Molluscs in the Levantine Upper Palaeolithic: implications for modern human diets and subsistence behaviour

Bosch, D.M.

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Author: Bosch, D.M.
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Chapter 2 • Ksâr 'Akil: Site background, sampling strategy, taphonomy, and vertebrate fauna

In the following chapter, background on Ksâr 'Akil as well as its surroundings, the history of research, the archaeological materials, and the stratigraphic sequence are provided. Further, the employed sampling strategy and its rationale for both the vertebrate and invertebrate assemblages are discussed. Throughout this thesis, information derived from the vertebrate fauna assemblages has been used to identify taphonomic possesses that affected the archaeological material. In addition, investigations of habitat exploitation patterns and taxonomic evenness of the vertebrate fauna have served to place the molluscan data into a broader context of past hunter-gatherer subsistence behaviour. From subchapter 2.6 onwards, the results of these zooarchaeological investigations are briefly described.

2.1 Ksâr 'Akil and the Antelias Valley

The Ksâr 'Akil rockshelter is situated roughly ten kilometres northeast of Beirut (Lebanon), on the Eastern Mediterranean coast. It is located in the Antelias Valley which terminates in the Bay of St. George (Fig. 2.1). Approximately two kilometres inland from this bay, the valley widens and the rockshelter is roughly one kilometre further inland in the northern slope of the valley (Ewing 1947, 1948, 1949). In prehistoric times, a limestone hill in the middle of the valley caused bifurcation of the Antelias River at the height of the rockshelter at about 80 metres above the current sea level. The name of the site is a contraction of the words *Qasr*, meaning inaccessible or fortified place, and *Aqil*, meaning intelligent or wise. The name probably refers to the Semitic 'high place' that used to be situated on the top of the central limestone hill that has since been quarried away. Although the high place no longer exists, the Ksâr 'Akil rockshelter itself still survives, albeit hardly accessible and filled with rubble from extensive quarrying activities (Bergman et al. 2012).

In the past, the south-facing opening of the rockshelter would have been protected by the hill (now quarried away) in the centre of the valley. Freshwater supply would likely have come from the adjacent Antelias River running down the valley. Furthermore, the Ksâr ‘Akil occupants would have had access to the small coastal plain (sahil), the steep slopes of the Lebanon Mountains, and the open highlands of the Beqaa Valley (Fig. 2.1). That the valley was attractive for prehistoric hunter-gatherers is evident from the rockshelter’s 23-metre stratigraphy containing abundant archaeological material remains and from other archaeological sites known in the vicinity. The faunal assemblages of these other sites are mentioned in Hooijer’s (1961) study of the Ksâr ‘Akil vertebrates. The Mugharet el-Bileni*,* or ‘wet cave’ (also known as Antelias Cave), is situated opposite Ksâr ‘Akil on the valley’s southern slope (Braidwood et al. 1951). Antelias Cave, formed by an underground stream, was excavated by the French geologist/archaeologist Zumoffen at the end of the nineteenth century. It contained late Palaeolithic to Neolithic deposits, spanning the time window of roughly 40–5 kya. Faunal remains include Mesopotamic fallow deer (*Dama mesapotamica*), roe deer (*Capreolus capreolus*), wild goat (*Capra aegagrus*), an indeterminate gazelle (*Gazella* sp.), wild boar (*Sus scrofa*), and the large landsnail *Helix pachya* (Hooijer 1961). Human remains include several long bones, a mandible, and a partial skeleton of an 8-month old foetus that probably originates from the Neolithic layers.

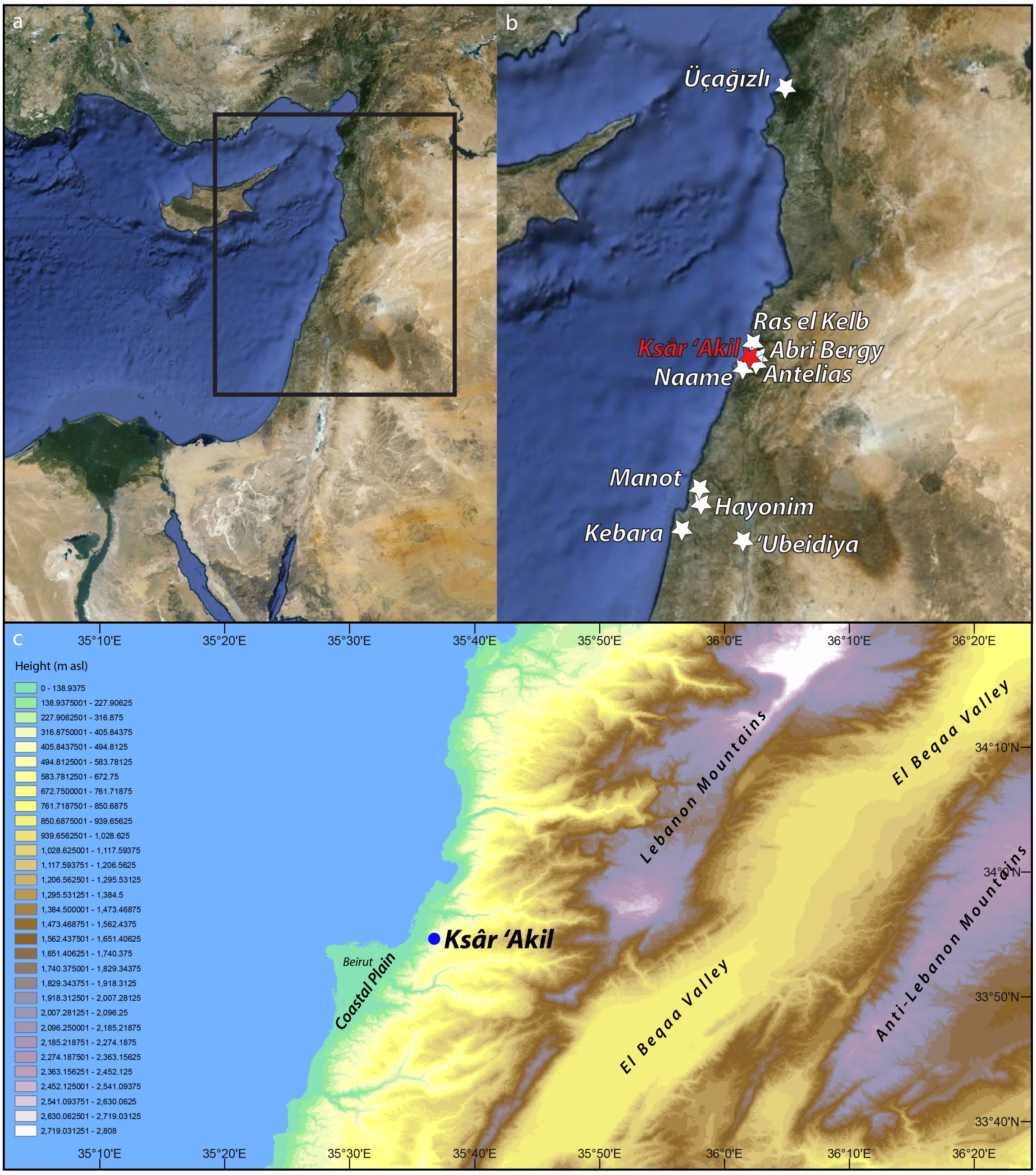

Figure 2.1: Maps showing the geographical location of Ksâr 'Akil and other sites mentioned in the text. (a) and (b): satellite image from http://maps.google.com; (c): Digital elevation data based on NASA's Shuttle Radar Topography Mission (SRTM) (downloaded from: https://lta.cr.usgs.gov/SRTM).

Approximately 400 metre upstream from Antelias Cave, another rockshelter, Abri Bergy, named after the French archaeologist Bergy (1873–1955), can be found. Here, Kebaran artefacts (dating to approximately 20–15 kya) were uncovered. The faunal assemblage comprises *Dama mesapotamica, Capreolus capreolus, Capra aegagrus, Sus scrofa, Ursus* sp., the terrestrial molluscs *Pomatias olivieri* (n = 2) and *Sphincterochila cariosa* (n = 1; although the latter was absent from the collection during this study). Several human remains were uncovered, among which a skull, mandible, and four cervical vertebrae of an adult male were noted (Hooijer 1961; van Regteren Altena 1962). Of these sites, however, the Ksâr 'Akil sequence is extremely rich in archaeological remains and shows by far the longest series of occupations spanning the Middle Palaeolithic to the Epipalaeolithic.

2.2 History of research

Ksâr 'Akil was discovered in 1922 by looters who bought the site and, in their search for gold, dug a 15-metre deep pit at the back of the cave (approximately squares D&E3–4 in the later excavation grid used by Doherty and colleagues). Professor Day, a geologist at the University of Beirut, was able to acquire some of the uncovered lithics and faunal remains and send them on to Paris and London (Ewing 1947). Abbé Breuil saw the material and recommended the site to one of his students, Rev. Doherty. Subsequently, a team from Boston College under the direction of Doherty conducted two field campaigns in 1937 and 1938. The site was larger and richer in archaeological deposits than anticipated, and although during the two extended field seasons excavations had reached a depth of 19 metres, there was still no bedrock in sight. After a break forced by World War II, the team finally reached bedrock at a depth of 23 metres in a final excavation season in 1947–1948 (Ewing 1947, 1948, 1949, 1960). In 1969, Tixier reopened the site and continued excavations until 1975. His team excavated down to a depth of nine metres, when they were forced to leave Lebanon due the outbreak of civil war (Tixier and Inizan 1981; Mellars and Tixier 1989).

2.3 The sequence of Ksâr 'Akil

The 23-metre sequence of Ksâr 'Akil contains deeply stratified deposits from the Middle Palaeolithic to the Epipalaeolithic (Fig. 2.2). The lowermost seven metres (16–23 metres below datum) mostly consist of reddish alluvial deposits that were formed by occasional flooding events of the nearby stream. Within these deposits, several Middle Palaeolithic layers (Layers XXXVII–XXVI) were uncovered (Ewing 1949; Wright 1962).

Above 16 metre, the sediments containing Upper Palaeolithic artefacts are generally brown-greyish in colour and intersected by complexes (e.g., at 16–17 metre and 10–11 metre) of red clay bands underlying a deposit of angular limestone blocks. Both Wright (1962;

Braidwood et al. 1951) and Ewing (1960) hypothesized that these periods of clay formation coincided with humid climatic conditions, potentially representing wetter phases of the last glaciation, but at present this cannot be verified. In the lowest complex, comprising archaeological Layers XXV–XXIV, a *Homo sapiens* maxilla fragment, named, was found accompanied by IUP artefacts. In addition, several faunal taxa including a large gazelle (*Gazella* cf. *gazella*), ibex (*Capra ibex*), hare (*Lepus* sp.), fox (*Vulpes vulpes*), and wild cat (*Felis silvestris*), appear at the start of the Upper Palaeolithic (Fig. 2.2; Table 2.4). In general, the IUP lithic artefacts (Layers XXV–XXI) are characterised by blade cores with opposed platforms and blanks with facetted platforms. Retouched tool types include the *chanfreins* (chamfered pieces)—typical for the Levantine IUP—which are retouched distally by an oblique or *tranchet* flake removal, endscrapers, and burins (Azoury 1986; Bergman 1988).

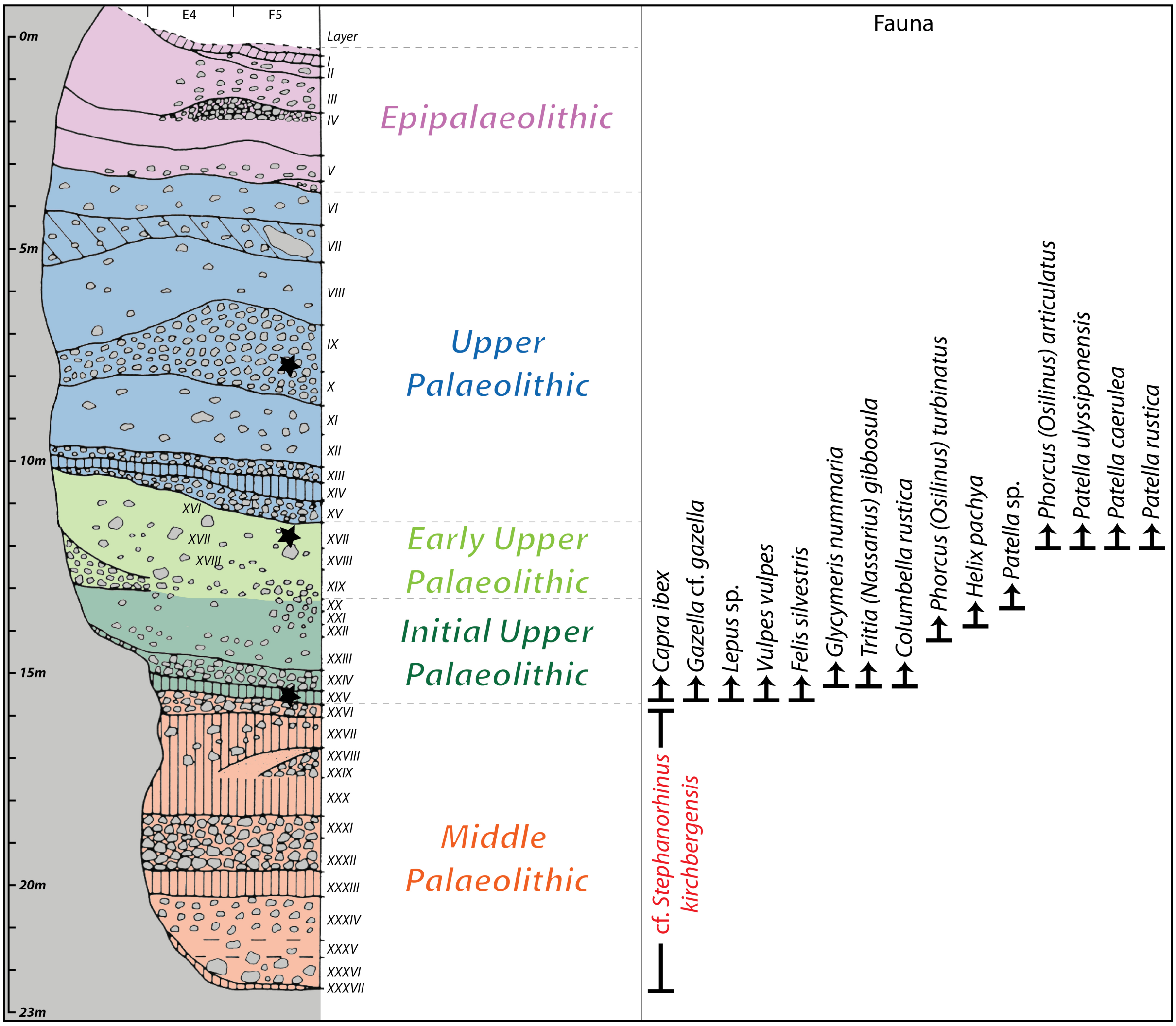

Figure 2.2: Ksâr ʻAkil stratigraphic sequence (redrawn after Mellars and Tixier 1989) with reference to the major archaeological divisions, stratigraphic position of the human remains (stars), and last (red) and first (black) appearance of several faunal taxa.

Subsequent archaeological layers (i.e., Layers XX–XIV) contain Early Ahmarian or Early Upper Palaeolithic lithic artefact assemblages. These assemblages are characterized by opposed platform cores and blanks with plain platforms. Retouched tool types mainly consist of endscrapers, retouched blades and bladelets, including so-called el-Wad points, which have fine and/or steep, usually dorsally retouched tips (Azoury 1986; Bergman 1988). A partial skeleton of an eight-year-old boy named Egbert and some remains of a second individual were found at the back of the cave, in square F3, in the Early Ahmarian Layer XVII (Ewing 1960; Bergman and Stinger 1989).

Above the 'classic Early Ahmarian', Layers XVIII–XVI, the attribution of Upper Palaeolithic archaeological layers to defined technocomplexes becomes somewhat complicated, and several interpretive frameworks have been put forward (Table 2.1; see also Tixier and Inizan 1981; Azoury 1986; Marks and Volkman 1986; Bergman and Goring-Morris 1987; Kersten 1987; Bergman 1988; Bergman and Stinger 1989; Mellars and Tixier 1989; Ohnuma and Bergman 1990; Kuhn et al. 2001; Williams and Bergman 2010; Douka et al. 2013; Leder 2014; Bosch et al. 2015a). For example, Bergman (1988; Williams and Bergman 2010) does not include Layers XV and XIV in his framework, as he claims those layers are sterile. However, a modest number of faunal remains including vertebrates and a few molluscs have been recovered (n = 344 and n = 3, respectively, for square F4). Most scholars agree that Layers VIII–VII can be assigned to the so-called Levantine Aurignacian (Bergman and Goring-Morris 1987), although some have questioned this name because radiometric data suggest that the Aurignacian first appears in Europe and later spread to the Levant by movement of European Aurignacian groups (e.g., Goring-Morris and Belfer-Cohen 2006). They argue, therefore, that the Levantine Aurignacian as a novel technocomplex does not exist and that it should be named simply Aurignacian.

Layer VI is variably placed in the final Upper Palaeolithic (Bergman 1988), the Epipalaeolithic (Mellars and Tixier 1989), the early or Proto-Kebaran (Kuhn et al. 2001), and the Atlitian (Williams and Bergman 2010). A new radiocarbon date on shell (see Chapter 3) of 32.7–31.9 ka cal BP suggests that this layer was formed prior to the last stages of the Upper Palaeolithic. This issue cannot be resolved without reinvestigation of the archaeological remains as well as a more detailed dating programme of this layer. Layers V–I are rather ephemeral and generally attributed to the Epipalaeolithic. Our new radiometric date for Layer V, i.e., 30.2–29.7 ka cal BP, same as for Layer VI, suggests that this layer is older than previously thought. The abovementioned interpretive schemes are largely based on lithic tool types and/or technology. Hooijer (1961), who studied the 1930s and 1940s vertebrate collections, divided the layers on the basis of changes in faunal composition in Phases 1 to 6, of which 3–6 are Upper Palaeolithic (see Table 2.1). These changes in species availability coincide with some, but not all, changes in lithic technology. Here, we generally follow the most recent division by Williams and Bergman (2010), apart from grouping all named and unnamed Upper Palaeolithic assemblages (Layers XV–VI) into one Upper Palaeolithic (see Bosch et al. 2015a), although in a subsequent paper we have chosen to treat Layer VI as a separate entity due to the substantial uncertainty in technological attribution of this layer (Bosch et al. 2015b). Overall, we have also sought to refer to individual layers so that the conclusions of this thesis may also be used within the frameworks proposed by other scholars.

Table 2.1: Division of the Upper Palaeolithic sequence of Ksâr ʻAkil into phases based on lithic typology (Mellars and Tixier 1989; Kuhn et al. 2001; Williams and Bergman 2010) and changes in faunal composition (Hooijer 1961).

Layer	Mellars & Tixier 1989	Kuhn et al. 2001	Williams & Bergman 2010	Hooijer 1961
I	Epipalaeolithic	early Kebaran	Epipalaeolithic (phase 7)	phase 6
II				
III				
IV				
V				
VI	Upper Palaeolithic		Atlitian (phase 6)	phase 5
VII		late Levantine Aurignacian	Levantine Aurignacian (phase 5)	
VIII				
IX			Unnamed Upper Palaeolithic (phase 4)	
X				phase 4
XI		mid Levantine Aurignacian	Unnamed Upper Palaeolithic (phase 3)	
XII		early Levantine Aurignacian		
XIII				
XIV	Transitional phase B	Upper Palaeolithic phase II B		
XV				
XVI			Ahmarian (phase 2)	
XVII				
XVIII				
XIX		Upper Palaeolithic phase II A		phase 3
XX				
XXI	Transitional phase A	Upper Palaeolithic phase I	Initial Upper Palaeolithic (phase 1)	
XXII				
XXIII				
XXIV				
XXV				

2.4 Material

The material studied here originates from the 1930s and 1940s excavations by Doherty, the only expedition to reach the IUP and EUP layers. Although excavation techniques were not up to present-day standards, all sediments were dry sieved, and special care was taken when excavating animal bones in anatomical association (Murphy 1938). Ewing (1947, 1948, 1949) was responsible for curating the faunal (and human) remains in the field from 1938 onwards and made a preliminary, very detailed, and impressively accurate account of faunal distribution throughout the sequence. Faunal remains were subsequently boxed up and sent to a specialist for a detailed paleontological study. This study was originally delegated to Bate, a specialist of Pleistocene Levantine faunas at the Natural History Museum in London, UK. However, she was not able to complete her study before her death in 1951. Therefore, the Ksâr 'Akil fauna was sent on to Hooijer at the Natural History Museum (known today as the Naturalis Biodiversity Center) in Leiden, the Netherlands, who studied the entire vertebrate material (Hooijer 1961). During his investigations, Hooijer separated vertebrates and invertebrates. The latter were handed over to his colleague van Regteren Altena for analysis (van Regteren Altena 1962). In the late 1980s and early 1990s Kersten conducted several faunal investigations specifically looking at Epipalaeolithic wild goat and Mesopotamic fallow deer (Kersten 1987) and sequence-wide studies of the bird remains (Kersten 1991) and microvertebrates (Kersten 1992). She kindly provided me with lists based on notes from the original excavators that correlate depths per square to the layers assigned by Ewing, thus linking the material from the 1937–1938 and 1947–1948 excavations. Both the vertebrate and invertebrate assemblages from Ksâr 'Akil remain stored in the Naturalis Biodiversity Center in Leiden (the units of fossil vertebrates and fossil mollusca, respectively). After the initial investigation by van Regteren Altena (1962), the invertebrates were studied by, amongst others, Reese, and were published in a comparative study of the Üçağızlı Cave I (Turkey) and Ksâr 'Akil early Upper Palaeolithic ornaments (Kuhn et al. 2001).

2.5 Sampling strategy

A substantial amount of faunal material has been retrieved during the Doherty and Ewing excavations of the 1930s and 1940s. These collections are stored in two full rows in the Naturalis depot (about 200 large depot boxes; see Fig. 2.3). Within these depot boxes, the bones were largely kept in their original small cartons with glued-on excavation labels containing information on provenience including the square, layer, and/or depth below datum. In determining what to study in the time available, several factors were taken into account. The aim was a comparative study of the earliest Upper Palaeolithic faunal assemblages to gain insight into the subsistence strategies used during these occupation phases. From excavation notes, it is clear that different datums, about a metre apart in depth, were used in subsequent field seasons. The excavators were aware of the problem and made lists correlating layers between squares still available today (see Hooijer 1961; Kersten 1991, 1992, 1987; Bosch et al. 2015a, b). Nevertheless, to overcome potential problems with correlating material from different squares and different excavation seasons, and due to the sheer amount of material available, we decided to take a vertebrate sample from a single square. The 1930s and 1940s excavation campaigns used a 2 × 2 metre excavation grid, thus constituting the smallest sampling unit (Fig. 2.4).

Figure 2.3: Naturalis biodiversity Center (Leiden, NL), fossil vertebrate unit, where the Ksâr ‘Akil bones are housed. The left side of the corridor is dedicated to the Ksâr ‘Akil collection.

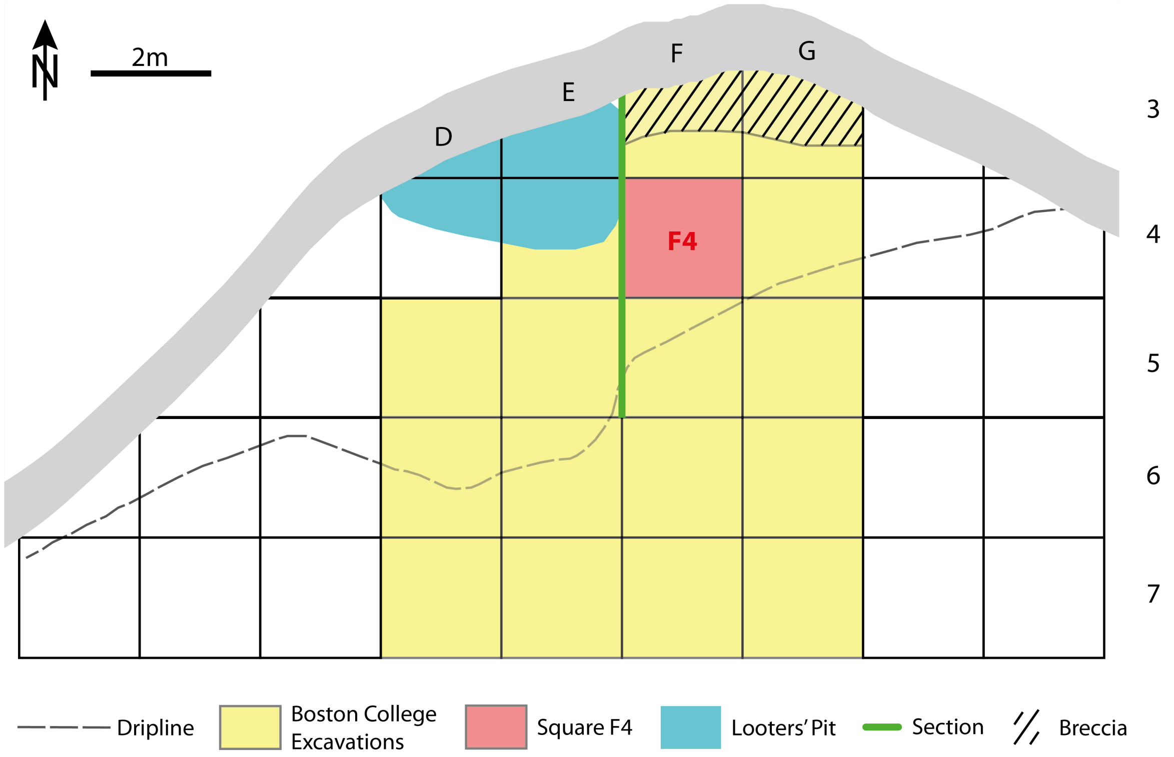

Figure 2.4: Map of the site Ksâr 'Akil (redrawn after Mellars and Tixier 1989) showing the extent of the Boston College excavations (yellow), the looters' pit (blue green), the brecciated area along the rockshelter's wall (hatched), the square F4 from which the sampled bone assemblages originate (red), and the location of the drawn Stratigraphic profile (green).

Excavation notes state that deposits close (up to 30–50 cm) to the rockshelter's wall were highly brecciated, which led to problems in recovering faunal remains, so I excluded all of row 3, i.e., squares D3, E3, F3, and G3 (Ewing 1947). Furthermore, any material from or close to the looters' pit was avoided (approximately squares D&E3–4), as it had been open since it was excavated in the early 1920s. Lastly, I wanted material from close to the published section drawings, which include squares E4 and F5 (see e.g., Bergman and Stringer 1989). This left squares F4, E5, and F5 to choose from. There is a discrepancy in the published literature regarding which squares were excavated in which years. According to Hooijer's (1961) notes, F3, E5, and F5 were excavated in the 1930s, whereas other squares, including F4, were done in the 1940s; this information was deduced from the labels and provenience data that accompanied the bones sent to him. He further states that the material from the 1930s is in 'better shape' than that of the 1940s excavations (Hoojier 1961: 4). However, Bergman went through an archive of unpublished excavation notes, and in 2010 a plan of the rockshelter was published. This indicated that F3, G3, E4, and F4 were excavated in the 1930s, and squares D5–F5, E6, and F6 were done in the 1940s (Williams and Bergman 2010: Figure 3). Ewing (1947: Figure 2) published a section drawing displaying the state of affairs at the end of the 1938 field season, albeit without mention of the squares used or orientation of the profiles. In the section, he drew the burial of Egbert, which was found in square F3. Moreover, Murphy (1938) writes that they used the section of E4 provided by the wall of the looter's pit as a starting point for their stratigraphy. This suggests that the profiles used formed the border between rows E and F and were drawn facing east (see also Braidwood et al. 1951: Figure 3). The fact that in Ewing's 1947 paper only the uppermost two metres of the square adjacent to E4 have been drawn suggests that the majority of either E5 or F5 was excavated in the 1940s. This in turn supports Bergman's representation of the excavation activities. Unfortunately, I had no access to Bergman's data, as this work was published after I selected my sample.

My decision, therefore, was primarily based on Hooijer's notes, the provenience data accompanying the fauna, and a visual inspection of the bones. Of the remaining optional squares (i.e., F4, E5, and F5), F4 is the only one for which the labels mention the archaeological layer in addition to the square and 'depth below datum' (see also Hooijer 1961). As mentioned above, Hooijer (1961) writes that the 1937–1938 material, which he takes to be F3, F5, and E5, is generally in better condition that the 1947–1948 material. However, on the basis of inspection of the bones in the Naturalis depots, cortical surface preservation is sufficient to detect cutmarks and other anthropogenic modifications and, moreover, does not appear to differ substantially between squares E&F5 on the one hand and square F4 on the other. Therefore, it could be that Hooijer's remark refers to the proportion of identifiable bones in the 1930s and 1940s assemblages. Certainly, long bone shaft fragments, many of which exhibit green (fresh) breaks, are abundant in the F4 material, especially in the Upper Palaeolithic layers.

The presence of shaft fragments, which are often hard to identify to species, are important in taphonomic studies such as those evaluating density-mediated attrition and the extent of carnivore damage. They further allow for identification of impact fractures relating to bone-marrow exploitation. For these reasons, the 2 × 2-metre square of F4 was selected for study. In total, the faunal assemblage of F4 comprises approximately 85,000 specimens, and although all material was subjected to initial curation activity, including acid treatment of all bones to remove calcretions, a further selection of layers for study was necessary. Of the IUP deposits, Layers XXV and XXII were chosen, and from the EUP, Layers XVIII, XVI, and XIV were selected, resulting in a total of 5,505 vertebrate remains. The invertebrate assemblage of the 1930s and 1940s excavations is much smaller than that of the vertebrates (to date: n = 3,571) and could be studied in its entirety. Overall, the abundance of both vertebrate and invertebrate remains per layer follows the same trends throughout the sequence, although Layers V, IX, and XVI show a higher relative proportion of shells; Layer XX displays a higher relative (estimated) abundance of bones (Fig. 2.5).

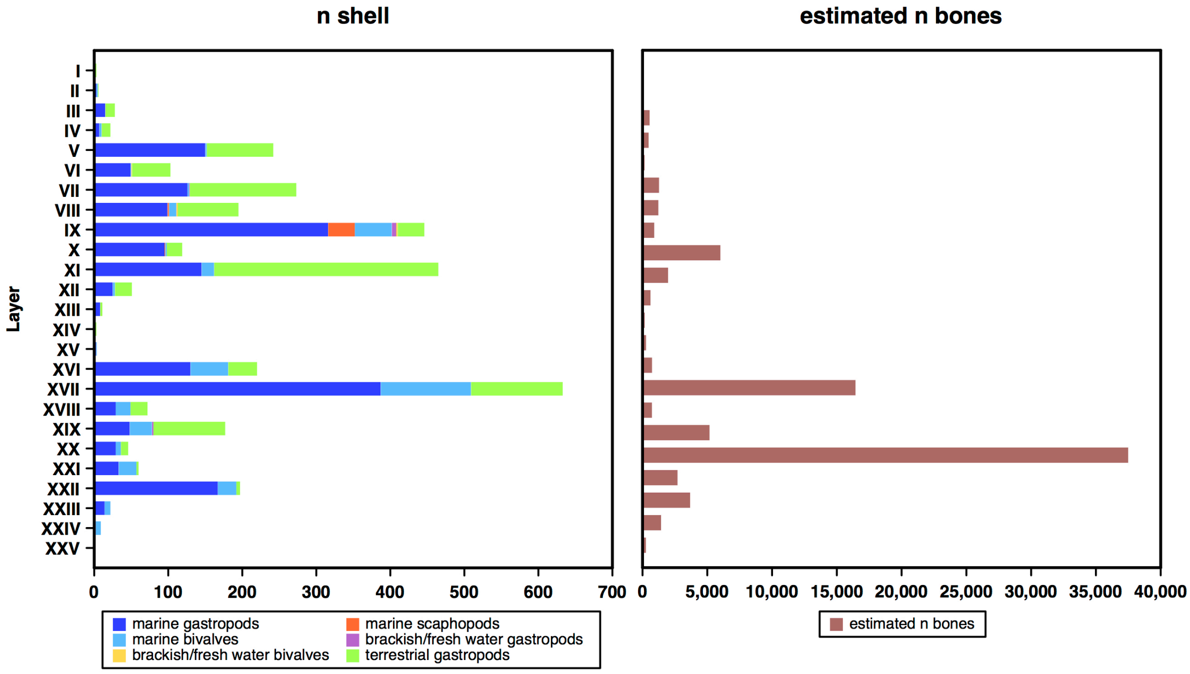

Figure 2.5: Comparison of the frequency of invertebrates (divided by class and habitat) of the total Ksâr 'Akil shell assemblage and estimated frequency of vertebrate remains (only from square F4).

2.6 Vertebrate fauna

The study of the sampled vertebrate fauna does not feature prominently in the chapters that follow, which focus on analyses of the mollusc assemblages. However, I have repeatedly relied on vertebrate data to place the molluscan data into context. These remains yielded clues on post-depositional processes and the extent of human involvement in various layers, and they provide quantitative data on hominin habitat exploitation and dietary breadth. Moreover, during treatment with 10% acetic acid and curation of the vertebrates, a modest number of shells and shell fragments (n = 767) was uncovered and published as the '2015 collection' (2015). Thus, although an in-depth zooarchaeological account of the vertebrates was beyond the scope of this thesis, a brief overview of the research methodology, taphonomy, and faunal composition is provided below (see also Appendix A for the data recording protocol).

All available material from square F4 was selected from the Naturalis Biodiversity Center depots in Leiden and transported to the Max Planck Institute for Evolutionary Anthropology in Leipzig for study. All exported units, whether individual bones or boxes of bones with a shared provenience, were assigned a lab number (DMB1–855, and 999). The faunal remains from the Middle Palaeolithic and Epipalaeolithic layers, as well as those of Layers VI, VII, IX, XV, XVI, and XVIII (n ~4,000), were previously cleaned using acid (Kersten 1987), but the majority (n ~80,000) of Upper Palaeolithic remains (Layers VIII, X–XIV, XVII, and XIX–XXV) were still covered in abundant concretions. To enable identification and inspection of cortical surfaces, these bones were also subjected to acid treatment. Whenever possible, fragile specimens including toothrows, shell fragments, and bones found in anatomical association were extracted and sediment samples (n = 10) were taken. The use of acid is sometimes criticised because it might hamper certain methods of chemical analysis and might affect the preservation of bone surfaces. Therefore, I only treated the F4 assemblage, leaving many thousands of bones from other squares untreated and accessible for other types of analyses. I further conducted a series of experiments to use just enough acid to loosen most attached sediments while leaving cortical surfaces intact.

The acid-treatment protocol involved submerging bones in a 10% acetic acid solution for at least eight hours, and subsequently, any remaining reaction was stopped with a base wash (10% sodium carbonate solution) for two hours. After this, the bones were thoroughly rinsed with normal tap water, dried, and bagged together with separately bagged labels containing information on the find category, layer, square, and the Naturalis inventory number or unique museum identification (RGM) number. Lithics, stones, and sediment samples were bagged per layer. Studied shells and bones were assigned an RGM number that was both written on the labels and included in a two-dimensional barcode.

2.6.1 Taphonomy

Taphonomic investigations focussed on evaluating natural processes and anthropogenic processes that affected the bone. These include breakage types, cortical surface weathering and preservation, burning, and human and animal modifications (Table 2.2). Overall the taphonomic signature of the faunal assemblages is very similar. Most (>90%) of the bones are fragmentary.

2.6.1.1 Breakage patterns

Evaluation of breakage patterns included the recording of the most prominent (i.e., primary) and secondary breakage types. Fresh or green breaks, often identified through spiral fractures of the cortical bone, occur when bone is still greasy, potentially when meat and bone marrow are available for humans, carnivores, or scavengers to eat. Dry breaks occur when the bones are devoid of flesh, no longer greasy, and become increasingly brittle due to a lack of organic content. This type of break can be caused by, for example, post-depositional processes such as trampling or crushing, but it cannot be directly linked (in most cases) to human and animal subsistence-related activities. Lastly, recent breaks are those that occurred during the excavation, curation, and storage of the bones. The category na consists of bones which show no primary and / or secondary breakage, or in few cases, the break was obscured by adhering sediment so that assessment of the breakage type was not possible. Among the Ksâr 'Akil fauna, dry breaks are most common (i.e., roughly 70% of primary breaks), and fresh or green breaks were encountered on approximately 20–30% of the bones depending on the layer (Fig. 2.6).

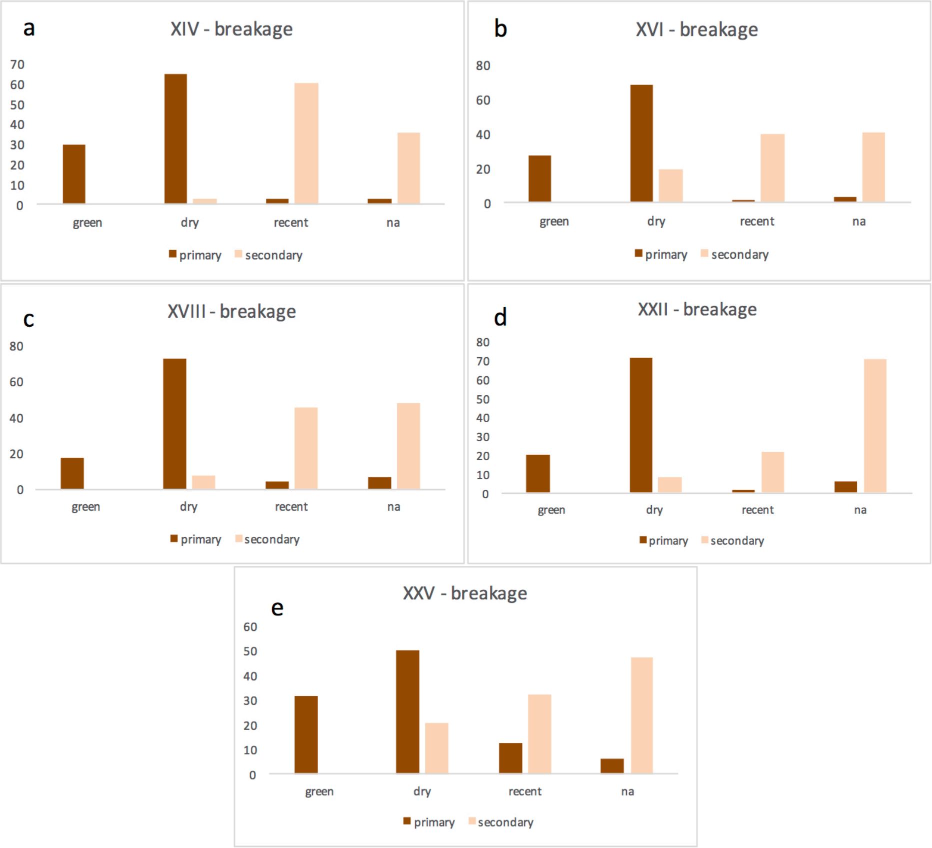

Figure 2.6: Frequency of primary (dark) and secondary (light) breakage types per layer. Green: breaks on fresh bones, Dry: breaks on dried bones devoid of flesh, recent: breaks which occurred during excavation, curation, and/or storage, na: bones without primary or secondary breakage or the type of fracture is obscured by adhering concretions. (a) Layer XIV, (b) Layer XVI, (c) Layer XVIII, (d) Layer XXII, and (e) Layer XXV.

2.6.1.2 Cortical surface weathering and preservation

The state of preservation of cortical bone surfaces was assessed using the stages (0–5) described by Behrensmeyer (1978) that range from no modification (stage 0), cracking of the cortical surface (stage 1) to thin (stage 2) and full (stage 3) cortical surface flaking, through to small rectangular pieces breaking off (stage 4), and finally deep cracks accompanied by flaking of the entire cortical plane (stage 5). In addition, I have added categories 6–8 to record surface modifications caused by smoothing and/or rolling, chemical weathering (including digestion), and geological staining, respectively (Fig. 2.7). Cortical surfaces are generally fairly well preserved, and in all layers, slight cortical surface weathering (i.e., stages 1–2) predominates. In the IUP (Layers XXV and XXII) there is a slightly higher incidence of geological staining, which includes red and black stains, sometimes accompanied by fungal and/or root etching damage, as well as travertine-like concretions. These geological adhesions do not substantially influence the percentage of visible cortical surface per bone between layers. In fact, few bones are fully free of adhering concretions, due to erring on the cautious side while carrying out acid treatment. However, the acid treatment increased the amount of cortical surface (generally >75%; Fig. 2.8) available for inspection for human and animal modifications.

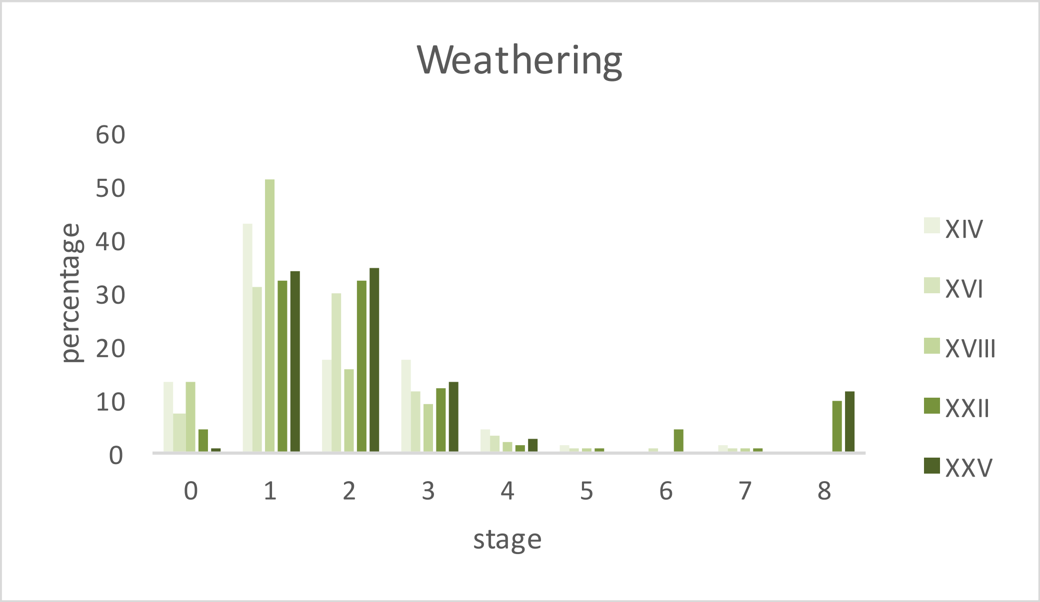

Figure 2.7: Frequency of cortical surface weathering per layer divided into the stages proposed by Behrensmeyer (1978): 0 - none, 1 - cracking of cortical surface, 2 - thin cortical surface flaking, 3 - flaking of cortical surface, 4 - small rectangular pieces breaking of, 5 - deep cracks and flaking of the entire cortical plane; added to Behrensmeyer’s stages are: 6 - smoothed and/or rolled, 7 - chemical weathering (including digestion), and 8 - geological staining.

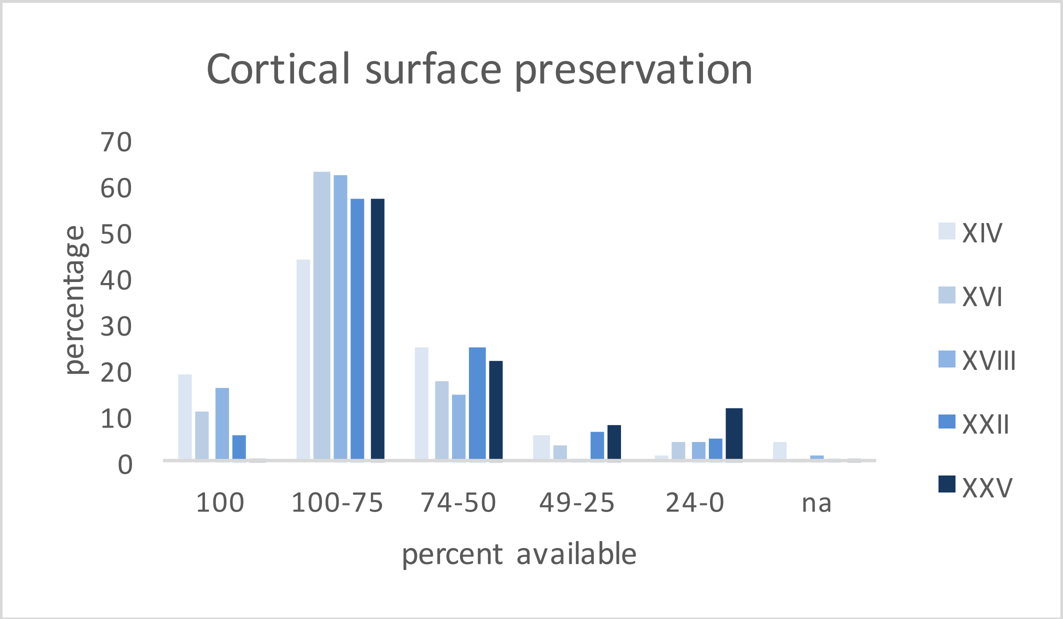

Figure 2.8: Frequency of the extent of cortical surface preservation per layer.

2.6.1.3 Burning

The extent of burning was recorded using the seven-stage system of Stiner et al. (1995) in which stage 0 is not burned, stages 1–3 comprise increasing states of carbonisation (i.e., <50%, >50%, and 100%, respectively) and stages 4–6 refer to calcination or whitening in the same steps. In Layers XXII, XVIII, and XVI, roughly 30–40% of the bones had been exposed, directly or indirectly, to heat (Fig. 2.9). Of these, approximately 5% shows traces of calcination (e.g., whitening of the bone, in combination with cracks and potlids), which has been argued to be a sign of direct exposure to a fire (Stiner et al. 1995), whereas carbonisation or darkening/blackening of the bone can occur while bones are buried (e.g., a fire is lit on top of a bone-bearing layer). In Layers XXV and XIV no calcined bones were recorded, and carbonisation drops to 12% in Layer XIV and one percent in Layer XXV. Several interpretations could explain the lower percentages: humans did not light fires, humans were altogether absent (but see below), or they made their fires in other parts of the rockshelter.

2.6.1.4 Human and carnivore modifications

Stratigraphically, both Layers XXV and XIV are part of so-called complexes thought to coincide with more humid climatic conditions and perhaps a less intense occupation or even a hiatus in the occupation of the rockshelter (Ewing 1947; Wright 1951). However, human modifications occur in the form of both impact fractures, caused by humans bashing bones open to reach the marrow inside, and cutmarks across all layers (Table 2.2). Inversely, modifications made by carnivores are extremely rare (<1%) in all studied IUP and EUP assemblages, and they are absent in Layers XXV and XIV, suggesting humans were the main contributor to the accumulation of bones.

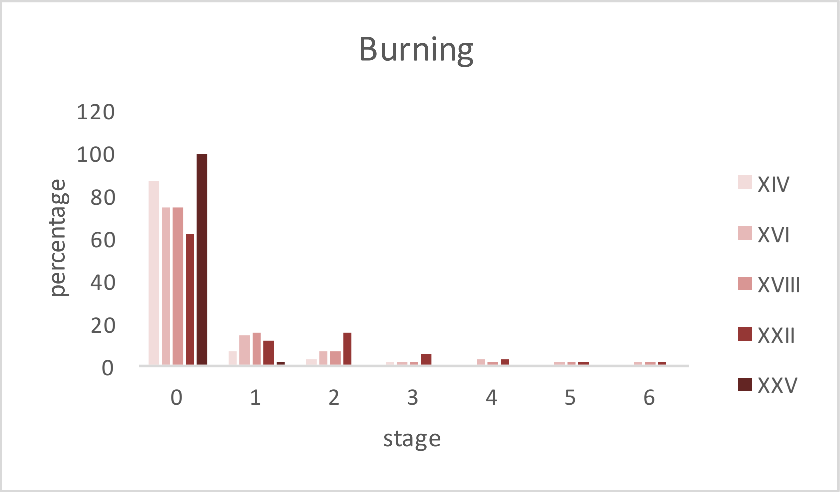

Figure 2.9: Frequency of burned remains per layer divided in the stages proposed by Stiner et al. 1995, 0 - not burned, 1 - <50% carbonised, 2 - >50% carbonised, 3 - 100% carbonised, 4 - <50% calcined, 5 - >50% calcined, 6 - 100% calcined.

The percentage of cutmarks lies between three percent and 13% and that of impact fractures between three and eight percent. Approximately one in five green breaks is accompanied by a discernible impact fracture in Layers XXII, XVIII, and XVI, whereas in layers that are part of the so-called stratigraphic complexes, Layers XXV and XIV, the impact fracture: green-break ratio is only one in ten. Perhaps this difference is caused by increased post-depositional edge damage in the latter two layers, although there is no apparent difference in surface weathering between layers belonging to one of the complexes and those which do not. Green breaks can be caused by butchery and bone marrow extraction by humans, but they can also be caused by carnivores (e.g., hyenas) cracking open bones. However, no clear carnivore modifications were discovered in the layers with a lower impact fracture to green breaks ratio. Other possibilities are that these differences are driven by sample size or that bone marrow extraction was practised elsewhere in or outside the rockshelter.

In summary, taphonomic investigations of the vertebrate fauna show that cortical surface preservation, even after acid treatment, is sufficient to convey human and animal modifications. The results show that carnivores contributed little to the formation of the IUP and EUP assemblages and that humans were the main contributor to the accumulation of these archaeological layers. Human modifications on the remains of Layer XIV suggest that, contrary to the assertion of Bergman discussed above (see Table 2.1; e.g., Bergman and Stringer 1989; Williams and Bergman 2010), humans visited Ksâr ‘Akil during the formation of this layer.

Table 2.2 (next page): Summary of the taphonomic signature of the Ksâr ‘Akil bone assemblages per layer. N bones: number of bones studied. Cortical surface weathering stages after Behrensmeyer (1978): 0 none, 1 cracking of cortical surface, 2 thin cortical surface flaking, 3 flaking of cortical surface, 4 small rectangular pieces breaking of, 5 deep cracks and flaking of the entire cortical plane, added to Behrensmeyer’s stages are: 6 smoothed and/or rolled, 7 chemical weathering (including digestion), and 8 geological staining. Burning stages after Stiner et al. 1995: 0 not burned, 1 <50% carbonised, 2 >50% carbonised, 3 100% carbonised, 4 <50% calcined, 5 >50% calcined, 6 100% calcined.

	XIV		XVI		XVIII		XXII		XXV	
	n	%	n	%	n	%	n	%	n	%
n bones	68		732		724		3449		236	
Primary breakage										
green	20	29.41	200	27.32	123	16.99	705	20.44	74	31.36
dry	44	64.71	501	68.44	523	72.24	2467	71.53	118	50.00
recent	2	2.94	5	0.68	31	4.28	59	1.71	29	12.29
na	2	2.94	26	3.55	47	6.49	219	6.35	15	6.36
Secondary breakage										
green	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
dry	2	2.94	142	19.40	53	7.32	287	8.32	49	20.76
recent	41	60.29	291	39.75	327	45.17	733	21.25	76	32.20
na	24	35.29	299	40.85	344	47.51	2429	70.43	111	47.03
Cortical surface weathering										
0	9	13.24	54	7.38	97	13.40	142	4.12	2	0.85
1	29	42.65	229	31.28	372	51.38	1115	32.33	80	33.90
2	12	17.65	220	30.05	112	15.47	1119	32.44	82	34.75
3	12	17.65	85	11.61	64	8.84	422	12.24	32	13.56
4	3	4.41	24	3.28	16	2.21	54	1.57	6	2.54
5	1	1.47	1	0.14	7	0.97	2	0.06	0	0.00
6	0	0.00	1	0.14	0	0.00	146	4.23	0	0.00
7	1	1.47	2	0.27	1	0.14	7	0.20	0	0.00
8	0	0.00	0	0.00	0	0.00	331	9.60	27	11.44
Available cortical surface										
100	13	19.12	80	10.93	117	16.16	199	5.77	2	0.85
100-75	30	44.12	459	62.70	449	62.02	1963	56.92	135	57.20
74-50	17	25.00	129	17.62	104	14.36	863	25.02	52	22.03
49-25	4	5.88	27	3.69	3	0.41	227	6.58	19	8.05
24-0	1	1.47	34	4.64	30	4.14	169	4.90	27	11.44
na	3	4.41	3	0.41	11	1.52	29	0.84	1	0.42
Burning										
0	59	86.76	542	74.04	535	73.90	2141	62.08	233	98.73
1	5	7.35	106	14.48	115	15.88	423	12.26	3	1.27
2	2	2.94	49	6.69	50	6.91	537	15.57	0	0.00
3	1	1.47	6	0.82	8	1.10	206	5.97	0	0.00
4	0	0.00	22	3.01	5	0.69	90	2.61	0	0.00
5	0	0.00	4	0.55	7	0.97	33	0.96	0	0.00
6	0	0.00	6	0.82	4	0.55	20	0.58	0	0.00
Carnivore modifications										
toothmarks	0	0.00	1	0.14	0	0.00	5	0.14	0	0.00
puncture	0	0.00	0	0.00	2	0.28	0	0.00	0	0.00
gnawing	0	0.00	0	0.00	0	0.00	1	0.03	0	0.00
none	68	100.00	731	99.86	722	99.72	3443	99.83	236	100.00
Human modifications										
cutmarks	6	8.82	25	3.41	28	3.86	253	7.28	31	12.97
impact fractures	2	2.94	59	8.05	39	5.37	143	4.12	7	2.93
chopmarks	0	0.00	0	0.00	1	0.14	0	0.00	0	0.00
none	60	88.24	649	88.54	658	90.63	3077	88.60	201	84.10

2.6.2 Compatibility of faunal composition by layer

Overall, the same vertebrate taxa are present throughout the IUP and EUP. They include: red deer (*Cervus elaphus*), Mesopotamic fallow deer (*Dama mesopotamica*), roe deer (*Capreolus capreolus*), aurochs (*Bos* sp.), ibex (*Capra ibex*), wild goat (*Capra aegagrus*), a small gazelle (*Gazella* cf. *dorcas*), a large gazelle (*Gazella* cf. *gazella*), wild boar (*Sus scrofa*), tortoise (*Testudo* sp.), brown bear (*Ursus arctos*), a large bear (*Ursus* sp.), lion (*Panthera leo*), wild cat (*Felis silvestris*), leopard (*Felis pardus*), wolf (*Canis lupus*), and fox (*Vulpes vulpes*), as well as a few bird, reptile (other than tortoise), and microfaunal remains (Table 2.4). Unidentifiable ungulate remains were assigned size classes, UNG1–5, (after Brain 1981: Appendix 1, Table 1), which conveniently separate the various cervids and bovids. Of the identifiable taxa, only Dorcas gazelle remains can be placed in size class 1 (<20 kg); size class 2 (~20–50 kg) comprises mountain gazelle, bezoar goats, and roe deer; size class 3 (~50–200 kg) includes wild boar, ibex, and Mesopotamic fallow deer; and size class 4 (~200–800) includes red deer and aurochs. The large caballine equid (n = 3) reported by Hoojier (1961) would also fall in this size class but was not recovered from the faunal assemblage of F4. Size class 5 (>800kg) would include rhinoceros, which is present in the Middle Palaeolithic but has not been identified in the Upper Palaeolithic deposits.

The aim of studying the vertebrate assemblage is to assess Upper Palaeolithic dietary breadth and what it can tell us about EUP and IUP subsistence behaviour. Optimal foraging theory and taxonomic composition indices have been widely used by archaeologists to investigate subsistence behaviour through time (e.g., Binford 1981; Grayson and Delpech 1998; Stiner 2001, 2005; Dusseldorp 2009; Lyman 2013). However, before comparing the data from several layers, we need to assess whether the assemblages in terms of numbers of identified specimens (NISP) and the minimal number of individuals (MNI) are comparable in quantity and degree of fragmentation.

If an assemblage is fragmentary, as almost all archaeological assemblages are, there is always the possibility that multiple fragments belong to one specimen (e.g., Grayson 1979; Marean 1991). In contrast, if only one fragment of a certain species is recovered, it by definition makes up an MNI of one. This potential interdependence between NISP and MNI (Grayson 1979, 1984) may substantially drive the results. Moreover, it is likely that in smaller assemblages or less fragmented ones, MNI values overestimate and NISP values underestimate the original faunal composition. Fragmentation is often caused by taphonomic processes, but excavation recovery techniques and past hunter-gatherer behaviour potentially contribute as well. Overall, the taphonomic signature between the studied layers is quite similar (see above). However, some of the analysed layers differ substantially in sample size. One way of addressing this issue is to investigate whether the degree of fragmentation between layers is similar across the assemblages that I want to compare. If there is a significant correlation between the natural log of the NISP (lnNISP) and of the MNI (lnMNI) of all studied layers, we can assume that the degree of interdependence is similar across all assemblages and that it does not significantly affect the observed taxonomic abundances. Moreover, especially if NISPs (or MNIs) or derivatives thereof (e.g., Heterogeneity index: H, inverse Simpson's index: 1/D, and Shannon evenness index: e; see Table 2.3) are used to compare samples from the various archaeological layers, the degree of interrelatedness per sample must be assessed.

Table 2.3: Overview of the applied taxonomic abundance indices.

Symbol	name	Other names	Formula/ description	remarks	reference
S	Taxonomic richness		Number of species per layer		Gaston 1996
H	Taxonomic heterogeneity	Shannon or Shannon-Wiener index	$H=-\sum P_i(\ln P_i)$; where P_i is the proportion of taxon i	The higher the value the greater the heterogeneity: values generally, between 1.5–3.5	Magurran 1988
e	Taxonomic evenness	Shannon index of evenness	$e=H/\ln S$	Values between 0–1, where 1 indicates an even and 0 an uneven faunal distribution	Magurran 1988
1/D	Taxonomic dominance	Reciprocal of Simpson's index	$1/D=\sum n_i[n_i-1]/N[N-1]$; where n_i is the NISP of taxon i, and N is 'NISP species'	The lower the value the greater the taxonomic dominance	Simpson 1949

Table 2.4 (next page): Vertebrate numbers of identified specimens (NISPs) and minimum numbers of individuals (MNIs) per layer. UNG: Ungulate, - Ungulate size class 1: ~<20 kg, 2: ~20-50 kg, 3: ~50-200 kg, 4: ~200-800 kg - NID: not identified, total n: total number of specimens.

layer	**XIV**		**XVI**		**XVIII**		**XXII**		**XXV**	
species	**NISP**	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**
ungulates										
Cervus elaphus	2	1	6	1	8	1	47	3	2	1
Dama mesopotamica	12	3	93	3	124	3	860	18	61	5
Capreolus capreolus	1	1	11	1	24	1	24	2	1	1
indet cervid			4		7		12			
Bos sp.	2	1	3	1	9	1	11	2	39	2
Capra aegagrus	6	2	62	2	39	2	502	10	14	2
Capra ibex	1	1	2	1	12	1	51	3		
Gazella cf. *dorcas*	2	1	7	1	10	1	5	1		
Gazella cf. *gazella*	2	1	2	1	9	1	2	2		
Gazella spp.			7		1		11		2	
indet bovid							3			
Sus scrofa	3	1	21	1	24	1	295	6	51	3
total ungulates	***31***	***12***	***218***	***12***	***267***	***12***	***1823***	***47***	***170***	***14***
small mammals										
Lepus sp.					1	1	1	1		
total small mammals					***1***	***1***	***1***	***1***		
reptiles										
Testudo sp.	1	1	5	1	29	2	20	2		
indet reptile					7	1				
total reptiles	***1***	***1***	***5***	***1***	***36***	***3***	***20***	***2***		
birds										
large bird					1	1	2	2	1	1
total birds					***1***	***1***	***2***	***2***	***1***	***1***
microfauna										
Arvicola sp.							1	1		
total microfauna							***1***	***1***		
carnivores										
Ursus sp.					1	1	1	1		
Ursus arctos					1	1	9	1	1	1
Panthera leo			1	1			1	1		
Felis silvestris					1	1	1	1		
Felis pardus							1	1	1	1
Canis lupus					1	1	11	1		
Vulpes vulpes							3	1		
Large carnivore							15		1	
Small carnivore							3			
total carnivores			***1***	***1***	***4***	***4***	***45***	***7***	***3***	***2***
ungulate size classes*										
UNG 1			3				1			
UNG 1-2			1				1			
UNG 2			54		48		137		1	
UNG 2-3	2		13		23		51		7	
UNG 3	30		286		229		1292		70	
UNG 3-4	2		14		14		69		6	
UNG 4	4		31		56		124		7	
total NISP	**70**		**626**		**679**		**3567**		**265**	
NID	2		116		56		116		7	
total n	**72**		**742**		**735**		**3683**		**272**	

In the following analyses (i.e., interdependence, relative abundance, and taxonomic composition indices), NISP is calculated as the number of specimens identified to species level—here called NISP sp.—(after Lyman 2008), thus excluding remains identified to order or family, and those that could only be attributed a size class, which is here called NISP total (Table 2.5). The correlation of lnNISP and lnMNI is evaluated using a simple best-fit regression analysis (Grayson 1984; Lyman 2008). As a significance test, the Pearson's correlation coefficient is used (as the values are not ranked). A strong significant correlation (see Fig. 2.10a; $r^2 = 0.81$; $r = 0.90$, $p = 0.039$) exists between lnNISP and lnMNI, suggesting that interdependence is distributed randomly across all assemblages.

A second method to assess interdependence is to test whether lnNISP and the logged number of species (lnS or lnNtaxa) are significantly correlated. For the Ksâr 'Akil samples the relation is not significant (Fig. 2.10b; $r^2 = 0.63$; $r = 0.79$, $p = 0.11$), indicating that the number of taxa cannot be compared between layers because it is not an interdependent variable. (Table 2.5). Therefore, these results warrant NISP-based faunal comparisons across layers but not based on the number of species per layer. Relative abundance of species across layers can potentially be compared, as they are NISP-based derivatives.

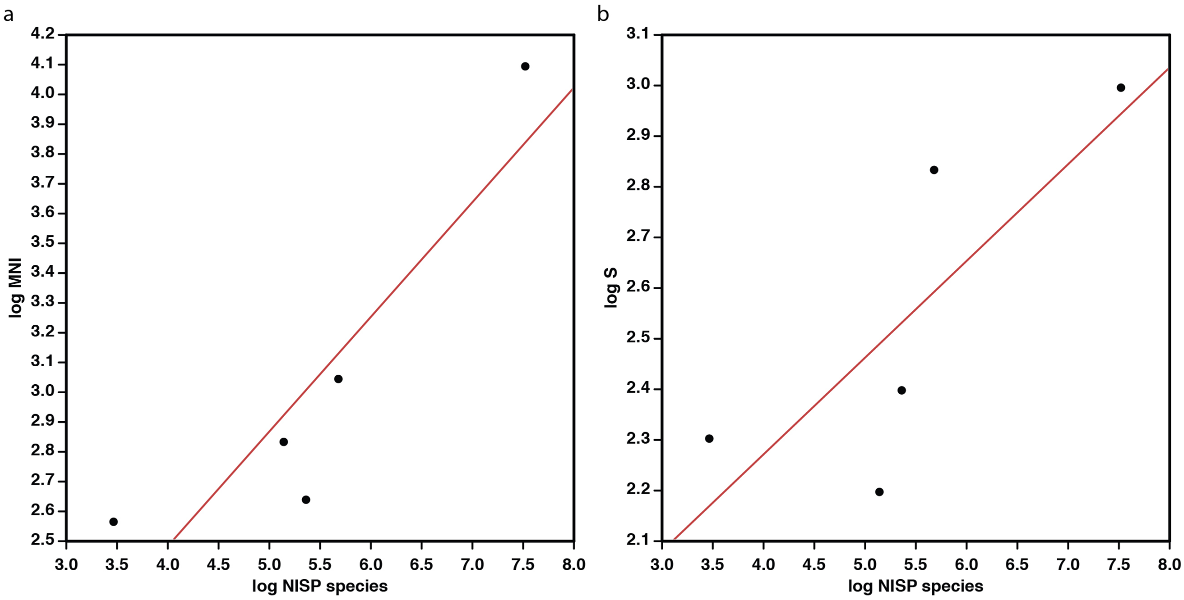

Figure 2.10: Relationship between a) NISP and MNI regression: $r^2 = 0.81$; $r = 0.90$, $p = 0.039$, and b) NISP and S regression: $r^2 = 0.63$; $r = 0.79$, $p = 0.11$ of the five assemblages studied.

Sample size is another potential bias that is evaluated. Similar to the interrelatedness issue, the question here is whether sample size is responsible for an assemblage's taxonomic composition. This issue can be tackled by plotting the frequency of one component within a sample, e.g., the dominant species, against the total NISP of this sample. If multiple components are not significantly related to the total NISP, this would indicate that sample size is not a driving factor in assemblage composition (Lyman 2008). For the Ksâr 'Akil sample we can look at the relative abundance (percent) of several common food species such as *Dama mesopotamica, Capra aegagrus,* and *Sus scrofa*. Again, a simple best fit regression analysis is applied. As a significance test the Spearman's rho (r_s: employing a t-distribution) is used because the values are ranked (Table 2.6). No significant correlations are found for any of the common taxa. The results of both interdependence and taxon relative abundance suggest that sample size is not a significant factor driving faunal distribution.

Table 2.5: The number (n), Number of identifiable specimens including those identified to size class (total NISP), those identified to species level (NISP sp.) and its logged values (lnNISP sp.), the minimum number of individuals (MNI) and its logged values (lnMNI), as well as the taxonomic richness (S) and logged (lnS), the taxonomic heterogeneity (H), evenness (e), dominance (1/D) per layer.

Layer	n	NISP total	NISP sp.	lnNISP sp.	MNI	lnMNI	S	lnS	H	e	1/D
XIV	72	70	32	3.46574	13	2.56495	10	2.30259	1.60779	0.69825	5.63636
XVI	742	626	213	5.36129	14	2.63906	11	2.39790	1.21701	0.50753	3.48157
XVIII	735	679	293	5.68017	21	3.04452	17	2.83321	1.92651	0.67997	4.48595
XXII	3683	3567	1846	7.52078	60	4.09434	20	2.99573	1.44566	0.48257	3.14503
XXV	272	265	171	5.14166	17	2.83321	9	2.19722	1.44284	0.65667	3.69096

Table 2.6 The abundance of the predominant prey species per layer, and the results of the Spearman rho tests. r_s: Spearman correlation, p: probability value.

	XXV	XXII	XVIII	XVI	XIV	r_s	p
NISP species	171	1846	293	213	32		
Dama mesapotamica	61	860	124	93	12	0.8	0.1
Capra aegagrus	14	502	39	62	6	0.3	0.62
Sus scrofa	51	295	24	21	3	0	1

2.6.3 Taxonomic composition

To evaluate faunal composition, I used a combination of several indices, namely S, e, H, and 1/D. (Table 2.5). As all these indices are calculated using NISPs, there is the possibility that these results are also driven by sample size rather than represent species composition. As with interdependence, the way to test this is to run regression analyses of these indices and lnNISP, where a significant correlation would indicate a sample size bias. Table 2.7 shows no significant relationship, which suggests that comparison of these indices across layers is warranted.

However, it is important to note that, although e values give an indication of the faunal distribution within a layer, they should not be compared across layers because they are calculated using both NISPs and S values. As shown above (Fig. 2.11), S values are not interdependent between layers and should therefore not be compared.

Table 2.7: The results of the Pearson's correlation coefficient and r-squared tests of the relation between lnNISP and taxonomic heterogeneity (H), evenness (e), and dominance (1/D).

Index	r	r^2	p
H	−0.12	0.01	0.85
e	−0.73	0.53	0.16
1/D	−0.82	0.68	0.09

2.6.4 Archaeological interpretation

On face value, there seem to be no substantial differences between heterogeneity, evenness, and dominance. All five assemblages are not very heterogeneous, with H values close to 1.5, but with 1/D values ranging between 3 and 4.5, they are not dominated by a single species. Not surprisingly, no significant change in overall taxon abundance could be observed ($r_s = 0.5$, $p = 0.39$).

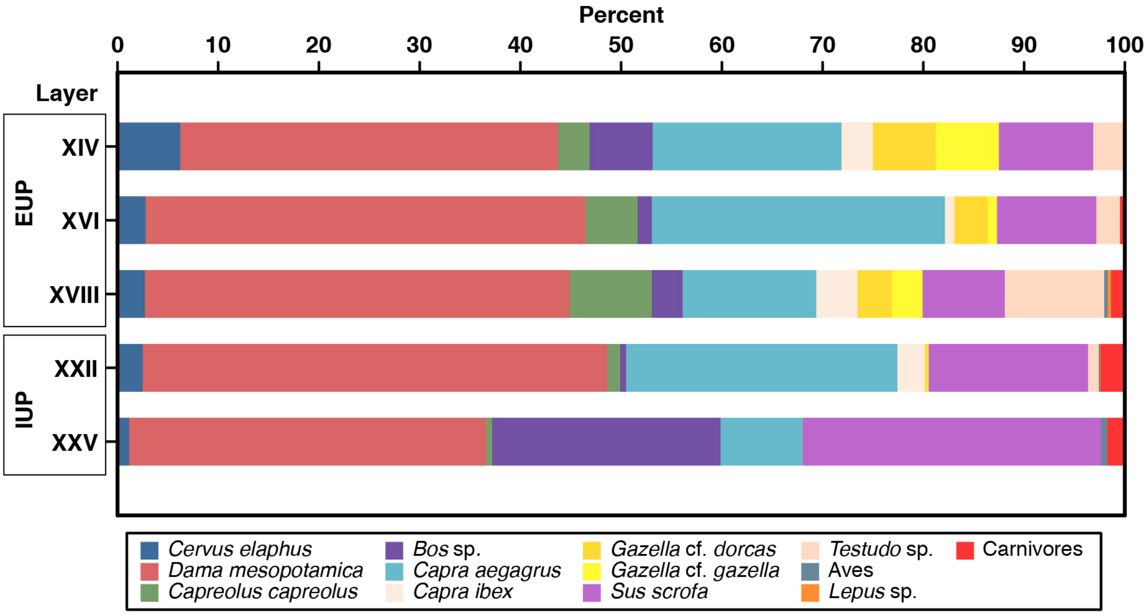

Figure 2.12: Species composition (%NISP) per layer (see Table 2.4 for NISP counts).

When the relative faunal composition is plotted through time (Fig. 2.12), it becomes evident that Mesopotamic fallow deer is always the most frequent taxon. However, in the Early Ahmarian the faunal distribution of the less-common taxa (i.e., excluding *Dama mesopotamica, Capra aegagrus*, and *Sus scrofa*) seems to be more evenly distributed. To test this, I plotted the relative abundance of less common prey-species (Fig. 2.13). The non-significant Pearson's correlation coefficient (for non-ranked variables) of $r = 0.66$, $r^2 = 0.44$, $p = 0.22$ suggests that the patterns observed in relative abundance are not driven by sample size. When plotted through time, the abundance of less-common taxa shows an increasing, but not significant ($r_s = 1$, $p = 0.39$), trend. Due to the low numbers ($n < 5$) of certain taxa, even when collated into broader IUP (i.e., Layers XXV and XXII) and EUP (i.e., Layers XVIII, XVI, and XIV) groups, it is not possible to statistically compare species abundance. Judging from the represented taxa, the non-significant trend involves a higher relative proportion of smaller-bodied taxa such as roe deer, gazelles, and tortoises over larger-bodied taxa such as red deer and aurochs. Indeed, collating the data into broader IUP and EUP categories a χ^2 test reveals a highly significant difference ($\chi^2 = 62.52$, df = 1, $p < 0.001$) between the abundance of larger-bodied prey (i.e., size class 3 and larger) compared with smaller-bodied prey (i.e., size class 2 and smaller).

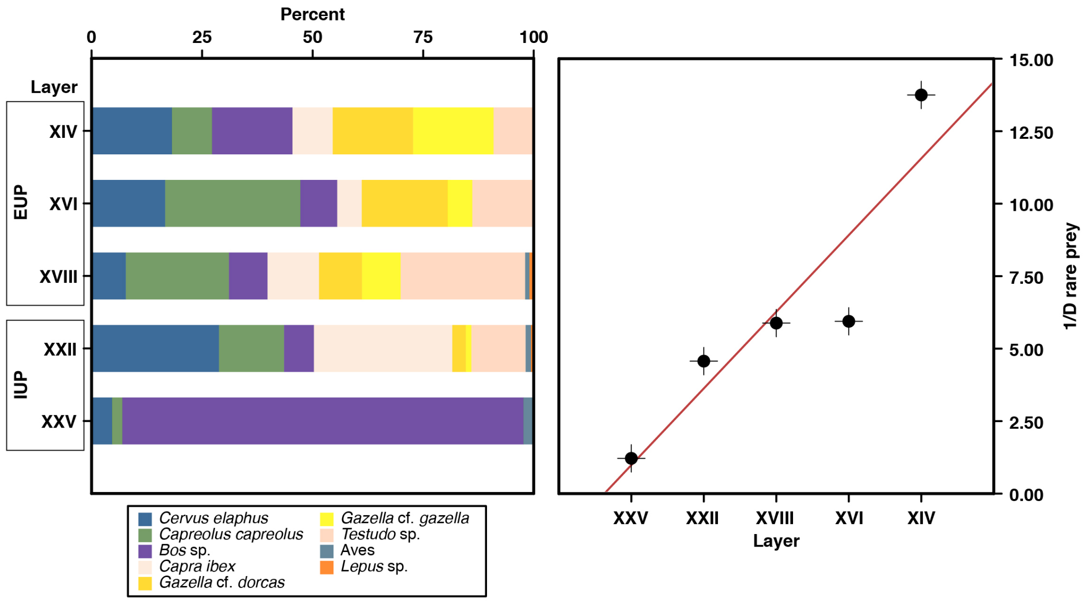

Figure 2.13: Species composition of less-common prey species per layer (left) and relationship of the taxonomic dominance 1/D across layers (right) regression: $r_s = 1$, $p = 0.39$.

Similarly, when plotted by body size (Fig. 2.14) a gradual but not significant ($r_s = 0.8$, $p = 0.10$) shift in faunal exploitation towards smaller-bodied prey becomes evident. When collating the data into broader IUP and EUP categories, a χ^2 test reveals a highly significant difference ($\chi^2 = 115.15$, df = 4, $p < 0.00001$). In other words, the data suggest that during the Early

Ahmarian, larger-bodied prey were on average less often targeted in favour of smaller-bodied prey but that the shift occurred rather gradually. Moreover, the distribution of less-frequently obtained prey is more even in the Early Ahmarian compared to the IUP.

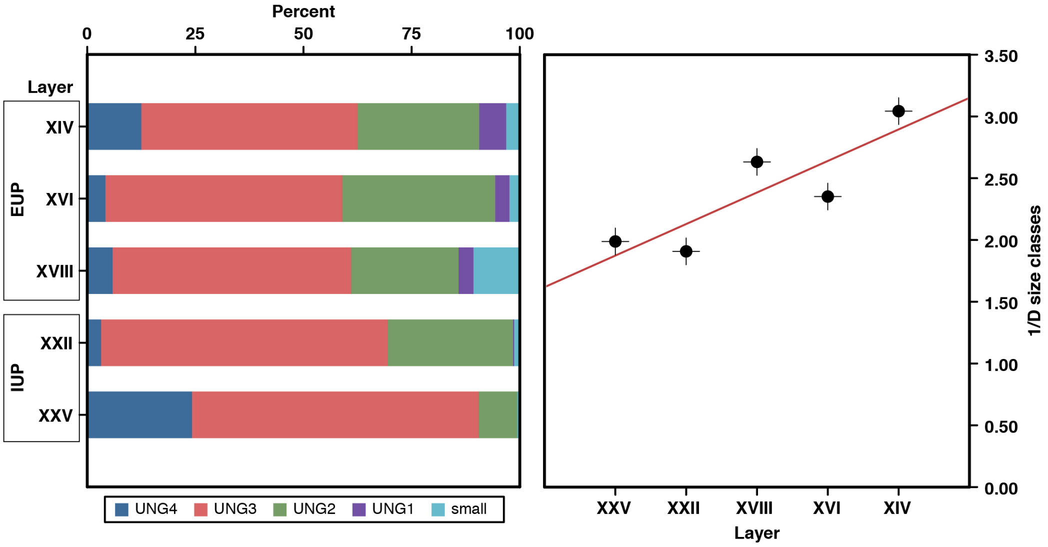

Figure 2.14: Composition of ungulate (UNG) size-class and small bodied prey (small), e.g., tortoise, birds and hare, per layer (left) and the relationship of the taxonomic dominance 1/D across layers (right) regression: $r_s = 0.8$, $p = 0.10$.

In an attempt to use archaeological faunal assemblages as an environmental indicator, Dorothea Bate (1937 in Hooijer 1961) compared relative frequencies of gazelle and Mesopotamic fallow deer using her so-called *Gazella-Dama* graph, the former animal being an indicator of arid and open or steppic conditions and the latter being a temperate woodland taxon. The *Gazella-Dama* graph for Ksâr 'Akil (Fig. 2.15) shows a significant increase ($r_s = 0.9$, $p = 0.04$) in the arid species from the start of the IUP to the end of the Early Ahmarian. Equally, a chi-square test between the collated IUP versus EUP data shows a significant difference ($\chi^2 = 69.42$, df 1, $p < 0.0001$). However, it is likely that this pattern is skewed with the coinciding change in faunal exploitation towards smaller-bodied prey (see Lyman 2008; Yesurun 2017). Shea (2003) suggests evaluating the zooarchaeological evidence, in his example from multiple Levantine Middle Palaeolithic sites, in terms of species' behavioural characteristics. In the northern Levant—Lebanon and northern Israel—he sees a higher frequency of 'territorial species and species that tend to live near or in woodlands' (e.g., *Cervus elaphus, Dama mesopotamica, Capreolus capreolus, Sus scrofa*, and *Gazella gazella*) relative to 'migratory and/or open country/steppic taxa' (e.g., *Bos* sp., *Capra aegagrus*, and *Capra ibex*), whereas the latter dominate the more southern and interior Levantine areas (southern Israel, Syria, and Jordan).

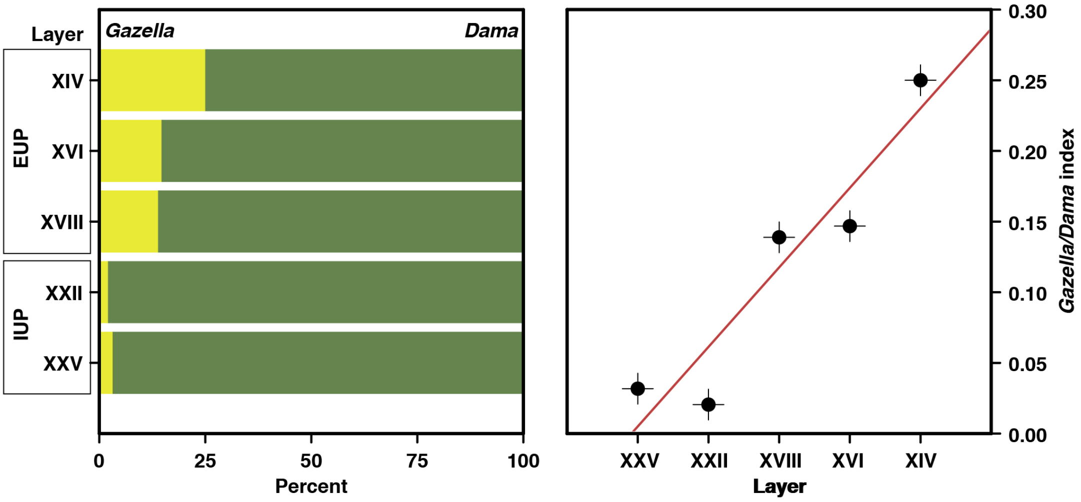

Figure 2.15: The *Gazella-Dama* graph (Bate 1937): the relative frequency (%NISP) of gazelle (i.e., *Gazella.* spp.) against Mesopotamic fallow deer per layer (left) for the five studied layers of Ksâr 'Akil. The relationship of the *Gazella/Dama* index across layers (right) regression: $r_s = 0.9$, $p = 0.04$).

Consistent with the site's location in the northern Levantine woodland zone, the relative frequency of territorial/woodland versus migratory/steppe fauna at Ksâr 'Akil displays a clear woodland dominated profile (Fig. 2.16) but shows no clear chronological trend ($r_s = -0.2$, $p = 0.75$). Moreover, the pattern suggesting increasing aridity throughout the early Upper Palaeolithic previously observed in the *Gazella-Dama* graph disappears. It seems likely therefore, that the *Gazella-Dama* graph is skewed by human change in subsistence practise, namely a preference for smaller fauna, rather than reflecting environmental conditions in a straightforward way.

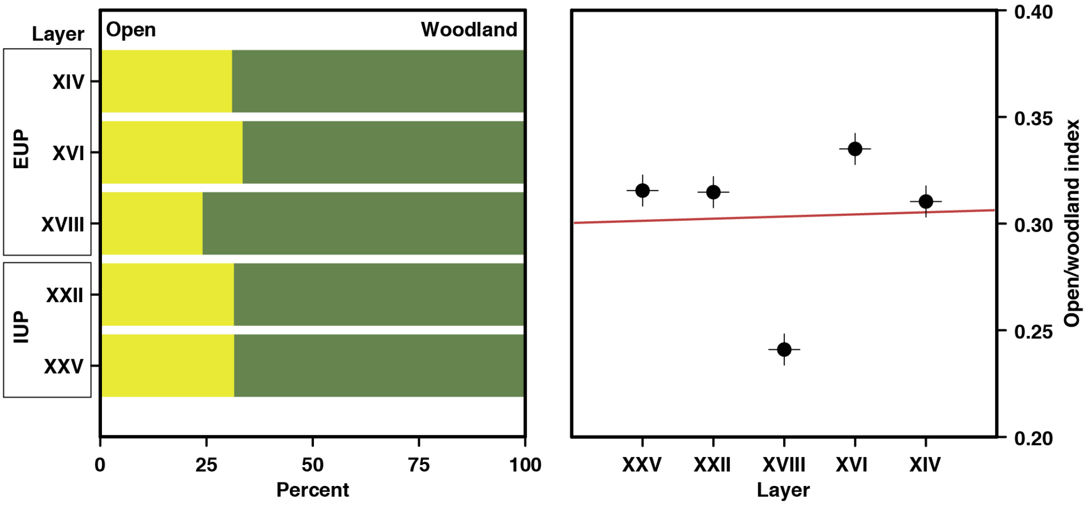

Figure 2.16: Relative frequency (%NISP) of territorial/woodland versus migratory/steppe fauna per layer (left) after Shea (2003). The relationship of the Open/woodland index across layers (right) regression: $r_s = -0.2$, $p = 0.75$.

2.6.5 Vertebrate fauna summary

Ksâr 'Akil is one of the few sites, together with the Middle Palaeolithic sites of Naame and Ras el-Kelb (both Lebanon), to display a terrestrial faunal composition characteristic of the eastern Mediterranean (temperate) woodland zone (e.g. Shea 2003). This is different from other Levantine sites such as the Mount Carmel Caves of Kebara, Hayonim, and Manot Cave (all Israel), that generally display a high incidence of arid taxa such as gazelle, bezoar goat, and other small bovids (Shea 2003; Rabinovich and Hovers 2004; Speth 2012; Hershkovitz et al. 2015). Moving more inland (e.g., the Middle Palaeolithic site of Umm el Tlel, Syria), these bovids are recorded to have been accompanied by donkeys, horses, ostriches, and camels (Griggo 2004). The data suggest that also in the early Upper Palaeolithic at Ksâr 'Akil faunal exploitation mainly took place in wooded areas probably on the seaward slopes of the Lebanon Mountains and perhaps on the coastal plain. Furthermore, the low frequency of open habitat arid species suggests that the highlands of the Beqaa Valley were less often targeted or that portions of hunted animals were not taken back to the site, although small-bodied arid species, such as gazelles, were exploited slightly more often in the Early Ahmarian. Thus, the Ksâr 'Akil vertebrate fauna show a clear woodland signal, with Mesopotamic fallow deer and wild boar prominently represented. At the same time, although species representation is fairly similar, faunal composition does change, especially between the IUP and EUP layers where a shift to a more evenly distributed occurrence of various less-common small-bodied taxa occurs.

In chapters 5 and 6, another avenue of faunal exploitation at Ksâr 'Akil, namely of invertebrates, is investigated. The data on the Ksâr 'Akil vertebrate assemblages discussed above are used to contextualise these molluscan data to gain a broader view, albeit not complete, of IUP and EUP subsistence strategies.

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