Contextual analysis of the use of space at two Near Eastern Bronze Age Sites

Final report on the vertebrate remains from the Tell Brak bulk-sieve samples

Keith Dobney and Deborah Jaques
Environmental Archaeology Unit
Biology Department
University of York

1 Introduction

The overall aim of the research project was to explore the possibilities of being able to classify differences in modes of human habitation within a large urban centre by integrating detailed data on the lithology and finds assemblages contained within the various excavated deposits. In terms of the vertebrate assemblages, attempts were made to utilise more detailed recording of the variations in preservation, "angularity" (i.e. the nature and appearance of broken surfaces), fragmentation, and amounts of burning in order to create a framework of statistical "signatures" for the remains from each deposit.

2 Methodology

2.1 Methods of data recovery

Vertebrate remains from all samples were screened through a 3.5mm sieve, with sub-samples (10 litres of bulk sediment) sieved through 1mm mesh. Only remains from >3.5-4mm fraction have been recorded in detail; those from the 1mm fraction from the 1996 season having, to date, merely been weighed.

2.2 Methods of data recording

A full protocol was devised for recording the vertebrate remains from both Tell Brak and Kilise Tepe and is described in greater detail by Baker (see Part 6, Section 2.2). This involved a range of quantitative and qualitative techniques which can be summarised as follows:

- At the context level, vertebrate remains were sorted into general taxa classes (i.e. large mammal, medium mammal, medium mammal 2, small mammal, bird, fish, amphibian, reptile and unidentified).

- For each of these general categories, counts of fragments showing varying types of preservation, "angularity", colour, and fragmentation were then made.

- The remains within the general taxa classes were further identified to species level (where possible) and total numbers of fragments, total weight, number of complete, measurable, unfused, butchered, burnt, rodent and dog gnawed were recorded. Counts of individual skeletal elements per species category were also noted (these additional zooarchaeological data do not figure in this report).

This information was originally recorded in the field on paper pro-formas and subsequently transferred into electronic form in the laboratory using Paradox for Windows version 5. However, data from those 1996 samples recorded at the EAU were recorded directly onto the computer. The full data archive (including database structure, field types, electronic data entry forms and analysis programmes) is stored at the EAU and is available on request.

2.3 Methods of analysis
Both univariate and multivariate statistical analyses were employed on this large dataset (see results section below) in order to explore possible differences between period (vertical context), broad structural categories (horizontal class) and, more specific context types (deposit class), see Preface Appendix 1.

2.3.1 Univariate methods In view of the widely differing numbers of samples which could be assigned to each separate vertical, horizontal and deposit class (see Tables 1 and 2) and the concomitant differences in total numbers of litres processed for each of these categories, it was necessary to standardise the main quantitative data for bones (i.e. fragment counts) between all samples and groups, in order that direct and meaningful comparisons could be made. This was simply achieved by dividing the total numbers of bone fragments by the total numbers of litres sieved (no/litre) - producing a value of the numbers of fragments per litre of soil processed. Thus, the majority of univariate statistics are based on these directly comparative values. The following analyses were all undertaken, grouping data by, horizontal and vertical context and by deposit class:

- Comparison of overall bone density
- Comparison of a variety of preservation indices (i.e. overall "preservation" and the "angularity" of the broken surfaces)
- Comparison of bone fragmentation
- Comparison of the frequency of burnt bone
- Comparison of the frequency of major taxa classes

2.3.2 Multivariate statistics (Correspondence analysis CA). As was the case for the archaeobotanical remains, multivariate statistics have been used to further investigate co-variational relationships between all those categories outlined above. Using CA in this way is perhaps one of the first times this approach has been used to explore vertebrate data not related to differences in frequency of taxa. As outlined by Colledge (this volume), CA is ideally suited to simple abundance data and makes no assumptions about the distribution of data within the dataset. As a result, analysis can be undertaken on raw counts, and there is no prerequisite for transforming simple count values into frequencies or proportions so that direct comparisons between groups can be made.

3 Practical details
During two seasons of the excavation at Tell Brak, a total of 141 samples from 138 separate contexts were processed (72 during 1995 and 69 during 1996). The vertebrate remains from the first season's samples were fully recorded in the field. Whilst those from the second field season were recorded at the Environmental Archaeology Unit (EAU), York.

In summary, 61 of the 72 samples from the 1995 season and 49 of the 69 samples from 1996 form the basis of this analysis.

4 Discussion of results

4.1 Bone densities

Measurements of bone density (i.e. numbers of bones per litre sieved) provide a simple and straightforward way of quantifying differences between deposits and may provide one way of exploring aspects of a variety of human activities (e.g. waste disposal). It would be expected that a direct correlation exists between actual quantity of bone recovered and the context type. For example, higher frequencies of bones may be expected in primary deposits such as dumps and pit-fills, whilst lower densities may occur in (for example) floor layers or construction deposits.

4.1.1 Mean bone densities - by deposit class. Mean bone density presented by deposit class (for all periods combined) indicates the highest concentration of bone to have been present in middens, followed by pit-fills and occupation deposits (Fig. 1). Interestingly, those samples classified as "miscellaneous" and "mixed" show the highest mean bone density values after middens, suggesting that these deposit classes perhaps contain elements of reworked midden or dump deposits. However, the wide variety of deposit types represented in these rather broad categories renders any interpretation of limited value. Samples with high density from occupation deposits may indicate the presence of waste dumped into abandoned buildings, or reworked material accidentally incorporated into packing or laid floor deposits.

4.1.2 Mean bone densities - by horizontal context. Mean frequency of bone is quite variable when viewed by horizontal class (Fig. 2). It is apparent that highest values are found in horizontal class F (within building: enclosed unroofed space, not courtyard) although there are only three contexts of that classification. Perhaps these were areas where small scale dumping of waste by separate households was undertaken within the town. Other areas where apparent high concentrations of bone were recovered included horizontal contexts C ("Unenclosed, unroofed space: other"), L ("within buildings: other rooms or unspecified") and X (mixed miscellaneous or uncertain). Horizontal contexts that were obviously kept generally free of bone waste include craft areas, reception/ "living" rooms, kitchens, and ritual areas.

4.1.3 Mean bone densities - by vertical context. Variation in the mean frequency of bone density by phase (Fig. 3) shows obvious higher mean frequencies of bone found in early-middle and middle Uruk periods. Although these data incorporate bone density values from numerous different context types (totals of which differ quite markedly between phases), these results may indicate changing disposal practices through time, with more rapid turnover and deposition of bone waste in the Uruk period compared with later Ninevite 5, third and second millennium. Alternatively, these differences in bone density could equally well represent differences in activity areas on the site (as outlined above) whereby the earlier deposits are mostly midden and rubbish deposits accumulating in abandoned buildings.

4.2 Preservation indices

4.2.1 Comparison of "preservation" for Tell Brak samples. In view of the fact that "preservation" as a concept in most vertebrate reports can be principally regarded as a more subjective recording criterion than "angularity, fragment size and even colour, data recorded in this fashion may be of dubious interpretative value.

4.2.2 Mean frequency of bone "preservation". On the basis of the above observation, it is interesting to note, therefore, that plots of the frequency of three major preservation criteria (i.e. good, fair and poor) showed practically identical ratios of these variables between deposit, horizontal class and vertical context (Figs 4-5 show data by deposit class). However, the usefulness of such a ubiquitous "signature" severely limits the use of "preservation" as an interpretative tool on the Tell Brak assemblage.

4.2.3 Comparison of "angularity" for the Tell Brak samples. It is important to remember that major differences in calcified tissue histology exist between the various vertebrate taxa which can mean that a single taphonomic process, affecting the same assemblage, can result in wholly different manifestations of preservation, "angularity" and colour on each taxonomic group. Differences in surface area, histology and calcification of fish, birds and mammals mean that preservation, angularity and colour may differ significantly between the major vertebrate groups. For example, fish bones are often ginger in colour, whilst bird remains (being hollow and light) often show more extensive chemical and physical damage to their surface than those from larger mammals. As a result, any comparison of the states of preservation etc. between assemblages from different temporal and spatial units must be restricted to the remains of a single taxonomic group. In this case, the assumption that is made is that any differences reflect real variations in taphonomic pathways and hence are more likely to provide direct or indirect information about human activities. As was the case for comparison of taxa., the most commonly occurring taxa groups (i.e. medium mammal and unidentified) have been employed to explore preservation, angularity and fragmentation.

4.2.4 Mean frequency of bone "angularity" - by deposit class. A major assumption in the interpretation of these data is that the broken surfaces of individual bone fragments become progressively more eroded (i.e. spiky - battered - rounded), as they progress from primary-secondary-tertiary deposits. In practical terms, this assumption infers that continual reworking of material will result in progressively more erosion, battering and rounding of the surfaces of fragments. However, this may not be the only taphonomic factor involved. Heavy physical erosion of bone fragments may also result from skeletal elements being exposed for extended periods of time to the natural elements. Thus, dumps/deposits of animal bones not rapidly buried may also demonstrate a weathered appearance where broken surfaces can appear "battered" and "rounded". Heavily "rounded" fragments of bone can also be found in deposits which have been moved and sorted by water action. Thus skeletal elements which have been transported distances along river beds or streams will appear similar to those from heavily reworked deposits.

Figs. 6-9 show the concentration and frequency of unidentified and medium mammal fragments on the basis of the appearance of each fragment's broken surfaces (i.e. its "angularity") by deposit class. The most striking fact is that the majority of unidentified fragments from middens, pit-fills and miscellaneous or uncertain classes are classified as "spiky". This strongly suggests that assemblages from these deposit classes contain primary dumps of waste, which have been buried rapidly. This hypothesis is supported by the seemingly low frequencies of "rounded" fragments in the same groups.

Although the concentration of so-called "battered" fragments is relatively constant for all deposit classes, their frequencies are highest in "structure", "constructional" and "occupation" deposits, suggesting high proportions of these assemblages contain material of different taphonomic trajectories. Those with "rounded" fragments may indicate the presence of heavily reworked material, although their proportion in all deposit classes is low. Interestingly, those classified as in-situ deposits show the highest proportion of "rounded" unidentified fragments, indicating the contrary, i.e. that a significant proportion of material from these deposits is perhaps not "in-situ".

4.2.5 Mean frequency of bone "angularity" - by horizontal context. When considering "angularity" by horizontal class, Figs. 10-13 shows that class A (unenclosed unroofed space: rubbish disposal) and class F (within building: enclosed unroofed space (not courtyard)) represent extremes in terms of the frequency of "spikey:battered" fragments. However, these horizontal classes are only represented by four samples. Almost all the unidentified fragments from A are battered, whilst the vast majority from F are spiky. Interestingly, F also produced the highest frequency of rounded fragments, again indicating that material of differing taphonomic pathways, i.e. reworked, residual material is also present. High frequencies of "battered" fragments were also recorded in horizontal class W (wall or similar structure) which almost certainly represents reworked/redeposited/residual material incorporated into mudbrick or wall packing. High frequencies of "battered" and rounded fragments were also recorded from horizontal context K (within building: ritual space) again suggestive of redeposited eroded bone present in laid floor layers or packing within the temple. The remaining horizontal classes all show similar frequencies of "spiky" and "rounded" fragments.

4.2.6 Mean frequency of bone "angularity" classes - by vertical context. Figures 14-17 show the concentration and frequency of unidentified fragments on the basis of "angularity" by vertical context. The most obvious feature is the high proportion of "spiky" fragments present in the middle Uruk period and the comparatively high frequency of "battered" fragments in samples dated as Ninevite 5. On face value this could broadly indicate that deposits from the Middle Uruk period contain less reworked/redeposited/residual material than those from the subsequent Ninevite 5 period (in fact to all other phases), whilst those samples of Ninevite 5 date contain the most. However, as can be seen from Tables 1 and 2, these differences could be explained by the fact that the most frequent deposit and horizontal class from each phase is widely different (i.e. the differences between "tip, midden or rubbish dumps" and "occupation" sequences).

4.3 Fragmentation indices

The degree of fragmentation of vertebrate material (and for that matter pottery) should hypothetically reflect the intensity of certain taphonomic events which have affected those deposits. For example one would expect high levels of fragmentation to occur on bones and pottery deposited in streets, lanes, courtyards as a direct result of increased human and animal trampling. Conversely, bones from primary middens and dumps would be expected to show less fragmentation if the material had been disposed of and buried relatively rapidly. The one overriding factor that others creating and using bone fragmentation indices have consistently ignored, is that the differences in size and bone histology of different taxa render any comparison, using more than one taxa, wholly spurious. In these cases, differences in mean fragment size will merely reflect differences in the proportions of fish, bird, small, medium and large mammal. As a result, the analysis of bone fragmentation at Tell Brak was undertaken only on the most frequently occurring taxa groups (i.e. medium mammal and unidentified). However, a further interpretative problem with the use of unidentified fragments lies in the very fact that they cannot be definitively identified to one of the major taxa classes which predicates that most of these fragments will indeed be small (although on the basis of the relative frequencies of the main taxa groups, it is probable that the vast majority of "unidentified" fragments must derive from medium mammals). This is illustrated well by Figures 18 and 19 which show that over 90% of all unidentified fragments fall into the <2cm class. This data is presented for medium mammal only.

4.3.1 Bone fragmentation ("Medium mammal") - by deposit class. Figure 20-21shows that the proportion of fragments <2cms is fairly constant throughout all deposit classes. Those classified as middens show slightly lower frequencies of <2cms and higher proportions of fragments between 2-4cms. Other than these subtle differences, the frequencies of the different size classes appear remarkably similar for all classes.

4.3.2 Bone fragmentation ("Medium mammal") - by horizontal and vertical context.
This homogeneity also appears to be the case when considering horizontal class and vertical context, and suggests that at Tell Brak, fragmentation can provide little useful information regarding human occupation and the use of space.

4.4 Comparison of burnt bone densities for the Tell Brak samples

The presence of burnt or heavily calcined bones within samples provides some clues regarding certain human activities, since bones can become burnt for a variety of reasons. These can be:

- as a direct result of cooking (extremities can be charred when joints of meat are exposed to the heat of a fire or oven), processing (bones contain valuable reserves of fat and marrow which can be liberated by direct or indirect heating; the application of flames to bone renders them brittle and therefore more easy to break)
- by their use as fuel (the high fat content of certain mammalian long bones render them useful as a source of fuel where other forms are scarce and the temperature of dung-fuelled fires can be significantly raised by the addition of bone).
- accidentally, as a result of smouldering embers and hot ashes being dumped onto domestic waste dumps of tips containing unburnt bone.
- accidentally, as a result of redeposited material being near or directly associated with either hearths, ovens or fire installations.

Distinguishing between these specific activities is, however, extremely difficult, although the concentration of burnt and unburnt fragments between different deposit and horizontal classes may provide some broad clues as to the nature of use.

4.4.1 Mean frequency of burnt bone - by deposit class. Figures 22-23 show the concentrations and frequencies of burnt unidentifiable fragments by deposit class. Although the proportions of burnt unidentifiable fragments do not vary hugely between each class, those with higher proportions include those classified as "miscellaneous", followed by "in-situ" deposits and then middens. Although little interpretation of those from "miscellaneous" deposits can be offered, higher frequencies from "in-situ" deposits can be readily explained by the fact that most are the contents of so-called fire installations. The mean concentration of unidentified fragments from this deposit sub-class is low (Fig. 4), in fact the no/litre is similar to those from both "structure" and "constructional" deposits where the presence of high proportions of possible reworked/redeposited/residual material is postulated (on the basis of "angularity" scores). It is therefore most likely that these fragments do indeed represent accidentally burnt residual fragments. The use of bone as fuel, however, cannot be ruled out in this particular instance, since there are relative high frequencies of heavily calcined bones (i.e. those heated for a prolonged period in a hot flame) from these installations.

Those from midden deposits may reflect a mixture of those burnt during cooking or processing and those accidentally charred through a variety of factors. However, the possible lower frequency of purported reworked material suggested on the basis of "angularity” scores may indicate that the burnt fraction represents deliberately or accidentally burnt domestic waste.

4.4.2 Mean frequency of burnt bone - by horizontal context. When considering the burnt unidentified fraction by horizontal class (Figs 24-25), highest concentrations come from class C (unenclosed unroofed space: other), F (within building: enclosed, unroofed space (not courtyard)) and G (within building: reception room/"living" room). However, sample numbers from these horizontal classes are relatively low , particularly in the case of "G" which is represented by only one sample. Horizontal classes which show the majority of unidentified bone to be burnt were again C and G, whilst moderately high frequencies were recorded from horizontal classes B, D, F and L. It is difficult to interpret this pattern , although, perhaps surprisingly, one of those with the lowest frequencies is H (kitchen), suggesting that perhaps these areas were kept moderately clean of ash and burnt material. This is supported by values for the mean concentration of bone (Fig. 8) which shows very low concentrations of vertebrate remains recovered from the seven kitchen samples.

4.4.3 Mean frequency of burnt bone - by vertical context. Once again, the interpretation of different concentrations and proportions of burnt unidentified fragments by phase is somewhat biased by the uneven distribution of total numbers of contexts and differing deposit classes between phases. However, this aside, Figs. 26-27 show that the highest proportions of burnt fragments were present in samples of early/middle, middle Uruk and 2nd millennium date, the lowest being those dated as Ninevite 5 and later 3rd millennium. One general observation that could be made is that if burnt bones were mainly those of residual origin, one would perhaps expect their frequency to increase through time. The fact that this does not appear to be the case, infers that a significant proportion of burnt fragments do in fact reflect contemporary human activities.

4.5 Comparison of the taxonomic composition of the Tell Brak samples

The overall dominance of two particular taxa groups ("medium mammal" and "unidentified"), in terms of sheer numbers of fragments, have meant that direct comparison of all six major taxa groups is impractical. As a result, the data are presented in two ways:

- Comparison of the mean frequency of medium mammal and unidentified only

- Comparison of the mean frequency of remaining minor taxa (i.e. small mammal, bird, large mammal and fish).

4.5.1 Mean taxa frequencies - by deposit class. Although the mean frequencies of the most numerous animal bone classes (i.e. medium mammal and unidentified fragments) do vary between all deposit classes (Fig 28), their relative frequencies do not (Fig 29). However, those remaining taxa groups (i.e. large and small mammal, bird and fish) show some noteworthy differences (Figs. 30-31). It is significant that in almost all contexts with significant proportions of fish fragments, the remains of bird are proportionally less frequent. This phenomenon appears to be present in those deposits classified as constructional, pit-fills and miscellaneous. It is also interesting to note that the deposit classes showing the highest concentration of fish bones are not middens or occupation deposits, but pit-fills and those classified as miscellaneous.

Perhaps surprisingly, occupation deposits contained relatively high frequencies of small mammal remains - although not identified to species - possibly representing the remains of commensal species. Small mammals found in pit-fills are likely to represent natural deaths, since steep-sided pits act as "pit-fall traps" for foraging small mammals, and the longer these are left open, the more small mammals will perish.

The fish remains recovered from occupation deposits may indicate that these areas were not systematically swept clean of refuse on a regular basis and that some domestic kitchen or table waste was allowed to accumulate. Alternatively, their presence may indicate reworked material already present in deposits used in floor or packing layers. However, the generally good preservation and uneroded nature of fragile fish bones suggests that the majority of this material is from primary deposits. Their high frequency in "constructional materials" could be explained by the fact that this includes a category classified as "refuse deposits with high organic content". However, a number of the freshwater species recovered from Brak are small (see Fish report by Wim van Neer). Their presence in so-called construction material (including packing materials of sand silt and clay) may be linked with the utilisation of sand silt and mud from the Jaghjagh by the inhabitants as a component of building materials. It is possible that, like the small mammals, some of the remains of smaller fish species may have been part of a natural death assemblage originally buried in river silts near the bank or flood regime, recovered accidentally, and transported to and deposited on the site within building materials.

Although fewer in number than "medium mammal" remains, "large mammal" fragments were recovered most frequently from midden deposits and also, somewhat surprisingly, from deposits classified as "in-situ". Common sense implies that they are unlikely to be the sort of waste which will be present in-situ and so a reinterpretation of those contexts originally classified as such may be appropriate.

4.5.2 Mean taxa frequencies - by horizontal context. Proportions of "medium mammal" and "unidentified" fragments appear to be comparable throughout most horizontal classes (Fig. 33). Higher frequencies of "medium mammal" fragments occur in horizontal class G (classified as "within building: reception room/living room") although this may be explained by the fact that only one context can be classified as such. In addition, slightly higher proportions of medium mammal fragments also occur in horizontal class H (classified originally as "within building: kitchen").

In terms of the less common taxa categories, one of the most noticeable observations is the apparent high proportions of small mammal fragments present in horizontal context K (classified as within building: ritual space) (Figs. 34-35) These remains are from a total of nine samples, all of which originate in one intensively sampled "temple/ritual" building. These remains are probably those of commensal small mammals living in and around the building during its use phase, or perhaps subsequent to it falling into disuse. Alternatively, they may represent the remains of small raptor pellets (probably owls) which may have roosted in the building after its abandonment. High powered microscopy of these remains should allow this to be established by the identification of characteristic damage to the bone surface and teeth caused by passage through the crop.

It is also clear that fish remains are more frequent in horizontal context C (unenclosed, unroofed space: other), H (within building: kitchen) and in X (mixed, miscellaneous or uncertain). The remains of birds are also most frequent in horizontal context H (within building: kitchen) and B (unenclosed unroofed space: craft activity), which is less easy to explain, whilst those of large mammals, although few in number, are primarily present in horizontal context groups C, F, L and X. These are all general areas where perhaps one might expect indiscriminant dumping of waste. From horizontal class D (street or lane) only fish and small mammals were recovered of the minor taxa groups.

4.5.3 Mean taxa frequencies - by vertical context. Although the absolute concentration of medium mammal and unidentified bone is variable through time (Fig. 36), their relative frequencies appear little changed through time (Fig. 37). This perhaps indicates similar taphonomic processes at work on this fraction throughout all periods. However, when comparing the four minor taxa by vertical context (Figs. 38-39), it is apparent that fish are most frequent in later third and 2nd millennium deposits, whilst bird remains are most frequent in deposits of early/middle Uruk and Ninevite 5 date. Fish appear particularly significant in the later 3rd millennium, to the exclusion of bird and large mammal remains.

4.6 Correspondence analysis

Overall, multivariate analyses of the Tell Brak data proved somewhat inconclusive and few clear patterns were observed. However, several plots do show some useful patterns and these are presented in Figs. A-D. The graphical outputs show the relative position of the variables and samples oriented according to the first two principal axes (axis 1 - horizontal, and axis 2 - vertical). Where there are obviously demarcated clusters of samples, it is an indication that those samples within a cluster not only comprise similar suites of variables, but also contain significantly different suites to those in others.

Whether samples were included depends on the total numbers of fragments present in each sample. In the case of analysis undertaken on medium mammal fragments, no samples were included which contained less than 10 fragments. For all other CA analysis, no samples which contained less than 20 fragments were included.

4.6.1 Correspondence analysis using bone "angularity" - by deposit class. Analysis of the angularity data by deposit class shows that the only visible groupings of data occur in deposit classes 2 (tip, midden, rubbish dumps) (Fig. A) and 5 (occupation sequences) by vertical context (Figs. B1 and B2). Samples from tip, midden, rubbish dumps dated to the Middle Uruk period are significantly different in character from those from the second millennium (Fig A). These are separated on the first axis, with samples from the Middle Uruk period being influenced by spiky fragments. The single sample dated as Ninevite 5 and those of second millennium date are influenced by rounded and battered fragments. Those of later date may contain more residual material, or perhaps indicate different kinds of waste disposal between these periods.

The angularity of bones from occupation sequences shows the vast majority of those samples dated as Ninevite 5, later third millennium and second millennium to have a similar composition, i.e. influenced by rounded and battered fragments on the first axis Fig.B1 and B2). Although few in number, those from the Middle Uruk period are almost separated from other samples on the first axis, being influenced by spiky fragments. It is clear, therefore that these separate groupings indicate different taphonomic pathways for the bones from occupation sequences, whereby those from the Middle Uruk period include less reworked/redeposited/residual material

4.6.2 Correspondence analysis using bone "angularity" - by horizontal context. Data from horizontal class L (Within buildings: other rooms or unspecified) by phase is the only data to show distinctive groupings (Figs C1 and C2). This shows separation on the first axis between samples of Middle Uruk and second millennium date. Those from the Middle Uruk period are influenced almost exclusively by spiky fragments whilst those from the second millennium are influenced by rounded and battered fragments. Once again it is clear that these samples contain bones of differing taphonomic pathways; those from the later period dominated by reworked/redeposited/residual material.

4.6.3 Correspondence analysis using mean taxa frequencies - by vertical and horizontal context. Figure D1 shows distinct groupings on both axes between the samples dated to the middle Uruk and Ninevite 5 periods. It would appear that samples from the later period are strongly influenced by the presence of bird remains whilst those from the middle Uruk period are primarily influenced by medium mammal remains (D3). This distribution is primarily a result of the bias in the Ninevite 5 period of samples classified as horizontal class B (i.e. Unenclosed, unroofed space: craft activity) (see Figure D2 where correspondence analysis shows samples from horizontal class B to group on the first axis, influenced by bird remains). Why this particular horizontal context should contain samples that are distinctive primarily on the basis of the presence of bird remains is difficult to explain.

5 Discussion

The main objective of this research project was to explore, as widely as possible, the potential for utilising vertebrate remains (integrated with other bioarchaeological, lithological and finds assemblages) in order to reconstruct more detailed spatial and temporal evidence of differences in human activities. As has been illustrated above, some success has been achieved both by the application of univariate and multi-variate statistics. It is clear that by constructing statistical frameworks for a number of variables, such as bone density, frequency of burnt bone, range of taxa, degrees of "angularity", more refined interpretative possibilities for better understanding a range of human activities is possible. What the above analysis has shown is that perhaps those criteria most usefully employed to these ends on vertebrate remains are simple densities and frequencies of bone, the densities of burnt bone, "angularity" (i.e. the nature of the broken surface) and to a lesser degree fragmentation. All these variables have produced significant insight into understanding the nature of deposit formation and to some extent, the taphonomic processes involved.

One of the most significant aspects of the work on the vertebrate remains is the growing recognition of reworked material. One of the main underlying assumptions of any temporal or spatial study is the guaranteed provenance of the material. Making assumptions about the similarity of taphonomic pathways between, for example, pottery and bone can be very misleading (Dobney *et al*. 1996 and 1997). However, this is part of the history of activities on the site and certainly is a significant piece of information about the "use of space".

Residuality needs to be detected, quantified and compensated for, although it is by no means straightforward. This is particularly true for deeply stratified urban sites (such as Tell Brak) where many deposits are secondary and, depending on the nature of the deposits, there will always be a greater or smaller level of "background noise". Too many lines of evidence are focussed towards discrete finds assemblages and little integration or synthesis of the detailed findings is ever made. Real problems are encountered with the concept and definition of "deposit class" i.e. defining the "status" of a layer in terms of its physical characteristics rather than as a relationship between a designated find and its associated stratigraphic unit.

The use of correspondence analysis has probably best illustrated this phenomenon. By plotting the statistical relationship of each sample, patterns in the data have certainly emerged. However, these patterns are based on a series of judgmental exercises where deposit and horizontal class have already been established without utilising data from the samples themselves. As a result, correlations between these predetermined "categories" and data from the samples are those which have been interpreted and discussed in this report. However, it is this very data from the samples that should also be considered when constructing these categories. The bare plots themselves do indeed often show some distinctive groupings of data without the superimposition of deposit class or horizontal context categories. Perhaps it would be interpretatively more useful to reverse the process, and consider why these simple sample groupings occur. It may well be that, since the characteristics of the vertebrate remains are similar for individual groups, the classifications of certain deposit classes and horizontal contexts may be flawed. At the risk of introducing a circular argument, should they not be also classified on the basis of the results of correspondence analysis?

In this project, deposit types have been classified into functionally defined categories. However, these will only be useful if categories relate to the types of formation processes they reflect (Roskams 1992). This is a complex taxonomic problem but must be the starting point for this kind of study. Once this is achieved, integration of activity "indicators" from finds group studies should be set against deposit type information.

Since there is no inherent way of dating biological remains by morphological characteristics (unlike other cultural artefacts such as pottery, coins metalwork, etc.), it would be extremely useful to undertake a series of multiple AMS dates on material from the various biological assemblages (both between and, more importantly, within selected deposits) in order to verify other criteria used for assessing the presence of residual material. For example, do the proportions of rounded and battered bones in an assemblage with generally good preservation in an apparently well-sealed pit-fill, represent older re-worked material or contemporaneous, but very different human activities?

6 Conclusions

In terms of this report, it is obvious that the vertebrate remains are merely part of a much larger and more complex interpretative framework. It is therefore unrealistic at this stage to expect this single line of evidence to provide comprehensive details of human activity. However, this statistical study of the bones from Tell Brak has provided some important new lines of evidence:

- It is clear that overall bone density provides important information regarding possible disposal practices and provides some clues to understanding the nature of different context types.

- Quantifying the nature of "angularity" of individual taxa groups is crucial in establishing the possible presence of reworked material which provides important clues to the origins of the deposit.

- The use of correspondence analysis in this study has not significantly enhanced our understanding of the relationship of some of the variables recorded, but it has the potential of being a powerful tool in understanding aspects of deposit formation and consequently human activity in future studies. It has been previously used to explore the relationships of vertebrate species between sites (Morena-Garcia *et. al.*1996), but never to characterise vertebrate remains on a contextual basis, and certainly not to explore preservation and fragmentation.

However, to truly begin to understand the nature of deposit formation, all lines of evidence from each separate deposit should be drawn together. It is imperative that this is the next step.

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Unfortunately, scientific studies of the methods used in the quantification of finds groups are few and far between and usually associated with a single artefact type rather than the whole assemblage. Unlike here, these studies are usually a product of an individual's personal initiative and not an implicit part of the overall formal post-excavation strategy. Methods employed are rarely explicitly discussed, statistically investigated or compared with those from other finds groups or biological assemblages.

Finds-based studies on residuality are more advanced in pottery and coin studies than they are for the various groups of biological remains and a number of ways of calculating likely residuality, based on the characteristics of the finds assemblage, have been employed. For example:

- *using simple size of pottery group to define the character of associated strata (Carver 1979)*

- *the use of seriation diagrams to elucidate site formation processes either incorporating the size of the pottery group (Carver 1980) or set against soil volumes (Evans and Millett 1992)*

- *employing indicators of wear on artefact groups, i.e. for pottery using average sherd weight (Bradley and Fulford 1980) or rim or base percentages to quantify fragmentation and crudely measure the brokenness of vessels (Mathieson 1994), using informally defined wear indices for coin preservation or by using fragmentation indices or colour variation for bone. However, problems lie not only in the technicalities of pottery quantification but also in the failure to distinguish between the many factors causing such degradation of ceramics (and bone) when interpreting the data (Hurst and Roskams 1984, 26).*

- *using average artefact date which can be set beside the latest date for the associated deposit to measure degrees of residuality (Evans and Millett 1992).*

All approaches lack a clear link to the character of the deposits from which the material derives and largely ignore the often wholly different mechanisms which predetermine in what manner various finds assemblages become incorporated into deposits. Without such integration, interpretation of artefact patterning will always be fraught with problems. For example, the fact that one pottery assemblage contains much smaller pieces than another may result from one having been re-deposited more times than the other. It may equally mean that the first group were deliberately smashed and deposited in a new structural element and that the latter may have been redeposited numerous times. Similarly, variation in the fragmentation indices of animal bones from the same deposits may equally reflect differences in contemporaneous butchery methods or craft/industrial utilisation as the presence of an earlier residual component.

Similarly knowing that the "average" artefact date for a deposit is much earlier than its latest date, does not, in itself, indicate directly how or why re-deposition occurred. In every case, one must set the results of one study against that of other artefact studies, and *against site context information in order to attempt to decide between conflicting interpretations.*

In order to meet the very real challenge that exists in trying to glean important archaeological information from deposits, several approaches are required. In the first instance the research questions should be limited in their scope; does mixing of certain materials only occur in certain types of deposits? What is the required level of resolution? How well is a deposit dated and how? It is extremely important that any future studies of this kind should define more closely the criteria used to assess where residuality occurs. Parity of recording should exist for pottery, bones and other materials (i.e. as here on bones, using preservation, angularity of new breaks, degree of fragmentation and wear.