Mammal and bird remains from the early Epipalaeolithic site of Ayn Qasiyya, Azraq, Jordan

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This paper reports on the mammal, bird and reptile remains recovered during excavations at Ayn Qasiyya in the 2005-2008 seasons. Large quantities of animal bones from three trenches with comparable stratigraphic sequences (Areas A, B and D; total area 48m^2) (Richter et al. 2009a) were recorded by location, locus and east and west bearings. The analyses reported here not only throw light on the subsistence economy and procurement strategies employed by people living at the site but also allows the Ayn Qasiyya fauna to be considered alongside data gathered from other Early and Middle Epipalaeolithic sites in the Azraq Basin. A number of these were excavated during the late 1970's, 1980's and early 1990s including the large-scale group aggregation locations sites Kharaneh IV and Wadi Jilat 6 (Martin et al. 2010).

METHODOLOGY

Animal bones were identified using reference collections housed at the Institute of Archaeology, University College London and the Natural History Museum Bird Reference Collection at Tring. Specimens sorted as diagnostic to taxa were separated from non-diagnostic bones for processing and recording: vertebrae, apart from atlas and axis, and ribs were generally not recorded. Identifiable specimens were measured (to nearest mm), weighed (to the nearest 0.01g) and fusion status and degree of intactness recorded. Attributes resulting from taphonomic processes including weathering, surface condition, gnawing and burning were also recorded. Morphometric data were assembled (following von den Driesch 1976) for some species including gazelle (*Gazella subgutturosa)*, cattle (*Bos primigenius*), equids (*Equidae* sp)*,* fox (*Vulpes* sp*)* and hare (*Lepus* sp). These data are presented in Appendix 1. Fragmentation, surface condition and colour were recorded for bones identified to taxa. This report also includes those bones from Area A examined in a preliminary study described in Richter et al. (2009a).

Two quantification methods were used: Number of Identified Specimens (NISP) as the basic measure of abundance and Minimum Number of Individuals (MNI) for establishing relative element survival (see Grayson 1984). In summary tables, NISP includes only specimens identified at least to order or family. A distinct method was used to determine NISP values for tortoise, since simply counting shell fragments (scutes) which are outgrowths of the rib/vertebrae axial skeleton, is not appropriate when vertebrae and rib fragments are generally not counted for most species. To avoid overestimating tortoise presence, scute numbers were divided by 60 (the number of scutes in carapace and plastron combined) before adding to the number of tortoise long bones (Martin et al. 2013: 656).

CONTEXTS AND ANIMAL BONES

Three areas A, B and D were excavated at the northern end of the Ayn Qasiyya pool; Area A on the southernmost pool edge, Area D at the most western point and Area B about 30 to 40 m north-west of Area A (Richter & Rohl 2006). More than 1,290 identifiable fragments of animal bone were recovered from Area A, where the majority were found in context 22 (NISP = 731) a former marsh deposit which showed signs of some reworking by animals, plants or water movement during its post-depositional history. A considerable quantity of bone was also recovered from context 60 (NISP = 379) which comprised a band of dark brown silt, 13 cm deep in places and partly underlying context 22; this context has been dated to 21,003-20,399 cal BP. Underlying contexts, 80 and 81, yielded smaller numbers of remains (NISP 88 and 96 respectively).

Area B yielded 3,872 identifiable bones and here the majority, more than 3,400 specimens, were found in context 1004, a reworked marsh deposit which also contained human remains associated with early Epipaleolithic occupation (Richter et al. 2009b).

Most of the bones recovered from Area D were embedded in creamy/grey carbonate concretions. Attempts were made to remove this coating using acetic acid treatment but some deposit was resistant; however thirty six specimens from several different contexts, including contexts 3005, 3003 and 3008 were identified to species with more than half representing gazelle.

BONE FRAGMENTATION, BURNING AND STAINING

Intensive dry- and wet-sieving yielded a total bone weight of c.100kg, most of which was highly fragmented measuring 1-2cms or less with occasional larger fragments and could not be identified. Amongst the 5,396 (number includes tortoise carapace/plastron fragments) bones identified to species, 81.9% were incomplete and less than 2.5 cm long and only 1.3% of bone exceeded 6.5cm in length. All areas showed similar patterns of significant bone size reduction such that for example the average fragment weight for Area B was 0.55g. This seems most likely to reflect deliberate, intensive human processing of bone. Other possibilities, such as fracturing of bone by trampling or vigorous disturbance during flooding, can be ruled out since the geomorphological assessment made during excavation found no evidence for either dry periods or significant inundation during occupation (Richter et al, 2009). Furthermore, the finding of a relatively undisturbed, crouched, human burial dating to the Early Epipaleolithic in Area B, with bones broken but more or less aligned (Richter et al. 2009b), strongly argues against significant post-depositional disturbance of these and surrounding deposits. Rather, animal bone breakage appears to have been deliberate and presumably associated with recovery of marrow and grease. Intensive fragmentation of larger bones from aurochs and equid may lead to an under-estimation of larger taxa.

Unequivocal evidence for burning was seen on 14% (c.700) of identified specimens and these included the full range of taxa. Of these 68% were burnt dark brown/black; 13.7% carbonised and 18.3% calcined. Much of the remaining bone was black in colour but did not appear to be burnt. In many cases the surface was smooth and snapping showed little penetration of black staining. Given the wetland environment, black colouration is more likely due to staining by manganese released during decomposition of organic matter and associated manganese oxide formed by oxidising bacteria which occur in wet/moist conditions (Potter & Rossman 1979; Dorn and Obalander 1981). Manganese oxide staining of bone has been recognised at El Miron Cave (Arroyo et al 2008) and Hayonim Cave and indeed Shahack-Gross, Bar-Yosef and Weiner (1997) developed a method involving Furier transform infra-red (FITR) spectroscopy to differentiate burnt bone (by identifying pyrolysed collagen) from stained bone. Black staining due to manganese compounds on human bones from cemeteries, such as those from Halton Abbey in the UK Midlands, have also been described and investigated using scanning electron microscopy and X-ray microanalysis (Rushton & Firn (2008).

TAXONOMIC DESCRIPTION OF THE AYN QASIYYA ASSEMBLAGE

The range and numbers of identified animal bones from each Area are shown in Table 1 and Figure 1. As with other Early Epipalaeolithic sites in the Azraq basin gazelle (*Gazella subgutturosa*) are the major hunted prey. The presence of cattle (*Bos primigenius*) and wild boar (*Sus scrofa*), while unusual in a steppic landscape, likely reflects the availability of water close to the site. Equids were present in all three areas and are discussed in more detail in a later section. Among the smaller mammals fox (*Vulpes vulpes*) and hare (*Lepus capensis*) are most common. A small number of bones from more uncommon species were also recovered including oryx (*Oryx leucoryx*) from Area A, as well as porcupines (*Hystrix* sp) and *Ovis*/*Capra*. Large canids, perhaps wolves (*Canis lupus*) occurred in numbers in both Areas A and B along with hyena (*Crocuta* sp.) also from Area B. Wild birds were another feature of these assemblages, including ostrich, large reed dwellers, waders and water-fowl. Birds identified to taxon are summarised in Table 1 simply as 'medium birds' and 'large birds' but are described below.

taxon		All areas NISP	%	Area A NISP	%	Area B NISP	%	Area D NISP	%	Other areas NISP	%
Equus caballus ferus	large equid	23	0.49	9	0.84	14	0.40				
Equus hemionus	small-medium equid	28	0.60			26	0.75	2	6.06		
Equus sp.	equid	172	3.69	63	5.86	96	2.77	10	30.30	3	3.13
Bos primigenius	cattle	110	2.36	51	4.74	58	1.68			1	1.04
Ovis/Capra	sheep/goat	3	0.06	2	0.19	1	0.03				
Sus scrofa	boar	18	0.39	9	0.84	9	0.26				
Gazella subgutturosa	gazelle	3834	82.19	765	71.16	2972	85.87	20	60.61	77	80.21
	large artiodactyl	14	0.30	11	1.02	3	0.09				
	medium artiodactyl	15	0.32			15	0.43				
	small artiodactyl	61	1.31	26	2.42	35	1.01				
Hyaena sp.	hyena	2	0.04			2	0.06				
Vulpes vulpes	fox	52	1.11	26	2.42	24	0.69			2	2.08
	large canid	33	0.71	15	1.40	17	0.49			1	1.04
	medium canid	1	0.02	1	0.09						
	small canid	1	0.02			1	0.03				
	small felid	1	0.02			1	0.03				
Lepus capensis	hare	161	3.45	71	6.60	84	2.43				6.25
Hystrix indica	porcupine	3	0.06	3	0.28						
Testudo graeca	tortoise***	3	0.06	1	0.09	1	0.03			1	1.04
	large bird**	35	0.75	2	0.19	30	0.87			3	3.13
	medium bird**	95	2.04	20	1.86	72	2.08	1	3.03	2	2.08
Total hunted/trapped/gathered prey		**4665**		**1075**		**3461**		**33**		**96**	
Microtus (guentheri)	vole	627		210		403		3		11	
Meriones sp	jird	2		2							
	rodent	14		12		2					
	frog	19		17		2					
	Total	**5329**		**1316**		**3868**		**36**		**107**	

Table 1: Animal remains identified to species/genus from Ayn Qasiyya Areas A, B and D shown as NISP counts and NISP%. Species identification of birds are shown in Table 8. Tortoise number derived by dividing numbers of carapace/plastron fragments by 60 and added to numbers of longbone/girdle fragments. (* scute/60 plus long bones/girdle, ** identified taxa only)**

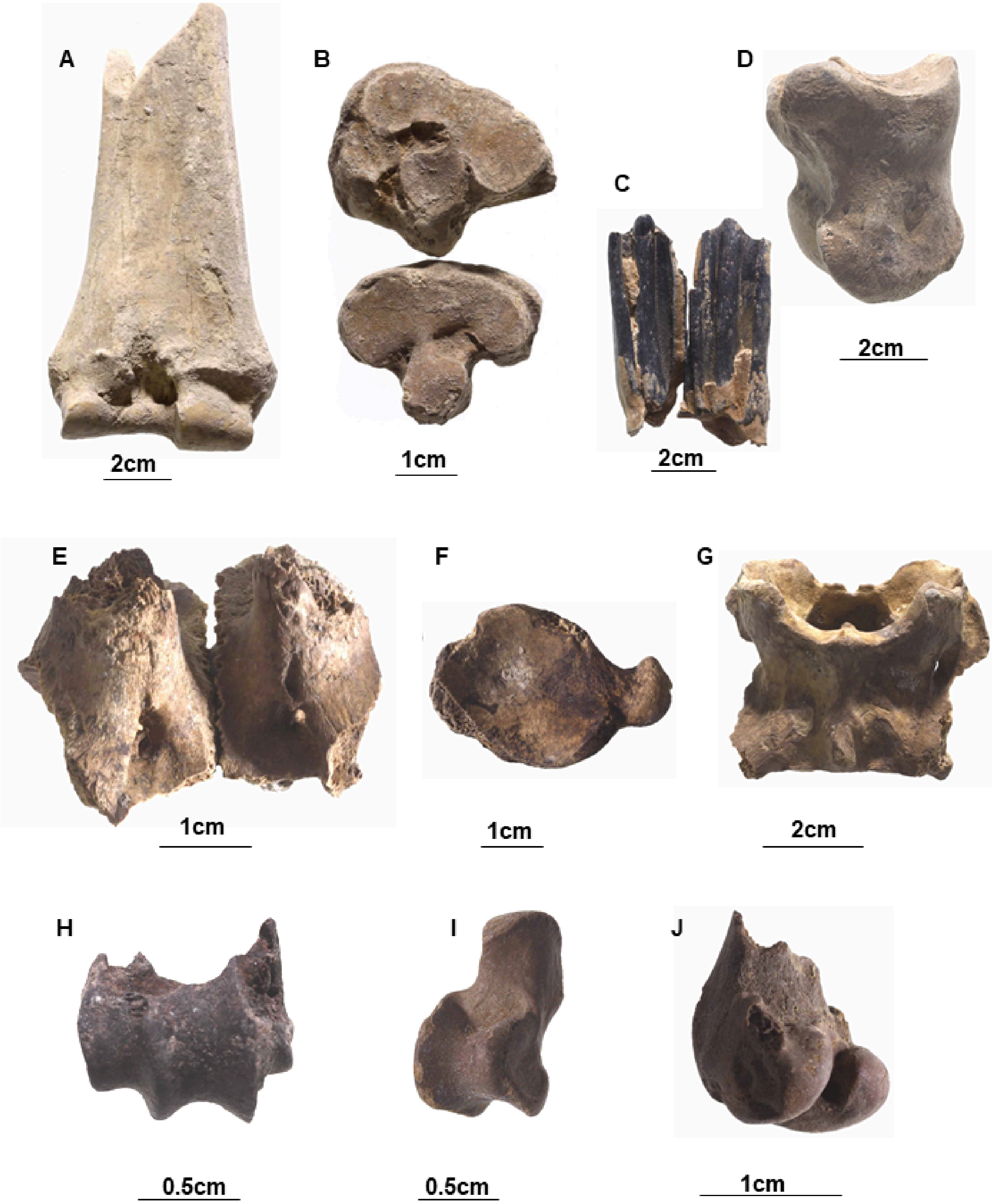

Figure 1: Examples of bones found at Ayn Qasiyya; all are from Area B apart from A and G which were found in Section1 and Area D respectively; accession number given. A. Equid distal left radius (1071); B. Equid second and radial carpals (1925 & 1926). C. Cattle loose upper tooth (2914) demonstrating tooth blackening. D. Cattle second phalanx (2912). E. Gazelle skull fragment at horn-core base. (2997). F. Gazelle left scapula glenoid (3139) with patchy black discolouration. G. Gazelle atlas, acetic acid treated (1037). H. Hare right distal humerus (955), burnt carbonised. I. Hare astragalus (3246). J. Hare left distal femur (2848) with patchy black discolouration.

While the variety and relative importance of species identified are roughly similar in the three areas various differences are apparent. For example, gazelle frequency appears to be higher in Area B than Area A, a feature associated with smaller numbers of equids and cattle (together with large and medium artiodactyls), wild boar and smaller mammals such as hare and fox. In Area D numbers are too small to make a meaningful comparison but it is perhaps notable that while equid and gazelle bones were present no cattle bones were identified. Patterns of sediment sequence and lithic material are very similar in all three areas, suggesting that the sediments were laid down as part of the same geomorphological process (Richter et al, 2009), and indeed variation of prey type numbers between areas may simply reflect location-related patterns of dumping. On the other hand it is worth noting that the differences between radiocarbon dates c.21-24k cal. BP for Area A, 20k cal. BP for Area B and 19.0-19.5k cal. BP for Area D (Richter et al 2013) might indicate that depositions were made over different, though overlapping, time periods and reflect changes in patterns of hunting over time.

Gazelle

Hunting practice As at other Early Epipalaeolithic sites gazelle were the dominant species amongst the hunted/trapped/gathered mammals accounting for 70.4% of bones recovered in Area A and 84.4% in Area B. The oval shape and lyrate twisting of recovered horn cores identified the species as the goitered gazelle *Gazella subgutturosa*. Areas A and B show a similar pattern of bone survival (Table 2) except that horn cores appear to be considerably more common in Area B (Area D numbers are too small to be useful). All body parts are represented but skulls, long bones and girdles are infrequent in comparison to small elements such as phalanges, carpals and tarsals, sesamoids, loose teeth and metapodia. Overall humerus, radius, femur and tibia survived relatively well and were common; astragali and calcanei also occurred in good numbers. The relative scarcity of atlas and axis might suggest cranium removal off-site but the frequency of mandibles argues against this idea. It is perhaps notable that no metapodia and very few phalanges were recovered from Area D, although mandibles, axis and horn core fragments, albeit in small numbers were present: such an absence of limb elements might point to a different routine of butchery/discard during this later phase of occupation.

	Area A		Area B		Area D		Uid	
element	**NISP**	**NISP %**	**NISP**	**NISP %**	**NISP**	**NISP %**	**NISP**	**NISP %**
occipital	2	0.3	6	0.2	0	0		
horn attachment site			3	0.1	0	0		
horn core	1	0.2	59	2.2	3	17.6		
atlas	1	0.2	1	0.0	0	0		
axis	3	0.5	10	0.4	2	11.8		
mandible with/without teeth	37	5.8	142	5.2	3	17.6		
maxilla with/without teeth	7	1.1	11	0.4			2	15.4
loose lower tooth	24	3.8	128	4.7	3	17.6		
loose upper tooth			20	0.7				
scapula	17	2.7	50	1.8				
humerus	9	1.4	88	3.3	2	11.8	2	15.4
radius	19	3.0	67	2.5				
ulna	5	0.8	24	0.9				
carpals	49	7.7	225	8.3	1	5.9		
metacarpal	24	3.8	16	0.6				
pelvis	5	0.8	54	2.0				
femur	8	1.3	95	3.5				
patella	7	1.1	64	2.4				
tibia	21	3.3	96	3.5				
os malleolare	2	0.3	13	0.5			1	7.7
tarsals	22	3.4	88	3.3			3	23.1
astragalus	18	2.8	81	3.0			2	15.4
calcaneus	14	2.2	74	2.7				
carpal/tarsal			2	0.1				
metatarsal	44	6.9	16	0.6				
metapodial	71	11.1	347	12.8				
first phalanx	119	18.6	382	14.1	1	5.9	1	7.7
second phalanx	61	9.5	324	12.0	1	5.9	2	15.4
third phalanx	51	8.0	220	8.1	1	5.9		
Total	**641**		**2706**		**17**		**13**	
other elements excluded from % calculation								
sesamoid	83		87		1			
tooth fragment	41		179		2			

Table 2: Identified gazelle elements shown as NISP and NISP %. Sesamoids and tooth fragments are not included but numbers are shown separately.

Butchery and modification The bone evidence indicates that whole carcasses were transported to the site and butchered locally. The survival profile of cranial parts is poor but retrieval of mandibles and some horn cores argues against removal of heads and dumping at the kill site; rather the lack of identifiable skull fragments might suggest crania were routinely smashed to access lipid rich brains. Similarly the poor survival of long bones likely reflects selective smashing of bone to retrieve marrow and fat. This view is supported by butchery evidence found on single examples of tibia, radius, humerus and metapodia which appear to have been split vertically; four astragali were also split in the same way. Smaller bones of the extremities also appear to have been cracked open; twenty-five phalanx 1 and six phalanx 2 were cut or snapped horizontally across the shaft while three phalanges were apparently split vertically. It seems that this pattern of breakage facilitated marrow/grease recovery.

A number of bones exhibited cut marks suggestive of carcass disarticulation and skinning; for example, parallel cut marks were seen on a phalanx 2 shaft and a metapodia distal condyle, in addition both the shaft of a calcaneum and anterior surface of three astragali showed single cut marks. Evidence of chopping across the distal ends of an astragalus, two distal humeri and an ulna proximal shaft was also noted.

While there is no direct indication that horn cores were modified or worked it seems likely that they were valued for their use as material for tool/ornament preparation. Evidence that they were removed intact is suggested by fifteen of the specimens reported here which are either substantial portions of intact horn cores or can be reconstructed from fragments identified in the same context; one rebuilt horncore was almost complete with a maximum length of 18cm (Figure 2).

Figure 2: Three examples of gazelle (*Gazella subguttorosa*) horncores recovered from Area B.

Separation of sexes The hunting of both males and females was investigated by plotting the sizes of scapulae and astragali using morphometric features which show sexually dimorphic size variation as described by Horwitz et al. (1990) where sexual dimorphism is scored as D % = male mean minus female mean/male mean. Figure 3 A shows bivariate plots for scapulae which have strong D% values and here the greatest breadth of the glenoid process - GLP (D%= 10.9) is plotted against greatest depth of the glenoid - BG (D%=7.5) A bivariate plot for astragali with greatest distal breadth - Bd (D%=8.0), plotted against the length of the lateral side – GLI (D%=6.6) is also shown in Figure 3B. Both plots show a wide spread of sizes where smaller animals are likely to represent females and the largest are likely males; as expected discrimination is strongest for scapulae but there are obvious overlaps in both cases which might indicate the presence of older, large females and young male yearlings which have not yet reached full size. This representation of males and females suggests that gazelle hunting at Ayn Qasiyya took place during winter and early spring, perhaps before birthing in March and May (Martin 2000) when the hinds become solitary and males group together in late spring and early summer.

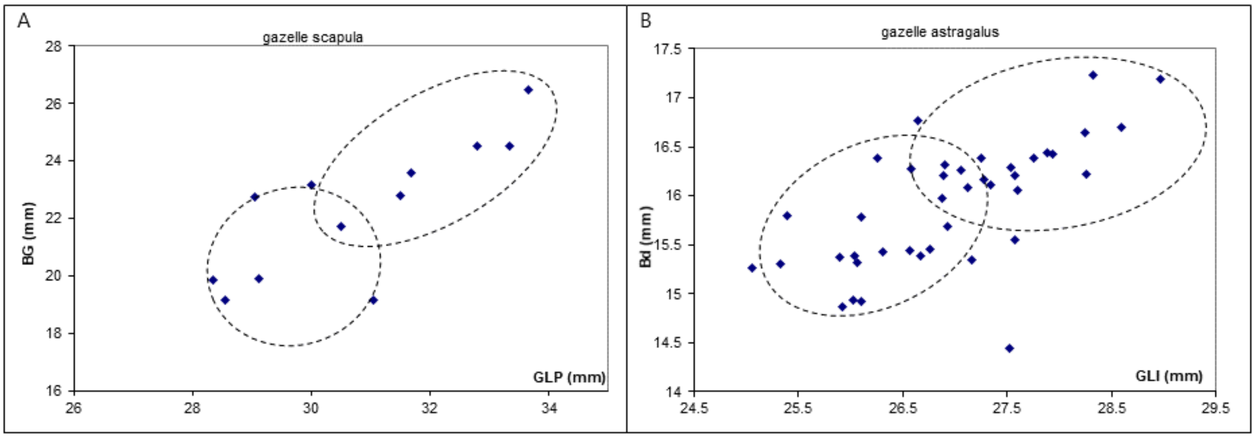

Figure 3: Bivariate plots showing: A - scapulae greatest length of the glenoid process - GLP (D%= 7.5), plotted against greatest breadth of the glenoid - BG (D%=10.9): B. astragali greatest distal breadth - Bd (D%=8.0), plotted against the length of the lateral side – GLI (D%=6.6). The spread of sizes suggest indicates two main age groups with the smallest grouping representing females and young and the largest males with some older, large females.

Age at death patterns Patterns of gazelle hunting were explored by estimating the proportion of juvenile gazelles culled in Areas A and B (following Davis 1983; Munro et al 2009). Epiphyseal fusion data is summarised in Table 3. The low numbers of young fawns culled in the first two months of life appears to indicate deliberate avoidance of hunting fawns and the same is also true, in both Areas A and B, for those aged 3- 8 months old. However, unfused elements of the very young do not survive well and their absence could also result from taphonomic processes. The frequency of unfused bones appears to increase with age such that the incidence of unfused bones which normally fuse at 8-10 months is higher, 14.3% in Area A and 31.4% in Area B. The disparity in relative proportions between the two areas might reflect the relatively low numbers of specimens from Area A but could also be explained by changes in hunting patterns over time or taphonomic differences between Areas A and B leading to a loss of juvenile bones in Area A.

		Area A			**Area B**	
element	**unfused**	**fused**	**% fused**	**unfused**	**fused**	**% fused**
proximal 1st phalanx	0.5	21		1	112	
proximal radius		9		1	26	
c. 2months	**0.5**	**30**	**98.4**	**2**	**138**	**98.6**
glenoid scapula	0	0		0	31	
distal humerus	0	2		1	41	
3-8 months	**0**	**2**	**100**	**1**	**72**	**98.6**
distal tibia	2	12		16	35	
8-10 months	**2**	**12**	**85.7**	**16**	**35**	**68.6**
proximal humerus	0	3		4	8	
distal femur	0	1		5	25	
proximal femur	1	3		11	24	
calcaneum	4	2		14	29	
distal metapodials	17	16		61.5	75	
proximal tibia	3	3		9	6	
distal radius	3	2		11	12	
10-18 months	**28**	**30**	**51.7**	**115.5**	**179**	**60.8**

Table 3: Gazelle fusion data from Areas A and B with numbers adjusted to reflect numerical weighting of elements. Times of fusion taken from Davis (1980a) and Munro et al (2009).

In both Areas 40-46 % of gazelle were culled as sub-adults at 10-18 months. These levels are greater than seen at other Epipaleolithic sites in the Azraq Basin which tend to be between 25% and 36% (Martin 2000 p257). For example at early Epipalaeolithic Kharaneh IV kill patterns were commensurate with natural herd structures such that in the Geometric and Late Kebaran Phases about 34-35% were taken at 10-18 months (Martin et al. 2010). In the Eastern Jordanian plateau higher levels of sub-adult culling are known only from the Late Neolithic site of Dhuweila, which lies in the Black Desert north-east of al-Azraq where c.39% gazelle were slaughtered in the 8-10 month period and 44.5% of in the 10-18 month old group (Martin 1998). Increased culling of juvenile gazelle has been recognised at Natufian sites in the coastal and hilly regions on the west side of the Jordan Valley and has been associated with increased sedentism (Davis 1989; Munro 2004). At Ayn Qasiyaa other explanations for this pattern of culling should be considered which take into account the nature of this vegetation and faunal rich wetland site. For example local conditions may have encouraged a second period of mating in late spring with fawning in November (Baharav 1983a,b) thereby increasing the numbers of juveniles present at any one time.

Alternatively the year around presence of game, water and vegetation may have made longer periods of settlement attractive, perhaps even year round occupation; in this case the summer months would have provided access to both juveniles in their first year and second year of life. In a different context but relevant to these observations it is striking that Davis 1983) deduced that at Hayonim Terrace gazelle had been hunted throughout the year including the summer, a finding based on gazelle age profiles which included both winter and summer juveniles. The much smaller assemblage retrieved from Area D provided no fusion information.

Gazelle bone survival Relative element survival for gazelle was explored using data from Area B where the largest assemblage was recovered. Relative body part survival was determined using a method based on MNI's, which takes into account the unevenness of skeletal element representation. Phalanx 2 showed the greatest relative survival (Minimum Number of Individuals: MNI = 59.5) and this was used as a baseline to construct the survival profile shown in Figure 4A. This profile reflects the observation that all bones have been subject to intensive smashing, with only the smaller elements such as phalanges, astragalus and patella, surviving in a recognisable form in good numbers (> 50%). Proximal ends of humeri, metapodia and tibia were particularly vulnerable to destruction. It is worth noting in the context of age of death that the apparent good recovery of distal metapodia can be ascribed largely to recovery of unfused epiphyses and with calcanei numbers made up of fused bones and unfused epiphyses. As described for other hunter/gatherer sites (Munro & Bar-Oz 2009) comprehensive bone smashing in order to retrieve marrow and fat was a likely routine practice at Ayn Qasiyya, although here there is a suggestion of further reduction before/after dumping. This view is supported by a comparison of gazelle bone survival and relative bone density (Figure 4B) which demonstrates that only 15% of the variance (Pearson's $r^2 = 0.151$) is due to relative density.

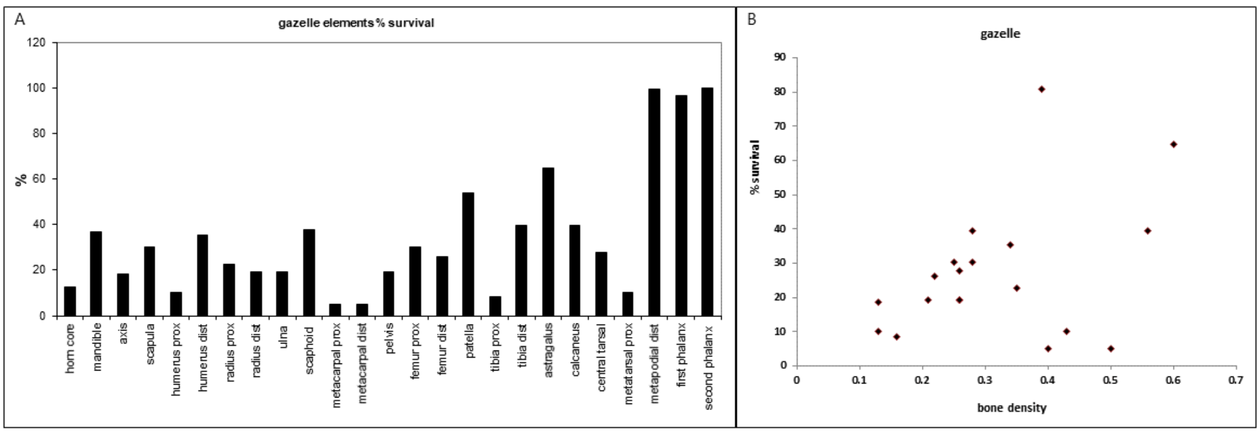

Figure 4. Gazelle body part survival A. As percentage of adjusted total; B. Relationship to bone density ; Pearsons r=0.3387 indicating only 11.5% of variance (r2) due to bone density.

Equids

Equids, which would have been grazing on the steppic vegetation, were the next most abundant meat bearing taxon accounting for c.4% of the whole assemblage. These animals would have been drawn to the area around the Ayn Qasiyya oasis by the need to replenish their water uptake regularly (Sneddon and Argenzio 1998; Mejdell et al.2005). Size variation amongst intact or near-intact elements suggested that two species were present and morphometric analysis (Appendix 1) showed the greatest breadth (GB) of third phalanges varied between 39.3mm and 64.8mm, and the medial trochlea tali of astragali between 44.7mm and 65.1mm; in addition the greatest breadth of the distal radius varied between 59.85mm and 71.41mm. Likely candidates are *Equus caballus ferus,* the wild horse and *Equus hemionus*, the wild ass, which are steppe dwelling and have been identified on other sites in the Azraq Basin (Martin et al. 2010). Separation of the two equid types by their size at Ayn Qasiyya was tentative and limited, however wild horses appeared to be present in Area A while both wild ass and wild horse were apparent in Area B.

Separation of species was also possible using an approach based on comparisons of surface patterning on intact teeth (Davis 1980a; Payne 1991) which is most informative where tooth wear is not excessive and enamel patterns were clearly visible. Figure 5 shows three mandibular teeth 2827 (3^{rd} molar), 1527 (1^{st} molar) and 152 (4^{th} premolar) with shallow exoflexids which do not penetrate the buccal fold, together with ‘V’ shaped linguaflexids (arrowed), features which are most often associated with *Equus hemionus*. The single maxillary tooth 978 (pre-molar 4) shows complex fossette and caballine folds, features commonly found for *E. caballus ferus*. Both equid species are likely to have provided a relatively large quantity of meat per kill since their edible meat corresponds approximately to 30-35% of total weight (Klingel 1974). In the present day the only wild horse that survives is the small Prezawlski horse, which nevertheless tends to be larger (body weight c.200-300kg) than the modern ass (body weight c.200-260kg) (Moehlman et al. 2008).

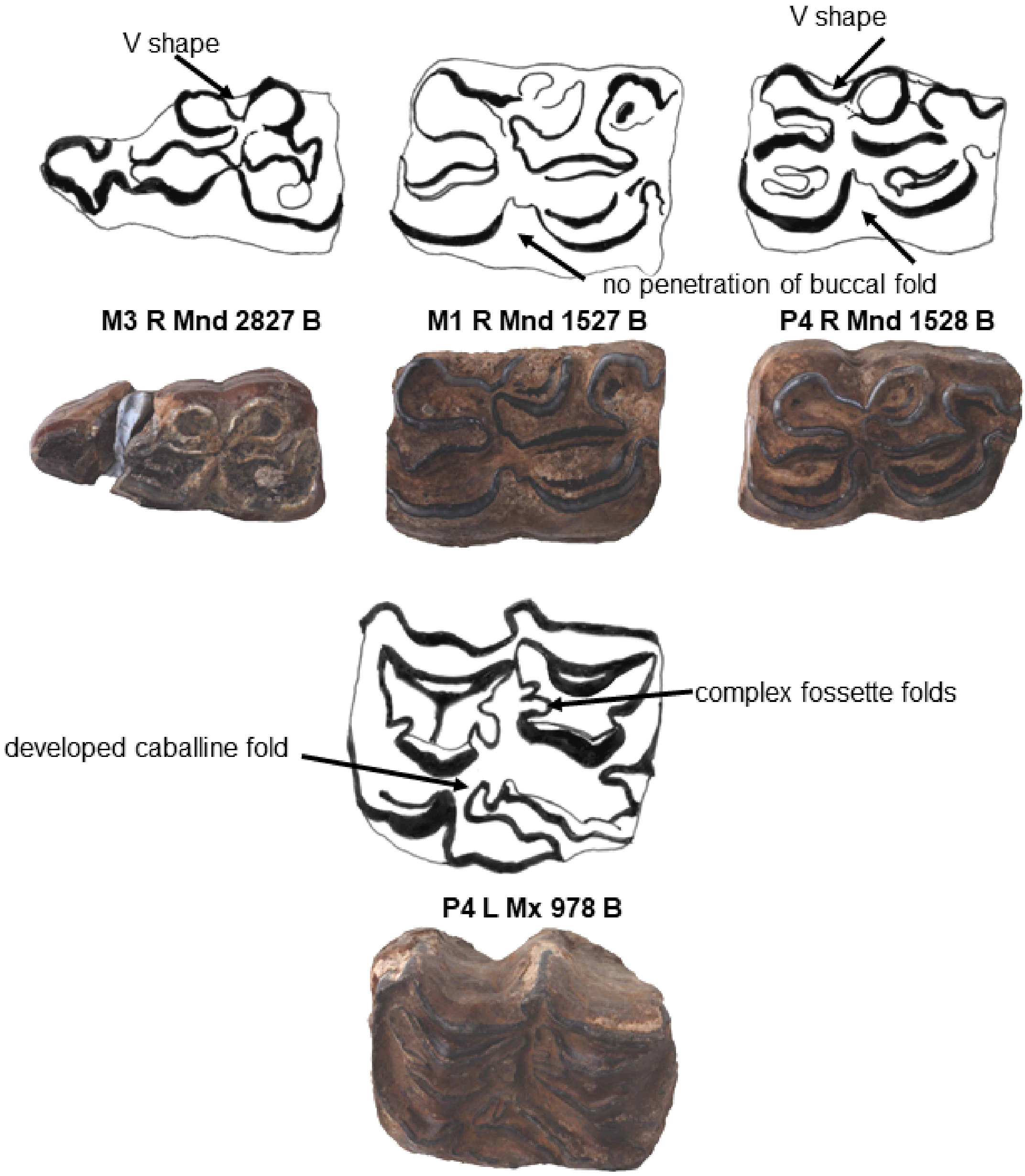

Figure 5: Equid teeth surface patterning. The four examples shown here can be tentatively assigned to equid type; specimens 2827, 1527 and 1528 show non-penetration of the buccal fold by a 'shallow' exoflexid (arrowed) together with a 'V' shaped linguaflexid, features which are most often associated with *Equus asinus*. Specimen 978 shows complex fossette and caballine folds characteristic of *E. caballus*.

The pattern of element survival for equids (Table 4) is similar to that observed for gazelle, with smaller bones apparently better preserved than long-bones, girdles and skull whose characteristic features were lost during bone smashing. Loose teeth are most common, accounting for almost 30% of the remains (listed along with tooth fragments in Appendix 2), with metapodia, phalanges and tarsal/carpals the next most numerous in both Areas A and B. Among the long bones humerus, radius and tibia were present in very small numbers while femurs and ulnas were unrepresented. Despite their relatively poor survival, fore-limbs, hind-limbs and crania were identified suggesting that at least on some occasions all body parts were carried to site, either as whole carcasses or partly dismembered.

	Area A		Area B		Area D		uid	
element	**NISP**	**NISP %**	**NISP**	**NISP %**	**NISP**	**NISP %**	**NISP**	**NISP %**
mandible with/without teeth			1	0.94				
loose teeth	16	29.63	30	28.30	7	63.64		
scapula	1	1.85	1	0.94				
humerus			3	2.83				
radius	1	1.85	3	2.83	1	9.09		
ulna								
carpal	3	5.56	21	19.81	1	9.09	1	50
metacarpal	1	1.85	1	0.94				
pelvis			1	0.94				
femur								
tibia	1	1.85	1	0.94				
astragalus			5	4.72				
calcaneus	1	1.85	2	1.89				
tarsal	7	12.96	7	6.60				
metatarsal	4	7.41						
metapodial	3	5.56	11	10.38			1	50
first phalanx	10	18.52	8	7.55	1	9.09		
second phalanx	4	7.41	4	3.77				
third phalanx	2	3.70	6	5.66	1	9.09		
anterior third phalanx			1	0.94				
total	**54**		**106**		**11**			
other elements excluded from % calculation								
tooth fragment	3		19		2			
sesamoid	4		10		1			
vertebra	2		1					

Table 4: Identified equid elements shown as NISP and NISP %. Sesamoids and tooth fragments not included but numbers shown separately.

Cattle Wild cattle (*Bos primigenius*) were also hunted at Ayn Qasiyya and accounted for 4.7% of hunted species in Area A and less than 1.7% in Area B. Wild cattle are considered to have weighed between 700 and 900 kg with about a third of the weight as meat weight (Estes 1974) which would have contributed significantly to the meat intake of the Ayn Qasiyya inhabitants. All body parts were found on site with the notable absence of skull and horn cores (Table 5) which were perhaps discarded at the kill-site or taken to another location as trophies. As found for equids, loose teeth, metapodia, carpals/tarsal and phalanges are relatively common while long bones and girdles were identified less frequently. While this pattern seems largely attributable to the size reduction of long bones it is also worth considering whether on some occasions jointed meaty sections from cattle, equid or gazelle carcasses were removed to nearby dry-land occupation locations yet to be discovered.

	Area A		Area B	
element	**NISP**	**NISP %**	**NISP**	**NISP %**
mandible with/without teeth	7	21.2		
loose tooth	4	12.1	5	13.9
humerus			1	2.8
radius	1	3.0		
ulna	3	9.1		
carpals			7	19.4
metacarpal	2	6.1	4	11.1
pelvis	1	3.0	1	2.8
femur	1	3.0	2	5.6
tibia	1	3.0	1	2.8
astragalus			2	5.6
calcaneus			1	2.8
tarsal	2	6.1	1	2.8
carpal/tarsal			2	5.6
metatarsal	2	6.1		
metapodial			3	8.3
first phalanx	3	9.1	2	5.6
second phalanx	3	9.1	3	8.3
third phalanx	3	9.1	1	2.8
total	**33**		**36**	
other elements excluded from % calculation				
sesamoid	8		4	
tooth fragment	10		18	

Table 5: Identified cattle elements shown as NISP and NISP %. Sesamoids and tooth fragments not included but numbers shown separately.

It is notable that cattle, which are readily linked with grassland and open woodland, were sharing a steppic landscape with equids and gazelle. However, during the Epipaleolithic more rainfall would have been experienced in the winter and spring months than in the present day (Garrard and Byrd 1992; Bartov 2002) replenishing bodies of water such as the oasis at Ayn Qasiyya which would have provided both vegetation cover and a good supply of water for cattle all year around.

Wild boar Small numbers of bones from wild boar (*Sus scrofa*) were also encountered amongst the Ayn Qasiyya assemblage; their presence confirms that the Ayn Qasiyya habitat offered dense thickets and marshy banksides which wild boar enjoy. They feed on vegetation such as bulrush, particularly underground roots and rhizomes, arthropods, snails and birds - especially ducks which are most vulnerable to predation while moulting (Giménez-Anaya et al 2008). The boar bones identified included fragments of two maxillae, a single mandible and metatarsal, phalanges and loose teeth (NISP=18); there was no indication that long bones and girdles had been present. Age estimation based on bone fusion was impossible since the proximal ends of phalanges and distal end of the metatarsal were absent and sex could not be determined owing to the scarcity of tusks.

Other artiodactyls Very small numbers of sheep/goat were identified from elements including the proximal epiphysis of a metacarpal, an astragalus and phalanx 3. The presence of these taxa in the environs of Ayn Qasiyya is unexpected, however small numbers of sheep/goat have been reported at other Epipalaeolithic eastern Jordan sites for example Middle Wadi Jilat 22 (Martin et al.2013) and Uwaynid 18 (Martin 1994). These Ayn Qasiyya animals most likely represent wild goat (*Capra aegagrus*) at this period, although wild sheep (*Ovis orientalis*) are known from Epipalaeolithic sites in northern Syria and northern and eastern Iraq (Uerpmann and Uerpmann 1987; Legge and Rowley-Conwy 1986).

Hare Amongst the smaller mammals hare (*Lepus capensis)* bones were most numerous, with a total NISP=160. All body parts, apart from fine skull fragments, were represented. Distal humerus, scapula glenoid and astragali were well-preserved together with small numbers of loose teeth and mandible fragments. Harrison and Bates (1991) noted a variable size polymorphism amongst Levantine hares and indeed there were some notable size differences amongst the Ayn Qasiyya hare; for example the greatest length (GL) of astragali varied between 12.8mm to 16.1mm while the breadth of the distal humerus (Bd) varied between 8.5mm to 11.4mm (Appendix 1).

Bearing in mind the apparent poor relationship between element survival and bone density displayed by gazelle and equids, it was of interest to examine these features in the hare where bones are considerably smaller and more fragile. MNI's were estimated for each element and the well-preserved distal humeri used as the baseline to determine representation of other elements. The survival of long bones apart from distal humerus was poor (Table 6) and only calcanei, astragali and scapula glenoids showed survival rate above 50%. Such poor survival could be related to bone density, however, when volume densities for hare bones determined by Cruz-Uribe and Klein (1998) were plotted against % survival values (Figure 6), it appears that density played virtually no part in the survival pattern accounting for only 3.7% of the variance. Hare bones would not yield worthwhile returns of marrow or grease and it seems most likely that their fragmentation is associated with taphonomic processes such as trampling or a deliberate smashing associated with waste disposal.

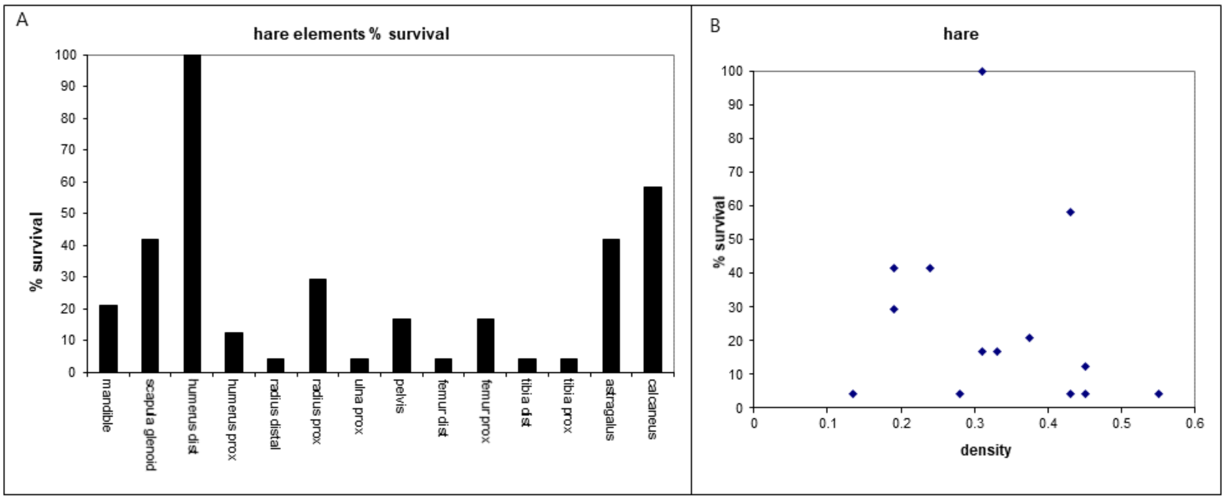

Figure 6: Hare body part survival shown in A. as percentage of adjusted total; B. Relationship to bone density ; Pearsons r=0.1916 indicating only 3.7% of variance (r2) due to bone density.

	Area A		**Area B**		**other**	
element	**NISP**	**NISP %**	**NISP**	**NISP %**	**NISP**	**NISP %**
mandible with/without teeth	3	4.4	2	2.4		
loose tooth	1	1.5	5	5.9		
scapula			10	11.8		
humerus	12	17.6	13	15.3		
radius	5	7.4	3	3.5		
ulna	2	2.9				
metacarpal	2	2.9	1	1.2		
pelvis	1	1.5	3	3.5		
femur	3	4.4	5	5.9		
tibia			4	4.7	1	100
malleolus	1	1.5				
astragalus			10	11.8		
calcaneus	6	8.8	8	9.4		
carpal/tarsal	8	11.8	5	5.9		
metatarsal	3	4.4	2	2.4		
metapodial	8	11.8	8	9.4		
first phalanx	10	14.7	4	4.7		
second phalanx	3	4.4	2	2.4		
total	**68**		**85**		**1**	
other elements excluded from % calculation						
tooth frags	5					
sesamoid			1			

Table 6: Identified hare elements shown as NISP and NISP %. Sesamoids and tooth fragments not included but numbers shown separately.

Fox and other carnivores Canids were also relatively well represented (total NISP = 69) with fox bones making up almost half of these. The fox specimens could represent the highly adaptable red fox (*Vulpes vulpes*) and/or the sand fox (*V. rupelli*). All body parts, except scapula and pelvis, were represented (Table 7) with femur, metapodia, phalanx 1 and loose teeth most common. Nine specimens provided limited morphometric data (Appendix 1). These predators, which adapt readily to many habitat types in the Levant (Harrison and Bates 1991), are likely to have been exploited for both meat and pelt.

	Area A		Area B		other	
element	**NISP**	**NISP %**	**NISP**	**NISP %**	**NISP**	**NISP %**
mandible with/without teeth		0	2	9.1		
loose tooth	3	11.1	4	18.2		
scapula	1	3.7	1	4.5		
humerus			1	4.5		
radius			2	9.1		
ulna			1	4.5	1	50
metacarpal	3	11.1	1	4.5		
metapodial	3	11.1	1	4.5		
pelvis			2	9.1		
femur	1	3.7	2	9.1	1	50
tibia	3	11.1	2	9.1		
astragalus	2	7.4				
calcaneus	1	3.7				
cuboid						
metapodial	2	7.4				
carpal/tarsal						
first phalanx	5	18.5				
second phalanx	2	7.4	3	13.6		
third phalanx	1	3.7				
total	**27**		**22**		**2**	
other elements excluded from % calculation						
caudal vertebra			1			

Table 7: Identified fox elements shown as NISP and NISP %.

The remaining canid bones were larger than those of the fox, with metapodials accounting for 38% of the total while phalanges, carpals/tarsals and a single scapula fragment made up the remainder. Two phalanges were possibly those of the striped hyena (*Hyaena hyaena*); other candidates for the remaining bones are golden jackal (*Canis aureus*) and wolf (*Canis lupus*), species which may still be encountered in north-east Jordan (Bunaian et al 2001). It is likely that these carnivores were killed for their pelts, but their slaughter may also be part of a deliberate drive to lessen carnivore predation on desirable human resources such as gazelle, wetland birds and their eggs.

A single felid mandible fragment was also recovered. This is likely to represent the jungle cat (*Felis chaus*) a diurnal species feeding largely on rodents, hares, birds and reptiles (Baker et al 2003) and which is associated with thick tamarisk, typha and phragmites vegetation alongside large bodies of water such as those which occurred during the Epipaleolithic period at Ayn Qasiyya. In the present day the jungle cat is confined to refuges along the eastern bank of the river Jordan.

Rodents A mandible fragment and two tooth fragments from a porcupine (*Hystrix indica*) were recovered from Area A. This species which is currently native in Jordan is known to occupy rocky hillsides, shrubland and grasslands feeding on vegetation, tubers and roots (Amr, 2000). It is protected from predation by rattling its long, stiff hollow quills and may deter an attack by impaling quills into the flesh of an attacker. It is notable that the Sioux and other native American groups used porcupine quills to decorate clothes (Lyford 1940) and it is possible that at Ayn Qasiyya the porcupine was hunted perhaps for its quills rather than as food.

Microtine vole (*Arvicola terrestris*) bones, mostly mandibles (NISP 215) and loose teeth (NISP 341), were recovered in large numbers from all three areas at Ayn Qasiyya. A single humerus and two ulnas were also identified. This relatively large water vole is a strong swimmer that lives around rivers and marshes with lush vegetation eating roots, bulbs and tubers and sometimes molluscs and small fish (Harrison and Bates 1991; IUCN 2012). It is unlikely that voles were part of the human occupant's diet at Ayn Qasiyya, however they would have been choice prey for carnivores and raptors hunting around the marshland and a proportion would have died a natural death. Thirteen bones from other unidentified rodents were also recovered.

Tortoise Tortoises (*Testudo graeca*) were uncommon at Ayn Qasiyya with just 70 carapace/plastron fragments recovered and a single femur fragment. Although tortoise have been identified in significantly larger numbers at other Eastern Jordan sites such as Epipalaeolithic Wadi Jilat 22, Kharaneh IV and Wadi Jilat 6 (Martin et al. 2010 & 2013; Martin 1994) these sites were located within wadis set in a steppic landscape; it is likely that the marshland oasis habitat at Ayn Qasiyya, especially the surrounding dense damp vegetation, was unsuitable for tortoise.

Birds

A wide variety of birds were present at Ayn Qasiyya (Table 8), the majority commensurate with wetland and marsh conditions with smaller numbers of steppe/desert species representing the broader environment.

		Area A		Area B		other	
Taxa	**common name**	**NISP**	**NISP %**	**NISP**	**NISP %**	**NISP**	**NISP %**
Cygnus	swan			1	0.91		
Anser sp.	goose			1	0.91		
Ducks - surface feeders							
Anas platyrhyncos	mallard	11	45.83	33	30.00		
Anas penelope	wigeon	1	4.17	1	0.91	1	33.33
Anas clypeata	shoveler	1	4.17				
Anas crecca	teal	2	8.33	1	0.91		
Tadorna tadorna	shelduck			4	3.64	1	33.33
Diving ducks							
Athya ferina	pochard			8	7.27		
Athya fuligula	tufted duck			9	8.18		
Athya nyroca	ferruginous duck			1	0.91		
Anatidae	duck sp.	1	4.17	2	1.82		
Waders							
Ardea cineria	grey heron			3	2.73		
Ardea purpurea	purple heron	1	4.17				
Bostaurus stellaris	bittern			19	17.27	1	33.33
Egretta alba	great white egret			4	3.64		
Ciconia ciconia	stork	1	4.17	1	0.91		
Gallinula chloropus	moorhen	1	4.17				
Fulica atra	coot	3	12.50	3	2.73		
Numensius	curlew			1	0.91		
Burhinidae							
Burhinus oedicnimus	stone curlew			2	1.82		
Struthionidae							
Struthio camelus	ostrich	2	8.33	6	5.45		
Raptors							
Aquila sp.	eagle sp.			1	0.91		
Accipter gentilis	goshawk			3	2.73		
Buteo buteo	buzzard			2	1.82		
Pheasants and partridge							
Alectoris chukar	chukar partridge			1	0.91		
Perdix perdix	grey partridge			2	1.82		
Syrrhaptes paradoxus	sandgrouse			1	0.91		
total		**24**		**110**		**3**	

Table 8: Birds identified at Ayn Qasiyya grouped by type. NISP and NISP% of the total number of birds is shown.

Swans and geese Single bones from a swan and goose were recovered from Area B. The former is most likely to represent the mute swan (*Cygnus olor*), a species that prefers lowland freshwater wetlands, lagoons and marshes with reed beds (del Hoyo et al. 1992; Madge and Burn 1988). The mute swan is presently classified as vagrant in Jordan (IUCN 2012) but may represent a single bird on migration to warmer climes during the winter months. The goose, most likely a greylag goose (*Anser* cf *anser)* is represented by a distal humerus. This highly gregarious species is native in Jordan, fully migratory and breeds during April/May in loose colonies in wetlands with fringing vegetation and in open grassland or steppe/semi-desert (del Hoyo et al. 1992, Madge and Burn 1988). Flocks of geese move to warmer climes after the breeding and moult migrations

(Beaman and Madge 1998; Scott and Rose 1996); thus while it is possible that the Ayn Qasiyya goose may have been a local resident breeding in the marshes it could also represent a winter visitor.

Ducks – surface feeders Five species of surface feeding ducks were identified in Areas A and B. Of these mallard (*A. platyrhynchos*) were most common, total NISP = 44, with small numbers of shelduck (*Tadorna tadorna*) and less common species such as wigeon (*A. penelope*), teal (*A. crecca*) and shoveler (*A.clypeata*).

Mallards are resident breeders in Jordan and may have nested at Ayn Qasiyya however they also assemble in large flocks at widely distributed wetland sites in the August to September post-breeding period. The presence of shelduck suggests that these birds were migrating south to warmer climes; in general they have a preference for saline habitats however they utilise freshwater habitats especially on migration (del Hoyo et al. 1992; Beaman and Madge 1998; IUCN 2012).

Wigeon, which chiefly breed in sub-arctic and boreal areas, are common and widespread migrants and likely winter visitors to Jordan wetlands (Kirwan et al. 2008). Similarly, teal breed across North Eurasia but winter well south of their breeding range with the Near East as an important wintering location. Here they are widespread from October to April, favouring shallow water on large open ponds and lakes; both wigeon and teal are likely to be hunted during the wintering season (Beaman and Madge 1998).

Shovelers have an extremely large range and are currently native to Jordan, breeding in marshy wetlands. They are passage migrants from late March to late April and mid September to early November with large concentrations at stop-over sites (Kirwan et al. 2008; IUCN 2012).

Ducks – bay ducks Three species of bay duck - pochard (*A. ferina*), tufted duck (*A. fuligula*) and ferruginous duck (*Athya nyroca*) - were identified. Pochard and tufted duck were relatively common in Area B; both species have an extremely large range and are listed as native to Jordan, Israel and Iraq. Pochard prefer nutrient rich water with abundant submerged macrophytes and prefer inland wetland (Madge and Burn 1988; Kirwan et al 2008). Tufted duck also prefer freshwater lakes and ponds with dense, encircling vegetation cover and survive on a diet of molluscs, aquatic insects and grain/seeds. They arrive in large numbers at breeding grounds in Late April and the Autumn migration begins in September; these birds are highly gregarious during winter (Beaman and Madge 1998; Kirwan et al. 2008).

The ferruginous duck, is a steppe based species with a widespread distribution in south and east Europe and south and west Asia; it migrates further south in winter, forming large flocks with other diving ducks and is likely to have arrived at Ayn Qasiyya as a winter migrant (Beaman and Madge 1998; IUCN 2012).

Waders Small numbers of rail bones were encountered including wing and limb bones from the coot (*Fulica atra*) and a single tibiotarsus of a moorhen (*Gallinula chloropus*). These species are both native to Jordan and associated with freshwater ponds and lakes with fringing vegetation.

Two stone curlew (*Burhinus oedicnemus*) humeri were also recovered from Area B; this bird is associated with stoney semi-desert, steppic landscape with low bushes and open areas in the Near East where it breeds. Migrant flocks assemble at wetlands in August to September (Kirwan et al. 2008; Beaman & Madge 1998).

A single scapula evidenced the presence of curlew (*Numenius arquata*) often seen on tidal mudflats and adjacent fields although in the breeding season they move inland to heathland and moorland. It seems likely that the Ayn Qasiyya bird was a migrant of the eastern race (*Numenius arquata orientalis*) migrating from Russia or Western Siberia across the Middle East on passage to Mediterranean or African coastal areas (del Hoyo et al. 1992; IUCN 2012).

Herons and storks Several medium large heron/egrets were identified amongst the bird bone assemblage . The most common was the great bittern (*Botaurus stellaris*) of the heron family (Area B NISP =19), which was identified mainly from coracoids, scapulae and a small number of humeri. This thickset bird forages in phragmites reed-beds, feeding on fish, eels and amphibians; it is currently resident in Jordan, but survival is threatened by drainage leading to loss of reed-beds and habitat.

The presence of the grey heron (*Ardea cineria*) was also marked by two coracoids and a scapula in Area B. This is a hardy bird found throughout Eurasia and Africa. Although they breed close to wetlands, building bulky nests of sticks (Bower and Rabago 2013), their presence at Ayn Qasiyya is more likely to reflect dispersal to warmer climes in September-October after the breeding season (IUCN 2012). The purple heron (*Ardea purpurea*), identified in Area A from a scapula, is also likely to have been a migrant visitor to Ayn Qasiyya. Both heron species inhabit dense beds of mature phragmites, feeding on fish, frogs and insects and nests on a platform of reeds (IUCN 2012; Beaman and Madge 1998; Kirwan et al. 2008).

In addition to herons, two bones from storks were identified; both represent the white stork (*Ciconia ciconia*), a large bird most common in eastern and central Europe and parts of Central Asia. The white stork finds most of its food, amphibians, insects, small mammals and small birds, amongst low vegetation and in shallow water. They are long distance migrants wintering in Africa and when migrating from Europe sometimes detour via the Levant making short term resting stop-overs (Cramp 1977; Beaman and Madge 1998). The great white egret (*Egretta alba*) was also identified by characteristic coracoids and scapulae; a rather localised species which breeds close to vegetation fringed lakes with dietary preferences similar to those of herons. This relatively uncommon egret, a partial migrant, may have been moving south in the winter when it was captured at Ayn Qasiyya.

Raptors Marsh lands provide attractive stop-overs for raptors to feed and water and not surprisingly six raptor bones were recovered from Area B. These included the humerus, tibiotarsus and femur from a goshawk (*Accipter gentilis*), the posterior phalanx and tarsometatarsus of a buzzard, probably the long-legged buzzard (*Buteo* cf *rufinus*), and the posterior phalanx of a large eagle (*Aquila* sp.). The goshawk has a very wide distribution, favouring forest bordering open shrubby steppic areas and will take grouse-size birds as prey (Miller et al. 2013). The long-legged buzzard favours steppe, semi-desert and desert-fringes and is currently resident in the Azraq Basin area (Beaman and Madge 1998). The eagle bone could derive from one of several species known to have hunted across the Azraq Basin; for example *A. nipalensis* or *A. chrysaetos* (Martin et al. 2013).

Other birds Eight ostrich (*Struthio camelus*) bones were recovered, four posterior phalanges, one anterior phalanx and a lumbar vertebra from Area B and two long bone fragments from Area A. This bird would have been a local native of the Ayn Qasiyya area during the Epipalaeolithic and much sought after as prey, since they weigh between 65-145kg providing a meat weight of 25-60kg. The ostrich does not fly and when threatened will lie flat on the ground or kick forward with their powerful legs and/or run away at up to 70km/h (Davies 2003). Ostriches feed mainly on seeds, shrubs, grass, fruit and flowers and can go without water for several days, but when available they drink water and take baths (Donegan 2002).

Ground-running, residential grouse/partridge size birds were also represented in low numbers, these included a humerus from a chukar partridge (*Alectoris chukar*), two humeri from a grey partridge (*Perdix perdix*) and a tibiotarsus from a Pallas's sandgrouse (*Syrrhaptes paradoxus*). These species inhabit semi-desert areas with low vegetation.

The cultural origin of all the bird bones described above is not in doubt; they were deposited amongst high densities of artefacts and mammal bones and it seems certain that they result from human activities.

Environment and Seasonality The majority of bird bones from Ayn Qasiyya are associated with wetland habitats and include both those that prefer shallow water with muddy bottoms, some that require deeper water for diving and large expanses of water for flight take-off. Dense vegetation around water margins are preferred habitats but others frequent more open fringes. This combination confirms that during the occupation at Ayn Qasiyya there existed extensive areas of open water with marshland, fringed with reed beds and shores for waders.

Table 9 summarises the residency and migratory patterns for birds which were hunted at Ayn Qasiyya and it is clear that potential bird game would have been present all year around; ducks would have been particularly abundant during autumn migration and winter. Year around human occupation/hunting cannot be entirely dismissed but winter occupation is without doubt as evidenced by presence of the ferruginous duck, egrets and heron. Given the general environment of the site it is reasonable to assume that the wetland birds were hunted locally, either by trapping or netting. Amongst the desert/steppe dwelling birds it is perhaps not unexpected that ostrich, which could yield substantial meat returns, was most popular while partridge and grouse were relatively few. The ostrich was similarly hunted in small numbers during the Early Epipalaeolithic occupations at Kharaneh IV alongside sandgrouse (Martin et al. 2010) and at Late Epipalaeolithic Azraq 18 (Martin 1994).

status	season	taxa	% NISP*
passage migrant/winter visitor?	passage Sept-Oct; then winter Oct-March marshy wetlands	swan	0.73
winter visitor; fewer local residents	April/May or Oct-March	greylag goose	0.73
surface feeding ducks			
all year around; resident	all year; large flocks wetland Aug and Sept	mallard	32.12
winter passage migrant	passage autumn Sept-Oct	shelduck	3.65
passage migrant and winter visitor	March - April passage; flocks wetlands in winter	wigeon	2.19
winter visitor	winter Oct-March marshy wetlands	teal	2.19
resident; migratory visitor	all year; flocks wetlands in winter	shoveler	0.73
bay ducks			
resident; winter visitor	all year; winter on lakes/wetlands Sept-April	tufted duck	6.57
resident; winter visitor	all year; winter flocks Oct onwards	pochard	5.84
uncommon winter visitor	winter vagrant	ferruginous duck	0.73
waders			
year round resident	all year	bittern	14.60
winter visitor	winter Oct-March	great white egret	2.92
resident and winter visitor	winter Sept-March marshy wetlands	purple heron	0.73
winter visitor	winter Sept-March marshy wetlands	grey heron	2.19
passage migrant	Sept-Oct ;Feb-April passage to/from Africa	stork	1.46
resident	all year	coot	4.38
resident	all year	moorhen	0.73
resident and winter visitor	allyear; Aug-Sept migrants at wetlands	stone curlew	1.46
passage winter migrant	Sept-Oct	curlew	0.73
raptors			
resident and passage	all year;some spring and autumn passage	goshawk	2.19
resident and passage	all year;some spring and autumn passage	buzzard	1.46
mainly resident; some passage migrant	all year;some spring and autumn passage	eagle sp.	0.73
others			
resident	all year	ostrich	5.84
resident	all year	chukar partridge	0.73
resident	all year	grey partridge	1.46
resident	all year	sandgrouse	0.73

Table 9: Seasonal residency and migratory patterns for birds hunted at Ayn Qasiyya.

Body Part Representation Table 10 shows the NISP % of identified and unidentified bird bones. In both cases scapulae, coracoids, humeri and tibiotarsi are most often well preserved and can be assigned to species while mandibles, clavicles, femora and tarso-metatarsi are poorly preserved and often unidentifiable. Sternae, radii and ulnas are less often well preserved and more difficult to identify to species firmly. Skull, mandible, sternum and synsacrum which are relatively fragile elements have not been recovered in identifiable form. Bird bone survival to some extent reflects relative bone density which is related to size, activity and habitat. Various studies of wetland birds (Livingstone 1989; Higgins 1999) have demonstrated that ducks and grebes have denser wing bones than leg bones and that amongst ducks, those which feed in shallow water and take flight easily, have more robust wing elements than deep water birds who must build up momentum before take-off.

	Unidentified NS=280 NS %	Identified Area B NISP=111 NISP %
mandible	1.1	0
clavicle (furcula)	1.1	0
scapula	18.2	15.2
coracoid	20.7	33.9
sternum	4.3	0
humerus	23.2	26.8
radius	5.4	0.9
ulna	3.2	0.9
carpometacarpus	6.8	4.5
anterior phalanx I	1.4	0.9
femur	0.0	0.9
tarso-metatarsus	1.8	0.9
tibio-tarsus	9.3	8.9
Bird posterior phalanx I	0.7	0
Bird posterior phalanx II	1.1	2.7
Bird posterior phalanx IV	1.4	2.7
bird quadrate	0.4	0

Table 10: Body part representation showing NS% and NISP% of identified and unidentified birds.

Although variable in number, the presence of all body parts confirms that complete carcasses of waterfowl, waders and steppic birds were carried onto site and bones discarded whether or not portions were selected for eating; this is also likely to be true for the ostrich, although it is possible that head and neck were removed before transportation.

COMPARISON OF HUNTING AND TRAPPING STRATEGIES AT EPIPALAEOLITHIC SITES IN THE AZRAQ BASIN

The overall patterns of hunting/trapping at Ayn Qasiyya are similar to those seen at many of the Epipalaeolithic sites in the Azraq Basin. This is illustrated in Figure 7 which compares Ayn Qasiyya prey proportions with those from Kharaneh IV, Wadi Jilat 6, Uwaynid 18, Wadi Jilat 22 and 8 and Azraq 18 (Martin 1994, Martin et al. 2010; Garrard and Byrd 2013). All the Early and Middle Epipalaeolithic sites show gazelle as the major hunted taxa (Figure 7). The overall intensity of gazelle hunting at Ayn Qasiyya (81% total prey) is less than that reported for other sites such as Kharaneh IV D with 91.6% gazelle and KHIV C 88.6% or Wadi Jilat 6 Upper 1-3 with 90.9% (Martin 1994; Martin et al. 2013). It is notable that numbers of gazelle are lowest at Wadi Jilat 22 where there is an unusually high incidence of birds, mostly raptors, and tortoises (Martin et al. 2013; grouped together as ‘others’).

Equids were present at all locations although their relative incidence varies from one site to another; numbers appear to decline significantly over time at Wadi Jilat 6 and possibly at KHIV, perhaps reflecting changes in environment and/or climate. Ayn Qasiyya is distinguished from most sites by higher numbers of cattle and boar and the presence of waterfowl (shown as 'others' in Figure 7). Notably, cattle are present at Ayn Qasiyya while generally absent at most wadi based sites, apart from Wadi Jilat 6 and Uwaynid 18 where very small numbers occur (Martin 1994). Cattle prefer locations where vegetation/tree cover and shade are provided, with good grazing and plentiful water nearby. It is of interest that cattle are abundant at the Late Epipalaeolithic spring site of Azraq 18 which is just 1.6km to the south and appears to have developed as an early-middle Natufian specialist cattle hunting location (Byrd 1989; Garrard 1991).

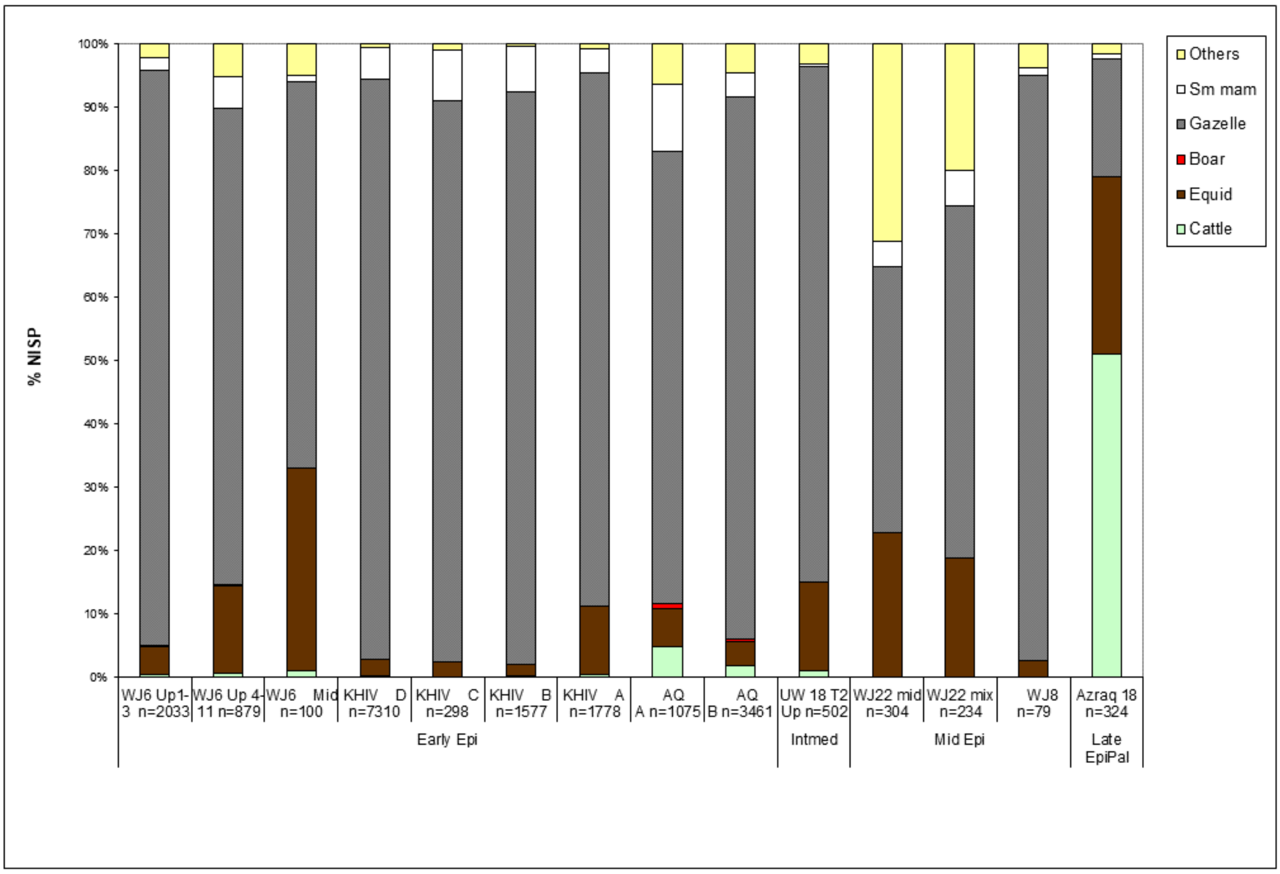

Figure 7: Ayn Qasiyya prey proportions compared with those from other Azraq sites including levels at Kharaneh IV (Martin, Edwards and Garrard 2010), Wadi Jilat 6, Uwaynid18, Wadi Jilat 22 and 8 and Azraq 18 (Martin 1994). 'Small' includes canids, felids, hare and fox; 'Other' includes tortoise, porcupine and birds.

DISCUSSION

Ayn Qasiyya is one of two former principal springs of the Southern Azraq marshes and in the present day lies within the Azraq wetland reserve. Analysis of basal sediment levels of various sites in the Azraq Basin (Wadi Jilat 6 and 22, Uwaynid 14 and Kharaneh IV) indicate standing surface water present at many locations throughout the area including a substantial lake in the late glacial maximum (Byrd and Garrard 1990; Garrard and Byrd 2013). The Epipalaeolithic landscape with lakes, marshlands and seasonal wadi rivers was crucial for the settlement of communities.

At Ayn Qasiyya the levels rich in bone and flint are ancient marsh deposits and although there is some evidence for reworking, these appear to have been relatively stable since the Early Epipalaeolithic. This view is supported by the discovery of a burial dating to that period comprising a squatting corpse placed in the marsh (Richter et al. 2009b) which still retained some positional structure with only partial displacement of skeletal bones. The long term stability of these deposits is significant since it confirms that the thorough smashing of animal bone occurred prior to discard and was the end product of human action to retrieve marrow, grease and brain lipids perhaps followed by further reduction prior to dumping. A notable feature of Ayn Qasiyya is that thus far no direct evidence of an associated settlement - floor surfaces, hearths - has been found, although the nearby presence of such a settlement can be assumed as a given.

The range of mammals and birds present at Ayn Qasiyya points to a multi-faceted landscape, with wetlands and steppe, blended at their adjoining margins by lusher, thicker vegetation and trees. The surrounding steppe vegetation made up of abundant herbage with perennial shrubs would have attracted the large herds of gazelle which were the focus of Ayn Qasiyya hunters as their major source of food. The presence of large and small equid together with cattle supports the notion of an area rich in grazing and associated with a permanent supply of drinking water, while the occasional boar indicates nearby shady thickets and trees. The surrounding steppe also provided intermittent meals in the form of ostrich, partridges, grouse, hares and foxes: various canids, as well as fox and hares, would have provided meat and pelts for bedding and clothing. The marshes and areas of open water, pools and lakes, were attractive habitats and stopping-over places for a wide range of water-fowl, waders and occasional raptors, offering another reliable source of meat and perhaps by-products such as feathers.

It is interesting that two large herbivores - equids and cattle - co-existed at Ayn Qasiyya. Recent modern day studies in the Camargue (Menard et al 2002) have investigated this sharing of landscape between modern ‘wild’ animals and demonstrated variable behaviour and food selection. In warmer seasons, mid spring to mid autumn, both equids and cattle use a wide choice of different habitats with equids allocating more than 60% of time to the marshes and cattle more than 40%. Both were feeding on marsh-type grasses but cattle focussed on herb-rich plants. In winter they spent most time in drier grasslands with equids eating more coarse grasses and cattle more broad-leaved plants. At Ayn Qasiyya these larger herbivores could have been hunted out on the steppe or on visits to the wetland for water.

The Eastern Jordanian steppe would have been a prime gazelle habitat, particularly for *G. subgutturosa*. Evidence from fusion analysis points to a high kill rate of sub-adult animals (40-46%) which is not commensurate with the average herd make-up where about 35% fall into this age group (Martin 2000). For sites in the Mediterranean and hilly regions of the western Southern Levant high numbers of sub-adults amongst the gazelle kill are generally thought to reflect over-hunting in response to population size increase (Stiner et al. 2000; Munro 2004) but this phenomenon can also be associated with all-year round hunting without significant population size increase (Davis 1997). This latter scenario should be considered in the case of Ayn Qasiyya particularly since water and water-fowl together with a variety of marshland/steppic wildlife are likely to have been available all year around at this wetland spring site. It is notable that at other contemporary Azraq sites, for example Kharaneh IV, a high subadult kill rate is not seen (Martin et al. 2010); however this site is not in the wetlands and it is likely that season of occupation was shorter than that at Ayn Qasiyya.

Other alternative explanations should also be considered including those linked with gazelle behaviour. In favourable conditions most adult females bear twins, however numbers of offspring for *Gazella subgutturosa* range from one to four and interestingly females can form four inguinal mammae, although in the wild today commonly only two are formed (Kingswood & Blank 1996). It would be of interest to establish whether in the past higher birthing rates occurred where drinking water and food were continuously abundant. There is a body of data which shows that if ideal environments are obtained over extended periods gazelle may have two fawning periods (Habibi 1991; Dunham 1997; Sempéré et al. 2001), which inevitably lead to a higher proportion of young animals.

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Note on preprint version

This paper was completed in 2013. No attempt has been made to update the text to reflect research published since 2013.

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Appendix - Osteometric measurements (*estimated)

Bos

find no.	area	context	east	north	element	GL	GB	Bp	Bd	BT	Ld	DLS	MCHDW	MCSC
234	B	1005	972	1007	humerus					70.44				
453	B	1016-1005	971	1008	metapodial								33.46	32.92
172	B	1016	972	1008	os crucho		38.94							
188	B	1005	972	1007	ph2	58.84		45.7	38.79					
2812	B	1004	971	1008.1	ph2	55.88		40.93	35.17 *					
2911	B	1004	971	1008.1	ph3						71.2	87.81		

Sus

find no.	area	context	east	north	element	GL	Bp	Bd	SD
2892	B	1004.1	971	1009	MT IV		16.69		
602	B	1004	972	1008	ph1	40.57	20.81	18.83	15.25

Vulpes

find no.	square	locus	east	north	element	GL	Bpc	Bp	Bd	Dc	Sd	LA	L (length)
73	A	22	987	1006.1	M1 mand								15.61
1039	section 1	002-4	506	574	ulna		6.58						
1762	B	1011-1	973	1008	pelvis							11.53	
1301	B	1011-1	973	1008	femur				16.15				
2788	A	22	987	1005.1	femur					11.29			
2812	B	1004	971	1009.1	tibia			17.25					
129a	A	22	987	1006.1	metapod				5.55				
129b	A	22	987	1006.1	metapod				6.81				
765	B	1004	972	1004-2	ph1	17.08		6.48	5.04		3.52		

Canid

find no.	square	locus	east	north	element	Bd
37	A	22	987	1005.1	metapod	8.41

Lepus

find no.	square	locus	east	north	element	GL	Glp	CAW	Bp	Bd	Bg	LA
3244	B	1004	971	1011-1	scapula		12.21				9.41	
3238	B	1004	971	1011-2	scapula		12.56				9.4	
3177	B	1004-1	971	1007	scapula		10.62				8.6	
2897	B	1004.1	971	1009	scapula		11.25					
1747	B	1011-1	973	1008	scapula		9.9				8.78	
3245	B	1004	971	1011-1	scapula		10.41				9.75	
624	B	1004	972	1008	humerus					9.49		
2460	B	1004-1	971	1007	humerus					10.12		
1594	B	1004-1	973	1008	humerus					8.71		
1824	B	1011-1	973	1009	humerus					8.88		
1189	B	1004	972	1008	humerus					8.7		
34a	A	22	987	1005.1	humerus					11.09		
34b	A	22	987	1005.1	humerus					9.96		
34c	A	22	987	1005.1	humerus					8.53		
113	A	22	987	1006.1	humerus					9.48		
955	B	1004	972	1004.2	humerus					11.1		
3099	B	1004	971	1012-1	humerus					11.39		
2800	A	22	987	1005.1	radius				7.58			
41a	A	22	987	1005.1	radius				7.38			
41b	A	22	987	1005.1	radius				7.11			
1042	section 1	002-4	506	574	radius					8.24		
128	A	22	987	1006.1	pelvis							10.75
1426	B	1011-1	973	1007	pelvis							10.93
1426	B	1011-1	973	1007	pelvis							10.4
2848	B	1004.1	972	1008	femur					13.76		
3032	B	1004-1	971	1012-1	femur					13.9		
292	B	1017	973	1008	astragalus	16.07						
2461	B	1004-1	971	1007	astragalus	14.42			8.3	4.2		
1190	B	1004	972	1008	astragalus	13.65			6.65	3.75		
956	B	1004	972	1004.2	astragalus	14.36			7.47	5.06		
292	B	1017	973	1008	astragalus	15.75			8.09	5.6		
3051	B	1004-1	971	1009	astragalus	14.98			6.67	4.35		
3078	B	1004	971	1008-1	astragalus	12.8.			6.31	4.47		
3246	B	1004	971	1011-1	astragalus	12.82			6.85	4.39		
969	B	1004	971	1008	calcaneum	25.58		9.62				
1188	B	1004	972	1008	calcaneum	28.84		10.1				
74	A	22	987	1006.1	calcaneum	28.77		10.44				
120	A	22	987	1006.1	calcaneum	26.166		9.28				
127	A	22	987	1006.1	calcaneum			8.28				
2895	B	1004.1	971	1009	calcaneum	29.07		10.71				
2896	B	1004.1	971	1009	calcaneum			9				
3094	B	1004-2	971	1010	calcaneum	25.77		10.82				
44	A	22	987	1005.1	metapod					4.52		

Equid

find no.	area	context	east	north	element	GL	BT	GB	Bp	Bd	BFd	CAW	GH	Ld	SD	LmT	Dp	Lf
2910	B	1004	971	1008.1	humerus		70.9											
1071	D2	3500	?	?	radius					59.85	50.22							
2131	B	1004-2	971	1009	radius					71.41	56.23							
?	A	22	987	1006.1	radius					68.24	57.05							
?	B	1004	973	1008	metacarpal					42.76								
2134	B	1004-2	971	1009	astragalus											44.74		
723	B	1004	972	1007-2	astragalus			47.85			46.74		55.95			56.98		
1661	B	1004	972	1008.2	astragalus								56.05			65.12		
171	B	1016	972	1008	calcaneum uf	81.17						46.79						
1991	B	1004	972	1008	grand os			35.42										
1378	B	1004	972	1008-1	grand os			39.7										
523	B	1017	973	1008	grand os			38.49										
2890	B	1004.1	971	1009	grand os			38.14										
523	B	1017	973	1008	carpal III			38.49										
1925	B	1004	971	1008	os tarsale			37.86										
1926	B	1004	971	1008	os tarsi centrale			40.9										
71	A	22	987	1006.1	metatarsal					41.35								
2133	B	1004-2	971	1009	metapodial					44								
1061	O2	2	967	1028	metapodial					41.13								
781	B	1016-1005	972	1008	metapodial					41.72								
240	B	1005	972	1007 G	ph1												31.23	
1598	B	1004-1	973	1007	ph1 half vertic												37.06	
2387	B	1004-1	971	1009	phi UF prox					36.45								
1794	B	1004-2	972	1007	ph1 half horiz				42*									
189	B	1005	972	1007	ph2	39.66			39.49	37.75					36.19			
2132	B	1004-2	971	1009	ph2	42.91			39.15	36.15					33.46			
1261	B	1004-2	972	1008	ph2	46.62			47.16	40.85					39.06			
1051	D2	3500-4	966	1027	ph3	40.38		55.29			40.64							
1568	B	1011.1	973	1008	ph3	35.08		39.33						33.75				22.9
1997	B	1004-2	971	1008	ph3	56.62		63.32		47.3				45				
351	B	1004	972	1009	ph3	35.81		34.6						36.9				
720	B	1004	972	1007-2	ph3	45.58		64.8*						41.01				
?	B	1017	973	18	ph3	50.05		50.8			41.58			41.65				
1051	D	3500-4	966	1027	ph3	36.19		c.55.8										
1991	B	1004	972	1008	distal sesamoid			35.42										
1378	B	1004	972	1008-1	distal sesamoid			39.7										
1225	B	1004	972	1008.1	distal sesamoid			39.05										

Equid teeth

						length	breadth
713	B	1004	972	1008	up molar 35.53	21.74	
1599	B	1004-1	973	1007	maxilla M1	27.22	28.91
1600	B	1004-1	973	1007	mandible pM3	28.68	17.53

Gazelle

find no.	area	context	east	north	element	GB	Lad
2207	B	1004	971	1001-2	axis	38.95	
2208	B	1004	971	1001-2	axis	36.7	
1480	B	1004-1	973	1008	axis	33.07	
1070	D2	3500	967	1028	axis	35.86	
1037	D2	3500-7	965	1027	atlas	55.66	12.2

Gazelle cont.

find no.	area	context	east	north	element	GLP	LG	BG
995	B		972	1008-1	scapula	31.5	25.8	22.8
815	B	1004	972	1007	scapula	31.68		23.57
787	B	1016-1005	972	1008	scapula	31.05	25.43	19.16
2007a	B	1004-2	971	1008	scapula	30.12		
2007b	B	1004-2	971	1008	scapula	29.12		19.91
712	B	1004	972	1008	scapula	33.66	25.3	26.5
1262	B	1004-2	972	1008	scapula	32.8	26.16	24.5
1754	B	1011-1	973	1008	scapula	29.06	24.31	22.75
1799	B	1011-1	973	1008	scapula	28.56	22.43	19.19
2592	B	1004	971	1007-6	scapula	28.35	21.46	19.85
2639a	B	1004-1	971	1009	scapula	33.34	23.11	24.51
2639b	B	1004-1	971	1009	scapula	30.51	21.02	21.73
11	A	22	987	1006.1	scapula	30.01	23.26	23.19
1940	B	1004	971	1008	scapula			22.34
3008	B	1004	971	1012	scapula	30.19	20.69	21.84
2931	B	1004-1	971	1008	scapula			24.04
2932	B	1004-1	971	1008	scapula	29.92		20.02
3139	B	1004-1	971	1007	scapula	29.08	23.27	19.44

Gazelle cont.

find no.	area	context	east	north	element	Bd	BT	Dp	HPH
1067	D2	3500-2	965	1027	humerus		28.31		
951	B	1004	973	1004-2	humerus	23.91			
1341	B	1004-1	973	1008	humerus	26.58	23.79		
1342	B	1004-1	973	1008	humerus	26.7	25.09		
1569	B	1011.1	973	1008	humerus	26.49	23.21		
1998	B	1004-2	971	1008	humerus	27.91	22.77		
562	B	1004	972	1007	humerus		23.34		
709	B	1004	972	1008	humerus		24.66		
735	B	1004	972	1007-2	humerus		19.52		
1662	B	1004	972	1008.2	humerus			42.55	
2390	B	1004-1	971	1009	humerus	23.91			
2391	B	1004-1	971	1009	humerus	23.88			
1817	B	1011-1	973	1009	humerus	26.64	23.4		
2630a	B	1004-1	971	1009	humerus	25.2	24.6		
2630b	B	1004-1	971	1009	humerus		23.32		
2631	B	1004-1	971	1009	humerus		23.2		
1067	D2	3500-2	965	1027	humerus	29.74	27.98		
951	B	1004	972	1004.2	humerus	24.67	22.36		
2999	B	1004	971	1012	humerus		25.57		
2926	B	1004-1	971	1008	humerus	27.08	24.17		
3125	B	1004	971	1009	humerus				32.37
3126	B	1004-1	971	1010	humerus				35.51

Gazelle cont.

find no.	area	context	east	north	element	Bp	Bd
708	B	1004	972	1008	radius	24.38	
1800	B	1011-1	973	1008	radius	25.31	
707	B	1004	972	1008	radius epi		22.56
225	B	1016-1005	971	1008	radius epi		23.09
1603	B	1004-1	973	1007	radius epi		20.63
1604	B	1004-1	973	1007	radius epi		22.44
1366	B	1004	972	1008-1	radius epi		24.22
964	B	1004	971	1008	radius epi		21.85
22	A	22	987	1005.1	radius epi		22

Gazelle cont.

find no.	area	context	east	north	element	Bp	Bd	MCLC	MCSC
3000	B	1004	971	1012	metacarpal		21.23	15.02	11.28
2636	B	1004-2	971	1009	metacarpal	21.23			

Gazelle cont.

find no.	area	context	east	north	element	Lad
2209	B	1004	971	1001-2	pelvis	29.6

Gazelle cont.

find no.	area	context	east	north	element	Bd
866	B	10004	973	1007	femur	33.5
1423	B	1011-1	973	1007	femur	32.27
1294	B	1011-1	973	1008	femur	31.57
456	B	1004	1007	973	femur	32.06
2632	B	1004-1	971	1009	femur	32.64
1423	B	1011-1	973	1007	femur	32.67

Gazelle cont.

find no.	area	context	east	north	element	GL	GB
12	A	22	987	1006.1	patella	27.19	19.64
1000	B	?	972	1008-1	patella	23.2	18.3
1001	B	?	972	1008-1	patella	25.1	18.1
440	B	1004			patella	26.27	21.83
2012	B	1004-2	971	1008	patella	25.22	20
758	B	1004	972	1004-2	patella	25.53	21.08
1979	B	1004-1	971	1008	patella	22.03	18.75
1272	B	1004-2	972	1008	patella	25.85	19.96
2588	B	1004	971	1007-6	patella	24.11	19.65
2638a	B	1004-1	971	1009	patella	24.37	20.68
2638b	B	1004-1	971	1009	patella	24.3	
2703	B	1004-1	971	1004	patella	21.88	18.24
2689	B	1004	971	1007-2	patella	23.76	18.07
931	B	1011+1004	973	1008	patella	23.65	20.02

Gazelle cont.

find no.	area	context	east	north	element	Bp	Bd	Dd
204	B	1016-1005			tibia		25.24	19.81
204	B	1016-1005	971	1008	tibia		22.47	19.51
289	B	1017	973	1008	tibia		23.68	
2158	B	1004-1	971	1004-1	tibia		23.18	20.71
2212	B	1004	971	1001-2	tibia		22.35	
256	B	1005	972	1007G	tibia		21.89	
1268	B	1004-2	972	1008	tibia	39.43		
212	B	1016-1005	971	1008	tibia		23.27	19.2
1474	B	1011-1	973	1008	tibia	33.67		
2637	B	1004-1	971	1009	tibia		20.75	
2823	B	1004.1	971	1012	tibia		20.99	
2824	B	1004.1	971	1012	tibia		21.15	
289	B	1017	973	1008	tibia		21.33	
3020	B	1004	971	1012	tibia		23.45	
2938	B	1004-1	971	1008	tibia	35.36		
2211	B	1004	971	1001-2	tibia epi dist		22.38	
425	B	1004	972	1009	tibia epi dist		18.88	
1487	B	1004-1	973	1008	tibia epi dist		18.58	
1947	B	1004-2	971	1005	tibia epi dist		20.59	
1816	B	1011-1	973	1009	tibia epi dist		23.31	
239	B	1005	972	1007G	tibia epi prox	32.55		

Gazelle cont.

find no.	area	context	east	north	element	GLl	GLm	Bd	Bd	Dm	Dl
1570	B	1011.1	973	1008	astragalus	26.1	24.76	16.63	15.78	14.12	14.83
2117	B	1011.1	973	1008	astragalus	27.06	24.68	15.85	16.26	14.87	15.07
2118	B	1011.1	973	1008	astragalus	27.58	25.1	16.52	16.21	15.94	15.65
241	B	1005	972	1007G	astragalus	28.25	26.23	16.5	16.64	15.3	16.09
575	B	1004	972	1007	astragalus	27.16	24.49	16.93	15.34	14.8	15.11
649	B	1004	973	1008	astragalus	26.26	23.76	15.98	16.39	14.4	14.86
725	B	1004	972	1007-2	astragalus	27.53	24.79	16.54	14.44	15.23	15.32
752	B	1004	972	1004-2	astragalus	27.54	24.71	16.78	16.29	15.1	14.61
753	B	1004	972	1004-2	astragalus	25.33	23.42	15.41	15.31	14.39	
312	B	1004	972	1007	astragalus	26.03	24.2	14.83	14.93	14.16	14.04
223	B	1016-1005	971	1008	astragalus	24.22			16.56	13.97	
1663	B	1004	972	1008.2	astragalus	26.58	24.58	16.68	16.27		
1601	B	1004-1	973	1007	astragalus	26.88	25.06	17.55	15.97	14.87	14.2
1972	B	1004-1	971	1008	astragalus	25.9	24.24	16.72	15.37	14.4	14.74
2222	B	1004	971	1012	astragalus	26.07	24.57	17.19	15.32	14.3	14.57
2397	B	1004-1	971	1009	astragalus	26.57	24.57	15.49	15.44		
1264	B	1004-2	972	1008	astragalus	28.26	25.73	15.76	16.22	15.12	15.7
1396	B	1004-2	972	1008	astragalus	27.58	25.55	16.03	15.55		14.89
1646	B	1004	972	1004-2	astragalus	26.67	24.62	14.43	15.39	14.62	14.63
1647	B	1004	972	1004-2	astragalus	25.93	24.19	15.27	14.87	14.43	14.32
1946	B	1004-2	971	1005	astragalus	27.94	25.55	16.16	16.43	15.43	15.34
?	B	1017	973	1008	astragalus	26.89	25.5	14.59	16.21	14.81	14.37
2582a	B	1004	971	1007-6	astragalus	26.31	23.64	16.89	15.43	13.84	14.3
2582b	B	1004	971	1007-6	astragalus	27.6	25.81	16.64	16.05	15.44	15.35
2582c	B	1004	971	1007-6	astragalus		24.62	16.43	15.88		14.45
2583a	B	1004	971	1007-6	astragalus	25.06	24.07	15.55	15.26	14.15	13.5
2617	B	1004-1	971	1009	astragalus	28.97	26.39	16.85	17.19	16.01	15.12
2628	B	1004-1	971	1009	astragalus	27.88	25.43	16.39	16.44	15.15	14.44
2549	B	1004-1	971	1008	astragalus	27.76	25.99	16.6	16.39	15.47	15.94
2656	B	1004	971	1008	astragalus	27.17		15.55	14.83	15.21	15.35
2657	B	1004	971	1008	astragalus		24.89		15.85	13.94	14.58
2698	B	1004-1	971	1004	astragalus	28.32	25.83	16.55	17.23	16.08	14.88
105	A	22	987	1006.1	astragalus		25.08	16.09	15.9		15.16
17	A	22	987	1005.1	astragalus		24.74		16.1		14.75
2854	B	1004.1	972	100?	astragalus	26.65	25.31	18.09	16.77	14.78	14.96
1344	B	1004.1	973	1008	astragalus	27.34	25.38	18.2	16.11	16.29	14.7
1345	B	1004.1	973	1008	astragalus	26.93	24.99	16.36	15.69	15.09	15.85
1929	B	1004	971	1008	astragalus	27.12	25.28	17.87	16.09	15.55	15.17
1931	B	1004	971	1008	astragalus	27.26	24.33	17.4	16.38	15.51	15.83
2916a	B	1004	971	1008.1	astragalus	24.65	23.14	13.51	15.38	13.4	13.62
2916b	B	1004	971	1008.1	astragalus	26.39		16.53	15.72	14.02	
2925	B	1004-1	971	1008	astragalus	27.05	25.37	16.45	16	14.71	14.47
3235	B	1004	971	1011-2	astragalus	26.83	25.79	17.86	16.28	14.16	14.55

Gazelle cont.

find no.	area	context	east	north	element	GL	Bp
2936	B	1004-1	971	1008	calcaneum	54.88	13.03
2031	B	1004-1	971	1010	calcaneum	58.57	17.86

Gazelle cont.

find no.	area	context	east	north	element	GL
2151	B	1004-1	971	1004-1	scaphoid	15.76
2265	B	1004	971	1007-1	scaphoid	15.65

Gazelle cont.

find no.	area	context	east	north	element	Bp	Bd	MCLC	MCSC
205	B	1016-1005	?	?	metatarsal		22.22	17.02	12.26
205	B	1016-1005	971	1008	metatarsal		22.2		
2125	B	1011.1	973	1008	metatarsal	19.05			
?	B	1004-1	971	1009	metatarsal		22.17	16.34	11.32
205	B	1016-1005	971	1008	metatarsal		21.96	16.78	

Gazelle cont.

find no.	area	context	east	north	element	CAW	MCLC	MCSC
1473	B	1011-1	973	1008	metapodial	21.95	15.97	
987	B	?	972	1008-1	metapodial	21.1		
793	B	1004	972	1007	metapodial	19.6	14.43	10.99
2618	B	1004-1	971	1009	metapodial	20.94		

Gazelle cont.

find no.	area	context	east	north	element	GLM47	Gt diam 45	Lst diam 46
2120/21	B	1004-2	971	1009	horncore broken estim	>140	34.5	21
1489	B	1011-1	973	1007	horncore broken estim		33.78	24.37
174	B	1016-1005	971	1008	horncore broken estim	>130	37	>25
202	B	1016-1005	971	1008	horncore broken estim		33.5	>24
419	B	1004	972	1009	horncore broken estim		34.24	21.95
1439	B	1004-1	973	1008	horncore broken estim	c.130	34.86	26.17
1394	B	1004.2	972	1008	horncore broken estim	c.170	31.8	21.37
2803	B	1004.2	971	1009	horncore broken estim	>120	30.02	21.33

Gazelle cont.

Gazelle Teeth

find no.	area	context	east	north	element	M3 Length	M3 Breadth
693	B	1004	972	1008	mand frag c M3	17.27	6.67
1605a	B	1004-1	973	1007	mand frag c M3	18.54	6.83
1605b	B	1004-1	973	1007	mand frag c M3	16.66	5.84
1635	B	1011-1	973	1008	mand frag c M3	19.21	7.18
2807	B	1004.2	971	1009	loose M3	17.89	6.93

Gazelle cont.

find no.	area	context	east	north	element	GL	Bp	Bd	SD	GLPe
874	B	10004	973	1007	ph1		9		7.45	
874	B	10004	973	1007	ph1		8.8			
875	B	10004	973	1007	ph1			8.4		
875	B	10004	973	1007	ph1			8.45		
1053	D	3003	964	1026	ph1	44.83	10.07	10.3		
828	B	1017	973	1008	ph1	35.8	9.5	8.6		35.6
947	B	1004	973	1004-2	ph1	37.56	10.94	9.02	7.53	
796	B	1004	972	1007	ph1	35.39	11.05	8.79	7.09	
2145a	B	1004-1	971	1004-1	ph1	38.42	9.42	8.43	6.98	
2145b	B	1004-1	971	1004-1	ph1	37.82	8.61	7.96	7.02	
2147	B	1004-1	971	1004-1	ph1		9.92			
2146	B	1004-1	971	1004-1	ph1			9.14		
2257a	B	1004	971	1007-1	ph1			8.58		
2256a	B	1004	971	1007-1	ph1		9.57			
2215	B	1004	E971	N1001-2	ph1	36.77	10.27	8.22	7.22	
2114	B	1011.1	973	1008	ph1	37.98	10.77		7.25	
247	B	1005	972	1007G	ph1	40.07	10.95	9.3	7.48	
683	B	1004	972	1008	ph1	35.78	10.37	8.82	7.88	
1273	B	1004-2	972	1008	ph1	43.53	9.88	8.37	7.47	
1274	B	1004-2	972	1008	ph1	37.9	11.19	9.05	7.67	
1472	B	1011-1	973	1008	ph1	40.7	9.2	9.08	7.28	
401	B	1004	972	10078	ph1	43.1	9.54	8.71	7.36	
402	B	1004	972	10078	ph1	37.37	10.24	8.68	7.88	
1779a	B	1004-2	972	1007	ph1	37.75	9.26	8.43	7.04	
1779b	B	1004-2	972	1007	ph1	42.76	9.13	8.72	7.36	
173a	B	1016	972	1008	ph1	37.25	11.19	8.62	7.78	
173b	B	1016	972	1008	ph1	37.7	10.86	9	7.36	
1699a	B	1004	972	1007-2	ph1	39.26	10.24	8.78	7.26	
1699b	B	1004	972	1007-2	ph1	37.58	11.46	7.67	7.95	
958	B	1004	971	1008	ph1	41.24	9.54	8.71	7.12	
959	B	1004	971	1008	ph1	40.83	9.58	8.54	7.06	
1744	B	1011-1	973	1008	ph1	41.37	9.04	9.16	7.52	
2753a	B	1004	971	1007-2	ph1	40.49	9.99	9.81	7.51	
2753b	B	1004	971	1007-2	ph1	36.35	10.18	8.87	7.59	
2753c	B	1004	971	1007-2	ph1	36.08	10.77	8.79	7.89	
2753d	B	1004	971	1007-2	ph1	37.59	10.18	8.56	7.45	
2753e	B	1004	971	1007-2	ph1	41.49	9.73	8.28	7.5	
2752a	B	1004	971	1007-2	ph1	37.58	13.23	8.91	7.24	
2752b	B	1004	971	1007-2	ph1	37.83	10.05	8.55	7.38	
2647a	B	1004	971	1008	ph1	38.4	11.23	8.59	7.71	
2647b	B	1004	971	1008	ph1	42.97	9.64	8.72	7.1	
49	A	2	987	1005.1	ph1	42.54	9.19	8.8	6.84	
78a	A	22	987	1006.1	ph1	41.23	9.62	8.68	6.9	
78b	A	22	987	1006.1	ph1	39.43	9.16	8.1	7.3	
78c	A	22	987	1006.1	ph1	35.78	10.23	8.33	7.29	
78d	A	22	987	1006.1	ph1	35.84	10.08	9.57	7.81	
5	A	22	987	1006.1	ph1	40.31	9.15	8.12	6.88	
2829	B	1004.1	971	1012	ph1	37.15	11.01	8.92	8.19	
1053	D	3003	964	1026	ph1	43.6	9.64			
947	B	1004	972	1004.2	ph1	36.35	10.91	8.76	7.44	
2918	B	1004	971	1008.1	ph1	40	9.09	7.75	6.43	
3009a	B	1004	971	1012	ph1	40.73	8.78	7.89	6.28	
3009b	B	1004	971	1012	ph1	36.66	9.04	7.95	6.61	

2944	B	1004-1	971	1008	ph1	38.53	10.44	8.64	7.75
3054	B	1004-1	971	1012	ph1	37.09	10.23	8.45	7.47

Gazelle cont.

find no.	area	context	east	north	element	DLS	GL	GLP	Bp	Bd	SD	GLPe
876	B	10004	973	1007	ph2				8.4			
830	B	1017	973	1008	ph2		20.5		8.1	8.3		
831	B	1017	973	1008	ph2		18.9		8.8	7.8		
923	B	1011-1004	973	1008	ph2		22.77		9.34	7.98		
935	B	1004	973	1008	ph2		22.55		9.35	9.06		
1036	D2	3500-7	965	1027	ph2		22.3		7.89	7.54		
1351	B	1004-1	973	1008	ph2		20.17		8.49	8.15		
361	B	1001			ph2				9.2		7.52	
800	B	1004	972	1007	ph2		21.23		9.36	8.59	6.84	22.16
801	B	1004	972	1007	ph2		22.43		9.71	9.04	7.81	23.1
802	B	1004	972	1007	ph2		21.2		8.96	7.51	6.37	
1038	Sec 1	002-4	5.6	574	ph2		23.8	23.8	9.42	8.83	6.42	
771	B	1004			ph2		20.6		9.13	8.13	7.82	
386	B	1004			ph2		20.06		8.7	7.38	6.61	
428	B	1004			ph2	21.8	20.39		8.43	7.2	6.37	
429	B	1004			ph2	21.22	20.36		8.68	8.19	6.39	
475	B	1017			ph2	22.87	20.91		9.04	8.4	6.56	
2148a	B	1004-1	971	1004-1	ph2		23.37		9.27	7.87	6.75	
2148b	B	1004-1	971	1004-1	ph2		21.64		8.47	7.34	6.09	
2149	B	1004-1	971	1004-1	ph2		22.47		8.36	7.78	6.67	
2259a	B	1004	971	1007-1	ph2		20.39		8.57	7.82	6.4	
2259b	B	1004	971	1007-1	ph2		21.74.		8.28	7.58	6.3	
2259c	B	1004	971	1007-1	ph2		20.67		8.48	7.47	5.72	
1575a	B	1011.1	973	1008	ph2		21.58		8.05	7.36	6.02	
1575b	B	1011.1	973	1008	ph2		21.08		8.73	7.95	6.84	
1575c	B	1011.1	973	1008	ph2		23.34		9.27	7.95	6.96	
2116b	B	1004-2	971	1009	ph2		22.44		8.61	7.37	6.29	
2116a	B	1004-2	971	1009	ph2		22.89		9.43	8.52	6.71	
275	B	1001	972	1008	ph2		19.78		8.42	7.45	5.8	
276a	B	1001	972	1008	ph2		20.39		7.35	6.59	6.76	
276b	B	1001	972	1008	ph2		19.39		7.18	6.44	5.81	
651	B	1004	973	1008	ph2		21.73		8.6	8.14	6.01	
652	B	1004	973	1008	ph2		21.49		8.41	8.19	6.69	
685	B	1004	972	1008	ph2		21.38		8.97	7.71	6.47	
686	B	1004	972	1008	ph2		22.35		8.73	8.16	6.52	
687	B	1004	972	1008	ph2		21.43		9.04	7.87	6.61	
730	B	1004	972	1007-2	ph2		21.98		9.62	7.61	7.33	
546	B	1004	972	1007	ph2		22.81		9.15	7.95	6.85	
543	B	1004	972	1007	ph2		22.27		9.03	8.68	6.53	
544	B	1004	972	1007	ph2		19.83		8.73	7.08	6.59	
542	B	1004	972	1007	ph2		21.94		9.28	7.96	5.92	
548	B	1004	972	1007	ph2		20.39		7.45	6.71	4.67	
1672a	B	1004	972	1008.2	ph2		20.88		8.33	7.69	5.96	
1672b	B	1004	972	1008.2	ph2		22.61		9.62	8.6	7.28	
1606	B	1004-1	973	1007	ph2		21.2		8.31	7.35	6.3	
1488	B	1011-1	973	1008	ph2		22.54		9.16	8.73	6.49	
1402	B	1004-2	972	1008	ph2		21.61		8.71	8	5.49	
192	B	1005	972	1007	ph2		20.88		8.36	7.5	6.7	
407	B	1004	972	10078	ph2		19.65		7.01	6.54	5.54	
1322	B	1004-2	972	1007	ph2		20.81		8.51	7.86	5.75	
1323	B	1004-2	972	1007	ph2		22.41		9.19	7.53	6.7	

1369	B	1004	972	1008-1	ph2	21.89	9.43	7.74	6.63
1781	B	1004-2	972	1007	ph2	21.49	8.48	7.79	6.21
2089	B	1004	971	1009	ph2	21.75	8.5	7.6	6.72
174a	B	1016	972	1008	ph2	212.4	9.13	8.08	6.78
174b	B	1016	972	1008	ph2	21.68	9.36	7.83	6.81
1702	B	1004	972	1007-2	ph2	21.84	8.76	6.33	6.31
1655	B	1004	972	1004-2	ph2	22.11	8.42	8.17	6.32
1751a	B	1011-1	973	1008	ph2	21.64	8.76	7.67	6.35
1751b	B	1011-1	973	1008	ph2	21.46	8.96	7.97	6.57
1751c	B	1011-1	973	1008	ph2	22.34	8.92	7.96	6.8
960	B	1004	971	1008	ph2	21.54	8.91	8.06	7.26
1830a	B	1004-2	972	1007	ph2	21.96	8.84	7.98	6.06
1830b	B	1004-2	972	1007	ph2	21.57	8.9	7.57	6.16
911	B	1017	971	1006	ph2	22.86	8.64	8.37	6.17
506	B	1013	973	1007	ph2	21.01	8.04	7.35	6.22
2574a	B	1004	971	1007-2	ph2	19.91	9.83	7.28	7.35
2574b	B	1004	971	1007-3	ph2	22.02	9.16	8.29	6.76
2574c	B	1004	971	1007-4	ph2	22.51	9.18	7.66	6.34
2574d	B	1004	971	1007-5	ph2	20.67	8.78	8.11	6.41
2574e	B	1004	971	1007-6	ph2	20.87	9.28	7.77	6.98
2616	B	1004-2	971	1009	ph2	24.09	9.4	8.51	6.74
2616	B	1004-2	971	1009	ph2	23.73	9.58	7.67	6.36
2616	B	1004-2	971	1009	ph2	23.02	9.14	7.65	6.52
2550	B	1004-1	971	1008	ph2	20.65	8.08	7.53	6.12
2648	B	1004	971	1008	ph2	21.64	8.74	8.07	6.57
2706	B	1004-1	971	1004	ph2	20.92	8.62	7.63	6.58
2676a	B	1004	971	1007-2	ph2	21.78	9.34	7.68	6.52
2676b	B	1004	971	1007-2	ph2	20.08	8.69	8.02	6.02
46a	A	2	987	1005.1	ph2	21.35	9.12	8.49	6.56
46b	A	2	987	1005.1	ph2	21.87	8.89	7.58	6.16
46c	A	2	987	1005.1	ph2	22.68	8.9	7.86	6.42
46d	A	2	987	1005.1	ph2	23.08	8.66	8.27	6.86
81a	A	22	987	1006.1	ph2	22.01	8.28	7.44	5.76
81b	A	22	987	1006.1	ph2	22.01	9.82	8.28	7.16
81c	A	22	987	1006.1	ph2	22.83	9.21	8.77	7.06
8	A	22	987	1006.1	ph2	20.93	8.53	7.46	5.93
95a	A	22	987	1006.1	ph2	22.5	8.79	7.61	6.68
95b	A	22	987	1006.1	ph2	20.41	8.4	7.89	5.83
95c	A	22	987	1006.1	ph2	22.16	8.65	7.62	6.14
2814	B	1004	971	1009.1	ph2	22.45	9.06	7.61	6.87
2834	B	1004.1	972	1008	ph2	22.19	8.89	8.48	6.64
2835	B	1004.1	972	1008	ph2	20.68	7.86	7.08	5.59
2830a	B	1004.1	971	1012	ph2	21.94	9.2	8.44	7.11
2830b	B	1004.1	971	1012	ph2	20.62	8.78	8.15	6.17
2830c	B	1004.1	971	1012	ph2	20.95	8.59	7.45	6.66
2853	B	1004.1	972	100?	ph2	21.94	8.49	8.18	6.79
1933	B	1004	971	1008	ph2	21.68	8.52	7.4	6.19
923	B	1011+1004	973	1008	ph2	22.9	9.28		6.15
1038	section 1	002-4	506	574	ph2	23.2	9.41	8.75	6.7
1036	D2	3500-7	965	1027	ph2	21.07	7.94	7.94	
3014a	B	1004	971	1012	ph2	20.49	8.4	7.66	6.02
3014b	B	1004	971	1012	ph2	21.84	8.86	7.57	6.2
3014c	B	1004	971	1012	ph2	21.51	8.86	8.01	7.16
3014d	B	1004	971	1012	ph2	21.88	9.01	8.12	6.62
3014e	B	1004	971	1012	ph2	21.09	8.82	8.02	6.74

3014f	B	1004	971	1012	ph2	21.97	9.34	8.3	7.01
3014g	B	1004	971	1012	ph2	21.81	8.58	8.17	6.31
2945a	B	1004-1	971	1008	ph2	21.73	9.15	7.7	7.08
2945b	B	1004-1	971	1008	ph2	21.84	8.47	7.57	5.86
2946	B	1004-1	971	1008	ph2	21.07	8.55	7.7	6.52
3025	B	1004-1	971	1012-1	ph2	22.22	8.87	7.73	6.68
3037	B	1004-1	971	1009	ph2	22.88	9.55	8.4	6.91
3059a	B	1004-1	971	1012	ph2	21.95	8.87	7.48	6.77
3059b	B	1004-1	971	1012	ph2	21.62	9.31	8.52	6.72
3059c	B	1004-1	971	1012	ph2	22.13	8.85	8.1	6.77

Gazelle cont.

find no.	area	context	east	north	element	DLS	Ld
805	B	1004	972	1007	ph3	26.62	21.11
774	B	1004			ph3	22.8	17.88
877	B	10004	973	1007	ph3		21.4
2150	B	1004-1	971	1004-1	ph3	22.98	
2263	B	1004	971	1007-1	ph3	23.95	19.04
1576a	B	1011.1	973	1008	ph3	24.07	19.77
1576b	B	1011.1	973	1008	ph3	21.13	
633	B	1004	972	1007	ph3	24.58	19.8
306	B	1004	972	1007	ph3	25.78	21.05
307	B	1004	972	1007	ph3	21.48	16.36
654	B	1004	973	1008	ph3	25.93	20.04
689a	B	1004	972	1008	ph3	24.58	19.11
689b	B	1004	972	1008	ph3	25.14	20.34
689c	B	1004	972	1008	ph3	24.31	19.68
759	B	1004	972	1004-2	ph3	24.91	19.67
552	B	1004	972	1007	ph3	25.63	21.54
553	B	1004	972	1007	ph3	23.88	19.37
554	B	1004	972	1007	ph3	23.66	19.35
1673	B	1004	972	1008.2	ph3	23.79	19.71
1978	B	1004-1	971	1008	ph3	24.64	20.55
1841	B	1011-1	973	1008	ph3	24.75	19.82
1372	B	1004	972	1008-1	ph3	24.09	20.26
2036	B	1004-1	971	1010	ph3	26.3	21.91
2088a	B	1004	971	1009	ph3	25.77	21.25
2088b	B	1004	971	1009	ph3	25.23	20.58
176a	B	1016	972	1008	ph3	24.92	20.23
176b	B	1016	972	1008	ph3	25.13	20.05
1705a	B	1004	972	1007-2	ph3	23.17	19.17
1705b	B	1004	972	1007-2	ph3	22.88	18.38
1656	B	1004	972	1004-2	ph3	23.84	19.21
1750	B	1011-1	973	1008	ph3	25.52	20.3
1636	B	1011-1	973	1007	ph3	27.5	22.52
2579a	B	1004	971	1007-6	ph3	26.93	22.65
2579b	B	1004	971	1007-6	ph3	25.59	21.14
2579b	B	1004	971	1007-6	ph3	23.53	18.43
2616	B	1004-2	971	1009	ph3	29.13	23.49
2616	B	1004-2	971	1009	ph3	25.75	21.05
2552	B	1004-1	971	1008	ph3	24.75	20.72
2707a	B	1004-1	971	1004	ph3	23.39	18.24
2707b	B	1004-1	971	1004	ph3	26.17	21.67
2678a	B	1004	971	1007-2	ph3	22.8	19.13
2678b	B	1004	971	1007-2	ph3	27.39	22.15

55a	A	2	987	1005.1	ph3	22.57	17.64
93a	A	22	987	1006.1	ph3	25.57	21.34
93b	A	22	987	1006.1	ph3	25.96	20.1
93c	A	22	987	1006.1	ph3	24.82	20.34
2815	B	1004	971	1009.1	ph3	24.98	20.89
1228	B	1004	972	1008.1	ph3	26.63	21.65
1229	B	1004	972	1008.1	ph3	28.2	22.68
1230	B	1004	972	1008.1	ph3	24.05	20.1
3017a	B	1004	971	1012	ph3	24.94	20.27
3017b	B	1004	971	1012	ph3	24.25	19.29
3017c	B	1004	971	1012	ph3	23.8	18.71
2947	B	1004-1	971	1008	ph3	26.26	21.74
2980	B	1004-1	971	1007	ph3	27.37	22.91
3027	B	1004-1	971	1012-1	ph3	25.65	20.7
3040	B	1004-1	971	1012	ph3	23.66	19.11
3062a	B	1004-1	971	1012	ph3	24.69	20.46
3062b	B	1004-1	971	1012	ph3	24.92	20.45