Contextual Analysis of the Use of Space at Two Near Eastern Bronze Age Sites
Final Report on the Archaeobotanical Analyses

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1 Introduction

The aim of the project was to "… recover a statistical characterisation of context type, including household rooms of varying function, streets and open areas, so as to provide a new tool for understanding the anatomy of different settlements." (Postgate and Matthews, 1995). Material forming the basis for this study was recovered from two seasons of excavation at the site of Tell Brak (in north eastern Syria) and three seasons at Kilise Tepe (in south eastern Turkey). All classes of 'environmental' remains (including plant material, bone, shell, pottery, etc.) were extracted from samples at the sites and it was the intention that these should be 'quantified' in various ways in order to define the differences or similarities in content between different context types.

This report presents the 'raw' data, analyses and initial results of the archaeobotanical investigations at the two sites. It comprises merely an inter-site and inter-disciplinary comparison and, at this stage, only minimal references are made to other similar studies. The initial interpretations have been made without the benefit of integration with other data sets. It was, however, always the intention that the project would draw on all the available lines of evidence and the next stage of the work will involve the synthesis of the results from other disciplines in order to substantiate any conclusions about 'use of space' at the sites.

[The author spent considerable periods of time during each of the three seasons of excavation at the sites recovering, sorting and recording the 'environmental' materials other than the charred plant remains. This greatly reduced the amount of time that could be devoted to the archaeobotanical analyses. As a consequence it was not possible to identify the full suites of taxa represented in the samples from the sites during the three-year funding period of the Leverhulme project (see section 4.4). It was recognised that by using only restricted/partial data sets, limitations would be imposed on the degree to which 'use of space' could be explored.]

2 Methods of Analysis

It should be emphasised that, unlike the other environmental materials preserved at the sites, the plant remains found within the occupation levels had survived because of exposure to fire. Differences in the 'quantity and quality' of the charred material can be accounted for in several different ways, not all of which relate to primary use of plant resources. Overall composition is determined in part by differences in the suites of plants which are brought to the sites (whether deliberately collected for food, fuel, bedding or construction material, etc., or accidentally, e.g. as inclusions with crops from the fields, etc.). Different processes required for preparation of the plant resources (e.g. processing crops to remove unwanted contaminants or chaff, etc.) also influence the range and abundance of taxa. The overall composition is, however, as much a result of secondary 'formation processes' as source function (Schiffer 1987). Of the plant materials deliberately brought to the sites only those that come into contact with fire (e.g. in preparation for their use) are likely to be represented in the archaeobotanical record. The material which survives burning is dependent on the 'robustness' of the plant taxa or plant parts, where the most fragile elements are either destroyed in the fires or, once charred, do not endure post depositional attrition. The 'loss' of taxa results in an alteration of the proportional representation of the plant components. Also the likelihood of 'dilution' of the charred plant remains within the mineral matrix of the sites, and of mixing with other contexts, either at the time of deposition or afterwards, is great and, similarly, the resultant densities would bear little resemblance to the original. The composition of the assemblages of plant remains is, therefore, determined both by the actual 'choice'[1] of collected taxa and also by the effects of taphonomic processes (either at the time of preparation of the plant resources or afterwards, once occupation is abandoned and deposits have become buried).

The investigation followed a 'pattern searching' rather than a 'problem oriented' approach (Jones 1991). Five different quantitative methods were used in the analyses of the archaeobotanical samples (see Table 1; Jones 1991; Colledge 1994). These were chosen specifically to investigate presence, abundance and preservation of the charred remains. Comparisons of the results of the quantitative analyses enabled assessment of the variations in these attributes within and between context classes. It was considered that variations in distribution and state of preservation of taxa throughout the occupation levels may be significant and may be linked in some way to

[1] The term 'choice' is not exactly appropriate for those plant taxa that were included as contaminants with harvested crops. In these cases 'subconscious choice' determined which material eventually ended up on the sites.

source activities involving plant materials, and thus may provide an indication of the "use of space" in different areas of the sites.

Samples were classified in four ways, according to a) trench; b) period (vertical context); c) horizontal context; and d) deposit class (see introductions for explanations of these classifications; Tables 2 and 20). The results of the analyses are considered according to each of the classifications and then a 'best fit' model is used to assess overall site trends.

3 Practical Details

The majority of plant remains were charred and there were only a few mineralised seeds in samples from both sites. The charred plant remains were recovered using the water separation method in a flotation machine (smallest mesh size used was 250 microns).

The flots were divided into two fractions by size, >1mm and < 1mm, prior to sorting. In most cases the entire >1mm fraction was sorted, but where the volumes were considered too large (time being the limiting factor in all the analyses) they were sub-sampled and a smaller volume was examined. The < 1mm fractions were sub-sampled and between 5-10 cm^3 were examined. All identifiable (and potentially identifiable) items, except wood charcoal, were extracted from the flots during sorting[2]. The numbers of taxa in sub-sampled fractions were 'multiplied up' to 'whole sample equivalents' for the final tables (Tables 4-10, 12-18 and 22-25). For the purposes of this exercise only the 'crop' plants were identified and used in the taxonomic analyses (see section 4.4).

3.1 Tell Brak

One hundred and twenty-eight samples from eight trenches at Tell Brak were examined[3]; these are listed in Table 3. It was not possible to use the full complement of 128 samples in all the analyses. Table 2 gives a breakdown of the numbers of samples in the different context classes.

3.2 Kilise Tepe

A total of ninety-four samples from thirteen trenches at Kilise Tepe were examined[4]; these are listed in Table 21. It was not possible to use the full complement of 94 samples in all the analyses. Table 20 gives a breakdown of the numbers of samples in the different context classes (for details of the criteria for attribution to different classes, see the Preface, Appendix 1). Categorisation by horizontal context was not possible for the Kilise Tepe samples. There is no unequivocal stratigraphic correlation between the trenches in the northern part of the tepe (east-west grid rows 18, 19 and 20; the main site) and those in the central part (squares I-L14) and so separate chronological sequencing was used for the two areas. In some analyses, therefore, the samples from the northern and central parts are considered independently.

4 Discussion of Results

4.1 Charcoal Densities

The total volume of charcoal (in this instance "charcoal" refers to all charred plant items, and not just to wood charcoal) was measured for all samples. The density value was the ratio of charcoal volume (in cm^3) to the volume of sediment processed (in litres). It was considered that high charcoal densities might be an indication of the greater frequency or intensity of use of fires, perhaps in preparation of plant foods, and that low densities could reflect the efficiency of clearing of debris from fires (i.e. efficiency of 'housekeeping'), or the degree to which burnt plant material had become dispersed or diluted within occupation deposits as a result of taphonomic processes (and *vice versa*). Jones comments also,

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[2] The flots were all scanned twice to ensure that all identifiable material had been extracted.

[3] The plant remains from trench HS4 were examined by C. Wilson as part of an MSc. dissertation at the University of Sheffield.

[4] The following samples were examined by D. Miller as part of an MSc. dissertation at the University of Sheffield: H18 2629 (96/33); I14 3458 (95/50); I14 3459 (95/49); I19 1781 (96/23); I19 2802 (96/34); I19 2817 (96/44); I19 2818 (96/42); I19 2823 (96/51); I19 2825 (96/52); I20 4003 (95/23); J19 1626 (95/20); J19 1644 (96/04); J19 1653 (96/06); J19 1656 (96/36); J19 1686 (96/45); J19 1690 (96/50); K19 1540 (96/37); K19 1560 (96/60); K20 1994 (96/35).
Samples H20 1855 (96/49), I14 3495 (96/25), and I19 1799 (96/29) were examined by Jo Bending as part of an undergraduate dissertation at the University of Cambridge.

"Density partly reflects rate of deposition and so can help to distinguish material discarded all at once from that discarded piecemeal over a period of time and mixed with other refuse."

(Jones 1991, 66)

4.1.1 Comparison of the charcoal densities for the Tell Brak samples

The mean densities of charcoal for the samples in the different context classes were compared with the overall mean value for the site (i.e. all samples = 1.2 cm^3/l; Table 3 and Figs. 1-4).

4.1.2 Mean charcoal densities – by deposit class (Fig. 1)

There are five deposit classes with charcoal densities above the overall mean value for the whole site: 'tip, midden, rubbish dump' (1.5 cm^3/l), 'structure' (3.2 cm^3/l; only 2 samples), 'construction materials: sand/clay/etc.' (1.3 cm^3/l), 'construction materials: refuse deposits' (2.0 cm^3/l), and 'occupation sequence: accumulation' (1.5 cm^3/l)[5]. Deposit classes with the lowest charcoal densities are 'pit fills: backfill' (0.6 cm^3/l), 'occupation sequence: laid floor/accumulation' (0.6 cm^3/l) and 'construction: destruction debris' (0.7 cm^3/l). '*In situ*: fire installation contents', have a low mean value, below that for the whole site.

4.1.3 Mean charcoal densities – by horizontal context (Fig. 2)

There are only three horizontal contexts with charcoal densities above the overall mean: 'unenclosed, unroofed: other' (4.0 cm^3/l); 'in building: enclosed, unroofed' (1.3 cm^3/l; only 3 samples); and 'in building: kitchen' (1.4 cm^3/l)[6]. The 'in building: ritual space' category has the lowest mean density of charcoal (0.4 cm^3/l). Other context types with low densities (all 0.9 cm^3/l) are, 'unenclosed, unroofed: craft activity', 'street/lane' and 'in building: unspecific'. The ratio of charcoal densities for contexts outside *versus* contexts inside is 1.71:0.98, indicating that deposits in enclosed spaces contain slightly less burnt debris.

4.1.4 Mean charcoal densities – by vertical context (period) (Fig. 3)

Only one vertical context has a mean density of charcoal above the overall mean, group V (2nd millennium), with a value of 1.9 cm^3/l. Two other context classes have mean charcoal densities equalling that of the site mean, group II (middle Uruk) and group IV (later 3rd millennium). The two remaining vertical context classes have the lowest densities of charcoal (both 0.7 cm^3/l).

4.1.5 Mean charcoal densities – by trench (Fig. 4)

Trenches HN, HS5 and HF2 (only two samples) have charcoal densities above the overall mean for the site (1.9 cm^3/l, 1.5 cm^3/l and 2.9 cm^3/l respectively). HS1 has a charcoal density equalling that of the site mean. The lowest recorded charcoal densities are for trenches HF1, HS6 and HS4 (0.2 cm^3/l, 0.7 cm^3/l and 0.8 cm^3/l respectively).

4.1.6 Summary of the results for Tell Brak (Fig. 5)

The overall mean charcoal density for Tell Brak of 1.2 cm^3/l is low but compares with other sites (Colledge 1994). The highest density is 21.33 cm^3/l and the lowest is 0.06 cm^3/l. Fig. 5 is a frequency histogram showing charcoal densities for the whole site. The frequency distribution is positively skewed, i.e. there are greater numbers of samples with lower densities. 69% of the samples have densities below that of the overall mean. This low value is indicative of deposits within which there has been a general dispersion of burnt plant debris.

The high charcoal density recorded for the 'tip, midden, rubbish dump' deposit class might be expected. These are areas where general 'household' refuse would be disposed of. The low density for the '*in situ*: fire installation contents' may be a result of the clearance of ashes from the fires, some of which may have spilled over on to the living surfaces, and this may account for the high charcoal densities in the 'occupation sequence: accumulation on floor' class. Mud bricks usually contain chaff temper, and exposure to fire would explain the high densities in the 'constructional materials' contexts. The low charcoal density recorded for the 'pit fill: backfill' is, perhaps, unexpected. It may indicate a gradual accumulation of 'weathered' sediments within the pits rather than deliberate dumping of domestic waste.

[5] Considerations of the mixed and miscellaneous classes have been excluded from the discussions because they have little relevance in the analyses.

[6] Considerations of the 'unenclosed, unroofed: rubbish', 'in building: reception room' (both comprise only one sample), 'wall', 'surface' and 'miscellaneous/mixed' classes have been excluded from the discussions.

Clearance of waste from domestic fires within buildings may be an explanation for the slightly lower charcoal densities in enclosed areas. Deposits in areas designated as 'kitchens' are likely to contain cooking waste and it is not surprising that high densities are recorded in these contexts. The low densities of charcoal in the 'ritual spaces' are consistent with their interpretation as areas of 'special' significance, where cleanliness of floor surfaces may have been important. It would seem, therefore, that the results of the analyses of variations in densities for both the deposit classes and horizontal contexts may in part be highlighting 'housekeeping' practices, involving the clearance of burnt debris away from living surfaces.

It is suggested that the variations in charcoal densities in the vertical contexts and trenches may be linked to factors associated with taphonomic processes and/or to the type of occupation represented. The greatest densities of charcoal are in the samples from the most recent period, and the overall trend seems to be for the earlier periods to have lower densities. It may be that the fragile burnt plant material is adversely affected by the various 'formation processes' (Schiffer 1987) after burial (e.g. as a result of wear/attrition/etc.), and that these effects are more pronounced with time. Matthews has noted that in HN and HF2 there was evidence for rubbish disposal and the high densities of charcoal in the two trenches are consistent with these findings (pers. comm.). Lower densities are recorded for trenches where there was evidence of internal rooms and domestic structures, for example in HF1 and HS3. It would appear, however, that neither taphonomy nor type of occupation adequately accounts for the patterns of variation in the charcoal densities for these two contextual classifications because no consistent trends were recorded.

4.1.7 Comparison of the charcoal densities for the Kilise Tepe samples

The mean charcoal densities for the samples in the different context classes were compared with the overall mean value for the site (i.e. all samples = 2.8 cm^3/l; Table 21, Figs. 56-59).

4.1.8 Mean charcoal densities – by deposit class (Fig. 56)

Only two of the five deposit classes represented at Kilise Tepe have charcoal densities above the mean value for the site: '*in situ* deposits' (which include fire installations; 3.3 cm^3/l) and 'pit fills' (4.4 cm^3/l). The lowest density is recorded for the 'occupation sequence' class, with a value of 1.7 cm^3/l.

4.1.9 Mean charcoal densities – by vertical context (period) (Figs. 57-8)

For the main site (Fig. 57) the latest periods have the highest densities of charcoal. The three most recent vertical contexts all have mean densities above the overall mean (Byzantine 7.5 cm^3/l, Later Iron Age 4.7 cm^3/l and Middle Iron Age 3.2 cm^3/l), and the fourth has a density equal to this value (Early Iron Age 2.8 cm^3/l). The earliest periods have densities below that of the site mean. The two Bronze Age contexts with the lowest densities of charcoal are the Early Bronze Age II (1.0 cm^3/l) and the Late Bronze Age (a-c) (0.6 cm^3/l; this context comprises only three samples). For the samples from this area of the site there is significant negative correlation between period and density of charcoal, implying that densities increase with decreasing age[7].

For the I-L14 trench (Fig. 58) the three Iron Age contexts have the highest charcoal densities, with mean values above that for the whole site: Early Iron Age 3.4 cm^3/l; Early-Later Iron Age[8] 3.5 cm^3/l; and Later Iron Age 3.7 cm^3/l (only one sample). The earliest period represented in this area (Late Bronze Age) has the lowest density of charcoal, with a value of 1.5 cm^3/l (this context comprises only two samples).

4.1.10 Mean charcoal densities – by trench (Fig. 59)

Six trenches at Kilise Tepe have high densities of charcoal, with mean values above (or equalling) that for the site, they include I19 (3.2 cm^3/l), J20 (3.4 cm^3/l), J19 (6.6 cm^3/l), I14 (2.8 cm^3/l) and K14 (3.9 cm^3/l). Trench K18 is represented by one sample only and this has a density of 6.1 cm^3/l. The lowest charcoal density is recorded for trench I20, with a mean value of 1.2 cm^3/l.

4.1.11 Summary of the results for Kilise Tepe (Fig. 60)

The mean charcoal density of 2.8 cm^3/l for Kilise Tepe is low but, as stated in 4.1.6, is comparable with other sites. The slightly higher value (compared with that for Tell Brak) may be as a result of the extensive burnt

[7] Using Spearman's rank correlation coefficient a value of – 0.8667 was calculated, this is significant at the 99% confidence level for n=9.

[8] An amalgamation of all samples of indeterminate Iron Age date.

destruction levels in many of the phases of occupation at the site (see introduction by Postgate). The highest recorded density is 14.30 cm^3/l and the lowest is 0.13 cm^3/l. Fig. 60 is a frequency histogram of the charcoal densities in the samples from Kilise Tepe and, as for Tell Brak, the distribution is positively skewed. 62% of the samples have densities below that of the site mean.

The high densities recorded for the 'pit fills' and the low densities recorded for the 'occupation sequences' would seem to be consistent with the clearance of burnt debris from 'living surfaces' and the deposition in contexts outside the inhabited areas.

The most obvious trend at Kilise Tepe appears to be in the categorisation of samples by vertical context. The correlation between increasing charcoal density and decreasing age of samples would seem to indicate that the post-depositional 'formation processes' are influencing the degree to which the plant remains survive within the occupation levels within the tell. The burnt destruction layers are as numerous in the early periods at the site and so it might be expected that the densities in the Bronze Age and Iron Age samples would be equally high. Certain trenches are situated at the periphery of the tell and in these exposure to 'weathering' of the occupation deposits at the edge of the steep slope may have had a detrimental effect on the charred plant materials. H19, H20 and I20 are all at the edge of the mound and all three have low mean densities of charcoal. The low densities recorded for K19 and K20 (situated more centrally on the tell) and the high density recorded for J20 (adjacent to the steep slope) cannot, however, be accounted for similarly. Position on the tell and proximity to the weathered slope does not, therefore, adequately explain the variations in densities at Kilise Tepe.

4.2 Preservation Indices

Grass seeds (family Gramineae) were ubiquitous and so these taxa were used to measure the 'preservation' of the samples from both sites. Each grass seed was given a 'preservation' score and these scores were averaged per sample to give the preservation index (Colledge 1994). Preservation was scored on a four-fold scale: '3' was assigned if the whole seed with intact testa had survived; '2' was given for whole seeds with fragments of testa missing and some surface damage; '1' was denoted if > $^2/_3$ of the seed was present and the surface had been badly eroded (but still recognisable to genus); and '0' was attributed to fragments and whole seeds which were very badly damaged (and unrecognisable to genus). Thus a higher index indicates better preservation. For the purposes of comparison the samples within the context classes were grouped according to whether they had bad (indices in the range of 0-0.5), poor (indices in the range 0.6-1.5), fair (indices in the range 1.6-2.5) or good preservation (indices of 2.6 and above). It was considered that the measures of preservation may indicate the degree to which samples had been affected by post-depositional attrition or wear.

> "Preservation is largely related to post-charring conditions both before and after burial – in particular to mechanical damage and the effects of wetting and drying."
>
> (Jones 1991, 66)

4.2.1 Comparison of the preservation indices for the Tell Brak samples

Of 98 samples (not all samples examined were assessed in this analysis or in the analysis of fragmentation) at Tell Brak 74% have poor preservation and 26% have bad preservation (Table 3; Fig. 14). The mean preservation index for the whole site is 0.7 (i.e. the overall preservation is poor).

4.2.2 Preservation indices – by deposit class (Fig. 6)

Fig. 6 presents histograms of the percentages of samples in the four preservation categories for each deposit class. All the deposit classes have mean preservation indices falling within the range 0.6-1.5, and with the exception of the 'pit fills: backfill' and '*in situ*: fire installation contents' all have a mean value of 0.7 (i.e. the same as the overall site mean). 'Pit fills: backfill' have a higher index of 0.8 (with 100% of samples within the poor preservation range) and '*in situ*: fire installation contents' have a lower index of 0.6 (with equal numbers of samples having bad and poor preservation).

4.2.3 Preservation indices – by horizontal context (Fig. 7)

The percentages of samples in the four preservation categories for the horizontal contexts are shown in Fig. 7. The context classes 'unenclosed, unroofed: craft activity' and 'in building: corridor' differ from the overall site trend, the former class has a greater number of samples with bad preservation and the latter has equal numbers with poor and bad preservation. Both have mean preservation indices of 0.5, thus falling within the range for 'bad preservation'. It should be noted, however, that these contexts have low numbers of samples ('unenclosed, unroofed: craft activity' 3 samples, 'in building: corridor' 2 samples). All other horizontal contexts have mean preservation indices that fall within the 0.6-1.5 range, and of those in this range all but 'unenclosed, unroofed: other' have a mean preservation index equalling the site mean of 0.7. The context class 'unenclosed, unroofed:

other' has a higher mean index of 0.8. Mean indices for contexts within buildings and for those outside are 0.6 and 0.7 respectively.

4.2.4 Preservation indices – by vertical context (period) (Fig. 8)

Fig. 8 shows the results of the analysis of preservation for the vertical contexts. In this classification the early/middle Uruk group (I) is noteworthy because it has a majority of samples with bad preservation. All the other context classes follow the overall trend for the site. The early/middle Uruk samples have a mean preservation index of 0.5, thus falling within the 'bad preservation' range. All the other vertical contexts have mean values in the 'poor preservation' range, of these only the Ninevite 5 group (III) has an index which differs from the site mean, and it has a higher index of 0.9.

4.2.5 Preservation indices – by trench (Fig. 9)

The percentages of samples from the different trenches in the four preservation categories are shown in Fig. 9. A majority of samples from HS6 have bad preservation. This trench has a lower mean index than the other trenches, with a value of 0.5. All the other trenches have mean preservation indices that are within the range 0.6-1.5 and, of these, two trenches have values that differ from the site mean. The preservation index for HF is higher than the overall mean with a value of 0.9, and the index for HS5 is lower, with a value of 0.6.

4.2.6 Comparison of the preservation indices for the Kilise Tepe samples

Of the 72 samples from Kilise Tepe for which it was possible to measure the preservation indices 74% have bad preservation, 25% have poor preservation and only 1% has fair preservation (Table 21; Fig. 69). The mean preservation index for the whole site is 0.4 (i.e. the overall preservation is bad).

4.2.7 Preservation indices – by deposit class (Fig. 61)

Fig. 61 shows histograms of the percentages of samples in the four preservation categories for the deposit classes represented at Kilise Tepe, and for each there is a majority of samples with bad preservation. The mean preservation indices for all deposit classes fall within the range 0-0.5. 'Constructional materials' and 'pit fills' have indices which equal that for the site and 'occupation sequences' and '*in situ* deposits' have lower indices of 0.3.

4.2.8 Preservation indices – by vertical context (period) (Figs. 62-3)

For the northern part of the tepe (Fig. 62), with the exception of the samples in the Middle Bronze Age, all vertical contexts reflect the trend for the whole site and have greater numbers of samples with bad preservation. A majority of Middle Bronze Age samples have poor preservation. The mean indices for all vertical contexts fall within the range 0-0.5. Both Early Bronze Age contexts, the Late Bronze Age (a-c), and the Middle and Later Iron Age contexts have preservation indices lower than that for the whole site (0.2, 0.3, 0.1, 0.3 and 0.1 respectively). The Middle Bronze Age, Late Bronze Age (d-f) and Early Iron Age periods have higher mean indices of 0.5.

With the exception of the Early Iron Age, all vertical contexts represented in the central area of the site (I-L14) have 100% of samples with bad preservation (Fig. 63). The Early Iron Age context has a majority of samples with bad preservation and only 20% with poor preservation. The two earliest periods (Late Bronze Age and Early Iron Age) have mean preservation indices of 0.5. The three later periods have indices below that of the site mean (the two most recent vertical contexts are represented by one sample only).

4.2.9 Preservation indices – by trench (Fig. 64)

Trenches I19 and J20 differ from the overall site trend and do not have a majority of samples with bad preservation (Fig. 64; in this analysis trench J18 is represented by only one sample). 50% of samples from I19 have bad preservation, and 48% and 12% (respectively) are in the 'poor' and 'fair' preservation ranges. It is the only trench for which the mean index falls within the 'poor preservation' range, with a value of 0.6. 60% of the samples from J20 have poor preservation. I20 and J20 have mean indices above that for the whole site (both 0.5) and all the other trenches have indices lower than or equal to the overall mean (H20 0.4, H19 0.3, K19 0.4, I14 0.3, K14 0.4).

4.3 Fragmentation Indices

The seeds of the grasses were also used to calculate fragmentation indices. Whole seeds and fragments of seeds were counted for each sample and the fragmentation index was the ratio of the numbers of fragments to the numbers of whole. Thus a higher index indicates that there are more fragments in a sample, i.e. a greater degree of fragmentation. The samples were grouped according to whether they had low (indices in the range 0-2.9), moderate (indices in the range 3.0-5.9), high (indices in the range of 6.0-8.9) and very high fragmentation (indices greater than 9.0). As for the measures of preservation, it was considered that the analysis of fragmentation would enable assessment of the degree of post-depositional 'disturbance' in different areas of the sites.

4.3.1 Comparison of the fragmentation indices for the Tell Brak samples

Of the 98 Tell Brak samples 32% have low fragmentation, 56% have moderate fragmentation, 8% have high fragmentation and only 3% have very high fragmentation (Table 3; Fig. 15). The mean fragmentation index for the site is 4.2 (i.e. overall there is a moderate degree of fragmentation).

4.3.2 Fragmentation indices – by deposit class (Fig. 10)

Fig. 10 shows the percentages of samples in the four fragmentation categories for the different deposit classes. The classes 'tip, midden, rubbish dump' and '*in situ*: fire installation contents' have a majority of samples with low fragmentation and, as such, do not follow the overall site trend. The former class has a mean fragmentation index of 2.8 and is, therefore, within the 'low fragmentation' range. The only other class for which the mean value is not within the 'moderate fragmentation' range is that of 'constructional materials' (classes 4a, 4b and 4c have been grouped), it has a high index of 6.1. Mean fragmentation indices for the other classes are: 'structure' 4.9; 'occupation sequence' 3.8; '*in situ*: fire installation contents' 3.4; and 'pit fills: backfill' 3.0.

4.3.3 Fragmentation indices – by horizontal context (Fig. 11)

Fig. 11 shows the results of the analysis of fragmentation for the horizontal contexts. The 'unenclosed, unroofed: craft activity' and 'in building: not courtyard' contexts differ from the site trend because the majority or all the samples in these classes fall within the 'low fragmentation' range (both consist of three samples only; the 'unenclosed, unroofed: rubbish' context comprises one sample). The mean fragmentation indices for these contexts are 2.5 and 1.8 respectively. The only other context which does not adhere to the overall site trend is 'in building: corridor' and in this category there are equal numbers of samples with high and moderate fragmentation (a mean value of 5.8; the class consists of two samples only). The 'street/lane' class has a mean index of 6.7, thus falling within the 'high fragmentation' range. All the other horizontal contexts have mean indices in the 'moderate fragmentation' range: 'unenclosed, unroofed: other' 4.1; 'in building: kitchen' 4.2; and 'in building: unspecific' 3.8. There is a slightly higher fragmentation index for contexts outside than for those within buildings, the former is 5.1 and the latter 3.6.

4.3.4 Fragmentation indices – by vertical context (period) (Fig. 12)

The percentages of samples within the four fragmentation categories for the vertical contexts are shown in Fig. 12. A majority of samples in the middle Uruk group (II) have indices that are within the 'low fragmentation' range. The mean fragmentation index for this context is the lowest, with a value of 2.6. All other period groups have mean indices within the 'moderate fragmentation' range. Context groups I, III and V (early/middle Uruk, Ninevite 5 and 2nd millennium) have values below that of the site mean: 3.2, 4.0 and 3.9 respectively. The later 3rd millennium group (IV) has a slightly higher mean value of 5.8.

4.3.5 Fragmentation indices – by trench (Fig. 13)

Fig. 13 shows the proportion of samples from the six trenches in the different fragmentation categories. HS1 differs from the site trend and has a majority of samples in the 'low fragmentation' range. It has the lowest mean index, with a value of 2.6. Of note for HS3 is that there are relatively high proportions of samples (>25%) with high and very high fragmentation and the mean index for this trench is the highest, with a value of 6.3. HS6, HF (1 and 2), HS5 and HN have mean fragmentation indices in the 'moderate' range and all values are below the overall site mean: 3.2, 4.0, 4.1 and 3.9 respectively.

4.3.6 Comparison of the fragmentation indices for the Kilise Tepe samples

Of the 72 samples from Kilise Tepe for which the degree of fragmentation could be assessed 36% have low fragmentation, 36% have moderate fragmentation, 17% have high fragmentation and 11% have very high fragmentation (Table 21; Fig. 70). The mean fragmentation index for the site is 4.6 (i.e. overall there is a moderate degree of fragmentation).

4.3.7 Fragmentation indices – by deposit class (Fig. 65)

Only the 'construction materials' deposit class adheres to the overall trend for the site, with the highest proportion of samples in the 'moderate fragmentation' range (this class has a mean index of 5.0). The 'occupation sequences' and 'pit fills' have high percentages of samples with low fragmentation and consequently have indices below that of the site mean (4.4 and 4.3 respectively). A majority of the samples in the '*in situ* deposits' class has high fragmentation. This is the only class that has a mean index that does not fall within the 'moderate fragmentation' range (a value of 6.4).

4.3.8 Fragmentation indices – by vertical context (period) (Figs. 66-67)

For the main site (Fig. 66) the Early Bronze Age II and Late Bronze Age (a-c) are the only vertical contexts with mean indices not within the 'moderate fragmentation' range. The Early Bronze Age II context has a majority of samples in the 'high' and 'very high' fragmentation ranges and, as a consequence, has the highest mean index of 7.5 (i.e. in the 'high fragmentation' range). All the Late Bronze Age (a-c) samples (three only) have low fragmentation. This period has the lowest mean index of 1.6 (i.e. in the 'low fragmentation' range). The Early Bronze Age III, Middle Bronze Age and Late Bronze Age (d-f) periods have higher (or equal highest) numbers of samples in the 'moderate fragmentation' range. Two of these contexts have mean fragmentation indices above that for the site (Early Bronze Age III 5.7, Late Bronze Age (d-f) 4.9) and the third has a lower mean index of 4.2. The Early Iron Age and Middle/Later Iron Age contexts (only three samples from each context) have greater numbers of samples with low fragmentation and mean indices below that of the site mean (3.8 and 3.7 respectively).

For I-L14 (Fig. 67; excluding the two periods represented by single samples only), the Late Bronze Age (d-f) context has the lowest mean fragmentation index, a value of 2.6 (this context comprises two samples only). The Iron Age contexts have mean indices which fall within the 'moderate fragmentation' range (Early Iron Age 3.9, amalgamated Iron Age samples 5.5).

4.3.9 Fragmentation indices – by trench (Fig. 68)

I20, J18 and K19 are the only trenches with mean fragmentation indices not within the 'moderate fragmentation' range (in this analysis J18 is represented by one sample only). I20 (only three samples) has the highest mean index of 6.3 (i.e. in the 'high' range) and K19 has the lowest mean fragmentation index of 2.3 (i.e. in the 'low' range). The fragmentation indices for the other trenches fall within the 'moderate' range. Of these H19, I19, J20 and I14 have indices below that of the site mean (4.1, 4.3, 3.2 and 4.5 respectively), and the remaining trenches have higher mean indices (H20 5.5, K14 4.8).

4.3.10 Summary of the preservation and fragmentation analyses for the Tell Brak samples

There are no Tell Brak samples that have good preservation and/or no fragmentation. The overall 'state of preservation' of the remains (i.e. poor preservation and moderate fragmentation) indicates that considerable wear had been caused by activities which took place at some time after the plant material was brought to the site. For the site as a whole there is significant negative correlation between preservation and fragmentation indices[9], implying that better preserved remains (i.e. those with high preservation indices) are less fragmented (i.e. have low fragmentation indices).

Of note for the analyses undertaken by deposit class is that the samples from 'pit fills: backfill' have slightly better than average preservation. Once deposited in the pits the charred plant remains may have suffered less damage than if they had been allowed to accumulate on the 'living surfaces' of the site. The charred material in the 'tip, midden, rubbish dump' class has low fragmentation and, similarly, these features would have been situated away from the living areas where there would have been less likelihood of disturbance by trampling. It is possible, therefore, that the variations in the overall 'state of preservation' of the charred plant material may in part be highlighting the differential effects of post-depositional attrition by trampling, and thus may be an indication of relative frequency of habitation or use of certain areas of the site. If this were the case it would be expected that the samples in the 'occupation sequence' classes would show poor preservation and high fragmentation indices, however they adhere to the overall site trend and no extreme values are recorded. The plant remains in the '*in situ*: fire installation contents' class have slightly worse than average preservation and this could be as a result of damage caused by the intense heat of the fires. The high fragmentation recorded for the samples in the 'constructional materials' class may be as a result of 'reworking' of sediments containing plant debris, for example to make mud bricks, thus causing breakage of the remains.

Of significance for the analyses of overall preservation according to the designations by horizontal contextual classes, is that the 'in building: corridor' class has bad preservation and the 'street/lane' class has high fragmentation (the latter class has low numbers of samples). Both are areas where there would have been human and possibly animal 'traffic', and where excessive disturbance to the deposits 'underfoot' would cause damage to any plant debris contained within. The 'unenclosed, unroofed: craft activity' class has bad preservation and this may also have been an area that had more regular use by the inhabitants. So, as with the patterns of variation in overall preservation for the different deposit classes, it would appear that the trends for the horizontal contexts may also be indicative of the frequency of use of space at the site. Samples taken from inside and outside buildings have similar preservation. There is, however, a greater degree of fragmentation in deposits from unenclosed spaces and this again may also be as a result of 'heavier' use of these areas.

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[9] Using Spearman's rank correlation coefficient a value of – 0.3112 was calculated, this is significant at the 99% confidence level for n = 98.

For Tell Brak there are no clear chronological trends in either preservation or fragmentation, with the exception that the samples in the earliest period of occupation (early/middle Uruk) have the worst preservation. Similarly there are no obvious explanations, in terms of the type and character of occupation, which would account for the variations in overall preservation within the different trenches and periods. Slightly better preservation is recorded in trenches HF1 and HF2. HF1 contained internal rooms with domestic structures as did HS1, for which there was low fragmentation (Matthews pers. comm.). This may be an indication of less frequent or restricted use of these 'household' areas. Contrary to these findings, HS3 (a trench comprising similar residential architecture) has high fragmentation and so it appears that there are no consistent trends in 'overall preservation' at the site. In a similar study undertaken by the author (for Epipalaeolithic and Neolithic sites in the Levant) the following was noted,

> "The differences in the quality of preservation of the plant material and the degree to which it fragmented are a result of the differences in the destructive 'formation processes' in operation at the sites. It was not unexpected, therefore, that the values of preservation and fragmentation were varied and, as such, could not easily be explained in terms of differences in site type, settlement location, etc."
>
> (Colledge 1994, 238)

4.3.11 Summary of the preservation and fragmentation indices for the Kilise Tepe samples

At Kilise Tepe, as at Tell Brak, there are no samples with good preservation and/or no fragmentation. The bad preservation recorded for the whole site may be due to the high incidence of destruction by catastrophic fires in many of the occupation phases, which would probably cause excessive damage to any plant materials brought to the settlement (see previous section and below for discussion of the overall preservation of samples taken from fire installation contexts). For the site as a whole there is significant negative correlation between the preservation and fragmentation indices[10], implying that better preserved remains (i.e. those with high preservation indices) are less fragmented (i.e. have low fragmentation indices).

Of note for the analyses undertaken by deposit class is that samples from '*in situ* deposits' have worse than average preservation and a high degree of fragmentation (at Kilise Tepe these include samples taken from fire installations). Similar results were recorded for the same contexts at Tell Brak. These findings are not surprising and tend to confirm that the intense heat of small-scale domestic fires causes substantial damage to plant remains. 'Pit fills' have lower than average fragmentation and again this substantiates findings at Tell Brak. It appears, however, that measures of overall preservation are not incontrovertible evidence for the relative frequency of use of space because, as at Tell Brak, the indices of preservation and fragmentation for the 'occupation sequences' at Kilise Tepe are not recorded as being either extremely low (for the former) or extremely high (for the latter). The samples from these deposit classes have slightly worse than average preservation but slightly lower fragmentation.

The samples from the earlier periods at Kilise Tepe have slightly higher fragmentation than the later periods but there is no significant chronological trend in overall preservation at the site. Trench H19 has slightly worse than average preservation and trenches I20 and H20 have high or higher than average fragmentation. The three trenches are all situated at the edge of the mound and, as stated in section 4.1.11, the deposits within may have been exposed to more weathering than those in trenches located centrally. These findings, however, are not consistent for all the trenches on the tell.

4.4 Comparison of the taxonomic composition of samples

If activities involving plant utilisation have been undertaken regularly in the same pre-defined areas of a site and if the suites of taxa used, or produced in processing, have consistent compositions it is likely that detection of *in situ* use of plant resources will be possible. The chances of being able to identify in the archaeobotanical record specific uses in specific areas are increased in those instances where there has been total destruction of a site by fire, such that the last episodes of domestic life are 'captured' and preserved by burning. If no such catastrophic event has occurred it is far less likely that plant utilisation in specific areas will be easily distinguishable.

In any archaeobotanical study, prior to interpretations being made about the use of resources in specific locations within a settlement, assumptions have to be made regarding the economic significance of the species identified in samples. With the exception of domestic crops, it cannot be assumed because taxa are represented in the archaeobotanical record that they were deliberately collected for use. Neither can it be assumed that higher numbers of one taxon and fewer of another is necessarily an indication of greater or lesser economic significance or preference. The contrary may be true. For example, deliberate exposure to fires of taxa that had not been collected for use (e.g. the waste from cleaning harvested crops) may be far more likely than the accidental burning of plant foods, and particularly those which do not require cooking in their preparation for use (e.g. green

[10] Using Spearman's rank correlation coefficient a value of –0.4564 was calculated, this is significant at the 99% confidence level for n=72.

leafy foods). Consequently there would be minimal representation of the plant foods and high numbers of contaminants of the crops. That said, in this study the identification of activities involving the processing of harvested crops is as relevant as the identification of contexts where those crops were prepared for consumption.

In this study only the crops found in the samples (represented by grains/seeds and chaff) were used as the basis for inferring deliberate use, since the reasons for their presence are less likely to be as ambiguous as the wild taxa[11]. In order to define the variations in composition the relative proportions of crop taxa, rather than absolute numbers, were compared within and between context types. Relative proportions of cereals and legumes have been compared within families in the understanding that different genera of the same family (e.g. wheat and barley) are more likely to have the same 'preservational histories' (i.e. are likely to come into contact with fires with the same frequency and exhibit a similar degree of robustness once charred). If proportions of taxa with different 'preservational histories' were compared it was considered that the likelihood of numerical bias would be increased. Differences in durability between groups of 'unrelated' taxa may result in the survival of greater numbers of some and loss of others on exposure to fire and thus the ratio values are more likely to be a measure of differential preservation rather than original abundance

The samples from both sites were dominated by the grains and chaff of cereals. The most comprehensive compositional analyses in this study, therefore, were undertaken for these crop taxa. Relative proportions were calculated and compared in order to enable the description of sample compositions in terms of the possible activities from which the grains and chaff may have derived. The ratios used were: barley grains to wheat grains (B:Wgns); barley grain to barley rachis (Bgrn:Br); glume wheat grains to glume wheat chaff (Ggns:Gsp; here chaff refers to spikelet forks i.e. all glume bases have been divided by 2 and added to the total number of spikelet forks); and glume wheat grains to free threshing wheat grains (G:Fgns). For the Tell Brak samples ratios of the numbers of cereal grains to culm fragments (i.e. nodal and basal fragments) were calculated (Cgns:Cu). This is a somewhat arbitrary value since the degree to which the culm breaks is completely random, but for the purposes of this exercise it provides a useful index of how the numbers of fragments vary within the different context classes. Tables 3 and 21 give the values of the ratios for all samples. If one taxon outnumbers another by a factor of greater than (or equal to) 10:1 it is considered that the relative proportions are 'significant' (see Charles *et al*, 1997). For example, this might indicate the relative purity of the cereals and hence whether the samples derived from storage contexts. A predominance of chaff may be evidence for areas where the cleaning and processing of cereal crops took place. Admixtures of high proportions of barley with high proportions of wheat chaff in samples may be an indication of the presence of charred fodder or dung (Charles 1998). The contexts from which these derived may be where livestock were kept or equally, could be where hearths or ovens, fuelled by dung, were situated (etc.). The prerequisite for discussions of 'use of space' was the identification of groups of samples, coincidental with the pre-defined contextual classes, with similar and distinct compositions[12].

4.4.1 Comparisons of the ratios of cereal taxa in the samples from Tell Brak – overall site trends

Cereals are the most abundant crops at Tell Brak. Hulled barley (*Hordeum sativum*), glume wheats (*Triticum monococcum* and *Triticum dicoccum*), free threshing wheats and oats (*Avena* spp.) are all represented in the samples (Tables 4-10). The proportions of grains and chaff of these taxa in the samples in the different context classes are shown in Figs. 16-26 (Figs. 16-17 deposit classes; Figs. 18-19 horizontal contexts; Figs. 20-23 vertical contexts; Figs. 24-26 trenches). The ratios of different taxa within the context classes are given in Figs. 27-30.

<u>B:Wgns</u> There is an overwhelming predominance of barley grains at Tell Brak. In 91% of the samples barley grains outnumber wheat grains (3% of samples contain only barley grains with no wheat grains) and in 15% the ratio of barley to wheat grains is greater than 10:1. Wheat grains are predominant in 8% of the samples and the highest ratio of wheat to barley grains is 5:1. There is only one sample comprising wheat grains and no barley grains.

<u>Bgrn:Br</u> In 69% of the samples there is a dominance of barley grains over barley rachis (including 16% with only grains and no rachis), and in 43% the proportions are greater than 10:1. Barley rachis outnumbers barley grains in 26% of samples and in 2% of these the ratio of rachis to grains is greater than 10:1. There is only one sample that comprises just barley chaff with no grains. For 2-row and 6-row barley the expected ratios of grains

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[11] The limitations of time also influenced the decisions of the author to concentrate on this group of plants. It is recognised that without the evidence of the wild/weed taxa the study is incomplete, however, it is the intention that the analyses will eventually be undertaken for the full suites of species represented in the samples. (The time factor also accounts for the fact that unlike Tell Brak, no study of the legumes at Kilise Tepe is presented).

[12] Limited emphasis is placed on the context classes which have few samples.

to rachis for unprocessed crops would be 1:1 and 1:0.3 respectively (for mixtures of the two varieties the ratios would fall between the two values[13]). 23% of the Brak samples fall within this range.

Ggns:Gsp Glume wheat grains are present in higher numbers than chaff (Gsp) in 12% of the samples (one sample comprises all grains and no chaff), and in only 1% are the ratios of grains to chaff greater than 10:1. In 87% of the samples chaff predominates (including 8% of samples which contain chaff and no grains), and in 16% chaff outnumbers grains in ratios greater than 10:1. In the spikelets of glume wheats there may be as many as three grains or as few as one, and so the expected range of grains to spikelet forks for unprocessed crops (e.g. mixtures of einkorn and emmer) would be 1:0.3 – 1:1. 14% of the Brak samples fall within this range.

G:Fgns In 82% of samples glume wheat grains are present in higher numbers than free threshing grains (including 44% which comprise only glume wheat grains). In 9% of the samples glume wheat grains outnumber the free threshing grains in proportions which exceed 10:1. In the 10% of samples that have more free threshing wheat, the ratios of grains of this taxon to grains of glume wheat are low, and none are above 10:1. 2% of these samples have only free threshing wheat grains.

Cgns:Cu In 97% of the samples from Tell Brak the cereal grains outnumber fragments of culm. The ratio of grains to culm is greater than 10:1 in 57% of samples, and is greater than 100:1 in 9%. In 3% of the samples culm fragments outnumber cereal grains.

The Tell Brak samples are dominated by high proportions of barley grains and glume wheat chaff. Most of the barley seems to represent cleaned or partially cleaned crops. Unprocessed barley is present in less than 25% of the samples. The glume wheat component in the samples is dominated by the by-products of the cleaning processes and there are low numbers of grains. Free threshing wheats are present in fewer samples and in smaller proportions than the glume wheats. The compositional trends are very marked at Tell Brak with certain cereal taxa dominating the assemblages.

4.4.2 Composition – by deposit class (Figs. 16-17)

B:Wgns (Fig. 27a) The overall site trend predominates and the majority of samples in all deposit classes have greater numbers of barley grains. The ‘constructional materials’ class comprises the highest proportion of samples in which barley outnumbers wheat grains (91%) and in 19% of these the ratio of the two taxa exceeds 10:1. The ‘*in situ*: fire installation contents’ class has the highest proportion of samples with greater numbers of wheat grains (36%). The ‘pit fills’ contexts have the highest percentage of samples containing only wheat grains (9%).

Bgn:Br (Fig. 28a) The compositional pattern apparent for the whole site predominates in all deposit classes, and in each there is a majority of samples with greater proportions of barley grains. ‘*In situ*’ deposits have the highest percentage of samples in which barley grains outnumbers rachis (90%; including samples with only barley grains and no rachis). The highest proportion of samples with greater numbers of rachis than grains is in the ‘occupation sequence’ class (35%). 43% of the samples in the ‘constructional materials’ class contain barley grains and rachis in proportions that would tend to indicate unprocessed crops.

Ggns:Gsp (Fig. 29a) As for the whole site, samples with greater proportions of glume wheat chaff predominate in all contextual classes. The ‘tip/midden/rubbish dump’ class has the highest percentage of samples comprising glume wheat grains in greater numbers than chaff (18%). In these samples the proportions of grains and chaff are indicative of unprocessed crops. All samples in the ‘*in situ* fire installation contents’ class have greater numbers of chaff items than grains.

G:Fgns (Fig. 30a) Glume wheat grains predominate in all deposit classes. In three classes there is a majority of samples comprising glume wheat grains and no free threshing grains: ‘tip, midden, rubbish dump’ (55% of the samples), ‘constructional materials’ (62%) and ‘*in situ*: fire installation contents’ (55%). The highest proportion of samples with greater numbers of free threshing wheat grains is in the ‘occupation sequences’ class (15%, of which 3% contain only free threshing grains).

Cgrns:Cu The ‘constructional materials’ and ‘occupation sequence’ classes have at least 50% of samples with ratios of less than 10:1 for numbers of cereal grains and culm fragments (54% and 50% respectively), i.e. with much higher numbers of basal and nodal culm fragments.

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[13] It is assumed that both 2-row and 6-row barley was present at Tell Brak. Calculations to determine the relative proportions of the taxa (based on the numbers of ‘straight’ and ‘twisted’ grains in the samples) have not been undertaken in this study.

4.4.3 Composition – by horizontal context (Figs. 18-19)

B:Wgns (Fig. 27b) The overall site trend is again manifest in all the horizontal contexts. In the 'unenclosed, unroofed: other' context a total of 44% of samples comprise 'significant' proportions of barley grains (i.e. 22% have ratios of barley to wheat greater than 10:1 and 22% have just barley grains). This context class also has the highest proportion of samples containing just wheat grains (11%). The 'unenclosed, unroofed: craft activity' context has the highest percentage of samples with wheat grains outnumbering barley grains (21%).

Bgrn:Br (Fig. 28b) One horizontal context is distinct from the others in not adhering to the site trend of having a majority of samples with greater proportions of barley grains. 56% of the samples in the 'unenclosed, unroofed: other' context have more rachis than grains and a further 11% have only rachis, hence a total of 67% in which rachis predominates. 57% of the samples in the 'in building: kitchen' context contain proportions of barley grains and rachis indicative of unprocessed crops.

Ggns:Gsp (Fig. 29b) As for the whole site, all context classes comprise a majority of samples in which glume wheat chaff outnumbers grains. Chaff predominates in all the samples of the 'kitchen' context. 33% of the samples in the 'unenclosed, unroofed: other' and 'street/lane' contexts have 'significantly' higher proportions of chaff (including samples with all chaff and no grains). The 'street/lane' context has the highest percentage of samples containing greater numbers of grains than chaff (17%), and in proportions which are representative of unprocessed glume wheat crops. Both samples in the 'in building: ritual space' have very high proportions of chaff (1:38; 1:28).

G:Fgns (Fig. 30b) The 'unenclosed, unroofed: other' context is not consistent with the overall site trend, unlike the other contexts it does not comprise a majority of samples in which glume wheat grains outnumber free threshing (only 44% of samples contain greater proportions of glume wheats). The 'street/lane' context has the highest percentage of samples that have only glume wheat grains and no free threshing grains (75%). The 'in building: unspecified space' context has the highest proportion of samples in which free threshing wheat grains predominate (19%, of which 2% contain only free threshing grains and no glume wheat grains).

Cgns:Cu Two horizontal contexts have a majority of samples which contain cereal grains and culm fragments in ratios of less than 10:1: 'unenclosed, unroofed: other' (56%) and 'in building: kitchen' (71%). So in these contexts there are relatively high proportions of culm fragments.

4.4.4 Composition – by vertical context (period) (Figs. 20-22)

B:Wgns (Fig. 27c) Group I (early/middle Uruk) is distinct because it does not adhere to the overall site trend, unlike the other vertical contexts it comprises a majority of samples (86%) with more wheat grains than barley. Group V (2nd millennium) has the highest percentage of samples in which the ratio of barley and wheat grains is greater than 10:1 (21%).

Bgrn:Br (Fig. 28c) Group V (2nd millennium) is the only vertical context in which there is not a majority of samples dominated by barley grains. 79% of the samples in this context comprise greater numbers of rachis than grains. The group I (early/middle Uruk) and group II (middle Uruk) contexts have over 50% of samples in which the ratio of barley grains to rachis is greater than 10:1 (57% and 55% respectively). Group IV (later 3rd millennium) has the highest percentage of samples (41%) with proportions of grains and rachis consistent with unprocessed crops.

Ggns:Gsp (Fig. 29c) The site trend is manifest in all vertical contexts. Group V (2nd millennium) has the highest percentage of samples in which chaff predominates (93%, including 17% which contain only chaff and no grains). Glume wheat grains are present in greater numbers than chaff in 18% of the group IV (later 3rd millennium) samples (including 3% that contain only grains). 15% of samples in groups II (middle Uruk) and IV (later 3rd millennium) contain grains and chaff in proportions indicative of unprocessed glume wheat crops.

G:Fgns (Fig. 30c) Group V (2nd millennium) is distinct from the other vertical contexts, it is the only context which contains samples in which free threshing wheat grains are present in greater proportions than glume wheat grains (38% of the total number, 3% of which contain only free threshing grains). Group II (middle Uruk) has the highest percentage of samples with just glume wheat grains and no free threshing grains (80%).

Cgns:Cu There are extremely low proportions of culm fragments in groups I, II and III. A majority of samples in groups IV and V (later 3rd millennium and 2nd millennium) have ratios grains to culm fragments of less than 10:1 (53% and 83% respectively). Group V is the only context which has samples in which the numbers of culm fragments outnumber the numbers of grains.

4.4.5 Composition – by trench (Figs. 23-26)

B:Wgns (Fig. 27d) HS6 is distinct from the other trenches and doesn't adhere to the overall site trend. 86% of the samples from this trench have greater numbers of wheat grains. HN has the highest percentage of samples in which barley grains outnumber wheat grains by more than 10:1 (24%), and a further 9% which contain only barley grains.

Bgn:Br (Fig. 28d) HN and HF are distinct from the other trenches as they do not have a majority of samples in which barley grains outnumber rachis. HF has equal proportions of samples in which barley grains are present in greater proportions than rachis, in which grains are present in the same numbers as rachis and in which rachis predominates (33.3%). 76% of the samples in HN have greater numbers of rachis than grains. 75% of the samples in HS5 have proportions of grains and rachis indicative of unprocessed barley crops.

Ggns:Gsp (Fig. 29d) The site trend predominates in all trenches. Trench HS3 has the highest percentage of samples in which glume wheat grains are present in greater numbers than chaff (21%; apparently representing unprocessed crops), with a further 4% which comprise only grains. HN has the highest proportion of samples containing only chaff with no grains.

G:Fgns (Fig. 30d) HN is distinct from the other trenches because it contains a high proportion of samples in which free threshing wheat grains predominate (30%, and a further 6% in which there are only free threshing grains with no glume wheat grains). Over 50% of the samples in four of the trenches comprise only glume wheat grains: HS3 (67%); HS1 (80%); HS4 (53%) and HF (1 & 2; 67%).

Cgns:Cu Two trenches have a majority of samples which contain cereal grains and culm fragments in ratios of less than 10:1, HS3 (54%) and HN (79%, with a further 9% which contain more culm fragments than grains).

4.4.6 Summary of the results for Tell Brak

In a study of the charred plant materials found at the Bronze Age site of Abu Salabikh in Iraq, Charles noted that there was a predominance of barley grains and glume wheat chaff in the samples. He comments,

> "Overall, the composition of the Abu Salabikh samples cannot have resulted from the differential breakdown of certain cereal components during the digestion of material from a maslin crop and must instead reflect the deliberate mixing of different fractions of two separate processed crops (Charles 1989, 248). As large quantities of chaff would not be suitable for human consumption, this deliberate mixture, of the grain of one species and chaff of another, was probably fed to livestock."
>
> (Charles 1998, 119)

Likewise, the high numbers of barley grains and glume wheat chaff in the majority of the samples from Tell Brak could perhaps be an indication of the ubiquity of animal food or dung in the deposits. The digested fodder, in the form of dung cakes, may have been used as fuel for domestic fires, thus explaining the admixtures of grains of one taxon with chaff of another in the charred assemblages. Fragments of dung were found in several of the samples from the site. The primary use of many of the plants represented in the charred assemblages may, therefore, have been as food for domestic animals. Mixing of the burnt debris from cooking, or floor sweepings, etc. with the spent fuels from the fires would account for the inclusion of other cereal taxa in the assemblages.

All the deposit classes adhere to the overall site trend in terms of the ratios of the various cereal components. Using this method of analysis to investigate taxonomic composition, no single class is distinctly different from the others and thus the classes could not be characterised (or distinguished) on this basis. The high numbers of culm fragments in the 'constructional materials' and 'occupation sequences' classes may be significant. The buildings at Brak were constructed of mud brick, and the bricks or decayed rubble were present throughout the site. The culm fragments in the 'constructional materials' class may, therefore, derive from the straw temper in the mud bricks. The stalks cut from the cereals may have been strewn on the floors of the buildings as a temporary 'carpet' above the compacted earth. This could explain the high numbers of basal and nodal culm fragments in the 'occupation sequence' class.

One horizontal context appears to be distinctly different from the others on the basis of the ratios of cereal components. A majority of the samples from the 'unenclosed, unroofed: other' class contain higher proportions of barley rachis than grains (it is also the only class for which there is not a majority of samples with greater proportions of glume wheat grains relative to free threshing grains). This class also has the highest percentage of samples with 'significantly' greater proportions of glume wheat chaff and together with large numbers of culm fragments. It may have been that these were areas, outside buildings and unbounded by walls, where it was convenient to process (i.e. thresh, winnow and sieve) the crops. The use of the stalks cut from the cereals as disposable flooring in kitchens may be a possible explanation for the large numbers of culm fragments in these contexts. Higher proportions of unprocessed barley in the kitchens may be an indication that the crops were kept there before use. Storage of the cereals in sheaves would also contribute to the amount of culm deposited in these contexts.

The most obvious trends in the taxonomic composition of the Brak samples appear to be chronological[14]. Wheat grains are predominant in the earliest period at the site and there seems to be an increase in the relative abundance of barley in the samples with time. The latest period (V, 2nd millennium) has both the highest percentage of samples with 'significant' proportions of barley grains and also the highest percentage with greater proportions of free threshing wheats than glume wheats. These trends can best be explained in terms either of the introduction of new crop types, or the changing preferences for different crops or of the necessity to exploit specific crops at certain times. Changing agricultural practices or processing techniques through time may also account for some of the temporally distinct compositional variations. The latest periods (IV, later 3rd millennium; V, 2nd millennium) have high proportions of culm fragments, in contrast with the earlier periods which have very few. This could be an indication of changes in harvesting techniques, for example in the later periods the cereals may have been uprooted (as attested by the presence of basal culm) or cut low on the stalks before being brought back to the site. The culms may have been considered a more useful commodity during these times.

4.4.7 Comparisons of the ratios of cereal taxa in the samples from Kilise Tepe – overall site trends

Cereals are the most abundant crops represented in the samples at Kilise Tepe. They include hulled barley (*Hordeum sativum*), glume wheats (*Triticum monococcum* and *Triticum dicoccum*), free threshing wheats, oats (*Avena* sp.) and millet (*Panicum/Setaria* spp.)[15] (Tables 22-25). Grains dominate the assemblages but chaff is present in the majority of samples. Figs. 71-77 show the proportions of grains and chaff in the different deposit classes (Figs. 71-72), periods (Figs. 73-74) and trenches (Figs. 75-77). Figs. 78-80 show the ratios of the different taxa in each of the context classes.

<u>B:Wgns</u> There is a higher percentage of samples with a predominance of wheat grains at Kilise Tepe. 48% of samples have more wheat than barley grains (including 1% with only wheat grains) whereas only 41% have greater numbers of barley grains (including 4% with only barley grains). Wheat grains outnumber barley grains in ratios greater than 10:1 in 6% of the samples. Barley grains outnumber wheat grains in ratios of greater than 10:1 in 5% of the samples.

<u>Bgrn:Br</u> Barley grains predominate in the samples from Kilise Tepe. In 61% of the samples there are barley grains and no rachis and in a further 31% barley grains outnumber rachis. Grains are present in ratios of greater than 10:1 in 4% of the samples. Rachis outnumbers grains in only 4% of the samples and is present in 'significant' proportions (i.e. in ratios greater than 10:1) in 1%. For 2-row and 6-row barley the expected ratios of grains to rachis for unprocessed crops would be 1:1 and 1:0.3 respectively (for mixtures of the two varieties, as is likely at Kilise Tepe, the ratios would fall between these two values). 15% of the Kilise Tepe samples fall within this range.

<u>Ggns:Gsp</u> Glume wheat grains without chaff are present in 27% of samples at Kilise Tepe and grains outnumber chaff in a further 19%. Grains are present in ratios exceeding 10:1 in only 1% of the samples. Chaff predominates in 31% of samples and outnumbers grains by more than 10:1 in 9%. A further 9% of samples contain only glume wheat chaff. There are no glume wheat remains in 10% of the samples. The expected range of grains to spikelet forks for unprocessed glume wheats (i.e. mixtures of einkorn and emmer, as found in the Kilise Tepe samples) would be 1:0.3 – 1:1. 15% of the samples at Kilise Tepe contain mixtures of grains and spikelet forks in proportions that fall between these values.

<u>G:Fgns</u> Free threshing wheat grains are present in only 31 samples (33% of the total number) at Kilise Tepe. In the majority of these samples glume wheat grains predominate (in 24 of the 31, i.e. 26% of all samples) and they outnumber free threshing grains by more than 10:1 in 6%. Free threshing grains are present in higher numbers than glume wheat grains in only 3% of samples and in none of these are the ratios greater than 10:1. 2% of samples comprise only free threshing wheat grains. The numbers of free threshing grains in the samples are so low that it was not considered relevant to quote this ratio in all the analyses.

[14] Because the vertical contexts are inextricably linked with the trench demarcations only the former groups are referred to in the discussions of taxonomic composition for both sites.

[15] The cereal taxa for which identifications are less certain are not included in this list, but these are included in the tables.

Cgns:Cu Cereal culm (basal and nodal fragments) is present in less than 25% of the samples (19 samples, i.e. 20%) at Kilise Tepe. No calculations of ratios were made for these taxa because the frequency of occurrence was so low.

Wheat grains are more abundant than barley grains at Kilise Tepe. The commonest wheat taxa are the glume wheats. Free threshing wheat grains and chaff are present in very few samples. The glume wheats appear to be represented in the samples either as cleaned grains or as partially processed and unprocessed crops. There are large numbers of samples (although not a majority) with a predominance of the by-products of the cleaning processes, i.e. chaff. Most of the barley appears to be represented as cleaned crop (i.e. grains without chaff) and only a small percentage of samples seem to comprise unprocessed spikelets.

4.4.8 Composition – by deposit class (Figs. 71-72)

B:Wgns (Fig. 78a) The 'constructional materials' differ from all other deposit classes and from the overall site trend in having a greater number of samples in which barley grains outnumber wheat grains. 50% of samples in this class have more barley than wheat and in only 40% are the proportions reversed. The 'occupation sequence' class comprises equal percentages of samples in which barley grains and wheat grains predominate. A majority of samples in the '*in situ* deposits' and 'pit fills' have greater numbers of wheat grains (67% and 56% respectively). In these two deposit classes there are relatively high numbers of samples in which the proportions of wheat grains to barley grains are greater than 10:1 (17% of '*in situ* deposits' and 7% of 'pit fills').

Bgn:Br (Fig. 79a) All deposit classes follow the overall site trend, with samples comprising a predominance of barley grains and very little barley chaff. In three of the classes there is a majority of samples containing over 50% barley grains with no chaff: 'constructional materials' (65%); 'occupation sequences' (63%); and '*in situ* deposits' (83%). The 'pit fills' class has the highest proportion of samples with only barley chaff and no grains (7%). All classes comprise few samples containing what may be unprocessed barley (the highest percentage is in the 'pit fills' - 22%).

Ggns:Gsp (Fig. 80a) 'Pit fills' are the only deposit class which adhere to the overall site trend of having a higher proportion of samples with greater numbers of glume wheat grains (59%). The 'occupation sequences' and 'constructional materials' have a majority of samples in which glume wheat chaff is present in higher numbers than grains (for the former class: 50%, 19% of which comprise only chaff; for the latter: 43%, 10% of which comprise only chaff). '*In situ* deposits' have equal numbers of samples in which grains and chaff predominate. 'Pit fills' have the highest percentage of samples in which the proportions of grains and chaff are indicative of unprocessed glume wheat crops (19%).

G:Fgns A majority of the samples in the 'pit fills' class contain free threshing wheat grains (52%).

4.4.9 Composition – by vertical context (period) (Figs. 73-74)

B:Wgns (Fig. 78b) For the main area of excavation the three Iron Age phases adhere to the overall site trend in having a majority of samples with higher proportions of wheat grains (Later Iron Age 60%; Middle Iron Age 83%; and Early Iron Age 58%, including 5% with only wheat grains). By contrast, and with the exception of the Early Bronze Age III context, the earlier periods comprise a majority of samples with greater numbers of barley grains (Late Bronze Age (d-f) 60%, including 10% with only barley grains; Late Bronze Age (a-c) 67%; Middle Bronze Age 77%; and Early Bronze Age II 57%). The Early Bronze Age III context has a higher proportion of samples with more wheat grains (83%). In 60% of the Byzantine samples barley grains outnumber wheat grains (including 20% which contain only barley grains).

For I-L14, the vertical contexts comprise a majority of samples with a predominance of wheat grains and, as such, comply with the overall site pattern.

Bgrn:Br (Fig. 79b) The overall site trend predominates in all vertical contexts and the majority of samples comprise an overwhelming predominance of barley grains with very little chaff. Over 50% of the samples in five contexts contain only barley grains with no chaff: Later Iron Age 80%; Middle Iron Age 100%; Early Iron Age 68%; Late Bronze Age (d-f) 80%; and Middle Bronze Age 69%. The Byzantine and Early Bronze Age II contexts comprise high percentages of samples in which the proportions of barley grains and chaff are indicative of unprocessed crops (40% and 50% respectively).

The contexts in I-L14 each comprise a majority of samples in which barley grains are predominant. Both samples in the Late Bronze Age (d-f) context and 40% of those in the Early Iron Age have grains and rachis in proportions which would tend to indicate the presence of unprocessed crops.

Ggns:Gsp (Fig. 80b) The later periods in the main area of excavation adhere to the overall site trend and for the contexts up to and including the Late Bronze Age (d-f) there is a majority of samples in which glume wheat grains predominate (including samples in which there are only grains; Byzantine 60%, including 40% all grains; Later Iron Age 80%, including 60% all grains; Middle Iron Age 100%, including 33% all grains; Early Iron Age 58%, including 32% all grains; and Late Bronze Age (d-f) 60% with just grains). The four most recent periods also have relatively high frequencies of samples with proportions of grains and chaff indicative of unprocessed crops (in order of increasing age: 20%, 40%, 33% and 21%). The earlier periods, however, include a majority of samples in which chaff is more abundant than grains (i.e. samples with just chaff and those in which chaff predominates): Late Bronze Age 67% (including 33% with only chaff); Middle Bronze Age 85% (including 15% with only chaff); and Early Bronze Age III 100% (including 17% with only chaff). Only 57% of the samples in the Early Bronze Age II context have any glume wheat remains, but of those that have 75% are dominated by glume wheat chaff. Of the earlier periods only the Middle Bronze Age context has any samples which comprise proportions of grains and chaff which suggest they may have derived from an unprocessed crop (only 8% of the samples from this context).

This chronological trend is not apparent in the I-L14 contexts. The Early Iron Age period in this area has a majority of samples in which chaff predominates (80%), otherwise the compositional differences are not clearly defined.

G:Fgns For the main area of the site the two latest periods are distinct in having a majority of samples in which free threshing wheat grains have been identified: Byzantine 80% and Later Iron Age 60%. All other vertical contexts have few samples (less than 50%) which contain free threshing wheat grains. Glume wheat grains outnumber free threshing grains in the majority of samples.

The Early Iron Age and Late Bronze Age contexts (the latter with only two samples) in I-L14 have high numbers of samples with free threshing wheat grains (80% and 100% respectively).

4.4.10 Composition – by trench (Figs. 75-77)

B:Wgns Trenches H20, H19, J20 and J19 comprise a majority of samples in which barley grains are predominant (47%, 75%, 67% and 57% respectively). All other trenches comply with the overall site trend in having greater numbers of samples in which there are more wheat than barley grains.

Bgn:Br The overall site trend predominates in all trenches. However, trenches H20, J19 and K14 differ from the others because they have few samples containing only barley grains and no rachis (42%, 29% and 14% respectively). With the exception of these three trenches all others have a majority of samples with just barley grains. These three trenches also have the highest percentages of samples containing proportions of grains and chaff indicative of unprocessed crops (H20 26%, J19 28% and K14 28%).

Ggns:Gsp Trenches H20, H19 and K14 have a majority of samples with a predominance of glume wheat chaff (68%, 83% and 57% respectively) and, as such, are at variance with the site trend. All the other trenches are dominated by samples with high numbers of glume wheat grains. Trenches I19 and I14 have the highest proportions of samples in which the grain and chaff proportions would tend to indicate unprocessed wheat (20% and 23% respectively).

G:Fgns Only one trench (J19) has a majority of samples (71%) in which free threshing wheat grains are represented.

4.4.11 Summary of the results for Kilise Tepe

The Kilise Tepe samples comprise greater numbers of grains than elements of chaff for both the barley and wheats. As at Tell Brak, certain components may have derived from animal fodder or dung. Excavations at the site revealed many burnt storage contexts (burnt as a result of large-scale destructive fires) in which cereal grains and pulses had been put into containers or pits for consumption at a later time. It may be more likely, therefore, that the charred assemblages in the samples at Kilise Tepe do at least in part represent human foods. In a study that included the analysis of a much more restricted number of samples from the site, but which involved the investigation of the full suites of taxa (including wild/weed species) Bending commented,

> "These analyses imply that there is little evidence to support dung fuel as a major source for the non-crop processing-related samples from Kilise Tepe. Wood charcoal makes up the bulk of the evidence for fuel, implying that the natural stands in the area had not been completely decimated, that trees were being managed, or that it was available from another source (as a trade product in its own right, or arriving as, say, packaging)."
>
> (Bending 1999, 33)

As at Tell Brak, no single deposit class at Kilise Tepe is so distinctly different from the others such that it would be easily distinguishable on the basis of the ratios of cereal taxa. The high proportions of barley grains in the 'constructional materials' class may be as a result of this 'lower status' crop being used preferentially as temper for mud bricks.

Again, as at Tell Brak, the clearest trends in terms of taxonomic composition at Kilise Tepe are chronological. The earlier periods (i.e. Bronze Age, with the exception of one of the phases) comprise samples in which there are greater proportions of barley grains than wheat grains, in the later periods the proportions are reversed. Free threshing wheat grains increase in abundance in the samples from the latest periods at the site. These trends, as explained in section 4.4.6, may be a reflection of changing preferential use or availability of the crop species with time. Similarly, different agricultural practices, including harvesting and processing techniques, could account for some of the compositional variations within and between the different periods. The analyses show that the proportions of grains and chaff change over time. The later periods comprise more samples in which glume wheat grains outnumber chaff and also in which barley grains are present without rachis. In her study Bending suggests that crop processing activities have influenced the composition of the assemblages at Kilise Tepe to a greater extent than any temporally defined changes in crop preferences, etc.,

> "The later stages of crop processing (sieving and hand picking) were being carried out on-site, and products stored in their cleaned or semi-clean form. Thus, the archaeobotanical assemblages appear to owe more to the various stages of crop processing (products, by-products and mixed by-products) than variations over time or space, or between context types, or external sources, such as dung fuel."
>
> (Bending 1999, 38)

Unfortunately it was not possible to investigate the variations in taxonomic composition in the different areas of the settlement (i.e. in the rooms, courtyards, etc.). This might have enabled the elucidation of the role or status of the cereal components at Kilise Tepe.

4.4.12 Comparisons of the proportions of pulses in the samples – Tell Brak (Fig. 50)

There are far fewer seeds of pulses than cereals in the Tell Brak samples. The samples are dominated by high proportions of lentils (*Lens* sp.; Tables 12-18). Other potentially edible pulses are represented by smaller numbers of seeds, and include pea (*Pisum* sp.), chick pea (*Cicer* sp.) and bitter vetch (*Vicia ervilia*). Some of the pulses may have been collected as fodder for the livestock.

There is little distinction between the different context classes in the deposit class and horizontal context categorisations on the basis of the proportions of pulses in the samples (no figures are presented for these contextual classifications). Fig. 50 presents bar charts showing the percentage representation of pulses in the samples according to the vertical context and trench designations. The clearest trends appear to be in the classification by period at Tell Brak. Group V (2nd millennium) is the only period for which the samples are not dominated by lentils. This group has high proportions of *Vicia ervilia* and *Pisum* sp. Overall there appears to be greater diversification with time. The proportional representations of the pulses in the different trenches reflect those which predominate in the chronological classification of samples.

4.5 Comparisons of the taxonomic composition of the samples using correspondence analysis

Multivariate analysis is used in this study to investigate further any co-variational relationships between the taxonomic composition of the samples and the context classes. It was relevant to use correspondence analysis as the multivariate technique because it is ideally suited to data of the abundance type. Correspondence analysis also makes no assumptions concerning the distribution of variables in the data set (i.e. there is no prerequisite for data with a normal distribution; Lange 1990). Exploration of the data sets using correspondence analysis is essentially an exercise in 'pattern searching', looking for meaningful grouping of samples by context type. In this study taxa were either included or omitted from the analyses in an attempt to define more clearly any observed patterns.

The graphical outputs show the relative positions of the taxa and samples, oriented according to the first two principal axes (axis 1 horizontal and axis 2 vertical). Only those plots for which there is clear grouping of samples within context types are presented and discussed. Where there are obviously demarcated clusters of samples it is an indication that those samples within a cluster comprise similar suites of taxa, and significantly different suites to those in other clusters.

The computer programme used to undertake correspondence analysis on the data was CANOCO, devised by Ter Braak (1988), and the programme used to plot the output from the analyses was CANODRAW (Smilauer 1992). The data files on which correspondence analysis was undertaken comprised matrices with samples in rows and 'raw' counts of taxa in columns.

4.5.1 Correspondence analysis using the cereal taxa – Tell Brak

The data sets from Tell Brak comprise 20 cereal taxa and 117 samples (Table 11). The results of the correspondence analyses are presented in Figs. 31-49.

4.5.2 Correspondence analysis – by deposit class (Figs. 36-38)

Figs. 31 and 36 present the correspondence analysis (hereafter denoted CA) plots for the Tell Brak samples categorised by deposit class and with all 20 cereal taxa included in the data sets. Only three classes seem to form more or less recognisable clusters of samples (there are some 'outliers' from each of these classes). The '*in situ*: fire installation contents', 'tip, midden, rubbish dump' and 'pit fills' classes appear to be closely associated. They are allied with the glume wheat grains and chaff at one extreme of axis 1. This pattern of association is apparent in many of the plots (not all of which are presented), and indicates that the taxonomic composition of the samples in the three classes is similar. Of the three classes the samples of the '*in situ*: fire installation contents' appear to form the most discrete cluster. For example, in Figs. 34 and 37, the CA plots including only cereal chaff in the data sets, the samples group at the extreme of axis 1 and are allied with the glume wheat chaff. Figs. 35 and 38 show the results of the analysis after the barley grains and rachis have been omitted from the data sets and the '*in situ*: fire installation contents' again separate out on axis 1, influenced in this plot by the glume wheats. In all plots the samples from the 'constructional materials' and 'occupation sequences' are diffusely distributed, forming no groupings or alliances.

4.5.3 Correspondence analysis – by horizontal context (Figs. 39-40)

The patterning of samples manifest in Fig. 39 (cf. Fig. 31), in which the analysis included all the cereal taxa in data sets, is repeated in many of the other plots (not all of which are presented). The most obvious grouping of samples are those in the 'street/lane' and 'unenclosed, unroofed: craft activity' horizontal contexts. Samples in the 'unenclosed, unroofed: craft activity' class are separated on axis 1 and associated with the glume wheats. The 'street/lane' samples fall within the two extremes on axis 1. A second plot (Fig. 40 and cf. Fig. 35) in which barley grains and rachis have been omitted from the data sets, shows a similar clustering of samples. In the first plot (in which all taxa are included in the data sets; Figs. 31 and 39) a small group of the samples belonging to the 'unenclosed, unroofed: other' class form a distinct cluster at one extreme on axis 1. These appear to be associated with barley chaff, cereal culm and free threshing wheat rachis.

4.5.4 Correspondence analysis – by vertical context (period) (Figs. 41-45)

The plot for CA including all the cereal taxa in the data sets shows a demarcation of samples that is repeated in other plots. Of note in the first plot (Fig. 41 and cf. Fig. 31) is an apparent time trend, with the samples in the latest period at the extreme right of axis 1 and the samples in the earliest periods at the left of the axis. The samples in groups IV and V (later 3rd millennium and 2nd millennium) form distinct clusters, whereas the samples from the three earliest periods have overlapping distributions. Group V samples are associated with barley chaff, free threshing wheats and culm and the earliest groups are allied with the glume wheats. Group IV samples are distributed between the extremes on axis 1 and seem to be influenced equally by the two sets of taxa. Fig. 42 (cf. Fig. 35) shows the plot for the analysis with barley grains and rachis omitted from the data sets. This shows separation of some of the group III samples (Ninevite 5) on the second axis. These samples are associated with cereal taxa that have uncertain identifications (e.g. cereal indeterminate, *Triticum* indeterminate, etc.). The samples in two earliest periods (early/middle Uruk and middle Uruk) have overlapping distributions and are more closely allied with the glume wheats. Fig. 43 (cf. Fig. 32) shows the plot for the analysis including cereal grains only. The majority of Ninevite 5 samples are separated from those of the two earliest periods on axis 2, and again there is little differentiation between groups I and II (the two Uruk phases). In this plot the group V samples (2nd millennium) clearly cluster at the origin and are obviously influenced in their distribution by the barley grains. Fig. 44 (cf. Fig. 33) shows the results of CA with all grains except barley in the data sets. The samples in the three earliest periods show similar relative distributions to those in the previous plot. Groups I and II (early/middle Uruk and middle Uruk) are associated with glume wheats and group III (Ninevite 5) is allied with indeterminate grains. In this plot the group V samples (2nd millennium) are separated on axis 2 and their distribution is influenced by the grains of free threshing wheat and oats (*Avena* sp.). Fig. 45 (cf. Fig. 34) shows the distribution of samples with only cereal chaff included in the data sets for the analysis. Again there is an apparent time trend shown in the plot, with the latest and earliest periods at the extremes of axis 1. Groups IV and V (later 3rd millennium and 2nd millennium) are clearly demarcated, whereas the three earliest periods are indistinguishable. Group V is associated with barley rachis, free threshing wheat rachis and culm, and groups I, II and III are allied with glume wheat chaff. Group IV samples are intermediate between the two sets of taxa.

4.5.5 Correspondence analysis – by trench (Figs. 46-49)

The patterns of samples categorised by trenches are similar to those observed in the plots with categorisation by period (i.e. the vertical contexts are inextricably linked with the trench demarcations). Fig. 46 (cf. Fig. 31) shows the plot for the correspondence analysis with all cereal taxa included in the data sets. The clusters of samples and associations between groups of samples are similar in many other plots (not all of which are presented). The HN samples form a distinct cluster and are separated on axis 1 from the samples in trenches HS6, HS4, HS1 and HF, for which there are completely overlapping distributions. HS3 and HS5 are intermediate between the two sets of samples on axis 1. HN samples are associated with barley chaff, free threshing wheats and culm and the samples from trenches HS6, HS4, HS1 and HF are allied with the glume wheats. There is greater separation of the HS4 samples in the plot of the analysis with only grains included in the data sets (Fig. 47 and cf. Fig. 32). The distribution of the HS4 samples is influenced by grains with indeterminate identifications. In this plot there is also some separation on axis 2 of the HS6 and HS1 samples which are associated with the glume wheats. A similar patterning is manifest in the plot for the analysis of all cereal grains without barley (Fig. 48 and cf. Fig. 33). HN samples are associated with free threshing grains and are separated on axis 2 from those of trenches HS6, HS1, HF and HS3, which are allied with the glume wheats. HS4 samples are influenced by the cereals of indeterminate identifications, as in the previous analysis. Fig. 49 (cf. Fig. 34) presents the results of the analysis with only cereal chaff included in the data sets. The groups of samples and associations of groups are similar to those shown in Fig. 46 (where all taxa are included in the analysis). HN samples are associated with barley rachis, free threshing wheat rachis and culm, and the cluster of samples at the other extreme of axis 1 are influenced by the glume wheat chaff.

4.5.6 Summary of the results for Tell Brak

The similarity in composition of samples in the '*in situ*: fire installation contents', 'tip, midden, rubbish dump' and 'pit fills' classes could be further evidence to support the idea that at Tell Brak the burnt debris from the fires was cleared out and deposited in the pits and middens. The regularity or routineness of these operations resulted in the distinct nature of the plant materials in the deposits from these contexts.

No archaeological details are provided about the specific functions carried out in the area designated as 'unenclosed, unroofed: craft activity', but it may have been that they involved the use of cereals in some way and resulted in the deposition of higher proportions of glume wheats in this context. Although the samples in 'street/lane' class appeared to have similar compositions it was not possible to define them in terms of a predominance of individual taxa or groups of taxa. Of note in these analyses, as in the analyses of composition on the basis of ratios of cereals, is that the 'unenclosed, unroofed: other' context is distinct. The results of correspondence analysis confirm the association with cereal chaff.

Correspondence analysis of the Tell Brak samples categorised by period gives the clearest demarcation of groups of samples. Comparison of the taxonomic composition using this statistical method confirmed the chronological trends that were defined in the analyses of the ratios of the cereals in the samples. The earlier periods are associated with the glume wheats and the latest (group V, 2nd millennium) is allied with barley, free threshing wheats, oats and cereal culm (group IV, later 3rd millennium is influenced equally by the two sets of taxa). The possible reasons for these compositional changes through time are stated in previous sections.

4.5.7 Correspondence analysis using the cereal taxa – Kilise Tepe

The data sets from Kilise Tepe comprise 23 cereal taxa and 94 samples (Table 26). The resultant plots from the correspondence analyses are presented in Figs. 81-95.

4.5.8 Correspondence analysis – by deposit class (Figs. 86-87)

Figs. 81 and 86 present the correspondence analysis plots for the Kilise Tepe samples categorised by deposit class and with all 23 cereal taxa included in the data sets. There are no obvious groupings of samples according to the different classes (i.e. samples from all classes are distributed evenly throughout the plot area). With the exception of some clustering of the 'occupation sequence' samples (cf. Figs. 84 and 87), this was the case for all the analyses. In this plot (of all cereal grains except *Hordeum*), samples from the 'occupation sequence' class group at the origin but in this instance, there are no easily definable alliances with specific taxa. It is concluded, therefore, that there is little (or no) distinction between the samples in the different deposit classes on the basis of the composition of the cereals.

4.5.9 Correspondence analysis – by vertical context (period) (Fig. 88-91)

Analyses were run including the samples from both the main NW area of the site and I-L14, so samples from the two areas appear in all the plots[16].

[16] There was some exploration of how CA plots varied when the samples from I-L14 were either included or excluded from the analyses. Initial findings seemed to indicate that inclusion of the samples made little difference to the overall pattern of distribution of samples in the different vertical contexts. For this reason (and

The plot for the analysis including all the cereal taxa in the data sets shows a demarcation of samples that is repeated in other plots (Fig. 88 and cf. Fig. 81). The patterns and groupings are, however, not as clearly defined (as for the Tell Brak samples) and there are overlapping distributions and 'outliers' for each of the examples described. The samples from the two earliest periods (Early Bronze Age and Middle Bronze Age) have coincidental distributions and are separated from those of the later periods (the Early, Middle and Late Iron Age). Interestingly the Late Bronze Age samples appear to ally more closely with the latter group of samples. The distribution of the Byzantine samples partially overlaps with that of the 'Iron Age group', but in this plot (and several others) there are also 'outliers' (i.e. distinct from the general spread of the majority of samples). In this first plot the Early and Middle Bronze Age samples are associated with glume wheat grains and chaff. The Iron Age (+ Late Bronze Age) samples cluster close to the origin and seem to be allied with barley and also glume wheat grains. Fig. 89 (cf. Fig. 82) shows the results of CA after two samples (J19 1653 (96/06) and K14a 3081 (96/15)) were excluded from the data sets[17]. There is some separation of the same two groups along axis 1, and again in this plot the Late Bronze Age context is more closely associated with the 'Iron Age group'. As in the previous plot, the earlier and later groups share an affinity with the glume wheat grains and are separated on the basis of associations with glume wheat chaff (for the former) and barley grains and free threshing wheat grains (for the latter). The results of CA with barley grains and rachis omitted from the data sets are shown in Figs. 83 and 90. Fig. 90 shows the same separation of the samples according to the earlier and later period groups along axis 2. Fig. 91 (cf. Fig. 85) presents the results of CA after all cereal grains have been excluded from the data sets (i.e. only cereal chaff is included in the analysis). In this plot only the Early and Middle Bronze Age samples form a clearly defined cluster (again associated with glume wheat chaff), whereas the samples from the other periods are distributed more diffusely.

4.5.10 Correspondence analysis – by trench (Figs. 92-95)

The patterns of samples categorised by trenches are similar to those observed in the plots with categorisations by period (i.e. the vertical contexts are inextricably linked with the trench demarcations). Fig. 92 (cf. Fig. 81) shows the distribution of samples after CA with all cereal taxa included in the data sets. The pattern of samples and associations manifest in this plot is repeated in other plots (not all of which are presented). The samples in H form the most distinct cluster and those from other trenches have overlapping distributions. Figs. 93, 94 and 95 (cf. Figs. 82, 83 and 85) show the same overall spread of samples.

4.5.11 Summary of the results for Kilise Tepe

As in the analyses comparing ratios of cereals, there was no distinction between the samples in the different deposit classes using correspondence analysis to assess overall composition.

The strongest trends at Kilise Tepe appeared to be those which were chronologically defined. Of note in these analyses is the distinction of two groups of samples, the earlier comprising the Early and Middle Bronze Age periods and the later encompassing the Late Bronze Age and Iron Age periods. Taxonomic changes through time have been outlined in the previous analyses and assessment of overall composition using correspondence analysis broadly concurs with these findings. The strongest affinities are of glume wheats (particularly chaff) with the earlier group of samples and barley and free threshing wheat with the later group (the latter also includes the glume wheats).

4.5.12 Correspondence analysis using the pulses – Tell Brak (Figs. 51-55)

Correspondence analysis was undertaken for data sets comprising 9 taxa and 117 samples (Table 19). Figs. 51-55 show the plots for analyses including all pulse taxa. Of interest in the plots of categorisations by deposit class and horizontal context is that the same groups of samples which were distinct on the basis of the composition of the cereals are similarly (although not as clearly) demarcated in these analyses. For example, in Fig. 52 the samples in the '*in situ*: fire installation contents' and 'pit fills' classes have overlapping distributions and appear to be coincidental with the lentils. In Fig. 53 the samples in the 'unenclosed, unroofed: craft activity' class form a distinct group, also associated with lentils. Figs. 54 and 55 show the results of the analyses for samples categorised by vertical context and trench. The patterning is less clear than for the corresponding plots of the analyses including the cereal taxa but the dominant trend is again that illustrated in the plot of samples designated according to period. The earlier periods are associated with the lentils at one extreme of axis 1 and the group V samples (2nd millennium) are distinct from these, and associated with the other pulses. As in the compositional

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for convenience) the samples were included in the data sets for the investigations of relationships between cereal taxa and period at Kilise Tepe (but it is recognised that more work needs to be done to investigate fully).

[17] If a sample contains very high numbers of one taxon or a taxon not included in other samples it will appear in a plot distinct from the general spread of samples. Its position at one extreme of an axis will tend to 'concentrate' the remaining samples at the other extreme. In order to investigate more fully the relationships of the majority of samples it is necessary, therefore, to exclude the 'outlier' samples from the data sets.

analyses of the cereals, the group IV samples (late 3rd millennium) are distributed between the samples of earlier and latest periods (i.e. between the extremes on axis 1).

5 Discussion and Conclusions

There was an implicit assumption from the outset that the two chosen sites were 'suitable' for the analyses and investigation of the 'use of space', and presumably the similarity both of site type and period of occupation were considered sufficient criteria to permit comparison of the data sets. It was assumed and accepted that tell sites of this period would provide a range of discrete contexts, whose extent/limits could be defined during excavation, and which could be described in terms of function/human activity by the archaeologist (either in the field or at the post-excavation stage).

Implicit in the project design also was the assumption that the quantity and quality of the environmental materials recovered from the sites would be adequate and appropriate to answer questions relating to the 'use of space'. For the archaeobotanical materials, it was assumed that the 'degree of resolution' of the data was such that definition and description of plant-based functions at the sites would be possible, and specifically, that the taxonomic composition of the archaeobotanical samples would be informative about specific plant use.

The following section addresses some of the issues outlined above. These will be covered more fully in the accounts of the next stage in the study, when all the data sets are integrated.

5.1 Resolution of the data: the suitability of the sites for the investigation of 'use of space' (Figs. 96-99)

Figs. 96-98 present frequency histograms comparing charcoal densities, preservation and fragmentation at the two sites.

The mean charcoal density is slightly higher for the Kilise Tepe samples and, as discussed in the earlier sections, this could be as a result of the greater incidence of large-scale destructive fires. The more common occurrence of fires (both spatially and temporally) would have increased the likelihood of the burning of plant materials which had been brought to the site, and hence result in higher densities of charcoal. Widespread exposure to fire may result in the preservation by charring of a greater range of types of plant resources and similarly, restricted exposure (perhaps only in small-scale domestic fires) may result in preservation of a more limited range. Differences in density may, therefore, be an indication of the differences in relative completeness of representation of plant products and by-products derived from human activities at the sites. If this were the case for the two sites in question, the comparison of assemblages of charred remains with the aim of defining common criteria for identifying areas in which specific functions were undertaken may not be wholly justified.

Preservation of the plant remains at Tell Brak was slightly better than of those found in the deposits at Kilise Tepe (mean fragmentation indices were, however, similar at both sites). As discussed in earlier sections, this may also be as a result of the differences in intensity and regularity of the fires at the sites. The analyses seemed to indicate that the plant remains found in the 'fire installations' (and therefore presumably exposed to the full intensity of the burning episodes) were badly preserved in comparison with those found in other contexts. At the site level, and as a result of the widespread occurrence of catastrophic fires, this may account for the slightly worse preservation of the samples at Kilise Tepe. Exposure of plant materials to extreme temperatures likely to produce the state of preservation recorded for the site, would also increase the possibility of differential loss of certain less robust taxa. This may lead overall to an under-representation of suites of plant remains, which may mean that specific activities involving these taxa are not detectable in the archaeobotanical record. Differences in preservation, as with differences in charcoal density, may also indicate biases in the degree of representativeness of activities utilising plant resources. This raises the question (as previously stated) as to whether comparison of the two sites would enable characterisation of the different contexts in terms of archaeobotanical components, given that activities may be more easily identifiable at one site than the other.

In her account of numerical analyses in archaeobotany, Jones states,

> "In archaeobotany, the purpose of numerical description is as a basis for the inference of past human behaviour (or occasionally for environmental reconstruction if natural seed rain can be isolated in non-charred assemblages). It is desirable, therefore, to choose for description a unit which results from a single human activity: one might call this unit the 'unit of analysis' and the activity described a 'behavioural episode'."
>
> (Jones 1991, 64)

Based on similar studies (e.g. Payne 1986) large sample sizes were set in order to maximise recovery of all environmental materials from the deposits at the sites. In contexts which represented regularly undertaken activities involving plant products or by-products of a distinct composition (and that were subsequently exposed to fire), the conflation of episodes within one large sample would not hinder detection of the nature of those activities. However, in those contexts that represented smaller-scale, infrequent or varied utilisation of plant resources (and whose products were burnt), conflation of several events within one large sample would preclude the identification of separate 'behavioural episodes'. The latter was inevitable at both sites. Excavators were able to define the extent of contexts by the boundaries of different fills, cuts, etc. but it was unlikely (and unreasonable to expect) that barely visibly lenses of burnt plant materials would constitute, in their terms, a discrete unit of excavation. With reference to contexts that represent an amalgamation of disparate episodes, Jones comments,

> "…, whereas in the latter the description may have little meaning because the sample is so heterogeneous, but this does not pose a serious problem until we move from sample description to interpretation of the assemblage."
>
> (Jones 1991, 64)

It is of interest in this study that the deposit classes which were distinguishable on the basis of overall preservation and taxonomic composition were the tips/middens/rubbish dumps (and pits), where the regular and repeated action of disposal of burnt debris had resulted in similar quantities and types of charred remains. The inevitability of conflation of the archaeobotanical evidence for separate functional episodes reduces the degree of resolution of the data and brings into question the suitability of this type of environmental artefact to identify 'small-scale' anthropogenic events (except in exceptional circumstances e.g. charred figs at Kilise Tepe, see Postgate's introduction).

5.2 Comparisons between Tell Brak and Kilise Tepe

In spite of the possible differences in the 'degree of representation' of plant-based activities, there are repeated patterns in the data for the two sites. Unsurprisingly, perhaps, the clearest patterns seem to be related to activities that involved the maintenance of rubbish. Analyses both of overall preservation and taxonomic composition appear to show that there was regular clearance of debris from fire installations and deposition in tips/middens/pits.

The analyses of overall preservation at both sites appear to show that the excessive wear/attrition in certain areas may have resulted in greater fragmentation and/or worse preservation and, as such, these attributes may be useful indices of the frequency of 'use of space'. Generally, however, these analyses were more informative about the processes that affected the degree to which the plant remains survived once they had become incorporated within the deposits of the tells. Although not entirely conclusive in all instances, there was a trend towards better overall preservation in the most recent levels at both sites.

Analyses of taxonomic composition clearly indicated that chronological trends were predominant at both sites. Changing proportions of cereals and pulses may reflect preferential use or differences in relative availability of crops, or developments in agricultural techniques through time.

In summary, this study has highlighted the fact that the archaeobotanical data were more informative about activities which resulted in large rather than small scale changes in the quantity, quality and composition of remains.

It should be stressed that these are preliminary results, established without the benefit of integration with those of other analyses. Consideration of the conclusions drawn from the studies of all "environmental" materials may confirm which attributes, when assessed in conjunction, would be informative about the "use of space" on tell sites. This may then lead to the possibility of the definition of certain contexts in terms of quantitative parameters, for example, densities and degree of fragmentation of bone, pottery and charred plant materials, overall preservation of bone and plant materials, etc.

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