies used in the management of the living population. This chapter will discuss the uses of ageing faunal remains and the main methods of dental ageing used in Iron Age studies. The advantages and limitations of different ageing methods for comparative analyses of faunal assemblages, in particular those of Grant (1975) and Payne (1973), will also be considered.

Uses of age data

It is widely accepted that certain husbandry regimes can generate specific and recognisable mortality profiles, usually characterised by the incidence of culling at particular ages; thus analyses of ages at death can identify particular husbandry strategies in the archaeological record (Payne 1973). This is a useful technique but it is limited; economic strategies of herd management that are highly specialised, for example for meat, milk or wool production, may be recognisable by their distinct mortality profile, but mixed economies that utilise a variety of potential animal products are much harder to recognise, having no such distinct patterns of mortality. A mortality profile lacking the key signatures of a specialised husbandry strategy may be taken as representing a mixed economy; however on its own the mortality profile can provide little information concerning the relative importance of the different primary and secondary animal products exploited within a mixed strategy.

Mortality profiles of the age at death of different populations provide a means by which differences in husbandry strategy can be recognised between different faunal assemblages. A comparison of mortality profiles from different assemblages can show differences in husbandry strategy within the broad label of "mixed economy". The relative differences in mortality between different assemblages may be interpreted as differences in economic strategies, and the nature of those differences indicative of the importance of different animal products. There is little overt evidence of highly specialised animal economies from Iron Age Britain, either because mixed animal husbandry was the most prevalent economic strategy or because the areas where specialised regimes were practised are the same areas where there is a dearth of archaeological faunal material. Thus the use of mortality profiles is of particular relevance to the Iron Age where the best way to define the nature of the mixed economic strategy of single assemblages is in relation to those of other site assemblages.

Methods of Ageing

Silver (1969) put forward a number of criteria by which the age of common domesticates could be determined from their skeletal remains. The most commonly used methods of age determination of skeletal remains involve study of the state of epiphyseal fusion of the post-cranial skeleton, and the developmental and degenerative state of the dentition. Epiphyseal fusion ageing is of limited use as it can only provide age estimates for sub-adults; once all the bones have fused (for example in a cow this will have occurred by about 4 years) no further age estimation can be made from the state of fusion even though the individual may live for many years longer. Another problem with this ageing method particularly relevant to archaeologists is that juvenile bones do not preserve as well as adult fused bones. The use of epiphyseal fusion data may thus result in consistent underestimation of the proportions of juveniles in a population. This in turn renders the resulting mortality profile unreliable.

Ageing data provided by the mandibular dentition is of more use than fusion data as it is less susceptible to the problems discussed above. Teeth and mandibles tend to display greater survivability than most post-cranial elements, and are therefore less affected by preservation bias, although infant mandibles are still more fragile than those of adults. The state of eruption of deciduous and then permanent teeth allows ageing of sub-adults in a similar way to the state of epiphyseal fusion. However, the subsequent degeneration of the adult dentition allows ageing of adults by examination of the extent of tooth wear.

Dental eruption can provide a reliable indication of the state of physiological maturity of an individual, although problems can arise when attempts are made to relate this to an absolute chronological age. A number of Iron Age faunal studies (e.g. Buckland-Wright's 1987 analysis of faunal remains from Poundbury) use absolute ages of tooth eruption derived from 19th century data by Silver (1969) to age specimens. However, Payne (1984) suggests that Silver's 19th century ages for cattle are inaccurate and that modern 20th century eruption timetables are more applicable to archaeological populations. Similarly for sheep, study of the Harlow Temple assemblage (Legge & Dorrington 1985) indicates that Iron Age dental eruption is more analogous to Silver's modern figures than the 19th century data, as the seasonal kill pattern of the Harlow Temple sheep only becomes apparent when using modern eruption times.

The same is true for pig; modern and ancient wild boar share the same eruption times as modern domestic pigs (Peter Rowley-Conwy pers. comm.). Consequently many other Iron Age faunal studies use Silver's modern eruption data to age specimens.

The use of different frameworks of chronological ageing are a barrier to reliable comparative studies of mortality profiles, as by assigning different chronological ages to the same physiological stage mortality profiles of very similar populations could appear very different. Similar problems of obtaining realistic absolute ages are also seen in methods that age teeth by the degree of wear. The age at which a tooth comes into wear is dependant upon the age at which that tooth erupts, and the chronological ages assigned to particular wear stages are just as variable as those given for particular eruption sequences. It is not just the appropriateness of Silver's 19th century chronological ages that is questionable; it is difficult to argue conclusively that any of the modern chronological frameworks, such as Payne's (1973) ages of dental eruption and wear based on modern populations of Turkish goats, are any more applicable to British Iron Age populations. Although it would appear that the use of modern dental data to age prehistoric populations is appropriate given that dental eruption and wear in the feral Soay sheep from St Kilda (thought to be the closest living analogy to primitive prehistoric breeds) is more in keeping with Payne's figures for Turkish goats, and Silver's figures for modern improved breeds than with the unimproved 19th century data (Clutton-Brock et al 1990).

To some degree the chronological framework used in an individual tooth wear study is unimportant, as it is the relative age of individuals and the proportions of each age group present that is of most significance when examining a mortality profile. However, as mentioned above, the use of different chronological frameworks is a barrier to reliable inter-site comparisons of mortality profiles. Ideally the use of a single methodology would enable reliable comparison of mortality profiles as all samples would be subject to the same physiological definitions of tooth wear with fixed chronological ages. Unfortunately in practice Iron Age faunal studies exhibit several different methodologies of ageing from dental wear, the two most common being those developed by Grant and Payne. A way around this incompatibility of different chronological ageing techniques would be to convert tooth wear data produced by one method into a format compatible with another, by ignoring absolute ages completely and relying on comparisons of relative physiological ages.

Two methods of ageing from dental wear: the advantages and limitations for comparative study of Iron Age faunal material.

Before attempting to develop a method of generating comparable results from different methods of ageing using tooth wear it is important to assess the advantages and limitations of the different approaches prevalent in the Iron Age faunal literature. The two main methods of ageing by dental wear will be compared with regards to their suitability for reliable and informative comparative studies of species mortality in Iron Age faunal assemblages.

With regards to comparing *published* Iron Age assemblages Grant's method has the advantage over Payne's because it is the most commonly used method. Therefore much of the data from different assemblages is already in a similar format which aids comparison. Out of 38 Iron Age site reports which provided systematic quantitative tooth wear data for sheep, 53% used Grant's method while only 32% used Payne's. In addition to its more frequent use, Grant's method is applicable to sheep, cattle and pigs, allowing comparison of mortality profiles between species as well as between different assemblages of the same species. Payne's method is for use only with sheep/goat mandibles. However Halstead (1985) has adapted Payne's method for use with cattle, and it is equally feasible to adapt a similar method for pig, as can be seen with other broadly similar methods used on Iron Age assemblages (e.g. Harcourt 1979, Maltby 1995a). Both the main approaches have advantages suited to comparative Iron Age studies.

The two different methods of ageing from tooth wear discussed here are described in detail in Payne's 1973 paper and Grant's 1975 report respectively. Both authors identify recognisable *tooth wear stages* for each of the mandibular molars and the permanent and deciduous fourth premolars, and use combinations of the different tooth wear stages seen in an individual to define its *mandible wear stage.* Hamilton (1982) provides a brief discussion of the many different advantages and limitations of both methods. The techniques differ in a variety of ways such as how the tooth wear stages are defined; Grant's method being more subjective while Payne's relies on more objective descriptions. Most important to this study however are the differences in how the tooth wear data is expressed.

Payne groups the mandibles according to their state of wear into broad bands which each represent a chronologically defined age group. Grant also groups mandibles according to their wear but in much smaller bands each of which represent a particular mandible wear stage that is defined by a number. This number relates to its age relative to other wear stages but not to absolute age. The different stages of all mandibles in a population are expressed by Grant in the form of a frequency diagram showing the numbers of jaws representing each mandible wear stage (fig. 29a). Payne expresses wear data in the form of a mortality curve by calculating the percentage of the population still alive at the end of each successive age stage (fig. 29b).

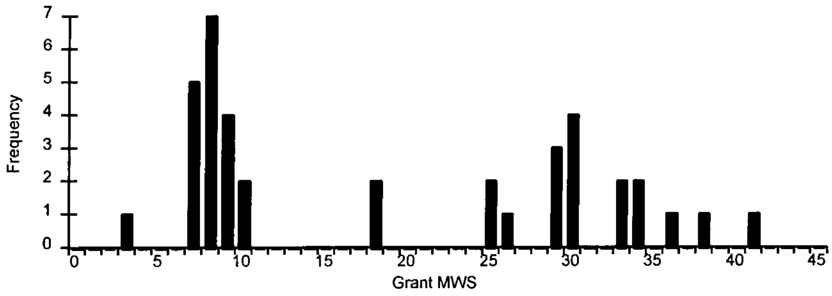
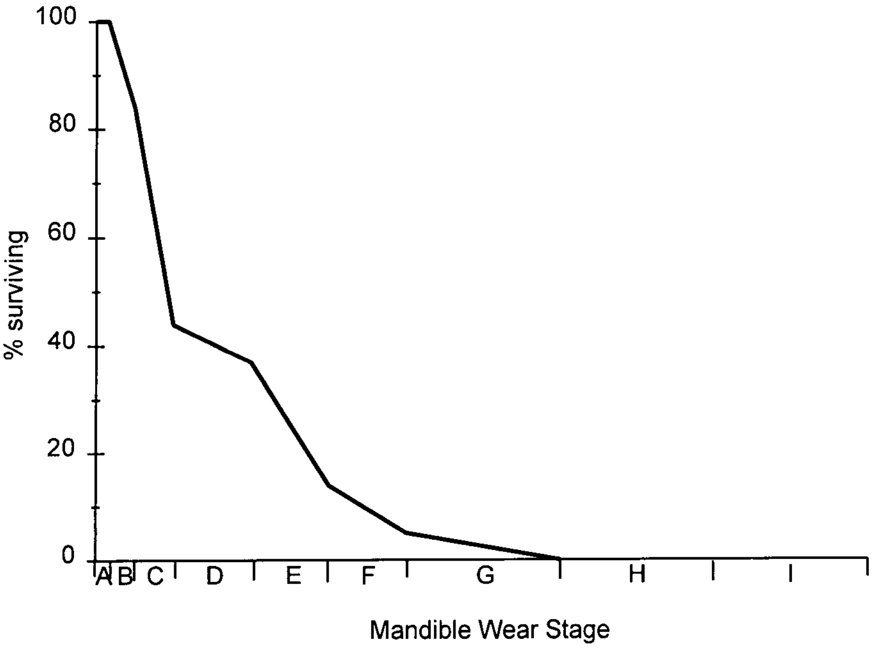


Figure 29: a) Grant Method: Frequency diagram showing number of jaws at each mandible wear stage in an Iron Age sheep population from Mingies Ditch, n=38. (after Wilson 1993).



b) Payne Method: Mortality curve showing the percentage of animals surviving at the end of each stage, based on the mandibles of an Iron Age sheep population from Mingies ditch, n=38.

The format of a mortality curve means that Payne's results allow fairly easy recognition of herd age structure and kill-off patterns, as well as direct comparison of different mortality curves on the same axes. Grant's method allows recognition of similar, or dissimilar, population structures but without the convenience of plotting several datasets on the same graph. Also, because Grant's method does not have a built in indication of absolute age, or at least the relative duration of different wear stages, it is harder to determine what the observed population structures equate to in terms of the classic meat, milk, or wool economies (fig. 30) characterised by Payne (1973).

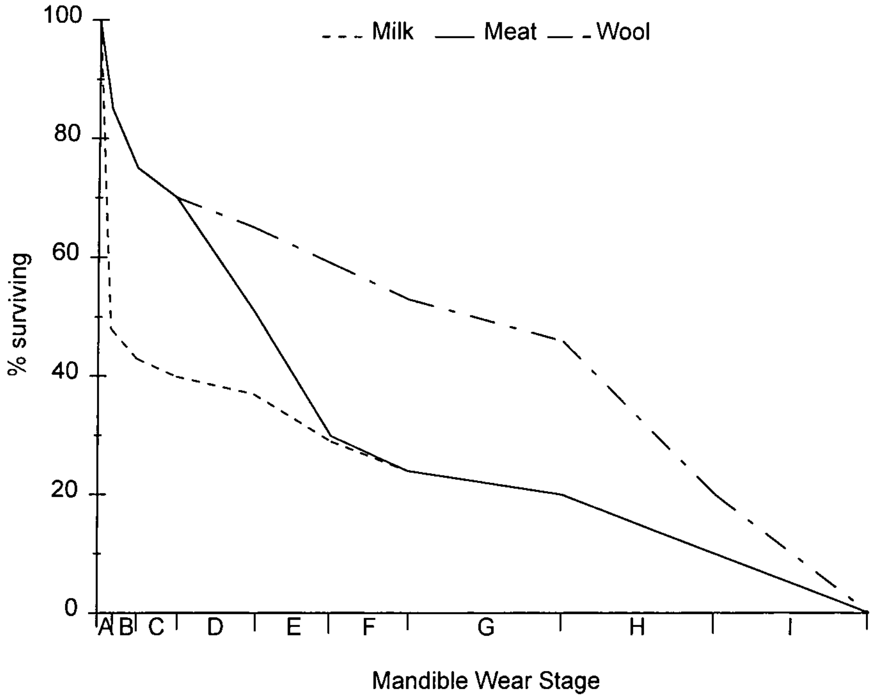


Figure 30: Model mortality profiles of sheep/goat for specialised production of milk, meat or wool (after Payne 1973).

The lack of a system of absolute ageing of wear stages in Grant's method means that all stages are given equal weight even though some stages may last significantly longer than others. Problems of interpretation may arise when there is a peak in a particular mandible wear stage; more animals appear to die in some wear stages but this may be a result of the duration of the wear stage rather than an increased death rate (Hamilton 1982). By putting less emphasis on particular wear stages and more on broader age bands, Payne's method serves to iron out the small fluctuations that can be highlighted by Grant's method and instead concentrates on the larger patterns that are important when comparing different populations and when recognising different husbandry regimes.

By using broader groupings encompassing the equivalent of several of Grant's mandible wear stages, Payne's method makes it possible to achieve meaningful results from a smaller sample size than is useful for Grant's. However while Grant's analysis does not lend itself to the generation of meaningful mortality profiles from small samples, it is easier to spot possible similarities between very small assemblages when looking at Grant frequency diagrams than when looking at mortality curves. The use of absolute ages in Payne's technique can be viewed both negatively and positively. The absolute ages assigned to each wear stage may not be applicable to all archaeological samples (Moran & O'Connor 1994) and thus give inaccurate age estimations; however, even if the absolute chronological ages are not totally accurate they still provide a framework of relative physiological ageing, and an indication of the duration of different wear stages.

Both Grant's method and Payne's provide a good indication of the relative ages of animals from archaeological contexts. However, while both techniques can be used to recognise populations of similar age structure, with Grant's method it proves harder to compare assemblages and interpret differences in mortality profiles. Payne's use of broad age ranges and mortality curves to express the data proves most useful when comparing the age structure of different populations, or when attempting to recognise particular husbandry regimes. As mentioned previously, much of the published age data for faunal remains (specifically for the British Iron Age) is however in the form of Grant's mandible wear stages. There is therefore a need for a means of translating Grant's wear stage data into the format used by Payne without having to expend time and energy re-analysing the jaws using Payne's method from the start. Such a method would enable direct comparison of the faunal assemblages and husbandry regimes from different published sites.

Chapter 8

Method For Converting The Results Of Different Analyses Of Mandibular Tooth Wear Into A Similar Format.

The majority of published bone reports that age individuals by dental development and wear employ either Grant (1975) or Payne's (1973) methods. A minority of assemblages have however been aged using various authors own methods. All these methods are, like Payne's, based on the principle of defining a physiological age (i.e. a state of tooth eruption/wear) and assigning an absolute chronological age to it. Any method using this principle is reasonably easy to adapt to Payne's scheme for sheep/goat, or similar schemes for cow and pig, by taking the given physiological wear descriptions, equating them to Payne's defined wear stages and reassigning the mandibles accordingly. Clearly defined tooth eruption and wear stages used in any method may be matched quite easily with Payne's physiological stages (defined in terms of tooth eruption and wear). The supposed chronological age assigned to each wear stage is usually best ignored when converting mandible ages from one method to another as it is quite common for different absolute ages to be assigned to the same physiological stage.

Grant's method is less straight forward to convert to a Payne style format as the physiological stages used are less broad and have no clear written description that can be easily equated to Payne's stages. Given that most of the Iron Age faunal assemblages studied use either Grant's or Payne's method to age mandibles it is important that the results of these analyses be converted to a similar format in order to enable a comparative study of mortality. In this chapter (see also Hambleton forthcoming) a method is described whereby Grant's mandible wear stages for sheep/goat, cattle, and pig are grouped into the broader physiological age ranges developed by Payne for sheep/goat (Payne 1973) and similar ranges developed by Halstead for cattle (Halstead 1985) and for pig.

Aim

The aim of this study is to define Payne and Halstead's age ranges A - I in terms of Grant's numerical mandible wear stages, thus allowing the results of a Grant analysis of tooth wear to be presented in a Payne style mortality curve format.

Method

The first stage is to define Grant's tooth wear stages a - p in the same way that Payne defines his tooth wear stages. This is done by drawing dentine diagrams similar to Payne's for each of

Table 2: Sheep Tooth Wear Stages

Payne Age Stage	**Suggested Age**	**Payne Definition**	**Grant Definition**
A	0-2 mth	m3/p4 unworn	m3/p4 ≤a
B	2-6 mth	m3/p4 in wear, M1 unworn	m3/p4 ≥b, M1 ≤a
C	6-12 mth	M1 in wear, M2 unworn	M1 ≥b, M2 ≤a
D	1-2 yrs	M2 in wear, M3 unworn	M2 ≥b, M3 ≤a
E	2-3 yrs	M3 in wear, post cusp unworn	M3 b - d
F	3-4 yrs	M3 post cusp in wear, M3 pre ◫–	M3 e - f
G	4-6 yrs	M3 ◫–, M2 ◫	M3 = g, M2 = g
H	6-8 yrs	M3 ◫–, M2 post ◫	M3 = g, M2 ≥h
I	8-10 yrs	M3 post◫–	M3 ≥h

Table 3: Cattle Tooth Wear Stages

Halstead Age Stage	**Suggested Age**	**Halstead Definition**	**Grant Definition**
A	0-1 mth	m3/p4 unworn	m3/p4 ≤a
B	1-8 mth	m3/p4 in wear, M1 unworn	m3/p4 ≥b, M1 ≤a
C	8-18 mth	M1 in wear, M2 unworn	M1 ≥b, M2 ≤a
D	18-30 mth	M2 in wear, M3 unworn	M2 ≥b, M3 ≤a
E	30-36 mth	M3 in wear, post cusp unworn	M3 b - d
F	young adult	M3 post cusp in wear, M3 < g	M3 e - f
G	adult	M3 = g	M3 = g
H	old adult	M3 = h or j	M3 h - j
I	senile	M3 = k or above	M3 ≥k

Table 4: Pig Tooth Wear Stages

Age Stage	**Suggested Age**	**Author's Definition**	**Grant Definition**
A	0-2 mth	m3/p4 unworn	m3/p4 ≤a
B	2-7 mth	m3/p4 in wear, M1 unworn	m3/p4 ≥b, M1 ≤a
C	7-14 mth	M1 in wear, M2 unworn	M1 ≥b, M2 ≤a
D	14-21 mth	M2 in wear, M3 unworn	M2 ≥b, M3 ≤a
E	21-27 mth	M3 in wear, post cusp unworn	M3 b - d
F	27-36 mth	M3 post cusp in wear, M3 < g	M3 e - f
G	adult	M3 = g	M3 = g
H	old adult	M3 = h or j	M3 h - j
I	senile	M3 = k or above	M3 ≥k

the stages a - p drawn by Grant. Once the equivalent tooth wear stages had been established it was possible to define Payne's mandible wear stages (A - I) using Grant's tooth wear stages in the same way that A - I are defined using Payne tooth wear stages. The mandible wear stages A - I for sheep/goat, cattle and pig are listed below (Tables 2, 3 and 4) together with their definitions in terms of both Payne and Grant tooth wear stages. In this paper the absolute ages used for stages A-I are those defined by Payne (1973) for sheep/goat, Halstead's (1985) ages derived from Higham (1967) for cattle, and ages based on Higham (1967) and Bull and Payne

(1982) for pig. No absolute ages are indicated on the mortality curves as relative age is considered more important than absolute age for the purposes of this study.

In order to establish which of Grant's mandible wear stages are equivalent to mandible wear stages A - I it was necessary to establish the Payne/Halstead wear stage of mandibles of known Grant mandibular wear stages. Using Grant's study of the Portchester Castle mandibles (Grant 1975) where each mandible is listed and the Grant wear stage (a -p) for each tooth is given it was possible to assign each jaw to one of age stages A - I. The same process was carried out for the collected mandible wear data tabulated in Grant's 1982 paper. Having assigned the mandibles listed in the 1982 paper to stages A-I it was possible to see which of Grant's mandible wear stages fell into the broader Payne/Halstead groups and thus equate groups of Grant mandibular wear stages to each of stages A - I respectively. The age stages A - I for sheep/goat, cattle and pig together with their equivalent Grant mandible wear stages are shown in the results (Tables 5, 6 and 7).

Results

There was some overlap between Grant mandible wear stages and stages A - I. Groups of some jaws all representing one Grant MWS may equate to two adjacent Payne/Halstead wear stages. In these cases the Grant wear stage was taken to be the equivalent of the single A-I stage represented by the majority of jaws in the group. The results of this analysis are shown in Tables 5, 6 and 7. Table 5 shows the Payne sheep/goat mandible wear stages A - I and their equivalent Grant numerical mandibular wear stages, Table 6 shows the same for cattle, and Table 7 for pig. The lack of older jaws in the pig sample prevented clear definition of the later stages G, H and I in terms of Grant mandible wear stages, thus stages G - I have been grouped together in Table 7.

Table 5: Sheep - Payne MWS and equivalent Grant stages.

Payne MWS	Grant MWS
A	1 - 2
B	3 - 7
C	8 - 18
D	19 - 28
E	29 - 33
F	34 - 37
G	38 - 41
H	42 - 44
I	45 +

Table 6: Cattle - Halstead MWS and equivalent Grant stages.

Halstead MWS	**Grant MWS**
A	1 - 3
B	4 - 6
C	7 - 16
D	17 - 30
E	31 - 36
F	37 - 40
G	41 - 43
H	44 - 45
I	46 +

Table 7: Pig - MWS and equivalent Grant stages.

Halstead MWS	**Grant MWS**
A	0 - 1
B	2 - 8
C	9 - 17
D	18 - 32
E	33 - 42
F	43 - 46
G - I	46 +

Testing the method.

It was noted when assigning Payne wear stages to the Portchester castle mandibles listed by Grant (1975) that not all the mandibles had Grant wear stages that were equivalent to the Payne/Halstead stages listed in Tables 5, 6 and 7, due to the previously mentioned problem of some Grant stages overlapping two A - I stages. It was important to establish whether this variation affected the reliability of results produced by translating Grant data to Payne/Halstead wear stages. The method was tested by comparing two mortality curves (fig. 31). One curve was based on A - I stages which were assigned to each jaw on the basis of their individual tooth wear stages using the Grant definitions given in tables 2, 3 and 4. The other mortality curve was generated simply by assigning jaws to stages A - I according to their Grant mandibular wear stage following tables 5, 6 and 7, regardless of what Payne stage the actual tooth wear suggested.

The two curves are remarkably similar which would suggest that the ranges of Grant wear stages shown in Tables 5, 6 and 7 do equate well to their assigned Payne stages. Any overlap of Grant stages from adjacent A - I stages does not significantly affect the reliability of the method.

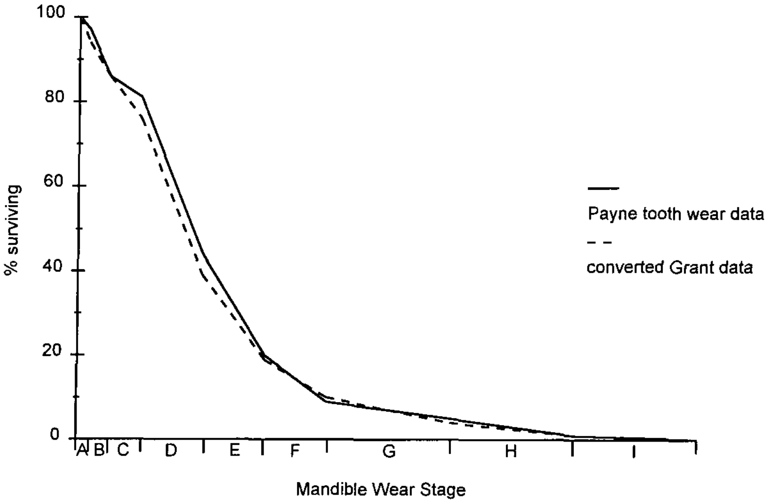
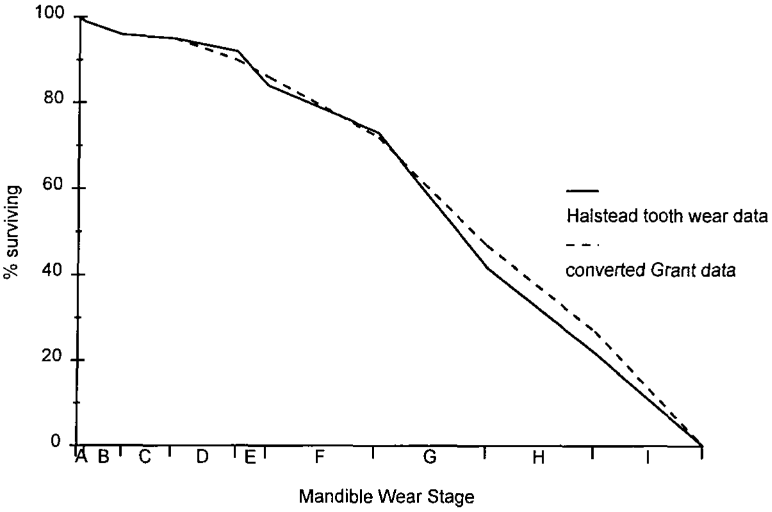
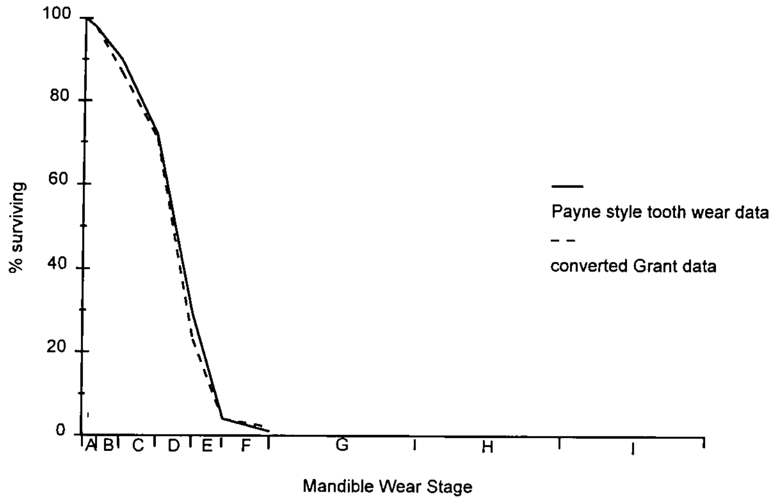


Figure 31: **a)** Mortality Curves for Portchester Castle Sheep Mandibles (n=167) generated by Payne analysis of Grant (1976) wear data, and conversion of Grant data to equivalent Payne stages.



b) Mortality Curves for Portchester Castle Cattle Mandibles (n=120) generated by Halstead analysis of Grant (1976) wear data, and conversion of Grant data to equivalent Halstead stages.



c) Mortality Curves for Portchester Castle Pig Mandibles (n=128) generated by "Payne" style analysis of Grant (1976) wear data, and conversion of Grant data to equivalent A-I wear stages.

Having demonstrated that the ranges of Grant wear stages chosen to represent stages A - I are appropriate and equivalent, it must also be established whether the converted Grant data still provides a reliable representation of the age structure of a population. The sheep/goat mandibles from the Iron Age site at Ashville provide the means to test this as both Grant's and Payne's methods were used to age the jaws (Wilson et al 1978). The mortality curves for the tightly phased and general Iron age mandible data produced using Payne's techniques from Wilson et al (op. cit.) were compared to those curves produced from converting the Grant age data to the Payne format using the method proposed here (fig. 32).

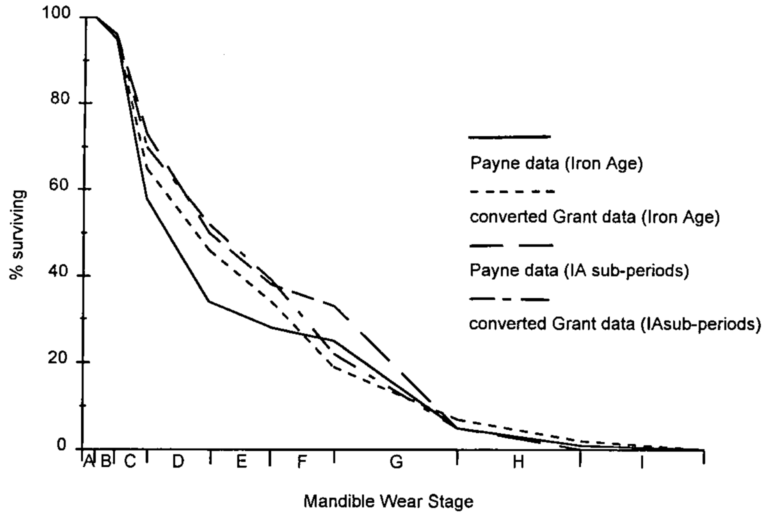


Figure 32: Mortality curves from the Ashville sheep mandibles (Iron Age, n==170, and Iron Age sub-periods, n=77.) generated by Payne analysis and converted Grant data. (from Wilson 1978).

The curves are fairly closely matched suggesting that the Grant to Payne conversion does produce results close to those produced by the original Payne analysis. However the curves especially for the general Iron Age material still differ slightly, thus it would appear that the conversion of Grant data to a Payne format may have a smoothing effect on the mortality profile. This would somewhat reduce the reliability of interpretations concerning kill-off patterns based on converted Grant data, though the difference is small. It is noticeable that there is less of a difference between the two sets of data for the more tightly phased material which might suggest that the differences in mortality profiles are not purely a result of the conversion technique.

The original 1978 Ashville data has been reassessed by Hamilton (1982) and this reassessment has shown that there were some errors made in the original tooth wear analysis. Hamilton's revised analysis shows a significant difference between the results of the original Payne analysis and the revised Payne data so the mortality curves were re-drawn using Hamilton's revised data (fig. 33). The resulting Payne and Grant to Payne conversion curves are a much better fit, suggesting that the previous differences were due to errors in the original Payne analysis rather than in the method used to convert Grant data to a Payne format. Unfortunately while the revised Payne data for the Iron Age sub-periods was published in Hamilton's paper the revised Grant data was not. This means it is not possible to test the sub-period data to discover whether the differences in the mortality curves from the original data were due to the Grant - Payne conversion process or due to errors made in the original tooth wear analysis as appears to be the case with the Iron Age data.

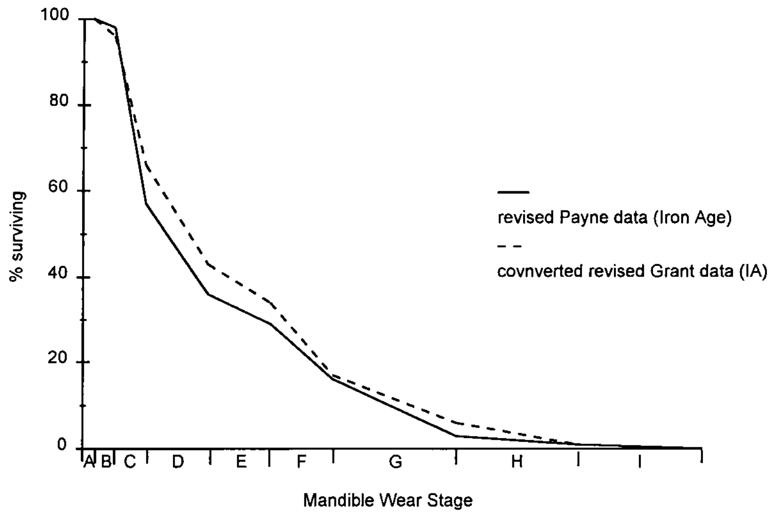


Figure 33: Revised Mortality Curves for Ashville sheep mandibles (Iron Age, n=121) , generated from revised Payne data and conversion of revised Grant data (from Hamilton 1982).

Discussion and conclusion.

The technique of converting Grant tooth wear data into a Payne Mortality curve format developed in this paper appears to produce accurate and viable results. Mortality curves produced using this technique should allow comparisons of animal husbandry regimes between different sites. However while mortality curves produced from Grant data are comparable caution should be exercised when comparing converted Grant data to Payne data as differences in the shape of the curves may be due to differences in the two techniques rather than in the actual mortality profile.

Grant's method of tooth wear analysis does not have the same capacity for including loose deciduous teeth as Payne's method, thus mortality curves produced from Grant data may show less infant death than a Payne curve produced by an analysis of the same assemblage. This potential problem seems small when one examines the Ashville data; the differences in infant mortality seen in the Payne curve and the curve for converted Grant data appear to be minimal. However, there may be a bias against infants in assemblages which are more heavily fragmented.

It has been shown that the results of Grant analysis of mandible wear data in sheep/goat, cattle and pig can be converted to a format equivalent to the results of a Payne tooth wear analysis. Using this conversion technique it is possible to make reliable comparisons of mortality data derived from both Grant and Payne style analyses of tooth wear.

Chapter 9

Mortality Profiles Of Iron Age Domesticates

Having established a method by which the majority of published tooth wear analyses could be presented in a similar format, a comparative study of Iron Age cow, sheep and pig mortality profiles was undertaken. As with the analysis of species proportions, any observable groupings, outliers, or general trends in the mortality profiles of different assemblages were noted for each species. An initial examination was carried out to test whether any of the observed patterns could be explained by the use of different methodologies or the effect of different analysts on the tooth wear data. The mortality profiles were then further tested for relationships with region, geology, topographical location, site type, and date.

Sample size

Of the faunal samples which provided tooth wear data, the number that allowed the construction of usable mortality profiles was 50 for sheep, 37 for cow and 24 for pig. In some instances there may be several different mortality profiles from the same site for a single species; this occurs where the faunal assemblage has been sub-divided into samples from different chronological periods.

The mortality profiles themselves represent a broad range of sample sizes; the number of mandibles used to construct each mortality profile ranges from 7 to 1033 for sheep, 6 to 311 for cow, and 5 to 158 for pig samples. On their own some of these samples would be considered too small to provide a reliable profile of mortality; in individual site faunal analyses groups of mandibles less than 15-20 are usually deemed too small to provide a reliable mortality profile, and samples below 40 (the minimum sample size recommended by Shennan 1988) are treated with caution. The same strategy would ideally be adopted for a comparative study; however since the majority of Iron Age samples, cow, sheep, or pig, are less than 40 mandibles, rejecting smaller samples would substantially reduce the available dataset and by doing so severely limit the scope of this comparative study.

It is apparent from comparing the mortality profiles that, despite the potential for small sample bias, the majority of smaller samples exhibit mortality profiles with the same overall similarities, groupings and patterns as those of the larger samples. Given the apparent similarities between the smaller and larger samples it would seem acceptable to include all but the very smallest samples in this comparative study, providing the small size of many samples is borne in mind, and is still considered as a possible source of bias and as an explanation for unusual mortality profiles.

Comparability of tooth wear data derived from different methods

The majority of assemblages used in this study employ either Grant's (1975) or Payne's (1973) methods of tooth wear analysis. There are also a number of other groupings of mandibular dental development and wear in use; these include those of Ewbank et al (1964), Harcourt (1979), Fifield (1988), and Maltby (1995a), as well as variations of the standard Grant and Payne methodologies. For the purposes of this comparative study tooth wear data from all the aforementioned schemes has been converted into a compatible (Payne style) format. A number of these methods provide only incomplete mortality curves, either because the method used only allows age determination up to a certain age (e.g. Ewbank's (1964) method only defines tooth wear stages up to the age of 3 years, so a mortality profile cannot be drawn beyond that age), or because the originally defined wear stages cannot be exactly equated to the defined stages A-I of Payne used in this study (e.g. In the sample from Owslebury where ranges of Grant MWS's have been used instead of single stages, the % survival in Payne stages A and B, and stages F and G, cannot be separately determined). The resulting mortality curves may still be included in this study as those sections of the curve which are present may still be reliably compared.

It is important to take into account the effects that the use of different methodologies and analysts in the original tooth wear analyses might have on the observed mortality profiles. There may be inherent tendencies to exclude or favour certain age groups which bias the results, causing the variation, patterns and trends observed among the Iron Age mortality profiles. All mortality profiles used in this study are presented in appendix 4, and the analyst and methods of tooth wear ageing used in the published site reports are listed in appendix 1. Some methods are used for only a small number of samples and therefore cannot be expected to exhibit the full range of variation in mortality profiles, particularly when the method in question is only used for one site, as is the case with Harcourt's (1979) ageing of the faunal material from Gussage all Saints. However, the more commonly used tooth wear data formats of Grant and Payne both exhibit the full range of variation in mortality curves observed among the Iron Age assemblages, supporting the conclusion that differences in mortality profiles are not an artefact of methodological differences. Similarly, there is no relationship between analyst and shape of mortality curve. This was true for cow, sheep and pig data, and implies that the use of tooth wear data derived from different methodologies, and by different analysts does not influence the shape of the mortality curve in any way that would reduce the reliability of this comparative study.

Tooth wear data for cow, sheep and pig were collected and converted into a similar format (% surviving at stages A-I defined in previous chapter). For each of the three species mortality curves were plotted. A visual comparison of the data was made; the mortality profiles of different samples were grouped on the same axes according to their region and any trends and patterns were noted, including any similarities to Payne's (1973) model mortality profiles for specialised milk, meat, and wool production. Further grouping of the samples according to their site geology, topographical location, site type, and date was undertaken in order to test for observable relationships between these characteristics and the mortality profiles, and consequently herd management strategy, of Iron Age cow, sheep and pig.

Pig

A comparison of the mortality curves for all the available pig tooth wear data (fig 34) reveals a great deal of similarity throughout the Iron Age dataset. All the samples, including the single sample from the western region where assemblages exhibit a relative abundance of pig, appear to show the bulk of the pig population dying before mandible wear stage F was attained. Two samples, those from Meare East, and Owslebury, exhibit a slightly higher proportion of the population surviving into stage F but the general conclusions concerning husbandry strategy remains the same for all the Iron Age pig samples.

The majority of animals are killed while exhibiting wear stages C, D, and E, roughly equivalent to ½ - 2 ½ years of age. Killing of pigs during the second and third years of life, as is seen in these samples, indicates intense exploitation of the pig population for meat. The strategy indicated by the mortality curves is one whereby animals are killed upon reaching adult, or almost adult size so that the highest weight of meat is yielded without having to expend resources on maintaining the animals at that weight for any length of time. The few older individuals surviving into adulthood (stages G, H, and I) probably represent a small number of individuals kept as breeding stock, or possibly wild boar included in the count of domestic pigs. The absence of these few older individuals in many of the samples may be a result of their small sample size; if only a small number of mandibles are recovered, the odds are that they will represent the most commonly occurring age group. The absence of evidence for older breeding stock in many of the samples need not preclude the existence of a sustainable cull; despite the majority of pigs being killed before the end of their third year, herds would have been sustainable as pigs produce large litters and may start breeding in their first year.

There is some variation to be observed among the pig mortality curves which may be the result of slight differences in herd management. However, given the small sample sizes involved, these mortality profiles are not sufficiently reliable to provide detailed interpretations of husbandry strategy, only the general interpretation of management for meat. The exploitation of pigs for meat is unsurprising given that pigs can provide little in the way of useful secondary products that warrant keeping individuals into late adulthood. Although pigs of any age are of use in arable farming as they can turn and manure soil before planting. What is worth mentioning is the fact that the steep gradient of the mortality curves and the almost complete absence of individuals surviving beyond 4 years indicates the adoption by Iron Age farmers of an extremely efficient herd management strategy.

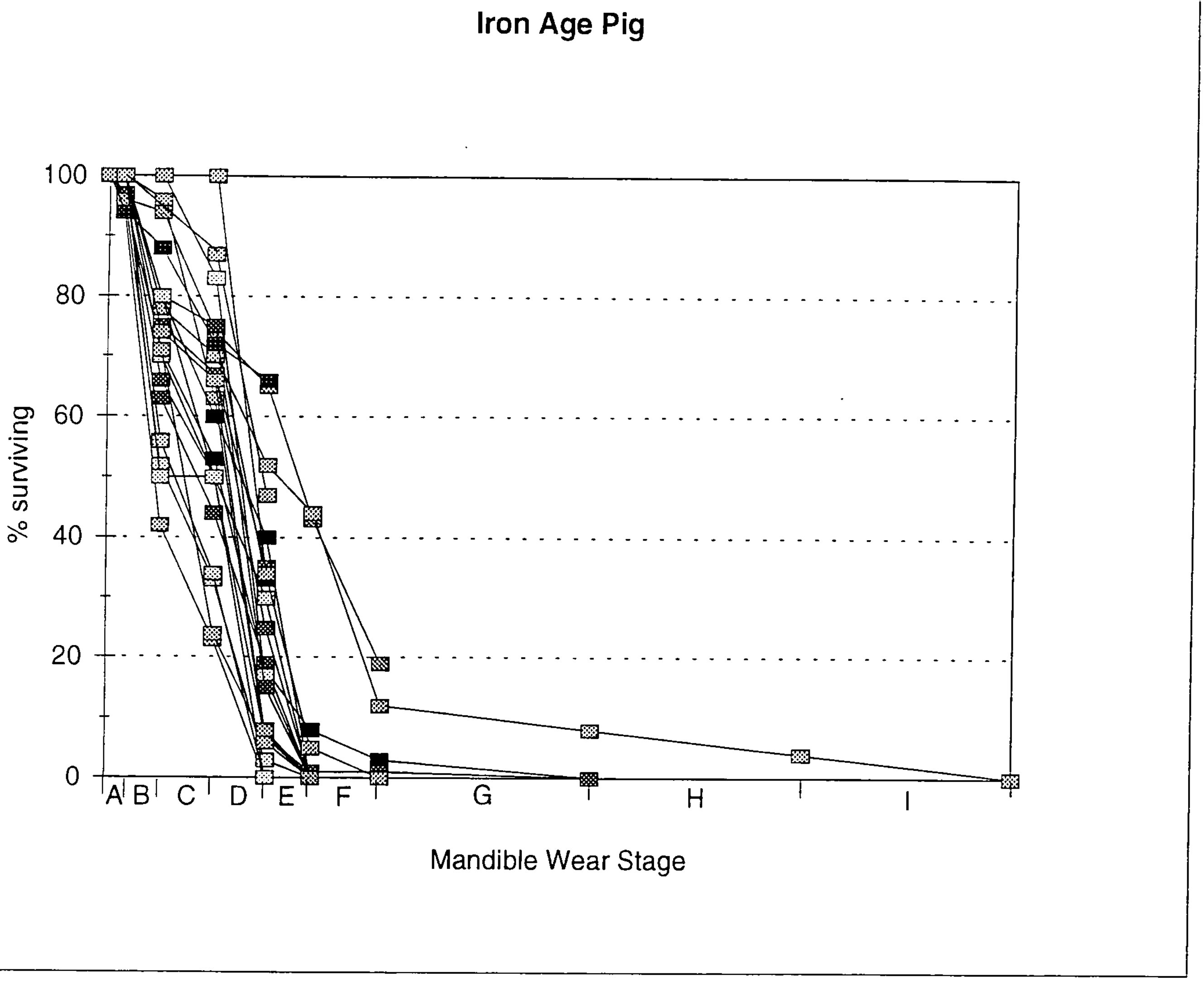


Figure 34: Mortality profiles of Iron Age pig populations from around Britain.

Sheep

Three regions yielded sufficient numbers of samples with tooth wear data to allow inter- and intra-regional comparison of sheep mortality profiles. The mortality curves of Iron Age sheep populations from Wessex and Central Southern England (fig. 35), Upper Thames Valley and surrounds (fig. 36), and Eastern England and East Anglia (fig. 37) were grouped according to region and plotted. Those few mortality curves derived from samples from the "other regions" were also grouped and plotted (fig. 38).

The overall impression of the Iron Age sheep mortality curves is one of similarity, although less uniform than is the case for pigs. Despite variation within the dataset the majority of mortality curves share a number of similar characteristics. In most instances there are very few individuals surviving into later adulthood (stages H and I), and the majority of individuals found on sites die while juveniles or sub-adults (stages C, D, E and F). Many samples exhibit their steepest drop in % surviving during stage C, roughly equivalent to the 6-12 month age group. Also apparent is a remarkably low incidence of neonatal and infant mortality (i.e. there is a marked absence of mandibles at wear stage A).

The low incidence of infant mandibles may be interpreted in a variety of ways. The effects of preservation and retrieval bias on the younger mandibles may account for the low incidence of infant material. Sheep mandibles of the 0-6 month age class have much lower survivability than older mandibles, particularly when exposed to canine attrition (Munson 1991). The poor survivability of young mandibles also increases the chance of a retrieval bias as the young mandibles are more likely to be fragmented and present in the form of individual loose teeth which are small and less likely to be recovered than the intact older mandibles. In addition to this a number of the methods of tooth wear ageing, particularly Grant's, rely on complete mandibles rather than loose teeth and consequently the infant remains are under-represented, even if loose teeth from fragmented jaws are present. It is possible that neonatal and infant mortality is genuinely low, although the complete absence of any deaths during the first 6 months (stages A and B) as indicated by the majority of the sheep mortality profiles is highly unlikely. Bearing in mind that the observed samples were all recovered from settlement sites, it is possible that the lack of infant material simply indicates that lambing did not take place on the sites; infant deaths occurring away from the site would therefore not be represented in the archaeological sample.

Lambing during spring while flocks were out to graze could also account for the absence of infant mandibles on settlement sites, while the deliberate culling of older animals for food or selective purposes would result in the remains of older animals being present at the settlement and thus being represented in the archaeological sample. The high incidence of mortality in the 6-12 month age class (stage C) is not in keeping with killing of prime meat animals (usually between 1½ - 2½ years for sheep); however this pattern may fit a scenario whereby flocks were kept on or close to settlements during the winter months. If this was the case then the stage C mandibles could represent those yearlings that failed to survive their first winter, or possibly even animals culled deliberately in order to maintain the herd at a desired size and taking place before loss of condition over winter. Modern Soay sheep appear morphologically similar to those sheep found in Iron Age faunal assemblages, and studies of modern feral Soay populations on St Kilda (Jewell et al 1974) show a substantial weight loss in yearlings during their first winter, beginning in late autumn (October/November). It is reasonable to assume similar patterns of weight loss in the Iron Age sheep, which would support the notion of a late autumn cull of excess yearlings (contra. Higgs & White 1963), but without more precise ageing of the stage C mandibles early autumn or winter kills within the 6-12 month age group cannot be discounted.

The presence of flocks close to settlements over the winter months would be in keeping with the notion that sheep husbandry in Iron Age Britain was often closely associated with extensive arable husbandry, particularly in central southern England (Cunliffe 1993; Van der Veen 1992); sheep could be grazed in late autumn, after harvest, on the arable land surrounding settlements for direct manuring of the soil, or stalled close to the settlement to allow collection of manure to spread on fields. Having cleared stubble and manured fields during late Autumn, killing excess yearlings before they lost condition over winter would be an efficient means of reducing the herd to a manageable size for winter grazing or fodder feeding before returning the flock to pastures further away from the settlement the following spring.

Continuing the analogy with the St Kilda Soay sheep, keeping the Iron Age flocks close to the settlements over the winter months would prove an advantageous management strategy for more reasons than the manuring of arable land. The breeding season occurs in late autumn, and having the animals close to the settlement at this time would facilitate any attempts by humans to selectively influence breeding. Maintaining flocks near settlements over the winter would not only allow continued manuring, and easy distribution of fodder, it would also allow farmers to keep a close eye on the pregnant ewes thus reducing pre-natal losses.

This model provides a plausible explanation for much of the observed Iron Age evidence, however it is still possible that the mortality profiles of many of the Iron Age sheep samples may be equally well accounted for by alternative models, for example a dietary preference for meat from yearlings. Although the proposed model fits well with the evidence it is only a model and cannot be taken as fact without substantial further research, including examination of tooth wear in the stage C groups for evidence of seasonal cull, and investigation of the reliability of the analogy between Iron Age and Soay sheep. Also, this model is by no means universally applicable to all the observed Iron Age faunal samples; there is sufficient variation among the sheep mortality curves to suggest a number of differences in husbandry strategy.

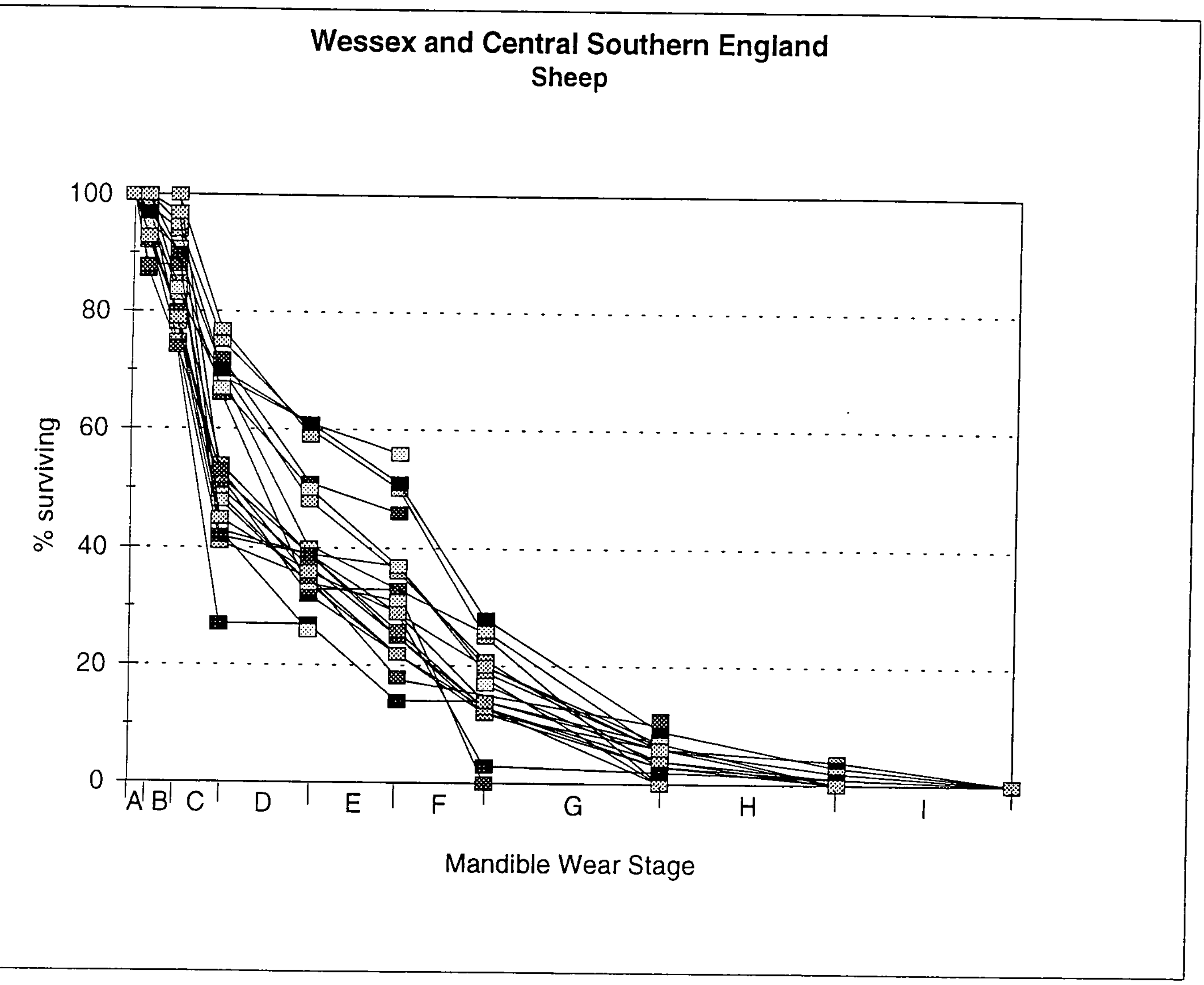


Figure 35: Mortality profiles of Iron Age sheep populations from Wessex and Central Southern England.

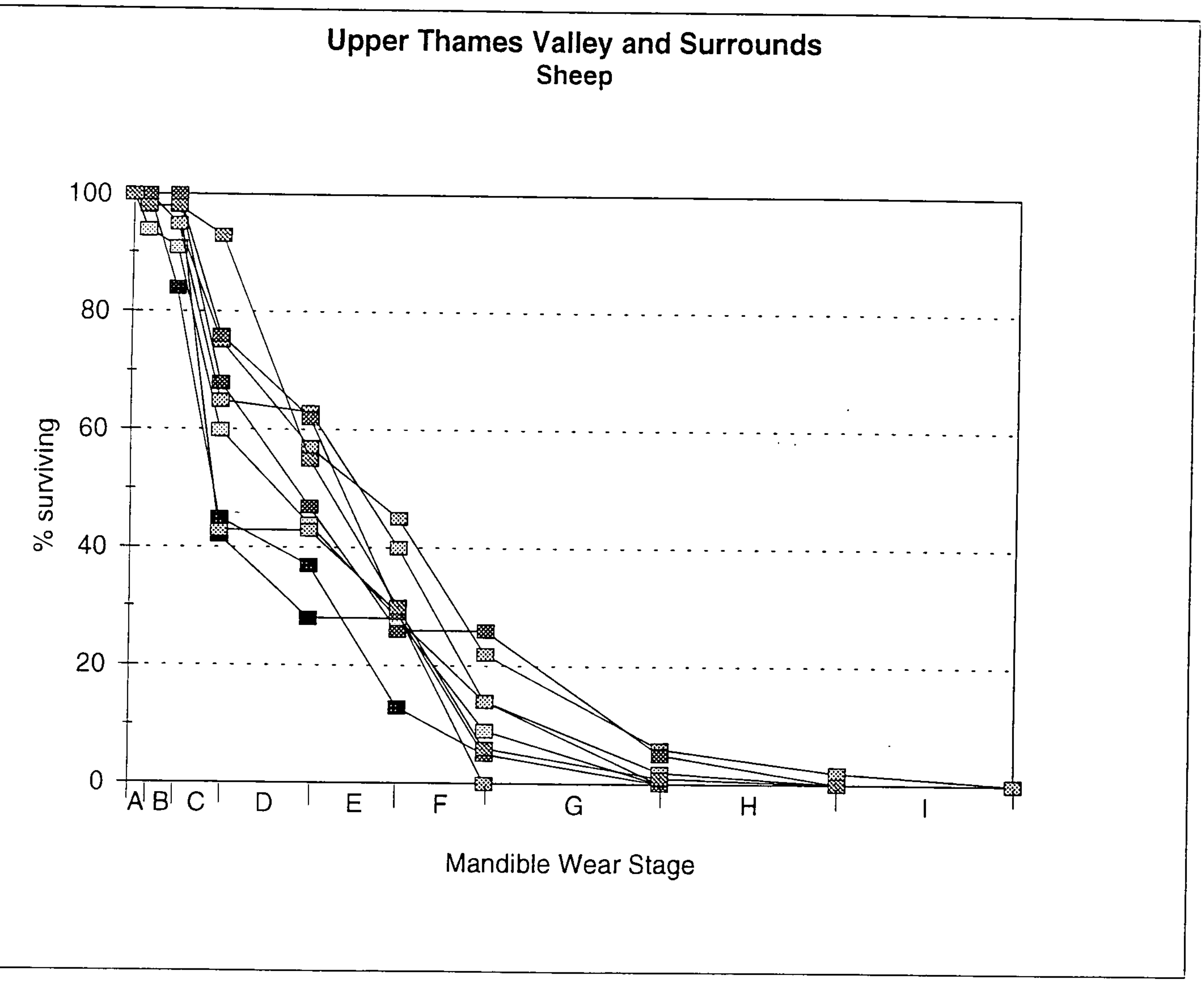


Figure 36: Mortality profiles of Iron Age sheep populations from the Upper Thames Valley and Surrounds.

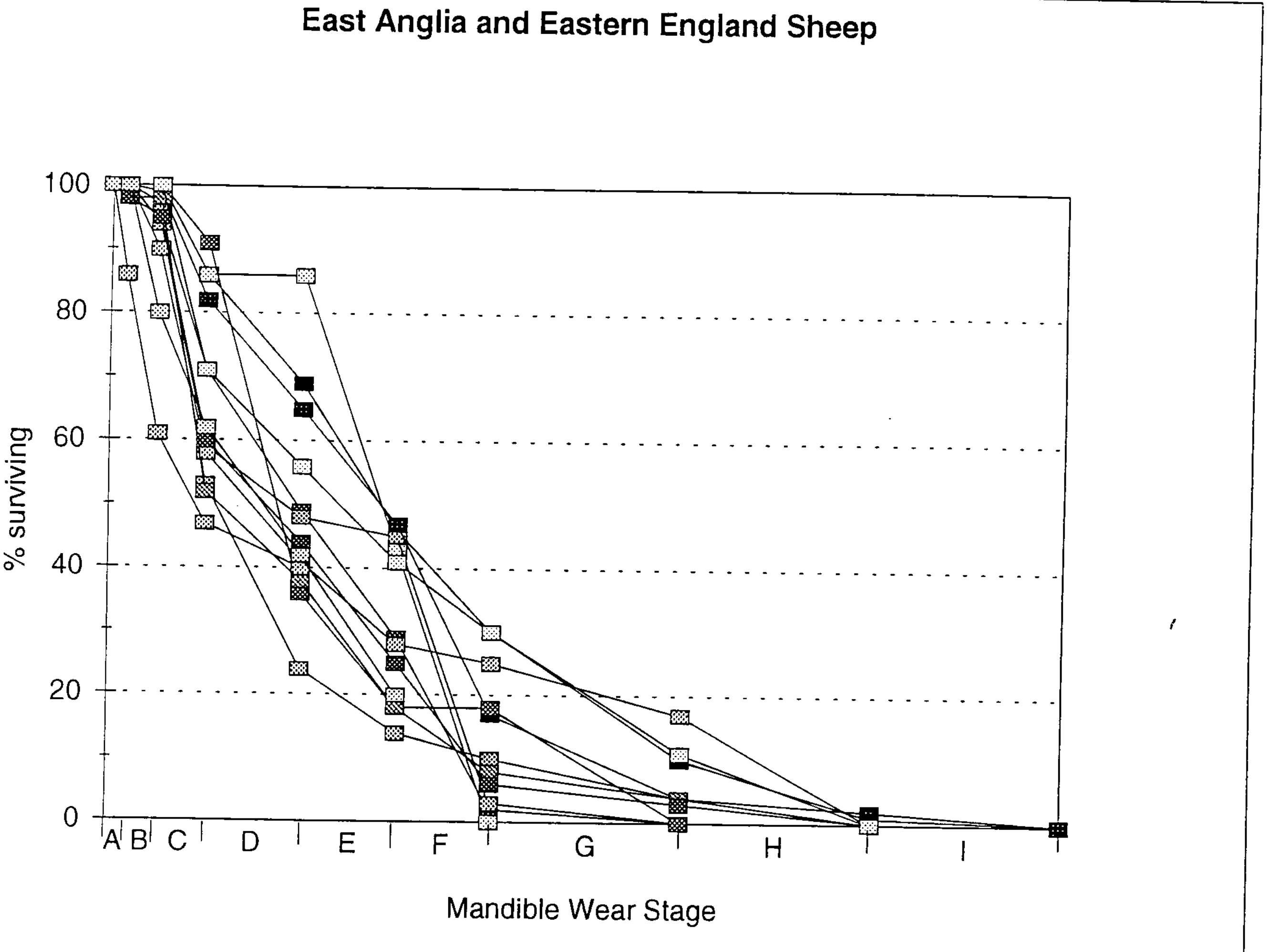


Figure 37: Mortality profiles of Iron Age sheep populations from Eastern England and east Anglia.

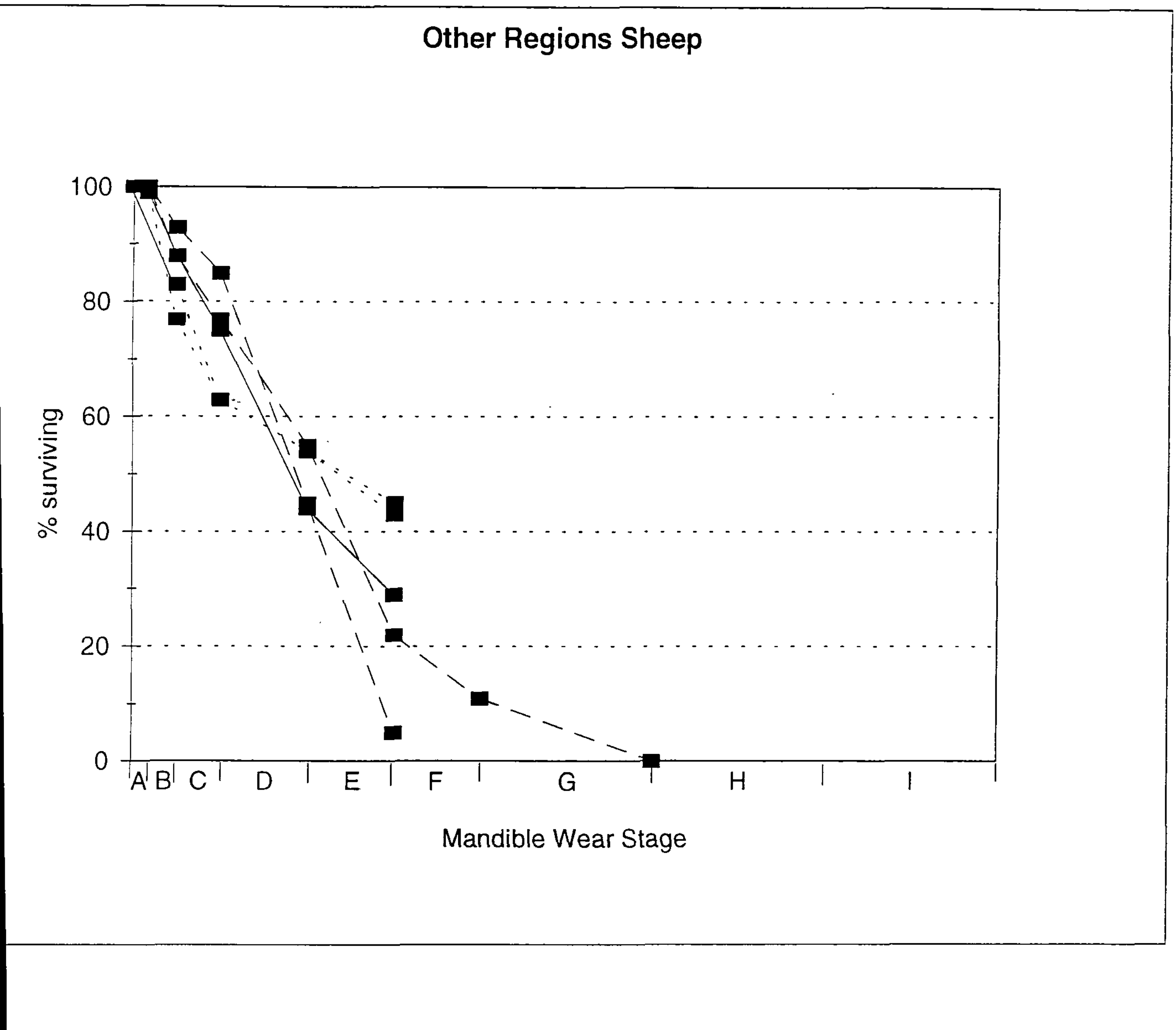


Figure 38: Mortality profiles of Iron Age sheep populations from other regions (Western England and Wales; Midlands; Northern England and Southern Scotland).

Sheep: regional analysis

A regional analysis of the mortality curves reveals a number of observable patterns in the mortality curves both within and between regional groups. The following section describes the different types of mortality curves and attempts to interpret these differences in terms of husbandry strategy. Patterns of sheep mortality within each region (figures 35, 36, 37 & 38) are discussed below. Following this, site characteristics such as underlying geology, topographical location, site type and date, will be explored for links with different strategies of herd management.

Wessex and Central Southern England (fig. 35)

The Wessex tooth wear data provides the largest regional group of Iron Age mortality curves for sheep. The mortality curves from this regional group are in keeping with those seen throughout the Iron Age dataset although the LBA-EIA sample from Old Down Farm could be considered an outlier as it exhibits an incidence of mortality at stage C noticeably greater than in the other Wessex samples. For the most part the mortality curves share the general Iron Age pattern described above; very low neonatal/infant mortality (stage A), steady rate of mortality in prime meat aged stock (stages D, E, and F), low incidence of older adults (stages H and I).

The most noticeable pattern among the Wessex samples is a split in the incidence of stage C mandibles. By the end of stage C the mortality curves have separated into *two main groups*; those with a lower incidence of mortality showing percentages of population surviving at the end of stage C between 65% and 80%, and those with a much higher incidence of mortality during stage C showing % surviving at 40-55%. The two groups with higher and lower percentages of population surviving are less apparent during older age stages as during each stage there is increased mixing of the two groups; however two discrete groups of mortality curves can still be distinguished at the end of stage D and E.

This differentiation in levels of mortality during the 6-12 month age class may be indicative of a difference in husbandry strategy. Those curves with higher % surviving at the end of the stage may represent predominantly natural mortality of yearlings over their first winter, perhaps with some additional culling for meat, while those curves with much lower % surviving may indicate a deliberate and more intense cull of yearlings. Both groups would fit with the general model of sheep husbandry described in the previous section, but the differences may be explained by differences in the intensity of arable farming, or differences in the emphasis on sheep as a food resource. It is possible to interpret those curves with lower incidence of stage C mortality as representing a husbandry strategy that was more intent on exploiting slightly older sheep for food rather than exploiting yearlings as a source of manure. Those curves with high stage C mortality may be more indicative of a strategy with a greater emphasis on secondary products, keeping the yearlings primarily as a source of manure and secondarily as a source of meat. Prime age animals are likely to have been culled for meat while older animals were less intensely exploited for meat but maintained for wool, manure and possibly milk.

It is interesting to note that the dichotomous pattern of stage C mortality discussed above is not purely an Iron Age phenomenon; similar patterns of mortality have been observed among the Bronze Age sheep assemblages from this region (Dale Serjeantson pers. comm.). The suggestion that Iron Age sheep husbandry strategies in this region were strongly linked with the requirements of arable agriculture, and that the differences in stage C mortality reflect differences in the intensity of arable production, is also applicable to the Bronze Age as both arable and pastoral husbandry appears to have been well established in the region during this period. It may be concluded that the mortality curves from Wessex are all sufficiently similar to share general interpretations of husbandry strategy, however there are noticeable intra-regional groupings, in particular at tooth wear stage C, which may be further interpreted as variations of that proposed husbandry strategy.

Upper Thames Valley and surrounds (fig. 36)

The mortality profiles from the Upper Thames Valley region exhibit similar patterns to those of the larger Wessex group. Again, there are low proportions of infants; the majority of individuals are juveniles and young adults, and there appears to be a similar separation of curves into two groups by the end of stage C characterised by low percentage population survival (40-45%) and higher % survival (60-80%). There is one exception to this pattern; the mortality profile from Ditches Hillfort does not exhibit the high level of mortality in stage C seen in the other samples.

The Ditches sample may be considered an outlier from the main Upper Thames Valley group in terms of more than just its mortality profile. Although situated in Gloucestershire, the site is not in the immediate Thames Valley area, neither is it a river valley site as the other sites yielding samples are. Many of the other site characteristics examined later in this chapter (underlying geology. height OD, date and site type) also set Ditches apart from the main group of Upper Thames Valley sites; it is a high status site with a very early villa (Trow 1988). The very low incidence of individuals below one year old, and the complete absence of adults over c. 4 years means the Ditches sheep sample is made up almost entirely of prime meat aged specimens. This may indicate that sheep were not kept on or directly around the site; the sample may even represent a bought in food resource.

The main group of data from this region may be interpreted in a similar manner to the Wessex material. There are slight differences from the Wessex material. On the whole the level of mortality in stage C for both clusters appears slightly higher than is seen in the Wessex samples, although the difference is small. It is possible that the intensity of the seasonal mortality of yearlings may be exaggerated by the effects of seasonal activity/occupancy on some of these sites. The flood plain site of Farmoor was seasonally occupied (Lambrick & Robinson 1979) and there may have been seasonal transhumance practised throughout the region. If only occupied for part of the year, during which a seasonal cull occurs, the extent of the cull may be exaggerated in the faunal sample as the "background" level of individuals from other age groups killed during the part of the year when the site was unoccupied will be absent from the sample. There is no evidence to suggest all Thames Valley sites were seasonally occupied, although if the intensity of occupation did vary throughout the year on some sites it might account for some of the inter- and intra-regional differences seen in the levels of stage C mortality among the Iron Age sheep populations.

Eastern England and East Anglia (fig. 37)

Many of the mortality curves from Eastern England have a similar appearance to those derived from the Wessex and Upper Thames Valley samples. There is a marked absence of neonatal and infant remains (stage A) in samples throughout the region except for the LIA-ERB sample from Puckeridge-Braughing which exhibits a high level of mortality in the 0-6 month age group. The rest of the samples show a relatively steady rate of mortality throughout stages D, E, and F (c. 1-4 years) with the exception of Grove Farm, Enderby which shows very high mortality during the second year of life (stage D). There is a very small proportion of older adults at most sites (stages H and I).

Despite similarities to the Wessex and Upper Thames Valley, the samples from this region do not exhibit the distinct differentiation into two groups during stage C that was observed in the other regions. Many of the curves have a steep gradient indicative of a high death rate during the 6-12 month age group, and show % survival values at the end of stage C that are within the ranges seen in the Wessex and Upper Thames Valley data. A number of other samples, however, do not exhibit the steep drop in % survival during stage C seen throughout the majority of Iron Age sheep samples, perhaps indicating a strategy not involving the arable-linked exploitation of yearlings.

Other regions (fig. 38)

The few samples recovered from other regions of Britain do not exhibit the same pattern of mortality as the bulk of the Wessex, Upper Thames Valley, and Eastern samples. As with other Iron Age sheep samples, there is little evidence to suggest large proportions of older animals. It is noticeable, particularly in the two northern and one midland sample, that most deaths occur by the age of 3, during the second and third years (stages D and E) suggesting a strategy primarily exploiting animals for meat. Also, in contrast to the southern and eastern regions, there is no steep drop in % survival during stage C suggesting the proposed model of arable-linked sheep husbandry strategies does not apply here. This is unsurprising. Although there is ample evidence for an established arable economy in parts of Northern Britain, arable farming was both more intensive and more extensive in Southern and Eastern Britain during the Iron Age (Van der Veen 1992).

The absence of any individuals of wear stage A in any of the samples may be a result of not keeping young animals on or near the settlement. However, individuals only marginally older (stage B, c. 2-6 months) are well represented at these sites, so it is more likely that the lack of very young remains is the result of preservation and retrieval bias. An unfortunate side effect of the use of Ewbank's method of recording tooth wear, and the grouping of several Grant MWS's means that it is not possible to extend the mortality profiles beyond wear stage E for several of the samples. Therefore it is not possible to comment on the exploitation of older animals at these sites.

Sheep: summary of regional patterns

The general conclusion to be drawn from the available Iron Age sheep mortality profiles is that sheep were mainly exploited by way of a "mixed" (i.e. non-specialised) husbandry strategy. "Non-specialised" means that the sheep were managed in a manner that did not concentrate on the production of a single product to the exclusion of others (e.g. Payne's 1973 curves). Concluding that the mortality profiles represent mixed husbandry strategies does not mean that flocks were not managed according to a particular strategy. Indeed, the sheep mortality profiles indicate animal husbandry regimes well suited to the specific requirements of the Iron Age farmers, in particular strategies complementing arable production.

A model has been proposed that explains the mortality profiles of most of the Iron Age sheep samples. Attempts have also been made to provide more detailed explanations of the differences in mortality profiles seen both within and between different regions. Having explained what the differences in mortality profiles may mean in terms of differing husbandry strategies, it is now important to see if these different patterns of husbandry are related to certain site characteristics or other factors that may help explain why different husbandry strategies were used at different sites.

Sheep: site characteristics

The mortality profiles were examined for any relationship with underlying geology, topographical location, site type, or date. There is little evidence to suggest any of these site characteristics had any major influence over the choice of Iron Age sheep husbandry strategy as there are no definite associations of a particular pattern of mortality with a particular site characteristic. It is possible that these factors did exert some influence over the choice of husbandry strategy, although the lack of any consistent association suggests that there were other factors acting to influence choice of husbandry strategy beyond those considered here. Despite the absence of any definite observable relationship between these site characteristics and choice of husbandry strategy, it is possible that there may be some tentative relationships that should be explored in order to provide possible explanations for the differences in husbandry strategies seen within the Iron Age dataset.

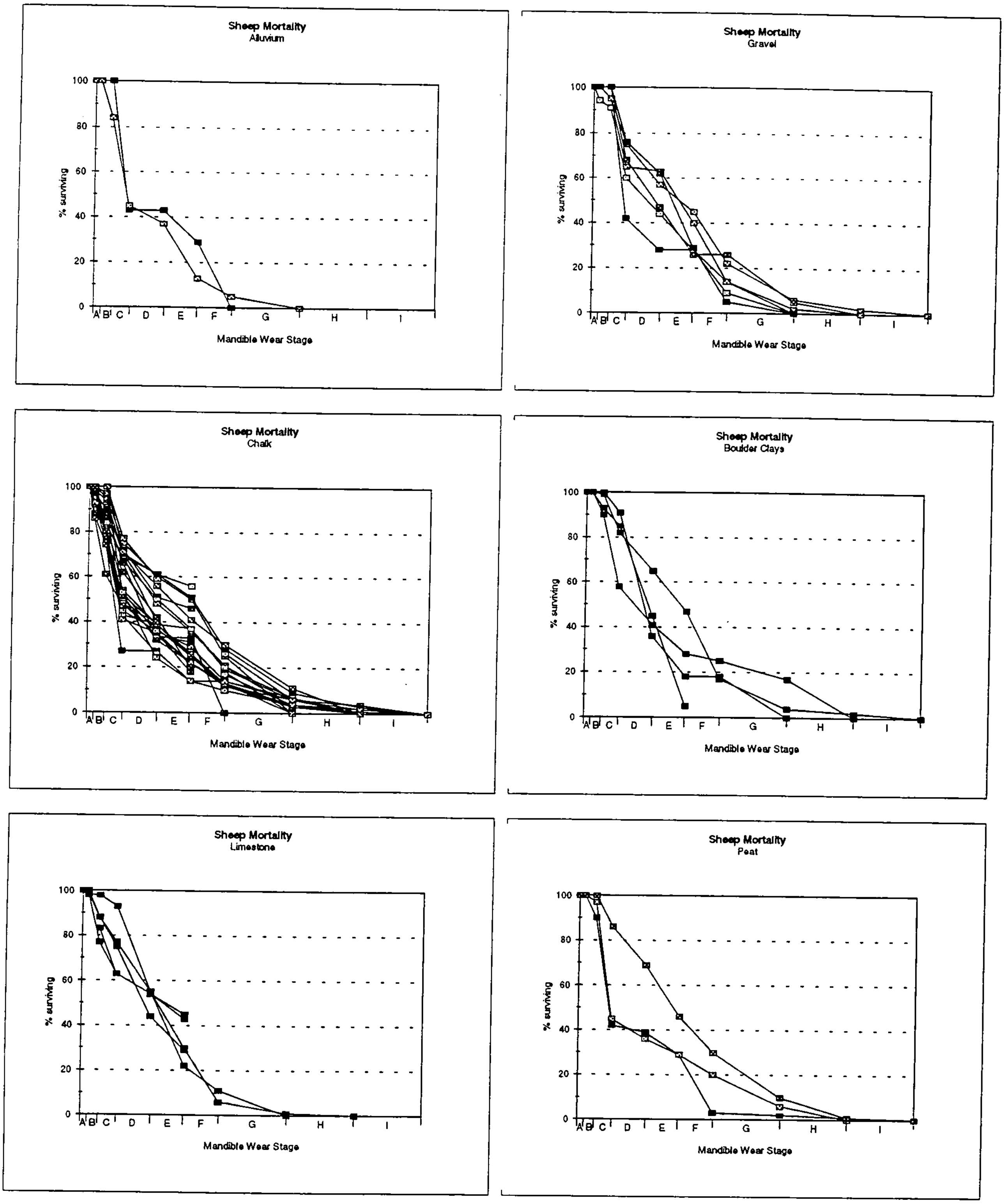


Figure 39: Mortality profiles of Iron Age sheep populations grouped according to site underlying geology.

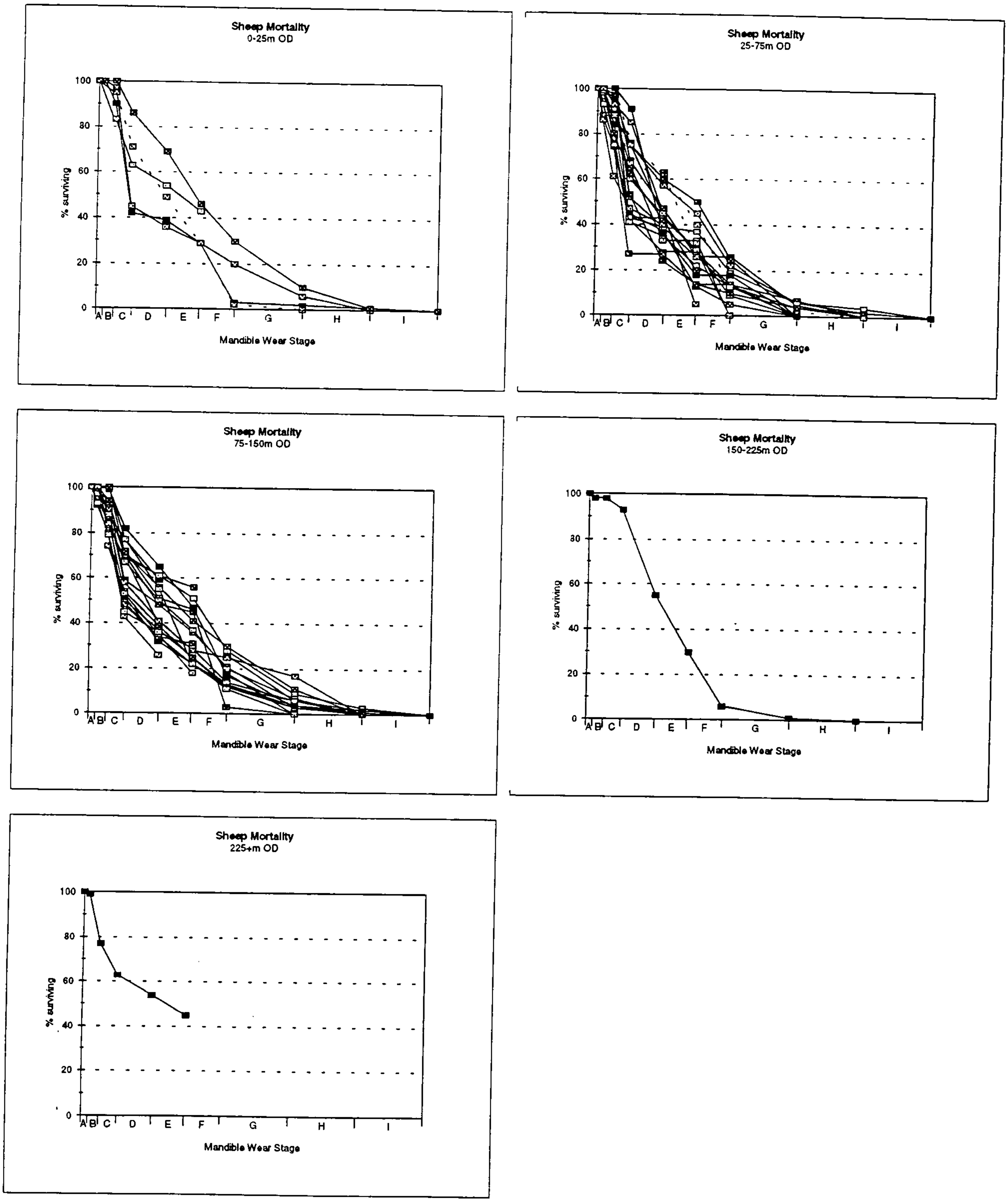


Figure 40: Mortality profiles of Iron Age sheep populations grouped according to site height OD.

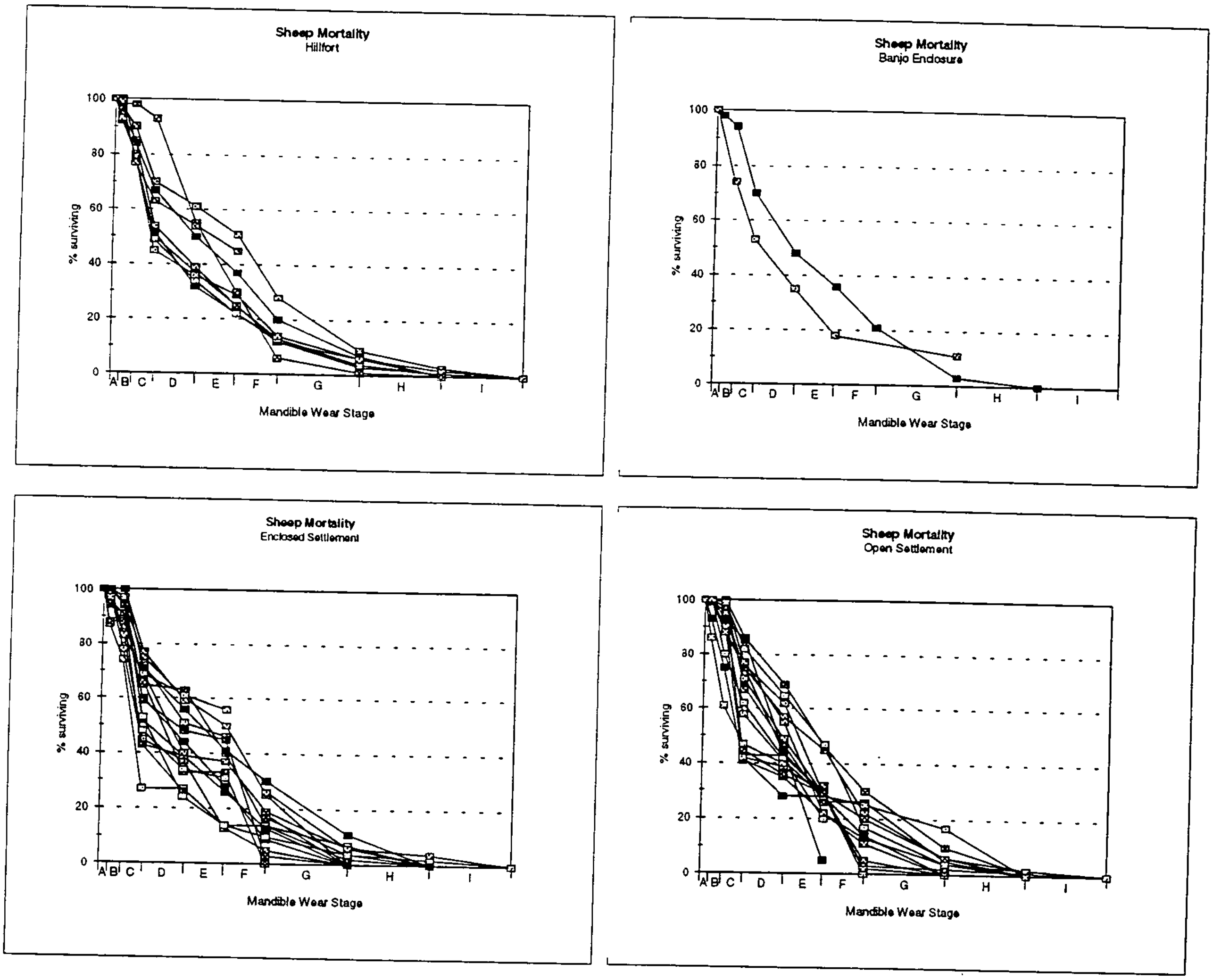


Figure 41: Mortality profiles of Iron Age sheep populations grouped according to site type.

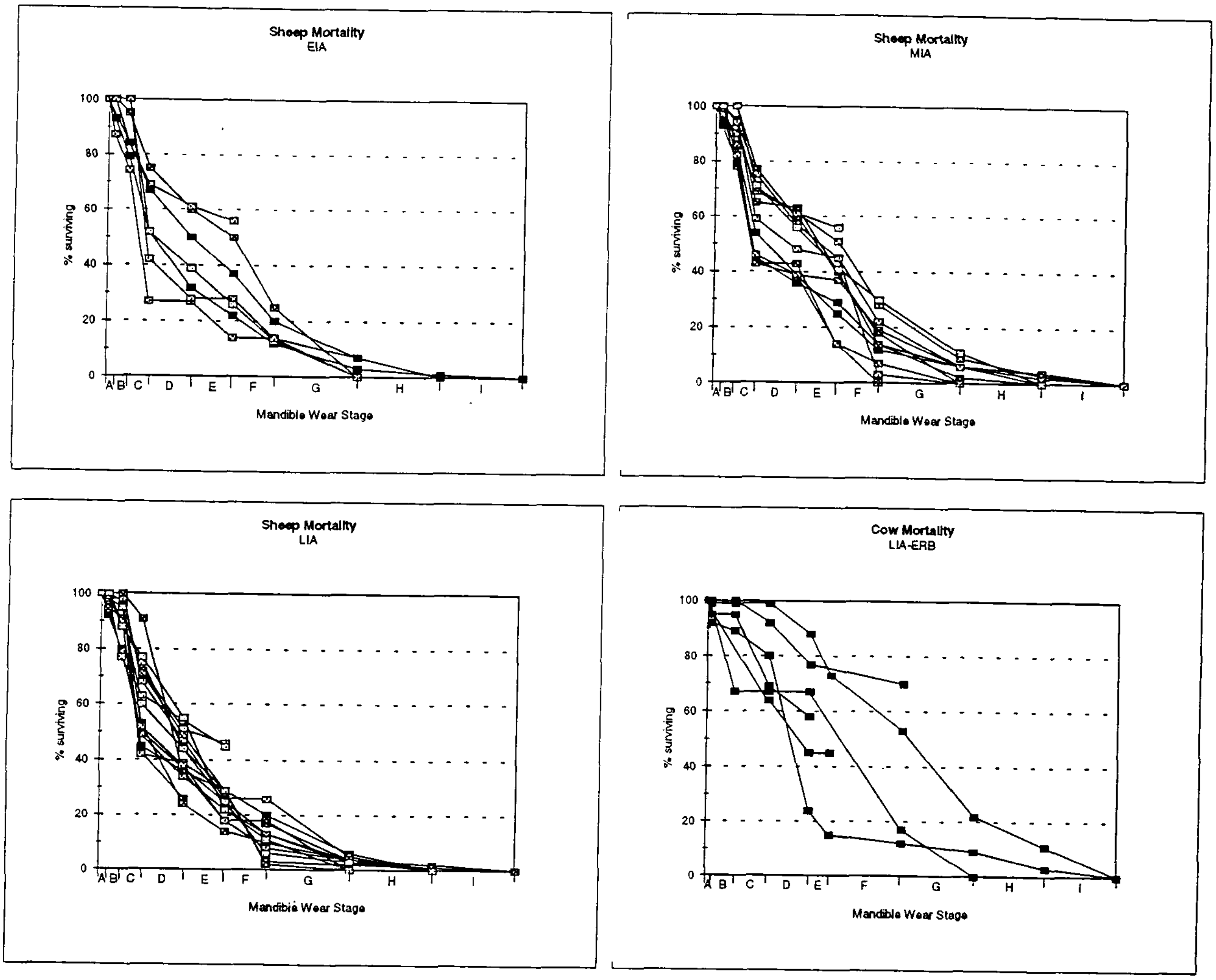


Figure 42: Mortality profiles of Iron Age sheep populations grouped according to site date.

Geology (fig. 39)

Differences in underlying geology fail to provide an explanation for the observed differences in husbandry strategy. The most noticeable differentiation within the mortality profiles (two groups with higher and lower % surviving at the end of stage C) can be observed among samples in the same geological category, thus this differentiation cannot be linked to differences in underlying geology. It is noticeable that, with the exception of the Cat's Water sample, the sites lying on peat and alluvium exhibit mortality curves with some of the greatest stage C mortality rates. As mentioned in the discussion of the Upper Thames Valley data, it is possible that seasonal occupation of sites at the same time of year as a cull of yearlings may account for the appearance of extremely high stage C mortality in some of the samples. The underlying alluvium or peat is indicative of low lying and possibly waterlogged sites that may have been subject to seasonal flooding during the Iron Age. Sites that were subject to seasonal flooding may well have been seasonally occupied, and this may explain the apparently high levels of stage C mortality observed in most of the samples from the peat and alluvium categories.

Topographical Location (fig. 40)

Within the complete Iron Age dataset there do not appear to be any associations of particular husbandry strategies/mortality profiles with the heights at which sites are located. The majority of samples are placed in the 25-75m OD, and 75-150m OD categories, and within these the full range of variation in mortality curves is present. Within each regional group there is also little evidence to suggest a link between husbandry strategy and topographical location, although within the Eastern material the samples from the 25-75m OD group exhibit a lower range of % surviving (20-45%) by the end of stage D, than is seen in the 75-150m OD group (% surviving 40-65% by end of stage D). It is possible that choice of husbandry strategy was in some way linked to, or influenced by the topographical location of settlements in the Eastern region. However no explanation for this possible relationship is immediately apparent, and the absence of similar patterns in the other regions would suggest that the phenomenon was not widespread throughout the British Iron Age.

Site type (fig. 41)

As with the other site characteristics, site type does not appear to influence the choice of husbandry strategy to any significant degree. A small number of samples from the Open Settlement category appear to show slightly lower levels of mortality during the first two years of life than the bulk of samples from other settlement types, but the differences in mortality profiles between the different site types are negligible. It is worth mentioning that within the Wessex samples, hillforts exhibit similar patterns of mortality profile to those of other types of site, including both levels of yearling mortality. This implies that the sheep husbandry strategies practised at hillforts were no different to those used at other sites in the region.

Date (fig. 42)

There is little sign of a link between the date of a sample and the mortality profile it exhibits. Those mortality curves from the LIA-ERB period all appear to have attained similar proportions of population surviving at the end of stage D; the % surviving at this point ranges from 35-55%, whereas in all other periods the range is greater. However, despite showing similar levels of % surviving by the end of stage D, the mortality levels before and after this point vary too greatly to suggest that the mortality profiles are the result of similar husbandry strategies.

There is one possible pattern evident among the samples from different age periods, although the number of samples in all regions other than Wessex is too small to say whether this trend occurs in other regions. The variation in the mortality profiles from Early Iron Age samples appears to be greater than that seen in the Middle Iron Age samples which, in turn, show greater variation than the Late Iron Age mortality curves. This progressively increasing similarity of the mortality curves, and reduction in the ranges of % survival, may be indicative of the gradual adoption of a more uniform approach to sheep husbandry during the Iron Age. The reason for this chronological trend is unknown but one possible explanation may be that a general increase in the intensity of arable production over time encouraged the adoption of similar husbandry strategies more suited to a primarily arable economy. Whatever the reason for this apparent convergence of husbandry strategies over time, the similarities in mortality profiles do not continue into the Early Romano-British period. The uniformity of husbandry strategies appears to be a phenomenon of the Iron Age period, the Mid to Late Iron Age in particular.

Sheep: summary of site characteristics

The site characteristics considered in this study do not appear to account for the different patterns of mortality seen in the Iron Age sheep material. Differences in site characteristics provide no explanation for the two levels of stage C mortality seen in the Wessex and Upper Thames Valley samples. The material from Eastern England shows a similar lack of association between mortality pattern and date, height, geology, or site type. While inter- and intra-regional patterns of mortality can be recognised within the Iron Age sheep samples, and these patterns explained in terms of husbandry strategy, it is apparent that no simple association with site characteristics can explain these patterns. It is probable that a variety of many different factors influence the choice of husbandry strategy. This study has recognised and suggested possible explanations for the general pattern of Iron Age sheep husbandry, however it would seem that the finer variations in mortality profiles may only be explained by further, more detailed analyses.

Cattle

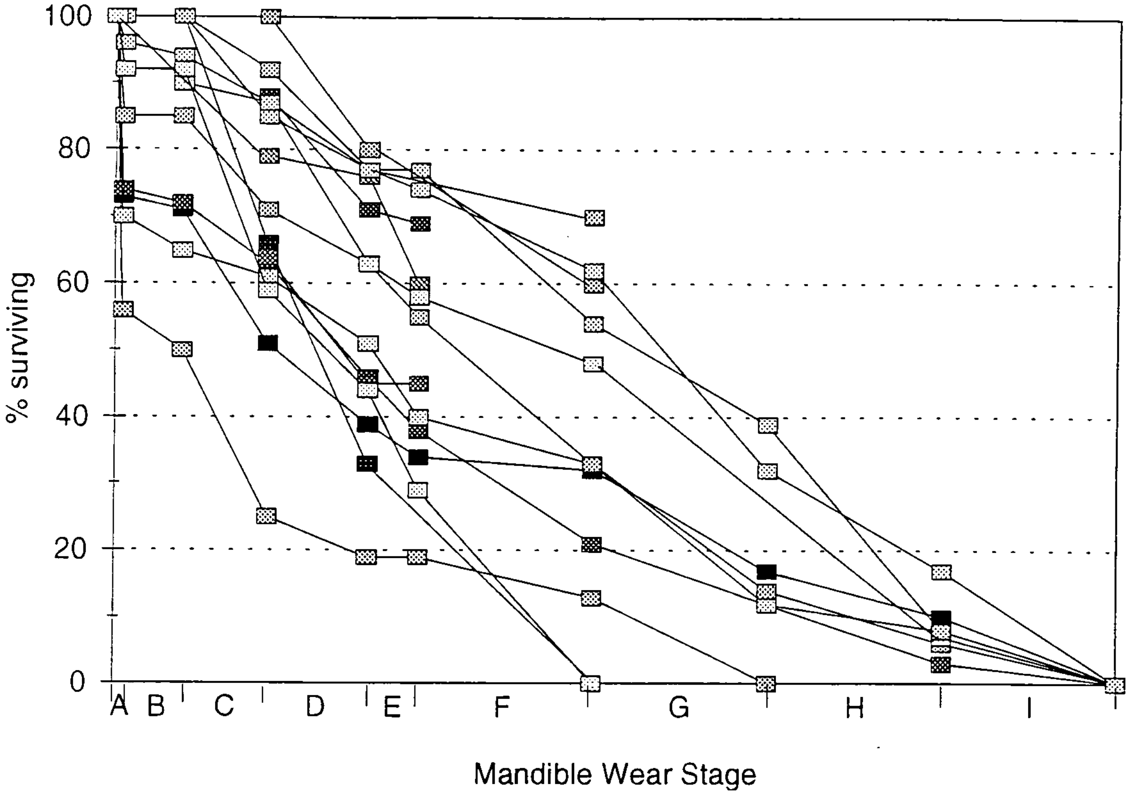
The Iron Age cattle dataset is somewhat smaller than the sheep dataset, but as with the sheep three regions yielded sufficient numbers of samples to enable comparisons of mortality profiles both within and between regions. The mortality profiles from the Wessex, Upper Thames Valley and Eastern regions may be seen in figures 43, 44, and 45 respectively. The remaining mortality curves from the other regions are presented in figure 46.

There is a great deal of diversity among the cattle tooth wear data. The range of % survival values at each wear stage is large and this is true for separate regions as well as for the whole Iron Age dataset. The cattle remains do not exhibit the overall similarity in mortality profiles observed in the pig samples and the sheep samples. The diversity of mortality patterns would seem to imply the use of a number of different cattle husbandry strategies throughout the Iron Age, both in terms of space and time. Many of the samples have higher proportions of older adults (stages G, H, and I) than are seen in the sheep samples, which would suggest that some use was made of older individuals. Older cattle are still used as a source of meat, however keeping cattle beyond prime meat age (c. 1½ - 3½ years) would only be worthwhile if exploited for additional purposes. The keeping of older cattle for traction would be in keeping with the evidence of arable production during the Iron Age, and fits well with the proposed model of sheep husbandry where animals are managed in a way that compliments arable farming. It is also likely that older cows were kept as breeding stock, and for milk.

The main difference in the profiles is among the younger animals (stages A-E); some samples have higher levels of mortality among these stages, suggesting a greater emphasis on cattle for meat, while others maintain a steady but low rate of mortality. There is also a great deal of variation within stage A, which could be indicative of differences in preservation and retrieval as much as in husbandry strategy (see the discussion above for sheep). The one similar feature is the comparatively low incidence of individuals at stage F among many of the samples. Stage F (young adults) represents the tail end of individuals selected for beef, but the youngest of those maintained for traction and breeding. The low mortality among young adults is therefore unsurprising as they are unlikely to be deliberately killed for meat, being a little too old to be considered prime beef cattle, but with many years ahead as a potential source of labour and dairy products. Despite the differences, there are a number of patterns among the regional groups that may shed further light on the strategies of cattle husbandry during the British Iron Age.

Wessex and Central Southern England
Cow

a) from MWS A



b) from MWS B

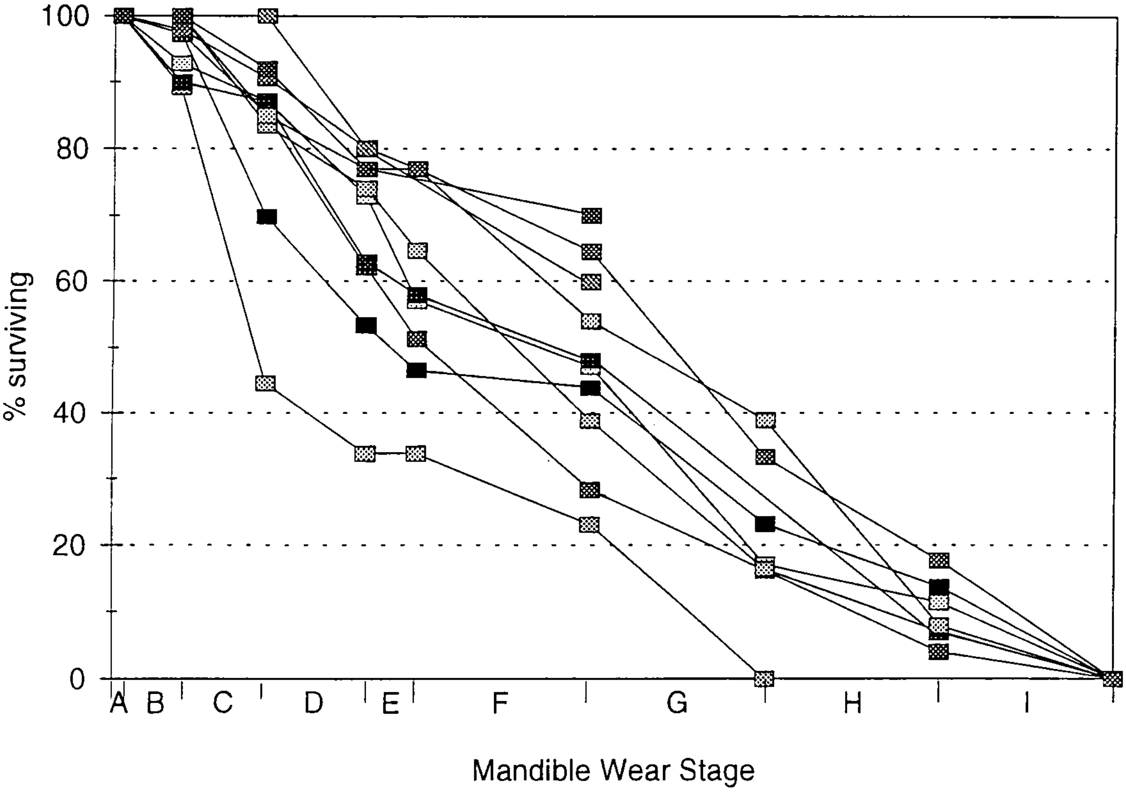


Figure 43: Mortality profiles of Iron Age cattle populations from Wessex and Central Southern England: **a)** including jaws at MWS A **b)** excluding jaws at MWS A

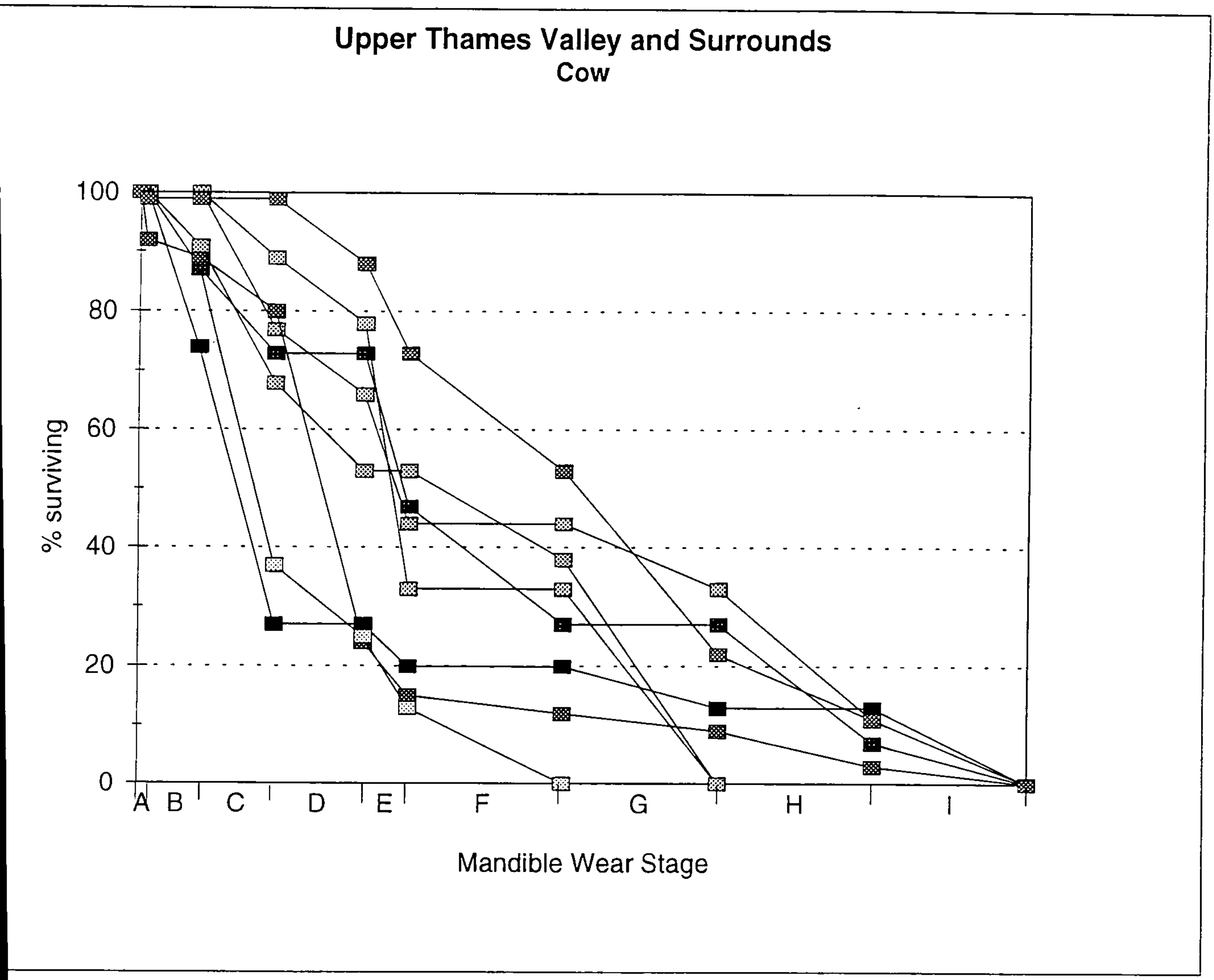


Figure 44: Mortality profiles of Iron Age cattle populations from the Upper Thames Valley and Surrounds.

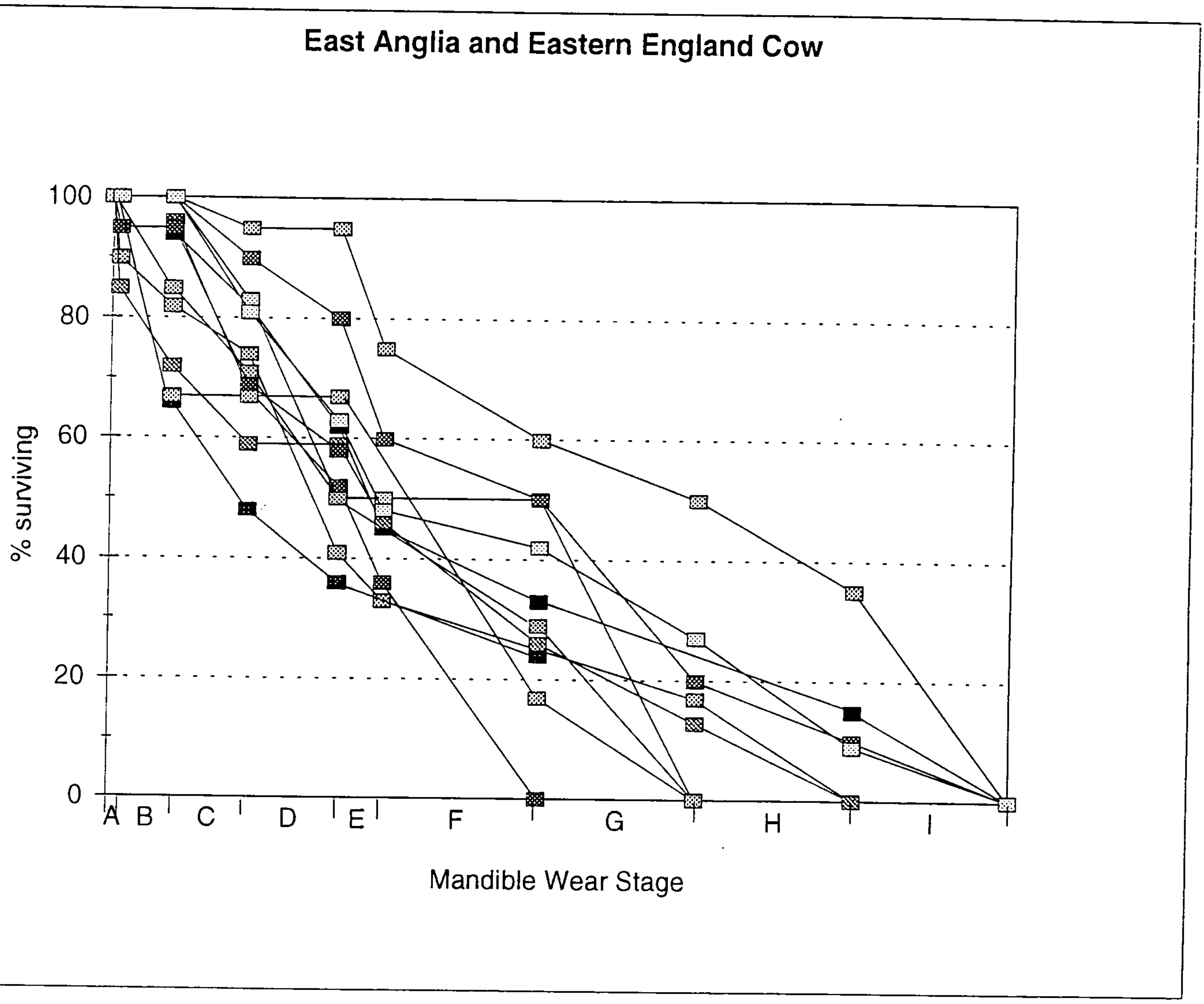


Figure 45: Mortality profiles of Iron Age cattle populations from Eastern England and east Anglia.

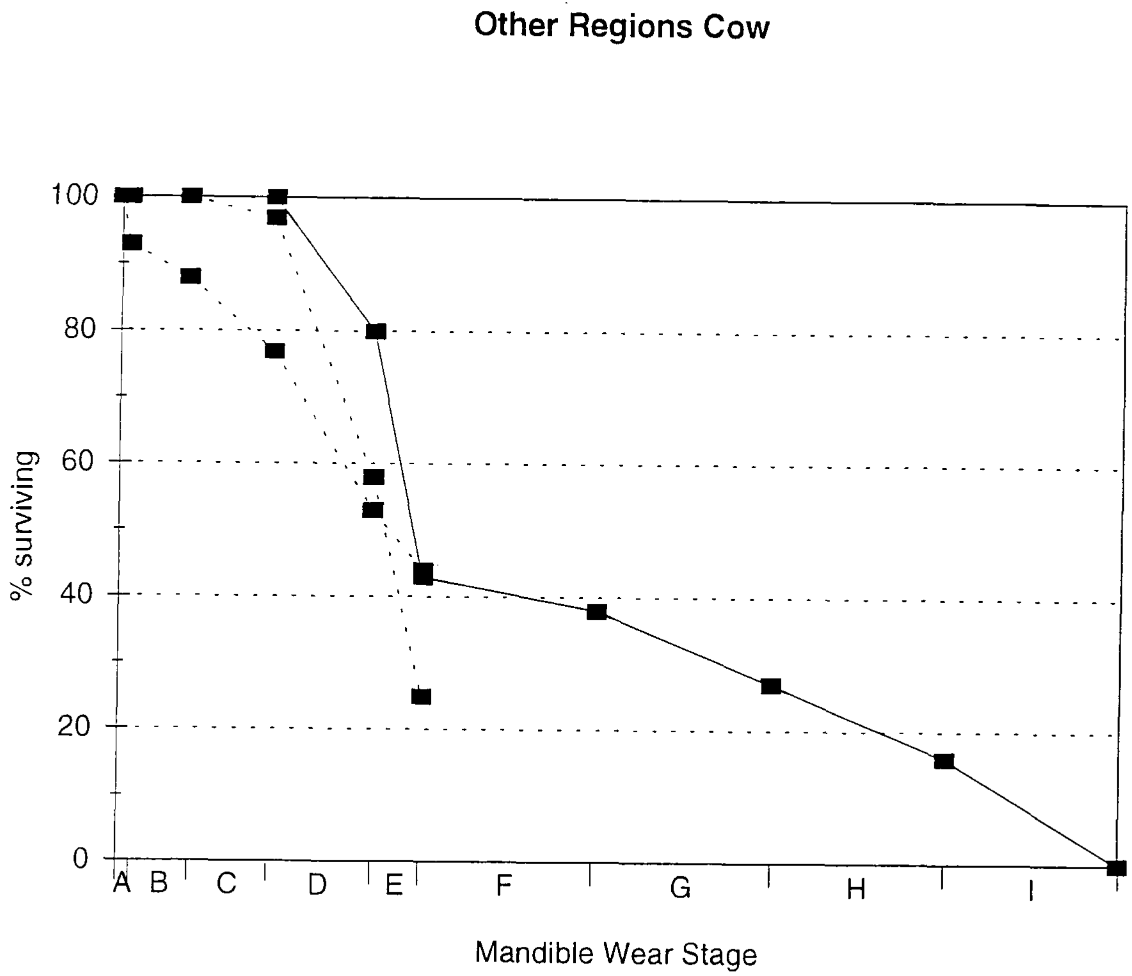


Figure 46: Mortality profiles of Iron Age cattle populations from other regions (Western England and Wales; Midlands; Northern England and Southern Scotland).

Cattle: regional analysis

Wessex and Central Southern England (fig. 43)

The broad spread of the curves in fig. 43a is, at first glance, suggestive of a broad variety of different husbandry strategies. Two samples (Meare East LIA, and Brighton Hill South MIA-LIA) have a complete absence of older individuals (stages G, H, and I) and the majority of individuals were killed during stages C-F. This is indicative of a husbandry strategy primarily concerned with exploiting cattle for beef. The remaining mortality curves exhibit a very broad range of % surviving values at each wear stage; however, closer examination reveals a great deal of similarity within the Wessex material.

The majority of the Wessex curves show a similar steady rate of mortality from Stage B onwards - most lines in fig. 43a are parallel despite being widely separated. The main source of variation in the Wessex dataset is the incidence of neonatal and infant mortality (stage A). This is supported by figure 43b which shows mortality profiles for Wessex assemblages (except for Meare and Brighton Hill South) excluding all stage A material; the resulting mortality profiles are much more alike and show a substantial reduction in the range of % surviving values at each stage. Despite apparent differences in the level of neonatal mortality the overall similarity of the mortality profiles from stage B onwards suggests similar strategies of cattle husbandry. With the exception of one sample with high incidence of stage C mortality there is a similar rate of mortality among individuals of all ages, suggesting a husbandry strategy geared towards more than just beef production. As with sheep, a number of Bronze Age cattle samples from the region share the mortality patterns observed in the Iron Age data, in particular the lack of heavy infant/neonatal mortality and gradual steady rate of mortality in all age groups (Dale Serjeantson, pers. comm.). The number of older animals and the lack of intense culls of prime beef stock could indicate exploitation of cattle for secondary products, mainly traction and milk.

The high levels of infant mortality in some of the samples, particularly those from Danebury, may be the result of a deliberate cull and therefore indicative of a focus on dairying. Deliberate killing of infants before weaning would make more milk available for human consumption. Other suggestions to account for the incidence of stage A individuals at Danebury include that of a specialised breeding establishment (Grant 1984b), and seasonal occupation (Stopford 1987). In each case, the assumption is that the other lower lying, non-hillfort settlements have complimentary husbandry strategies. The present study demonstrates that this is not the case, as a number of non-hillfort settlements exhibit neonatal/infant mortality and a number of other hillfort samples do not. No other samples from the region exhibit neonatal/infant mortality levels as high as at Danebury, and this may be taken to indicate that Danebury has a unusual husbandry strategy. However, there is no indication from other settlements of a hillfort/non-hillfort differentiation in husbandry strategy.

The different levels of infant mortality among these otherwise similar profiles may be the result of any number and combination of factors. The absence of stage A individuals may be due to poor preservation and recovery of small, fragmented juvenile remains. Alternatively, cattle may not have been kept on the settlement during the calving season so stage A individuals may never have been deposited on the settlement in the first place. High levels of infant mortality are as likely to be the result of deliberate culling, as the effects of seasonal occupation of the settlement during times when animals at stage A were present, or the export of older individuals away from a breeding establishment. It is also possible that the Wessex samples are simply exhibiting natural levels of variation in neonatal mortality.

Upper Thames Valley and surrounds (fig. 44)

The mortality profiles from this region differ markedly from the Wessex curves. The majority of Upper Thames Valley profiles do not exhibit the steady mortality rate of the Wessex samples, and instead show extremely heavy mortality during stages C, D, or E. The main exception to this is the sample from Ditches Hillfort. As with the sheep material, the Ditches sample (from the Cotswolds) does not exhibit the same patterns as the samples from the Upper Thames Valley; instead the curve is more gradual with substantially lower levels of mortality during the first three years of life (stage A-E). The Ditches mortality curve indicates no specialised concentration on prime beef aged individuals, and it is probable that cattle were exploited for secondary products as well as for meat. The absence of any individuals below three years is not in keeping with preferred methods of exploitation for milk, even though a dearth of infants may be the result of taphonomic bias.

The Later MIA sample from Mingies Ditch differs slightly from the remaining samples. Instead of exhibiting a heavy drop in % survival during a single stage, the steepest part of the curve takes in two stages (C and D). Although not concentrating on a single age cohort like the other samples, the later MIA Mingies Ditch material is still indicative of a husbandry strategy concentrating on meat production. Although the intense cull occurs at different ages in different samples, the majority of the Upper Thames Valley curves indicate a primarily meat based cattle economy. Those individuals killed at stage C represent the younger range of prime beef animals; providing animals were killed towards the end of stage C (c. 1½ years) they may be considered prime beef age, however if killed at the beginning of the stage (c. 8 months) animals would have been too young to be considered prime beef stock. A more detailed analysis of the tooth wear patterns would be required in order to establish more accurately the age of individuals within the stage C bracket.

Those samples which exhibit culling of younger beef cattle (stage C and D) have very low proportions of older animals, less than 20% of the population live beyond 3 years. This mortality pattern would suggest a highly specialised husbandry strategy geared towards beef production where older animals are maintained in sufficient numbers to maintain the herd, but there is little or no emphasis on the keeping of older stock for secondary products, or as draught animals. Those samples exhibiting an older beef cull (stage E, c. 2½ - 3 years) maintain higher proportions of older animals (up to 50%). This pattern suggests a slight variation in husbandry strategy whereby there is still a concentration on beef production but sufficient older animals are maintained to suggest animals were also maintained for secondary products.

Eastern England and East Anglia (fig. 45)
Unlike the Wessex and Upper Thames Valley regions the samples from Eastern England do not appear to show any particular uniformity in husbandry strategy. The mortality profiles not only exhibit a broad range of percentages of population surviving at each stage, there is also variation in the shape of the curves. The EIA sample from Blackhorse Road shows a similar mortality profile to many of the Wessex samples; low mortality of sub-adults and, with the exception of stage E, steady rate of mortality through to old age. This sample exhibits a very high proportion of older animals suggesting a concentration on secondary products of cattle (as for other samples the absence of very young specimens may be taphonomic and does not preclude the possibility of milking). In direct contrast is the sample from West Stow which exhibits a high rate of mortality in prime beef cattle and no individuals surviving beyond early adulthood, a pattern that suggests a concentration on meat production or even, given the lack of older or very young animals, the importation of beef cattle onto the site.

Within the remaining samples there are both similarities and differences in mortality profiles to be observed. The mortality curves tend to be steepest among prime beef age individuals; steeper than is seen in the Wessex data, suggesting some deliberate exploitation of cattle for meat, but without the intense culling of single age cohorts observed in the Upper Thames Valley region, suggesting husbandry strategies were not heavily specialised towards beef production. There is some variation in the exploitation of older animals, some samples showing a steady decline in population through to very old age (stage I) while other mortality curves terminate at the end of stage G or H. Although there are differences in the ages to which older animals are kept, there are older animals present in sufficient proportions in many samples to suggest secondary products were also an important consideration of many husbandry strategies within the region. There is no indication of specialised husbandry strategies geared towards a single product, rather the reverse; an attempt to maximise opportunities to utilise cattle for as many different products as possible.

Other regions (fig. 46)
Of the three cattle samples (Mount Batten, Dragonby, and Port Seton) from the remaining regions, only one sample (Port Seton) provides a complete mortality profile. Despite this, it is still possible to draw some conclusions as to the probable cattle husbandry strategies they represent. All three curves show the majority of individuals killed while sub-adults, the steep gradient of the curve during stages D and E indicative of a concentration on prime beef animals. It would appear that the husbandry strategy at these sites was aimed primarily at meat production, although in two of the samples approximately 45% of individuals survive to

adulthood which might suggest deliberate maintenance of older individuals as a source of dairy products and labour.

Cattle: summary of regional patterns

The Iron Age cattle mortality profiles examined in this study reveal distinct regional patterns of cattle husbandry. The Wessex samples are mainly indicative of strategies focusing on dairying and other secondary products, while in the Upper Thames Valley the emphasis appears to be on meat production. The Eastern region exhibits a little more internal variation but on the whole husbandry strategies appear to be non-specialised, and attempt to exploit cattle for both primary and secondary products to differing degrees. There is a certain amount of internal variation within regions which may reflect differences in husbandry strategies. The inter- and intra-regional patterns of cattle mortality seen in the Iron Age dataset must be examined for relationships with different site characteristics in order to attempt more detailed explanations of the different choices of husbandry strategy.

Cattle: site characteristics

The mortality profiles were examined for any relationship with underlying geology, topographical location, site type, or date. There do appear to be a number of possible associations of certain patterns of mortality with particular site characteristics; however these relationships tend to be observed only within the Iron Age dataset as a whole and not within individual regions.

Geology (fig. 47)

Most geological categories contain too few samples to discern any associated patterns in mortality. The majority of samples come from sites overlying either chalk or gravel and there are sufficient samples in these two categories to discern a pattern in the distribution of particular types of mortality curve. The different patterns of mortality curve associated with chalk are the same as those seen throughout the samples from Wessex and central southern England. The patterns of mortality profile seen among the gravel samples are also those apparent in the Upper Thames Valley. At a regional level there is no discernible difference between chalk and gravel profiles in the Eastern material, and the absence of any Wessex gravel sites and any Upper Thames Valley chalk sites prevents further testing of the apparent trends. In the absence of any observed intra-regional differences related to underlying geology it is impossible to determine whether differences in geology are a cause of regional differences in mortality profiles, or a result of them.

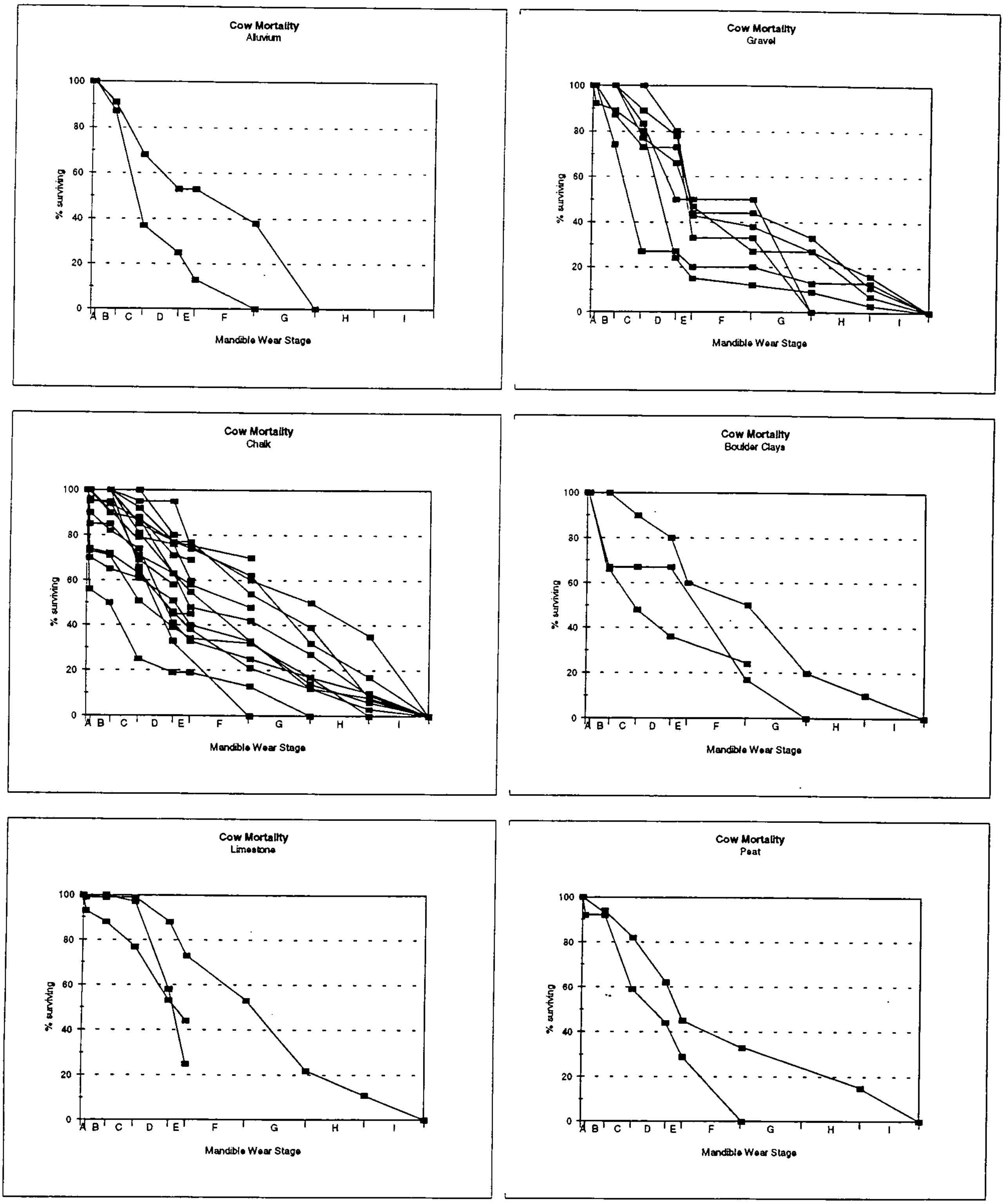


Figure 47: Mortality profiles of Iron Age cattle populations grouped according to site underlying geology.

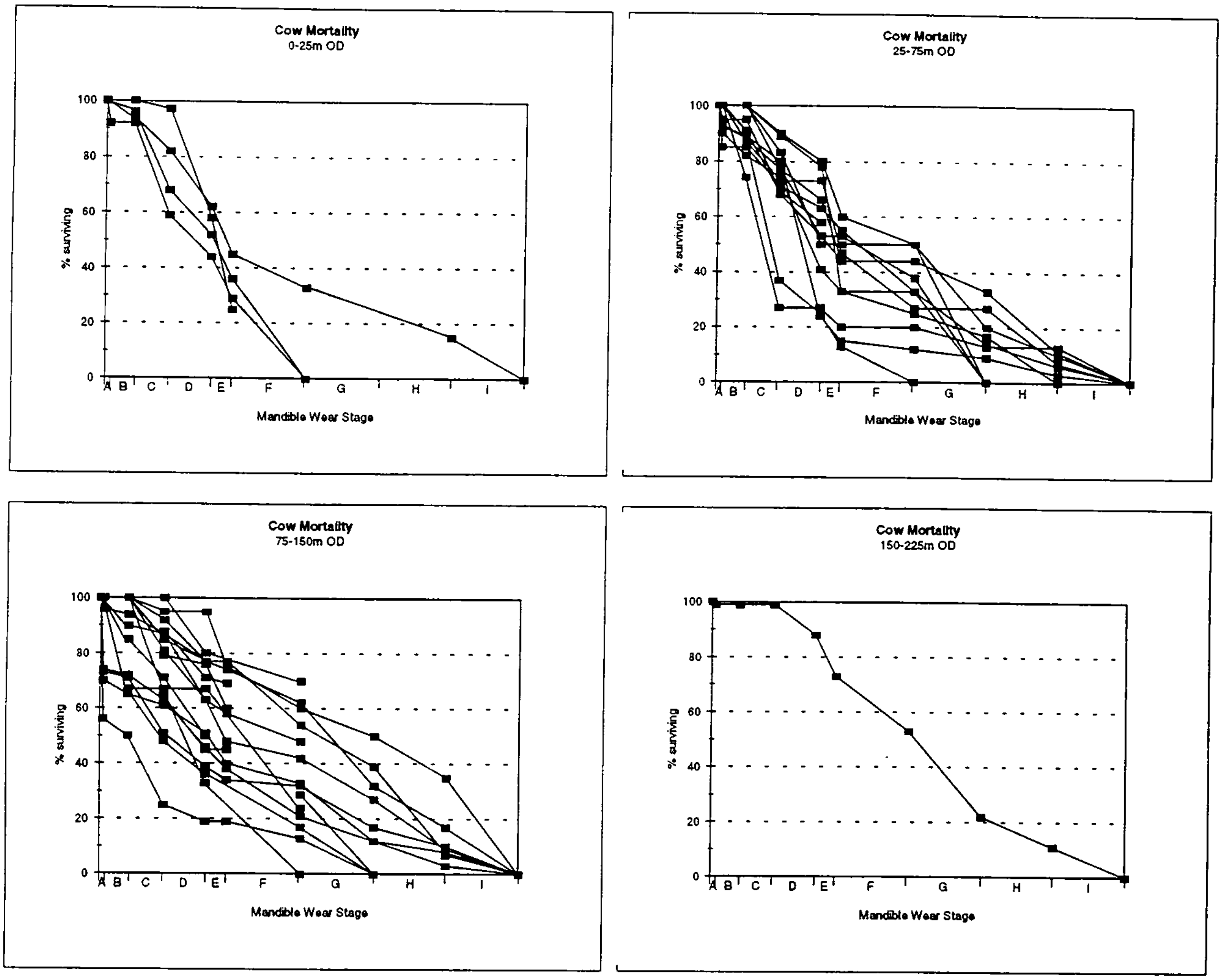


Figure 48: Mortality profiles of Iron Age cattle populations grouped according to site height OD.

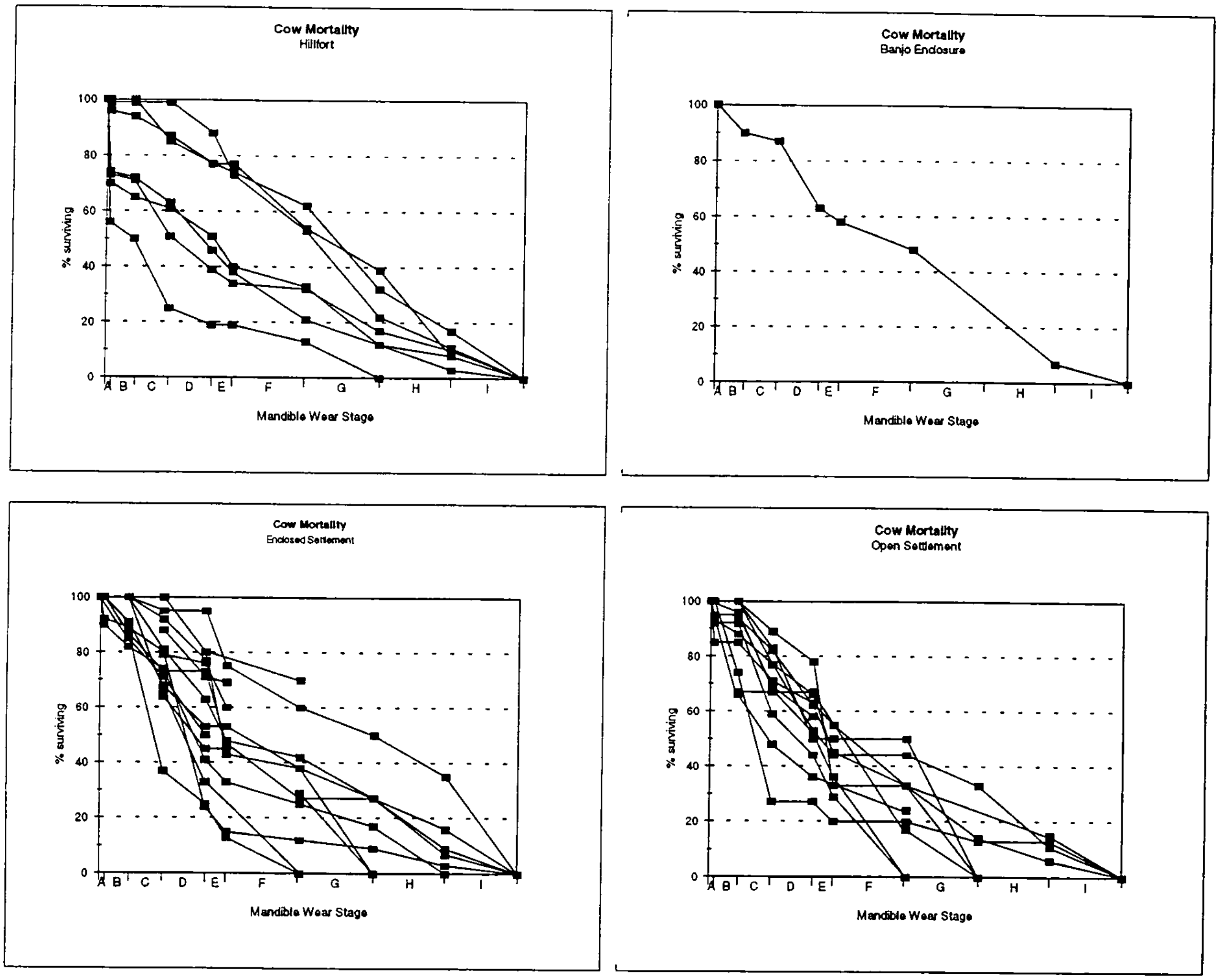
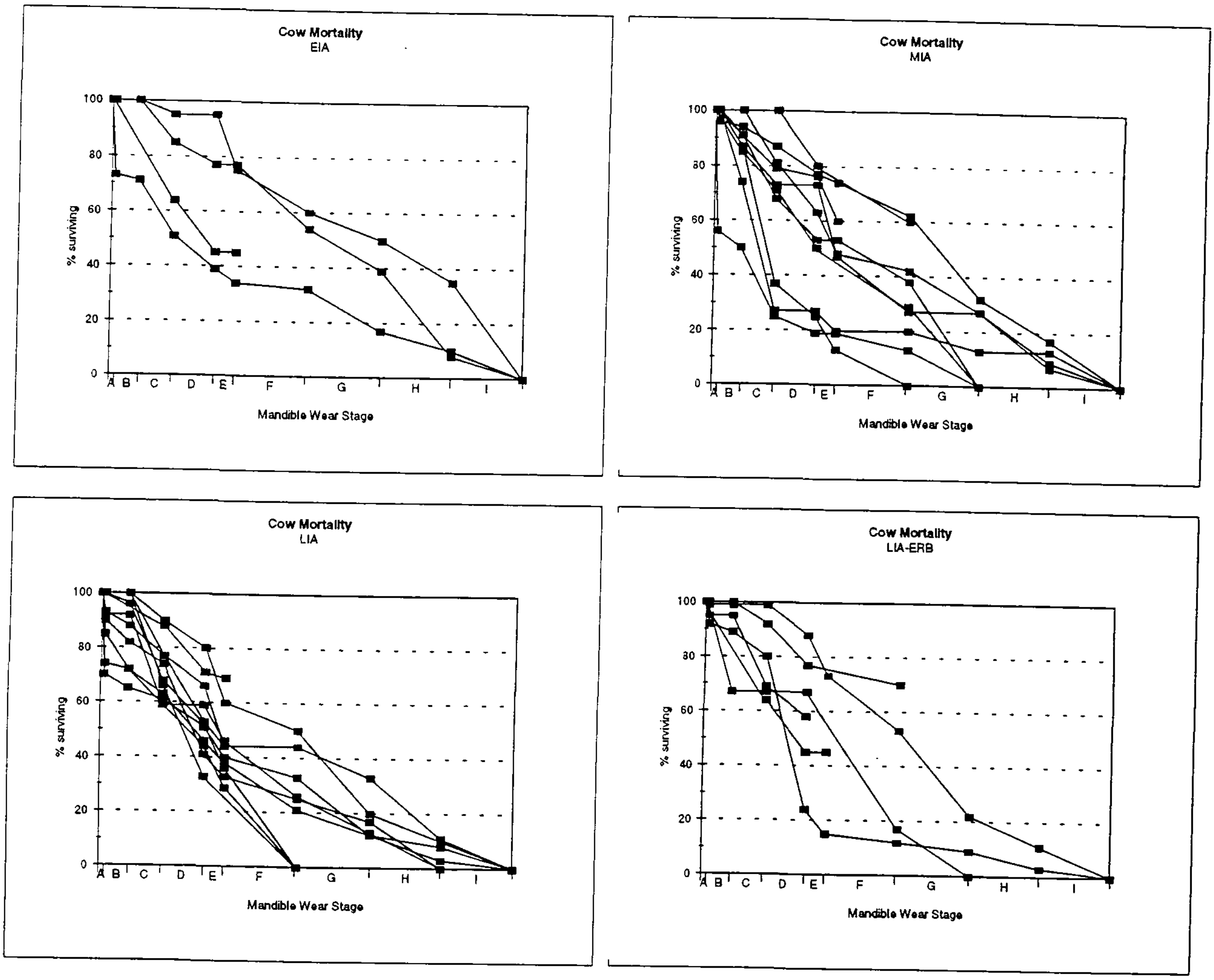


Figure 49: Mortality profiles of Iron Age cattle populations grouped according to site type.



Cow Mortality EIA

Cow Mortality MIA

Cow Mortality LIA

Cow Mortality LIA-ERB

Figure 50: Mortality profiles of Iron Age cattle populations grouped according to site date.

Topographical location (fig. 48)

There appears to be a slight trend in the distribution of different types of mortality curve according to height OD. Mortality profiles of samples from the 0-25m OD category seem to indicate a meat orientated husbandry strategy. The same is true of the 25-75m OD samples which appear similar to the Upper Thames Valley group, although some curves are smoother, while the 75-150m OD group comprises mortality profiles with less emphasis on meat similar to the Wessex material. As with the underlying geology, these apparent associations of particular patterns of mortality with particular height categories may represent either cause or effect of the regional differences. There is no conclusive relationship between height and mortality pattern in the Eastern samples, and there are no Upper Thames Valley samples in the 75-150m OD category to test the relationship. The Wessex samples are almost exclusively from the 75-150m OD category; there is only one sample from the 25-75m OD range which exhibits a mortality profile perfectly in keeping with the higher settlements.

If the relationship between height and husbandry strategy is real it might be explained by the different suitability of higher and lower lying areas to keeping cattle. As mentioned in the chapter comparing species proportions, lower lying sites with better access to water would probably have been more suited to keeping larger herds of cattle than the dryer upland sites. It is possible to exploit larger herds specifically for meat and still maintain a viable breeding population from the small percentage of older individuals. However, small herds cannot remain viable without a sufficiently large adult population so are more suited to a secondary products based strategy where the high percentage of older stock also serves as a breeding population.

Site type (fig. 49)

The hillfort samples all appear to have quite similar mortality profiles except for differences in the level of neonatal mortality. The samples from banjo enclosures exhibit mortality profile in keeping with those from hillforts, while the open and enclosed settlement categories exhibit a variety of different mortality profiles, including some similar to the hillfort samples. The similarity of the hillfort samples is probably the result of regional similarity, as the majority of hillfort samples used in this study come from the Wessex region. A separate examination of the Wessex, Upper Thames Valley, and Eastern regional groups revealed no discernible relationship between mortality pattern and settlement type.

Date (fig. 50)

There does not appear to be any link between date and choice of cattle husbandry strategy. The samples from all Iron Age periods exhibit a variety of different mortality patterns. There is possibly slightly less variation among the LIA samples but this is by no means indicative of a uniform husbandry strategy. There are no relationships discernible at regional level.

Cattle: summary of site characteristics

There are some associations between mortality pattern and particular site characteristics. However these mortality patterns are also closely linked with regional groupings so it is difficult to determine whether the observed associations explain the regional groupings, or vice versa. There are intra-regional variations among the samples which cannot be explained by a direct relationship with a particular site characteristic, although within most regions there do appear to be similarities in husbandry strategy. The main differences in husbandry strategy are to be observed between different regions.

Conclusions

It has been shown that different types of tooth wear data can be converted into a similar format and used to produce reliable and informative comparisons of mortality profiles for Iron Age pig, sheep and cattle. The comparisons have revealed a remarkable similarity in the mortality profiles of pig throughout the Iron Age dataset, while analysis of the sheep data has revealed a number of interesting intra-regional variations and cow data has revealed some distinct regional patterns.

The pig mortality profiles can be readily explained in terms of a husbandry strategy aimed exclusively at meat production. The sheep dataset shows more variation in choice of husbandry strategy, but the majority of mortality curves are in keeping with the proposed model of a mixed husbandry regime closely related to arable production. The cattle mortality profiles are the most varied, but do appear to fall into regional groups within which similar husbandry strategies are practised; a mixed/dairy strategy in Wessex, meat specialisation in the Upper Thames valley, and a mixed strategy in Eastern England.

The differences in mortality profiles have been explained in terms of husbandry strategy although the reasons why different strategies were chosen at different sites are harder to explain. Analysis of the different mortality patterns reveals no definite relationships with particular site characteristics that may have provided reasons for choice of strategy. It is likely that a variety of different factors influenced the specific details of husbandry strategy at different sites. While it is possible to attempt to explain the broad differences in Iron Age animal mortality profiles, explaining the smaller differences requires more detailed analysis of the faunal material, and further consideration of different site characteristics.

This study has successfully compared a number of different types of published tooth wear data, and has enabled recognition and interpretation of the different husbandry strategies employed by Iron Age farmers to exploit their domestic herds.

Chapter 10

Summary/Discussion: Animal Husbandry Regimes In Iron Age Britain

The studies of quantification, ageing, and to a lesser extent body part representation, for cattle sheep and pig have revealed a number of interesting patterns within the Iron Age faunal assemblages examined. Certain groups of Iron Age faunal assemblages exhibit similarities in species proportions and mortality patterns among the three main domesticates; these groups may coincide with particular regions, or with certain shared characteristics of the sites from which the faunal samples were recovered. The observed patterns have been interpreted in terms of husbandry strategy. The interpretations of species proportions and mortality profiles may be used together to provide models of animal husbandry regimes throughout the British Iron Age. Not all regions possess sufficiently large datasets to allow new models of husbandry to be generated. Despite the lack of data from some regions, it is possible to see whether the results of this study support or contradict the models of husbandry proposed in previous Iron Age overviews and regional comparisons. This chapter aims to summarise possible models of animal husbandry regimes that may explain the observed patterns of species proportions and mortality profiles. The validity of previous models of Iron Age animal husbandry is tested for each region against the results of this study.

Regional Patterns

Wessex and central Southern England

The faunal dataset from Wessex and Central Southern England is the largest of all the regions studied and provides sufficient information to allow detailed models of husbandry strategy to be proposed. The Iron Age faunal samples from around Britain exhibit a range of species proportions, within which the Wessex samples exhibit a narrower range; they tend to have higher percentages of sheep than cow, with consistently low percentages of pig. Sheep are well suited to the chalk downland pastures, whereas cattle are less suited to the dry, high ground of the region which would account for the larger herds of sheep. Sheep are also suited to integration into an arable economy, grazing on stubble and providing manure, and the evidence for extensive arable cultivation throughout Wessex might also explain why sheep were favoured. The apparent increase in the proportion of sheep compared to cow from the Early to Late Iron Age may well be associated with an increase and intensification of arable production from the Middle Iron Age onwards in Wessex. The model proposed to explain the increasingly uniform patterns among the Wessex sheep mortality profiles (chapter 9) is also that of an arable linked animal strategy. The cattle mortality profiles seem to suggest a concentration on secondary products and the keeping of older individuals which would fit in with the notion of small cattle herds which could not sustain continued culling of prime beef aged stock and still retain reproductive viability.

Both the species proportions and mortality profiles exhibit a certain degree of intra-regional grouping among the Wessex samples, including an apparent increase in the importance of sheep throughout the Iron Age period and definite splitting of the sheep assemblages into two distinct groups with different rates of yearling mortality. Despite these internal variations the majority of Wessex faunal samples form a broadly similar cohesive regional group, suggestive of a degree of uniformity in husbandry strategy. The general model for Wessex is of a primarily sheep based arable linked animal economy, with cows of secondary importance and then pigs. Sheep were important as an aid to arable cultivation and were probably grazed on the stubble during late autumn to clear and manure fields, yearlings were killed for meat before losing condition over winter and meat was also obtained from prime aged specimens, although sufficient older animals were maintained to provide a source of wool and possibly milk. Cattle appear to have been kept into old age, and although undoubtedly used as a source of meat were not in most instances managed specifically for beef. Cattle were probably kept primarily as a source of dairy products, as well as supporting the arable economy by providing manure and traction. Pigs were managed exclusively for meat. The results of this study support similar models of arable linked animal husbandry regimes previously proposed for the Wessex region (e.g. Cunliffe 1991 & 1993, and Grant 1984a, 1984b & 1991). However, there are a number of samples exhibiting oddities that do not fit the wider patterns of husbandry observed.

The Danebury samples exhibit species proportions and sheep mortality curves in keeping with the samples from other Wessex sites, but cattle mortality curves indicate a higher incidence of neonatal/ infant individuals than in other samples. This high incidence of very young cattle may well be the result of good preservation and retrieval, a suggestion supported by the high % occurrence of all the skeletal elements including those of small size and low survivability in the Danebury sample. As indicated in chapter 4, it is not possible to compare directly the skeletal element representation at different sites but it is plausible that the differences in the incidence of neonates/infants among the Wessex cattle samples may be due to taphonomic differences, rather than differences in husbandry strategy. Here the majority of Wessex cattle mortality profiles are interpreted as representing broadly similar husbandry strategies, the differences in infant mortality mainly the result of taphonomic chance rather than human design.

Both Grant (1984a) and Stopford (1987) interpret the high proportion of infants as the result of human activity; Grant argues for a specialised breeding centre, and Stopford for seasonal occupation. The results of this study fail to support either theory as both presuppose the presence of contemporary sites with contrasting cattle mortality profiles, either as the recipients of stock from the breeding centre, or the sites occupied during the remaining seasons. This would mean that a number of the Wessex sites (the implication being in both models the non-hillfort sites) would exhibit complementary cattle mortality profiles that differ from the Danebury material. There is no evidence for any difference in mortality pattern between the hillfort and non-hillfort sites as both exhibit similar mortality from wear stage B onwards, and a selection of both groups exhibit stage A mortality.

There are other differences within the Wessex faunal assemblages beyond variation in cattle infant mortality. The Groundwell Farm sample contains a substantially higher percentage of pig than is seen in any of the other Wessex samples, although there are insufficient data to determine whether the mortality profiles of the three main domesticates also differs from those of the other Wessex samples. The samples from Meare contain the high percentages of sheep and low percentages of cattle seen in other Late Iron Age Wessex samples, and the sheep and pig mortality profiles are also similar to other Wessex sites. However the cattle mortality profile is distinctly different, showing almost exclusively sub-adult (prime beef) individuals. The different nature of Meare when compared to other assemblages from the region may be the result of choice of in husbandry strategies associated with its wetland environment such as seasonal occupation and transhumance.

It is apparent from these outlying samples that none of the proposed models are universally applicable across the region, although the similarity of the majority of samples indicates a degree of uniformity in the animal husbandry strategies of Iron Age Wessex. The mortality patterns of sheep, cattle and pig remain quite consistent throughout the dataset, the main differences being the relative species proportions which appear to differ according to the type of site and show a definite increase in the importance of sheep throughout the Iron Age, possible in conjunction with an intensification of arable husbandry.

Upper Thames Valley and surrounds

The Upper Thames Valley faunal assemblages do not share with Wessex the same trend of increasing percentages of sheep through the Iron Age. Indeed, there does not appear to be any recognisable relationship between date and either species proportions or mortality profiles, although there are too few samples of different periods to rule out the possibility completely. The Upper Thames Valley dataset is much smaller than that from the Wessex region and most of the sites yielding faunal samples share similar geology, topographical location, date and settlement type, which means any intra-regional differences in husbandry strategy cannot be reliably linked to differences in site characteristics. With the exception of Ditches Hillfort (an outlier in terms of geographical, geological, and topographical location, date and site type) the Upper Thames Valley samples form a coherent group with similar species proportions and mortality patterns, as well as similar site characteristics.

The main intra-regional variation is in the cattle mortality profiles which show intense culls at different ages in different samples. Although these are significant differences in the details of herd management, the differences in terms of general husbandry strategy are small; all heavy culls are of prime meat aged individuals even if of different age groups within that range. The sheep mortality profiles also fall into separate intra-regional groups with different levels of mortality in the 6-12 month age group, although as with cattle the general sheep husbandry strategy is broadly similar throughout the dataset. Pig mortality profiles do not form any distinct intra-regional groups and reveal a consistent meat based husbandry strategy throughout the region. The Upper Thames Valley samples exhibit a continuous range of broadly similar species proportions with no evidence of any separate intra-regional grouping. All samples have low percentages of pig and roughly equal percentages of sheep and cattle remains. Despite some slight differences in the sheep and cattle mortality profiles the results of this study indicate the adoption of broadly similar animal husbandry strategies across the region.

An *inter-regional comparison of the Wessex and the Upper Thames Valley* samples reveals both similarities and differences in the husbandry strategies of the two regions. The sheep mortality profiles from the two regions are alike even to the extent of the same distinct intra-regional grouping. The similar sheep mortality patterns together with evidence for the importance of arable husbandry (Jones 1984a) suggest the Upper Thames Valley sheep were exploited in the same way as the model proposed for the Wessex sheep. Although there is some overlap of species proportions, the Upper Thames Valley sites generally have higher percentages of cow and lower percentages of sheep than the Wessex samples. This may indicate either lesser importance of sheep or a greater importance of cattle. The similarities in all other aspects of sheep samples in the Upper Thames and Wessex regions might suggest that the differences in species proportions reflect a difference in the importance of cattle rather than a difference in sheep husbandry. This is supported by the cattle mortality profiles which show significant differences in cattle husbandry strategies between the two regions.

The cattle husbandry strategy proposed for the Upper Thames valley region is one of exploitation primarily for meat with a small percentage of individuals kept into old age for breeding purposes, as a source of milk, and to support the arable economy with traction and manure. It is probable that this pattern of herd management would require reasonably large herds in order to sustain the high levels of sub-adult (prime beef) mortality and still retain a viable herd structure. Although percentage representation of different species in a faunal sample cannot be directly related to herd size it can provide some indication of their relative occurrence, and the higher percentages of cattle in the Upper Thames Valley samples is in keeping with the model of large cattle herds. This is in contrast to the model proposed for the Wessex samples where the low percentages of cattle are interpreted as reflecting small herds, a notion supported by the mortality profiles which show the high proportions of older animals necessary to maintain the reproductive potential of small herds.

The model of animal husbandry strategy proposed for the Upper Thames Valley during the Iron Age is of a broadly uniform strategy similar to that of the Wessex sites with respect to pig and sheep, but with larger cattle herds and a greater emphasis on husbandry for beef. As suggested by Grant (1984b), these inter-regional differences in animal husbandry strategy may be related to the landscape and environment of the two regions. The Wessex samples come primarily from chalk downland sites situated over 75m OD, while the Upper Thames Valley samples come from river valleys or gravel terraces below 75m OD. The lower lying river valley pastures, having a permanent water supply close by, are more suited to cattle than the chalk downlands as cattle are required to drink large amounts of water twice daily. Sheep are less well suited to the river valley pastures as they are susceptible to liver fluke and foot-rot when kept on damp ground. Being drier the chalk downland pastures are much more suited to sheep, which can obtain sufficient water just from grazing. The Upper Thames Valley sites therefore had the potential to sustain larger herds of cattle than the Wessex sites whose higher pastures were more suited to keeping sheep.

The results of this comparative study do lend support to some previous interpretations of Iron Age animal husbandry, although the validity of other models is difficult to establish. The relative proportions of cattle and sheep remains in both the Wessex and Upper Thames Valley samples support Grant's argument for a relationship between landscape and husbandry regime in the two regions. Although, without sufficient mortality profiles from low lying Wessex sites and higher Upper Thames Valley sites to test the hypothesis, it is equally possible that the different husbandry strategies are related to other regional characteristics. Lambrick's (1992) model of Iron Age farming on the Upper Thames gravels is difficult to test since there are insufficient numbers of samples of different date to determine whether or not the faunal remains reflect the proposed Middle Iron Age intensification and increased production and development of specialised husbandry strategies from EIA to LIA. The intra-regional variation within the cattle mortality profiles may be indicative of variation in animal husbandry strategy and the reasonably high percentages of cattle may reflect the development of specialised pastoral farming, However without evidence of changes in animal husbandry strategy over time or a decrease in arable farming at certain sites, this study can neither support or disprove Lambrick's model. Cunliffe (1991) argues that in his Midlands region, which includes the Upper Thames Valley, "evidence for animal husbandry....does not differ significantly from that of the Wessex region" (ibid. 392). Despite overlapping ranges of species proportions and similar treatment of sheep and pig, Cunliffe's argument is refuted by the different cattle husbandry strategies revealed in the samples from these two regions (cf. Maltby 1996).

Eastern England and East Anglia

The faunal samples from Eastern England and East Anglia share similarities in species proportions. The two main outlying samples have relatively high percentages of pig remains, a characteristic which may be associated with high status or romanised sites as both come from a major Late Iron Age/Early Romano-British settlement complex (cf. King 1988). The majority of the Eastern samples have high percentages of cow (>40%)and form a reasonably cohesive group distinct from the Wessex and Upper Thames Valley samples. The importance of cattle as part of the animal economy does not appear to be linked with low lying sites as suggested for the Upper Thames region; sites both above 76m OD and below 25m OD all show an emphasis on cattle over sheep. The sheep mortality profiles show a little more intra-regional variation than those from Wessex or the Upper Thames Valley, although the eastern samples do not fall into two distinct intra-regional groups. Some mortality profiles indicate sheep husbandry strategies similar to those of Wessex and the Upper Thames Valley, although sheep obviously contributed substantially less to the animal economy of sites in the Eastern region. Other sheep mortality profiles from the region suggest exploitation of animals after their first year for meat, and possibly wool and manure. The cattle mortality curves also vary, although the overall pattern of cattle husbandry seems to be of mixed strategies utilising sub-adults for beef and older animals for secondary products.

It is apparent from the results of this study that the models of husbandry proposed for Wessex and for the Upper Thames Valley are not applicable to the Eastern region. Sheep may have played an important role in the economy of the region as a support to arable cultivation, or as a source of meat and wool, but that role was small compared to the contribution from cattle. Cattle husbandry strategies did not concentrate on a single product, rather cattle were managed for a mixture of primary and secondary products. Within this broad model of mixed cattle husbandry there is scope for a variety of strategies with varying emphases on different products. It is impossible to determine the arable strategy of the region from the Iron Age faunal remains, however it is possible that the differences in animal husbandry regimes between the Eastern and Southern regions may reflect differences in the arable economies. The smaller populations of sheep mean that any support of arable cultivation by the animal regime would be likely to involve cattle to a greater extent than in other regions where cattle were less important. The diverse landscape of the Eastern region may also contribute to the variation in husbandry strategies; the region encompasses land above and below the 75m contour as well as coastal and fenland environments, all of which may have influenced the choice of husbandry strategy at local level.

There is a dearth of previous models of animal husbandry strategy in Eastern England and East Anglia with which to compare the results of this study. Cunliffe's (1991) review of Iron Age husbandry strategies in different areas of Britain largely overlooks this region. Champion (1994) suggests that the Iron Age agricultural economy of Eastern England mainly involved production at local level, and that the Middle Iron Age possibly heralded a reorganisation of the agricultural economy. However, this model concentrates primarily on the non-faunal material as Champion maintains there is little available Iron Age faunal evidence from the region. Although not as large as the Wessex dataset, there is still sufficient quantification and tooth wear data to allow some analysis of the animal economy of the region. It is probably a consequence of the domination of Wessex in Iron Age research that there is not more consideration of the animal husbandry strategies of Eastern England in the existing literature.

Other Regions

The lack of detailed models of animal husbandry regimes is even more apparent for the rest of Britain. The absence of models is partly due to the fact that there is less Iron Age faunal material recovered from northern and western regions because of poorer preservation conditions than are prevalent in the south east, but the problem is compounded by a concentration of archaeological research on Wessex and the south east. Despite this apparent bias there were sufficient samples from northern and western regions for a comparative study of species proportions. There is the tacit assumption in many Iron Age overviews that it is possible to extrapolate husbandry regimes for most of Britain from those regions with large amounts of faunal data; this assumption is clearly misguided as the results of this comparative study show differences in faunal assemblage composition indicative of regional differences in animal husbandry strategy. The main limitation to providing detailed models of animal husbandry for these regions is the lack of sufficient numbers of mortality profiles. Although there is insufficient tooth wear data to allow detailed analysis of herd management it is still possible to use to species proportions to infer something of the animal husbandry strategies adopted in the northern, western, and midlands regions.

The samples from the *Midlands* region have species proportions similar to those of the Upper Thames Valley sites, although there is a little more variation in the relative importance of pig among the midlands samples. Cunliffe (1991) includes the Upper Thames Valley as part of the Midlands region but although the species proportions are similar, without mortality curves to compare it is impossible to say whether the Upper Thames valley model is applicable to any of the Midlands samples. As with the Upper Thames Valley samples, there is some overlap of the Midlands species proportions with those of the Wessex samples but there is no indication to suggest the Wessex model is applicable to the Midlands region. Knight (1984) proposed a model for part of the Midlands region, suggesting a mixed Iron Age economy with later expansion and intensification of stock rearing and an increase in the emphasis on secondary products from sheep. Again, in the absence of age profiles it is impossible to test the validity of this model using the existing published faunal evidence from the region.

The *Western England and Wales* samples also fail to provide sufficient mortality curves to enable a detailed analysis of animal husbandry strategies. The region covers a large geographical area with a number of very different environments including a mountainous region in central Wales, for which Cunliffe proposed a pastoral economy, and peripheral lower lying coastal and inland areas which Cunliffe suggests practised a mixed farming strategy. Unfortunately there are insufficient samples from across the region to see whether there are significant intra-regional differences in husbandry related to landscape and environment. Also, examination of the faunal material alone cannot determine the relative economic importance of arable and pastoral husbandry at a site which means the results of this study cannot be used to test the validity of Cunliffe's model for the region. What is apparent from the analysis of species proportions is that pig is much more important in the Western samples than in those from other regions. The higher percentages of pig are a distinct feature of the Western samples and indicates a pattern of husbandry different to those seen in other regions. High incidence of pig may be interpreted in a number of ways; a dietary preference, high status sites, presence of surrounding woodland, or a variety of other suggestions may account for the numbers of pig, but all require further cultural and environmental evidence as support. Whatever the explanation for the observed species proportions, it should be remembered that the samples are all from hillforts and should not be considered representative of the Western region as a whole.

Northern England and Southern Scotland is another large geographical region with highland, lowland and coastal environments. The broad range of species proportions exhibited by the faunal samples suggests a broad diversity of husbandry strategies throughout the region, although the lack of mortality profiles prevents the development of detailed models of animal husbandry strategy. Many northern sites have provided evidence of extensive arable cultivation (Van der Veen 1992), and Piggott's (1958) model of a purely pastoral economy for the whole of northern and western Britain has long since been disregarded. However, further faunal data is required to establish the nature of animal husbandry within the region. Additional faunal analyses might also be used to examine whether the preservation biases that have resulted in such small datasets from Northern and Western Britain have also influenced the composition of the surviving bone assemblages.

This comparative study has provided a number of insights into the animal husbandry regimes practised in Iron Age Britain. The Iron Age animal economy appears to have focused on sheep and/or cattle, with some exploitation of pig. Cattle and sheep appear to have been managed for a variety of primary and secondary products; some mortality profiles are indicative of more specialised strategies concentrating on a particular product although probably not to the exclusion of all others. A number of distinct regional groups were recognised within the overall range of species proportions and mortality profiles. As well as inter-regional variation, a number of intra-regional patterns were also distinguishable, particularly within the large dataset from Wessex. The results of this study have been used successfully to generate new models of animal husbandry strategy, and to determine the validity of a number of previous models of animal husbandry for Wessex and the Upper Thames Valley. Analysis of the faunal evidence from all regions has provided information concerning the diversity or uniformity of husbandry strategies both within and between regions. Although there are insufficient data to generate detailed models of animal husbandry for all of Iron Age Britain, the results of this comparative study do provide a summary of the existing faunal evidence and also highlight gaps in our knowledge that may be used to direct further research.

Future work

As a result of undertaking this comparative analysis of faunal assemblages some suggestions can be made concerning the direction of further research into animal husbandry regimes in Iron Age Britain. These include expansion of the faunal dataset by excavation targeting particular regions and types of site, and more detailed analysis of the existing faunal material. Ideally more faunal assemblages should be recovered from the Northern and Western regions and the Midlands. It is these areas in particular that require expansion of the faunal dataset in order to increase our knowledge of regional patterns of husbandry. There is the potential for expanding the Iron Age dataset without further excavation simply by ensuring all existing assemblages are analysed and the results published; analysis and publication of the Staple Howe animal bones and publication of the Broxmouth faunal assemblage would further our knowledge of animal husbandry strategies in the Northern region.

As well as increasing the number of faunal samples from regions with small Iron Age datasets, thoughtful expansion of larger regional datasets could also benefit our understanding of regional husbandry strategy. For example, expanding the Upper Thames valley dataset to include assemblages from upland sites (over 75m OD) and the Wessex dataset to include lower lying sites (below 75m OD) would provide the means of testing the hypothesis that differences in topographical location and landscape is the main reason for the differences in husbandry strategy between the two regions. The large proportion of samples from above 75m OD in the Wessex dataset may well be the result of past research focusing on hillforts. The Danebury environs project may help redress the balance somewhat by concentrating on non-hillfort sites, as well as shedding light on the patterns of animal husbandry strategy of inter-related sites.

Adding new faunal assemblages to the existing Iron Age dataset is desirable but further analysis of the existing material would also increase our understanding of animal husbandry strategies. In particular a more detailed analysis of tooth eruption and wear data could be undertaken to test for evidence of seasonal activity, and selective culling of same-aged cohorts. It has been suggested that some Iron Age sites, in particular Danebury and Meare, were foci of seasonal activity (Stopford 1987). Use of established methods of examining juvenile dentition for evidence of seasonality (e.g. Legge & Dorrington 1985; Legge et al 1992) could determine whether any Iron Age faunal assemblages showed signs of enhanced seasonal activity.

The scope of this study was limited to the three main Iron Age domestic species: cattle, sheep, and pig. In addition to undertaking more detailed analysis of these three species, future studies should include all species commonly found on Iron Age settlement sites. The socio-economic role of other domestic species, such as horse and dog, and how this relates to the cattle, sheep and pig husbandry regimes would be an important extension of research into Iron Age domestic animal husbandry. The treatment of wild species, both marine and terrestrial, and their economic contribution is another aspect of Iron Age animal economies worthy of further consideration.

Another area of particular importance highlighted by this study is the need to recognise the effects of taphonomic bias on an assemblage. Future comparative studies of Iron Age animal husbandry strategies should involve some means of filtering out the effects of taphonomic influences on the composition of an assemblage. This is necessary in order for differences between faunal samples to be reliably interpreted in terms of differences in husbandry strategy, rather than being masked by the effects of differing taphonomic histories.

Other reviews of Iron Age faunal evidence call for more intra-site analysis of faunal assemblages (e.g. Grant 1984b, Maltby 1994 & 1996). Intra-site analysis involves consideration of subsets of the faunal assemblage, comparing the composition of the faunal samples from different context types and different areas across the site. While it is important to obtain as much detailed information as possible about each sites assemblage, there is a danger of concentrating too much on individual sites rather than groups of sites. Understanding of animal husbandry strategy need not be limited to individual sites; inter-site and inter-regional studies are essential to further our understanding of husbandry regimes. Production may have been at local level at the majority of Iron Age sites, but interaction between sites and broader regional environmental and cultural factors influencing husbandry strategy can not be recognised without comparing several sites. However, intra-site analysis of faunal material can be used to further understanding of animal husbandry beyond that of the individual site. The more information that is available about individual faunal assemblages, the more detailed inter-site comparisons can become. Therefore more detailed intra-site analysis should be undertaken to further our understanding of Iron Age animal husbandry at individual sites and at a broader regional level.

Various suggestions have been given above for future work that may further our understanding of animal husbandry strategies as inferred from archaeological faunal assemblages. The faunal evidence alone can provide a great deal of information about the animal economy, as this study has shown. However there are other sources of environmental and cultural evidence that may be used in conjunction with animal bones to provide further information about animal husbandry. For a fuller understanding of Iron Age animal husbandry it is important to consider how the animal and plant husbandry strategies interacted, and the relative importance of arable and pastoral contributions to the economy. Animal husbandry and arable cultivation are often closely linked and the arable strategy may well have influenced, or been influenced by, the choice of animal husbandry strategy. The animal economy represents only one part of a larger whole, and it is important to bear this in mind when attempting to reconstruct Iron Age animal husbandry regimes.

Chapter 11

Methods: Evaluation And Future Direction

The aim of this study, to produce reliable comparisons of published faunal assemblages from Iron Age Britain, has been achieved using a combination of different methods. The main principle behind the choice of methodology was that it should compare existing published data using straightforward visual comparisons to recognise trends and patterns that could be interpreted in terms of strategies of animal husbandry. The comparative study was aimed at highlighting and explaining differences in the composition of faunal assemblages, and recognising broad similarities within and between regional groups of faunal samples. It is important to assess how successful the methods have been in helping achieve these aims, and to propose further work that could benefit future comparative faunal studies. This chapter will discuss the suitability of the methodology for comparing the available British Iron Age faunal data, and how applicable these methods are to comparative studies of faunal material from other periods or geographical locations. The particular problems in applying these methods to Iron Age data will also be discussed, together with suggestions for improving the comparability of future published faunal material.

Identification of trends and outliers

The methods used to compare both quantification and ageing data successfully distinguished a number of groups of samples with broad similarities, and allowed easy recognition of the outlying samples. Several inter- and intra-regional patterns of species proportions were recognised. These include regional characteristics such as the predominance of sheep in the samples from Wessex; the predominance of cattle in the Eastern samples; the higher incidence of pig in the samples from Wales and Western England; and intra-regional trends such as the increase in the percentage of sheep in the Wessex samples from the Early to Late Iron Age periods. Clear patterns also emerged from the analysis of tooth wear data; distinct regional differences in cattle mortality profile were apparent between the Wessex and Upper Thames valley samples, and within the Wessex and Upper Thames Valley sheep samples two distinct intra-regional groups with different levels of stage C mortality were also visible. The methods also differentiated between regional groups and a number of outliers; analysis of species proportions revealed abnormally high percentages of pig in the samples from Puckeridge-Braughing and Skeleton Green in the Eastern region, while the cattle mortality profile from the one low-lying wetland site at the outskirts of the Wessex and central southern England region (Meare) was distinctly different from the broadly similar patterns of the other Wessex samples.

Visual analysis of the data proved very effective; it was possible to pick out regional groups, intra-regional trends and outlying samples. Visual analysis of tripolar graphs and mortality profiles to recognise patterns in the data and determination of the strength of these relationships is, however, subjective. Given this, and the tendency for ranges of species proportions and patterns of mortality of different inter- and intra-regional groups to overlap, it is not always possible to accurately define the parameters of the different groups. The patterns most clearly visible have little overlapping of values with other groups and contain lots of samples to show repetition of the trend. How clearly visible a pattern is provides the only indication of the strength of the trend or relationship; the subjective nature of visual analysis means it is not possible to quantify to what extent an observed pattern is real or due to chance.

Despite the subjective nature of visual assessment, it is unlikely that the use of objective *statistical methods* of analysis could have contributed any more to this comparative study of Iron Age faunal assemblages. Much of the available data is unsuitable for use in statistical tests, either because sample sizes are too small or because the effects of different variables are impossible to quantify. For example the number of ageable mandibles, n=7, used to generate the Farmoor sheep mortality profile is substantially lower than the recommended sample size of 40+ for use in statistical analysis of mortality profiles (Shennan 1988).

It is probable that the differences between samples from different groups are not statistically significant. However, it is not the degree to which samples differ that distinguishes one group from another but the homogeneity of samples within those groups. The visual distinctions between different groups are based on repeated observation of certain characteristics in several faunal samples. A mortality curve from each of the two groups observed within the Wessex sheep dataset would not appear significantly different according to a Kolmogorov-Smirnov test, and it is unlikely that a visual assessment would register any major differences between the curves, as the overall shape of the two curves would be broadly similar. Only when several curves are considered together does the dichotomy in stage C mortality levels become apparent. In this instance the differences in the samples are too small to be picked up by statistical analysis. Conversely, the differences in species proportions are too great; the internal variation in cattle, sheep, and pig proportions within a visually discernible group is often quite large, and it would not be surprising if samples from within the same group had statistically significant differences in species proportions. Again, it is not the actual values that are important in recognising patterns but the grouping of several broadly similar samples. A difference in the percentage of each species in different samples of 5-10% either way would probably register as statistically significant, but given the number of potential biases affecting the composition of faunal assemblages this level of difference means very little in real terms.

Published data: Limitations and recommendations

In theory the methods used in this study provide a reliable means of comparing different published faunal assemblages, and recognising inter- and intra-regional similarities and differences in assemblage composition that can be tested for relationships with a number of different site characteristics. These observations may then be used to build up a picture of patterns of Iron Age animal husbandry throughout Britain. *In practice* the successful application of these methods is limited, in some cases severely, by the quality and quantity of published bone reports.

The following section highlights some of the main limitations of using published data when attempting a comparative study of British Iron Age animal husbandry, and recommendations are made for ways to improve the usefulness of future faunal reports for research of this sort. Many of the problems encountered during the course of this study are not specific to the British Iron Age. Recent regional reviews of British environmental archaeological data throughout all periods from the Neolithic to Medieval undertaken by a number of different analysts have all met with similar problems of availability, accessibility and comparability of published data (Dale Serjeantson & Sue Stallibrass pers. comm.). The majority of limitations and recommendations discussed therefore apply to analyses of faunal remains of all periods from Britain and further afield.

It was mentioned in the previous chapter that the lack of published faunal assemblages from particular regions was a barrier to our understanding of animal husbandry within these regions and throughout the whole of Britain. There were also absences of data *within* the published material that further limited the comparative analysis of Iron Age faunal samples. The lack of consideration of skeletal element representation in many of the reports provides a prime example of how the quality of individual bone reports limited this comparative study. This is a problem that also limited the effectiveness of the comparative studies of both quantification and ageing data.

The method of comparing *skeletal element representation* could not be successfully applied to Iron Age faunal assemblages. This failure was primarily due to the absence of body part data in an appropriate format. Few Iron Age faunal reports consider skeletal element representation in any detail, if at all. Thus the full potential of analysing the representation of different body parts is not realised for the Iron Age material. Even when the representation of different body parts is considered it is most often the NISP for each element which is recorded, not the MNE (cf. chapter 5 for details of these quantification units). This is highly unsatisfactory as it means the effects of differential transport, human and animal attrition, survival, and retrieval are likely to have been obscured by the effects of differential fragmentation. It is very probable that the proposed method of comparing skeletal element representation would have been an effective means of highlighting and comparing the effects of taphonomic biases and human processing on different Iron Age faunal samples, had there been MNE data available. The methodological variation between analysts, the inappropriate format of data, and the overall lack of such information prevented the analysis of skeletal element representation within the Iron Age dataset.

Future comparative studies of Iron Age faunal material should aim to analyse the representation of different skeletal elements to increase our general understanding of the dataset and to tackle specific questions about the composition of particular assemblages. Comparing the survival of different elements between different species may serve to highlight differential preservation of species which in turn would affect interpretation of species proportions. Similarly skeletal element analysis may reveal the effects of retrieval bias against smaller elements, which might also be indicative of a retrieval bias against smaller infant material, and this could effect the mortality profiles. Analysis of body part might also indicate that certain species were present at a site primarily in the form of meat joints, suggesting that a particular species was an imported food resource and not part of the overall husbandry regime. Future analyses of skeletal element representation may help determine whether the higher incidence of the larger species (cow and pig) compared to the smaller sheep in the Western samples, the differences in neonatal/infant cattle mortality in the Wessex samples, and the almost complete absence of anything other than prime meat aged cattle, sheep, and pigs in the West Stow assemblage, are the effects of taphonomic bias or husbandry strategy. Consistent use and publication of MNE data in faunal reports would enable this sort of detailed analysis of skeletal element representation to be undertaken.

Ageing methods were seldom overlooked in the same way as body part representation, but the information given in the reports was not always in a useful format. Although ageing was considered in most reports, not all authors presented tooth wear data as some analyses were undertaken before established methods of ageing from tooth wear had been developed. Even after the development of these techniques, toothwear data is often absent from reports. Where dental eruption and wear is considered there are a variety of different methods in use for analysing and presenting age data; this makes direct comparison of the age data from different assemblages very difficult.

Use of a consistent method for recording the state of eruption and wear of individual teeth, both loose and in mandibles, and publication of this raw data would solve the problem of comparability as the data would be available for later analysis using a single consistent methodology even if different methods of analysis were used in the original report. In the case of cattle, sheep, and pig, Grant's (1975) method is probably the best way to record the state of eruption and wear in individual teeth and tooth groups; it provides a record of eruption and wear that is suitable for use in all existing ageing methods based on the mandibular cheek teeth (e.g. Payne 1973, Maltby 1995a, & Ewbank et al 1964) including seasonality studies (e.g. Legge & Dorrington 1985). Also, using Grant's system, data can be easily presented in compact tables which is an advantage where publishing space is restricted. When one considers the amount of space given over to publication of measurement data in faunal reports, the addition of a short appendix listing toothwear data does not seem unreasonable and would be greatly beneficial to subsequent faunal studies.

Quantification information is commonly available in published reports, but not always in a consistent format. Analysis of species proportions would ideally have involved comparison of MNE data, as would analysis of body part representation, but MNE has not yet been widely adopted by Iron Age faunal analysts so the more widely available NISP data was used to compare species proportions instead. The adoption of new units of quantification may aid interpretation of species proportions within an assemblage, but the publication of additional quantification data in established formats such as NISP will enable direct comparisons with an existing large faunal dataset.

The Iron Age faunal analysts use no *consistent methodology*, and this makes inter- site comparisons very difficult. Unless comparable forms of data are used, no reliable interpretations of taphonomy or husbandry can be made. Often data from different assemblages may appear to be comparable when in actual fact it is not; for example, as explained in chapter 5, the term NISP may be applied to data obtained by a number of different methods so comparing NISP data from different assemblages is not necessarily comparing like with like. A *clear statement of all methods* used to obtain data is an essential requirement of all faunal reports if there is to be the possibility of ensuring that only truly comparable data is used in inter-site and inter-regional analyses.

The publication or *increased accessibility of raw data* would also substantially improve the comparability of different faunal assemblages. A number of assemblages could not be included in comparative analysis of quantification or ageing data because the final data format was not usable, even though earlier formats of data used in the generation of the final published results could have been used in this study. An example of this is the tooth wear data from Stanwick (Rackham forthcoming) and Thorpe Thewles (Rackham 1987). In its final published format Rackham's wear data cannot be used to generate mortality curves that can be directly compared with those from other samples; however, initially wear was recorded according to Grant's (1975) methodology and in that state could have been used in this comparative study. In the same vein, reports which only give NISP for each species as a percentage and not as an actual number could not be included as there was no guarantee that the total NISP for cow, sheep, and pig was greater than the 300 specimens required for inclusion in the comparative analysis. Had the actual NISP been published in addition to the final calculated percentage the samples might not have been excluded.

Access to more raw and intermediate data might also have enabled an analysis of skeletal element representation. The MNI for each species was calculated for many of the Iron Age samples, and intermediate forms of data used in calculating the MNI, if accessible, could be used to show body part representation. The MNI is calculated by determining the MNE of the most commonly occurring skeletal element, and in order to determine which is the most commonly occurring skeletal element the MNE for different elements must be determined. If the MNE data was available for sufficient samples it might be possible to utilise it in a comparative analysis of skeletal element representation.

Often small faunal assemblages remain unpublished because the sample sizes involved are too small to enable reliable interpretation of animal husbandry at the site. Although on their own small assemblages provide very limited information, use of small assemblages in this study has shown that when compared to larger samples it may still be possible to recognise key similarities and differences among the faunal assemblages. Thus the inclusion of a small sample in a comparative study may add to its interpretation. Inclusion of small samples can also improve comparative studies by increasing the available dataset, provided the potential problems of small sample bias are borne in mind and it is known which are the undersized samples. It is therefore important that as well as improving the quality and quantity of data from large faunal assemblages, data from small assemblages is also made available by publication.

While consistent use of the same methodology would no doubt improve comparability of published faunal analyses it is not a realistic long term solution to the problem. As new and better analytical techniques are developed they should be used in Iron Age faunal analyses; there is little merit in limiting the potential information available from faunal assemblages by continued use of outdated methods simply because it ensures comparability. It is recommended that all faunal reports give a clear explanation of all methods used so that it is known exactly what the different forms of data represent and how compatible they are. It is also recommended that while new developments are to be encouraged, consistent methodologies are used where possible to aid comparability. Publication of, or improved access to raw and intermediate data would also prove a considerable aid to comparative studies of the British Iron Age, and other faunal assemblages. Faunal data is a valuable source of environmental evidence that should not be wasted; when consistent high quality reporting and accessibility of data is maintained, archaeological faunal assemblages have the potential to broaden our understanding of many aspects of Iron Age society.

Use of methods outside the British Iron Age

The purpose of this study was to compare British Iron Age faunal assemblages; however it is hoped that the methods used to do this, or at least the principles behind them, may be applicable to faunal assemblages from other periods and locations. The main factor limiting comparative analysis of British Iron Age faunal samples is likely to pose a similar problem to other comparative studies, namely the lack of sufficient data in appropriate comparable formats. Differences in the main animal species is the other main reason why direct application of the methods used in this study would not be possible. Where appropriate, different categories of site characteristics may be substituted for geology, height, date and settlement type in order to test for relationships specific to the dataset.

NISP is probably the unit of quantification most commonly used in faunal studies so the use of NISP data in the comparison of species proportions from different assemblages would seem to be a broadly applicable method. If another reliable method of quantification, such as MNE, was more commonly used, the same principles of comparing species proportions could still be applied to the dataset, but using an alternative quantitative unit to NISP. The adaptability of this method of comparing species proportions using tripolar graphs for use with other faunal datasets is already well established. Prior to this study the method has been used in a number of different comparative studies (e.g. King 1978 & 1984; Lepetz 1996), in particular the method was used to great effect in King's comparative study of Romano-British faunal assemblages. The main problem in applying this method of comparing species proportions to alternative datasets arises if the assemblages are not predominantly comprised of the same three main species. If there is a great deal of variation in the main animal species, or if more or less than three species tend to predominate, the use of tripolar graphs to visually compare species proportions is not a suitable method of analysis. However, the principle of comparing the species composition of faunal assemblages in order to recognise similarities and differences in husbandry regimes remains sound, even if an alternative to tripolar graphs has to be found.

The principle of comparing mortality profiles of each of the main species in order to recognise patterns of selective culling and herd management is also appropriate for use with other faunal datasets. In practise the method of generating Payne style mortality curves from different types of tooth wear data may only be used for sheep/goat, cattle or pig as the wear stages used and their duration are species specific. However the method may be adapted for any species which can be reliably aged by dental eruption and wear, and for which an appropriate timetable of wear exists, provided tooth wear data has been recorded in a comparable format. In addition to the methods of comparing species proportions and mortality patterns, provided there are sufficient samples with MNE data there is no reason why the method of comparing skeletal element representation should not also be applicable to other datasets.

The approach used in this comparative study would appear to be best suited to faunal datasets which are comprised mainly of sheep, cattle and pig. Ideally datasets should be large. This ensures that any patterns within the dataset are repeated by enough samples to be easily recognised; as illustrated by the emergence of clear intra-regional groups in the largest regional dataset (Wessex & central southern England, 55 samples). Intra-regional patterns within smaller regional datasets are however more ambiguous. Although the details of each method may require some adaptation, the principles of comparing species proportions, mortality patterns, and skeletal element representation may be applied to any faunal dataset.

Summary

This study has successfully developed a widely applicable methodology for the comparison of published faunal data produced by different analysts using a number of different methods. A need has been highlighted for a higher standard of treatment of Iron Age faunal assemblages, including greater accessibility to raw and intermediate forms of data, clear declarations of all methods used and, where possible, production of comparable data by consistent use of established methodologies. The methods used in this study may be used to compare published faunal data from other periods and regions, and are equally appropriate for use with fresh data. A number of regional patterns of husbandry strategy have been identified, some of which are related to particular site characteristics. The results of this study have enabled the testing of old models of animal husbandry regimes, and have allowed new models of animal husbandry strategy to be put forward for the British Iron Age.

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Appendix 1

Information available in published Iron Age faunal reports

Appendix 1 provides a list of the Iron Age site faunal assemblages used in this study, together with author references for the published bone reports and, where provided, the National Grid Reference of each site. Also listed are details of information available in these reports relevant to this study; including units of quantification (NISP, MNI, or MNE), method of toothwear analysis, and method of comparing skeletal element representation.

Site Name	Author	NGR	NISP	MNI	MNE	Toothwear Cow	Toothwear Sheep	Toothwear Pig	Element Info
Abbotstone Down	Maltby 1986		Yes				Maltby		NISP
Appleford	Wilson 1980	SU 521 937	Yes	Yes					
Ashville	Wilson & Hamilton 1978	SU 483 973	Yes	Yes		Grant	Grant & Payne	Grant	
Aston Mill Farm	Lovett 1990	SO 952 354	Yes	Yes		Grant	Grant	Grant	
Baldock	Chaplin & McCormick 1986	TL 251 340		Yes	Yes	Chaplin & McCormick			MNI
Balksbury	Maltby 1995b	SU 350 445	Yes			Grant	Grant	Maltby	NISP
Bancroft	Holmes & Rielly 1994	SP 827 403	Yes	Yes		Grant (grouped)	Payne	Grant (grouped)	NISP
Barton Court Farm	Wilson 1984	SU 510 977	Yes	Yes		Grant	Grant & Payne	Grant	
Bishopstone	Gebbels 1977	TQ 467 007	Yes						NISP
Blackhorse Road	Legge et al 1988	TL 233 336	Yes	Yes		Payne/Halstead	Payne		
Bramdean	Clutton-Brock 1982	SU 628 282	Yes						NISP
Brighton Hill South	Maltby 1995a	SU 607 686	Yes			Maltby	Maltby	Maltby	NISP
Brigstock	Field 1983	SP 925 841	Yes	Yes					
Budbury	Westley 1970	ST 821 611	Yes						
Burgh	Jones et al 1987 & 1988	TM 244 523	Yes	Yes		Grant	Grant	Grant	NISP
Bury Wood Camp	Bunting et al 1963	ST 817 740	Yes						
Castle Ditches	Hogg 1977	ST 059 700	Yes	Yes					
Catcote	Hodgson 1968	NZ 491 316	Yes	Yes	Yes		Ewbank		NISP
Cat's Water	Biddick 1984	TL 217 990	Yes	Yes		Grant	Payne & Ewbank		NISP & MNE
Chalton	Startin 1976		Yes						
Chilbolton Down	Maltby 1984	SU 411 391	Yes						NISP
Claydon Pike	Wilson & Allison unpublished	SU 192 997	Yes	Yes		Grant	Grant	Grant	
Copse Farm	Browne 1985	SU 895 065	Yes	Yes					
Coygan Camp	Westley 1967	SN 284 092	Yes						
Croft Ambrey	Whitehouse 1974	SO 444 668	Yes	Yes			Ewbank		
Dalton Parlours	Bery 1990	SE 402 445	Yes	Yes		Grant	Grant & Payne	Grant	NISP
Danebury	Grant 1984a & 1991	SU 324 377	Yes	Yes		Grant	Grant	Grant	NISP
Dinorben	Gardner & Savory 1964	SH 968 757		Yes					
Ditches	Rielly 1988	SO 996 095	Yes	Yes	Yes	Grant	Grant & Payne	Grant	NISP & MNI
Dragonby	Harman 1996	SE 905 138	Yes			Ewbank	Ewbank		NISP
Edix Hill	Davis 1995	TL 374 495	Yes				Payne		NISP
Eldon's Seat	Cunliffe & Philipson 1968	SY 939 776	Yes				Ewbank (grouped)		NISP & MNE
Farmoor	Wilson 1979		Yes	Yes			Grant	Grant	
Farningham Hill	Locker 1984	TQ 545 674	Yes						NISP
Garton Slack	Noddle 1981		Yes	Yes					
Grimthorpe	Jarman et al 1968	SE 816 535	Yes				Ewbank		NISP
Groundwell Farm	Coy 1981	SU 157 889	Yes						
Grove Farm	Gouldwell 1992	SK 551 001	Yes	Yes	Yes	Grant	Grant	Grant	
Gussage all Saints	Harcourt 1979	ST 998 101		Yes		Harcourt	Harcourt	Harcourt	

Haddenham	Evans & Serjeantson 1988	TL 41 74	Yes	Yes					
Hardingstone	Gilmore 1969	SP 764 574	Yes						
Hartigans	Burnett 1993		Yes	Yes		Grant	Grant		NISP
Hawks Hill	Carter et al 1965	TQ 155 554	Yes						
Heathrow	Sutton 1978	TQ 084 766	Yes	Yes					NISP
Ivinghoe Beacon	Westley 1968	SP 960 169	Yes						
Little Somborne	Locker 1979	SU 389 328	Yes						
Maiden Castle	Armour-Chelu 1991	SY 669 885	Yes				Grant		NISP
Market Deeping	Albarella 1997	TF 158 115	Yes	Yes	Yes	Grant & Payne	Grant & Payne		NISP & MNI
Meare 1984	Backway 1986	ST 44 42	Yes	Yes	Yes				NISP & MNI
Meare East 1982	Levine 1986	ST 447 423	Yes	Yes		Higham	Payne	Bull & Payne	
Meare West 1979	Bailey et al 1981	ST 445 423	Yes	Yes	Yes		Payne		NISP
Micheldever Wood	Coy 1987a	SU 527 370	Yes				Payne		
Mingies Ditch	Wilson 1993	SP 391 059	Yes	Yes		Grant	Grant	Grant	
Mount Batten	Grant 1988	SX 48 53	Yes	Yes		Grant (grouped)	Grant (grouped)	Grant	NISP
Old Down Farm	Maltby 1981b	SU 356 465	Yes				Grant		NISP
Ower	Coy 1987b	SZ 000 860	Yes						NISP
Owslebury	Maltby 1987	SU 525 246	Yes			Grant (grouped) & Maltby	Grant (grouped) & Maltby	Grant (grouped) & Maltby	NISP
Pennyland	Holmes 1993	SP 862 411	Yes	Yes		Grant (grouped)	Payne	Grant (grouped)	NISP
Port Seton	Hambleton & Stallibrass forthcoming	NT 409 754	Yes	Yes	Yes	Grant	Grant	Grant	NISP & MNE
Poundbury	Buckland-Wright 1987	SY 682 911	Yes	Yes					NISP
Puckeridge-Braughing	Fifield 1988	TL 387 236	Yes	Yes		Fifield	Fifield	Fifield	NISP
Rope Lake Hole	Coy 1987c	SY 932 777	Yes				Grant (grouped)		NISP
Rucstalls Hill	Gregory 1978	SU 651 515	Yes	Yes					
Skeleton Green	Ashdown & Evans 1981	TL 386 238	Yes	Yes			Ewbank		NISP
Slonk Hill	Sheppard 1978	TQ 226 065	Yes	Yes					NISP
Stanwick	Rackham forthcoming	NZ 183 118	Yes	Yes	Yes	Grant/Rackham	Grant/Rackham	Grant/Rackham	MNE
Sutton Walls	Kenyon 1954	SO 525 464							
Thorpe Thewles	Rackham 1987	NZ 396 243	Yes			Rackham	Rackham	Rackham	NISP
Uley Bury	Levitan 1983	ST 784 989	Yes	Yes					NISP
Wakerley	Jones 1978		Yes	Yes	Yes				NISP & MNI
Watkins Farm	Wilson & Allison 1990	SP 426 035	Yes	Yes		Grant	Grant	Grant	
Wavendon Gate	Dobney & Jaques 1996	SP 903 369	Yes	Yes					NISP
Weekley	Whatrup & Jones 1988	SP 886 818	Yes	Yes	Yes				MNI
West Stow	Crabtree 1990	TL 797 714	Yes	Yes		Grant (grouped)	Grant (grouped)	Grant (grouped)	NISP
Winklebury	Jones 1977	SU 614 528	Yes	Yes					NISP
Winnall Down	Maltby 1985	SU 498 303	Yes			Grant	Grant		

Appendix 2

Site characteristics and species proportions of Iron Age faunal assemblages

Appendix 2 lists particular site characteristics of each of the Iron Age faunal assemblages used in this study, and the number of identified cattle, sheep, and pig fragments in each sample. Site characteristics include the geographical region in which each site is located, underlying geology and topographical location of site in metres Ordnance Datum, the date of each faunal sample, and the type of settlement from which the assemblage is derived.

Site Name	Region	Geology	Height m OD	Date of sample	Site Type	Cow NISP	Sheep NISP	Pig NISP
Abbotstone Down LIA-ERB	Wessex and Central Southern England	Unknown	Unknown	LIA - ERB	Other	326	258	63
Appleford EIA-MIA	Upper Thames Valley and Surrounds	Gravel	26-75	MIA	Open settlement	198	99	53
Ashville EIA	Upper Thames Valley and Surrounds	Gravel	26-75	EIA	Open settlement	157	242	47
Ashville MIA	Upper Thames Valley and Surrounds	Gravel	26-75	MIA	Open settlement	366	727	112
Ashville LIA	Upper Thames Valley and Surrounds	Gravel	26-75	LIA	Open settlement	290	334	86
Ashville total IA	Upper Thames Valley and Surrounds	Gravel	26-75	IA	Open settlement	1072	1841	326
Aston Mill Farm MIA	Midlands	Gravel	Unknown	MIA	Other	279	276	74
Aston Mill Farm total IA	Midlands	Gravel	Unknown	IA	Other	314	299	83
Baldock LIA	Eastern England and East Anglia	Chalk	26-75	LIA	Open settlement	22*	39*	14*
Balksbury EIA	Wessex and Central Southern England	Chalk	76-150	EIA	Hillfort	272	420	72
Balksbury MIA	Wessex and Central Southern England	Chalk	76-150	MIA	Hillfort	1542	2308	282
Balksbury total IA	Wessex and Central Southern England	Chalk	76-150	IA	Hillfort	1814	2728	354
Bancroft EIA-LIA	Eastern England and East Anglia	Boulder	76-150	IA	Open settlement	503	317	83
Bancroft LIA-ERB	Eastern England and East Anglia	Boulder	76-150	LIA - ERB	Open settlement	256	208	71
Bancroft total IA	Eastern England and East Anglia	Boulder	76-150	IA	Open settlement	795	548	156
Barton Court Farm LIA-ERB	Upper Thames Valley and Surrounds	Gravel	26-75	LIA - ERB	Enclosed settlement	443	415	93
Bishopstone MIA - LIA	Wessex and Central Southern England	Chalk	26-75	LIA	Enclosed settlement	304	247	78
Blackhorse Road MIA	Eastern England and East Anglia	Chalk	76-150	MIA	Enclosed settlement	353	136	33
Blackhorse Road total IA	Eastern England and East Anglia	Chalk	76-150	IA	Enclosed settlement	455	183	44
Bramdean MIA phase 2	Wessex and Central Southern England	Chalk	76-150	MIA	Banjo	179	394	52
Bramdean total MIA	Wessex and Central Southern England	Chalk	76-150	MIA	Banjo	277	498	107
Brighton Hill South E-MIA	Wessex and Central Southern England	Chalk	76-150	MIA	Enclosed settlement	134	267	52
Brighton Hill South M-LIA	Wessex and Central Southern England	Chalk	76-150	LIA	Enclosed settlement	159	337	58
Brighton Hill South LIA-ERB	Wessex and Central Southern England	Chalk	76-150	LIA - ERB	Enclosed settlement	930	751	138
Brighton Hill South total IA	Wessex and Central Southern England	Chalk	76-150	IA	Enclosed settlement	1227	1355	248
Brigstock enclosure IA	Midlands	Boulder	76-150	IA	Enclosed settlement	180	183	46
Brigstock total IA	Midlands	Boulder	76-150	IA	Enclosed settlement	187	347	67
Budbury EIA	Wessex and Central Southern England	Limestone	76-150	EIA	Hillfort	971	1067	220
Burgh LIA	Eastern England and East Anglia	Chalk	26-75	LIA	Enclosed settlement	585	697	178
Bury Wood Camp	Wessex and Central Southern England	Limestone	76-150	IA	Hillfort	124	235	44
Castle Ditches ?MIA - RB	Western England and Wales	Unknown	26-75	IA	Hillfort	150	158	40
Catcote LIA-RB	Northern England and Southern Scotland	Boulder	26-75	LIA - ERB	Open settlement	340	349	47
Cat's Water total IA	Eastern England and East Anglia	Peat	0-25	IA	Open settlement	2596	2224	393
Chalton total IA (both sites)	Wessex and Central Southern England	Chalk	76-150	IA	Open settlement	113	168	31
Chilbolton Down EIA-MIA	Wessex and Central Southern England	Chalk	76-150	MIA	Enclosed settlement	113	229	15
Claydon Pike MIA	Upper Thames Valley and Surrounds	Gravel	Unknown	MIA	Open settlement	270	258	26
Claydon Pike MIA-LIA	Upper Thames Valley and Surrounds	Gravel	Unknown	LIA	Open settlement	294	271	28
Copse Farm LIA Trench B	Wessex and Central Southern England	Alluvium	0-25	LIA	Open settlement	241	195	77
Coygan Camp MIA-LIA	Western England and Wales	Limestone	76-150	LIA	Hillfort	381	101	97

Coygan Camp total IA	Western England and Wales	Limestone	76-150	IA	Hillfort	434	121	101
Croft Ambrey MIA	Western England and Wales	Limestone	225+	MIA	Hillfort	489	573	509
Croft Ambrey LIA	Western England and Wales	Limestone	225+	LIA	Hillfort	167	282	247
Croft Ambrey total IA	Western England and Wales	Limestone	225+	IA	Hillfort	656	855	756
Dalton Parlours MIA-LIA	Northern England and Southern Scotland	Limestone	76-150	LIA	Open settlement	166	495	34
Danebury EIA	Wessex and Central Southern England	Chalk	76-150	EIA	Hillfort	3679	9253	2275
Danebury MIA	Wessex and Central Southern England	Chalk	76-150	MIA	Hillfort	1911	5730	1681
Danebury MIA-LIA	Wessex and Central Southern England	Chalk	76-150	LIA	Hillfort	8355	25892	5338
Danebury LIA	Wessex and Central Southern England	Chalk	76-150	LIA	Hillfort	5953	18290	2162
Danebury total IA	Wessex and Central Southern England	Chalk	76-150	IA	Hillfort	21025	62359	12016
Dinorben EIA	Western England and Wales	Limestone	151-225	EIA	Hillfort	16*	14*	5*
Ditches LIA-ERB	Upper Thames Valley and Surrounds	Limestone	151-225	LIA - ERB	Hillfort	2028	1644	668
Dragonby MIA-LIA	Midlands	Limestone	26-75	LIA	Open settlement	2745	5871	1277
Edix Hill LIA	Eastern England and East Anglia	Unknown	Unknown	LIA	Other	177	337	102
Eldon's Seat MIA	Wessex and Central Southern England	Other	76-150	MIA	Other	140	305	31
Eldon's Seat LBA-EIA	Wessex and Central Southern England	Other	76-150	EIA	Other	508	408	35
Eldon's Seat total IA	Wessex and Central Southern England	Other	76-150	IA	Other	648	713	66
Farmoor	Upper Thames Valley and Surrounds	Alluvium	26-75	IA	Open settlement	89	69	19
Farningham Hill LIA	Eastern England and East Anglia	Chalk	26-75	LIA	Enclosed settlement	530	500	65
Garton Slack IA D	Northern England and Southern Scotland	Other	Unknown	IA	Open settlement	1275	3955	535
Garton Slack IA E	Northern England and Southern Scotland	Other	Unknown	IA	Open settlement	1063	2644	625
Garton Slack IA F	Northern England and Southern Scotland	Other	Unknown	IA	Open settlement	456	874	142
Garton Slack total MIA-LIA	Northern England and Southern Scotland	Other	Unknown	LIA	Open settlement	2794	7473	1302
Grimthorpe IA	Northern England and Southern Scotland	Chalk	151-225	IA	Hillfort	403	184	57
Groundwell Farm total EIA-MIA	Wessex and Central Southern England	Limestone	76-150	MIA	Enclosed settlement	556	1886	1288
Grove Farm phase 2	Midlands	Boulder	26-75	LIA	Open settlement	184	87	85
Grove Farm phase 3-5	Midlands	Boulder	26-75	LIA	Enclosed settlement	292	163	88
Grove Farm total LIA	Midlands	Boulder	26-75	LIA	Other	476	250	173
Gussage all Saints phase 1	Wessex and Central Southern England	Chalk	76-150	EIA	Enclosed settlement	28*	46*	13*
Gussage all Saints phase 2	Wessex and Central Southern England	Chalk	76-150	MIA	Enclosed settlement	27*	79*	18*
Gussage all Saints phase 3	Wessex and Central Southern England	Chalk	76-150	LIA	Enclosed settlement	56*	112*	22*
Gussage all Saints total IA	Wessex and Central Southern England	Chalk	76-150	IA	Enclosed settlement	111*	237*	53*
Haddenham MIA (Had V)	Eastern England and East Anglia	Unknown	0-25	MIA	Enclosed settlement	180	620	40
Haddenham MIA (Had VI)	Eastern England and East Anglia	Unknown	0-25	MIA	Enclosed settlement	73	186	45
Haddenham total MIA (both sites)	Eastern England and East Anglia	Unknown	0-25	MIA	Enclosed settlement	253	803	95
Hardingstone LIA-RB	Midlands	Unknown	76-150	LIA - ERB	Other	489	599	141
Hartigans	Eastern England and East Anglia	Gravel	26-75	IA	Open settlement	144	30	2
Hawks Hill IA	Eastern England and East Anglia	Chalk	76-150	IA	Banjo	234	738	274
Heathrow EIA	Eastern England and East Anglia	Gravel	0-25	EIA	Other	31*	11*	16*
Ivinghoe Beacon EIA	Eastern England and East Anglia	Unknown	225+	EIA	Hillfort	1243	658	140

Little Somborne IA	Wessex and Central Southern England	Unknown	26-75	IA	Other	268	256	45
Maiden Castle EIA-LIA	Wessex and Central Southern England	Chalk	76-150	MIA	Hillfort	950	3010	405
Market Deeping MIA-LIA	Eastern England and East Anglia	Unknown	0-25	MIA	Unknown	131	117	22
Meare 1984 LIA	Wessex and Central Southern England	Peat	0-25	LIA	Open settlement	419	847	221
Meare East 1982 LIA	Wessex and Central Southern England	Peat	0-25	LIA	Open settlement	173	710	180
Meare West 1979 MIA-LIA	Wessex and Central Southern England	Peat	0-25	LIA	Open settlement	442	1142	238
Micheldever Wood MIA	Wessex and Central Southern England	Chalk	76-150	MIA	Banjo	836	1147	326
Micheldever Wood LIA-ERB	Wessex and Central Southern England	Chalk	76-150	LIA - ERB	Banjo	320	356	154
Micheldever Wood total IA	Wessex and Central Southern England	Chalk	76-150	IA	Banjo	1156	1503	480
Mingies Ditch late phase MIA	Upper Thames Valley and Surrounds	Aluvium	26-75	MIA	Enclosed settlement	217	438	41
Mingies Ditch MIA	Upper Thames Valley and Surrounds	Aluvium	26-75	MIA	Enclosed settlement	521	914	103
Mount Batten total IA	Western England and Wales	Limestone	0-25	IA	Other	1423	741	781
Old Down Farm EIA	Wessex and Central Southern England	Chalk	26-75	EIA	Enclosed settlement	126	161	53
Old Down Farm EIA	Wessex and Central Southern England	Chalk	26-75	EIA	Enclosed settlement	302	340	92
Old Down Farm MIA	Wessex and Central Southern England	Chalk	26-75	MIA	Enclosed settlement	401	699	85
Old Down Farm LIA-ERB	Wessex and Central Southern England	Chalk	26-75	LIA - ERB	Enclosed settlement	153	223	38
Old Down Farm total IA	Wessex and Central Southern England	Chalk	26-75	IA	Enclosed settlement	1022	1637	289
Ower LIA-RB	Wessex and Central Southern England	Unknown	0-25	LIA - ERB	Open settlement	101	132	238
Owslebury MIA	Wessex and Central Southern England	Chalk	76-150	MIA	Banjo	1390	2107	643
Owslebury LIA	Wessex and Central Southern England	Chalk	76-150	LIA	Banjo	880	1430	477
Owslebury LIA-ERB	Wessex and Central Southern England	Chalk	76-150	LIA - ERB	Open settlement	5308	2475	957
Owslebury total (MIA-ERB)	Wessex and Central Southern England	Chalk	76-150	IA	Other	7578	9284	3696
Pennyland MIA	Eastern England and East Anglia	Other	76-150	MIA	Enclosed settlement	710	341	94
Port Seton LIA-ERB	Northern England and Southern Scotland	Gravel	0-25	LIA - ERB	Enclosed settlement	536	91	80
Poundbury total IA	Wessex and Central Southern England	Chalk	26-75	IA	Other	432	910	120
Puckeridge-Braughing LIA-RB	Eastern England and East Anglia	Other	26-75	LIA - ERB	Open settlement	1348	1546	1412
Rope Lake Hole EIA-MIA	Wessex and Central Southern England	Chalk	26-75	MIA	Open settlement	137	152	22
Rope Lake Hole MIA	Wessex and Central Southern England	Chalk	26-75	MIA	Open settlement	134	222	29
Rope Lake Hole LIA	Wessex and Central Southern England	Chalk	26-75	LIA	Open settlement	402	616	74
Rope Lake Hole total IA	Wessex and Central Southern England	Chalk	26-75	IA	Open settlement	673	990	125
Rucstalls Hill EIA-MIA	Wessex and Central Southern England	Chalk	76-150	MIA	Enclosed settlement	233	470	48
Skeleton Green LIA-RB	Eastern England and East Anglia	Chalk	26-75	LIA - ERB	Open settlement	786	449	1202
Slonk Hill EIA-MIA	Wessex and Central Southern England	Chalk	26-75	MIA	Open settlement	144	208	74
Slonk Hill total IA	Wessex and Central Southern England	Chalk	26-75	IA	Open settlement	198	354	94
Stanwick phase 1 LIA	Northern England and Southern Scotland	Boulder	76-150	LIA	Open settlement	160	182	73
Stanwick phase 2 LIA	Northern England and Southern Scotland	Boulder	76-150	LIA	Open settlement	165	124	23
Stanwick phase 3 LIA	Northern England and Southern Scotland	Boulder	76-150	LIA	Open settlement	448	197	62
Stanwick phase 4 LIA-ERB	Northern England and Southern Scotland	Boulder	76-150	LIA - ERB	Enclosed settlement	1373	576	275
Stanwick total IA	Northern England and Southern Scotland	Boulder	76-150	IA	Other	2219	1101	444
Sutton Walls LIA	Western England and Wales	Gravel	76-150	LIA	Hillfort	863	752	355

Thorpe Thewles MIA-LIA	Northern England and Southern Scotland	Boulder	26-75	LIA	Enclosed settlement	747	284	130
Thorpe Thewles LIA	Northern England and Southern Scotland	Boulder	26-75	LIA	Open settlement	841	400	268
Thorpe Thewles total IA	Northern England and Southern Scotland	Boulder	26-75	LIA	Other	1588	684	398
Uley Bury period 1 MIA	Western England and Wales	Limestone	151-225	MIA	Hillfort	131	181	126
Uley Bury period 2 MIA-LIA	Western England and Wales	Limestone	151-225	LIA	Hillfort	175	215	44
Uley Bury total MIA-LIA	Western England and Wales	Limestone	151-225	LIA	Hillfort	382	510	190
Wakerley MIA-LIA	Midlands	Limestone	76-150	LIA	Enclosed settlement	196	220	52
Watkins Farm MIA	Upper Thames Valley and Surrounds	Gravel	Unknown	MIA	Enclosed settlement	405	429	87
Wavendon Gate LIA	Eastern England and East Anglia	Other	76-150	LIA	Banjo	413	79	11
Weekley MIA-LIA	Midlands	Limestone	76-150	LIA	Enclosed settlement	281	1327	482
Weekley LIA	Midlands	Limestone	76-150	LIA	Enclosed settlement	1424	1266	413
Weekley total IA	Midlands	Limestone	76-150	IA	Enclosed settlement	1705	2593	895
West Stow MIA-LIA	Eastern England and East Anglia	Other	Unknown	LIA	Open settlement	1390	890	270
Winklebury EIA-MIA	Wessex and Central Southern England	Chalk	76-150	MIA	Hillfort	752	1802	263
Winnall Down EIA	Wessex and Central Southern England	Chalk	26-75	EIA	Enclosed settlement	699	589	123
Winnall Down MIA	Wessex and Central Southern England	Chalk	26-75	MIA	Open settlement	838	1307	259
Winnall Down total IA	Wessex and Central Southern England	Chalk	26-75	IA	Other	1606	1966	397

*MNI values

Appendix 3

Representation of the different skeletal elements in Iron Age faunal assemblages

Appendix 3 tabulates numbers of skeletal elements represented in Iron Age pig, cattle, and sheep assemblages. Information is derived from published Iron Age faunal reports. The unit of quantification differs between assemblages and is therefore listed for each sample.

Wessex and Central Southern England

Cattle	NISP Abbotstone Down	NISP Balksbury EIA	NISP Balksbury MIA	NISP Bishopstone	NISP Bramdean	NISP Brighton Hill South	NISP Chilbolton Down
mandible	43	34	217	13	15	173	8
vertebra	6	17	68	2	8	70	9
rib	0	0	6	not given	0	4	not given
scapula p	29	23	123	1	7	86	9
pelvis	12	20	94	1	4	34	6
humerus	20	20	137	0	2	60	11
femur	9	9	83	0	6	37	8
radius	16	19	75	0	4	36	7
ulna	13	6	43	1	4	27	2
tibia	18	14	105	0	5	55	3
calcaneum	9	2	22	0	1	16	3
astragalus	5	1	15	0	3	9	not given
metacarpal	13	10	70	0	metapodials 8	28	5
metatarsal	18	12	63	0		48	5
phalanx 1	7	3	14	phalanges 0	0	5	2
phalanx 2	2	0	3		2	6	3
phalanx 3	1	0	2		1	2	0

Wessex and Central Southern England

Cattle	NISP	NISP	NISP	NISP		NISP	MNE	NISP	NISP
	Danebury EIA	Danebury MIA	Danebury MIA-LIA	Danebury LIA		Eldon's seat	Eldon's seat	Maiden Castle	Meare 1984
mandible	77	39	145	156	mandible	95	48	71	49
atlas & axis	58	19	155	103	vertebra	not given	not given	79	7
scapula p	71	46	216	141	rib	not given	not given	116	not given
pelvis	81	35	169	123	scapula p	not given	not given	43	8
humerus p	43	20	78	47	pelvis	not given	not given	35	5
humerus d	78	37	200	136	humerus	13	7	45	17
femur p	52	18	131	65	femur	12	6	41	18
femur d	39	17	113	46	radius	20	10	59	23
radius p	68	45	216	142	ulna	10	5	37	12
radius d	43	27	123	66	tibia	22	11	41	23
ulna p	60	31	169	119	calcaneum	11	6	17	5
tibia p	40	20	98	53	astragalus	15	8	11	9
tibia d	54	40	158	114	metacarpal	61	31	48	11
calcaneum	36	38	135	92	metatarsal	24	12	52	9
astragalus	60	41	159	96	phalanx 1	33	5	43	phalanges 7
metacarpal p	66	26	170	76	phalanx 2	13	2	29	
metacarpal d	45	22	112	69	phalanx 3	9	2	13	
metatarsal p	64	26	132	90					
metatarsal d	45	23	86	75					
phalanx 1	147	62	272	159					
phalanx 2	115	48	179	113					
phalanx 3	79	30	132	65					

Wessex and Central Southern England

Cattle	MNI Meare 1984	NISP Meare West	NISP Old Down Farm	NISP Ower	NISP Owslebury	NISP Poundbury	NISP Rope Lake Hole IA-RB	NISP Winklebury
mandible	9	not given	75	12	1084	18	103	69
vertebra	2	not given	131	6	397	40	43	167
rib	not given	not given	17	5	27	38	80	174
scapula p	4	13	38	0	444	23	46	47
pelvis	2	not given	73	8	253	7	40	59
humerus	4	11	68	4	306	15	40	20
femur	3	15	36	3	244	8	21	28
radius	5	7	49	5	236	14	29	26
ulna	8	not given	30	2	173	7	22	13
tibia	4	6	48	4	285	15	25	36
calcaneum	5	14	15	not given	91	7	not given	12
astragalus	not given	11	17	not given	76	19	not given	8
metacarpal	5	10	32	metapodials 9	235	22	metapodials 98	17
metatarsal	3	9	30		275	11		27
phalanx 1	0	not given	phalanges 64	phalanges 5	141	phalanges 11	phalanges 62	18
phalanx 2	1	not given			67			15
phalanx 3	1	not given			28			12

Upper Thames Valley and Surrounds

Cattle	NISP	MNI
	Ditches	Ditches
mandible	207	36
vertebra	18	4
rib	not given	not given
scapula p	188	28
pelvis	104	14
humerus	68	18
femur	92	22
radius	47	17
ulna	52	21
tibia	94	19
calcaneum	30	18
astragalus	22	13
metacarpal	36	11
metatarsal	74	18
phalanx 1	64	not given
phalanx 2	42	not given
phalanx 3	44	not given

Eastern England and East Anglia

Cattle	MNI Baldock	NISP Bancroft LBA-EIA	NISP Bancroft LIA-ERB	NISP (+cow size frags) Burgh	NISP Cat's Water	NISP Edix Hill	NISP Farningham Hill	NISP Hartigans
mandible	22	2	39	107	308	not given	41	42
vertebra	not given	3	19	67	85	not given	23	3
rib	not given	0	5	291	not given	not given	4	not given
scapula p	11	3	7	55	126	8	30	1
pelvis	12	0	11	40	66	6	23	9
humerus	13	4	12	36	170	6	19	2
femur	7	0	7	34	137	1	13	5
radius	11	radius/ulna 4	radius/ulna 23	55	150	3	14	9
ulna	3			18	76	not given	7	3
tibia	7	1	14	52	164	12	16	5
calcaneum	10	not given	not given	8	not given	15	1	1
astragalus	10	not given	not given	4	not given	9	5	2
metacarpal	16	metapodials 3	metapodials 31	30	181	4	24	6
metatarsal	12			56	144	4.5	4	7
phalanx 1	not given	phalanges 0	phalanges 5	12	phalanges 78	12	phalanges 15	4
phalanx 2	not given			10		not given		1
phalanx 3	not given			1		4		0

Eastern England and East Anglia

Cattle	NISP	NISP	NISP	MNI	NISP	NISP	NISP
	Heathrow EIA	Heathrow LIA-RB	Market Deeping	Market Deeping	Pennyland	Puckeridge-Braughing	Skeleton Green
mandible	11	8	not given	not given	68	88	42
vertebra	not given	not given	not given	not given	104	6	125
rib	not given	not given	not given	not given	13	not given	not given
scapula p	5	2	3	2	31	139	77
pelvis	6	2	3	2	40	93	41
humerus	3	2	7	4	43	117	62
femur	1	0	1	1	38	63	46
radius	6	3	radius/ulna 9	radius/ulna 3	radius/ulna 52	111	49
ulna	2	0				31	24
tibia	3	1	8	4	57	132	64
calcaneum	1	1	7	4	not given	57	not given
astragalus	1	3	6	3	not given	37	not given
metacarpal	3	2	4	3	metapodials 64	73	17
metatarsal	3	1	3	2		77	34
phalanx 1	not given	not given	9	2	phalanges 37	83	phalanges 49
phalanx 2	not given	not given	not given	not given		25	
phalanx 3	not given	not given	not given	not given		23	

Eastern England and East Anglia

Cattle	NISP Wavendon Gate	NISP West Stow
mandible	74	127
vertebra	6	20
rib	not given	not given
scapula p	32	69
pelvis	23	38
humerus	25	54
femur	40	51
radius	32	59
ulna	10	24
tibia	36	76
calcaneum	11	34
astragalus	3	31
metacarpal	9	61
metatarsal	7	62
phalanx 1	4	53
phalanx 2	0	22
phalanx 3	0	18

Western England and Wales

Cattle	NISP Mount Batten		NISP Uley Bury
mandible	12	mandible	64
atlas & axis	20	vertebra	39
scapula p	17	rib	51
pelvis	13	scapula p	19
humerus p	2	pelvis	10
humerus d	4	humerus	19
femur p	4	femur	8
femur d	5	radius	radius/ulna 19
radius p	6	ulna	
radius d	3	tibia	21
ulna p	7	calcaneum	0
tibia p	0	astragalus	0
tibia d	9	metacarpal	metapodials 18
calcaneum	15	metatarsal	
astragalus	9	phalanx 1	phalanges 29
metacarpal p	19	phalanx 2	
metacarpal d	5	phalanx 3	
metatarsal p	20		
metatarsal d	4		
phalanx 1	27		
phalanx 2	34		
phalanx 3	21		

Midlands

Cattle	NISP Dragonby	NISP Wakerley	MNI Wakerley	MNI Weekley MIA-LIA	MNI Weekley LIA
mandible	150	46	27	17	92
vertebra	not given	not given	not given	not given	not given
rib	not given	not given	not given	not given	not given
scapula p	124	10	8	5	25
pelvis	103	not given	not given	10	43
humerus	78	15	9	2	16
femur	86	5	4	2	11
radius	radius/ulna 186	19	11	4	36
ulna		0	0	6	17
tibia	104	16	8	8	35
calcaneum	36	7	5	4	27
astragalus	21	12	6	6	27
metacarpal	69	20	11	7	39
metatarsal	90	18	9	2	36
phalanx 1	90	15	2	not given	0
phalanx 2	45	5	1	not given	0
phalanx 3	29	8	8	not given	not given

Northern England and Southern Scotland

Cattle	NISP	NISP	NISP	NISP	MNE	%NISP
	Catcote	Dalton Parlours	Grimthorpe	Port Seton	Port Seton	Thorpe Thewles
mandible	22	13	31	89	42	100
vertebra	28	not given	21	25	not given	14
rib	not given	not given	15	1	1	not given
scapula p	19	11	13	30	21	69
pelvis	6	14	22	36	16	44
humerus	34	5	17	23	16	48
femur	11	6	11	14	5	27
radius	21	8	radius/ulna 30	24	12	47
ulna	10	3		11	7	19
tibia	23	7	19	22	12	36
calcaneum	16	not given	8	7	7	20
astragalus	18	not given	9	13	13	27
metacarpal	24	metapodials 17	metapodials 53	27	16	54
metatarsal	23			37	22	67
phalanx 1	36	phalanges 42	phalanges 29	11	10	45
phalanx 2	22			4	4	22
phalanx 3	8			0	0	11

Wessex and Central Southern England

Sheep	NISP Abbotstone Down	NISP Balksbury EIA	NISP Balksbury MIA	NISP Bishopstone	NISP Bramdean	NISP Brighton Hill South	NISP Chilbolton Down
mandible	53	39	274	11	59	181	24
vertebra	2	7	157	2	13	28	1
rib	1	1	0	not given	37	7	not given
scapula p	4	8	91	6	4	30	9
pelvis	2	11	80	2	3	35	6
humerus	8	16	96	9	10	58	5
femur	3	11	93	2	8	41	7
radius	21	41	208	1	7	93	14
ulna	0	13	46	2	1	14	2
tibia	40	47	279	14	14	177	17
calcaneum	1	5	14	1	2	9	0
astragalus	0	0	3	1	6	6	not given
metacarpal	13	24	143	12	metapodials 10	41	9
metatarsal	29	39	225	11		107	8
phalanx 1	5	8	18	phalanges 3	2	17	9
phalanx 2	0	0	0		3	7	1
phalanx 3	1	0	0		1	5	1

Wessex and Central Southern England

Sheep	NISP Danebury EIA	NISP Danebury MIA	NISP Danebury MIA-LIA	NISP Danebury LIA		NISP Eldon's seat	MNE Eldon's seat	NISP Maiden Castle	NISP Meare 1984
mandible	383	241	1510	1033	mandible	89	45	286	52
atlas & axis	143	73	472	324	vertebra	not given	not given	164	18
scapula p	182	106	677	441	rib	not given	not given	51	not given
pelvis	200	124	614	486	scapula p	not given	not given	37	21
humerus p	93	62	246	162	pelvis	not given	not given	113	51
humerus d	263	142	782	588	humerus	32	16	210	37
femur p	143	95	433	259	femur	18	9	171	29
femur d	105	88	353	244	radius	35	18	347	52
radius p	230	114	651	450	ulna	11	6	93	6
radius d	171	80	442	333	tibia	42	21	291	95
ulna p	155	85	387	308	calcaneum	6	3	28	10
tibia p	132	60	316	225	astragalus	6	3	32	5
tibia d	246	117	626	489	metacarpal	35	18	179	39
calcaneum	145	104	363	292	metatarsal	27	14	267	62
astragalus	179	120	362	321	phalanx 1	10	2	105	phalanges 26
metacarpal p	202	104	536	339	phalanx 2	1	1	17	
metacarpal d	174	93	408	258	phalanx 3	0	0	14	
metatarsal p	178	115	524	361					
metatarsal d	133	78	338	225					
phalanx 1	447	288	751	600					
phalanx 2	172	124	285	265					
phalanx 3	109	68	158	102					

Wessex and Central Southern England

Sheep	MNI Meare 1984	NISP Meare West	NISP Old Down Farm	NISP Ower	NISP Owslebury	NISP Poundbury	NISP Rope Lake Hole IA-RB	NISP Winklebury
mandible	17	not given	158	15	1150	58	227	175
vertebra	4	not given	351	7	250	100	44	372
rib	not given	not given	85	1	71	100	68	312
scapula p	11	33	43	6	138	37	44	42
pelvis	9	not given	67	7	173	23	44	52
humerus	11	43	83	8	304	27	75	57
femur	6	38	90	4	309	22	49	96
radius	8	19	141	14	492	44	163	105
ulna	6	not given	43	3	98	17	27	41
tibia	12	41	130	12	814	35	259	171
calcaneum	7	25	27	not given	62	11	not given	30
astragalus	3	21	28	not given	80	14	not given	32
metacarpal	7	10	81	metapodials 19	296	22	metapodials 286	69
metatarsal	11	25	113		445	21		100
phalanx 1	3	not given	phalanges 180	phalanges 1	183	phalanges 61	phalanges 39	84
phalanx 2	2	not given			85			38
phalanx 3	0	not given			28			26

Upper Thames Valley and Surrounds

Sheep	NISP Ditches	MNI Ditches
mandible	206	53
vertebra	36	13
rib	not given	not given
scapula p	161	54
pelvis	126	41
humerus	90	37
femur	66	16
radius	95	44
ulna	36	14
tibia	173	46
calcaneum	21	16
astragalus	21	16
metacarpal	35	12
metatarsal	51	12
phalanx 1	22	0
phalanx 2	0	0
phalanx 3	1	0

Eastern England and East Anglia

Sheep	MNI	NISP	NISP	NISP (+sheep size frags)	NISP	NISP	NISP	NISP
	Baldock	Bancroft LBA-EIA	Bancroft LIA-ERB	Burgh	Cat's Water	Edix Hill	Farningham Hill	Hartigans
mandible	39	3	27	140	253	not given	28	5
vertebra	not given	1	9	42	69	not given	30	0
rib	not given	0	12	234	not given	not given	9	not given
scapula p	15	0	9	60	67	10	5	0
pelvis	6	2	11	28	43	6	8	1
humerus	23	2	14	38	118	16	11	2
femur	10	0	3	38	51	9	7	0
radius	20	radius/ulna 6	radius/ulna 22	90	254	9	23	2
ulna	6			8	45	not given	4	0
tibia	27	0	32	113	333	15	31	1
calcaneum	9	not given	not given	4	not given	11	1	0
astragalus	6	not given	not given	2	not given	10	2	0
metacarpal	19	metapodials 5	metapodials 21	80	154	9	4	1
metatarsal	17			84	181	7	7	1
phalanx 1	not given	phalanges 1	phalanges 3	18	phalanges 25	7	phalanges 14	0
phalanx 2	not given			0		not given		0
phalanx 3	not given			0		2		0

Eastern England and East Anglia

Sheep	NISP	NISP	NISP	MNI	NISP	NISP	NISP
	Heathrow EIA	Heathrow LIA-RB	Market Deeping	Market Deeping	Pennyland	Puckeridge-Braughing	Skeleton Green
mandible	16	3	not given	not given	73	208	71
vertebra	not given	not given	not given	not given	25	3	48
rib	not given	not given	not given	not given	7	not given	not given
scapula p	3	0	2	1	14	197	38
pelvis	0	0	2	1	12	73	31
humerus	4	1	2	1	16	134	39
femur	0	0	0	0	10	124	17
radius	3	2	radius/ulna 9	radius/ulna 3	radius/ulna 31	128	26
ulna	0	0				33	25
tibia	7	3	12	6	32	157	41
calcaneum	0	0	1	1	not given	26	not given
astragalus	0	1	4	2	not given	5	not given
metacarpal	4	0	2	1	metapodials 18	59	21
metatarsal	1	0	4	2		77	21
phalanx 1	not given	not given	0	0	phalanges 4	17	phalanges 7
phalanx 2	not given	not given	not given	not given		7	
phalanx 3	not given	not given	not given	not given		1	

Eastern England and East Anglia

Sheep	NISP Wavendon Gate	NISP West Stow
mandible	14	85
vertebra	0	7
rib	not given	not given
scapula p	1	19
pelvis	4	22
humerus	5	36
femur	2	19
radius	9	66
ulna	3	5
tibia	12	106
calcaneum	0	4
astragalus	0	6
metacarpal	4	45
metatarsal	4	43
phalanx 1	0	2
phalanx 2	0	1
phalanx 3	0	1

Western England and Wales

Sheep	NISP Mount Batten		NISP Uley Bury
mandible	21	mandible	96
atlas & axis	6	vertebra	0
scapula p	6	rib	0
pelvis	10	scapula p	26
humerus p	5	pelvis	21
humerus d	10	humerus	16
femur p	5	femur	22
femur d	6	radius	radius/ulna 36
radius p	15	ulna	
radius d	2	tibia	30
ulna p	5	calcaneum	0
tibia p	0	astragalus	0
tibia d	5	metacarpal	metapodials 12
calcaneum	4	metatarsal	
astragalus	9	phalanx 1	phalanges 15
metacarpal p	6	phalanx 2	
metacarpal d	3	phalanx 3	
metatarsal p	17		
metatarsal d	6		
phalanx 1	12		
phalanx 2	2		
phalanx 3	3		

Midlands

Sheep	NISP Dragonby	NISP Wakerley	MNI Wakerley	MNI Weekley MIA-LIA	MNI Weekley LIA
mandible	455	68	39	97	161
vertebra	not given	not given	not given	not given	not given
rib	not given	not given	not given	not given	not given
scapula p	209	12	7	18	33
pelvis	161			30	39
humerus	243	15	11	23	36
femur	185	14	7	8	9
radius	radius/ulna 366	33	12	20	37
ulna		2	2	4	10
tibia	488	40	26	28	36
calcaneum	37	2	2	5	8
astragalus	27	2	2	5	3
metacarpal	197	18	10	20	44
metatarsal	228	11	11	17	47
phalanx 1	54	3	1	not given	0
phalanx 2	21	0	0	not given	0
phalanx 3	4	0	0	not given	not given

Northern England and Southern Scotland

Sheep	NISP Catcote	NISP Dalton Parlours	NISP Grimthorpe	NISP Port Seton	MNE Port Seton	%NISP Thorpe Thewles
mandible	40	12	26	11	5	68
vertebra	55	not given	11	1	not given	8
rib	not given	not given	11	2	2	not given
scapula p	25	8	0	0	0	20
pelvis	12	9	17	4	3	26
humerus	36	8	5	6	6	48
femur	13	18	10	3	2	23
radius	27	25	radius/ulna 12	5	5	77
ulna	15	6		0	0	4
tibia	33	23	13	7	4	100
calcaneum	17	not given	1	1	1	11
astragalus	13	not given	1	1	1	6
metacarpal	16	metapodials 54	metapodials 12	7	6	34
metatarsal	24			8	5	51
phalanx 1	0	phalanges 239	phalanges 2	0	0	13
phalanx 2	0			1	1	5
phalanx 3	0			0	0	1

Wessex and Central Southern England

Pig	NISP	NISP	NISP	NISP	NISP	NISP	NISP
	Abbotstone Down	Balksbury EIA	Balksbury MIA	Bishopstone	Bramdean	Brighton Hill South	Chilbolton Down
mandible	19	10	46	13	16	50	1
vertebra	2	2	7	2	4	10	0
rib	1	1	2	not given	0	2	not given
scapula p	3	4	30	1	8	27	1
pelvis	2	4	8	1	1	7	0
humerus	3	5	28	0	5	13	1
femur	4	5	0	0	1	14	2
radius	1	2	12	0	3	11	0
ulna	4	1	9	1	1	11	0
tibia	6	7	20	0	2	13	0
calcaneum	0	1	3	0	0	1	not given
astragalus	0	0	0	0	0	1	not given
metacarpal	metapodials 1	1	2	0	metapodials 4	1	0
metatarsal		5	3	0		2	0
phalanx 1	0	1	0	Phalanges 0	4	3	0
phalanx 2	0	0	0		0	4	0
phalanx 3	0	0	0		3	1	1

Wessex and Central Southern England

Pig	NISP Danebury EIA	NISP Danebury MIA	NISP Danebury MIA-LIA	NISP Danebury LIA		NISP Maiden Castle	NISP Meare 1984	MNI Meare 1984
mandible	80	67	263	149	mandible	36	19	2
atlas & axis	43	20	89	89	vertebra	41	1	2
scapula p	55	37	174	81	rib	8	not given	not given
pelvis	44	40	125	62	scapula p	42	9	3
humerus p	27	22	60	22	pelvis	18	15	5
humerus d	42	42	145	74	humerus	30	14	4
femur p	36	25	70	13	femur	8	18	4
femur d	31	31	79	21	radius	18	2	1
radius p	47	38	116	56	ulna	24	2	2
radius d	24	27	56	25	tibia	15	17	4
ulna p	57	44	162	80	calcaneum	6	3	2
tibia p	34	21	53	21	astragalus	2	3	2
tibia d	47	35	112	66	metacarpal	8	6	2
calcaneum	52	26	95	44	metatarsal	9	1	1
astragalus	37	29	95	38	phalanx 1	7	phalanges 24	4
metacarpal p	54	46	138	52	phalanx 2	7		2
metacarpal d	48	38	107	39	phalanx 3	7		1
metatarsal p	46	31	101	38				
metatarsal d	41	25	74	30				
phalanx 1	99	82	187	83				
phalanx 2	60	50	101	58				
phalanx 3	36	29	66	20				

Wessex and Central Southern England

Pig	NISP Meare West	NISP Old Down Farm	NISP Ower	NISP Owslebury	NISP Poundbury	NISP Rope Lake Hole IA-RB	NISP Winklebury
mandible	not given	40	41	685	20	30	40
vertebra	not given	4	5	120	4	1	32
rib	not given	1	1	53	27	2	1
scapula p	2	9	7	167	10	16	36
pelvis	not given	4	4	97	5	4	8
humerus	2	16	4	206	4	10	18
femur	2	4	9	143	8	2	8
radius	4	4	4	64	5	9	28
ulna	not given	18	2	93	1	7	22
tibia	6	10	8	174	4	10	26
calcaneum	10	6	not given	38	0	not given	14
astragalus	9	4	not given	37	1	not given	12
metacarpal	6	9	metapodials 3	35	3	metapodials 12	0
metatarsal	6	6		34	1		0
phalanx 1	not given	phalanges 12	phalanges 4	79	phalanges 1	phalanges 6	12
phalanx 2	not given			48			6
phalanx 3	not given			23			0

Upper Thames Valley and Surrounds

Pig	NISP Ditches	MNI Ditches
mandible	90	20
vertebra	32	16
rib	not given	not given
scapula p	34	12
pelvis	31	12
humerus	31	15
femur	16	7
radius	23	7
ulna	20	8
tibia	22	6
calcaneum	17	10
astragalus	10	5
metacarpal	23	7
metatarsal	13	4
phalanx 1	12	0
phalanx 2	6	0
phalanx 3	4	0

Eastern England and East Anglia

Pig	MNI	NISP	NISP	NISP (+sheep size frags)	NISP	NISP	NISP
	Baldock	Bancroft LBA-EIA	Bancroft LIA-ERB	Burgh	Cat's Water	Edix Hill	Farningham Hill
mandible	14	9	13	44	57	not given	7
vertebra	not given	0	0	2	2	not given	1
rib	not given	0	0	not given	not given	not given	0
scapula p	9	0	10	11	39	4	6
pelvis	4	1	3	24	20	3	6
humerus	11	1	9	14	26	6	6
femur	2	0	1	13	24	3	0
radius	4	radius/ulna 2	radius/ulna 4	6	10	3	0
ulna	6			17	22	not given	2
tibia	3	1	5	16	42	2	3
calcaneum	2	not given	not given	0	not given	4	0
astragalus	2	not given	not given	0	not given	2	0
metacarpal	0	metapodials 2	metapodials 3	7	metapodials 21	4	0
metatarsal	0			9		1	0
phalanx 1	not given	phalanges 2	phalanges 2	3	phalanges 1	10	phalanges 3
phalanx 2	not given			0		not given	
phalanx 3	not given			0		1	

Eastern England and East Anglia

Pig	NISP Market Deeping	MNI Market Deeping	NISP Pennyland	NISP Puckeridge-Braughing	NISP Skeleton Green	NISP Wavendon Gate	NISP West Stow
mandible	not given		16	171	229	3	34
vertebra	not given		1	2	116	0	2
rib	not given		1	not given	not given	not given	not given
scapula p	1		8	103	65	1	26
pelvis	3		3	85	75	4	15
humerus	2		8	85	49	0	28
femur	0		1	76	43	0	9
radius	radius/ulna 3		radius/ulna 6	90	42	1	4
ulna				59	52	0	6
tibia	4		8	140	73	0	3
calcaneum	0		not given	42	not given	0	3
astragalus	0		not given	6	not given	0	8
metacarpal	1		metapodials 3	55	47	0	6
metatarsal	1			38	45	0	6
phalanx 1	6		phalanges 1	24	phalanges 24	0	5
phalanx 2	not given			2		0	0
phalanx 3	not given			0		0	0

Western England and Wales

Pig	NISP Mount Batten		NISP Uley Bury
mandible	72	mandible	47
atlas & axis	68	vertebra	0
scapula p	22	rib	0
pelvis	8	scapula p	23
humerus p	2	pelvis	6
humerus d	9	humerus	5
femur p	0	femur	0
femur d	0	radius	radius/ulna 6
radius p	9	ulna	
radius d	1	tibia	7
ulna p	3	calcaneum	0
tibia p	2	astragalus	0
tibia d	5	metacarpal	metapodials 3
calcaneum	7	metatarsal	
astragalus	4	phalanx 1	phalanges 2
metacarpal p	12	phalanx 2	
metacarpal d	2	phalanx 3	
metatarsal p	12		
metatarsal d	3		
phalanx 1	15		
phalanx 2	6		
phalanx 3	12		

Midlands

Pig	NISP	NISP	MNI	MNI	MNI
	Dragonby	Wakerley	Wakerley	Weekley MIA-LIA	Weekley LIA
mandible	120	not given	not given	34	36
vertebra	not given	not given	not given	not given	not given
rib	not given	not given	not given	not given	not given
scapula p	73	9	7	14	21
pelvis	21	not given	not given	4	12
humerus	65	8	6	6	10
femur	37	0	0	2	4
radius	radius/ulna 63	8	5	11	9
ulna		10	6	12	18
tibia	52	13	8	5	13
calcaneum	18	4	4	8	5
astragalus	11	0	0	1	3
metacarpal	18	0	0	0	1
metatarsal	15	0	0	0	2
phalanx 1	16	0	0	not given	0
phalanx 2	11	0	0	not given	0
phalanx 3	1	0	0	not given	not given

Northern England and Southern Scotland

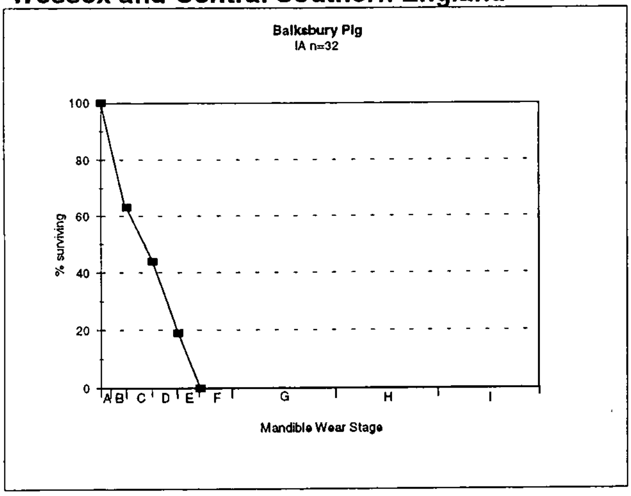
Pig	NISP Catcote	NISP Dalton Parlours	NISP Grimthorpe	NISP Port Seton	MNE Port Seton	%NISP Thorpe Thewles
mandible	17	3	7	25	14	100
vertebra	0	not given	0	1	not given	9
rib	not given	not given	0	3	3	4
scapula p	4	0	3	4	4	30
pelvis	2	2	3	1	1	27
humerus	3	2	8	4	4	29
femur	1	2	1	0	0	10
radius	0	1	radius/ulna 12	2	2	13
ulna	0	3		2	2	12
tibia	1	1	1	0	0	29
calcaneum	0	not given	2	1	1	9
astragalus	0	not given	0	0	0	3
metacarpal	metapodials 8	metapodials 1	metapodials 1	1	1	12
metatarsal				2	2	9
phalanx 1	0	phalanges 6	phalanges 1	0	0	4
phalanx 2	0			0	0	2
phalanx 3	0			0	0	3

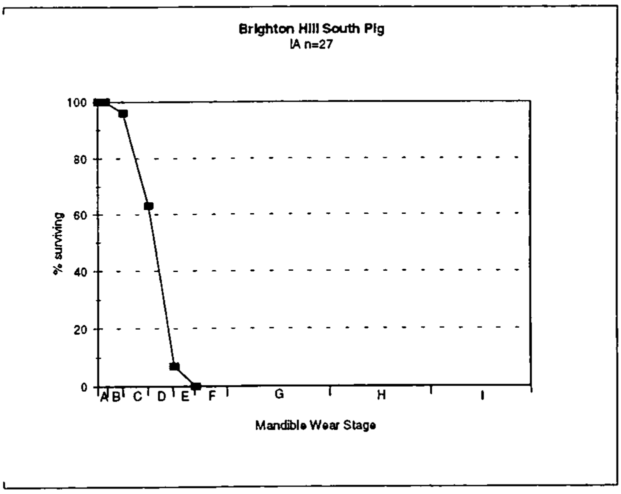
Appendix 4

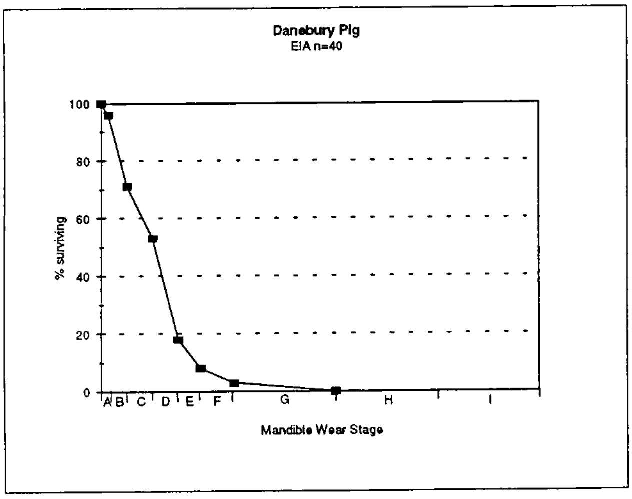
Mortality profiles based on tooth wear data

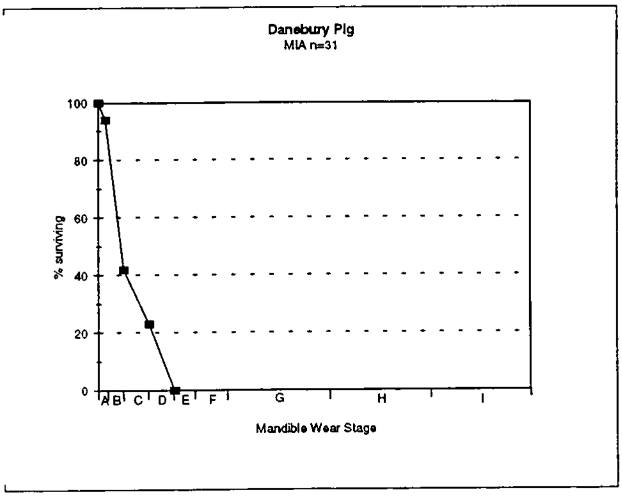
Appendix 4 provides mortality profiles of cattle, sheep, and pig assemblages derived from published tooth wear data using the method set out in chapter 8. Graphs are grouped separately for pig, sheep, and cattle and are arranged by region.

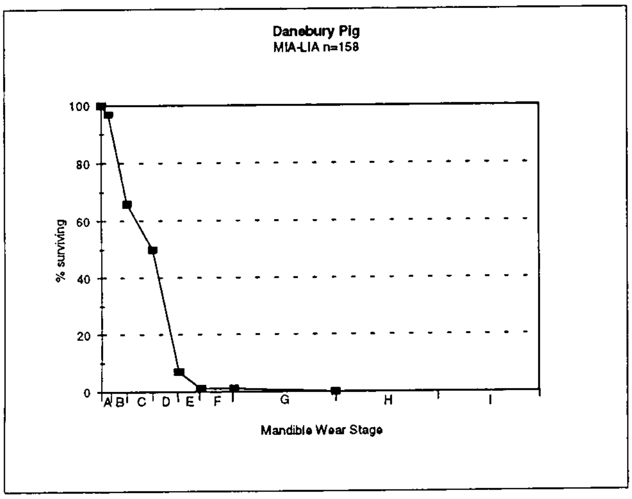
Wessex and Central Southern England

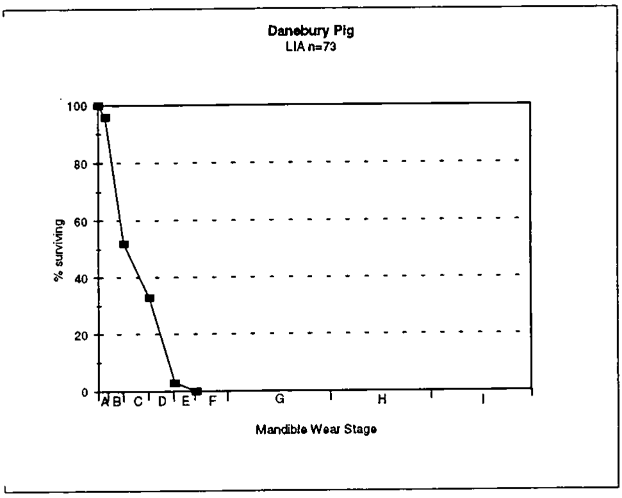

Balksbury Pig
IA n=32

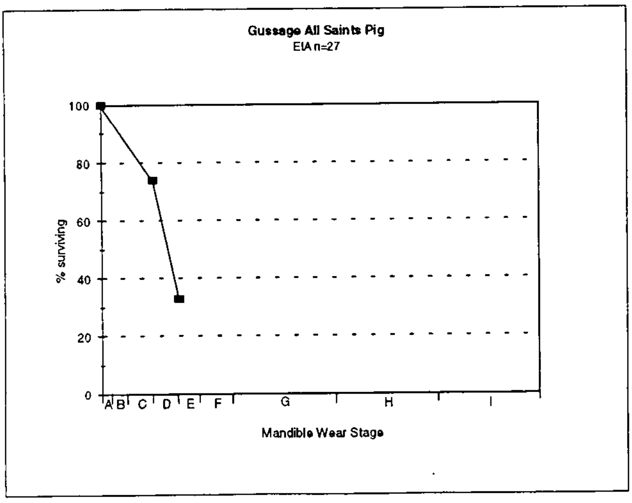

Brighton Hill South Pig
IA n=27

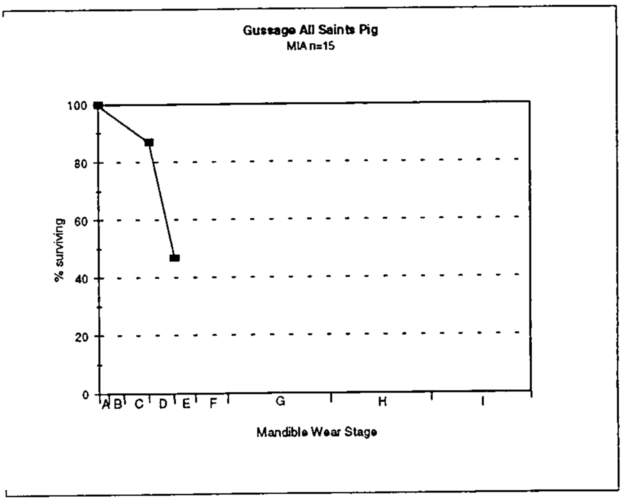

Danebury Pig
EIA n=40

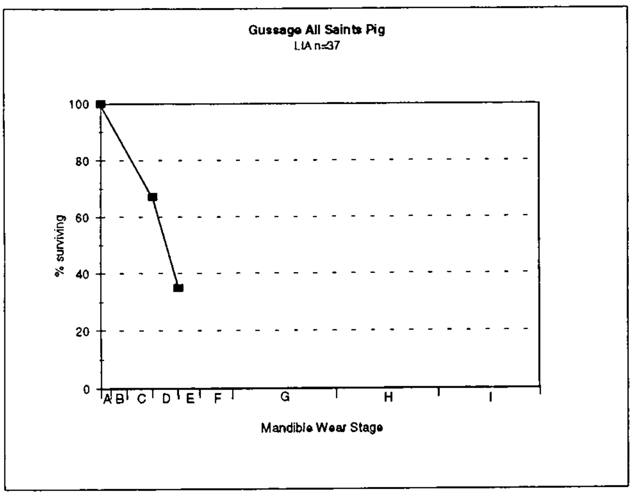

Danebury Pig
MIA n=31

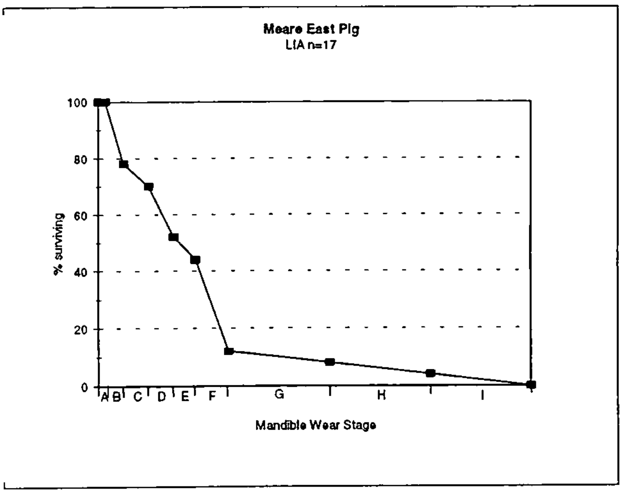

Danebury Pig
MIA-LIA n=158

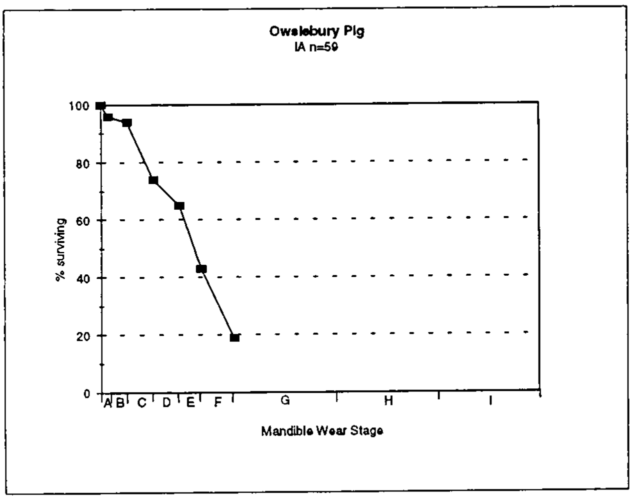

Danebury Pig
LIA n=73


Gussage All Saints Pig
EIA n=27

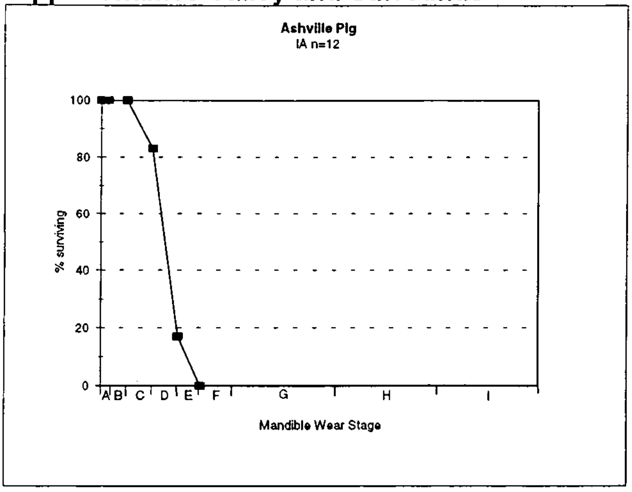

Gussage All Saints Pig
MIA n=15

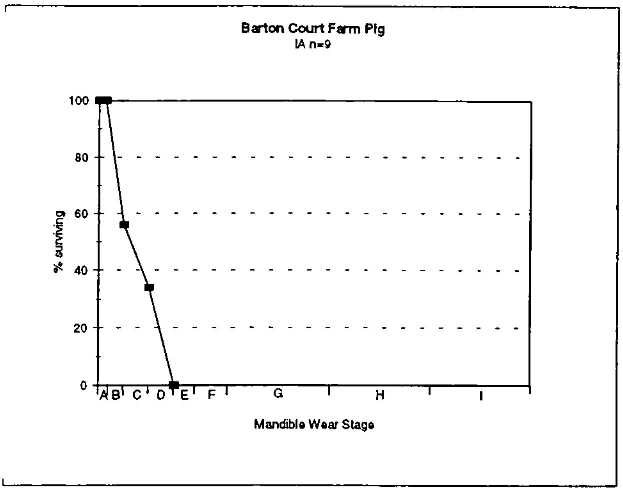

Gussage All Saints Pig
LIA n=37
% surviving
100
80
60
40
20
0
A B C D E F G H I
Mandible Wear Stage

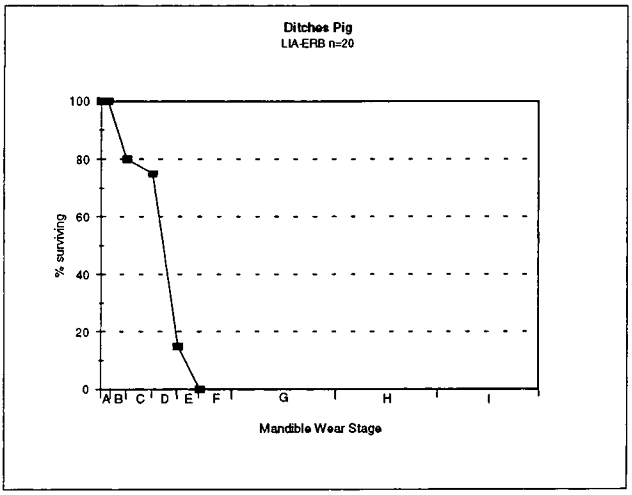

Meare East Pig
LIA n=17
% surviving
100
80
60
40
20
0
A B C D E F G H I
Mandible Wear Stage

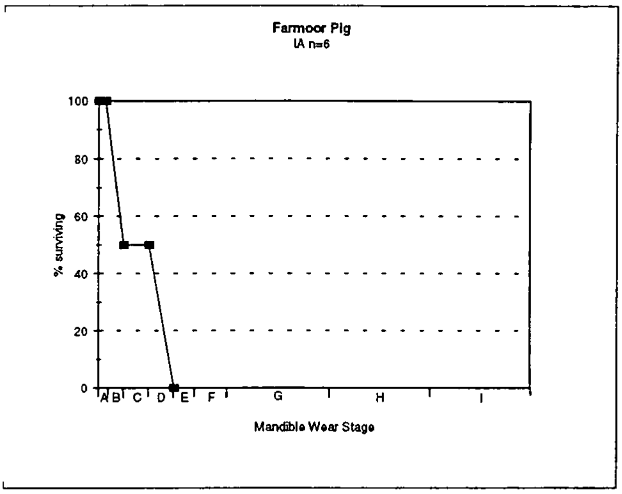

Owslebury Pig
IA n=59
% surviving
100
80
60
40
20
0
A B C D E F G H I
Mandible Wear Stage

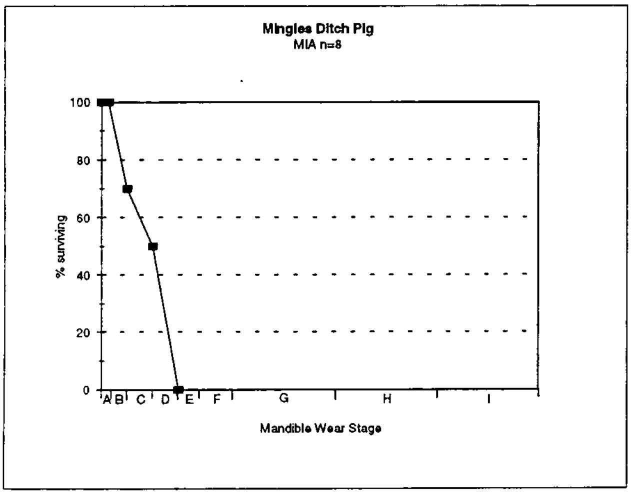
Upper Thames Valley and Surrounds


Ashville Pig
IA n=12

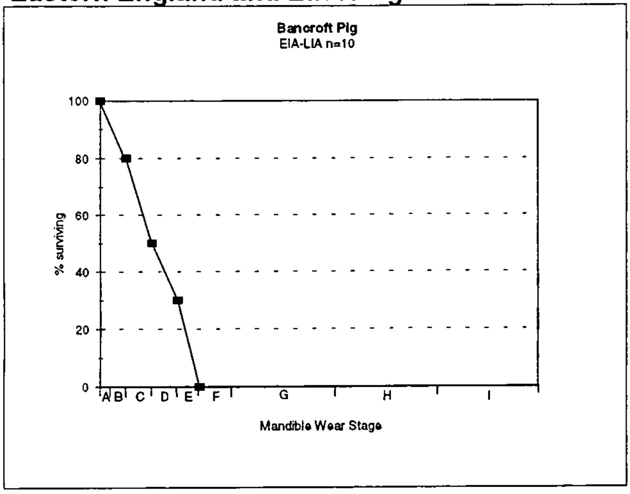

Barton Court Farm Pig
IA n=9

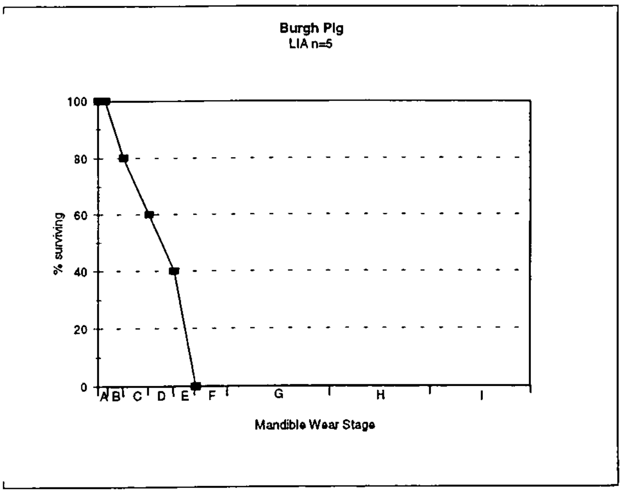

Ditches Pig
LIA-ERB n=20

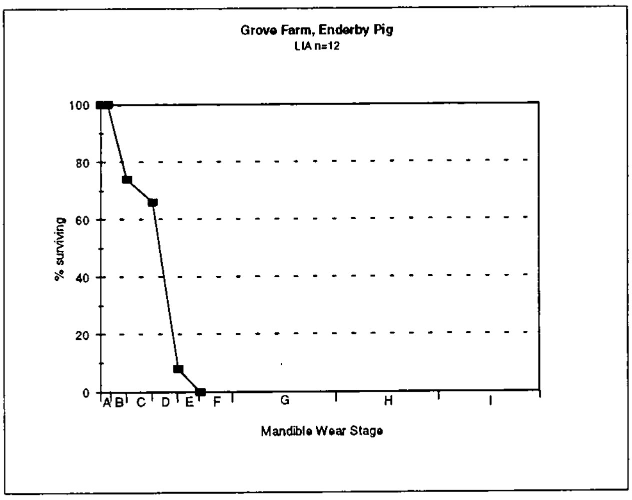

Farmoor Pig
IA n=6

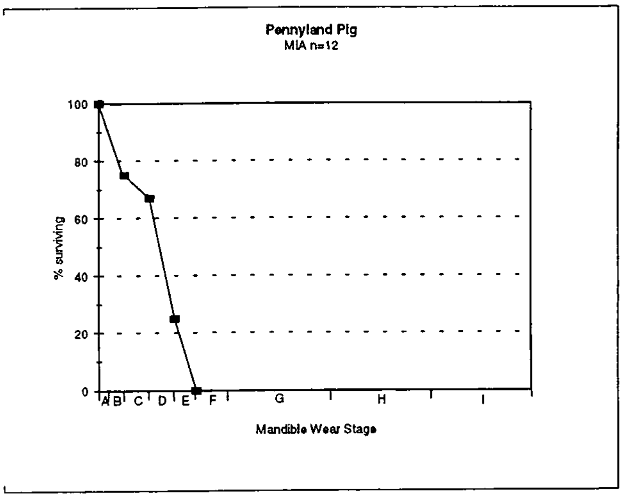

Mingies Ditch Pig
MIA n=8

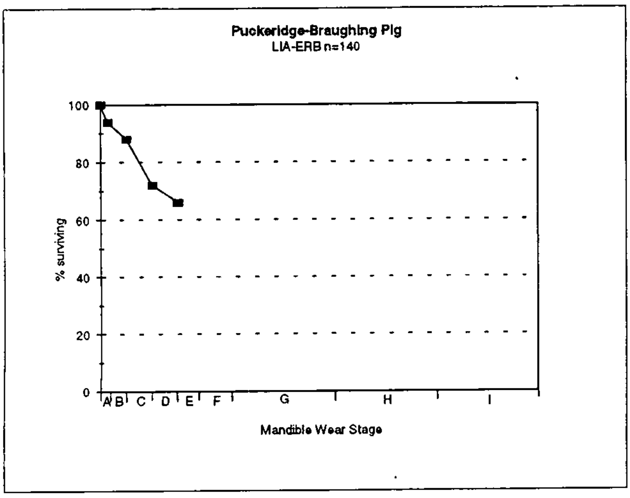
Eastern England and East Anglia

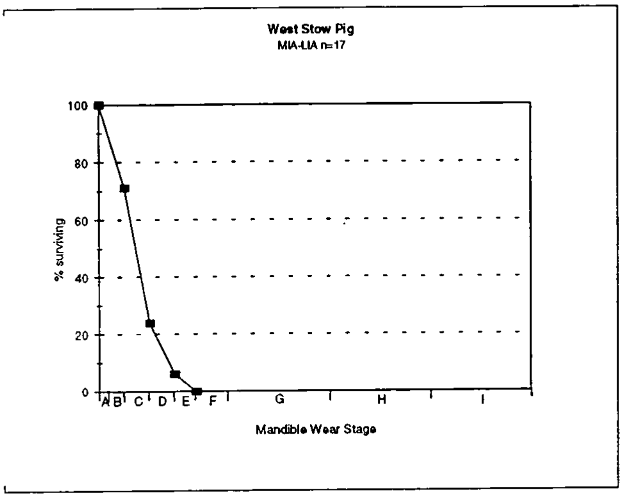

Bancroft Pig
EIA-LIA n=10


Burgh Pig
LIA n=5

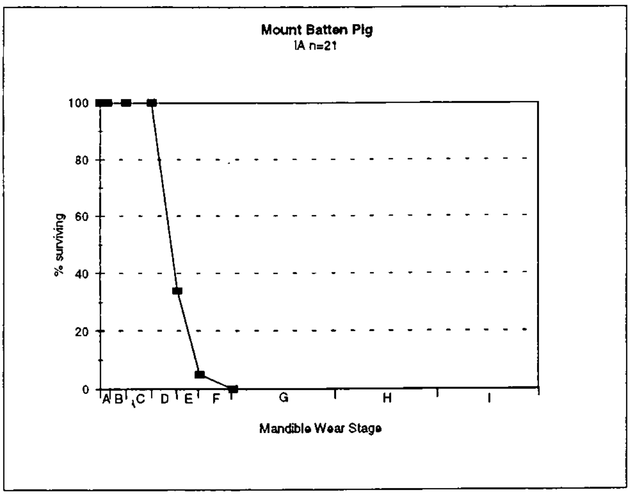

Grove Farm, Enderby Pig
LIA n=12


Pennyland Pig
MIA n=12

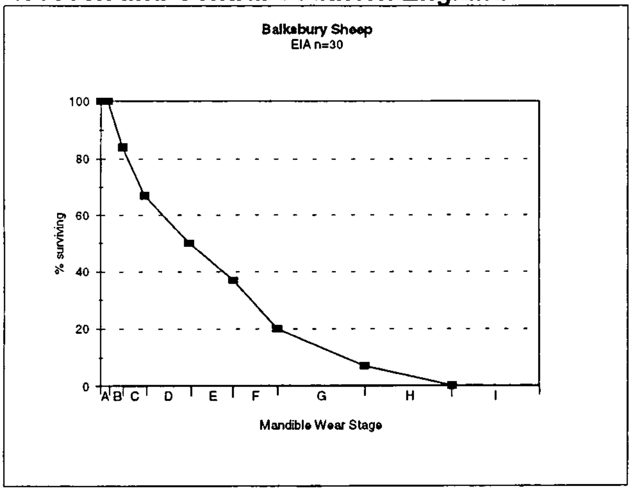

Puckeridge-Braughing Pig
LIA-ERB n=140

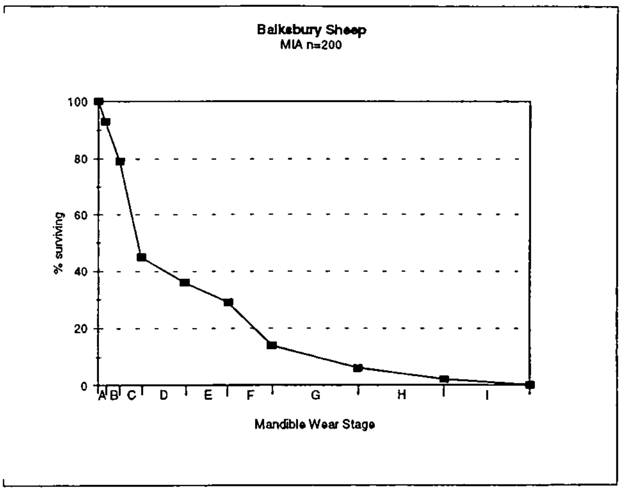

West Stow Pig
MIA-LIA n=17

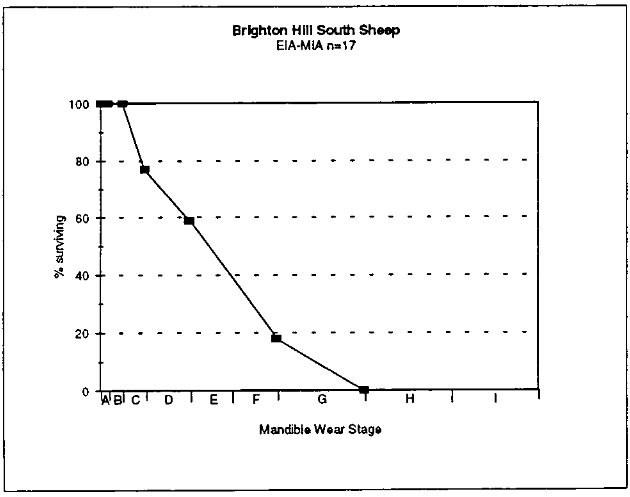
Western England and Wales

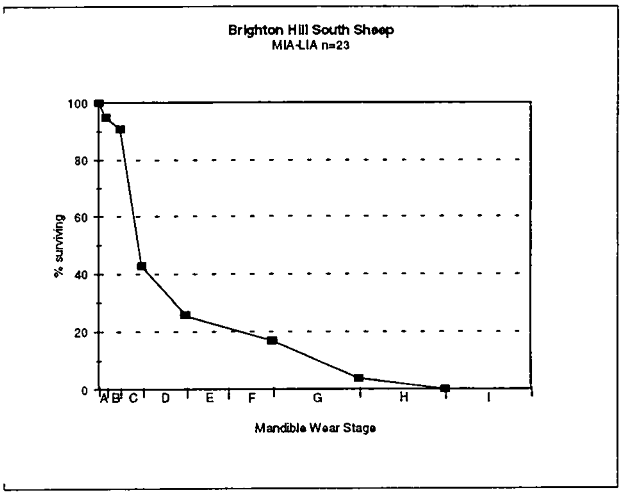


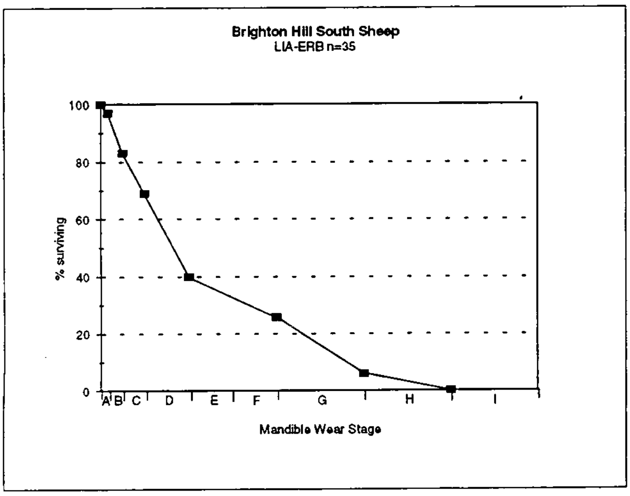
Wessex and Central Southern England

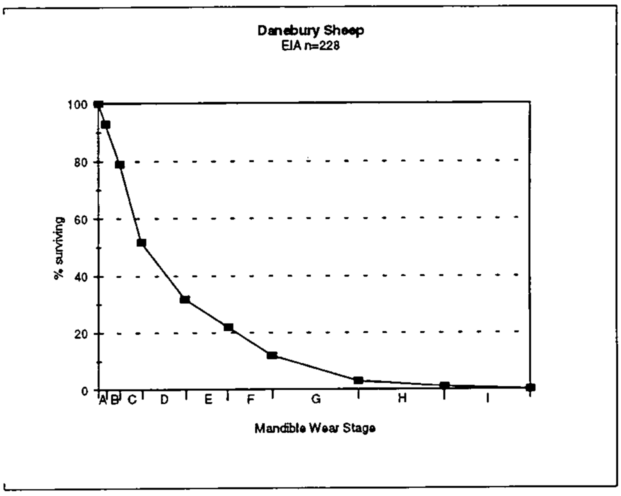

Balksbury Sheep
EIA n=30

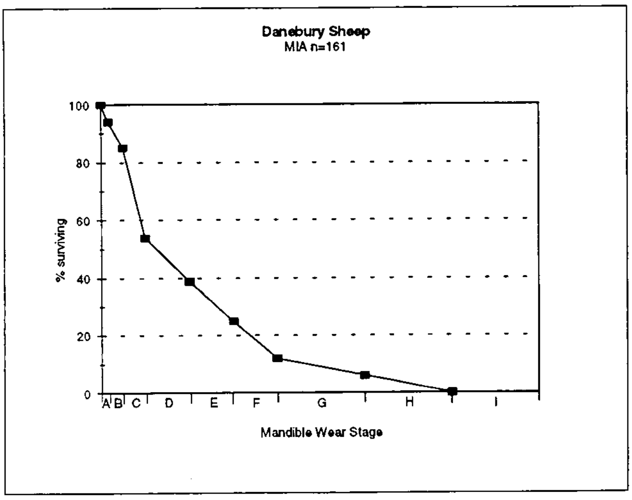

Balksbury Sheep
MIA n=200

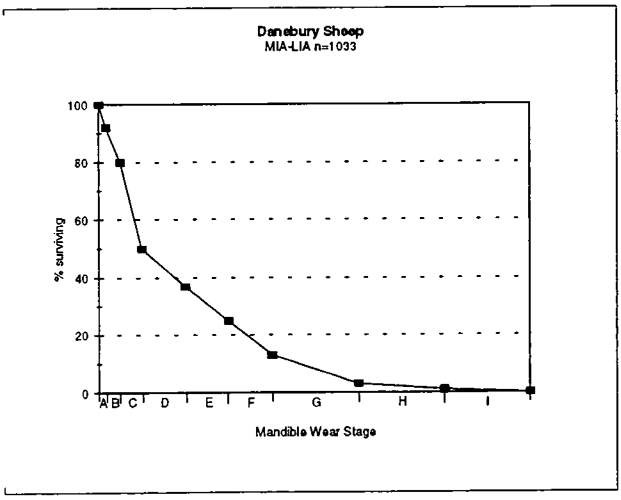

Brighton Hill South Sheep
EIA-MIA n=17

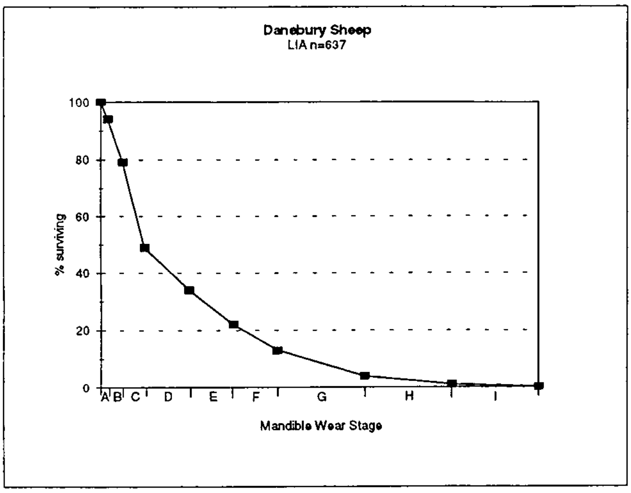

Brighton Hill South Sheep
MIA-LIA n=23

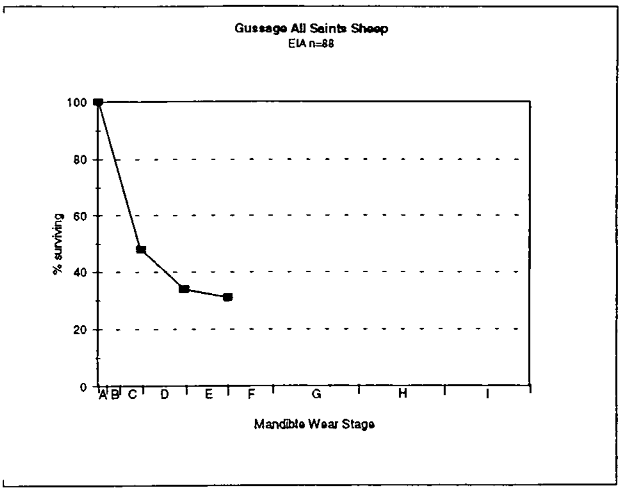

Brighton Hill South Sheep
LIA-ERB n=35

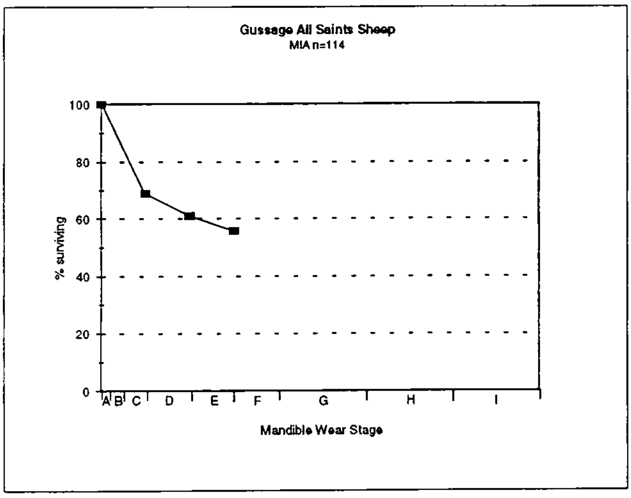

Danebury Sheep
EIA n=228

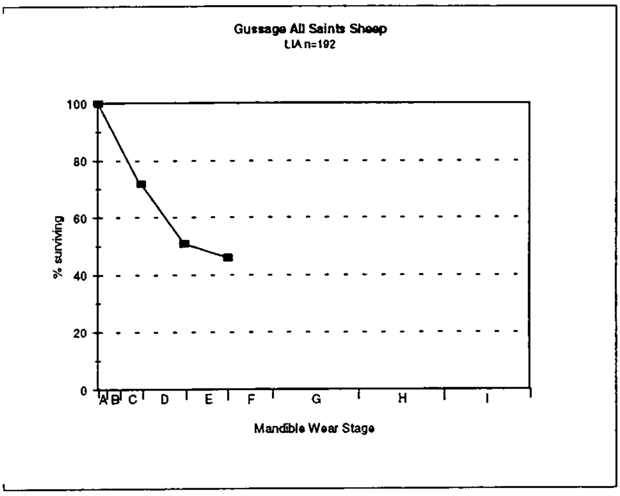

Danebury Sheep
MIA n=161

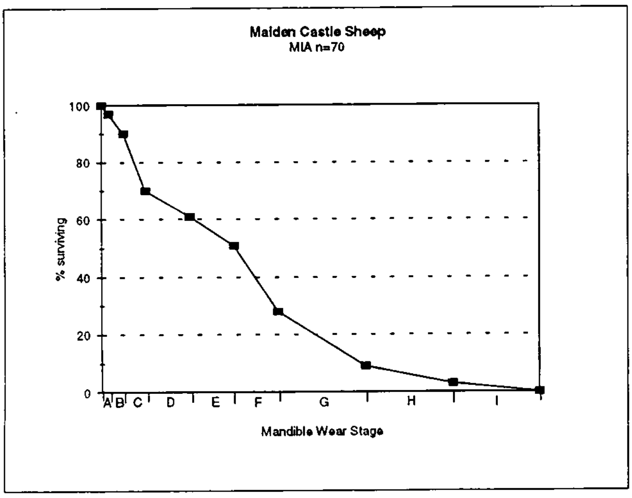

Danebury Sheep
MIA-LIA n=1033

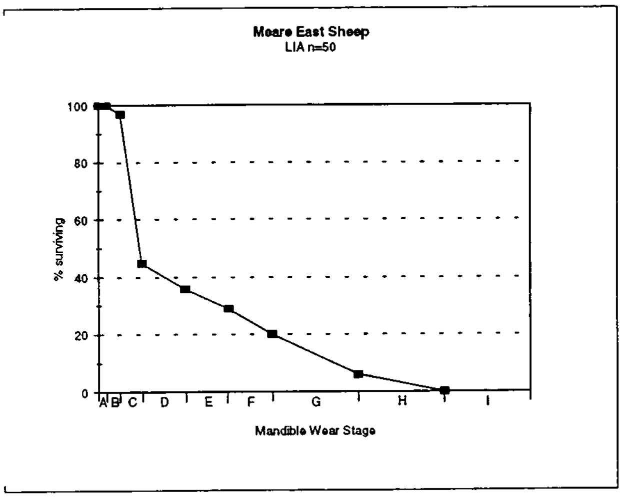

Danebury Sheep
LIA n=637

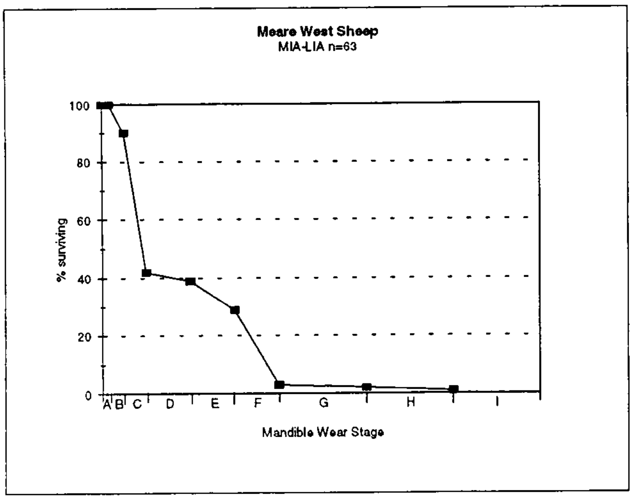

Gussage All Saints Sheep
EIA n=88

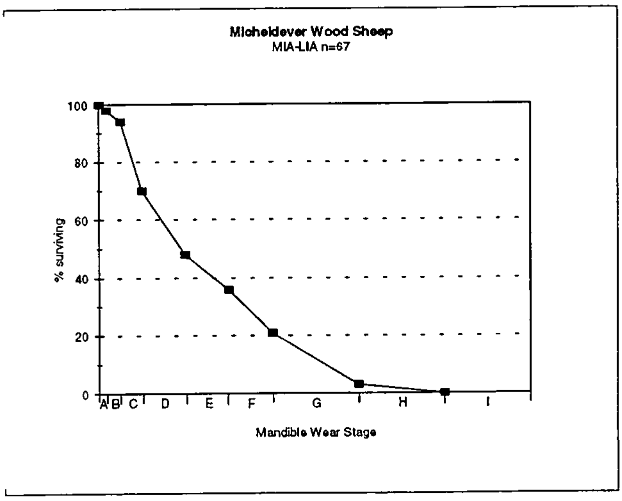

Gussage All Saints Sheep
MIA n=114

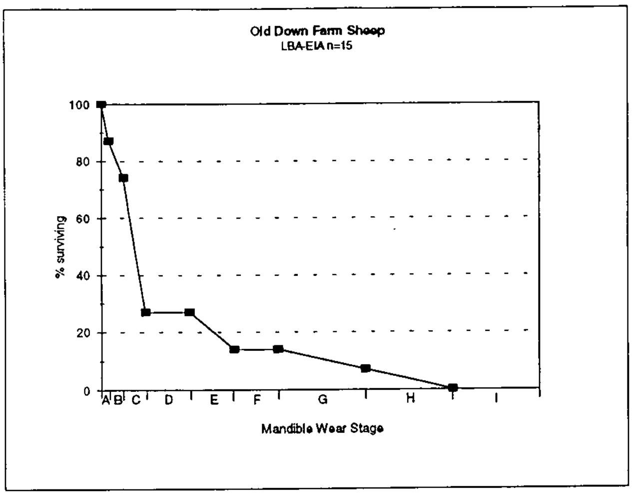

Gussage All Saints Sheep
LIA n=192

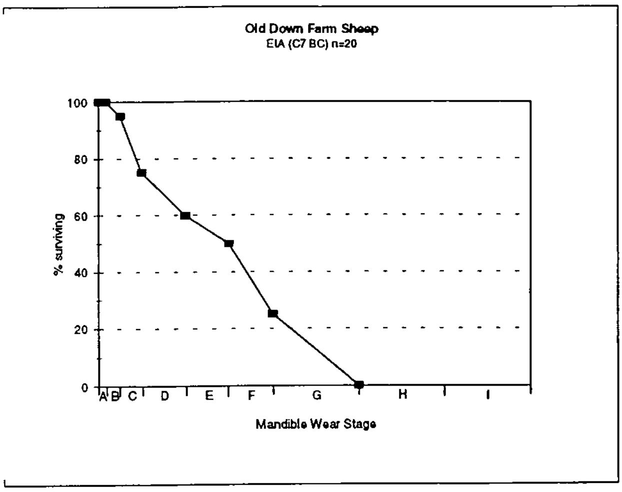

Maiden Castle Sheep
MIA n=70

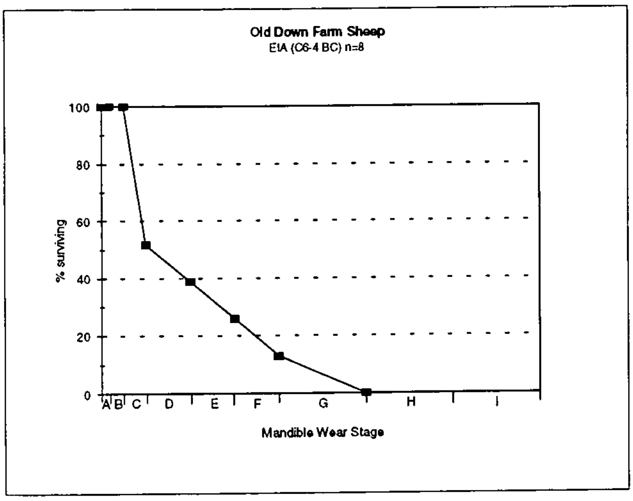

Meare East Sheep
LIA n=50

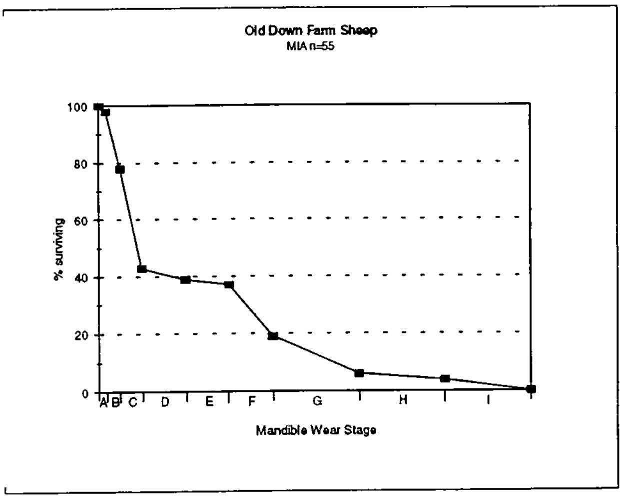

Meare West Sheep
MIA-LIA n=63

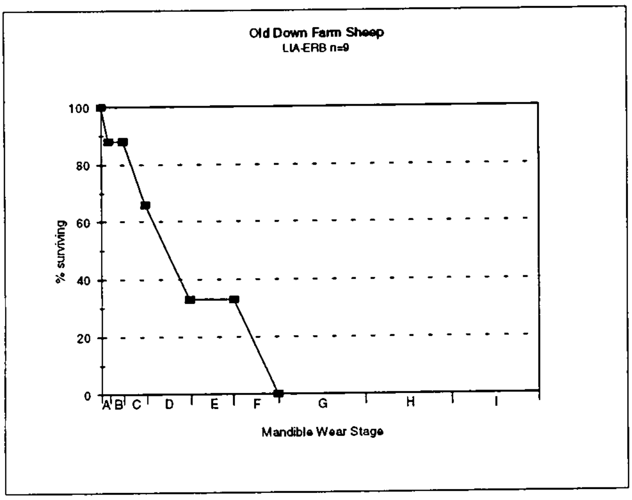

Micheldever Wood Sheep
MIA-LIA n=67

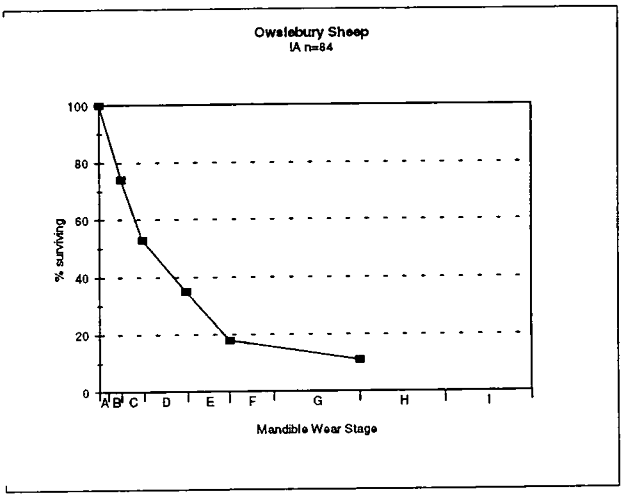

Old Down Farm Sheep
LBA-EIA n=15

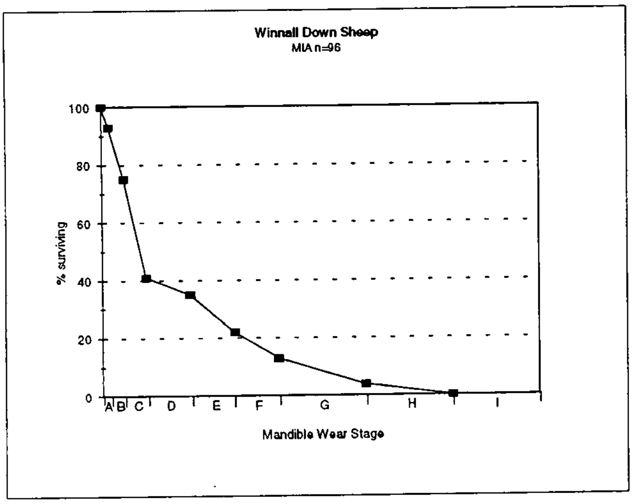

Old Down Farm Sheep
EIA (C7 BC) n=20


Old Down Farm Sheep
EIA (C6-4 BC) n=8

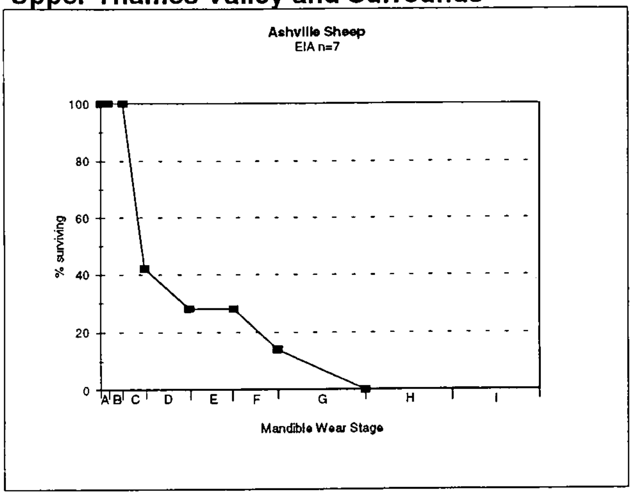

Old Down Farm Sheep
MIA n=55

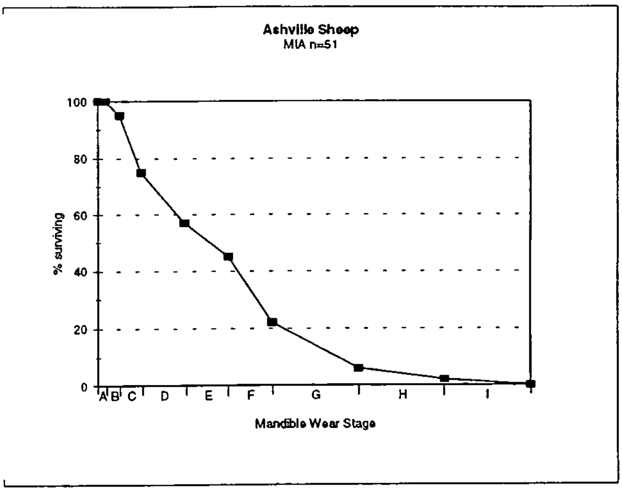

Old Down Farm Sheep
LIA-ERB n=9

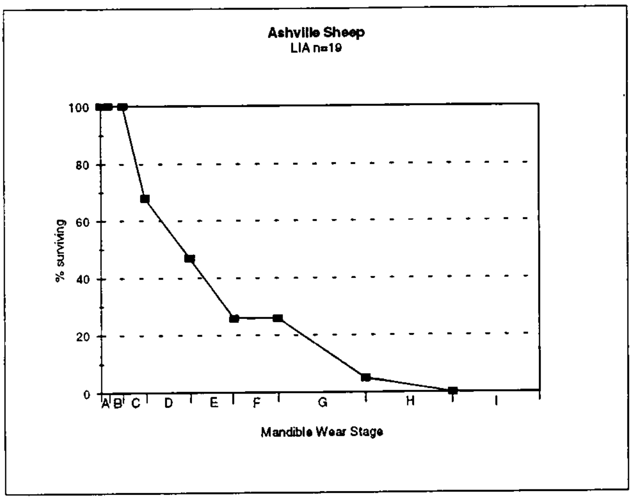

Owslebury Sheep
IA n=84

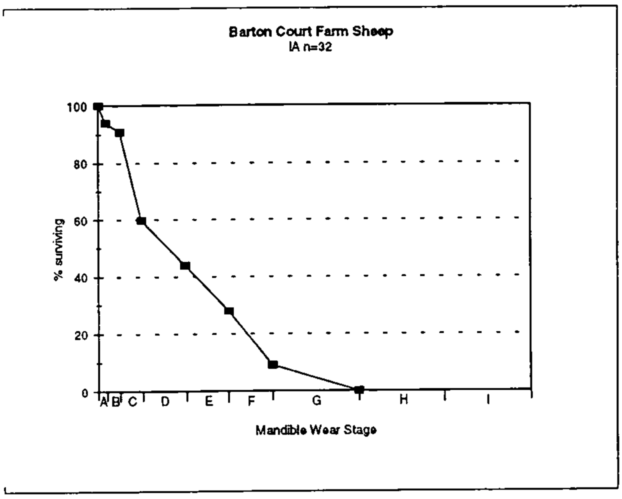

Winnall Down Sheep
MIA n=96

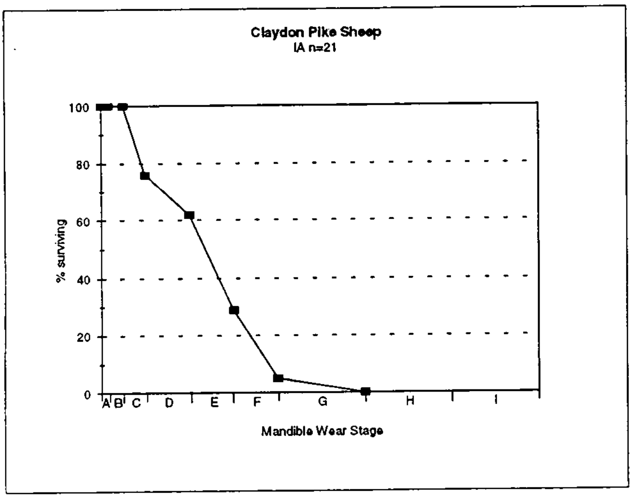
Upper Thames Valley and Surrounds

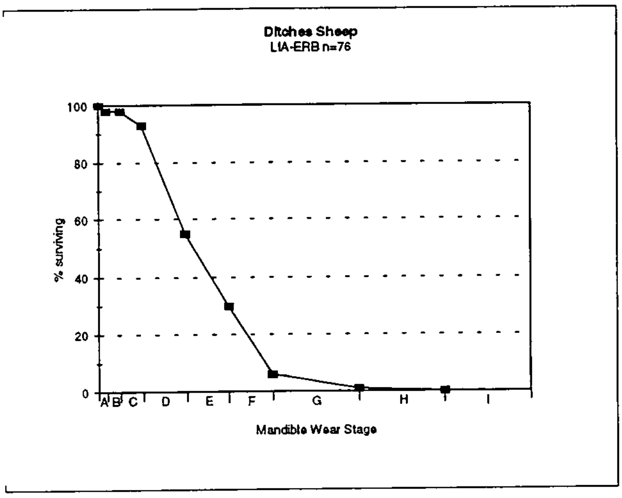

Ashville Sheep
EIA n=7

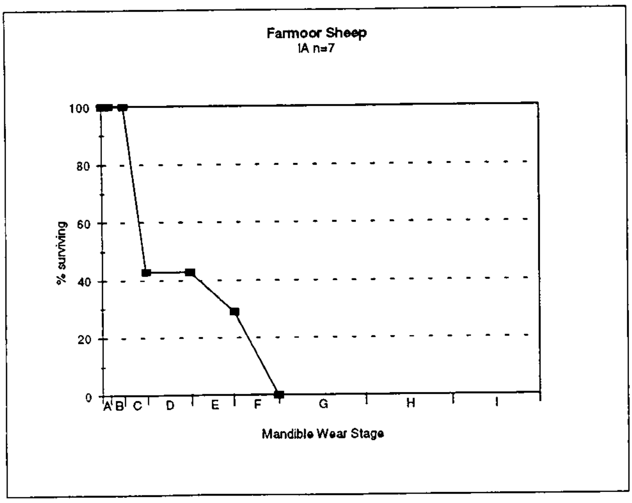

Ashville Sheep
MIA n=51

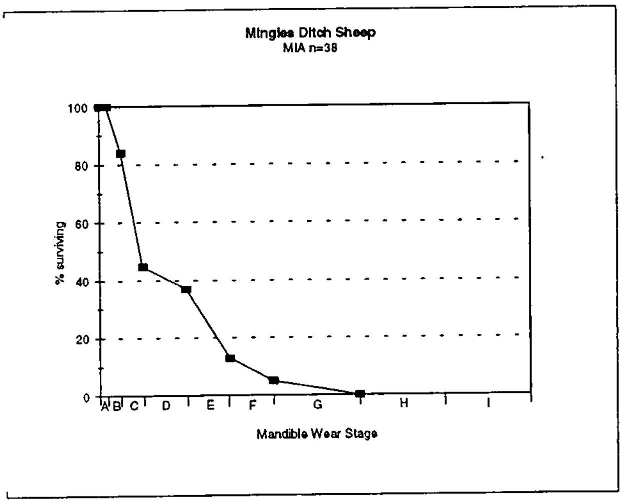

Ashville Sheep
LIA n=19

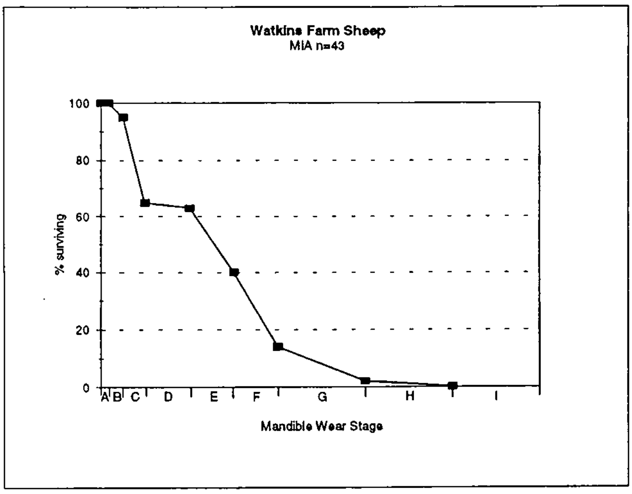

Barton Court Farm Sheep
IA n=32


Claydon Pike Sheep
IA n=21


Ditches Sheep
LIA-ERB n=76

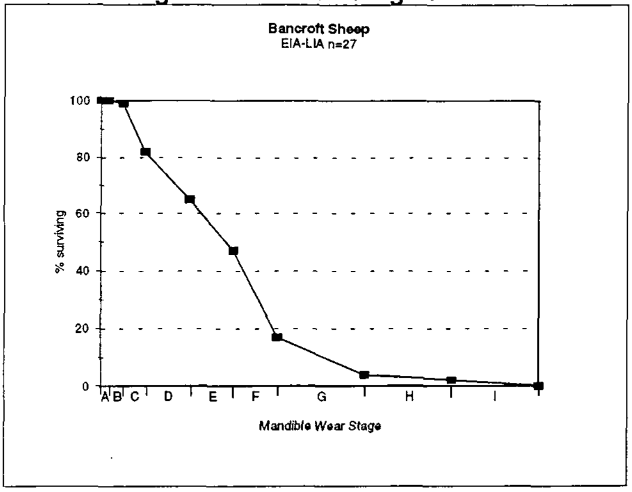

Farmoor Sheep
IA n=7

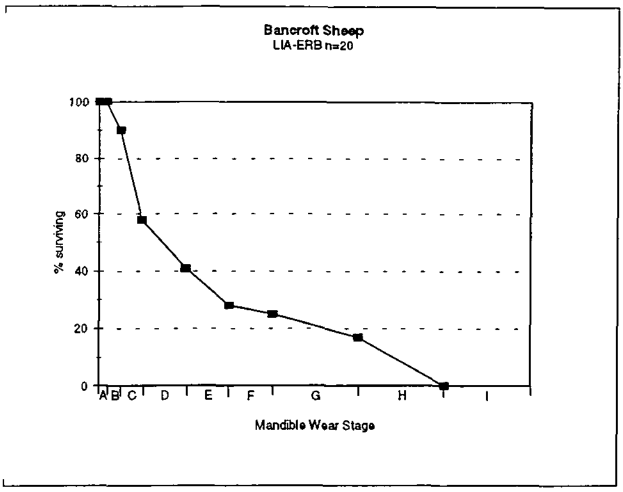

Mingies Ditch Sheep
MIA n=38

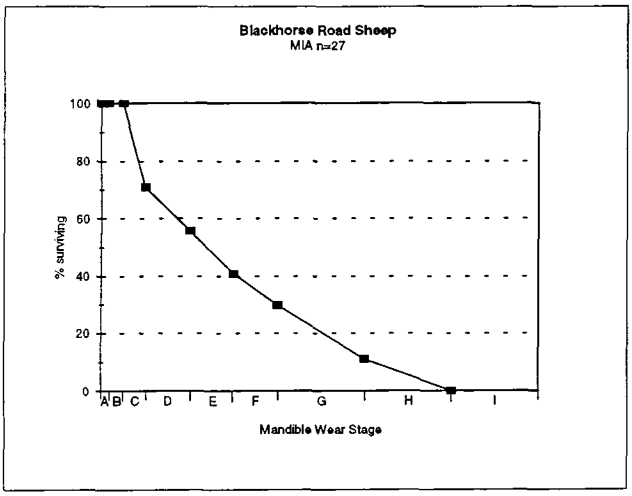


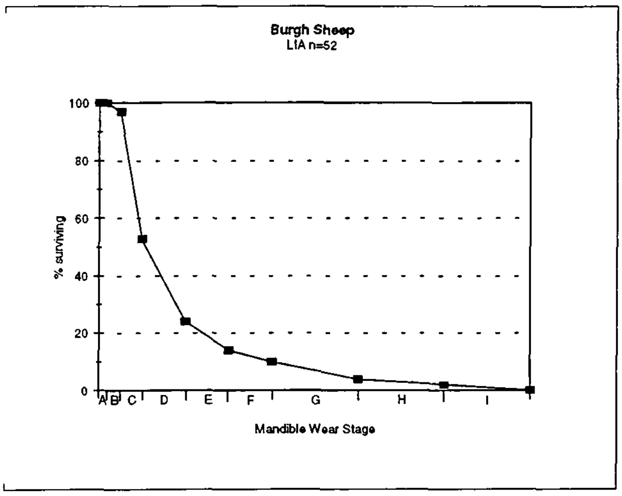
Watkins Farm Sheep
MIA n=43

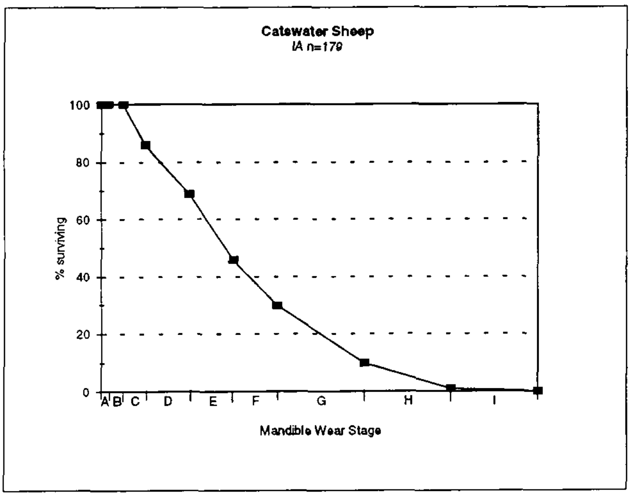
Eastern England and East Anglia

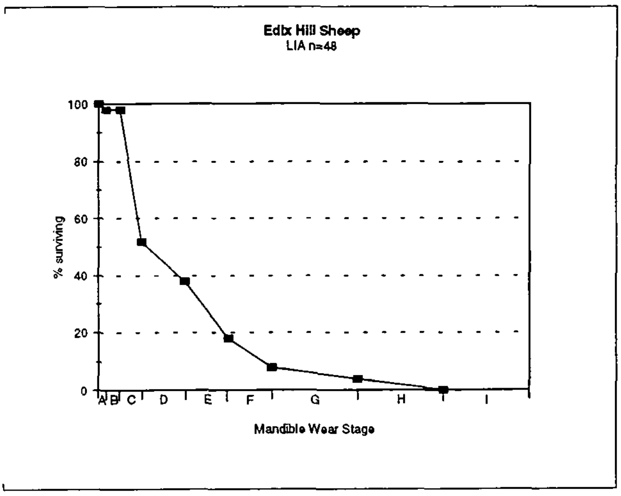


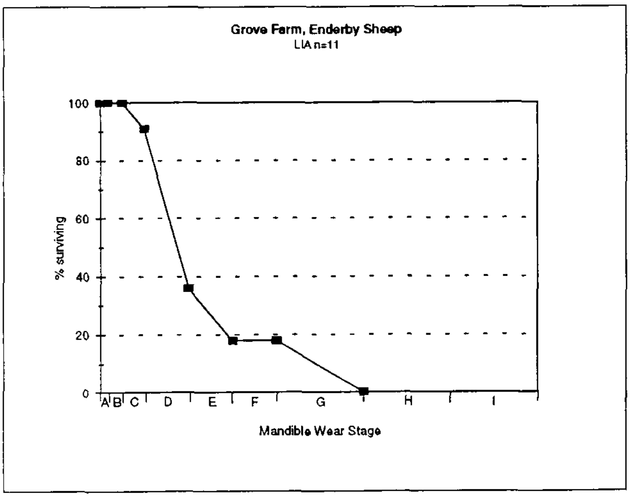


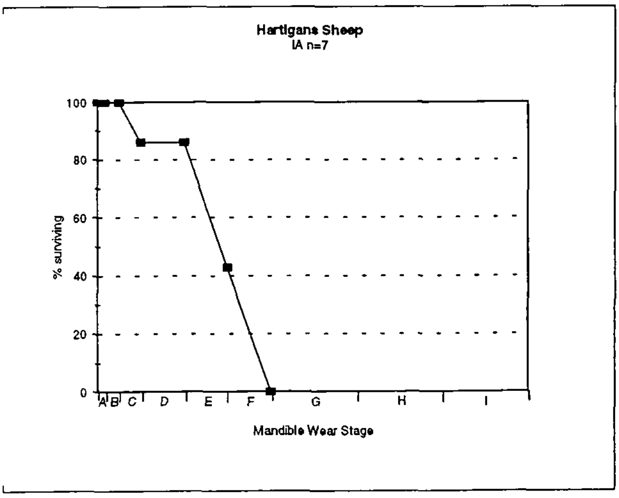


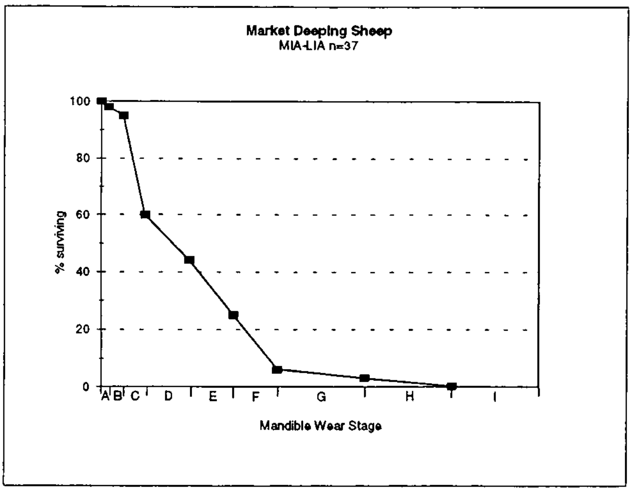


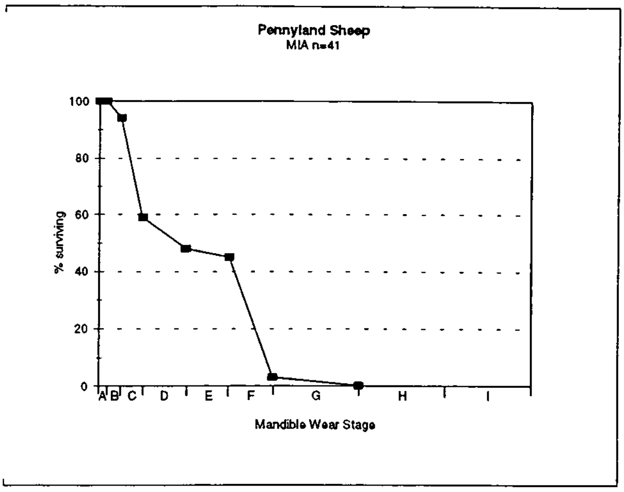


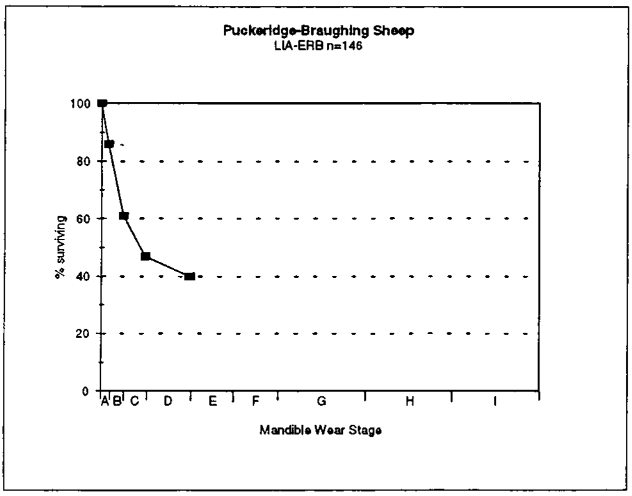


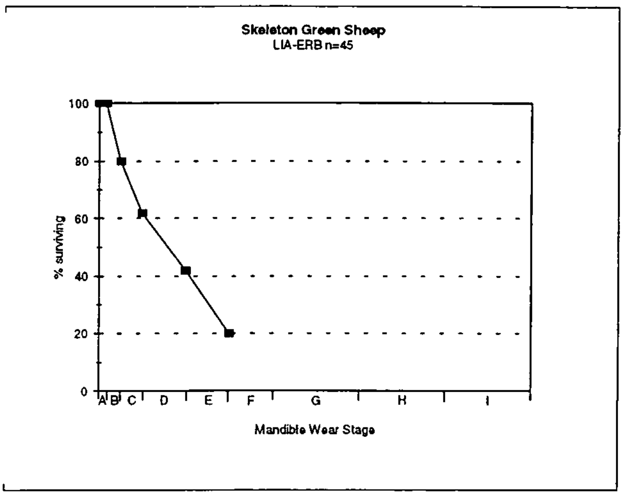


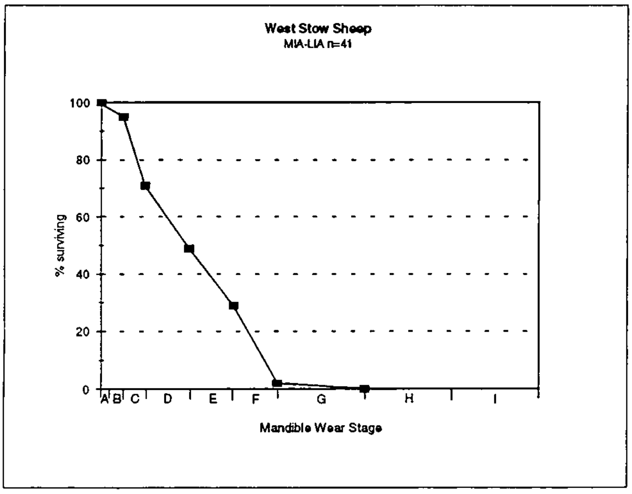



Market Deeping Sheep
MIA-LIA n=37
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage

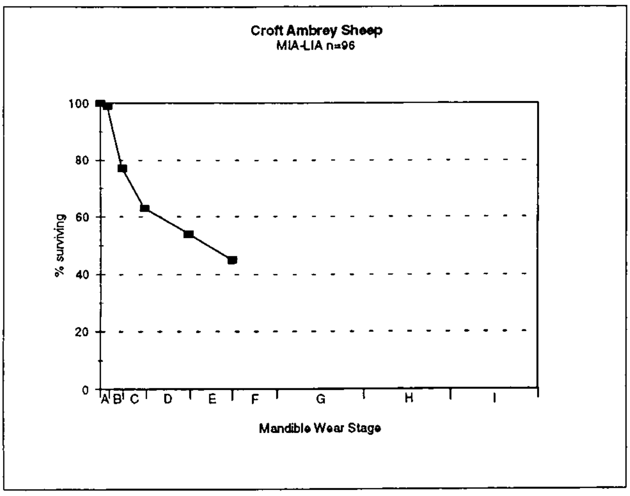

Pennyland Sheep
MIA n=41
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage

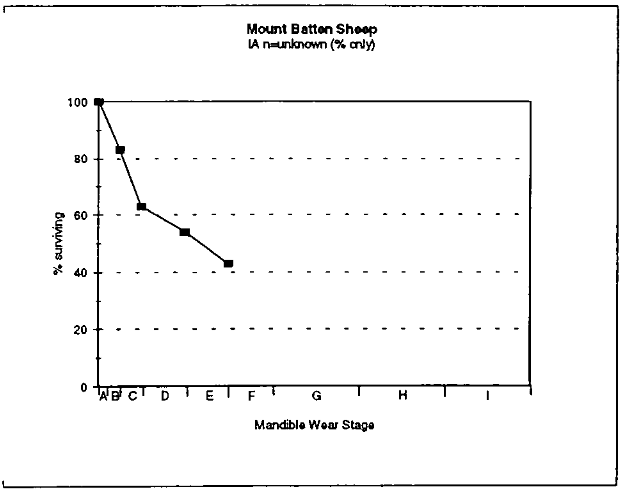

Puckeridge-Braughing Sheep
LIA-ERB n=146
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage


Skeleton Green Sheep
LIA-ERB n=45
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage

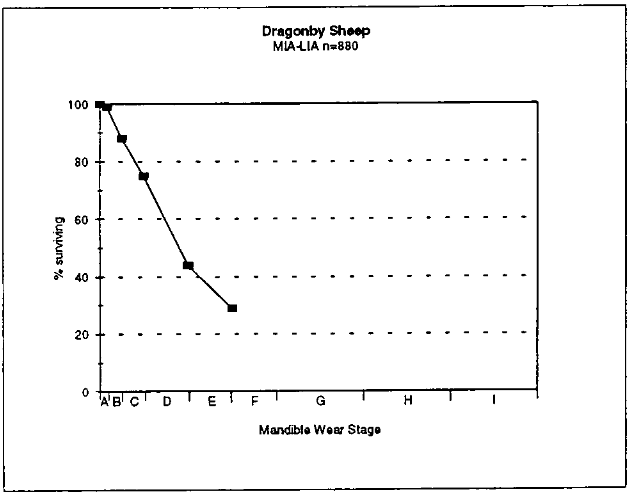

West Stow Sheep
MIA-LIA n=41
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage

Western England and Wales

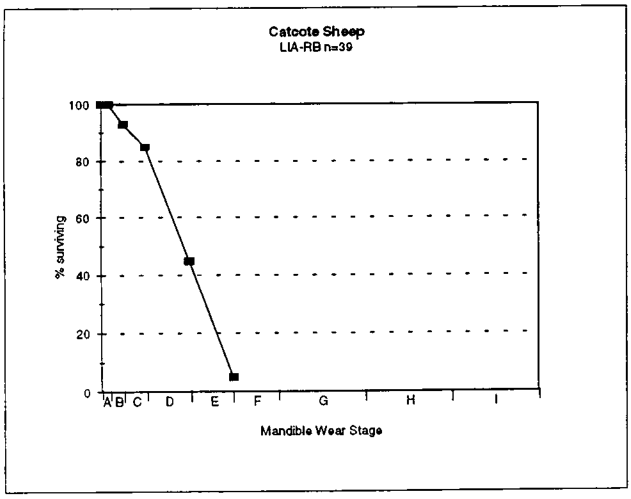


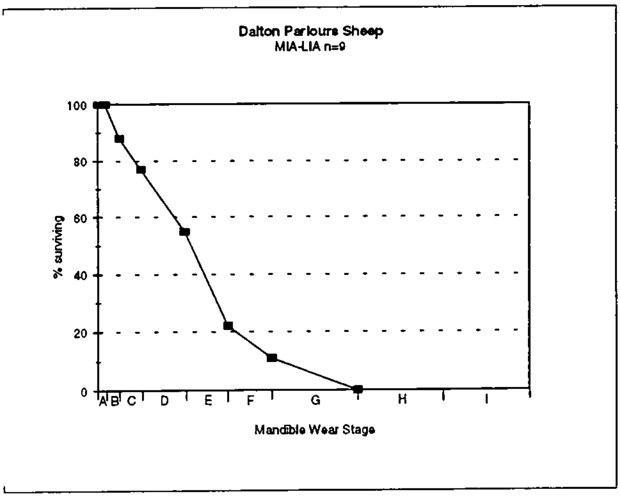


Midlands

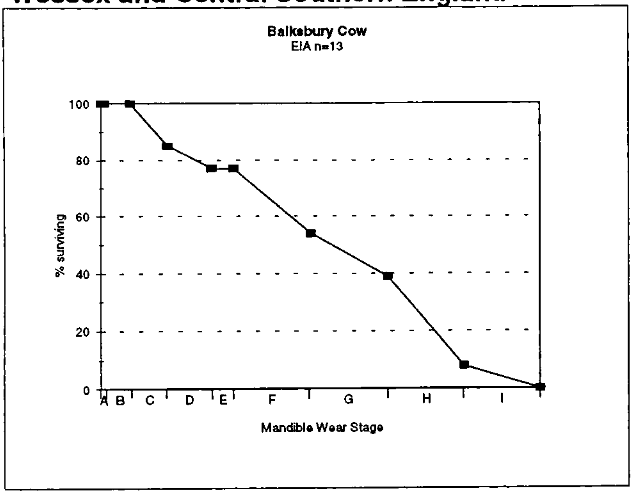


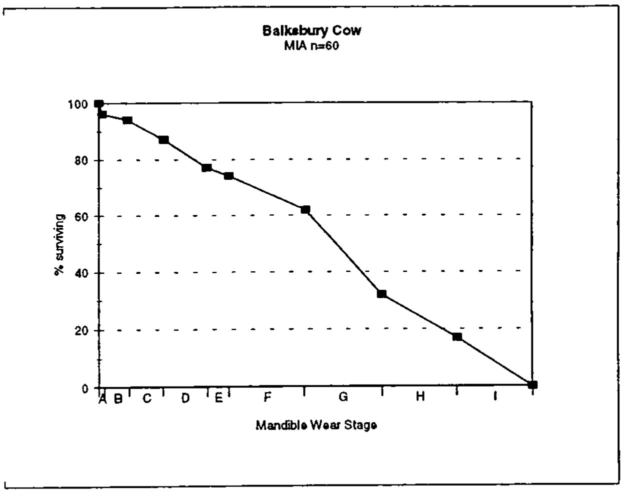
Northern England and Southern Scotland

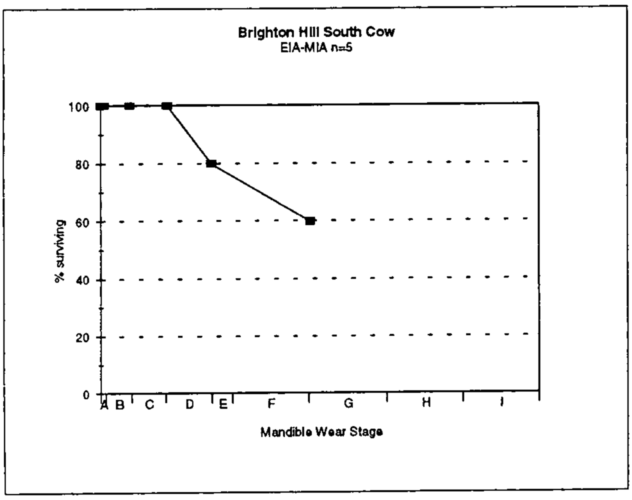


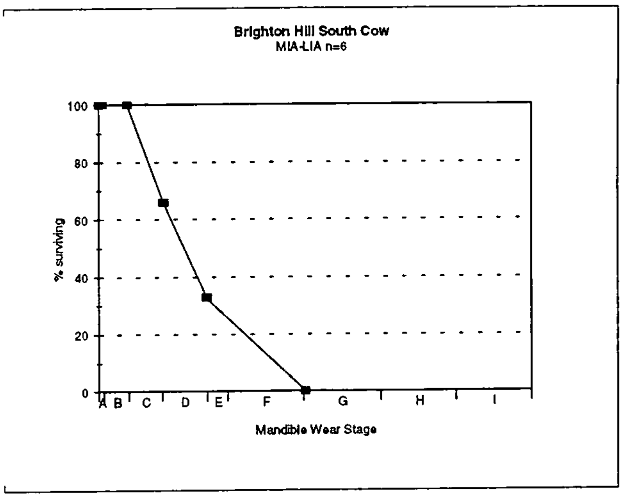


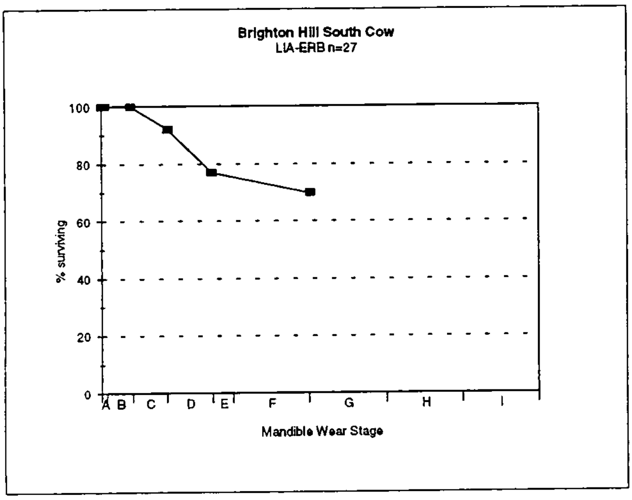
Wessex and Central Southern England

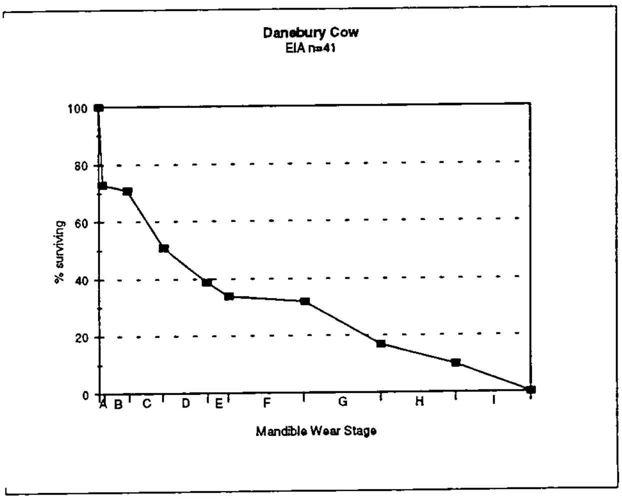

Balksbury Cow
EIA n=13

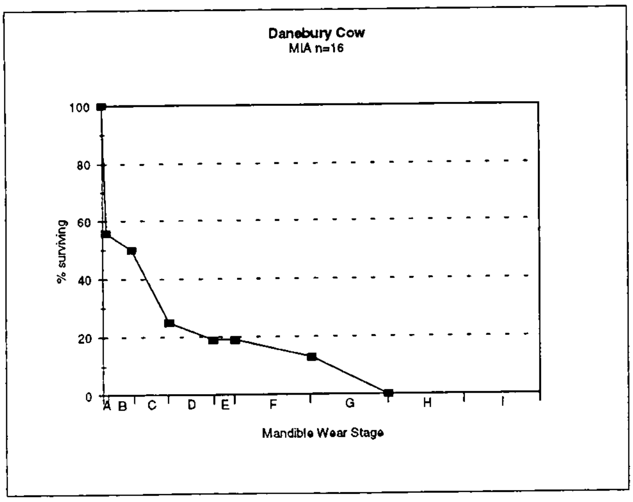

Balksbury Cow
MIA n=60

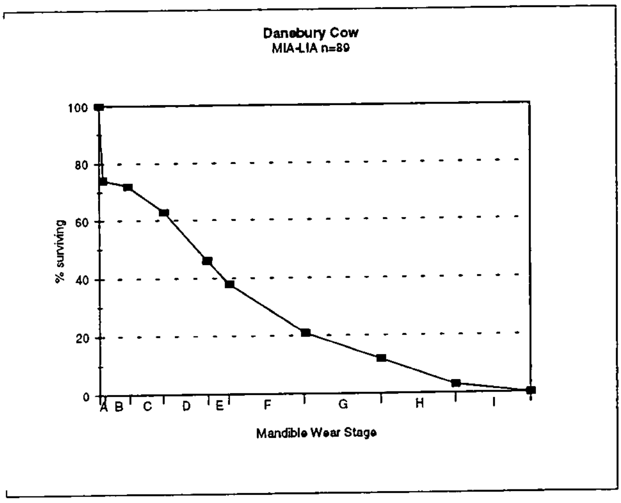

Brighton Hill South Cow
EIA-MIA n=5

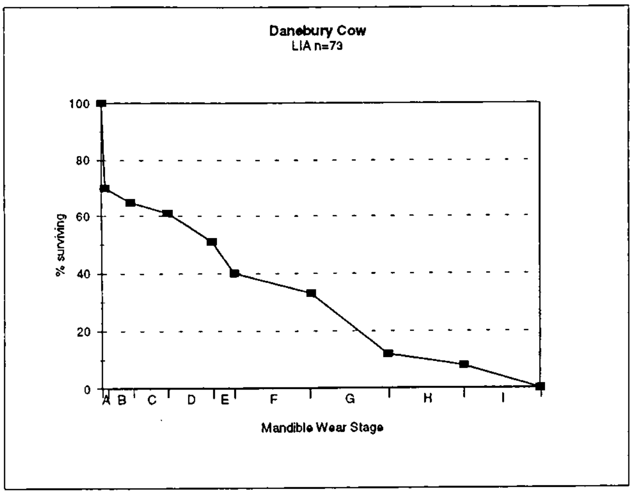

Brighton Hill South Cow
MIA-LIA n=6

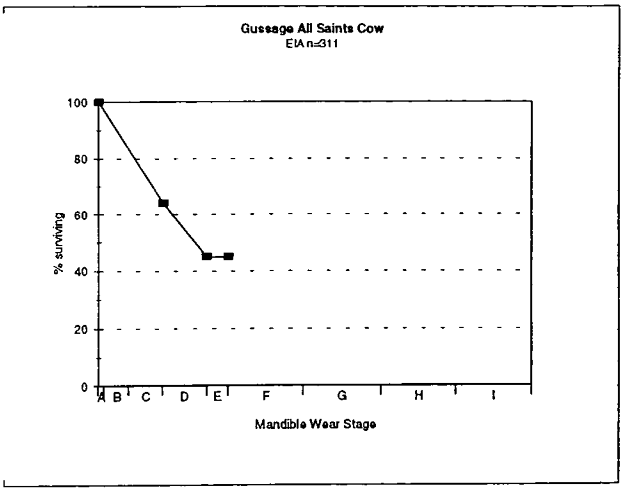

Brighton Hill South Cow
LIA-ERB n=27

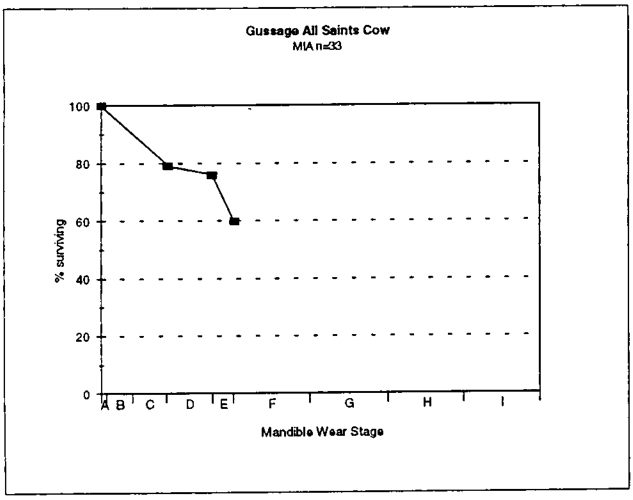

Danebury Cow
EIA n=41

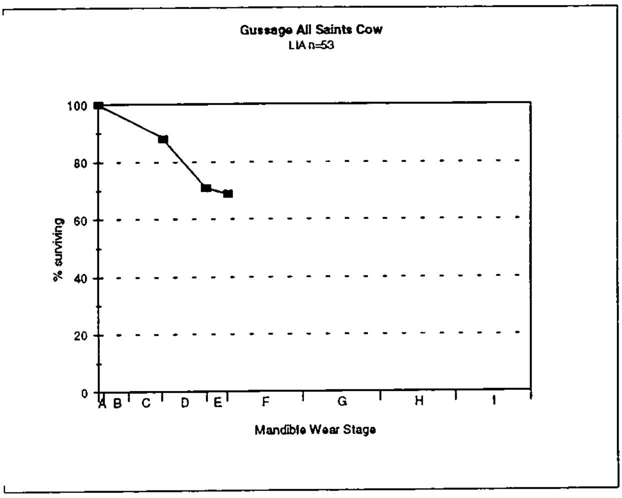

Danebury Cow
MIA n=16

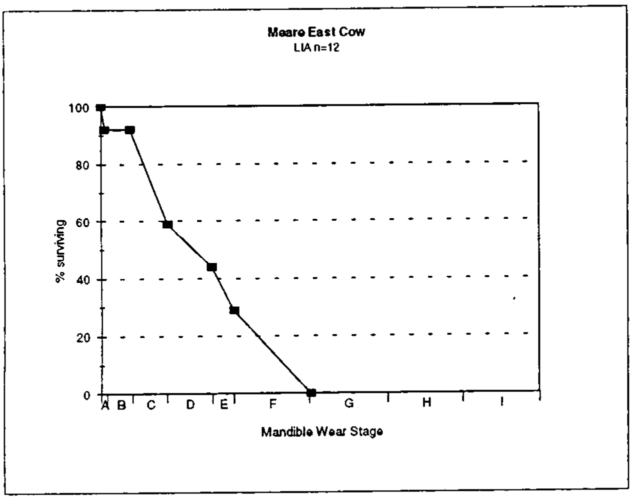

Danebury Cow
MIA-LIA n=89

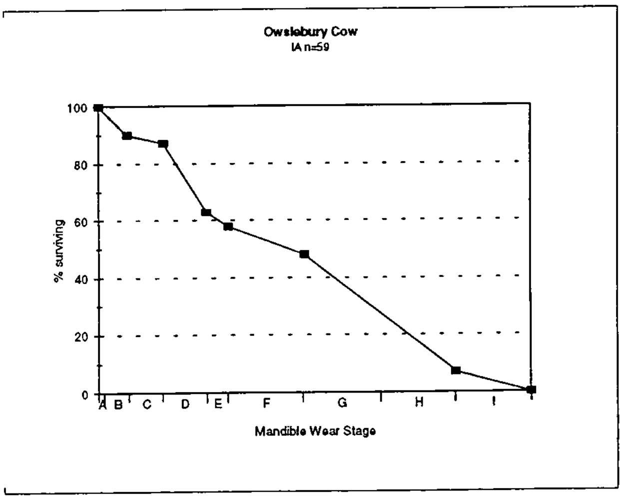

Danebury Cow
LIA n=73
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage

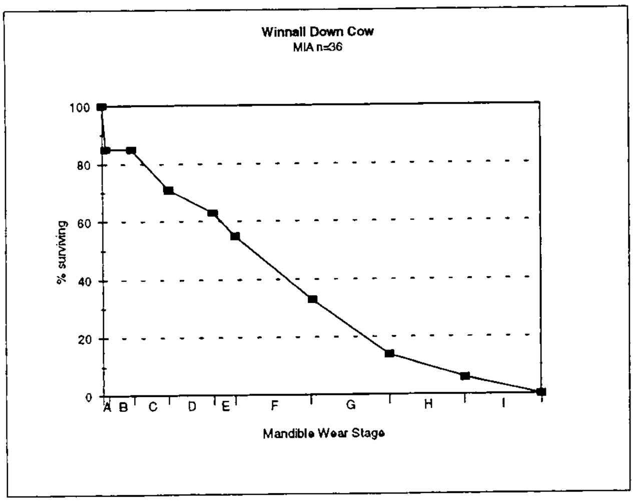

Gussage All Saints Cow
EIA n=311
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage


Gussage All Saints Cow
MIA n=33
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage

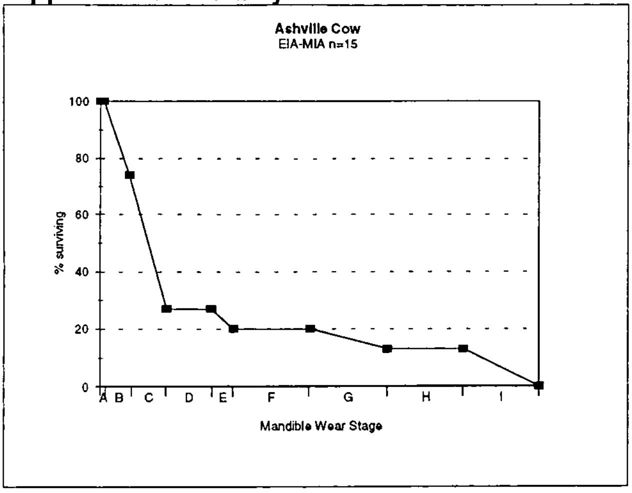

Gussage All Saints Cow
LIA n=53
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage


Meare East Cow
LIA n=12
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage

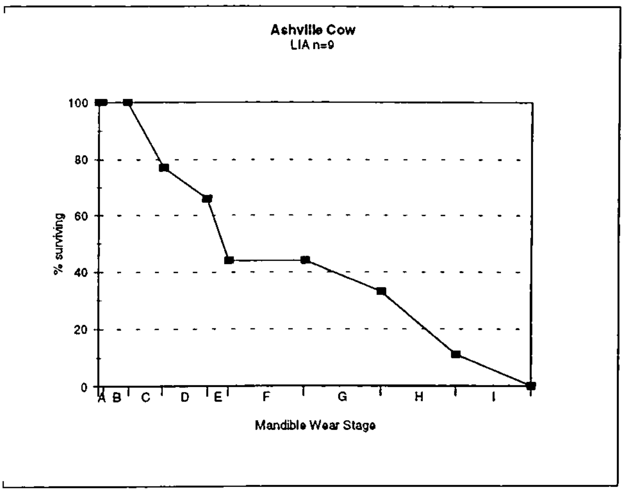

Owslebury Cow
IA n=59
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage


Winnall Down Cow
MIA n=36
100
80
60
40
20
0
% surviving
A B C D E F G H I
Mandible Wear Stage

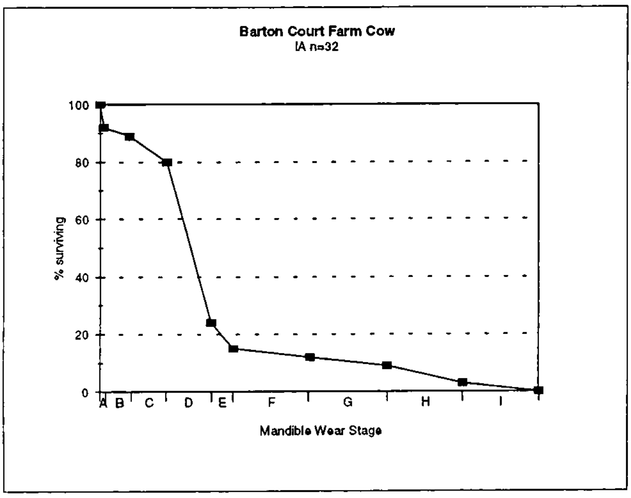
Upper Thames Valley and Surrounds



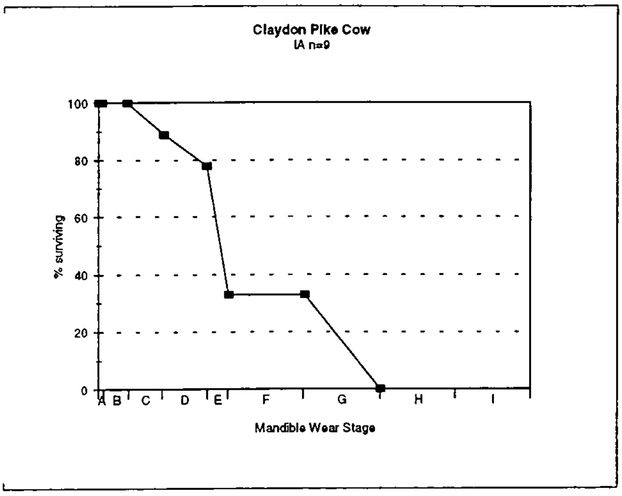
Ashville Cow
EIA-MIA n=15



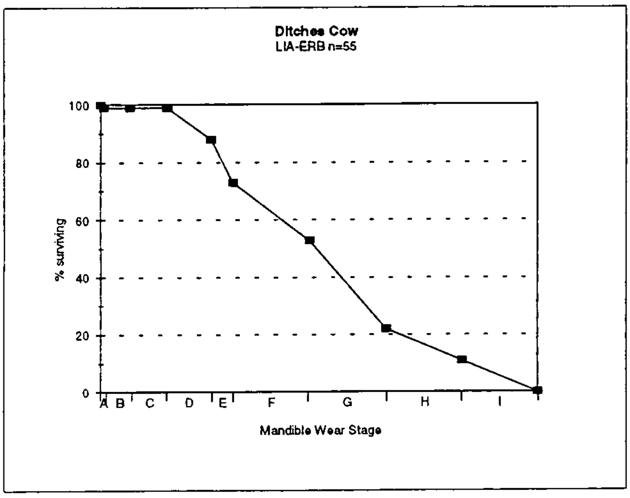
Ashville Cow
LIA n=9



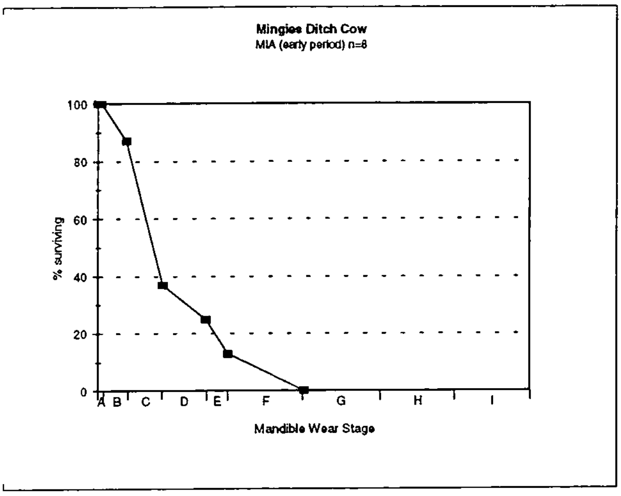
Barton Court Farm Cow
IA n=32



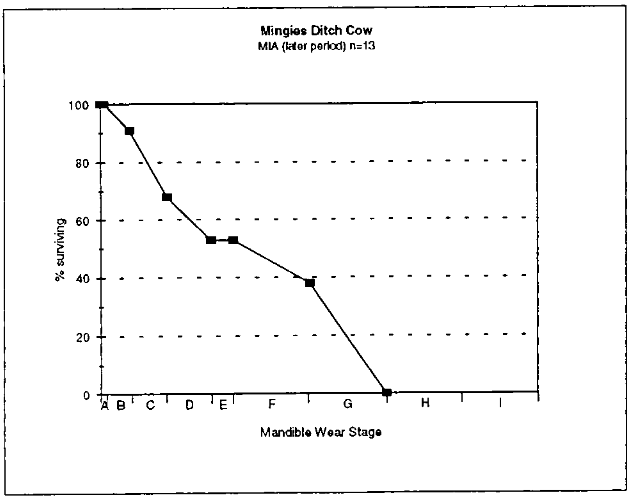
Claydon Pike Cow
IA n=9



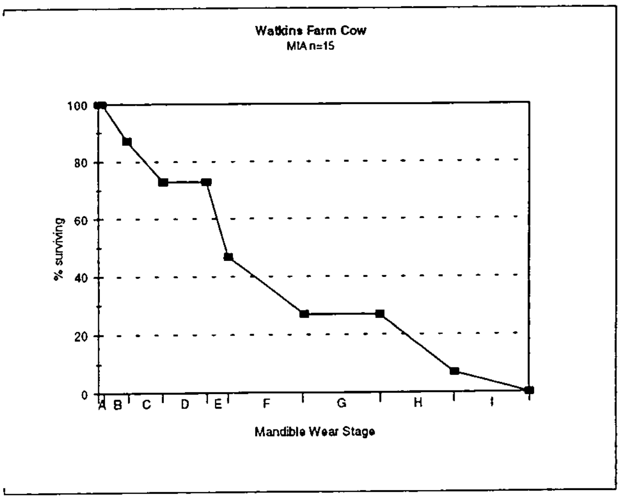
Ditches Cow
LIA-ERB n=55



Mingies Ditch Cow
MIA (early period) n=8

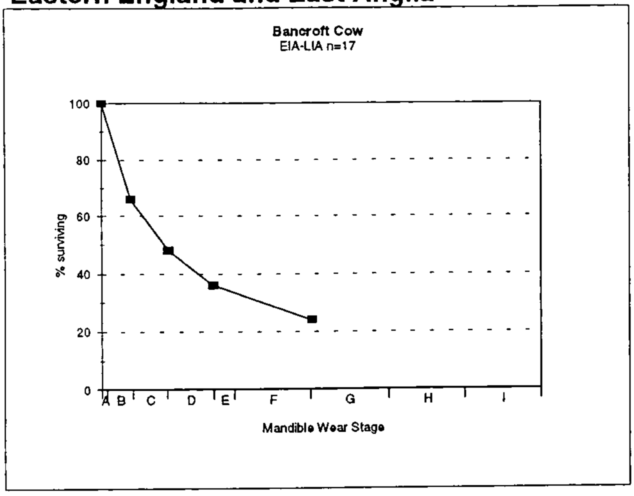


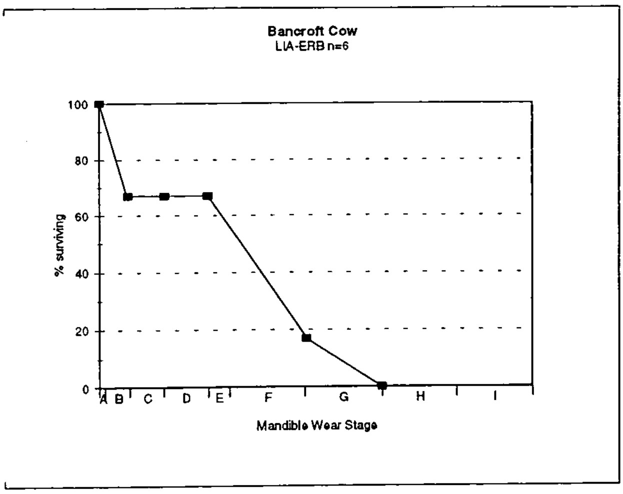
Mingies Ditch Cow
MIA (later period) n=13

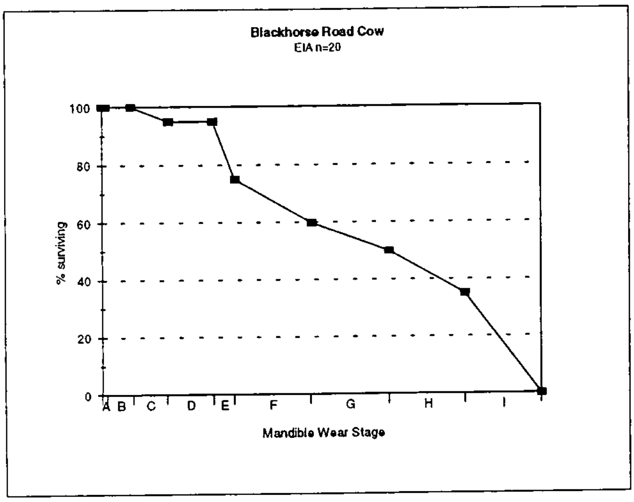


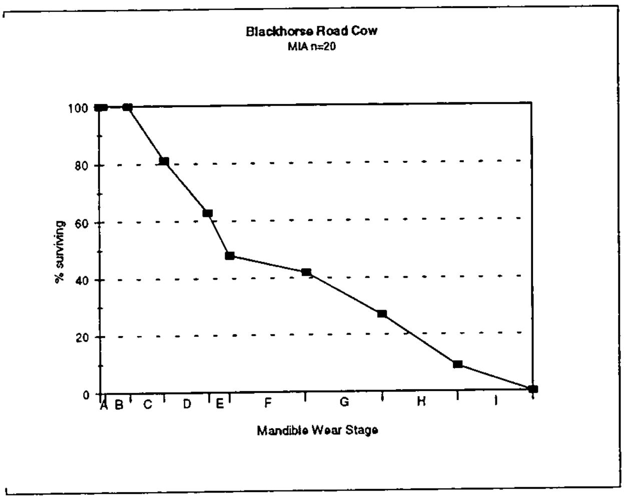
Watkins Farm Cow
MIA n=15

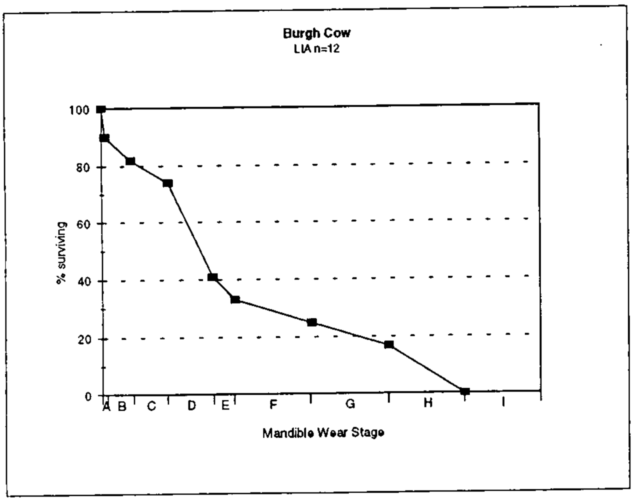
Eastern England and East Anglia

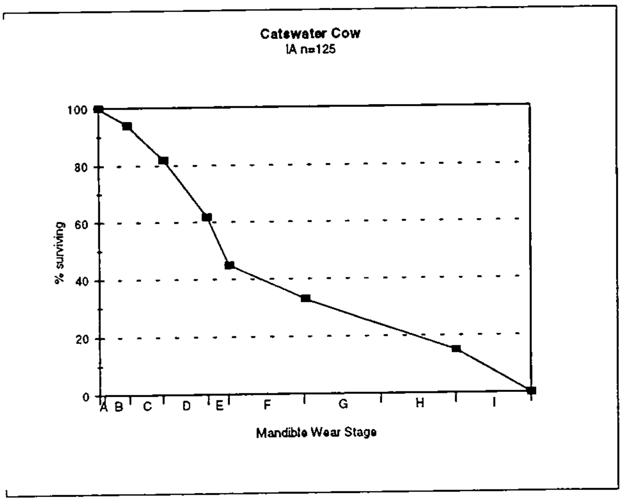

Bancroft Cow
EIA-LIA n=17

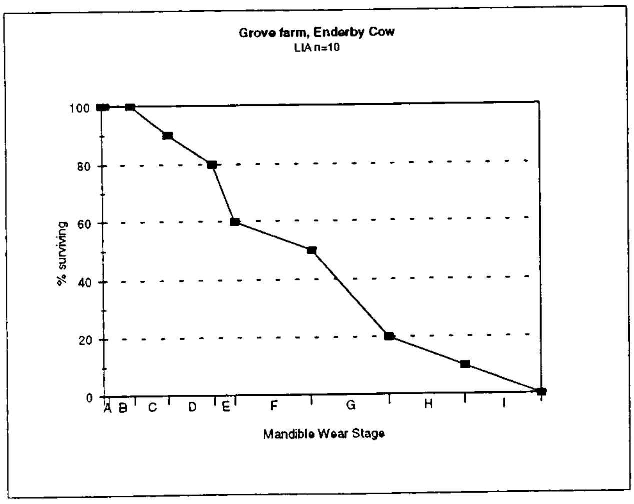

Bancroft Cow
LIA-ERB n=6

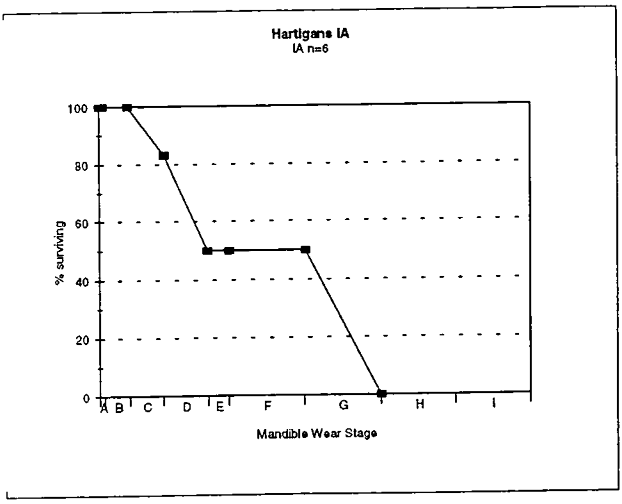

Blackhorse Road Cow
EIA n=20

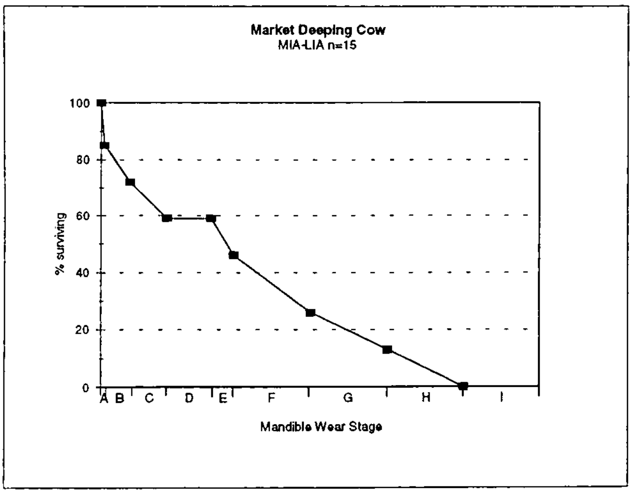

Blackhorse Road Cow
MIA n=20

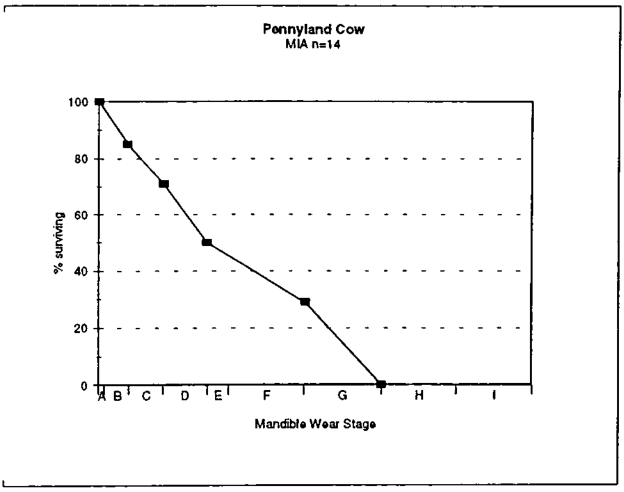

Burgh Cow
LIA n=12

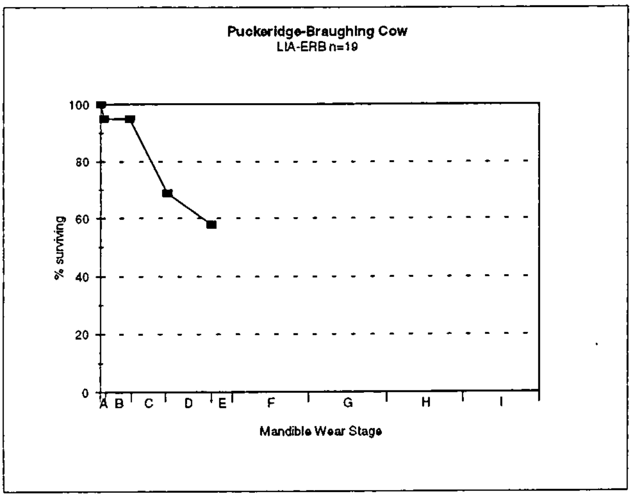

Catswater Cow
IA n=125

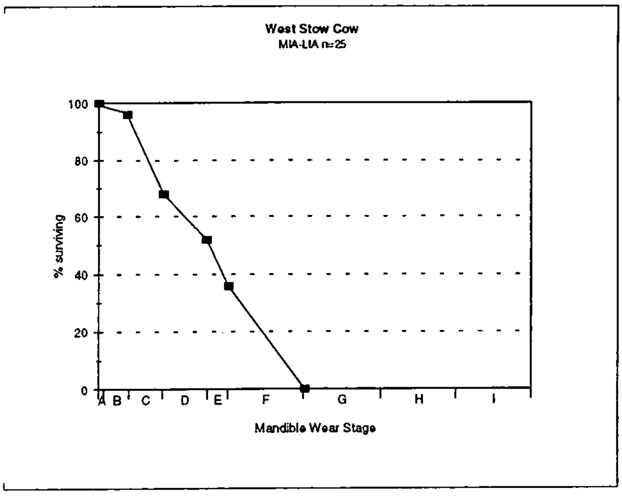

Grove farm, Enderby Cow
LIA n=10


Hartigans IA
IA n=6

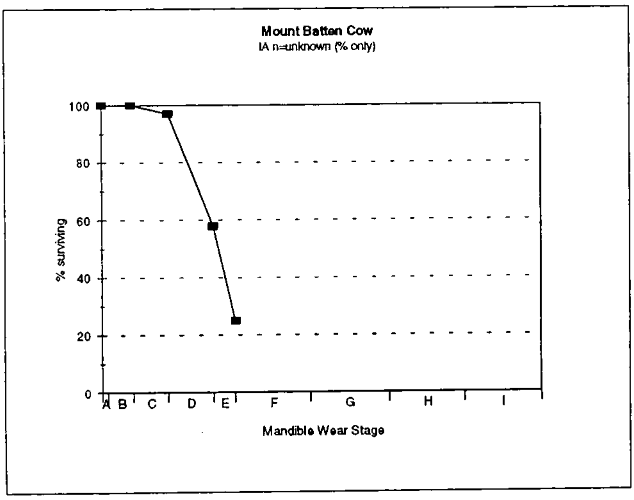

Market Deeping Cow
MIA-LIA n=15


Pennyland Cow
MIA n=14

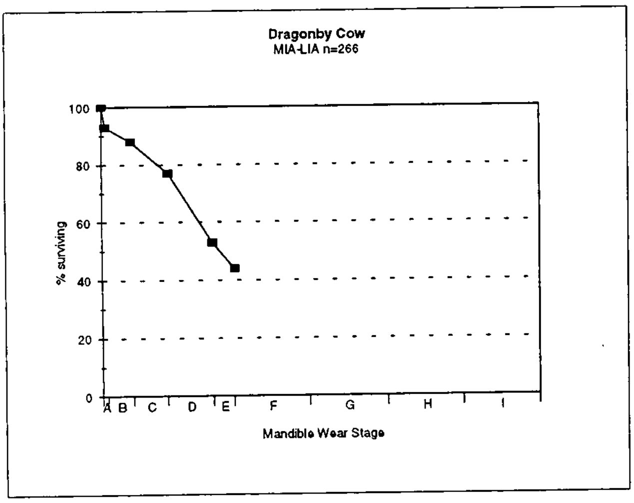

Puckeridge-Braughing Cow
LIA-ERB n=19


West Stow Cow
MIA-LIA n=25

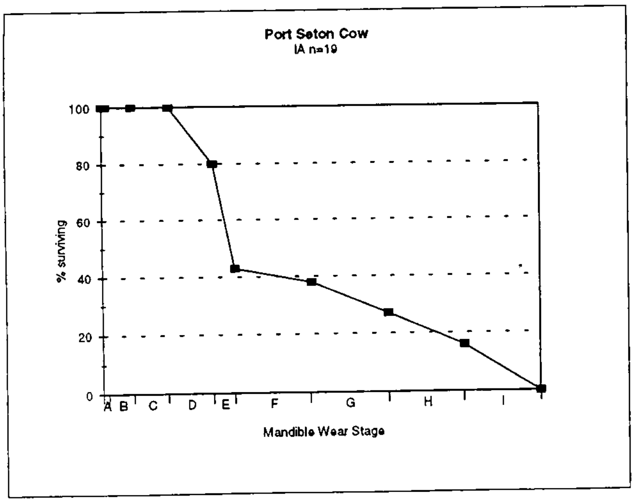
Western England and Wales



Midlands

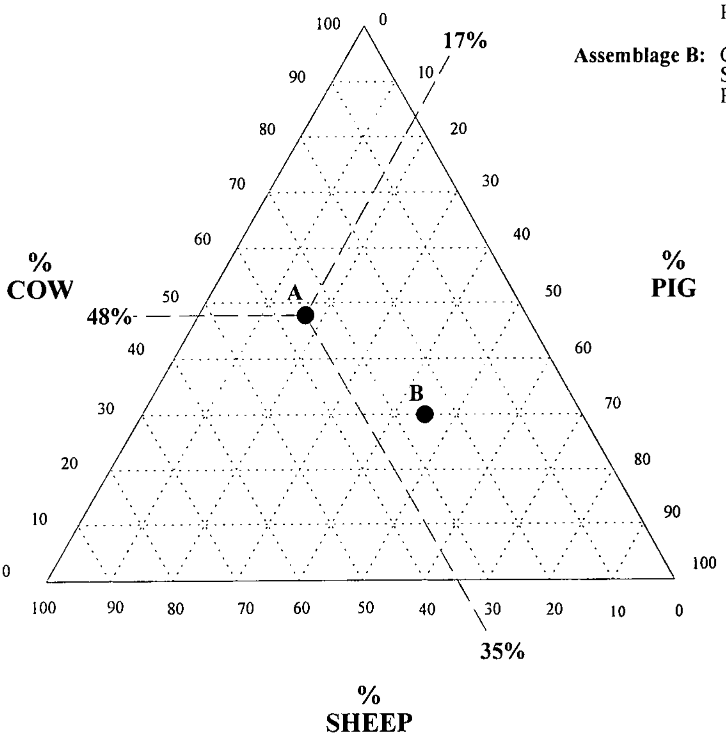


Northern England and Southern Scotland



Appendix 5

Reading Tripolar Graphs



Assemblage A: Cow 48%
Sheep 35%
Pig 17%

Assemblage B: Cow 30%
Sheep 35%
Pig 45%

Each point represents a faunal assemblage comprising cow, sheep, and pig remains. The relative percentage of each of these three species in the assemblage determines the position of the point on the graph. To discover the relative percentage of a particular species in a plotted assemblage, read across from the correct species axis in the plane shown by the dashed lines.