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PUTTING THE MEAT BACK ON OLD BONES: A REASSESSMENT OF MIDDLE PALAEOLITHIC FAUNA FROM AMUD CAVE (ISRAEL)

Liora KOLSKA HORWITZ[1], Hitomi HONGO[2]

ABSTRACT

This paper addresses the problem of the scientific value of "old" faunal assemblages. It describes and discusses the data resulting from a re-examination of the faunal assemblage, recovered by the Tokyo University Scientific Expedition to Western Asia, from the Middle Palaeolithic site of Amud Cave located in the Upper Galilee (Israel). It re-assesses species identification relative to the original study undertaken by Takai (Suzuki, Takai 1970) and that undertaken subsequently by Griggo (2004), and provides additional archaeozoological information on age, sex and skeletal element representation as well as bone taphonomy. These data are also compared to faunal remains from the same site recovered during more recent excavations at the cave by a joint Israeli-American team (Rabinovich, Hovers 2004).

Keywords: Amud Cave, Middle Paleolithic, taphonomy, age profiles.

RÉSUMÉ

Ce papier aborde la question de la valeur scientifique des « anciens » échantillons de faune. Il décrit et discute les données résultant d'un ré-examen du matériel faunique récolté par la Tokyo University Scientific Expedition to Western Asia au cours des fouilles d'Amud Cave (Haute Galilée, Israël). Il reprend l'identification des espèces faite dans l'étude d'origine de Takai (Suzuki, Takai 1970) et celle faite par la suite par Griggo (2004). Il apporte des informations archéozoologiques supplémentaires sur l'âge, le sexe et la représentation des éléments squelettiques ainsi que sur la taphonomie. Ces données sont également comparées aux restes de faune du même site récoltés au cours de fouilles plus récentes de la grotte menées par une équipe américano-israélienne (Rabinovich, Hovers 2004).

Mots-clés : *Grotte d'Amud, Paléolithique moyen, taphonomie, profils d'abattage.*

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1. Department of Evolution, Systematics and Ecology, The Hebrew University of Jerusalem, Israel, email: lix1000@gmail.com

2. School of Advanced Sciences, Graduate University for Advanced Studies, Hayama, Miura, Kanagawa, Japan, e-mail: hongou_hitomi@soken.ac.jp

INTRODUCTION

Archaeozoologists are frequently faced with the dilemma of how to deal with faunal collections deriving from "old" excavations *i.e.* those carried out in the 19th and early to mid-20th centuries. Some of these faunal assemblages were analyzed and published at the time of their recovery, while many others have languished in museums unstudied. Today, these "old" collections often represent the only faunal remains recovered from a site, and are thus repositories of unique scientific information. However, even when more recent excavations have been undertaken at the same site, the "old" assemblages still retain their value by presenting a record of the areas that have been obliterated through excavation. In order to obtain a comprehensive picture of the site, all material originating from the site needs to be studied. Furthermore, re-analysis of "old" collections may raise new research questions, thereby guiding future research goals. As succinctly stated by Stiner (1994, p. 11): "Any excavation campaign, old or new, is a destructive act, and there would be no justification for undertaking new excavations if today's archaeologists can glean nothing from old collections with the benefit of an altered perspective."

Despite their value, analysis of such "old" collections poses a challenge to faunal researchers due to problems of "second-order changes" (Reitz, Wing 1999). Frequently encountered problems are the absence of clear documentation of archaeological contexts, insufficient information on excavation procedures, and most importantly, selective and partial bone recovery (absence of sieving and loss of remains of small sized taxa/skeletal elements), as well as the discarding of unidentified splinters and retention of only the more complete elements. Even for "old" assemblages that were studied and published around the time of their excavation, it is necessary to assess the validity of the results based on what appear to be outmoded or insufficient methods of identification and analysis which are inadequate for present-day research purposes (*e.g.* absence of taphonomic analyses). Assessing the value of these "old" collections following re-analysis is best accomplished through comparison with recently excavated bone samples from the same site.

In this spirit, the current paper presents a comparative study of the faunal assemblages recovered from the Middle Paleolithic site of Amud Cave in the Western Galilee, Israel. The site is particularly well-known in the scientific literature due to the rich corpus of Neanderthal skeletal remains it has yielded. An "old" faunal collection originating from the first excavations undertaken at the site by a Japanese team during the early 1960's, is evaluated here against a new collection deriving from investigations carried out in the 1990's by Israeli-American researchers.

AMUD CAVE

History of excavations

In 1925 the first Middle Palaeolithic human fossil in Israel was discovered by Turville-Petre (1927) at the site of Zuttiyeh situated on the Sea of Galilee. This specimen was assumed to be coeval with Neanderthal specimens known from Europe, although already at that time Keith (1927) noted that the Zuttiyeh specimen exhibited several modern morphological features. Subsequently, during the 1930's, investigations at the sites of Skhul and Tabun on Mount Carmel and Qafzeh Cave near Nazareth, yielded remains of two morphologically distinct hominids, both associated with Levalloiso-Mousterian artifacts: Neanderthaloid at Tabun, while the skulls from the sites of Skhul and Qafzeh were identified as having morphological features characteristic of modern humans (Garrod, Bate 1937; McCown, Keith 1939; Vandermeersch 1981). These finds sparked a debate, which continues till today, as to the origin and affinities of these Near Eastern hominids, as well as to the similarities and differences in their associated Middle Palaeolithic industries, modes of subsistence and behaviour (for example: Condemi 1991; Vandermeersch 1992; Zilberman, Smith 1992; Bar-Yosef 1995; Arensburg, Belfer-Cohen 1998; Rak 1998; Shea 1998, 2003; Hovers, Belfer-Cohen 2006).

This was the scientific background against which the 1961 field season at Amud Cave, located in the Western Galilee (Israel), was initiated by Tokyo Universities Scientific Expedition to Western Asia (*fig. 1*). During this first season, remains of four hominid skeletons were found, including an almost complete *in situ* skeleton, Amud I, which was attributed to Neanderthals (Suzuki, Takai 1970). These finds reinforced the hypothesis of a Neanderthal presence in the Levant. The lithic industry associated with the hominid bearing layers was studied by Watanabe (1970) and characterized as homogeneous but of a transitional Middle to Upper Palaeolithic type. A second excavation season was undertaken in 1964 when further Neanderthal skeletal remains were recovered. The finds from the two excavation seasons at Amud were published in a monograph by Suzuki and Takai in 1970, and included a description of the fauna by Takai.

Fig. 1—Map showing location of Amud Cave and other Middle Palaeolithic sites in Israel.

Subsequently, between 1991 and 1994, a series of excavation seasons were undertaken at the site by a joint Israeli-American team (Hovers 1998a, b, 2004; Hovers *et al.* 1995). They too recovered Neanderthal skeletal remains, thus a total of 16 Neanderthals have been recovered from the site of which the majority represent children or infants. Most hominids are incomplete and represented only by isolated teeth and bones (Sakura 1970a, b; Rak *et al.* 1994; Hovers *et al.* 1995; Alperson-Afil, Hovers 2005).

The site

Amud Cave is located within the narrow valley of the Amud river (Nahal Amud), 5 km northwest of the Sea of Galilee on the edge of the Jordan Valley. The cave is situated at the top of a steep cliff *ca* 30 meters above the present valley floor at *ca* 110 meters below modern sea level. The vegetation around the site today is Irano-Turanian with a mean annual precipitation of *ca* 450 mm.

Two excavation Areas (A and B) were investigated by the Suzuki excavation team (*fig. 2*). The deposit reached depths of *ca* 4.5 meters and comprised two main stratigraphic layers termed Formation A and B respectively (Chinzei 1970). The uppermost layer in the cave (Formation A) consisted of disturbed deposits of late Holocene age (5th millennium BC to present day) and yielded ceramics, lithic artifacts and animal bones. Underlying this was Formation B containing skeletal remains of Neanderthals associated with a Middle Palaeolithic lithic industry and large quantities of fauna.

The subsequent Israeli-American excavation at the site, initiated in 1992, used the same basic grid, and continued excavation in Areas A and B, as well as extending excavation into a third area termed Area C (*fig. 2*). The stratigraphic sequence identified in the earlier excavations was confirmed but further resolution was obtained within each of the original Formations. The Middle Palaeolithic deposit in Area A was identified as primarily made up of a mixed ashy, loose-grey matrix while Area B was mainly composed of fine-grained, silty laminated hearths, black to grey in colour. This clarified the original identification of these layers published by Chinzei (1970), who suggested that they represented alternating black soils and grey concretions. Cemented calcareous deposits were also found in both areas. The following is the new stratigraphic sequence and summary of dates (outlined in Hovers 2004; Rabinovich, Hovers 2004):

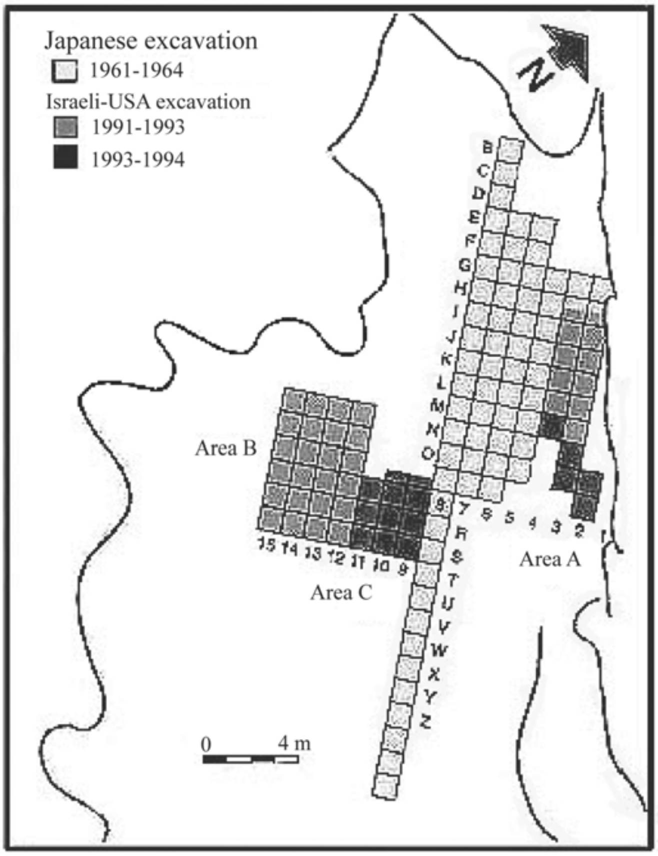

Fig. 2—Sketch showing location of excavation Areas A, B and C and areas excavated by (a) the Japanese excavation in 1961-1964 and (b) Israeli-USA excavation in 1991-1994 (based on Hovers 1994: fig. 2).

The uppermost Holocene deposit, Formation A, comprises three Units:

A1—surface (brown soil), mixed material;

A2—pits dug into Formation B, some reaching the bedrock;

Post-B1—erosion of deposits.

The Middle Palaeolithic deposit, Formation B, comprises four main Units:

B1—consolidated ash, limestone rubble containing archaeological remains and dated by TL to 57.6 kyr ± 3.7 kyr and by U-series to 53 kyr ± 7 kyr;

B2—silty ash with archaeological remains dated by TL to 65.5 kyr ± 3.5 kyr and U-series to 61.9 kyr;

B3—a sterile hiatus, containing collapsed cave roof and wall rubble;

B4—anthropogenic ash layer, includes outlines of hearths, dated by TL to 68.5 kyr ± 3.4 kyr; U-series to 70 kyr ± 11 kyr; and ESR to 68.5 kyr;

B5-7—concretion layer, down-slope from the cave terrace.

The TL, U-series and ESR dates all corroborate that the cave was occupied between *ca* 70,000-55,000 BP with an occupational hiatus for as long as several thousand years between Units B2 and B4 (Valladas *et al.* 1999; Rink *et al.* 2001). Lithic material from the different Middle Palaeolithic Units is relatively homogeneous and rich with artifacts made primarily on flint (of several kinds). The lithic industry of Formation B is a typical Mousterian industry (Ohnuma, Akazawa 1988; Ohnuma 1992; Hovers 1998b). As described by Hovers (1998b, 2004) and Alperson-Afil and Hovers (2005), it contained elements manufactured using hard hammer technique. Nodule cores are rare, with high numbers of modified flakes used as cores. Unipolar convergent Levallois flaking methods predominate, with few dorsal scars evident on the cores. Flakes, blades and triangular flakes were rarely modified by additional retouch.

The hominid remains appear to have been intentionally disposed of, since the vast majority were recovered against the east wall of the cave in Excavation Area A and originated from the Middle Palaeolithic Units B1 and B2 (Hovers *et al.* 1995). Although no macro-botanical remains were recovered, phytoliths demonstrate the exploitation of woody and herbaceous plants (Poaceae-grass family) (Madella *et al.* 2002). It has been suggested that the remains of Palmae (palms) and Moraceae (fig-tree family) represent wood used for fire or even for food *e.g.* green parts of palm trees, while the grasses may represent remains of bedding or seeds used for food.

THE FAUNAL ASSEMBLAGE

Samples

Takai study

The faunal collection from the original Japanese excavation at the site was first studied and published by Takai (1970). It is a small assemblage of 495 identified bones; 239 from Formation A and 256 from Formation B (*fig. 3a-b, appendix A*). This assemblage was catalogued by individual piece and curated in the Tokyo University Museum collection.

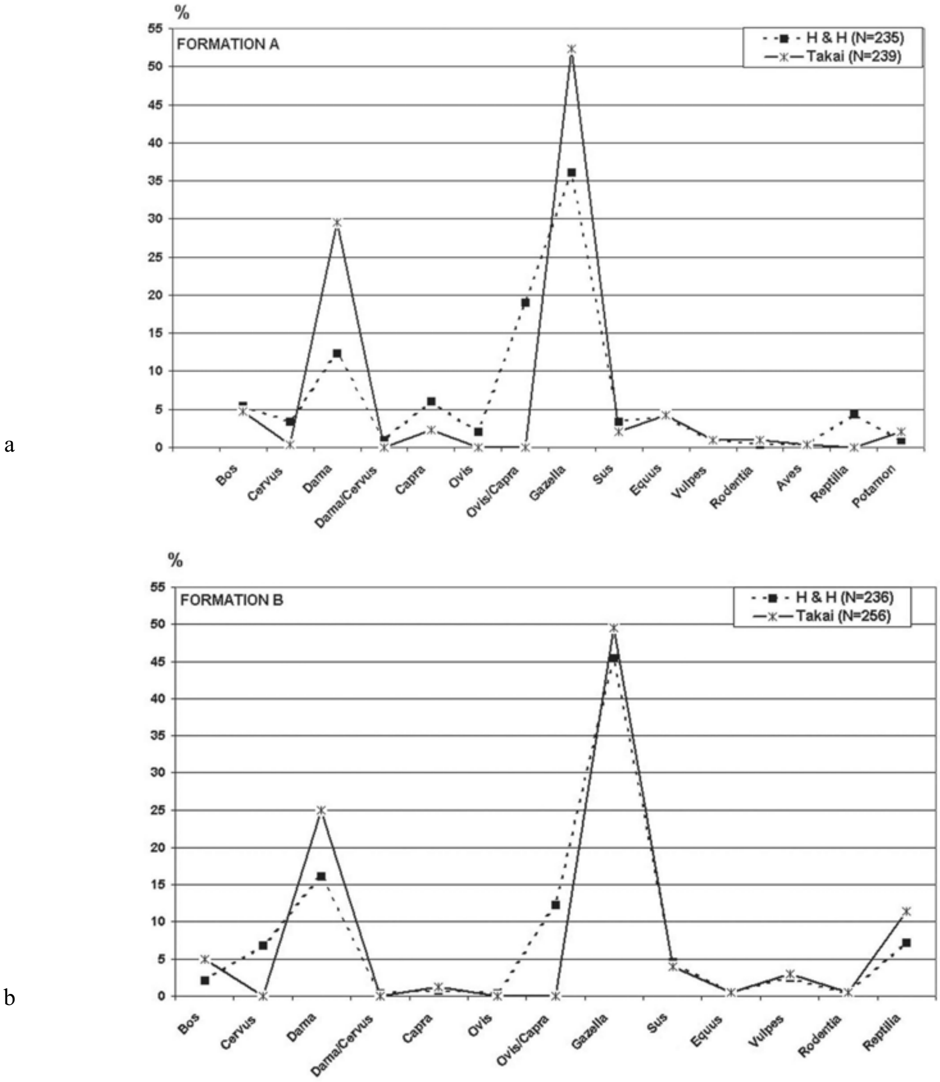

Fig. 3—Histogram showing species representation for the Takai and the Hongo and Horwitz studies respectively, for (a) Formation A and (b) Formation B.

Griggo study

The original Takai sample from Formation B was restudied by C. Griggo and included in a comparative table of Mousterian fauna published in 2004. Griggo lists identifications for a total of 208 bones, which is 48 bones less than noted by Takai (*fig. 4a, appendix A*). Beyond species determination, given only as frequencies, no other data are provided in this publication.

Rabinovich and Hovers study

A detailed study of the fauna recovered from Formation B by the new Israeli-American excavations was recently published by Rabinovich and Hovers (2004), including species, age, bodypart and taphonomic data (*fig. 4a-b, appendix A*). Just over 2000 bones from Units B1 and B2 (*i.e.* sub-units of Formation B) were identified, most to species but others to the level of body size class.

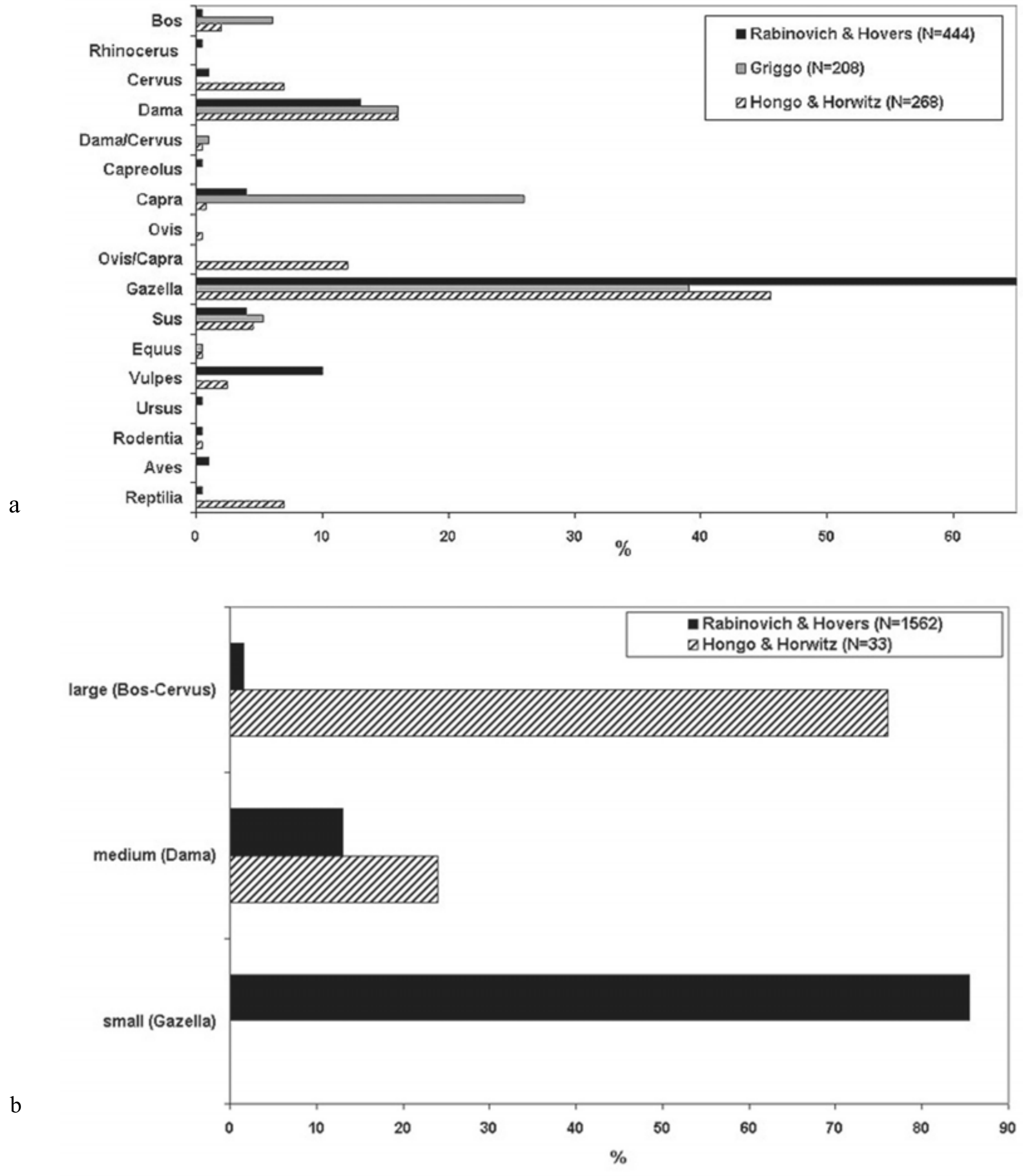

Fig. 4—(a) Comparative frequencies of identified species (based on NISP counts) for the Hongo and Horwitz study, Griggo study and Rabinovich and Hovers study. (b) Comparative frequencies of bones identified to size class for the Hongo and Horwitz study, and the Rabinovich and Hovers study.

Hongo and Horwitz study (H and H)

This study, undertaken by Hongo and Horwitz, re-analysed the original Takai collection held in the Tokyo University Museum. Material from both Formations A and B was studied. The aim of this investigation was to verify some of the early species identifications and to add information on age profiles and taphonomy, including skeletal element representation and surface modifications, which had not previously been studied.

There is a great disparity between the number of bones curated in the Tokyo University Museum and the statement by Takai (1970, p. 53) that "more than twenty thousands pieces of fossil mammalian bones" were recovered. Since, the vast majority of surviving bones are identifiable, it seems that with a few exceptions, all the unidentified bone fragments from the excavation had been discarded. This seems likely since Takai noted (1970, p. 53) that "The mammalian bones are generally too fragmentary to be identified and the species represented are very much limited in number". Consequently, the surviving assemblage has been greatly reduced in both quantity and quality, a factor which severely limits this study, especially the investigation of taphonomy.

A total of 503 bones were studied by us (*table 1, appendix A*)—235 bones from Formation A, and 236 bones from Formation B. This includes some bones not previously identified, but lacks 20 bones that have been mislaid, presumably when the collection was moved within Tokyo University.

Identified bones	Formation A		Formation B	
	NISP	Notes	NISP	Notes
Bos	11	3 *B. taurus* size	5	1 *B. primigenius* size
Cervus	6		16	
Dama	25		39	
Dama/Cervus	2		0	
Capra	12	1 domestic	2	
Ovis	4	all domestic	1	domestic
Ovis/Capra	38	7 domestic	29	a few possibly domestic
Gazella	73		107	
Sus	7		11	
Equus sp.	8	5 *E. asinus*	1	*E. asinus*
Vulpes	1		6	
Other small mammal	1		1	
Aves	1		0	
Reptile	9	all *Testudo*	17	1 *Ophidia*, 16 *Testudo*
Potamon	2	not recorded by Takai		
Sub-Total	200		235	
Bone fragments				
Bos size	21		20	3 *B. primigenius* size
Bovid	1		1	ident. as *Gazella* tooth by Takai
Cervus size	3		4	
Dama size	2		1	
Medium mammal	6		7	
Small mammal	2		0	
Sub-Total	35		33	
Assemblage Total	235		268	20 specimens missing that were recorded by Takai; 4 new specimens recorded by Takai (1 *Capra*, 3 *Gazella*)

Table 1—Species representation for Formations A and B according to the Hongo and Horwitz study.

Species Representation

Table 1 lists species identifications resulting from our investigation (H and H), while appendix A, figures 3a and 3b present comparative data illustrating species representation from the Takai study and that from the present study.

Formation A

As demonstrated in figure 3a, essentially the same faunal spectrum was identified in the uppermost Formation A by both Takai, and Hongo and Horwitz. Some of the differences are noted below:

(a) there are more caprines in this sample than previously identified, and many of these represent domestic sheep/goat (*Ovis aries*/*Capra hircus*), including a twisted goat horncore, clearly belonging to a domestic animal. The majority of sheep and goat remains are isolated teeth such that their identification as wild or domestic animals was difficult to determine;

(b) at least 7 of the post-cranial remains of cattle from Formation A were identified as belonging to domestic animals based on their small size and gracility. The rest were teeth and their status could not be determined;

(c) most of the equid remains were identified as those of domestic donkey (*Equus asinus*) rather than *E. caballus* as identified by Takai;

(d) some bones previously attributed to fallow deer (*Dama*) by Takai have been more appropriately identified as red deer (*Cervus elaphus*);

(e) some previously unidentified bones could now be placed in a general Cervid (*Dama/Cervus*) category, even if not identified to genus or species. Due to points (d) and (e), the frequency of fallow deer in the H and H sample is some 15% lower than that given by Takai.

A further difference in species attribution between the Takai and H and H samples pertains to the identification of a non-human primate, a macaque. An isolated tooth (catalogue number 61168 in Takai 1970) was found in Formation A during the first excavation season by the Japanese team. It was described in the 1970 publication as the upper left first molar of a primate, *Macaca* sp. Unfortunately the original tooth is now missing from the faunal collection held at the Tokyo University Museum, but a cast exists in the appropriate box that appears to correspond to the missing tooth in terms of its form and size, as shown in the published photographs (Takai 1970, Plate 11.1a-1e).

The last known osteological evidence of macaque from the Levant is from the site of ’Ubeidiya in the Jordan Valley of Israel, dated to 1.4 million years BP (Tchernov, Volokita 1986; Belmaker 2006). These remains, identified as *Macaca sylvana*, relate to a late Pliocene-early Pleistocene invasion of African elements into the eastern Mediterranean area. Following this event, the Saharo-Arabian desert belt served as an effective barrier for most African taxa, so that primates as well as a wide range of other species could not migrate north. The presence of macaque at Amud is then of special interest given its more recent date.

Examination of the cast of the Amud tooth shows that its size and morphology are those of a human upper second deciduous premolar (dp4) with four obliquely orientated cusps. It exhibits none of the typical features of macaque molars which are small and bunodont with four cusps arranged in pairs (*i.e.* with parallel cusps), forming two bucco-lingually oriented folds. Moreover, the crown is narrow bucco-lingually. In *Homo* the tooth crowns are lower and broader than in other primates and the enamel is thicker. In size and shape the Amud tooth falls within the range of variation shown for modern human dm4’s, and is neither that of a macaque nor a Neanderthal.

Formation B

As illustrated in figure 3b and appendix A, H and H identified higher numbers of caprine remains than did Takai. Using the criteria of Boessneck (1969), both *Capra* and *Ovis* were identified and the remaining caprines were placed in a combined *Capra/Ovis* category. Several bones are those of domestic animals, notably a well preserved *Ovis* mandible. Undoubtedly these represent intrusive elements from the overlying Formation A. In his study of the Takai assemblage, Griggo (2004) also identified a significantly higher numbers of caprines than did Takai (*fig. 4a*). Similarly, both Griggo and H and H identified red deer in the assemblage, a species not noted by Takai as occurring in either Formation A or B. As a consequence, gazelle and fallow deer frequencies reported here are lower than those presented by Takai, primarily due to the new identifications.

Aside from a distal tibia (identified as that of aurochs on the basis of its robustness and large size), all the other cattle remains identified by H and H from Formation B are teeth, and thus it was difficult to determine whether they represent aurochs or large-sized domestic animals. In addition, H and H found that the isolated equid incisor (identified as E. *asinus*), from Formation B, belonged to the same animal as represented in Formation A, and thus was intrusive into Formation B. As illustrated in figure 4a, Griggo (2004) reported a smaller NISP count for Formation B than either Takai or Hongo and Horwitz. This partly stems from the fact that he did not include reptiles, small mammals and carnivores in his list.

The fauna from Units B1 and B2, which make up Formation B following the stratigraphy of the new Israeli-American excavation, have been published by Rabinovich and Hovers (2004). In this publication they reported finding no statistically significant differences between these Units in species representation. Therefore, they have been combined in this paper (*fig. 4a*). Both gazelle and fallow deer dominate this new sample and the old Takai assemblage. However, several additional species are present in the new sample: rhinoceros, bear, roe deer, a range of arboreal and steppic rodents, as well as 6 species of birds. The expanded spectrum of species undoubtedly relates to the augmented size of this collection, following the rule that rare taxa have a better chance of being represented in larger assemblages (Grayson 1984). Of specific interest is the absence of equids in the new collection, which reinforces the notion that the single equid tooth from the Takai Formation B sample is indeed intrusive and that equids were not exploited during the Middle Paleolithic at this site.

In all four studies it is evident that *Gazella* is the most common taxon, although the relative frequencies vary somewhat between the different analyses (*fig. 3b*, *4a*). It is also evident that many of the remains previously identified only to size class, as medium mammals (*fig. 4b*) can be attributed to gazelle. This augments the gazelle frequencies significantly.

Takai identified the gazelle species at Amud as belonging to the goitered gazelle, *Gazella* cf. *subgutturosa*. Subsequently, based on horncore morphology and size, Davis (1980, 1982) demonstrated that all gazelles in Middle and Epipalaeolithic sites in northern Israel are referable to the mountain gazelle, *Gazella gazella*. Based on the examination of the morphometrics of the gazelle horncores represented in the Takai sample (*table 2a*, *2b*, *fig. 5*), using criteria given in Uerpmann (1982), Harrison and Bates (1991), Helmer (2000) for *G. subgutturosa* and Davis (1980) and Tchernov *et al.* (1986/1987) for *G. gazella*, as well as post-cranial biometry (*table 3*), it is evident, as noted by both Griggo (2004) and Rabinovich and Hovers (2004), that the species represented at Amud is the mountain gazelle.

Fig. 5—Photograph showing gazelle female horncores from Formation B (scale in cm).

Portion of horn preserved	Preserved frag. greatest length	Preserved frag. greatest mesio-lateral diameter	Preserved frag. greatest anterior-posterior diameter	Maximum mesio-lateral diameter of horncore base	Maximum anterior-posterior diameter of horncore base
Horncore tip area	28.4	10	10.7	-	-
Horncore tip area	39.1	7.5	8.1	-	-
Horncore tip area	29.4	8.6	9.8	-	-
Horncore tip area	40.9	9.1	9.6	-	-
Horncore tip area	32.4	-	9.9	-	
Horncore tip area	37.5	8.4	7.6	-	-
Horncore tip area	23.8	7.8	8.2		-
Middle of horncore	32.7	10.3	10.8	-	-
Middle of horncore	33.1	9.1	9.4	-	-
Middle of horncore	26.7	7	7.7	-	-
Middle of horncore	28.1	8.6	10.1	-	-
Almost complete	33.6	11.1	11	-	-
Almost complete	-	-	-	12.7	13
Almost complete	49.8	-	-	11.5	12.7
Almost complete	45	-	-	12.8	13.2
Almost complete	47.8	-	-	10.6	11.7
Horncore base	30.3	-	-	10.9	11.9
Horncore base	-	-	-	12.6	13.2

Table 2a—Gazelle horncore measurements from Amud (in mm).

Sample	Horncore base mesio-lateral diameter			Horncore base anterior-posterior diameter		
	X	SD	Range	X	SD	Range
Amud (N = 6)	11.8	0.97	10.6-12.8	12.6	0.66	11.7-13.2
Modern female *G. gazella* (N = 15)	8.9	0.83	6.7-9.9	9.68	0.93	7.4-11.1
Modern male *G. gazella* (N = 15)	22.2	1.87	18.7-25.2	30.9	2.21	26.5-35.30
Modern female *G. dorcas* (N = 5)	14.1	1.00	13.0-15.6	14.5	1.43	12.8-16.8
Modern male *G. dorcas* (N = 7)	22.01	1.48	20.0-24.0	28.78	1.26	26.7-30.4

Table 2b—Comparison between the horncore measurements from Amud and those of modern Gazella *(in mm).*

Scapula	GLP	LG	BG	SLC		
	30.1	24.3	19	17.1		
Astragalus	GLl	GLm	Dm	Dl	Bd	LA
	28.8	27	16	15.4	16.4	21.9
	28.3	26.2	15.6	16	17.7	22.1
	27.4	-	16	15.3	16.5	-
	27.7	25.6	-	16.5	17.1	22
	27.9	25.7	15.5	15.7	17.1	21.6
	30.7	28.1	17	17.5	18.7	23.9
	29.8	27.5	16.2	16.5	18.6	23
	-	-	16.2	16.3	18.3	-
	-	-	15.7	15.8	16.7	-
	28.6	26.3	14.9	14.4	16.5	22.2
2nd Phalanx	GLpe	Bd	Bp	Dd		
	21.6	7.7	-	-		
	-	8.2	8.1	8.82		
	-	6.2	7.64	8.01		

Table 3—Gazelle post-cranial measurements from Amud (in mm) (cf. von den Driesch 1976).

Ageing

Gazella

The age at death of gazelles was established using tooth eruption and wear of the deciduous fourth premolar and three permanent molars. Wear stages of the mandibular teeth, both tooth rows and isolated teeth, were scored following Payne's scheme for sheep and goats (Payne 1973). In addition, the state of wear of maxillary teeth was recorded according to 3 categories "slight", "moderate", or "heavy".

In order to calculate the relative proportions of the different age groups, the sample scored for Formation B included 32 mandibular tooth rows and 4 isolated teeth. Observations of the state of wear of 9 maxillary tooth rows and 3 isolated maxillary molars were also included. For the Formation A sample, we scored 27 mandibular tooth rows and 5 isolated teeth. The state of wear of 1 maxillary tooth row and 4 isolated maxillary teeth was also included. For each sample, the wear stage of the deciduous fourth premolar and 3 permanent molars was examined. For mandibular or maxillary tooth rows, wear stages of the most recently erupted tooth were used for the analysis. The results were classified into four age categories:

—young: dp4 slight or moderate wear, M1 slight wear
—juvenile: M1 moderate wear, M2 slight wear
—sub-adult/adult: dp4 heavy wear, M1 heavy wear, M2 moderate wear, M3 slight wear
—old: M2 heavy wear, M3 moderate or heavy wear

The proportion of teeth in each age category was then calculated and is illustrated in figure 6.

It is clearly demonstrated in figure 6 that gazelle exploitation in Formation B concentrated on prime-age animals. Close to half (47.9%) of the samples from this period were killed in the sub-adult/adult age stage (in Payne's scale up to about 3 years of age). Substantial numbers of juveniles and old animals were also hunted. Indeed, the proportion of gazelles killed during the juvenile age stage is 27.1% while old animals comprise slightly more than 20% of the sample. In contrast, few young animals were identified and comprised only some 4%. This concentration on sub-adult/adult animals is unchanged in Formation A, with about 43% of the sample falling into this age category. The proportion of young animals in the Formation A sample is also low (8.1%). Consequently, the age profile in both periods corresponds well to a hunting strategy aimed at prime age animals, although slightly more old animals were hunted in Formation A.

The age profile of gazelles in the Takai sample from Amud resembles that based on 37 mandibles found during the new Israeli-USA excavation (Rabinovich, Hovers 2004). The gazelle mandibles from the recent excavation also indicate a hunting strategy concentrating on prime-age adults, with close to 60% of the mandibles belonging to adults. However, the proportion of old animals is lower (8.1%), and young animals constitute a high 32% of the samples. The higher numbers of animals in the young category undoubtedly relates to their inclusion of animals that we categorized as juveniles, while criteria used to separate old from adult animals, may also have differed.

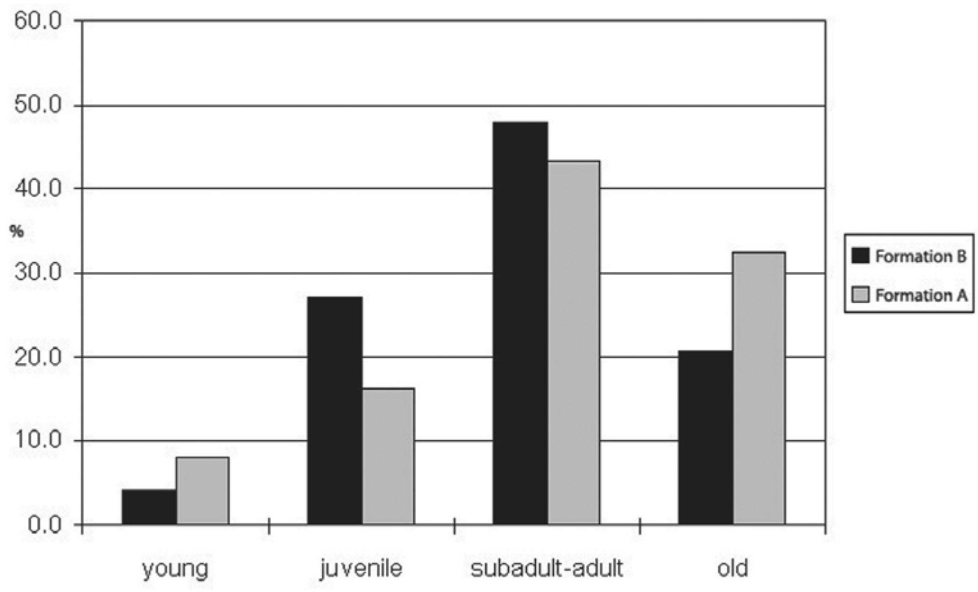

Fig. 6—Histogram showing the age of gazelles in Formations A and B, based on dental attrition.

Dama

Tooth wear of *Dama* was recorded based on the scheme outlined in Brown and Chapman (1990). For Formation B, 16 mandibles and 2 isolated mandibular teeth as well as the observation of tooth wear of 5 maxillary teeth were used for the analysis. For Formation A, 8 mandibles with teeth and one isolated lower M3 as well as one maxillary teeth row were used.

The age classes used in this study are as follows:
Brown and Chapman's group (a) and (b) = young and juvenile animals (up to 2 years);
Brown and Chapman's group (c) = sub-adult/adult (over 2 years up to 5 years);
Brown and Chapman's group (d) = old (6 years and older).

Our results indicate that we have a rather late kill-off for *Dama* in Formation B, about 30% of the animals killed by 2 years, a further 30% by 5 years, and 39% in the oldest age group (6 years or older). In Formation A, a similar trend is found with 20% culled by 2 years, 40% by 5 years, and 40% in the oldest age group. Despite the rather large ranges included in each age category, it is clear that the majority of animals in both samples were culled either as prime age or as mature (old) animals. A similar conclusion was reached by Rabinovich and Hovers (2004) for aged *Dama (*and *Capra*) jaws and teeth from the new excavation. However, in that study only 6 jaws were examined for both these taxa.

The gazelle dentitions from Amud reflect a typical hunted age profile, with a high proportion of sub-adult and adult animals, but few young or old individuals. In contrast, the kill-off pattern for *Dama* is biased towards older animals. These differences may reflect greater hunting pressure on gazelles which were exploited at a younger age. An alternative, although considered by us as unlikely, is that these differences reflect a hunted (gazelle) versus a scavenged fauna (fallow deer). The paucity of post-cranial remains does not enable us to test this hypothesis. Likewise, the impact of diagenetic factors on the preservation of immature versus adult teeth and bones cannot be assessed due to sampling constraints inherent in this small and incomplete sample.

Sexing

A total of 18 gazelle horncores are preserved, of which 5 are almost complete, while the rest consist of broken fragments of the tip, base or mid-horn region (*table 2a*). As shown in this table, where possible, measurements of horncore length and anterior-posterior and medio-lateral diameters were taken. In addition, cross-sectional shape was assessed visually. Both parameters facilitated sexing of the horncores using criteria and comparative data given in Tchernov *et al.* (1986/1987) and Horwitz and Goring-Morris (2001).

As illustrated in figure 5 and table 2a, all the horncores are short and narrow (the largest diameter measurement is a little over 13 mm), and rounded in cross-section. Comparison with horn measurements for modern adult male and female mountain and dorcas gazelles (*table 2b*), clearly shows that the Amud specimens are closest to those for adult female mountain gazelle, although slightly larger (*table 2a*). The larger size of the Amud females may be attributed to size change which occurred since the Pleistocene rather than to species differences. No male gazelle horncores were identified in this sample. Unfortunately, no comparable data on gazelle sexing is given for the new assemblage by Rabinovich and Hovers (2004), but a preponderance of female gazelles was documented by Speth and Clark (2006) for the Middle Palaeolithic assemblage of Kebara Cave, Israel. They attributed this sex bias to encounter rates and availability of animals in the landscape rather than the season of cull.

Due to the fragmented nature of most of the horncores in the Takai sample, it was not possible to ascertain with certainty the minimum number of females represented. However, assuming that the 5 almost complete horncores plus the 7 horn tips represent a total of 12 horncores, with equal numbers of rights and lefts, then we arrive at a total of 6 animals.

Skeletal elements

A major difference between the old and new excavation samples is that unidentified bone fragments are available for the latter. The new assemblage is characterized by a very high proportion of unidentified long bone shafts, which are of relatively small size. This reflects the extreme fragmentation of bone at the site and has been interpreted as a result of the intensive exploitation of animals for marrow (Rabinovich, Hovers 2004).

In this sample, *Dama* was represented by few skull elements and maxillary teeth-mainly post-cranial remains and mandibles. There are more fallow deer long bones in B2 than in B1, but the differences between the Units are not statistically significant.

Analysis of distribution of body elements of *Gazella* between Units B1 and B2 in the new assemblage, showed some significant differences between them. For example, gazelle is represented by more cranial elements in Unit B2 than in B1, and more trunk elements (ribs, vertebrae) in B1. Rabinovich and Hovers (2004) found no clear evidence for selection of skeletal parts based on utility indices, nor evidence for density mediated attrition. Therefore differences between B1 and B2 were interpreted as reflecting differences in hunting strategies of animals, *i.e.* cultural selection of body parts.

The same type of analysis of skeletal part distribution was not possible for the Takai assemblage since it is heavily biased towards cranial elements, especially mandibles (*table 4*). With or without isolated teeth, the majority of elements in the collection are those of the crania (*table 4*). This biased representation is clearly the result of the fact that most of the post-cranial remains have been discarded. This is evident since the majority of the post-cranial shaft fragments were small pieces that were encrusted in calcareous deposits (Prof. Chinzei, pers. com. 2006). Consequently, teeth and horncores that were more easily identifiable appear to have been selected for cleaning while the broken long bones were discarded.

Formation A	*Gazella*		*Dama*		*Ovis/Capra*	
	NISP	%	NISP	%	NISP	%
Postcranial	10	13.7	5	20	10	18.5
Cranium	48	65.8	12	48	14	25.9
Isolated teeth	15	20.5	8	32	30	55.6
Total NISP	73	100	25	100	54	100
Formation B	*Gazella*		*Dama*		*Ovis/Capra*	
	NISP	%	NISP	%	NISP	%
Postcranial	15	14	5	12.8	3	9.4
Cranium	80	74.8	23	59	11	34.4
Isolated teeth	12	11.2	11	28.2	18	56.3
Total NISP	107	100	39	100	32	100

Table 4—Skeletal element representation in the Takai sample—Hongo and Horwitz analysis.

Modifications

As illustrated in figure 7, in the Takai sample, close to half of the specimens from Formation B were burnt. This result is in accordance with the extensive evidence for fire found in this level at the site, such as ash lenses and hearths (Hovers 2004). A high proportion of burnt bones was also observed in the faunal assemblages from the new excavation. More than 50% of the bones show traces of burning in Unit B1 and about 20% in Unit B2. Two explanations have been offered to account for the extensive burning of the bones and the fact that burnt and unburnt bones occur together; namely that they were used as fuel or alternately that the burnt material represents dispersed hearth debris ((Rabinovich, Hovers 2004).

Cutmarks were found on relatively few bones, with some 5% of bones in the Takai assemblage exhibiting butchery damage (*fig. 8*). This is also the case in the assemblages from the new excavation. Here, only 1% of the bones from Unit B1 and 3% from Unit B2 had cutmarks, and these were found mainly on long bone shafts (Rabinovich, Hovers 2004).

Fewer traces of modification are found on bones from Formation A. About 24% of these bones show traces of burning, and only about 3% have cut marks (*fig. 7*). In both the Takai and the new assemblages, modification of bones by carnivores is rare, which probably corresponds to the fact that very few carnivore bones have been found in the Amud assemblages.

Many of the faunal remains were found crushed and cemented in the calcareous deposits. As such it is likely that many of the traces of modification, either by hominids or animals, have been obscured by the acid preparation of the bones used to remove the calcareous deposits.

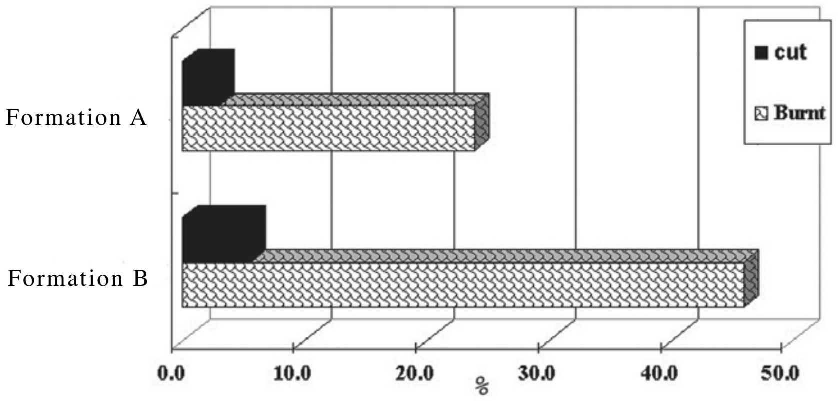

Fig. 7—Frequencies of bones exhibiting anthropogenic modifications from the Hongo and Horwitz study for Formations A and B respectively.

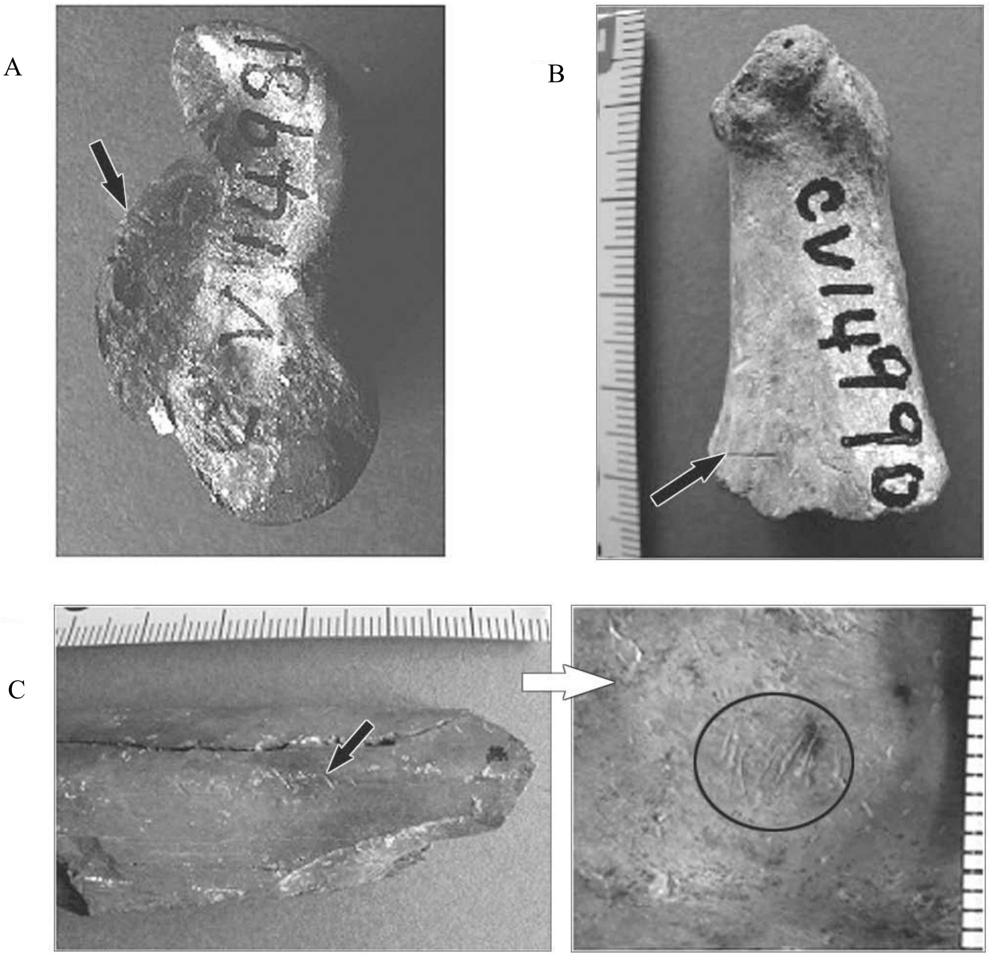

Fig. 8—Cut marked bones from Formation B. Top left: gazelle astragalus; top right gazelle: calcaneum; bottom: fragment of large mammal shaft—with close up.

Comparison of Formation A and B

Comparison of Formations A and B, shows that the same range of taxa are represented—Cervids, *Gazella*, *Ovis/Capra*, *Bos, Equus, Sus, Vulpes*, Rodentia, Aves and Reptilia—even in similar frequencies. The main difference is the presence of numerous bones of domestic taxa in Formation A (*table 1*). This is consistent with the fact that Formation A is essentially a mixed, multiple period Holocene assemblage containing archaeological remains spanning the Neolithic through Islamic periods, and has yielded remains of domestic animals—sheep, goat, donkey and cattle. Thus, the high frequencies of gazelle and cervid remains in Formation A are surprising (*table 1*). It is not possible to determine whether these are *in situ* or Middle Palaeolithic in origin since, with the exception of two species, all are found in the region today. The exceptions are the wild bezoar goat (*Capra aegagrus*) which became extinct shortly after the Neolithic, and the fallow deer (*Dama mesopotamica*) which disappeared, following the introduction of firearms, in the late 19th century (Yom-Tov, Mendelssohn 1988). Although gazelle and fallow deer remains are present on nearby sites, such as in the Bronze and Iron Age levels at Tell el-Oreme near the Lake of Galilee (Manhart, von den Driesch 2000), in these later periods hunting is of minor importance as attested by both species comprising less than 10% of the total identified assemblage at this site. In contrast, in Amud Cave Formation A, these two wild taxa alone comprise over 45% of the remains—gazelle 36.5% and fallow deer 12.5%—suggesting that many of these bones originate in the underlying Middle Palaeolithic deposits of Formation B. They may have accidentally become incorporated into Formation A, since Unit A2 represents pits dug into Formation B, some of which reach bedrock. This is borne out by the presence of an equid incisor in Formation B that fits a domestic specimen from Formation A, and the presence of domestic caprines, including a mandible of a domestic sheep, in Formation B (both are discussed above).

CONCLUDING REMARKS

The presentation of our findings based on the re-examination of the surviving faunal assemblage excavated by a Japanese team at Amud Cave in the 1960's, has demonstrated the value of examining old collections. As illustrated here by the macaque tooth, independent re-examination of species identifications may resolve some important biogeographic issues.

Not only could species identifications be assessed, but a wide spectrum of additional data could be gleaned from this sample—specifically data on ageing, sexing and bone modification. The validity of these findings are unequivocally corroborated by those based on the larger, more comprehensive, faunal assemblage recovered during the new Israeli-USA excavations (Rabinovich, Hovers 2004). Indeed, given the far smaller size of the Takai bone assemblage, the concordance of the results is impressive.

However, the Japanese assemblage is clearly biased, since it contains almost no post-cranial or fragmented remains. This factor has severely limited analysis of skeletal element representation and interpretation as to the factors which may have contributed to the formation of this assemblage, which would have offered further insights into Neanderthal behaviour.

Given this limitation, what conclusions can still be drawn from this re-analysis of the Amud collection? The first is that Middle Paleolithic Neanderthals clearly played a major role in the creation of this assemblage, given the presence of anthropogenic modifications to the bones—burning and cut marks, evidence of butchering and food preparation. They exploited a limited range of medium to large-sized species—predominantly gazelle and fallow deer. Prime-age adult gazelles, especially females, were the favoured prey, while older animals were targeted among the fallow deer. Few very large sized species—red deer, aurochs (and rhinoceros)—were exploited and it cannot be discounted that the bear bone, recovered from the new excavation, represents a cave dweller rather than a prey species. Moreover, it is evident that carnivores have played a minor role in the creation of this bone assemblage, given the paucity of their skeletal remains in the cave as well as the near absence of typical damage to the bones.

Although limited in size and missing the full complement of bones, the "old" Amud assemblage fully corroborates what we now know about this site as well as other late Mousterian assemblages from the Levant (*e.g.* Speth, Tchernov 1998; Shea 2003; Griggo 2004; Speth, Clark 2006). Clearly, it is possible to put meat back on old bones, and that "old" collections such as that studied here are of value and should not be ignored.

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Formation A Holocene	H and H (N = 235)	Takai (N = 239)
Bos	5.4	4.7
Cervus	3.4	0.4
Dama	12.3	29.5
Dama/Cervus	1.0	-
Capra	6.0	2.3
Ovis	2.0	-
Ovis/Capra	19.0	-
Gazella	36.1	52.3
Sus	3.4	2.0
Equus sp.	4.0	4.2
Vulpes	1.0	1.0
Rodentia	0.4	1.0
Aves	0.4	0.4
Reptilia	4.4	-
Potamon	1.0	2.0

Formation B Middle Paleolithic	H and H (N = 236)	Takai (N = 256)	Griggo (N = 208)	Rabinovich and Hovers (N = 444)
Bos	2.1	5	6.3	0.2
Rhinocerus	-	-	-	0.2
Cervus	6.8	-	5.8	1.0
Dama	16.1	25	15.9	13.5
Dama/Cervus	0.4	-	1.0	-
Capra	0.8	1.2	26.0	4.0
Ovis	0.4	-	-	-
Capra/Ovis	12.3	-	-	-
Gazella	45.5	49.5	39.4	65.5
Sus	4.6	4.0	5.3	4.0
Equus sp.	0.5	0.5	0.5	-
Vulpes	2.5	3.0	-	10.0
Ursus	-	-	-	0.2
Rodentia	0.4	0.5	-	0.2
Aves	-	-	-	1.5
Reptilia	7.2	11.4	-	0.2

Appendix A—Species frequencies for assemblages discussed in text

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