9.2.4: The "under-representation" of immature animals in age profiles

One problem often cited (although seldom supported by experimentally derived data, or discussed at any length) is that unfused bone is less dense than fused bone. Consequently, it has been claimed that as a result of destructive taphonomic processes, unfused bone will naturally be underrepresented in the archaeological record (Davis 1987 p39, Klein and Cruz-Uribe 1984 p43, Payne 1972 p76, Reitz and Wing 1999 p182, Watson 1978 p97). In fact, interpretations often explain the absence of animals from Groups 1 and 2 as being the result of destructive taphonomic processes (Grant 1975 pp394 - 395, Halstead 1992 p37). An examination of figure 9.10 reveals that this line of reasoning contains a fundamental flaw. This figure shows that a notable discrepancy in bone density exists between unfused and fused examples of Group 2 elements (no unfused group 1 elements are available for study). In the event of taphonomically mediated bone loss from an assemblage, such a discrepancy would indeed lead to an under-representation of the unfused group 2 bones in the archaeological record. This would indeed produce an age profile with a notable absence of animals of less than approximately one year old (the pattern that is usually associated with taphonomic bias).

However, most of the Group 4 bones also display this feature. Consequently, it would also be expected that, in the event of density mediated bone loss, unfused group 4 bones will *also* be under-represented in the archaeological record. Therefore, the preservation bias affecting unfused bones from group 1 and 2 elements is also applicable to unfused group 4 elements.

Consequently, the age profile produced by destructive taphonomic processes is potentially one of absence of unfused examples of all age/fusion classes.

It is possible to simplify age profiles to such an extent that the potential bias between fusion groups is reduced (eg Davis 1983 p58). In his study of gazelles, Davis examined only the radii, metapodia, femora, tibiae and calcanea (whether he looked at proximal or distal ends, or both, is not specified). Since, according to Davis, these epiphyses all fuse at between 10 and 15 months of age, the percentage of unfused epiphyses was deemed to represent approximately the percentage of animals that died at less than one year of age. This method effectively uses only one fusion group to obtain age data. Consequently, the potential of differential preservation of each of the fusion groups is not an important consideration. However, if the assemblage has been subjected to taphonomic destruction, it is extremely likely that a preservation bias will still exist between the fused and the unfused material being examined. Any such bias could be minimised by ensuring that the elements under analysis are those that display as little difference in bone density between their unfused and fused states as possible (eg distal metapodia, distal radius or proximal femur). The extent of this bias is, as yet, unknown, but could conceivably result in the misinterpretation of the data.

Age information can be extracted from the archaeological record by examining either several or a single fusion group. In either case, the variation in bone density between either fused and unfused bones or between fusion groups means that preservation bias might exist.

9.2.5: The relative densities of the fusion groups

A feature of figure 9.10 is that the Group 2 elements (both fused and unfused) tend to be denser than the Group 4 elements. This is a fact that was first demonstrated by Brain (1976 p111). However, it is now possible to augment Brain's observations by noting that, in the case of Group 2 elements, even the unfused examples are denser than the fused examples of Group 4 specimens. Consequently, if equal numbers of each bone type were deposited and exposed to taphonomic destruction, more unfused pelves would be expected to survive than fused distal femora. To this extent, the assumption that *all* fused material is generally denser than *all* unfused material, implicit in many archaeological interpretations, is incorrect.

9.2.6: The possible relationship between density difference and age difference between two individuals

A further point raised by figure 9.7 and discussed in section 9.2.1.2 concerns the magnitude of the difference between the densities of unfused and fused material. The evidence presented so far suggests that, overall, the density of an animal's skeleton gradually increases throughout its life. The difference in bone density between an unfused and a fused element is therefore partly a function of the ages of the two animals from which they came. If a fused specimen was from a very old individual, this difference might be expected to be relatively large. However, if this specimen had only just fused (ie the animal was much younger), then the difference in density between the two bones would be smaller. Thus, the extent to which unfused material is absent from the archaeological record will vary according to the age at which the majority of the animals died. Unfortunately, the data produced by this project are unsuitable to test this hypothesis. It has already been noted that the older individuals from the experimental material tended to be female, while the younger individuals tended to be males or castrates. This confounding of the data means that the results of any test of this hypothesis will potentially be the product of the animals' sex as well as age.

9.2.7: Bone density at the time of fusion

Although, as stated above, the general trend is for bone density to increase gradually throughout life, there are some exceptions. For example (as mentioned in section 8.2.3) the sudden drop and recovery of density in newborn animals does not conform to this pattern. Equally there is the possibility that female animals might lose bone density in old age with the onset of osteoporosis (see section 8.9.3). Another exception to the general trend of increasing bone density has not been discussed yet and relates to the density of elements as they undergo fusion.

Figure 9.11 is a line graph showing the bone density of most of the scan-sites examined in this project that undergo fusion. The scapula and proximal femur have been omitted from this graph because the scan-sites are not positioned exactly on the fusion plane. The densities of each scan-site immediately before, during, immediately after and one year after fusion are shown. The values used are the averages of all of the individuals with appropriate fusion status and age.

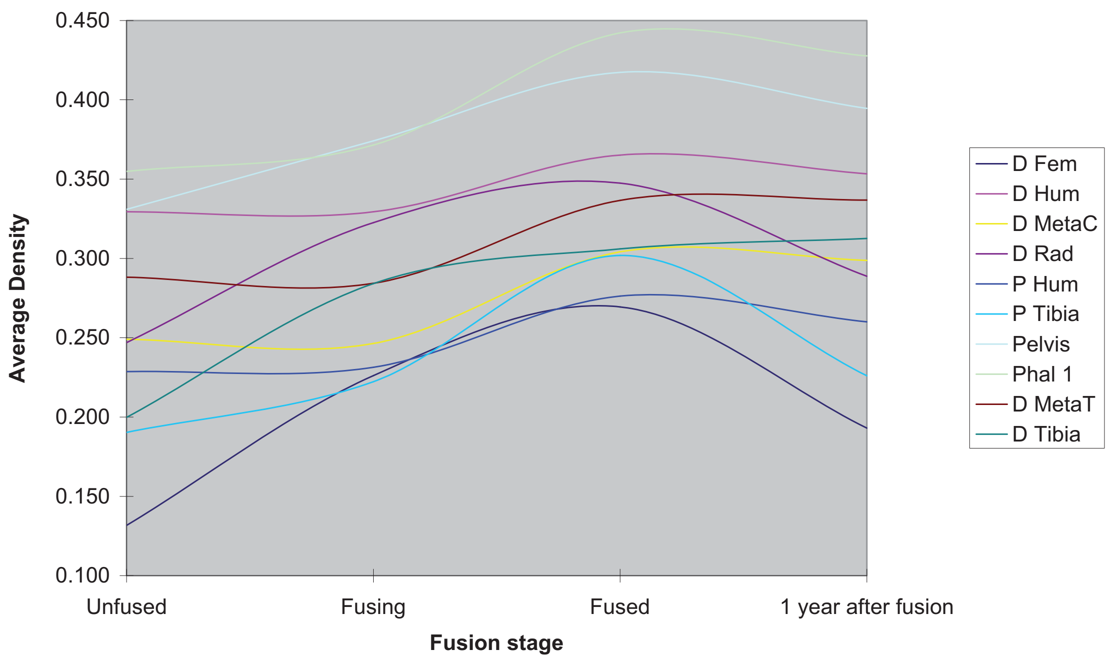

Figure 9.11: Showing the bone densities of the fusion planes before, during and after fusion. The general trend is one of a peak in bone density around the time of fusion.

This figure shows that, for the majority of the scan-sites, there is an increase in density towards the moment of fusion, followed by a decrease in density in the year following fusion.

That a pattern such as this exists can be explained with reference to the work of Lewall and Cowan (1963 p632). These authors noted that, as an element undergoes fusion, the surfaces of its epiphysis and diaphysis unite to form a layer of bone throughout the thickness of the fusion plane. This bone layer will appear on a radiograph as a pale (radiodense) line and explains why fusing or recently fused bones appear to be relatively dense according to the methods used in this project. Following fusion, this radiodense bone layer is removed and the scan-site reverts to a slightly lower density. The implications of this phenomenon for differential destruction of bone at various developmental stages are unknown.

9.2.8: Summary and some implications for the analysis of age profiles from archaeological sites

The results produced by the experimental part of this project have contributed significantly to the previous understanding of bone density and how it can influence archaeologically derived age profiles. This contribution can be summarised as follows.

- Unfused bones are generally less dense than their fused counterparts.
- The scan-sites on early fusing bones are generally more dense than those on late fusing bones.
- The scan-sites on unfused early fusing bones are generally more dense even than those on fused late fusing bones.
- The magnitude of the difference in density between a fused and unfused scan-site is to a greater extent a function of the difference in age between the two.
- Neonatal bones experience a dramatic loss of density shortly after birth, followed by a rapid recovery and then a gradual density increase throughout life. This is punctuated only by slight and brief increases in the density of each scan-site as it fuses. It is possible that in some individuals (females) bone density will decrease in later life, with the onset of osteoporosis.

The findings that are summarised above have significant implications as to the way in which archaeological interpretation is carried out. Below are a number of recommendations as to how these findings might be incorporated into archaeological analyses, so that the biasing effects of taphonomic destruction are minimised. Naturally, not all of these recommendations will always be appropriate (depending on the specific research questions or the nature of the archaeological material concerned). Also, until the precise relationship between bone density and bone destruction has been determined, many of the points that follow can only be expressed in general terms. This is because it is not yet possible to translate the density of a bone into the actual number of specimens that will survive a predefined destructive process.

- An age profile of an assemblage that has experienced some degree of taphonomic destruction will have depleted numbers of unfused Group 2 and 4 elements. Until the precise nature of the relationship between bone density and bone survival can be established, the extent of this depletion cannot be predicted. However, the potential for this bias to exist must be considered when interpreting age profiles derived from fusion data.
- Where the age structure of an assemblage is being examined with reference to a restricted number of elements (or only one fusion group – Davis 1983 p58) it is advisable to ensure that the elements examined show as little variation as possible between their unfused and fused states (eg distal metapodia).
- The changes in density of neonatal bone and bone that is fusing are somewhat difficult to model. Consequently, it might be advisable to omit this material from analyses where density mediated destruction is likely to influence any interpretation.
- Dental data may provide an indication of the age range of the animals from an assemblage. Where this spread is great (the assemblage contains both very young and very old animals), the difference in density between unfused and fused elements will be comparably great. Consequently, the potential for age related bias is relatively great. If the age spread is small (most of the animals died at about the same time), then the difference in density between unfused and fused bones will be similarly small. This means that the potential for age related bias is small. No such methodology has been devised by this project, but it forms an ideal avenue for further work.

The remainder of this chapter will use the faunal assemblage from the Neolithic site of Çatalhöyük, in Turkey, to demonstrate how the findings of this project can be applied to aid archaeological interpretation. The analysis of the site will follow some of the methods that are most commonly used in archaeological analysis. However, wherever possible, the methods and interpretative models will be adjusted in order to take account of the findings of this chapter so far.

9.3: An Introduction to the Neolithic Site of Çatalhöyük, Turkey

This section will present the Neolithic site of Çatalhöyük, Turkey, as a case study to which the findings of this project can be applied. First, the site will be described and the reasons why it is suitable for this type of analysis will be presented. Next, an archaeological model will be proposed, enabling two contrasting faunal assemblages to be defined and compared. The impact of destructive taphonomic processes on each assemblage will be assessed and the processes that lead to the observed differences will be discussed. Finally, the impact of destructive taphonomic processes on the age profiles from each of the two assemblages will be explored and the validity of each age profile will be assessed.

As well as offering an interpretation of the faunal material from Çatalhöyük specifically, the following section aims to demonstrate the ways in which the data produced by this project can be used to improve the interpretative powers of an archaeologist. In order to do so, it will occasionally be necessary to modify some of the methods most often used to interpret archaeological assemblages.

9.3.1: Site Background

Çatalhöyük is a well known site that is situated on the Konya Plain in central Anatolia, Turkey. The site occupies two mounds. The lower (western) mound covers 8.5 ha, and contains mainly Chalcolithic layers, with some much later occupation. The main (eastern) mound covers 13.5 ha and has a maximum height of approximately 20 m. It is largely Neolithic in date, again with some later levels. It is the Neolithic layers, dated as being from the late ninth to the eighth millennia bp (uncalibrated radiocarbon date), of the east mound for which Çatalhöyük is best known. These are the strata that will provide the archaeological data for this project.

Figures 9.12: Showing the location of the site of Çatalhöyük in Turkey.

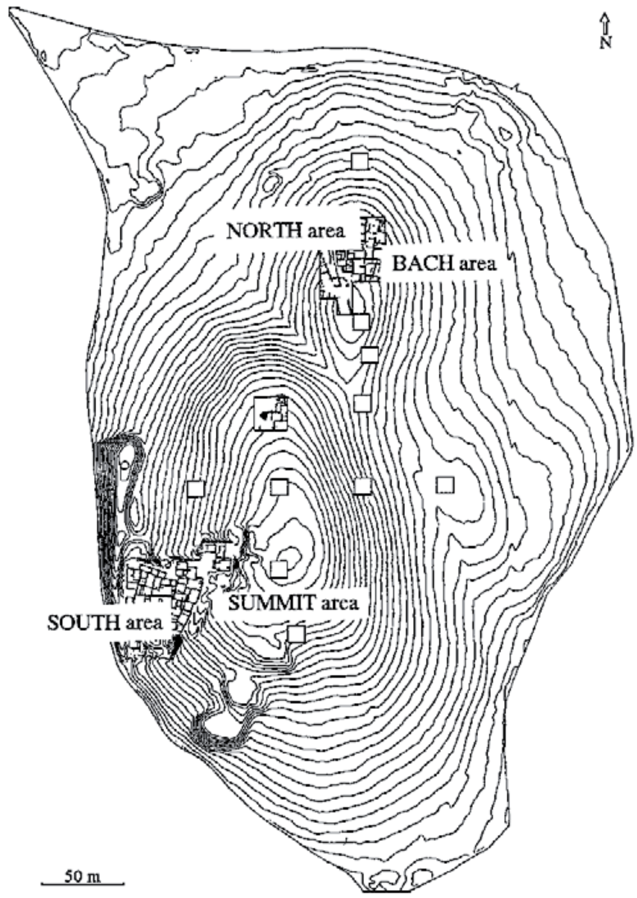

Figure 9.13: Contour map of the eastern mound only, and indicates the positions of the trenches currently being excavated. The material examined in this part of this project was all recovered from these trenches.

The site was discovered and first excavated by James Mellaart in the 1960s. These early excavations revealed a complex of mud brick buildings, the external walls of which were frequently shared. This rendered external doors and windows an impossibility, and access to many of the buildings was almost certainly through the roof. Some interior walls of the buildings were painted or decorated with plaster reliefs depicting zoomorphic or abstract images (Mellaart 1967 pp77 - 177). The abundance of plastered animal skulls and horns (especially bucrania) contributed to Mellaart's conclusion that the ancient inhabitants of Çatalhöyük were followers of an animal (and probably a cattle) cult (Mellaart 1998 p35).

Analysis of the faunal material from Mellaart's early excavations was carried out by Perkins (1969) and Ducos (1988). The rather sparse report published by Perkins concluded that approximately 70% of the animal bones were from cattle (Perkins 1969 p178). This figure has since been challenged (Russell and Martin 2000 p166), and is now believed to have been inflated by the practise of hand-picking the material from the archaeological deposits, resulting in a bias toward the collection of larger bone fragments. The analysis by Ducos of faunal material from the site has suggested that although cattle were morphologically wild, both the sheep and the cattle were subjected to a rudimentary breeding regime (Ducos 1988 pp96 - 98).

In the 1990s, excavations at Çatalhöyük were renewed under the directorship of Professor Ian Hodder. These recent excavations returned to Mellaart's original 1960s trenches as well as excavating a number of additional areas elsewhere on the mound. These excavations are ongoing and the findings of these recent excavations are summarised by Hodder (1998). At least 40 litres of sediment from each context (or 100%, for the very small contexts) is collected for flotation and all archaeological material is removed from both the light and the heavy fractions produced (using a 0.3mm mesh). The remainder of each context is screened through a 4 mm mesh from which artefacts are picked by hand. This strategy means that the artefact recovery from the site is excellent.

Currently, all analysis of faunal material itself is carried out on the site during the excavation season. The vast quantities of animal material being recovered combined with pressures of time mean that analysis is focussed on 355 "priority units". These are the contexts that are deemed by the excavators and finds specialists, at the time of excavation, to be of particular interest or significance. Animal bones from the priority units are subjected to a very detailed analysis, and the data produced are recorded on a specially designed computerised database. The result is that a large and high quality data set relating to the faunal material from the site is available. The nature of the faunal database has been summarised in table 9.4.

	Total Fragments	**Total Fragments Identified to Species**	**Total Fragments from "Sheep Sized" Animals**	**Number of Diagnostic Zones from "Sheep Sized" Animals**
All Contexts	397879	26955	15766	2083
Priority Contexts only	298037	15462	9473	1037

Table 9.4: Showing the number of bone fragments identified to various levels for both the whole site and the priority contexts only. Out of a total of nearly 400000 fragments (from the entire site), only about 1000 (from the priority contexts) were from sheep and included diagnostic zones. This table relates to all skeletal elements. The number of diagnostic zones from elements examined by this project is lower (see table 9.5.)

The faunal analysis of the site so far has demonstrated that sheep, rather than cattle, are the most commonly represented species from the site and account for as much as 80% of the bone material recovered so far (Russell and Martin 2000 p167). In addition to questions of subsistence and economy, current research is focussed on clarifying the broad range of past human-animal relationships at Çatalhöyük, including the role of domesticates in the society. The possible ritual nature of this relationship is also being addressed. At this stage it is clear that animals played an important role in life at Çatalhöyük in the past, although the nature of this role requires further exploration (see Martin 2001). To enable this, some understanding of the taphonomic processes acting on the assemblage is vital, so that the extent to which the bone frequencies represent human decision making rather than natural attrition can be assessed.

The need for the taphonomic processes acting at Çatalhöyük to be understood (and the potentially high quality of the data available from the site) means that Çatalhöyük is an ideal choice of site for this study.

9.3.2: The archaeological faunal material

There is, available to the zooarchaeologist, a wide range of methods of quantifying faunal material. These include the number of identifiable specimens (NISP), minimum number of individuals (MNI), minimum number of animal units (MAU) and diagnostic zones (DZs). Each method contains a number of inherent advantages or disadvantages (Lyman 1994 pp97 - 113). The use of DZs for this analysis has already been justified (see section 7.1.3). This justification is centred around the fact that the recording system at Çatalhöyük records specifically the number of DZs on each recovered bone. By ensuring that the scan-sites coincide with the DZs, it has been possible to ensure that the density data produced relate to exactly the same portion of the bone that is being counted. In addition, the shaft scan-sites are also positioned on portions of the bones that are explicitly recorded as being present or absent.

As well as enabling the scan-sites to be reliably identified in the assemblage, the use of DZs as the primary quantitative unit in this analysis has the undesirable effect of significantly reducing the number of specimens available for analysis. Of a total of 397879 bone fragments so far analysed at Çatalhöyük (all species) only 1108 have been identified as being from sheep. Of these, only 174 are sheep DZs from the elements under analysis here that had been recovered from a priority unit. In order to increase this small sample, it will be necessary to examine all animals that have been identified as being either sheep, sheep/goat or sheep/goat/roe deer (animals that have been identified as being either goat or roe deer have been removed from this analysis). A comparison of the number of animals positively identified as being sheep with the number of definite goats and roe deer shows that where a positive identification is not possible, the probability that the individual is in fact a sheep is high (see table 9.5). This course of action is therefore justified.

	Identified as Sheep	Identified as Goat	Identified as Roe Deer	Sheep/Goat/Roe Deer
Number of DZs Recovered	143	14	3	436
% DZs Recovered	89%	9%	2%	

Table 9.5: This table refers only to elements examined by this project. It shows the numbers of positively identified sheep, goat and roe deer DZs recovered from Çatalhöyük. The number of possible sheep/goat/roe deer is also shown. This number exceeds the total of the other three because it includes "possible" identifications. Percentages are of the total, positively identified assemblage.

Table 9.5 shows that of the 436 sheep/goat/roe deer DZs, the vast majority (89%) will be sheep while goat and roe deer will contribute 9% and 2% respectively. The strategy of assuming that most of these animals are sheep has the effect of increasing the number of DZs potentially available for study from 143 to 436.

9.4: The Impact of Taphonomic Processes on the Element Frequencies from Çatalhöyük

By using the density data produced by this project to explore the impact of destructive taphonomic processes at Çatalhöyük, the relevance of the data to archaeological analysis will be demonstrated. To enable an analysis of the taphonomic biases at Çatalhöyük, it is first necessary to create an archaeological model.

9.4.1: Ancient conceptions of "space" and "rubbish"

An understanding of the ways in which the ancient inhabitants of Çatalhöyük viewed and used the spaces around them will contribute to the building of such a model through which the taphonomic history of the site can be explored. A distinction has been made between *internal* and *external* space at the site. Internal space, in this context, refers to the inside of the many buildings that have been uncovered at Çatalhöyük (these buildings have been interpreted, not unreasonably, as being dwellings). External space refers to the areas outside these buildings, such as middens, penning areas, "industrial areas" or the derelict remains of dwellings.

In general, internal areas are characterised as being regularly cleaned, while the external areas are less obviously subject to this type of cleaning and maintenance. Although this generalisation is valid, the true picture is one of considerable complexity. For example, artefactual studies have suggested that the internal areas are divided into specific activity zones and that some internal areas might be considered cleaner than others (Conolly 1994, Conolly 1998, Last 1994, Underbjerg 1998).

Similarly, excavated evidence suggests that the external areas were far from homogenous. Instead, as suggested above, discrete activity areas existed. Dumps of household rubbish coexisted with areas that might have been used for the penning of animals or for the manufacture of lime plaster (Matthews 1999). Derelict buildings were filled with deposits in order to provide a level surface on which further buildings could be constructed. The artefactual evidence from these "building fill" deposits suggests that they had distinct depositional histories from most of the other deposits on the site (Kennedy and Fairbairn 1999 (cited in Matthews 1999), Last 1995). Furthermore, it has been suggested that the external areas attributed to the penning of animals were, in fact, covered (Matthews 1999). In this respect, these areas are not truly external. It seems, therefore, that neither the internal nor the external space at Çatalhöyük was viewed by the ancient inhabitants of the site as being homogenous. Instead, complex subdivisions of space existed (even the dumping of waste within a single midden deposited was apparently patterned – Underbjerg 1998). This subdivision of space would, to some extent, have been governed by cultural rules and practices, the nature of which can only be guessed at.

This complexity is mirrored by the treatment of "rubbish" at Çatalhöyük. It has been tentatively suggested that most of the food preparation and cooking activities at Çatalhöyük took place within the dwellings, while the refuse from these activities were regularly removed from the buildings and deposited outside as waste (Martin and Russell 2000). However, this is probably an oversimplification of what is in fact a much more complex set of depositional processes (Martin and Russell 2000). Excavated evidence from the site suggests that different material would be disposed of in different ways (Kennedy and Fairbairn 1999 (cited in Matthews 1999)). For example, two contexts (numbers 1315 and 1347) from outside building 1 in the North area (see figure

9.13) are composed of what appears to be burnt "building rubble" that may represent clearance from building 1, following the fire that is known to have partially destroyed it. These contexts contain a high density of animal bone. However, the presence of numerous "special" items (eg a cache of various unworked stone, broken figurines and the skull of a dog) suggests that they do not conform to the general food refuse model proposed for the external areas of the site. Similarly, the deposits that represent the infilling of disused buildings do not necessarily conform to the model being proposed here. These are relatively sterile and are quite unlike the "middens" of discarded household refuse identified elsewhere on the site.

The picture that emerges is one of a complex system of deposition and redeposition of material. As suggested above, the different treatment of different "types" of material was probably based on currently unknown cultural systems and practices.

9.4.2: Building an archaeological model

Modelling such complex and poorly understood systems as those described above is impracticable and unlikely to yield many valid results. Instead a simpler view of the depositional processes active at Çatalhöyük must be sought.

Even against the background of complexity described above, it is valid to return to the broad distinctions between internal and external space that have already been alluded to. That the internal areas were rigorously cleaned, while the external areas were the sites of "dirty" activities (waste disposal, animal penning etc.) is generally accepted (Last 1995, Martin 1995, Martin and Russell 2000). At the very least, it is possible to assume that the ancient inhabitants of the site had different perceptions of these two types of space. This observation alone provides a basis for a simplified model of the taphonomy of Çatalhöyük. Indeed, Matthews (1993) has suggested that "clean sequences of floors must be studied in light of the large quantities of refuse dumped outside them".

It is possible to hypothesise that since internal and external areas can be viewed as being distinct, the taphonomic histories of the material recovered from them is similarly distinct. It is further possible to suggest that the internal areas were sheltered, and regularly cleaned, while the external areas were subjected to higher levels of weathering (associated with exposure and movement of material), gnawing and other destructive taphonomic processes. These external areas are likely also to have been where waste from food preparation and consumption would have been eventually deposited. Consequently, the external areas will be characterised by containing large quantities of burned and butchered material. Given the quantities of food debris littering these areas, a high incidence of bone that has been gnawed and digested (probably by dogs) would also be expected.

It is suggested that this contrast between these two types of space might be expected to be reflected in the bone assemblages themselves. The areas outside the dwellings might have been subjected to more extensive taphonomic destruction. A hallmark of such assemblages is that the most frequently occurring bones (or bone parts) are the densest, with the least dense elements being scarcer. The assemblages from within the dwellings might be expected to be mediated by some other factor, or factors.

The model can be summarised by means of table 9.6.

	Factor responsible for element frequencies	**Evidence, in element frequencies**	**Evidence, in taphonomic signatures**
External Areas	Mediated largely by density	Most abundant DZs are the densest	Shows **high** incidence of taphonomic signatures
Internal Areas	Mediated largely by some other factor	Most abundant DZs show some other feature	Shows **low** incidence of taphonomic signatures

Table 9.6: Summarising the archaeological model proposed above. The bone assemblages are formed largely as a result of different processes and this difference is reflected in the element frequencies and the taphonomic signatures of the material.

This model is clearly based only on the final depositional location of the archaeological material (ie the context from which it was archaeologically excavated). It is unable to account for any movement or alteration of material prior to its final deposition. However, it is assumed that the final depositional location of material somehow relates to the taphonomic history of the material. One of the aims of the following analysis is to test this assumption.

It must be stressed that the model proposed above is based on a highly simplified version of a complex (and poorly understood) set of systems and practices that seem to have existed at Çatalhöyük. The following analysis will test this simplified model, and will attempt, where possible, to highlight the actual processes that are responsible for the formation of each assemblage.

9.4.3: Defining the contexts used in the model

The model described above necessitates the amalgamation of all of the excavated contexts into either "internal" or "external" categories. This will both enable the model to be tested and will also greatly increase the number of DZs available for study in each context category.

Each excavated "priority" context from Çatalhöyük has been assigned to a "group for analysis" by the excavators in order to facilitate post-excavation analysis. It is possible to define each of these 14 categories as being either internal or external in nature. Table 9.7 shows how this division was made.

Internal /External	Group for analysis	Example contexts
Internal	Burial fill	All burial fills
	Fill between walls	All fills between walls
	Fill or use of feature	Fills of bins, hearths, ovens
	Internal floors	General internal floors and raised platforms
	Internal occupation debris	All internal occupation debris, from floors
External	External midden	All external middens
	External occupation debris	All external occupation debris, from floors
	Fill in building	All fills in buildings
	Lime burning	All lime burning areas
	Midden in abandoned building	All middens in abandoned buildings
	Penning	All penning areas
	Fire spots	All (non-structured) fire spots
	Fill in other cuts	Fills of postholes, scoops and pits

Table 9.7: Describing internal and external contexts in terms of their grouping for analysis. Examples of contexts for each grouping are also given.

In addition to these contexts, some were not defined as being either internal or external and so will be excluded from this analysis. These were either arbitrarily defined by the excavator or consisted of building materials (such as mortar or bricks) or clusters of artefacts. The majority of the above definitions are self-explanatory. All burial fills, for example, fall into a single grouping for analysis, which can be defined as being internal (since all burials from the site occurred within buildings). The definition of internal floors and occupation debris as being internal is also self-explanatory. However, the definition of "fill between walls" requires clarification. These contexts were strictly speaking external, but were deposited between the walls of buildings in spaces that were inaccessible to humans and animals. It was therefore deemed that such deposits would be protected from additional taphonomic processes. As such their taphonomic signature would be expected to be almost indistinguishable from that of true internal contexts and so their definition as being internal was justified. "Fill in building" also requires explanation. These contexts represented the filling of abandoned buildings with mainly midden material so that a level platform could be created to serve as the footing for a new building. They therefore represent midden or redeposited external material and are not associated with the occupation of a dwelling as the grouping name might suggest.

The examples of the "fills between walls" and the "fills of buildings" shows that the terms "internal" and "external" assemblages are not literally descriptive of the spatial location of the contexts. However, this categorisation is intended to reflect the processes to which a deposit has been subjected rather than any strict spatial division. Thus, the labels remain as useful descriptive terms for these two types of assemblage.

9.4.4: Testing the archaeological model

The above hypothesis can be tested by comparing the density of each scan-site with the representation of that scan-site in the archaeological record. It is expected that in external contexts the most common scan-sites will be those with the highest bone density, while the least common will be the least dense. Conversely, the material from internal contexts may show a similar pattern, although this is expected to be less marked. Any deviation from this pattern can be explained in terms of human decision making or the influence of other factors (eg size) on bone preservation.

This analytical method is very similar to those used by previous researchers (Binford and Bertram 1977 pp127 - 152, Brain 1976 pp112 - 115, Butler and Chatters 1994 pp417 - 420, Elkin 1995 p35, Kreutzer 1992 pp289 - 290, Lyman 1984 pp282 - 296, Willey *et al* 1997 p524). These researchers have variously used regression analysis, Spearman's rank correlation coefficient or graphical methods (where some measure of bone survival is plotted against bone density) to illustrate their results. It has recently been suggested that the statistical methods traditionally relied upon may be an inappropriate method to use in these circumstances (Orton and Rennie Unpublished, Rogers 2000 pp111 - 112). Instead, the graphical method is preferred. This has the not inconsiderable advantage of being able to incorporate the density *ranges* already discussed into the observations. The use of ranges rather than specific density values is intended to provide a better representation of the true (variable) nature of animal bone density. This differs from previous approaches, because by relying on specific density values, these assumed (wrongly) that bone density did not vary between different individuals of the same taxon. For the sake of completeness and compatibility with earlier work, Spearman's rank correlation coefficient will be noted in passing.

Figure 9.14 is a graph that shows how many DZs (as a percentage) were recovered from the internal contexts (*x*-axis) against their density values (*y*-axis). The scan-sites are listed in order of increasing abundance. The densities are represented by vertical lines. These lines relate to the interquartile range for each scan-site referred to on page 9.1. By using these lines in the figure, it is possible to appreciate that the density of a scan-site will probably fall somewhere within a range rather than at a specific point. The points marked midway along each line represent the median density values. If the hypothesis outlined above is correct, then the highest density scan-sites will be the most numerous, while the lower density scan-sites will be comparatively scarce. An examination of figure 9.14 reveals that no such pattern exists.

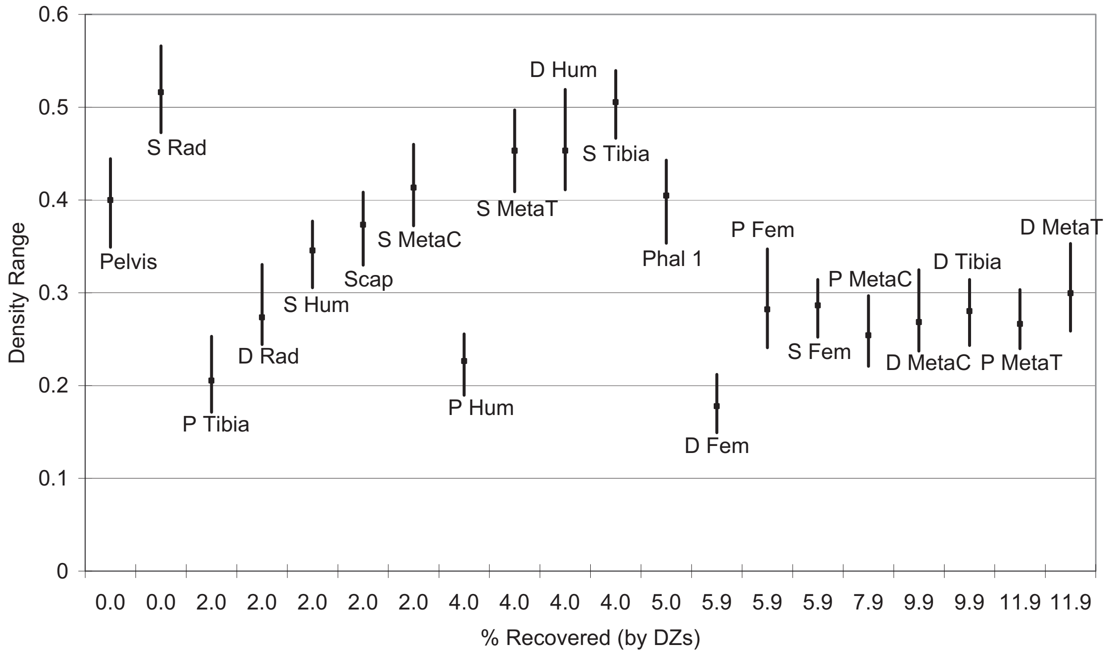

Figure 9.14: Showing the frequency of scan-sites recovered from the internal contexts against their density ranges. The most frequently recovered scan-sites are listed first. The total number of scan-sites recovered from internal contexts was 72. The data refer to fused and unfused bones only.

Figure 9.15 is also a graph that shows the relationship of frequency of DZs recovered and the density of the scan-sites. In this case, the data refer to material recovered from external contexts.

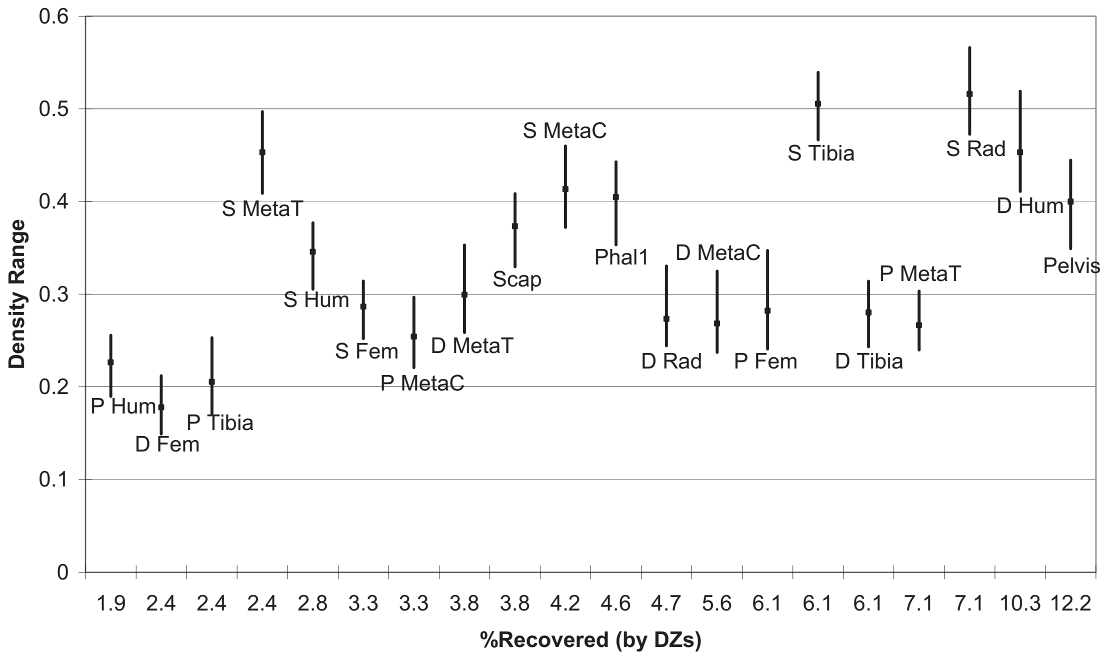

Figure 9.15: Showing the frequency of scan-sites recovered from the external contexts against their density ranges. The most frequently recovered scan-sites are listed first. The total number of scan-sites recovered from external contexts was 334. The data refer to fused and unfused bones only.

In this case, the pattern does fit the predictions of the model. The higher density scan-sites are among the more numerous, whilst the lower density scan-sites are less frequently recovered. This pattern is not pronounced, but can readily be identified.

Neither of the two figures shown above supports the hypothesis fully. It is clear that in both cases additional variables are responsible for the formation of the archaeological record. A fuller interpretation of these figures and a discussion as to what these additional variables might be is presented below.

9.4.5: Discussion of the internal assemblage

As predicted by the model, the material from the internal assemblage does not appear to correlate positively with its density and so cannot be seen to have been significantly affected by destructive taphonomic processes. A calculation of the correlation between the number of each DZ recovered and the median of the density of the scan-sites returns an r value of 0.073 (p= 0.758). There is therefore no correlation at an acceptable level of probability.

It seems, therefore, that factors other than bone density are responsible for the formation of this bone assemblage.

Closer examination of figure 9.14 reveals a number of facts that may contribute to a greater understanding of these data. Firstly, it might be expected that the relatively dense bone shafts would be better represented than the less dense bone ends. They are, however, generally among the least common DZs to have been recovered. This suggests that the absence of the bone shafts is the result of some factor other than their density. They may, for example, have been deliberately broken by humans in order to extract bone marrow. Alternatively, the reason may be more methodological in nature.

The density values produced by this project for both trabecular and cortical bone reflect the amount of bone material that exists per unit volume of bone element. Clearly, trabecular bone and cortical bone differ significantly in their physical structure (eg in terms of shape, collagen content, osteon density etc. See chapter 4). It is quite possible that although a trabecular scan-site might have exactly the same density value as a cortical scan-site, these structural differences mean that each has a different probability of surviving destructive taphonomic processes. It is structural differences such as these that cause cortical bone to be most resilient under bending forces, while trabecular bone is more suited to withstanding impact (Currey 1984 pp101 - 104 and p121). These fundamental differences in the mechanical adaptations of bone mean that it may not be appropriate to examine the relative frequencies of cortical and trabecular bone together.

If cortical and trabecular DZs from internal contexts are examined separately, the correlation between both and bone density changes (for the cortical scan-sites: $r = -0.500$; $p = 0.170$. For the trabecular scan-sites: $r = 0.605$, $p = 0.049$). It therefore appears that in these contexts, trabecular bone frequencies are being controlled to some extent by their density values, while cortical bone frequencies are mediated by some other factor.

It is possible that human decision making is responsible for the fact that bone density does not appear to mediate the frequencies of cortical scan-sites from the internal areas. For example, the pattern being observed here might be produced if, during the course of food preparation, the ancient inhabitants of Çatalhöyük were *not* subjecting cortical parts of the skeleton to as great a degree of mechanical stress as they were trabecular parts. It is difficult to imagine the reasoning behind any decision to process parts of a skeleton differently on the grounds of the structure of its bones alone. It is therefore necessary to conclude that this explanation for the patterns described above is either a poor one, or that it is based on cultural practices that are not yet understood.

An alternative explanation of these patterns is that cortical and trabecular bone reacts differently to mechanical forces (even if these forces are the same across the entire skeleton). It can therefore be argued that even if cultural treatment and taphonomic processes acted on all parts of a skeleton equally, the destruction of cortical bone is controlled less by density than the destruction of trabecular bone. The result would be a pattern of trabecular scan-sites whose frequencies are correlated with their bone densities, while cortical scan-sites show a lesser correlation (a pattern not unlike the one being discussed here).

This section has shown that, although density does not at first appear to have controlled the destruction of bone in the internal assemblage, close examination shown that it may have controlled the destruction of trabecular scan-sites only. This interpretation is based on a small number of elements (a total of 53 DZs were recovered from the internal areas at Çatalhöyük) and so further research based on larger assemblages is needed in order to verify the value of this interpretation.

9.4.6: Discussion of the external assemblage

The bone material recovered from the external contexts shows a greater tendency to agree with the proposed model. The Spearman's rank correlation coefficient for the number of DZs compared to the median density value of the corresponding scan-sites is 0.466 (p= 0.038). The correlation is therefore positive (but slight) and statistically significant at the 0.05 level. This result is comparable to that obtained by Butler and Chatters (1994 pp418 - 419), Ioannidou (2000 p286), Kreutzer (1992 p289) and Lyman (1984 p285). It is also worth noting that, when calculated separately, the correlation coefficients for cortical and trabecular bone are r= 0.209 (p= 0.589) and r= 0.811 (p= 0.002), respectively. This may be used as evidence to support the idea that the mechanical behaviour of cortical and trabecular bone is different, and so they are perhaps more appropriately examined separately. This supports the suggestion that bone density mediates bone destruction in cortical scan-sites to a lesser extent than it does in trabecular scan-sites.

On the whole, the correlation between bone frequency and bone density from the external assemblage is greater than that from the internal assemblage. This is true if the scan-sites are examined together, of if the trabecular and cortical bone is examined separately. This suggests that the external material has been subjected to a higher level of taphonomic destruction than the internal material.

Density is not the sole factor determining the bone frequencies at Çatalhöyük (otherwise the correlation coefficient would be r= 1.0 and figures 9.14 and 9.15 would be perfectly linear). Some of the factors that are known to affect bone destruction are described in chapter 3 and an expansive list is provided by Stallibrass (1990 p160). Without considerable additional research, it is not possible to determine what these additional factors are. Even if such research were possible, it is likely that a complex interaction of numerous factors is responsible for the bone frequencies being observed.

The model proposed at the beginning of this analysis predicted that the external assemblage would show evidence of having been formed as a result of destructive taphonomic processes, while some other factor was responsible for the formation of the internal assemblage.

However, the data have so far suggested that both internal and external areas from Çatalhöyük have been subjected to some degree of taphonomic destruction. Although density mediated taphonomic processes appear to have had some role in the formation of both the internal and external assemblages (especially in the case of the trabecular scan-sites), their impact on the external assemblage seems to have been greater. The actual processes responsible for this difference can be explored by examining the bone fragments themselves.

9.5: Taphonomic Profiles of the Internal and External Areas

This section will attempt to characterise the two assemblages (internal and external) in terms of their taphonomic histories. This can be achieved by drawing on "taphonomic signatures" (described below). By doing so, it may be possible to offer suggestions as to the processes that are responsible for the differences in bone frequencies between the two assemblages that were described above.

9.5.1: "Taphonomic signatures"

Very often, destructive taphonomic processes leave signatures on the bones or bone fragments they have affected. Such signatures include gnaw marks, butchery marks, signs of weathering or discoloration caused by burning. By examining the incidence of these signatures in an assemblage it is possible to create a "taphonomic profile" that offers some indication of the nature and intensity of different destructive processes that have acted on the material. What follows is the creation and discussion of the taphonomic profiles for both the internal and external bone assemblages from Çatalhöyük.

The taphonomic profiles have been derived from all bone fragments (rather than the DZs only) from all sheep-sized species. This material will predominantly consist of sheep or goat, although very occasional fragments from dogs or small pigs may also be included. Larger species were excluded from this analysis, because it is possible that taphonomic processes will differentially affect individuals of significantly different size (as a result of either deliberate human choice or natural processes). It is necessary to examine all fragments from sheep-sized animals at this stage because, by their very nature, taphonomic processes tend to fragment bones. Therefore, smaller fragments will be more likely to display taphonomic signatures than the generally larger DZs.

In order to avoid double counting fragments, those exhibiting modern breaks were also excluded from the analysis. By examining all bone fragments, rather than simply the DZs alone, the taphonomic profile will relate to the assemblages as a whole. This also had the effect of considerably increasing the number of bone fragments from which the profiles were derived.

The taphonomic signatures to be examined are weathering, gnawing, digestion, butchery, burning, fragment length and element completeness.

9.5.2: Weathering

The first taphonomic signature to be addressed is the incidence and degree of weathering of the bone material. Weathering of a bone, as explained in section 3.3.1, is partly related to its exposure to cycles of changes in temperature or moisture (Miller 1975 p217). It is likely, therefore, that bone from environmentally relatively stable internal deposits will be less weathered than the more exposed material from external deposits. Exposure and reburial of bone is likely to disturb the stable environment (in terms of weathering) of buried bone, thus contributing to the weathering process (pers comm Louise Martin). Of course, the duration of exposure will also affect the extent to which bone has been weathered, so if material from external contexts is buried rapidly, while material from inside the buildings remains exposed for a protracted period, the pattern of weathering may be different. Since weathering has the effect of weakening bone, a significant difference in the weathering status of the two assemblages might be translated into different rates of bone destruction within the two assemblages.

The method of assessing weathering that is used at Çatalhöyük is adapted from weathering stages devised and used by Behrensmeyer (1978). At Çatalhöyük, the stages used range between 0 (unweathered) and 6 (very heavily weathered). The scores are essentially subjective, and so some inconsistencies between the various faunal specialists working at the site can be expected. Such inconsistencies never give rise to a disagreement of more than a single weathering stage. Consequently, only relatively large differences in weathering stage (of more than one) can be seen as being important. Smaller differences are potentially the result of recording error.

Figure 9.16 shows the proportion of each assemblage that was assigned each weathering score. The fragment counts have been converted to percentages of each assemblage.

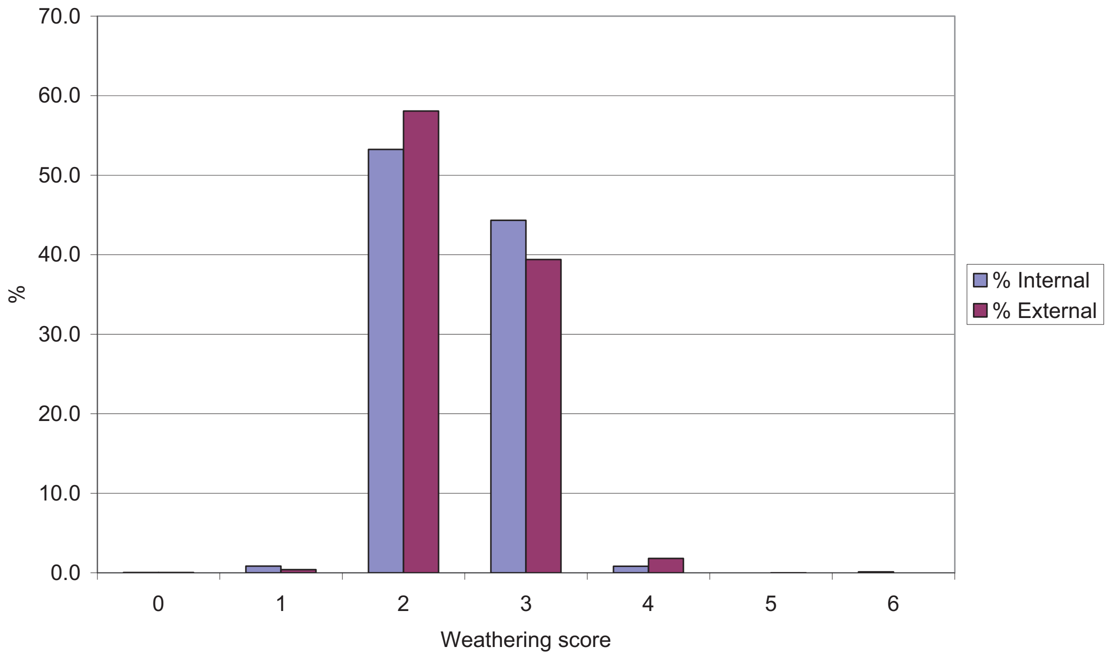

Figure 9.16: Showing the percentage of bone fragments at each weathering stage for both the internal and external assemblages.

Figure 9.16 shows that the weathering stages for the bone material from each assemblage are essentially the same. The majority of both assemblages are at weathering stage 2, closely followed by stage 3. The difference between weathering stage 2 and 3, in terms of bone destruction, is very small. A bone at stage 2 is hardly more or less likely to survive destructive taphonomic processes than the same bone at stage 3. Furthermore, as mentioned above, this difference may be attributable to recording error. The small differences that can be seen on figure 9.16 are therefore unlikely to have any noticeable effects on bone preservation.

A more interesting difference between the two assemblages can be seen at stages 1 and 4. The internal assemblage has slightly more fragments at stage 1, while the external assemblage has slightly more fragments at stage 4. This feature is small, but is most unlikely to be the result of recording error. That the external assemblage has more well weathered material and the internal assemblage has more hardly weathered material fits with the model of weathering proposed above. However, because the differences are very small, they are again unlikely to result in significant differences in bone preservation.

The hypothesis that bone material recovered from internal contexts will be less weathered than that derived from external contexts has been supported. However, the extent of this difference is so small that no significant difference in bone preservation due to weathering can be expected. It seems unlikely, therefore, that the differences in bone frequencies noted in the previous section are the result of weathering.

9.5.3: Gnawing

Some of the material from Çatalhöyük shows evidence of having been gnawed by both carnivores and rodents. Numerous studies have demonstrated that gnawing results in biases in element frequencies – the least dense bones being removed first. The previous section noted that the external areas at Çatalhöyük appear to have been affected by a density mediated destructive process to a greater extent than the internal areas. It is quite possible that gnawing is the agent responsible, since it would be expected to produce an assemblage similar to that observed from the external contexts at the site. If this is the case, then bones exhibiting gnawing marks would be expected to be relatively frequent in the external areas and scarce in the internal assemblage.

Figure 9.17 shows the proportion of each assemblage that exhibited each of a variety of gnawing marks.

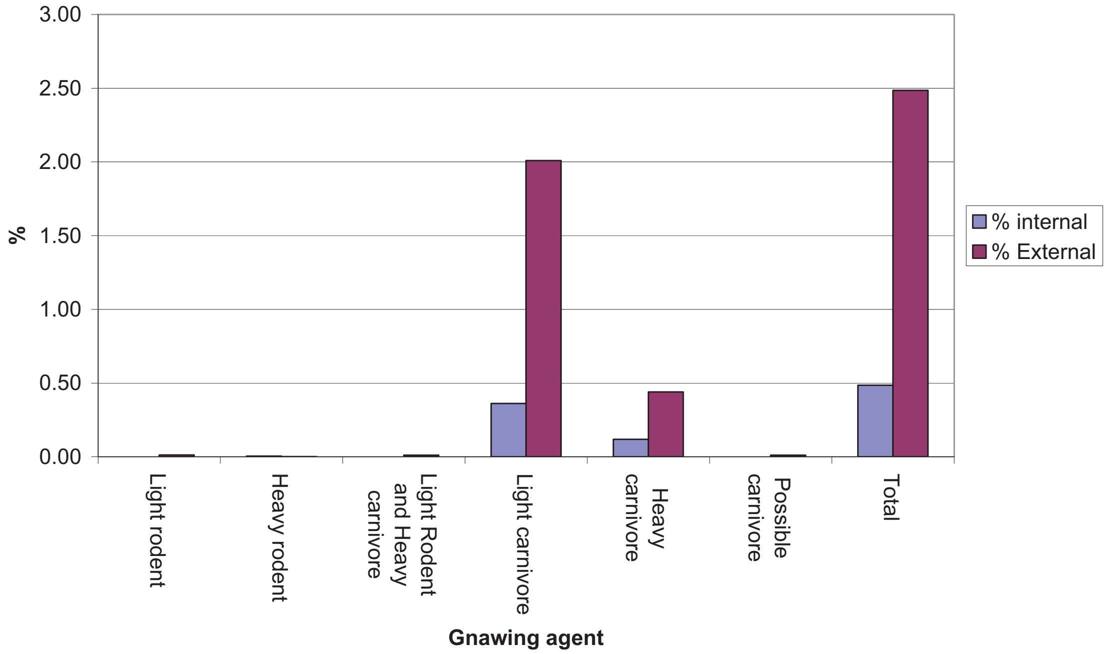

Figure 9.17: Showing the percentage of bone fragments exhibiting different types of gnawing for both the internal and external assemblages.

Figure 9.17 shows that the proportions of gnawed material are low (no more than a total of 2.5%). It also shows that the main gnawing agents at the site were carnivores. Perhaps the most important feature of figure 9.17 is that it clearly shows that bone from external areas was significantly more affected by carnivore gnawing than bone from internal areas. This suggests that carnivores (probably domestic dogs) had considerably more access to the external areas of the site than they did to the interior of the buildings. These dogs would have scavenged and gnawed discarded food waste and other bones. By doing so they would undoubtedly have consumed the diagnostic parts of the bones (the bone ends) and so contributed considerably to the density mediated pattern of element frequencies observed for the external assemblage.

This analysis has provided strong evidence that the differences in element frequencies between the two assemblages are at least partly the result of the gnawing action of carnivores.

9.5.4: Digestion

If the above assertion is true, then one would naturally expect the majority of the digested material to be recovered from the external areas of the site. Digested bone can be recognised by its shiny “acid-etched” appearance. Following gnawing by dogs, some bone fragments are inevitably swallowed and are subjected to the digestive processes of the animal’s stomach. Some of these fragments will not survive the process of digestion. Since the bones that are swallowed will tend to be those that are more prone to mechanical destruction, and those that are destroyed by digestion itself will also be the least dense, this process will clearly contribute to density mediated element frequencies within an assemblage. Moreover, the presence of digested bone implies carnivore action in the vicinity, and so the biases associated with gnawing might also be expected (assuming that the gnawing and defaecation take place in the same area).

Digestion is both a density mediated process itself and can also be (cautiously) taken as secondary evidence that another density mediated process (gnawing) has affected the assemblage. It is therefore possible to hypothesise that the external assemblage will show a higher proportion of digested bones than the internal assemblage.

Table 9.8 shows the proportion of bone fragments from each assemblage that exhibits signs of having been digested.

	% Possibly Digested	% Digested	Total
Internal	0.07	1.02	1.09
External	0.24	6.59	6.83

Table 9.8: Showing the percentage of bone fragments that showed signs of digestion (or possible digestion) for both the internal and external assemblages.

The most notable feature of table 9.8 is that the great majority of the digested bones from the site were recovered from external contexts. Provided that these bones are the result of the action of domestic dogs (and there is no reason to doubt this), these data support the hypothesis that domestic dogs were at least partly responsible for the density mediated pattern of bone frequencies observed for the external assemblage.

9.5.5: Butchery

It was explained in section 3.3.4 that butchery is a taphonomic process that is often less likely to produce density mediated bias in archaeological assemblages. This is because butchery is largely controlled by human decision making and cultural conditioning. However, within these controlling factors, density mediated biasing will occur.

Butchery is apparent in the archaeological record as cut, chop or saw marks on bones. It should be noted, however, that an absence of these features does not necessarily mean that butchery was not taking place. This is because it is quite possible to dismember or otherwise prepare an animal for consumption without leaving these marks on the bones.

If a significant difference in the incidence of butchered bone between the two assemblages can be identified, then this process may be argued to be at least partially responsible for the differences in element frequencies that are being explored. Table 9.9 shows the percentage of fragments from each assemblage that exhibited butchery marks.

	% Butchered
Internal	0.09
External	0.41

Table 9.9: Showing the percentage of bone fragments that showed signs of butchery for both the internal and external assemblages.

Table 9.9 shows that only a small percentage of the two assemblages showed signs of having been butchered. However, the external assemblage shows a relatively higher proportion of butchered bone fragments. This may indicate that butchery at Çatalhöyük generally took place in external areas. Alternatively, butchery may have been an internal activity and the waste may then have been removed to external areas. It is impossible to state with certainty where this material originated, but it is certain that the majority of it was eventually deposited in external areas on the site. If butchery can be assumed to produce a (partially, at least) density mediated bone assemblage, then this process may have contributed to the differences in bone frequencies between the two assemblages that are being investigated.

Such small numbers of butchered bone fragments have been recovered from the site that it is unlikely that butchery constituted a significant taphonomic process. Furthermore, human decision making and preference are bound to have a significant bearing on the effect of butchery on the nature of an assemblage and so the ability for butchery to generate a density mediated assemblage is in some doubt. It is for these reasons that, although the external assemblage displays a higher incidence of butchered bone, this process is unlikely to have contributed significantly to the density mediated appearance of the external assemblage. Indeed, butchery may have had the effect of partially masking the pattern.

9.5.6: Burning

Like butchery, burning is a taphonomic process that leads to the destruction of bone and is usually mediated in part by density and also by human decision making. It is a human decision that determines which bones are burned, for how long and at what temperature. It is largely density that determines which of these bones survive the process.

A note was made of all of the faunal material excavated from Çatalhöyük if it displayed discoloration associated with burning. The colour of the incinerated material was used to estimate the burning stage that each fragment had reached. Figure 9.18 shows the relative frequencies of bone fragments from each of the two assemblages that had reached a variety of burning stages.

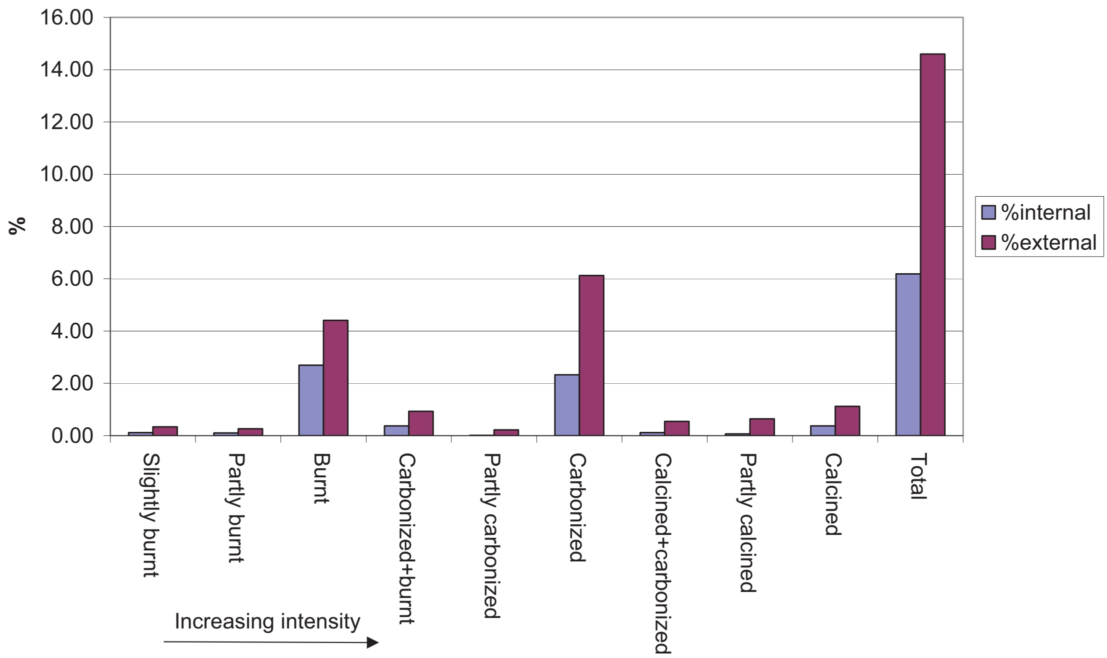

Figure 9.18: Showing the percentage of bone fragments exhibiting different types of burning for both the internal and external assemblages. The categories of burning type are listed in order of increasing burning intensity.

It is clear from figure 9.18 that the external assemblage contains considerably more burned bones than the internal assemblage. This is the case for every category of burning that was used (although “burned” and “carbonised” bone predominates). Again, unless the material is from an *in situ* burning feature such as an oven, it is impossible to be sure where this material originated. It is only possible to conclude that the material from the external assemblage has been subjected to a higher incidence of incineration.

This higher incidence of burning can be used to explain partially the fact that the external assemblage appears to be relatively strongly density mediated, while the material from internal contexts is less so. As was the case for butchery, since the human decision making has a significant effect on determining which bones will be burned, the connection between bone density and survival of incineration is only a secondary one.

9.5.7: Fragment length

So far, this taphonomic description of the two assemblages has focussed on direct evidence of taphonomic processes. This information can be complimented by turning to more general data. By examining the size of the bone fragments in each assemblage it might be possible to gain some indication as to the degree of degradation they have experienced. Highly degraded assemblages would be expected to contain smaller bone fragments than those that have experienced less taphonomic destruction. This information can be gained without necessarily knowing which taphonomic process was actually responsible for the degradation.

The maximum length of each bone fragment excavated from Çatalhöyük was recorded and these data are shown in figure 9.19.

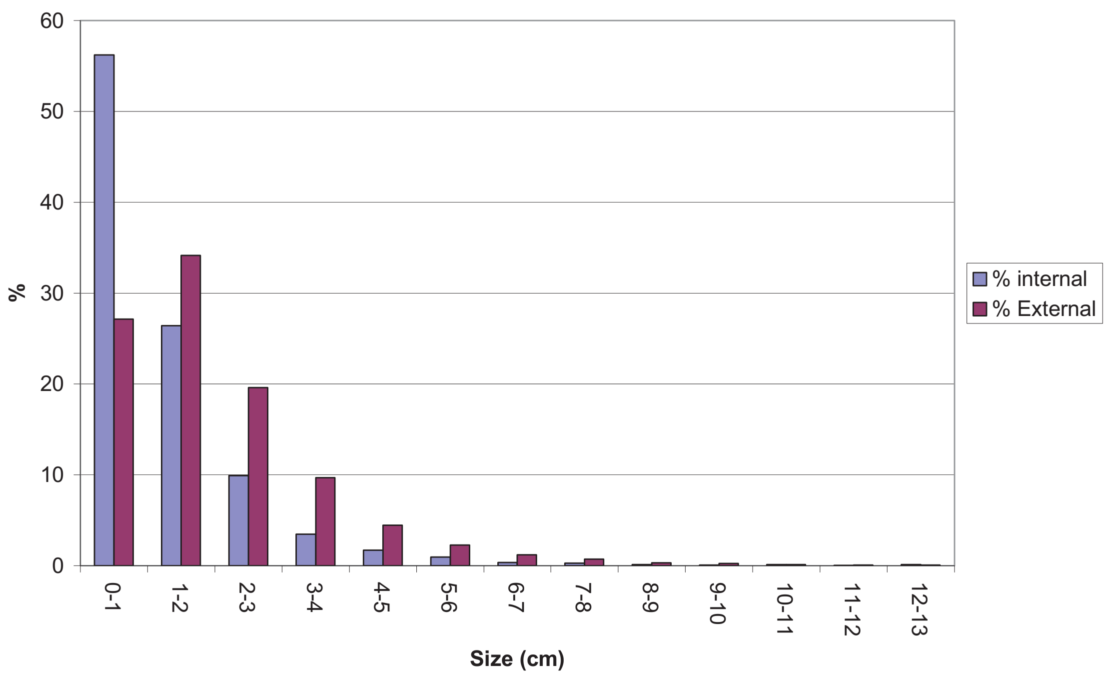

Figure 9.19: Showing the percentage of different lengths of bone fragments for both the internal and external assemblages.