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Identification, classification and zooarchaeology

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Summary

Identification of preserved biological materials is often regarded as a skill which has little to do with analysis and interpretation. This paper argues that in zooarchaeological studies—here with particular reference to vertebrate remains—identification procedures deserve more detailed consideration, because these procedures have a significant effect on the results of faunal studies. It is suggested that most identifications are made within a system of usually unspecified rules which vary from one analyst to another. Improvements in comparability between faunal studies will result if these rules are considered before beginning an analysis, and if the rules are made explicit in publications.

Introduction

Most archaeological studies employ typologies as descriptive and analytical devices. The conscious use and analysis of typologies dates from the publication of Krieger's (1944) paper, and a large, complex, and sometimes acrimonious literature has been devoted to typology in general and artefact typology in particular (Hill and Evans 1972; Whallon and Brown 1982). In spite of the continuing typological debate there would appear to be a general consensus that typologies are artificial devices designed to expedite research in specific areas (Hill and Evans 1972; Hayden 1984) and that 'types of types' (Steward 1954) exist.

Typological debates continue in many sub-disciplines of archaeology, and these generally concern the appropriateness of certain typologies for solving certain archaeological problems. For example, typologies of microchipping have been called into question by Vaughan (1985) on the basis of experiments which suggest that the correlation between microflake form and the material worked by the stone artefact is not as good as once thought. Similarly, the utility of some typologies of lithic debitage have been questioned by Sullivan and Rozen (1985).

There has been relatively little debate about typology in the analysis of animal remains from archaeological sites. This is because most zooarchaeologists have assumed that the system with which they describe specimens may be imported intact from zoology. As a result most methodological developments have been in the interpretation of organic remains rather than in their classification and description. The one important exception to this is the discussion concerning the identification of cut marks and breakage patterns on bone (e.g. Behrensmeyer *et al.* 1987; Binford 1981; Johnson 1985; Morlan 1986; Shipman 1981). Typologies of these phenomena are concerned with the identification and classification of humanly-produced modifications rather than the identification of the faunal element on which they are found. They therefore resemble artefact typologies, and share all the problems and advantages inherent in such methods.

In this paper I will briefly consider the theory of identification, then examine the use of classificatory systems to describe and 'identify' faunal specimens from archaeological sites. It will be suggested that zooarchaeologists should consider their identification systems more carefully in order to increase the degree of standardisation of data presentation and reduce the possibility of interpretive error resulting from misapplication of identification methods. Examples will be drawn largely from vertebrate zooarchaeology. It is in this field that problems of identification are most likely to occur, because zooarchaeologists are generally concerned with identifying elements or parts of elements of complex endoskeletons. Analysis of other animal remains, such as molluscs or insects, is usually concerned with identification of relatively complete shells or exoskeletons. This is not to say that many of the problems discussed below will not occur; however, the problems are probably less acute than in the field of vertebrate zooarchaeology.

I should point out at the start of this paper that I have deliberately avoided discussing 'case studies' which I consider to be examples of poor identification procedures or data reporting. Most zooarchaeologists, including myself, have made errors of the types discussed below. It will not serve any purpose to select a few examples from the many to illustrate the points made here.

Identification, classification and typology

The initial stage of any zooarchaeological analysis is to group specimens into meaningful categories. Although this may appear to be similar to the creation of artefact typologies, which also group objects into meaningful groups, there are differences between the two processes. These differences stem from the distinction which must be made between classification and typology on the one hand and identification on the other. Classification is the process of grouping objects or other phenomena into groups based on similarities and differences (Hill and Evans 1972, 233). Typology is a special form of classification, in which phenomena are assigned to the same type if they share consistent patterning of attribute states (ibid.). Biologists have distinguished identification from classification (Sneath and Sokal 1973, 3), noting that identification is the assignation of an organism to a previously established classificatory system.

Archaeologists who study artefacts may wish to use previously established typologies and 'identify' their artefacts by reference to those systems. However, they are always free to modify such typologies or to develop new typologies if existing systems are inadequate for their research design. As a result, there may be debate about the relative merits of different typological systems to assist in the solution of the same research problem. Alternatively, one may apply two completely different typologies to the same artefact assemblage if one wishes to investigate two different areas of human behaviour. For example, typologies of ceramics or lithics which are useful for constructing culture history may be inappropriate for analysing site function.

Archaeologists who study animal remains, or any other largely unmodified organic material, generally organise their specimens into groups by a process of identification. No matter what the research orientation, it is commonly assumed that the initial step of a faunal analysis is to group species according to well-defined attributes preserved in chitin, shell, bone or teeth. This accounts for the widespread establishment of comparative collections and the publication of identification guides and keys. Most zooarchaeologists believe that pre-existing classificatory systems can be employed in the analysis of organic remains. This view is further enforced by fairly frequent pleas for standardisation of data reporting in zooarchaeology (e.g. Clason 1972; Grigson 1978; Driver 1983), such standardisations being impossible without a general agreement that there is a single appropriate classificatory system.

This attitude is certainly reasonable, and many specimens can indeed be grouped using two biological schemes. The first of these is the standard binomial nomenclature; the second is a fairly well standardised system of anatomical description. Using these systems '*Bison bison* left femur' is likely to be well understood throughout the English speaking world and (with one translation) throughout the entire world. This stands in contrast to artefact typologies which, in some areas, have become so cumbersome as to become almost unworkable, and which contain few standardised terms acceptable in more than one language.

If one accepts some of the assumptions (discussed below) inherent in the classification '*Bison bison* left femur' then this is a reasonable way of describing faunal remains. In fact, most vertebrate remains can be described quite precisely by three variables—species, element, and part of element, the latter following a system such as Brumley's (1973) butchering units or Watson's (1979) diagnostic areas. Some specimens may be described further, using categories such as age, sex or pathological condition, but these are usually a distinct minority of the entire assemblage.

Are faunal identifications a form of typology? In some ways they do resemble artefact typologies. Bones are grouped by considering a variety of attributes, with multiple attribute states. The groups are exclusive, and can be defined by non-random associations of attribute states. However, there are important differences between a system of bone identification and artefact typology. The binomial system assumes phylogenetic relationships between animal groups, which is not the case with artefact typologies. The binomial system is hierarchical, while many artefact typologies are not. The basic unit of zoological classification - the species - is essentially defined by its reproductive behaviour, while the basic unit of typology - the type - does not exist as a population and has no capacity for perpetuation. Finally, modern artefact typologies are designed to solve specific research problems, while zoological systems of classification are often used as descriptive referents in research which does not deal with phylogeny.

Methods of identification and their effects on bone groups

Of the three major attributes defined above (taxon, element and modification), the third will not be discussed in this paper, as it is often describing an artificially induced condition of the bone, and consequently most zooarchaeologists have to be explicit in developing non-zoological typologies to describe bone fragments or other aspects of bone modification. Identification of specimens is essentially a matter of grouping specimens by taxon and element.

The methods by which bone fragments are identified ought to be relatively simple. First, it is necessary to identify the element represented by the complete bone or bone fragment. Unless one can identify the element represented, it is usually impossible to justify identification of taxon. It may be possible, using such criteria as bone thickness or surficial characteristics to identify some fragments to the class level without first identifying the element. For example, long bone fragments with cortical bone thicknesses over a few millimetres are unlikely to be anything except mammals (unless one is working in an area with large reptiles or large flightless birds), and many cranial bones of fish display distinctive surficial characteristics which distinguish them, as a class, from other vertebrate classes. However, I strongly suspect that in many cases the assignment of bone fragments to categories such as 'unidentifiable mammal' or 'unidentifiable bird' is the product of wishful thinking. This is particularly likely in the case of birds, where size ranges and cortical thickness of bone fragments frequently overlap with the smaller mammalian species.

It is worth emphasising that assignation of any bone fragment to all but the most general taxonomic group cannot be undertaken without identification of the element. Generally, once one considers specimens below the level of the class, there are no readily observable features of the gross morphology which permit identification of the taxon without prior or concomitant identification of the element. Terms such as 'small ungulate long bone fragment' are meaningless, although they are sometimes encountered in the zooarchaeological literature. If the features on the fragment are sufficient for identification as a small ungulate (as opposed to a medium-sized carnivore, for example), then they will certainly be sufficient to identify the element from which the fragment derives.

The second stage of identification is to assign the identified element to a taxonomic group. Such identifications may range from very general (e.g. the order or family) to the particular (species or subspecies). Regardless of the specificity of the identification, it follows that the identification guarantees distinction from other taxa at the same level of specificity. Thus, the identification 'Canidae' should guarantee that the specimen could not belong to any other mammalian family, such as Felidae or Cervidae. Similarly '*Canis lupus*' implies that no other members of *Canis*, such as *C. familiaris* or *C. latrans* are represented.

The use of such a classificatory system depends upon the following:

1. Zooarchaeologists employ the existing binomial nomenclature used by zoologists.

2. Identification to the given taxonomic level is justified by the methods employed.

These principles are investigated further below.

Use of binomial nomenclature

The International Code of Zoological Nomenclature (ICZN) provides rules for the classification of animals by order, family, species etc. and, like many artefact typologies, is a way of simplifying an incredible array of diversity (Jeffrey 1977). It is organised in such a way as to suggest degrees of relationships between phenomena; for example, animals of the same genus are thought to be more closely related (i.e. they diverged more recently from a common ancestor) than other members of the family to which the genus belongs. The zoological classification is also an artificial classificatory device, as are archaeological typologies. With the possible exception of the species, all other hierarchical levels of the system are imposed by zoologists, rather than by nature.

One must remember that, because the binomial system defined by the ICZN is artificial, there are other ways to develop classifications of animals. For example, one could describe groups based on diet, locomotion and size, such as those used by some paleoecologists (e.g. Van Couvering 1980). The emphasis in zooarchaeology, paleontology and paleoecology on identification of taxonomic groups defined by the ICZN is because of the general belief that identification of the species allows one to infer a wide range of other information, including tolerances to a variety of climatic conditions, habitat types utilised, and various behavioural traits (e.g. social behaviour; migrations etc.). The reason for the continued use of the binomial system of nomenclature is probably because most other possible classifications of vertebrates will operate at a more general level than the species, and identification of bones using standard zoological categories allows them to be regrouped into other classificatory schemes if required.

In most cases the use of the binomial system does not cause problems, but one must recognise that zooarchaeologists frequently modify the system, usually by recognising size classes which cross-cut established taxonomic divisions. The most widely used example of this would be a designation such as 'large ungulate'. Such an identification for Late Pleistocene/Holocene faunas of Canada might include bones of horse, bison, musk ox, camel, wapiti and moose, from two separate orders and four separate families. From the same fauna one might also recognise 'small ungulates', which could include deer, caribou, sheep, mountain goat, pronghorn antelope and possibly even saiga antelope; in this case the taxonomic category includes two families from a single order. Thus, while bones with many diagnostic features might be assigned a taxon based on established zoological classifications, bones with fewer diagnostic features may be 'identified' using a system which groups specimens from separate lineages into a single category based on an attribute (size) which is not relevant to the zoological system. Thus, some cervids (moose, wapiti) are separated from other cervids (deer), but grouped in the same 'large ungulate' category as bovids, camelids and equids. This is somewhat analogous to the provisions in the International Code of Botanical Nomenclature which allow the category 'form-genus' to describe superficially similar fragmentary plant fossils which may derive from a variety of different families (Jeffrey 1977, 40).

The implications of this methodology are probably not critical to zooarchaeology, although one wonders whether it is really worth making these types of identifications, as virtually no inferences or deductions are ever made from such information. However, as will be discussed below, if one begins to make assumptions about which species are really represented in these very general taxonomic categories, the potential interpretive value increases and new problems arise.

Identification systems

As a zooarchaeologist, one is occasionally stopped in hallways or, more disconcertingly, in conference receptions and asked to identify a specimen. After a few instances of embarassingly implausible identifications, one learns to ask some critical questions before making a pronouncement. "Where does it come from?" and "How old is it?" are the two I have used most frequently. Such preliminary questions reveal something rather interesting about our identification methods—we frequently rely upon the context of the specimen to aid our identifications. It would appear that our methods do not simply depend on recognising 'diagnostic' characters on bone fragments, but also on other assumptions which are rarely stated. These assumptions are worth examining in some detail.

Assumption 1: Although taxonomic groups are defined by a host of characteristics, most of which are not preserved archaeologically, single bones exhibit sufficient diagnostic characteristics to allow identification, frequently to the species level.

This assumption is the basis for zooarchaeological identification. Yet very few bones in the post-cranial skeleton are diagnostic of the species if one has to select one species from the entire animal kingdom. For example, the presence of a large bovid femur fragment on a 3000 year old site from the Canadian plains virtually guarantees the identification *Bison*, and in many cases analysts will identify *Bison bison*. However, on a historic period site from the same area, many femur fragments would be indistinguishable from domestic cattle, and would be recorded as *Bos/Bison*. What zooarchaeologists really mean when they identify a bone fragment is that, given our knowledge of what animal species are likely to have been found in an area during a particular time period, one can identify a fragment based on a combination of size and morphological characteristics. In the above example, the bison femur fragment is probably not distinguishable from those of European bison or some African and Asian bovids. However, given the likely geographic range of fauna, the possibility of there being an Old World bovid in the assemblage is considered so unlikely as to be dismissed.

Another problem associated with this assumption is the concept that the zoological taxonomy is immutable, whereas in fact it is in a constant state of revision. For most vertebrate zooarchaeologists this is not a major problem, because revisions tend to be rare and minor. However, it can lead to some embarrassingly over-confident identifications. For example, until recently ornithologists identified two species of flickers in western North America, the red-shafted flicker (*Colaptes cafer*) and the yellow-shafted flicker (*C. auratus*). These are now considered as subspecies of a single species, the common flicker (*C. cafer*). If one reads zooarchaeological reports from the 1960s and 1970s one can find bones of both original 'species' identified. One suspects that, in reality, the skeletons of these two types of bird exhibit so much overlap that one cannot separate them, and certainly today few people would attempt to separate bird subspecies on osteological characters. The fact that the two types were originally divided into separate species probably produced a state of over-confidence in zooarchaeologists, who felt that osteological differences ought to be found. Today no one attempts to make the distinction which was made a decade or so earlier, because the taxonomy has changed, not the birds.

Assumption 1 therefore requires some modification. Bones are not identified solely by their morphology and size. Rather, a great many possible species are excluded as candidates by virtue of their position in time and space. Furthermore, species which can be separated by zoologists are not necessarily separable on the basis of osteology.

Assumption 2: The methods for identification are sufficiently well tested that one does not need to justify most identifications, except in relatively rare circumstances.

In most zooarchaeological publications there is little discussion of identification methods. Perhaps zooarchaeologists feel that their methods of identification are so easy to use that the methodology requires little discussion. Perhaps they rely to so great an extent on 'experience' that they cannot describe their methods. Generally, discussion of identification methods is confined to relatively rare species, when it is important to demonstrate that the identification is justified. In addition to personal experience, zooarchaeologists use three methods for identifying fragments:

(a) comparative collections;

(b) published guides or keys;

(c) measurement systems.

The use of comparative collections is widespread, and probably forms the basis for most identifications made by zooarchaeologists. However, most comparative collections (including the one I use) are really inadequate for their intended purpose. Returning to an earlier example, the identification '*Bison bison* left femur' is usually arrived at through the following type of mental process : 'clearly a large ungulate, based on morphological characteristics and size; perissodactyls can be eliminated on the basis of morphology, so it must be an artiodactyl; the only artiodactyls of this size on the Canadian plains at 3000 BP are bison, moose and wapiti; specimen was compared with an old male bison which died in a zoo, a juvenile moose donated by a game farm, and a mature female wapiti culled from a national park; characteristics most resemble the bison'. While this may exaggerate the deficiencies of comparative collections, there are few which contain sufficient numbers of specimens to cover age and sex variation, individual variation, or variation resulting from life in different habitats. Most identifications using comparative collections are therefore 'best guess' approximations, usually based on inadequate comparative samples.

The use of identification guides and keys also poses problems. A key is a formally laid out system of identification, usually organised in such a way that presence or absence of characteristics can be used to identify a species. Keys usually have a branching form, so that one begins by looking for features characteristic of gross taxonomic groupings, and then proceeds to finer divisions (Pankhurst 1978). Such keys are rare in vertebrate zooarchaeology or paleontology, because each species possesses hundreds of bones, and bones are generally found as fragments. Consequently, a formal key would be required for each part of each element of the skeleton, or at least for those areas generally considered most useful for separating taxonomic groups. While attempts to do this have been made (e.g. various keys in Gilbert *et al.* 1985), most published aids to identification cannot be described as keys. In most cases they are usually collections of illustrations, sometimes with notes discussing diagnostic characteristics (e.g. Gilbert 1980; Olsen 1964; 1968; Smith 1979; Schmid 1972). As I have suggested (Driver 1987) the existence of such guides is somewhat anomalous. For the frequently occurring species in an area, one can anticipate that most zooarchaeologists will have access to comparative collections which contain those species, and 'hands on' inspection is likely to be better than illustrations for the purposes of identification of fragments. For rare species, on the other hand, it is surely better to take the specimens to a comparative collection which contains the species than to rely on an illustration to identify a rarity. The only guides which have any real value to zooarchaeologists are those which summarise the results of observations of large numbers of specimens and discuss distinctive diagnostic characteristics which consistently occur (e.g. Olsen 1960; Brown and Gustafson 1979; Lawrence 1951). Such publications are relatively rare, and even those which are based on observations of many specimens rarely provide information on how many specimens of each species were consulted or the locations from which specimens were obtained. Nevertheless, they are quite important as a supplement to a comparative collection, because they point out consistent diagnostic differences between morphologically similar species.

Most zooarchaeological identifications are made through a combination of comparative collections and illustrated guides, generally used in a complementary fashion. Good illustrated guides will be the result of examination of many specimens, and should partly solve the problem of most comparative collections—insufficient representation of intra-species variation. The comparative collection is essential for the identification of fragments, and for examining details of bone morphology.

Measurement systems of varying degrees of complexity have been used by zooarchaeologists. At the most simple level, all analysts use gross size to eliminate certain taxa from consideration. Thus, to return to the example of the bison femur, sheep is excluded on the criterion of size rather than morphology, because both sheep and bison share many morphological features. More complex systems of measurement involve taking multiple measurements on a single specimen, and are generally only used to separate closely related species. These measurements may be compared using a bivariate plot (e.g. Davis 1987, figure 1.12) or by using multivariate statistics (e.g. Morey 1986). While such methods appear to be sound, as they are based upon measurements which discriminate between modern specimens of known taxonomic affiliation, they can be misleading. Many modern species exhibit considerable geographic variation and, while a system of measurements may discriminate between two closely related sympatric species, it is not necessarily the case that the method can be applied in other regions or in the past. Identification by measurement also requires relatively complete specimens, and can only be applied to a relatively small proportion of fragments.

Assumption 2 therefore requires some qualifications. We do not systematically test the quality of our identifications using 'blind' tests. The only criterion for the validity of identifications is the reputation and experience of the analyst. Consequently we have no idea of the accuracy of our methods. All identification methods have potential flaws, and while most zooarchaeologists would probably agree that most identifications are probably accurate, they have no empirical or theoretical basis for this claim.

Taxonomic diversity

A further problem in identification concerns the very uneven diversity of species in separate lineages. In part this is due to differences in the importance of 'lumping' and 'splitting' for taxonomists studying different vertebrate classes. In part it also reflects the evolutionary history and adaptive radiation of certain vertebrate lineages. The problem for the zooarchaeologist is that some types of animals are easily identified to the species level, because nothing else anywhere in the world resembles their skeletons, while other species are virtually indistinguishable on osteological evidence. For North America we could cite the familiar beaver (*Castor canadensis*) as an example. Many of the bones of this species are so distinctive that a high frequency of specimens can be identified confidently to the species level. This situation can be contrasted with North American microtine rodents, whose post-cranial skeletons are so similar that, with the exception of the very large muskrat, individual bones can only be identified to the family or sub-family level. Identification of species for microtines can only be undertaken through analysis of teeth, and even then some species are not separated easily. Clearly, we can expect a higher frequency of bones of some species to be identified to the species level than others. If a major goal of zooarchaeological analysis is calculation of relative frequency of species, some species will be more abundant simply because their skeletons are more easily identified.

There appears to be no solution to this problem at present. It is not possible to calculate species abundance by selecting only elements (such as crania and mandibles) which are commonly identifiable to species in most cases, because cultural factors (e.g. butchery methods or differential transportation of elements) and natural factors (e.g. many taphonomic processes) may differentially affect the presence of these elements on a site. Calculation of minimum numbers of individuals (MNI) is not a solution either. Grayson (1979) has shown that MNI is not independent of the number of indentified specimens (NISP); consequently, MNI does not provide an estimate of relative abundance independent of the number of identified elements. Species with large numbers of identifiable post-cranial elements will provide higher MNI values than species in which only mandible and cranium can be identified to species.

Identification by association

Most of the discussion so far concerns the problems of actually identifying individual specimens. In spite of the various problems discussed, most zooarchaeologists would probably agree that an unknown but high percentage of specimens identified by reasonably competent and experienced zooarchaeologists familiar with the fauna of a particular region are correct. However, further problems are encountered when zooarchaeologists begin to make assumptions about the specific identity of taxa identified to a more general level than that of the species.

We can begin this discussion by considering the relatively rare circumstance of identifying bones from a site where a single species is encountered. Although zooarchaeologists working in the North American plains are familiar with this in the case of bison kill sites, on a global scale this is a somewhat unusual occurrence. If one examines faunal reports from bison kill sites, one finds that species identifications are made of some elements which would normally be relegated to a much more general taxonomic category. In fact, in most cases, virtually every bone fragment which can be identified to element is assumed to be from a bison. In such a case one can argue that this practice is reasonable, and that if all the femora, humeri, crania, etc. are from *Bison bison*, then less diagnostic elements such as rib shaft fragments or vertebral zygapophyses are probably from the same species. However, the identification of these fragments to the species level depends entirely upon their association with the specimens which possess characteristics which allow identification of species. If such fragments were encountered in sites in which other large ungulates were identified, they would almost certainly be relegated to the category 'large ungulate', or some such similar designation.

The practice of 'identification by association' is not only, as I will show, potentially misleading; it is also unnecessary. With the possible exception of articulated specimens (a special instance discussed later), every bone fragment should be identified on its own merits. Thus, a summary of fauna from a monospecific assemblage should include fragments identified to the species, genus and family level, as well as some fragments identified to the archaeologically created categories of the 'large ungulate' type. Once the identifications have been made and tabulated, the zooarchaeologist may wish to argue that, for the purposes of certain analyses (perhaps element frequency), the assumption will be made that all fragments identified to more general levels are in fact from a single species. In other words, the previously hidden assumption is made clear, the reasoning behind the assumption is made plain, and one can then proceed with the analysis.

Such a procedure is recommended here not simply because it places identification on a more formal footing. It has practical implications for inter-site comparisons. To illustrate this, one may imagine two single-component archaeological sites, X and Y, located in the same general region but in different habitats. Site X contains three species: a large ungulate (U1), a small ungulate (S), and a lagomorph (L). Site Y contains four species : two large ungulates (U1 and U2), and the same small ungulate and lagomorph found in Site X. The analyst of the Site X fauna identifies all large ungulate bones as U1, all small ungulate bones as S and all lagomorph bones as L, using the type of 'identification by association' principle discussed above. The analyst of the Site Y fauna identifies some large ungulates as U1 and some as U2, but many fragments are not diagnostic of either species even though they are recognizable as large ungulates. These cannot, of course, be identified to species, although they could, as discussed later, be included in a general 'large ungulate' category. Like the analyst of Site X, the Site Y analyst also uses 'identification by association' whenever possible, and therefore identifies all small ungulate and lagomorph bones on Site Y as S and L respectively. We can therefore envisage two assemblages for each site. The first (the actual assemblage) represents the real numbers of fragments of each species which were in fact present at both sites. The second (the reported assemblage) is composed of specimens identified by the analysts (Table 1).

As the example shows, differences in identification methods may lead to different relative frequencies of different species. For example, the ratio of L to U1 changes from 2:1 in the actual site Y assemblages to 5:1 in the

Site	U1	U2	S	L
X_{actual}	100	-	100	100
%	**33**	-	**33**	**33**
Y_{actual}	50	50	100	100
%	**17**	**17**	**33**	**33**
$X_{reported}$	100	-	100	100
%	**33**	-	**33**	**33**
$Y_{reported}$	20	20	100	100
%	**8**	**8**	**42**	**42**

Table 1. Element frequencies and percentages for fauna on two hypothetical sites.

reported assemblages. Similarly the ratio of L to all ungulates (U1 + U2) changes from 1:1 in site X to 5:2 in the reported assemblages from site Y, even though the actual ratio remains constant from one site to the next.

Cases such as this will not necessarily arise, provided that zooarchaeologists are aware of such problems in the data. However, unless the analyst of site X clearly differentiates between specimens which can be identified positively as species U1 and those which can only be identified on their own merits as large ungulates, the data produced by the analysis will be of limited value in any comparative studies, because it will not be possible to sort out which bones are really identifiable to the species level and which are assumed to belong to that species.

One could argue that such a problem would not arise if the analyst of site Y reported values for an extra category—'large ungulate'. Indeed, this is a fairly common procedure in zooarchaeology. While this would solve the problem of looking at ungulate to lagomorph ratios, it still creates problems. For example, the importance of U1 in the Site Y assemblage still cannot be compared with U1 values from Site X because criteria used to identify the bones differed from one assemblage to the other. If, on the other hand, the site X analyst had used the 'large ungulate' taxon for specimens which could not be identified positively as species U1, the assemblages would be comparable.

One other possible solution would be to calculate the ratio of U1 to U2 in the site Y assemblage, and then make the assumption that this same ratio applies to the 'large ungulate' category. The 'large ungulates' could then be assigned proportionately to species U1 and U2, and comparisons could be made with site X. Again, there are serious problems with this method. For example, if butchery practices differed between the two ungulate species, then more 'large ungulate' fragments would derive from the species which had undergone more frequent bone breakage and comminution. The situation could be further confused if we added more sites to the example with new species of small ungulates and lagomorphs at some of the sites.

There are other problems with 'identification by association'. The practice almost certainly encourages complacency in identification procedures. If one begins with the assumption that all bones found in a supposedly monospecific assemblage are indeed from one species, then the likelihood of identifying the rare bone of another species of similar size is considerably diminished.

The practice of 'identification by association' is of little value to zooarchaeology. Apart from being dishonest, such identifications can lead to either confusion or unwarranted conclusions. The practice should be discontinued. Zooarchaeologists should identify to a particular taxon only those bones which can unquestionably be assigned to it.

A set of procedures for zooarchaeological identification

Identification of specimens by zooarchaeologists is an attempt to place them into taxonomic and anatomical categories used in zoology. In view of the general robusticity of the system of binomial nomenclature, and (with the possible exception of fishes) the system for naming individual bones, this method of classification would seem to be the most appropriate for the initial stages of any zooarchaeological analysis in which knowledge about species representation is important. Even if one does not wish to use the binomial system and standard anatomical terms, most other imaginable classifications require prior knowledge of the taxon and element. Consequently standard zoological descriptors will continue to be important in zooarchaeological classification.

It is important for zooarchaeologists to realise that the evidence used by zoologists to establish their classificatory systems include a wide range of data which can never be observed in the archaeological record (Ross 1974). There is no expectation that all, or any, bones or bone fragments will be sufficiently distinctive to identify unequivocally the species defined by consideration of whole specimens. The classification that zooarchaeologists use was developed to meet the needs of zoologists who almost always have many complete specimens of the animals they are attempting to classify. It is inevitable that many zooarchaeological specimens will be recorded as 'unidentifiable'.

If most zooarchaeologists accept the use of zoological terms to identify bone fragments, one might expect unanimity on standardised methods for data reporting. However, it is unrealistic to propose this. Individual zooarchaeologists have different confidence levels (with a tendency for the more experienced to be less willing to differentiate between closely related species). Since comparative collections differ in quality, one's ability to identify bones is partly a function of where one works. Furthermore, different research goals may require different approaches towards identification. For example, if research is primarily oriented towards analysis of subsistence, it might well be a waste of time tracking down the occasional passerine bone in an assemblage dominated by large mammals. Alternatively, palaeoenvironmental studies require species identifications, and bone fragments which cannot be identified to that level can often be ignored, even though in other contexts they might provide information about element frequency or butchery. However, although we cannot expect complete standardisation of data reporting, it is nonetheless necessary to inform other archaeologists of how one has implemented the system of identification. In order to do this, one has to follow certain procedures, and these are outlined below.

Prior to beginning an analysis one should develop a set of rules about how identifications are to be made. I suspect that very few zooarchaeologists do this, although many assume that they have done so. In most cases, one has a fairly good idea of the type of fauna which will be recovered from a site, and can predict fairly well what sorts of decisions will be required during the course of the analysis.

The first rule of virtually any analysis must be that each fragment will be identified on its own merits, so that 'identification by association' does not occur. However, one may decide to make exceptions to this rule (although I personally do not). For example, a complete articulated skeleton might contain some bones which are identifiable to species, while other are only identifiable to genus if found as individual specimens. In such a case, one might decide to allow the identification to species of all bones which are clearly articulated. Similar decisions must be made in the case of bone fragments which can be glued together. If one finds twenty fragments of a moose tibia which can be reconstructed, should it be identified as a single fragment of moose? Should each individually identifiable fragment be counted? Should each fragment be counted as a separate identifiable piece? One can make arguments for all procedures, but whichever is to be followed must be established prior to the beginning of the analysis, and should also be reported (briefly) in the faunal report.

One must also make decisions about how one will make taxonomic distinctions. As noted earlier, assumptions are always made about what species are represented in the fauna. If one begins with no assumptions, then identification is virtually impossible, because every fragment will have to be checked against far more species than is realistic. For example, on Canadian high arctic sites dating to the last 5000 years, the only Canidae likely to occur are *Canis lupus*, *C. familiaris*, *Alopex lagopus* and *Vulpes vulpes*. For most analysts these form the universe from which any specimens identified as Canidae must derive. Such North American species as *Canis latrans*, *Vulpes velox* or *Urocyon cinereoargenteus* will be excluded from consideration by most analysts prior to attempting to identify canid bones. Decisions not to include certain species as possible sources of fauna result in a greater proportion of specific identifications. For example, using the Arctic example cited above, a canid femur which was demonstrably larger than a big fox but much smaller than a small wolf would have to be identified as a dog, *Canis familiaris*. However, if one was to include *C. latrans* in the list of 'possible' species for the area, then the specimen would probably be identified as 'dog/coyote sized canid'.

In addition to deciding what species might be present in the area, analysts must also decide what elements of the skeleton can provide specific identifications. This varies from one taxonomic group to another. For example, identification of the various species of *Canis* must be undertaken on fairly complete mandibles or crania; distinctions between mule deer and white-tailed deer can be made only on the antlers. On the other hand, many bones of *Castor canadensis* can be identified to species because there are no closely related species in the region being studied. If one is willing to produce a list of species which are likely to occur in the site (which I have argued above is essential), then one should be able to predict in advance which species are likely to be difficult to separate. This will allow one to decide prior to the analysis which elements exhibit so much overlap in morphology and size that distinctions between species cannot be made. Once such decisions have been made, they should be adhered to, and should be reported in the published analysis.

Finally, it is very important that zooarchaeologists attempt whenever possible to report identifications in more detail than is usually done, so that the nature of identification methods can be understood by other archaeologists. As noted above, this should include brief notes about what taxa were considered separable, and what elements were used to separate taxa. Ideally, descriptive zooarchaeological reports which provide the basic information about a site's fauna should also include tables in which numbers of elements (or parts of elements, or butchering units, etc.) are recorded for each taxa. This not only allows other analysts to manipulate data on element frequency, it also provides a very good guide to the identification procedures utilised. For example, if a zooarchaeologist practices 'identification by association', these tables will show elements such as ribs identified to fairly specific levels; on the other hand, tables produced by a zooarchaeologist who does not use the method will show ribs and other less diagnostic elements relegated to a more general category. Admittedly, such tables take up space. This problem can be solved by carefully constructed tables and a lot of fine print. It can also be solved by the somewhat controversial use of microfiche appendices or even floppy discs. The introduction of many tables of data is not generally approved by editors and publishers, but without them much of the information recorded by zooarchaeologists is lost. Such data are often vital to future researchers, and zooarchaeologists should promote their use.

Conclusions

The classification of specimens by element and taxon is a preliminary step of most zooarchaeological analyses. Zooarchaeologists generally use classificatory systems borrowed from zoology. It has been shown that the assumptions made by zooarchaeologists when using these systems, especially binomial nomenclature, are partly invalid. Furthermore, the procedures for actually identifying specimens are rarely made explicit, nor are most zooarchaeological identifications susceptible to testing or critical evaluation. We can place no confidence limits on identifications.

While it is desirable to begin testing our abilities to provide correct identifications, using carefully constructed blind tests to assess the reliability of the methods, we can make zooarchaeological data more trustworthy by following some simple procedures. We must make explicit which species have been considered as the 'universe' from which identifications have been made. We must outline the way in which identifications were made, including details of comparative collections, keys, guides, and measurement systems used. We should avoid 'identification by association'. Data reporting should include more than a list of taxa accompanied by NISP and MNI values. Publication of data should, at the very least, include lists of elements identified to various taxa, preferably organised by provenance.

The arguments for these recommendations are unambiguous and easily defended. Zooarchaeological analysis does not stop at the site level. Any attempt to work with data compiled by other researchers requires that one assess whether data sets are comparable, and this means that details of identification procedures and results must be made explicit. If zooarchaeology has any claims to be scientifically based we must adopt procedures which make the methodology of data production clear to other researchers. Only then can past research contribute to future syntheses.

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