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TITLE The role of wild fauna in urban economies in Wessex

THE ROLE OF WILD FAUNA IN URBAN ECONOMIES IN WESSEX

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The role of wild fauna in any urban economy is complex. It may be of significance in maintaining a balanced diet or providing gourmet food, of importance for skins or other by-products, a valued asset for sport and prestige, and an element of even urban life which threatens man's livelihood.

We can attempt to sort out these various roles of wild fauna from the bones that remain by a careful study of the place of deposition, the fragmentation, and the butchery. As in most aspects of archaeology the strands are difficult to separate. Marks of knives on bones, for example, can be made in killing, skinning, butchery before or after cooking, at table, and after discard. Further complications occur when animals caught as predators are eaten and wild animals are kept as pets.

Quantitative assessment of the relative importance of wild fauna in the diet is almost as difficult as an assessment of the relative roles of plant and animal foods. One problem is that the wild element in particular is from several animal classes which show various degrees of preservation (fish, crustacea, birds, and mammals for example at many Wessex sites).

Later in this paper I have discussed the problems of dietary reconstruction across classes.

In all such quantitative reconstructions we must remember that animals eaten 'bones and all' or in stews while providing excellent sources of calcium leave no bones for consideration. Domestic cats and dogs may also completely consume a great deal of bone and this can be a significant factor on urban sites.

Before dealing in detail with actual results and the methodology of quantification I shall first briefly discuss problems of sampling in urban sites. The final sections of the paper are an attempt to see these studies in perspective relative to nutritional and behavioural research. The overall emphasis throughout is deliberately on the dietary role of wild vertebrates.

The Importance of Rural and Continental Parallels

Any study of animal bones from an urban site must be linked with such parallel studies as can be made on relevant contemporary rural sites. This is especially true when attempts are made to measure the extent of exploitation of wild fauna, for such a comparison will help us to judge the extent to which 'urbanness' itself is a factor in, for example, dietary differences, and design investigations into the relative importance of local and cultural components.

In Britain the extent to which foreign invasions and imports may have altered diet (especially the degree of exploitation of wild fauna) can likewise not be assessed without careful comparison between our own work and that of bone analysts in countries of origin of the various ethnic groups or results from known trading partners. The close ties between workers at Hamwih (Saxon Southampton) and Dorestad, Holland have already shown up some interesting similarities and differences between the respective domestic animals and it is only by an extension of such studies, possibly with a unified system of bone recording, that we shall be able to discover the causes of dietary change through time and the extent to which introduction of new animal stocks was significant.

Sampling Urban Sites for Bones

One aim of archaeozoologists is to answer dietary and nutritional questions. This requires large enough samples of material which we know was derived from food preparation, meal debris, or faeces. Conventional sampling theory when applied to complex urban sites must take into account our past experience and knowledge of the types of bone deposition.

Sampling requirements for urban bones are twofold. At the beginning or before excavation there must be a considered experimental design to take in a representative sample of all these types of deposit, which is modified as necessary as excavation proceeds. With urban sites there needs to be a great deal of feedback from archaeozoologist to archaeologist and digger. Second, where actual collections are too great to be studied totally in depth, subsampling procedures must be instituted. This will rarely be necessary in the future for macroscopic samples obtained by conventional digging now that computer coding and microprocessors are available but for sieved material with its vast heaps of residues from guardrobes subsampling has to take place.

Methods of sieving best applied to urban sites will vary from site to site and according to the type of material but manual flotation and sieving as described for Winchester by Green (1979,) provides an adequate check for us on Wessex sites provided that those sorting the residues are trained in the recognition of fish, bird, and mammal material. A very small amount of vertebrate material also floats.

As well as deposits yielding dietary information industrial deposits of various kinds will involve bones and many quite unlikely deposits can preserve good bone, eg street layers and courtyards, but the dietary interpretation of these is more difficult than that for pits, guardrobes, and kitchen layers.

What is left on site for us to excavate is a sample (of what was deposited and in turn of the populations of animals existing at the time). If from our sample we attempt to reconstruct man's diet rather than these shadowy populations we make the reconstruction easier by a whole stage. Binford (1979,) puts this better in describing the kernel of his Nunamuit work : ' our interest is in the actual use made of the animals as food, not in making poor estimates for what could have been a kill population while ignoring the reality of the assemblage before us'. There is no doubt that to approach the reality of an assemblage on an urban site the archaeozoologist will need to work on site using samples taken by volume from each deposit. Only in this way can the true relationship between wild and domestic remains and that between mammal, bird, and fish be seen.

This is not to say that ecological studies relating to domestic and wild populations of the time are unimportant but they are undoubtedly more difficult and capable of a lower order of resolution than the more immediate reconstruction of diet on most urban sites.

The Size and Function of Urban Bone Samples

In an urban site the samples we obtain are usually too small for our purposes. They may threaten to bury us in mountains of boxes but when the bone analyst comes to grips with these 'enormous' samples he usually finds that there is too little material from certain periods, certain types of deposit which will tell him about diet, and certain classes of society. He will also discover that the samples have not been carefully enough collected or preserved; and that once the large number of species likely to occur in a rich urban site (perhaps 50 or more) and the number of anatomical elements (several hundred) are taken into account it is impossible to do any useful statistics on what is left. Of recent years we have seen some large urban collections from London (Armitage, this volume), Winchester (Biddle, forthcoming), Southampton (Bourdillon & Coy 1979), Exeter (Maltby 1979) and York amongst others. Work on these collections has shown that the more complex the urbanisation the greater looms the problem of insufficient sample size.

In Wessex these problems initially appear much more acute in multiperiod urban Winchester than in Middle Saxon Southampton - yet are they ? In earlier Hamwih excavations there was the major problem of difficult or apparent lack of stratigraphy, and the puzzle of sorting out differences within the lifespan of Hamwih were as severe as some of the problems of more complex urban sites if we were to attempt to solve them from the bones. This may be less true of the current extensive Six Dials excavations at Southampton.

There is the additional complication that Hamwih was in a very rich estuarine area and marine and coastal exploitation to be seen in all its detail needs routine bulk sampling to assess the role of fish. At Hamwih a 5 litre sample is removed from each recognizable layer and treated for the extraction of seeds and small bones. Very little useful additional data for the larger mammals and birds is obtained but the sieved samples give a different picture for small birds and fish.

With all we now know from Hamwih is it still worth taking samples from every layer ? This is something we are still discussing with the workers at Southampton. To some extent we know that it is still of value . Only by using careful manual sieving are we really getting to grips with the intrinsic nature of each deposit (the 'reality of the assemblage' discussed above), for example, the close association or otherwise of the various types of dietary material.

It is not always possible by just looking at a soil sample to tell whether it is rich in small bones and it must be disaggregated and wet sieved - at Hamwih this is partly because of the nature of the soil. Without sieving it is therefore not possible to predict those rare yet important layers which are rich in material. Such richness may be the result of an extraordinary degree of preservation rather than an especially rich exploitation of fauna. What causes this is not fully understood but one possibility is a quick infilling of the pits which excludes oxygen from the material swiftly and efficiently.

Such well-preserved layers must give a less biassed picture of diet than those where differential preservation has taken a greater toll and only by intensive retrieval, including sieving, can we learn to recognize the degree to which a sample has lost its evidence and therefore judge its reliability for dietary reconstruction or for the assessment of domestic/wild or mammal/bird/fish ratios. Preservation of material in the Hamwih pits is probably aided considerably by the large amount of bone in them which would raise the pH and tend to produce the right conditions for bone preservation.

Sieved samples therefore, in addition to providing more information on material not retrieved by conventional excavation, may provide clues to the relative importance of the different food classes; demonstrate the fact that food has been through the alimentary tract ; and possibly act as the most sensitive indicator we have for detecting minor shifts in the diet which may be seasonal or cultural. Fish otoliths, scales, and bones, like mammalian teeth, provide us ultimately with a tool for sorting out not only seasonal but nutritional detail by a study of individual incremental growth and the incremental and sieving detail could together tell us a lot. It is however unlikely that the amount of investment archaeology can put into these methods can do more than scrape the surface of this evidence for many years to come.

The above discussion may suggest that bone analysis must therefore be both on a massive and a microscopic scale and this is so if we are to answer the questions that archaeologists need to answer - for example far-reaching questions on origins, evolution, discontinuity, and status in urban people - all of which are linked with dietary and other aspects of animal bones.

Massive residuality and contamination are also factors which lead to a rapid reduction from apparent to actual sample size when bone analysts are comtemplating urban collections. It is now becoming possible to pick out bones of a particular period by eye just as it is with pottery. But bone is far less reliable for this purpose at present and will probably always be so. The range of variation from Roman times onwards in our major domestic animals is such that no-one can say as yet 'this is a sixteenth century sheep' with any degree of certainty. But major changes in the appearance of stock, the incidence of young animals for slaughter (Maltby, 1979,), the incidence of certain wild species exploited for food, and characteristic butchery patterns can already give dating clues for complex urban sites especially where other evidence is lacking. Bones themselves often provide good evidence for redeposition (Biddle, forthcoming). By itself, the proportion of the bone which is fallow deer may be the most reliable indicator we have for some periods of the status of urban inhabitants.

All the points in the above paragraph strongly confirm the need to study the animal bones from urban sites for archaeological reasons as an intrinsic part of the site data base not as a fringe activity to be dropped when money runs short. Current archaeozoological work often places too much stress on remote reconstructions of past ecologies and husbandry and flippant discussion of rare finds and discoveries and perhaps not enough stress on the reconstruction of diet from bones and the depositional and preservational aspects of bone of direct relevance to archaeological interpretation.

The differential survival of bones, referred to above for Hamwih, is a wide subject currently of great interest to archaeozoologists. Eventually it may become possible for us to assess the reliability of each bone sample for dietary reconstruction by criteria it shows with respect to preservation. This day is at present some way off and it is the initial studies which need so much material. Some must be carried out on rural sites as urban collections introduce too many new factors. Such parallel taphonomic studies on rural sites carry great relevance to our urban preservational problems and are of direct concern to any interest in domestic/wild exploitation for the results obtained are controlled fundamentally by the methodology.

Quantitative Methods for Assessing Domestic to Wild Ratios

I was very impressed by Professor Olsen's account of the unreliability of bone quantification but I would suggest that the results he discussed showed overinterpretation of small samples rather than the danger of quantification itself.

For the study of the Melbourne Street bones from Saxon Southampton (Bourdillon & Coy 1979) the methods of fragment counts, bone weights, and minimum numbers of individuals were used for quantifying specific ratios and therefore ultimately domestic to wild ratios. In Table 1, a and b give results for Melbourne Street which respectively exclude and include fish . These results show that almost 100% of the bone fragments (99.8%) came from domestic animals but that this figure is reduced to 97.1 % if fish results are included.

[TABLE 1 HERE]

Table 1

Hamwih, Melbourne Street, Middle Saxon
Wild/domestic percentages for the whole site and for feature 16, site V

WHOLE SITE

a Mammals and birds only

	wild	domestic
by fragment count	0.2 %	99.8
by bone weight	0.1	99.9
by minimum numbers	3.7	96.3

b Mammals, birds, and fish

by fragment count	2.9	97.1
by bone weight	0.1	99.9

SITE V, FEATURE 16

c Mammals and birds only

	wild	domestic
by fragment count	0.5	99.5
by bone weight	0.5	99.5
by minimum numbers	16.0	84.0

d Mammals, birds, and fish

by fragment count	20.0	80.0
by bone weight	0.7	99.3

Note All the fragments included above are from species which we deduced were eaten on this site.

Weight estimations in Table 1 a and b give the same result, presumably because compared with the size of the major mammals most of the fish were small . Minimum number counts were not attempted for the fish material.

Results are also given for an exceedingly rich feature (Site V, Feature 16) which was partially sieved. These results must not be taken too seriously for the excavation of the sites took place before the major sieving programme that subsequently developed at Southampton Archaeological Research Committee excavations. The results available for feature 16 - a large pit - do not give us all the relevant detail to make comparisons that we now collect in the light of subsequent experience. To what extent the richness of Feature 16 is cultural, preservational, or related to the use of sieving is not quite clear but the results are added for interest in Table 1c & 1d to suggest that the overall site picture shown in Table 1a & b may be misleading - presumably at least in part as a result of poor preservation and the absence of a sieving programme.

Once again Table 1 shows in c & d an increase in the proportion of fragments assigned to wild vertebrates (this time a significant one from 0.5 to 20 %) when fish are included. Bone weight results change little, presumably for the reason given above, and again minimum numbers are not included for fish but the minimum numbers for wild mammal and bird makes a significant increase from 0.7 to 16.0 %. In practice this is due to a higher incidence of small wild bird bones in Feature 16 - at least partly the result of the sieving.

The results do therefore give an indication that for an accurate reconstruction of diet and for the calculation of domestic/wild ratios it is essential both to include the results of fish identifications (fish bone retrieval itself is a problem unless diggers are trained in its recognition) and to include results from a regular programme of sieving.

Table 2 shows results for identifiable bone fragments from Feature 16 discussed above and again results should not be taken too seriously in their detail because of the methodological limitations for Feature 16 mentioned above. Working in two places of decimals is necessary because of

Table 2

Fragments, weights, individuals, and meat for Melbourne Street V, Pit 16

	1 number of fragments	2 weight of bone Kg	3 MNI *	4 individual weight of meat (50% carcase) Kg	5 meat (3 x 4) Kg
(HORSE)	4	–	1	–	–
CATTLE	2501	60	19	137.5	2612
SHEEP	1412	11.8	17	18.8	320
GOAT	25	1.3	6	18.8	113
PIG	718	7.9	18	43.8	788
(DOG)	3	–	1	–	–
(CAT)	38	–	2	–	–
(SMALL MAMMAL)	13	–	5	–	–
RED DEER	2	0.2	1	35	35
ROE DEER	1	0.02	1	12	12
GOOSE	57	1 (domestic bird)	6	3	18
FOWL	187		15	2	30
DUCK	2		1	0.7	0.7
WOODCOCK	1		1	0.2	0.2
CROW	7		2	0.2	0.4
G N D **	1	0.2 (wild bird)	1	0.5	0.5
(BUZZARD)	1		1	–	–
THRUSHES ETC	9		7	0.04	0.28
(AMPHIBIA)	20	–	8	–	–
RAY	8		1	2.5	2.5
SALMON	2		1	1.0	1.0
HERRING	1		1	0.1	0.1
EEL	592		6	0.01	0.06
WHITING	5		5	0.04	0.2
?POLLACK	1		1	0.1	0.1
BASS	19		3	0.5	1.5
SCAD	28		3	0.02	0.06
SEA BREAM	3	0.42 (fish)	1	0.1	0.1
MACKEREL	4		1	0.1	0.1
MULLET	8		2	0.7	1.4
GARFISH	1		1	0.2	0.2
FLOUNDERS/PLAICE	583		25	0.2	5.0
TOTALS	6257	82.8	164	278.11	3942.4

* minimum number of individuals
** great northern diver

[TABLE HERE] the small weights for some species. Minimum numbers are included here with the proviso that fish minimum numbers are probably severe underestimates because of the large number of unidentifiable fish bones. Certain key vertebrae can be used to give a quick estimate of numbers even with very large numbers of fish bones but obviously head bones are a lot easier. When we are faced with large quantities of fin rays unidentifiable to species the problem is more critical and at the time Melbourne Street was studied our ichthyological abilities did not match up to this. Minimum numbers are however given for all the vertebrates in Feature 16 for interest as at the pit level this statistic has some value. The other work at Melbourne Street on mammals calculated minimum number of individuals by examining closely the elements of each species (spread out at one viewing) and determining how many animals were involved taking into account epiphysial fusion. Detailed study of the mandibles normally gave the highest minimum number.

This work suggested that cumulative results for minimum numbers (ie totalling results for each pit) and the recalculation of minimum numbers for the site as a whole (by a new viewing) probably gave results which were misleading and mathematically unsound. But for the reconstruction of a particular assemblage as for Feature 16 minimum numbers must be considered as a part of the analytical method although there will be very different results if the unit for their calculation is the layer rather than the feature. It is not possible to do this in retrospect for Feature 16.

The incompleteness of Table 2 as a picture of the food remains from the feature must be stressed. We know that oysters, whelks, winkles and mussels were also involved, probably crustacea and eggs as well. There were also several thousand unidentifiable bone fragments, including approximately 3,000 fish fragments.

We are not quite sure which species were eaten. Species in brackets in the table were assumed not to have been eaten because of a lack of actual evidence for exploitation on the site. All the small bird species, however, have been included as food on the basis of evidence of butchery on one specimen. All fish have been included.

In Table 2 two stages of reconstruction were used: from the fragments in the feature (column 1) the minimum number of individuals (MNI) was assessed (column 3). From this MNI and the estimated weight of an animal (extrapolating from bone size to animal size with reference to modern specimens) meat values were estimated (columns 4 and 5), taking 50 % of carcase value as meat. Meat weights were then multiplied by MNI for the pit. The Manching estimations were used for the major domestic animals (Boessneck et al 1971, 9) and estimations for the others were from specimens with similar sized bones in the Faunal Remains Project's collections - fish values particularly were great approximations. Deer weights were from Corbet and Southern (1977, 416). Table 2 shows that on the basis of meat estimations (perhaps the real meaning for us of 'reality of the assemblage') the amount of meat derived from wild vertebrates would be less than 2%.

What do these results show ? First they suggest that the overall results for Melbourne Street, Hamwih, as in Table 1a and 1b may be underestimates for the use of wild species to supplement the diet. The overpowering importance of fish by fragment but not presumably by weight of meat is a measure of many factors which will be discussed more fully in a later section.

How reliable are such rich finds as those of the pit discussed ? The extent to which they can be used to interpret food remains for the whole site will depend upon the conditions that led to their deposition and our overall view of the site. But it is quite probable that for Hamwih such rich finds give a more accurate picture of the total diet and for that reason we cannot relax our efforts in sampling every layer for small bones.

The two stage reconstruction should probably go in qualitative terms as well as quantitatively. We should reconstruct as follows:

bone fragments ⟶ individual carcases ⟶ food value

and 'food value' does not just mean 'meat' or 'calories' - but more of this later.

Urban Sites versus Contemporary Rural Sites

Comparison of results from Hamwih with those from a small site at Ramsbury, Wiltshire, of a roughly similar date demonstrates that even specific percentages of major species are very different, with rural Ramsbury showing a greater concentration on horse and pig although the former was not necessarily eaten (Table 3). Ramsbury also shows a higher dependence upon wild mammal meat as shown by

(TABLE 3 HERE)

Table 3 Specific Percentages (Fragments) for Hamwih and Ramsbury

	HAMWIH	RAMSBURY
HORSE	0.1 %	10.8
CATTLE	49.6	31.8
SHEEP/GOAT	30.3	22.4
PIG	14.4	24.4
DEER	0.02	4.4
OTHERS	5.58	6.2
	sample 48,214 fragments	sample 2,471 fragments

methods similar to those used for Hamwih in Table 1.

These figures were worked out in several ways, some of them directly comparable with the Hamwih methods (numbers of fragments and weight of bone) except that the distinction of cattle and red deer bones at Ramsbury was more difficult because of the large size of the red deer and the large quantity of it (Coy, 198). At Hamwih red deer , <u>Cervus elaphus</u> L, was so rare that all the large artiodactyl remains were assumed to be from cattle even if they came from areas difficult to distinguish - like vertebrae, ribs, scapula blades, and pelves. For Ramsbury it was considered unreliable to do this so that the levels of identification made tended to correspond to those in Table 4. 'Cattle-sized' fragments could have come from horse, cattle, or red deer in the main (assuming on this site that there were no fallow deer before their Norman reintroduction). 'Sheep-sized' fragments were those calculated to have come from animals of roughly sheep size like sheep, roe deer, goat and pig. This is more realistic for our purposes than to attempt further differentiation into a greater number of classes for unidentifiable fragments as is done in some classification systems. It must be realised that these 'unidentifiable' fragments were often unidentifiable to anatomical element as well as to species.

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Bones at the second level of identification were the really significant ones as far as the wild/ domestic ratios were concerned at Ramsbury. Those identified as cattle/ red deer could either all be put into the wild or all into the domestic category or any division of the material between the two categories that we required could be made. This gave us a <u>range</u> rather than an exact figure for the percentage of wild fauna in the diet, dependent upon whether the level 2 identifications were included as cattle and sheep/goat (giving a lower figure for wild) or as roe and red deer (higher figure for wild).

Table 5 gives a comparison of Hamwih and Ramsbury figures for the percentage of fragments which came from wild vertebrates using the range method described above. Ramsbury has ranges as explained above dependent upon where the level 2 identifications go but for Hamwih the lower figures given assume no problem of contamination of cattle and sheep with deer bones, the middle figure derives from the results for feature 16 discussed above which took note of fish, and the notional upper figure for the range is denoted here by '?'. This

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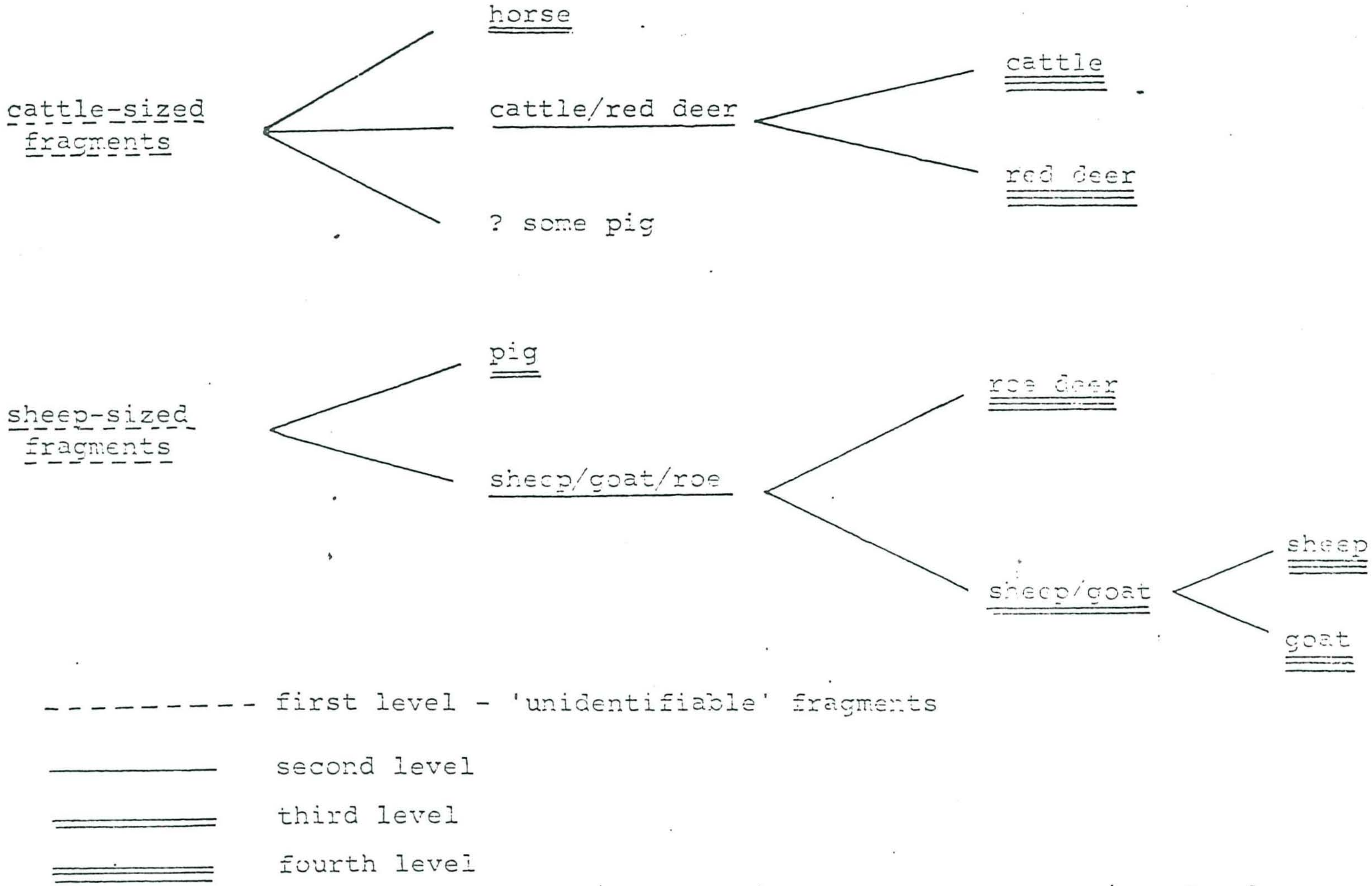
Table 4 LEVELS OF IDENTIFICATION



jpc Ramsbury

Table 5 Range of possible percentages of wild vertebrate fragments

	HAMWIH	RAMSBURY
percentage by fragments	0.2 - 20* - ?	5.0 - 14.6
percentage by weight	0.1 - 0.7 - ?	5.9 - 16.4
MNI	? - 4.0 - ?	not calculated
WBE	not calculated	6.0 - 16.9

Note Only results for species which present evidence that they were eaten are included here except for fish (Hamwih only) which are <u>all</u> included.

* Middle values are those for Site V, feature 16

could be calculated if Ramsbury methods of cattle/red deer distinction were used and would obviously provide a higher figure for wild species but would be quite wrong. Similar results obtained from bone weights are given in Table 5. Minimum numbers were not calculated for Ramsbury but obviously as for Hamwih would have given results very different from those derived for fragments and weights as they are measuring a different thing. The method of 'whole bone equivalents' (WBE) is that used by Griffith for Iron Age material on the M 3 Motorway material (Griffith 1978) where a fragment is scored on a crude 'whole', 'half', 'more than half', 'less than half' basis to counteract differential fragmentation between different sites and species. These fractions are totalled to give the number of whole bones to which a collection is equivalent. This figure for Ramsbury gives results not so very different from those obtained from fragment counts and weights but differences arise with the WBE method when comparisons are made between species.

These results are only pointers to the sort of comparison which could be made with unified methods and more control over site choice and taking of the bone collection. They show the danger of comparing, eg, wild/ domestic ratios, unless methodology and many other factors are the same. At Ramsbury the species of wild mammal exploited were mostly roe deer, Capreolus capreolus (L), and red deer, Cervus elaphus L, although fur species - beaver , Castor fiber L; fox, Vulpes vulpes (L); and badger, Meles meles (L) - and a few wild bird remains were found. Comparison with Hamwih is interesting. The overall dependence upon domestic stock for bird and mammal meat at Hamwih could mean a lack of opportunity for hunting for a number of reasons but it could also merely reflect a mode of life and evolution along the path of urbanism. Ramsbury with its close contact with a diverse and extensively wooded area and a wide river plain would be a difficult place to divorce oneself from the pleasures of rural sport, whether legal or illegal, and the need for the flavour of game. The variety of shore and estuarine food at Hamwih - crustacea, molluscs, and fish of a variety of species - would compensate adequately for any dietary boredom or deficiency, and yet one marked feature of Hamwih is the lack of extensive exploitation of coastal birds or sea fish.

The ease with which an adequate and interesting diet could be obtained from domestic mammals and birds and their products; easily-caught estuarine fish (eels and flounders); and occasional supplements of shellfish presumably made this unecessary. To what extent the way of life of the Hamwih people differed from that of the contemporary Ramsbury inhabitants (the bones were probably left by the iron-workers) is debatable. In both cases extensive exploitation of wild fauna seems to be lacking and the results obtained from the animal bone seem to reflect the possibilities of the surroundings superimposed upon a background of a successful mammalian and avian husbandry.

Detailed consideration of the role of wild vertebrates in the diet of Roman and medieval Winchester must await the results from the Winchester Research Unit (Biddle, forthcoming) and our own work on material excavated in Winchester in the 1970s. Similarly for Southampton post-Saxon material is still being studied but preliminary results (Bourdillon 1979) suggest a different pattern of exploitation from the Saxon one. Rural contrasts for these are again difficult to find in terms of excavated bone but small quantities from many sites are being computer coded and should eventually provide us with sufficient data (Coy 198).

Dietary Reconstruction across Vertebrate Class Boundaries

Perhaps this is the point at which to look in more detail at this attempt to cut across class boundaries in the vertebrates (fish, birds, and mammals) and to review the various methods which can be used to compare the results for fish, birds and mammals. Such methods may be regarded as an essential route if the true role of wild fauna is to be assessed. Some complications arising in such reconstructions are taken up below:

1. The Problem of Unidentifiable Bones

← Taking Table 1 in conjunction with Table 5 it can be seen that the figures derived for the animals which served as food using fragment counts and bone weights methods are sometimes but not always of the same order for the two methods. There are some important points to note in the derivation of such tables. First, all the figures in Table 1 are derived from identifiable (that is identifiable to species) bones so that all cattle-sized, sheep-sized, and unidentifiable fish fragments are excluded. There is really no fair way of doing otherwise except to proportion the unidentifiable remainder between the most likely species . Although such a procedure would make no difference within the classes - eg it would not alter the proportions for cattle/sheep/pig - it would alter the proportions between classes.

If the 3,000 odd unidentifiable fish bones from Feature 16 were included they would make the proportion of fish fragments to mammal and bird fragments much higher than is so at present Table 1d. The difference it makes depends upon the relative identifiability of the classes. It might alter proportions even if cattle-sized and sheep-sized fragments were added too.

This highlights a great danger in making quantifications across classes. To be comparable from site to site the figures must be given alongside a definition of the level at which specific identifications are made and must state whether unidentifiable or assigned (eg 'cattle-sized', 'fish') bones are included. This sounds a complicated business but if the methods are so described there is no reason why such figures cannot be used both for comparisons between features and periods on one site or for inter-site comparisons. Computer coding such as that described for our own work (Coy 198), although it makes the calculations simpler, is no solution as the coding used must still be adequately described.

2. Fragment Numbers in the Different Classes

Fragment numbers are perhaps the major cause of variation between the different classes. Skeletons of amphibians and birds are highly specialised, by reduction in the number of elements, for leaping and flying respectively. In frogs there has been a reduction in the number of vertebrae and in birds the vertebrae are fused together in some areas; there is also a specialised wrist and ankle , a reduction in the number of digits, a specialisation of the skull, and a lack of teeth.

Table 6 shows a detailed comparison between the number of skeletal elements available for archaeological preservation in a sheep (which has fewer toes and teeth than some mammals), a fowl, and a cod.

TABLE 6 HERE]

It may therefore be dangerous to extrapolate directly from numbers of fragments across class boundaries. Whereas direct comparisons of sheep, cattle, and pig fragments might be reasonable, a comparison of sheep, fowl, cod would need to take into account not only the relative numbers of the skeletal elements in these species but any evidence we had as to the likelihood of the species showing different degrees of preservation . Hamwih work suggested that this varied slightly between the different domestic species (Bourdillon 198 ,) but calculations were not made for the other classes. Cod/plaice/eel comparisons should also strictly speaking take into account the variation of vertebral and fin ray numbers for the different species.

3. Skeleton Weight and Meat Values

In Table 1a and 1 c the two methods gave results of the same order but once fish were included there was a considerable discrepancy between the two methods. This is not to say that either is wrong. Both are valid results for the bones analysed but tell us different things and the extent of their difference will be the significant factor in comparisons within the site and between sites. The difference is mainly caused by the small size of the fish bones which therefore produce a small weight relative to fragment counts. On the whole the fish represented in Hamwih are smaller in weight than the individual mammals and birds eaten, so that the fragment numbers of fish bones provide them with an artificially high proportion of the total compared with the proportion they gain by weight of bone.

Bone weights themselves can be used to reconstruct meat values - an alternative method to the MNI method used with Table 2. The method is more fully discussed for Melbourne Street (Bourdillon & Coy 1979, 34) and assumes a skeleton weight of 7% of total carcase weight and a value of 50 % of each carcase as usable meat. These values are the ones currently used by most archaeozoologists and are based on earlier work on the continent of Europe. Meat weights can also be calculated in Table 2 from the column 2 results. They give a figure of 99 % domestic animals by meat weight compared with the value of 98 %+ using minimum numbers. Although the relative proportions may not be so different the actual weight of meat arrived at from the skeleton weight method is only a fraction of that derived via the method of minimum numbers and it is probably true to say that the larger figure is, at the pit level, the more reliable and the reduction (to less than a sixth) that occurs when the skeleton weights are used is a measure of the extent to which the bones have disappeared (Bourdillon 198).

Table 6 Approximate Number of Skeletal Elements available in a Mammal, Bird and Fish (from prepared specimens)

SHEEP (including teeth)	250
FOWL	100
COD	300 (+ scales)

If meat values are to be given across classes can we use these overall figures of 7 % for the percentage of skeletal material and 50 % for the percentage of meat in a carcase ? The latter has been criticised by Stewart & Stahl (1977) who suggest that much more work on modern carcases is needed. This is certainly true and allowances must be made for the different classes - their work only discusses mammals. Andrew Jones has made an important point in this volume about the weight of female fish carrying eggs. With respect to the 7% value for skeleton weight I made a few preliminary observations on skeleton weights and total carcase weights on a number of specimens in the collections of the Faunal Remains Project. There is a very large amount of variation within each class according to the state of the body fat supplies. Further work may show that the 7% and 50% values are not even accurate for mammals and that across-class meat estimations cannot use the same figure for all classes.

Mammal skeletons ranged from a bone percentage of 5.3% by weight for a well-fed zoo wild boar to one of 10.5% in a starving wolf. Birds have bones with thin walls and a low weight compared with their external volume but skeleton weights still came out at 4.2 to 6.2% of total weight for a group of wild birds which had been shot in flight and were presumed typical of healthy wild stock. Typical museum specimens are obviously not reliable for such calculations as they are often casualty birds and preparation of such specimens frequently shows up anomalies and past injuries which may have contributed to a low body weight (eg beak deformities in birds) and to their accidental death.

Fish skeletons similarly gave results below the 7% figure but ranged from 2.8 to 6.9 % of total weight. In cartilaginous fish (dogfish, sharks and rays) the results were lower than this. A typical example from the collections was 1.6%. But this may alter somewhat as calcification of the skeleton occurs during the life of the fish. Bucklers of thornback ray as frequently found on Wessex urban sites certainly give scanty evidence for what may often have been a fish of 20 or 30 kilos. The role of cartilaginous fish has been much underestimated in dietary reconstruction.

[TABLE 7 HERE]

These results are highly speculative and I merely add them in Table 7 because they may stimulate further work and because they do demonstrate well the link with health

Table 7 Percentage of Total Carcase Weight represented by the Skeleton in some Modern Specimens

MAMMALS

zoo wild boar (culled)	5.3 %
zoo brown bear (culled)	5.7
badger (killed by car)	5.7
domestic dog (culled)	5.8
immature domestic pig (died)	7.0
immature zoo fallow deer (died)	8.7
zoo wolf (winter death)	10.5

BIRDS

snipe	(shot)	4.2 %
pochard	(shot)	4.3
domestic hen	(healthy)	4.9
teal	(shot)	5.6
woodcock	(shot)	6.2
coot	(killed by car)	6.7
english partridge	(car)	7.8
rook	(found dead)	8.2
common gull	(found dead)	8.6
swan	(died of wounds)	9.0

mentioned above. Necessary care in such measurement involves accurate weighing on accession of modern specimens and difficulties with gutted, skinned, plucked, and wet specimens must be adequately recorded. The preparation of the skeleton must involve the saving of every bone so that obviously only skeleton collections prepared with archaeozoology in mind or by an extraordinarily conscientious museum preparator will be suitable. Most museum specimens lack hyoids, sesamoids, and cartilaginous ribs. The cleaning and degreasing of specimens should be by a uniform method (eg Binford 1978, 18). Ours vary a lot in the efficiency of degreasing and this may make unreliable the few results given here.

Total weights and meat weights of all specimens taken into modern comparative collections are useful for the alternative method of meat estimation using minimum numbers but careful boning-out is usually the last consideration in skeleton preparation as the best specimens have a habit of arriving at the most awkward times. Both the methods of meat estimation therefore do justify the careful preservation not only of enough data with each modern comparative specimen but the careful preparation of all bones of a skeleton.

It is possible that in the future the examination of incremental data from the teeth of some species will enable us to make an assessment of the nutritional and husbandry status of archaeological animals so that our estimates of carcase weight can be improved.

4 Minimum Number of Individuals

The difficulty of assessing fish minimum numbers has already been discussed in an earlier section. Because of the large number of elements in a fish skeleton, especially a flatfish, there is a lower chance in any collection of fish bones of two bones being the same element and therefore counting as a minimum of two fish. Work done by Wheeler and Jones (1976) is valuable as it allows more accurate estimates of fish meat from individual bones. The size range of some fish is so enormous and skeleton collections always seem to lack a comparable specimen of the right size so that such work correlating measurements with weights is a better way of ensuring that fish weights take their correct proportion in across-class meat figures.

As discussed earlier, minimum numbers are of direct value for the interpretation across classes of the bone material in a single deposit. A collection of several dozen fin rays may be the remains of one plaice whereas a similar number of bird bones will be from several birds. In such a case only minimum numbers can give an accurate across-class meat estimate. In the case of eel vertebrae scattered thinly throughout a deposit (as often happens at Hamwih) how can MNIs help ? While not knowing the answer to this particular problem I would suggest that it one for on-site investigation.

5. Domestic/Wild Distinctions

Whereas the points raised above may all involve some adjustments to any mammal/bird/fish calculations the problem here strikes at the root of wild/domestic distinctions in mammals and birds. Specific percentages assessed by all the methods discussed above depend upon correct identification and for some genera this may not be possible where wild and domestic forms are closely similar. It is difficult enough for some species even with whole bones, eg postcranials of wildcat and domestic cat, dog and wolf, ferret and polecat. Small meat-bearing bones like ribs ; small fragments of scapula and pelvis; and immature bones of red deer/ cattle and sheep/goat/roe deer are very difficult to distinguish. Wild and domestic species may be butchered differently, creating further bias.

One additional bias is the varying levels of erosion and preservation which may alter the ratio and detailed composition of the 'identifiable' and 'unidentifiable' fractions of the sample.. This will be especially true if, as we suspect, certain anatomical elements are most likely to disappear . Anatomical elements vary enormously in the extent to which the whole bones and various fragments of them are identifiable to species.

This rather long section may have suggested that across-class assessments of diet are too difficult. Many of the points discussed above apply to some extent to the normal calculations of specific percentages which every archaeologist has learned to expect in a bone report. With a few additional points to note, wild/domestic ratios are no more complicated and across-class reconstructions not impossible. For all these forms of result there are pitfalls but the major pitfall is an inadequate description of methodology. It is more difficult to make a choice of method but with computer-based recording there is no need as recording can be for all these possibilities except that computer reconstruction of the contents of an individual layer may not give such an accurate estimation of minimum numbers as a visual assessment made during excavation and recording.

The Nutritional Value of Wild Vertebrates

Only the first stage of the suggested reconstruction:

bone fragments → individual carcases → food value

has been mentioned so far and a part of the second stage (the amount of meat). To assess accurately the value of each carcase it is necessary to take into account the dietary elements in it. Table 8 gives an idea of the wealth of variation in just the vitamin A content in a cross-section of foods which we know were all available to the inhabitants of Hamwih.

It would be a different picture when any other element was discussed whether it was calories, proteins, individual amino acids, the calciferols, the different fats, or roughage (now usually called 'dietary fibre' and recognized as being a complex dietary factor sometimes altering the composition of other substances within the body). Different species are good sources of some nutrients - lamb, oysters and almonds are good sources of riboflavine; scallops and wheat contain relatively high amounts of phosphorus .... For a discussion of the food value of Hamwih shellfish see Winder (1979).

Research into the distribution of nutrients throughout even the common foods is only just beginning in earnest as it is realised that many of the commonest Western diseases today are diet-related. Such work will help to illuminate the significance of past diets. As it progresses it should give us a clearer picture of the nutritional value of particular foods, parts of animals, and dietary combinations. Nutritional information today is misleading and often based on assumptions which are being disposed of now at a fast rrate. The value of traditional foods and behaviour patterns connected with diet (eg Harris, 1975, on the sacred cow) have often been underestimated in the past as modern diets have leapt too smartly into the 'junk' food era.

To take just one example, the recent research into dietary fibre mentioned above (eg Trowell 1972, 1976, Spiller and Amen 1976) now supports suggestions made over 30 years ago by Cleave and others that lack of fibrous content was a major cause of many modern diseases.

Table 8

The Quantities of Vitamin A in Some Foods Available to the Inhabitants of Mid-Saxon Southampton (Hamwih)

	international units / g
halibut liver oil	up to 110,000
herring liver oil	5,000
cod liver oil	600 - 1,000
sheep's liver	500
cheese	20 -40
eel (raw)	40
herring flesh	1.5
cod flesh	a trace
oysters	3

Here is something which may link up with archaeological evidence of past diets and - who knows - fiberology may one day become a new archaeological discipline !

Certainly such useful discussions of optimisation in human diet as those of Binford (1978) and Jochim (1976) would be enriched by a discussion of the nutrient distribution in the carcases of the animals eaten, with seasonal effects taken into consideration. The food choice decisions made by man may have evolved to exploit these efficiently. Although what leads people to make the choice may be a simpler matter which they can rationalise (eg Binford's account of radi us fracture to assess caribou marrow), there may be other factors which have actually led to the selection of the behaviour observed (eg in this case perhaps the distribution and concentration of calciferols - the precursors of what used to be called vitamin D - in an environment with ultra-violet light problems.

Obviously such desperate matters of winter survival in the Eskimo are extremes compared with the events in urban Britain but from North to South in Britain dietary requirements will certainly have been different in detail. Different parts of different animal species concentrate chemicals which are important constituents of a balanced diet and changes in treatment of carcases through time could have had far- reaching effects. The actual feeding habits involved in obtaining these essential constituents will vary from place to place and family to family (just look in shoppers' baskets at any supermarket) and from North to South in Britain. Acording to Allen (1968,) the earlier concentration on pigs in East Anglia and Yorkshire has continued as pork sausages in the former and giant sales of Spam in the latter. Considerable variations may be observed from county to county.

Presumably in the past differences may have been more marked. People with a more diverse home area as at Hamwih (with its good range of domestic mammals and birds and wealth of sea foods) would not perhaps evolve such a complex and carefully regulated food selection as would those with more constraints on their ability to obtain the essentials for a balanced diet. Width of choice is an important consideration and this is where the eating of wild species may be most significant. But domestic animals are generally better fed and show more regular growth (Grue 1976,4) and are often considered to have a better flavour (for comments on the flavour of domestic and wild geese see Hawker, 1830,200). This century, large scale marketing has probably reversed this trend in some species.

On the other hand game may hang better than domestic stock. Hanging produces not only tender meat but eventually those flavours of decay savoured by some. Some wild species may also provide nutrients not present to the same degree in domestic food and not only their flavour but their nutritional value will change according to their diet.

Adaptations in man to a more restricted diet could have made it more difficult to adapt to other areas in cases where man and perhaps his animals moved. To what extent evidence of a wide variety of foods reflects shortage of some dietary elements cannot as yet be known but increases in variety in the diet may reflect behaviour related to poor diet and reduced crop yields within the medieval periods (perhaps with greater variety for those able to attain it). It might be possible in urban medieval material to link increase in variety of both plant and animal foods or an increase in exploitation of marine and wild resources with a documented decrease in quality or supply of domestic animal meat or with evidence for high prices. Bones alone cannot show up such changes and a close link with seed and documentary evidence, such as that discussed by Titow (1972,20) is needed. Changes may be gradual and they may be short-lived in archaeological terms but there is no reason why the analysis of really large quantities of well-dated deposits cannot show them up in time.

Guild ordinances of 1300 in the Oakbook of Southampton (Studer 1910), for example, illustrate the tremendous stress placed upon the maximum utilisation within the town of fish brought into it. Ruddock (1951) points to the extensive medieval trade with even Russia and the Baltic quite early on. Closer trading partners may have been responsible for much of the large sea fish whose bones we find in the post-Saxon levels (Studer 1913; Foster 1963; Cobb 1961; and Quinn 1937/8 provide interesting documentary support for this).

Careful excavation could tell us more by associating finds. Some species of fish which do not occur much locally, eg herring, are obviously imported and finds could be tied up well with documentary evidence. In fact herring is not found very often in Southampton excavations although large amounts were imported. It does turn up in large quantities however in Winchester. Customs and toll records are not complete and here bones can certainly eventually tell us much more than the documentary sources. But the extent of the trading as revealed by the surviving documentation does mean that straightforward projections of bone finds into environmental interpretation could be unreliable as early as the Saxon period.

Food Choice and Natural Selection

The choice of food by an individual depends upon many factors besides availability. Some are presumably genetically controlled as a result of adaptations developed in the past and others a result of the variety of early diet. These factors must be taken into account when we study the bones from archaeological sites, especially food preparation deposits and remains of meals, for only by an awareness of the complexity of these shall we notice changes of significance which may be of archaeological importance.

There is no doubt that if left to themselves successful members of a species will make a balanced food choice. This is how natural selection works - at last appreciated by some who study man - Harris (1968, 51) describes the mechanism as ' adaptive evolutionary transformations which are neither comprehended nor consciously selected by the individual members of the society '. Some modern views of natural selection use the phrase 'inclusive fitness' to express that nebulous core of living organisms upon which natural selection operates. Diet must be seen as an important part of the battle to optimise inclusive fitness (Blurton-Jones 1976,442). The mechanisms are complex and the crude picture of natural selection as a matter of life or death or numbers of offspring no longer applies (McFarland 1977,20). The complex optimisation studies which have taken place of recent years in both animals (eg McFarland 1976) and man open the way now to a much fuller application of natural selection theory to human behaviour by archaeologists and anthropologists. A detailed analysis of dietary behaviour is inseparable from any behavioural study and even urban man cannot be left out of this however hard we try.

Conclusions

With this background of incompletely understood ramifications of diet into the formation of behaviour patterns we can also attempt to sort out the changes in diet in terms of increase and decrease in variety and changes in relative composition. How can we go about reconstructing the relative values of the different ingredients in the diet of past urban populations especially with a view to assessing the role of wild fauna ? Are the bones that remain all that we have and are they enough ?

I maintain that they are enough if we can only set about it in a broad enough plane to solve those basic questions which are of direct relevance to what archaeologists want to know and not just a restricted approach governed by questions that archaeologists think that bones can answer. We shall need to use the evidence from all the vertebrate classes, from plant material, and from surviving documentation in combination.

It will be necessary to make an across-class assessment of all the vertebrate material and to take into account the evidence for the other dietary ingredients such as animal products and invertebrates. It will also be necesasry to think of food in terms of nutrients rather than only to consider bulk, meat, or protein.

As we grow more confident of our material it is possible to appreciate the large amount of data that is really there. There is no doubt that in the case of bones the bone analysts must be very closely involved in the sampling design and in any selection of material. The problems of dealing with large amounts of data must be tackled and the necessary leaps made in techniques, time and manpower.

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