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CAMEL USE IN THE PETRA REGION, JORDAN: 1st CENTURY BC TO 4th CENTURY AD

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Abstract

From antiquity onwards, the camel has played an important role in human exploitation of desert regions in the Levant. In this paper, different aspects of camel use at the site of ez Zantur in the Petra region (southern Jordan) will be discussed with reference to the osteological and iconographic evidence of the 1st century BC (Nabataean), which marks the earliest occupation of the city of Petra, through to the 4th century AD (Late Roman period). The several uses of the camel are examined as a dietary element, a beast of burden, a source of raw material for artefact manufacture and a cultural symbol.

Keywords: Jordan, Nabatean, Late Roman period, camel, food, manufacture, iconography.

Résumé

Dès l'Antiquité, le dromadaire a joué un rôle important dans l'exploitation humaine des régions désertiques du Levant. Cet article présente les différents aspects de l'utilisation du dromadaire par les habitants d'ez Zantur, dans la ville de Pétra (au sud de la Jordanie), à partir des données ostéologiques et iconographiques datées du I*er* *s. av. J.-C. (période nabatéenne), qui marque l'occupation la plus ancienne de la ville, jusqu'au* IV*e* *siècle de notre ère (période romaine tardive). Les multiples utilisations du dromadaire comme part du régime alimentaire, comme bête de somme, comme source de matière brute pour l'artisanat et comme symbole culturel sont examinées.*

Mots-clés : *Jordanie, Nabatéen, période romaine, dromadaire, alimentation, artisanat, iconographie.*

INTRODUCTION

The term "Nabataean" most readily evokes the word "camel". Even the earliest Classical source that mentions the Nabataeans, the 1st century BC scholar Diodorus of Sicily, noted that "*some of the Nabataeans keep camels, others sheep that feed in the desert*" while slightly later, the Greek geographer Strabo stated that for the Nabataeans "*Camels afford the service they require instead of horses*" (Hackl *et al.* 2003). Beginning as nomads, and later as sedentary communities, the Nabataeans dominated trade routes from

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the Arabian Peninsula to the ports of the eastern Mediterranean and inland settlements. During some three centuries, from the 2nd-1st centuries BC to the 1st century AD, they traded in spices, incense, perfumes and medicinal products which brought them great wealth and power.

It has been assumed that camels were the primary beasts of burden kept by the Nabataeans. Indeed Peters (2001, p. 337) noted that the importance of the dromedary increased with the development of trade from the southern Arabian peninsula to the Mediterranean coast. They would have been the most suitable pack animals for the long-distance caravans in arid regions, which transported large quantities of luxurious products. Moreover, given their strength, camels would have been the most suitable draught animals for hauling heavy architectural elements used in the construction of the monumental tombs and buildings which characterise Nabataean cities, including the capital of the Nabataean kingdom, Petra, located in southern Jordan. Despite the available historical and archaeological sources, the association between the Nabataeans and camels has been neglected from an archaeozoological perspective. We have no precise information as to which species of camel they had, no estimate as to the number of animals needed to develop and maintain Nabataean trade routes, nor any in-depth information as to the precise economic, social and symbolic role played by this species in the world of the Nabataeans. In order to offer a better appreciation of all these aspects, this paper focuses on the archaeozoological evidence for camel exploitation in the Petra region, based on faunal assemblages dating to the 1st century BC—which marks the earliest occupation of the Nabataean city of Petra—through to the 4th century AD (Late Roman period).

THE CAMEL BONE ASSEMBLAGE

Between 1988 and 2001, the small hill of ez Zantur, a domestic quarter of the city of Petra, was excavated by a swiss team from Basel University, under the patronage of the Swiss-Liechtenstein Foundation for Archaeological Research Abroad. Four sites have been investigated: ez Zantur I, II, III and IV, situated on three different terraces (Bignasca *et al.* 1996; Kolb 1998; Kolb *et al.* 1999; Kolb, Keller 2000). Nabataean and Late Roman private houses have been found at ez Zantur, as well as a Nabataean workshop. About 40,000 animal bones have been collected and analysed since the beginning of the excavation (Studer 1996, 2002). Among them 691 have been identified as camel bones, a large enough and hence representative sample to facilitate investigation of the way in which Nabataeans and Romans exploited this typical desert animal.

METHODS OF SPECIES ATTRIBUTION

One problem is the identification of the species of camel represented, since this requires distinguishing between the bones of the dromedary (*Camelus dromedarius*), those of the Bactrian camel (*Camelus bactrianus*) and hybrids (*Camelus bactrianus* x *Camelus dromedarius*). These hybrids are principally the result of crossing Bactrian males and dromedary females, a practice already in evidence during the 1st millennium BC in the Middle-East, and still observed today (see Potts 2004 for an overview about camel hybridization). As even the earliest faunal material from Petra is relatively late, dating to the 1st century BC, the presence of wild camels (*Camelus thomasi*) was not considered feasible (see Peters 2001 for an overview of this species).

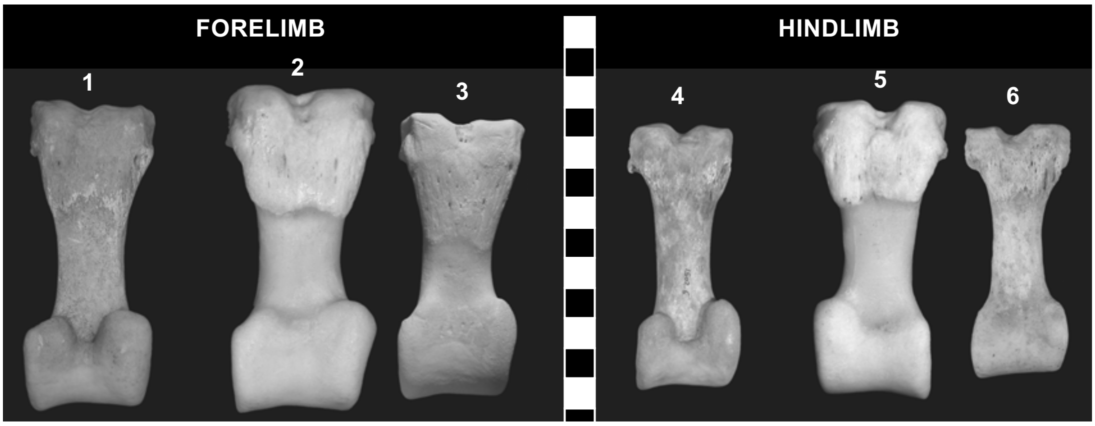
Already in 1903, Lesbre provided criteria, essentially ratios calculated on complete bones, with which to separate the bones of Bactrian camels from those of dromedaries. In a more recent article on Levantine sites, primarily Tell Jemmeh, Wapnish (1984) emphasized the importance of identifying camel bones to the species level and discussed morphometrical criteria for separating them on the basis of the metapodia. In another important study published in 1990, Steiger offered further useful morphological criteria for archaeozoologists, including biometry to separate anterior and posterior phalanges. However, the criteria for distinguishing between the two species still requires further study, since there is a lack of clarity on this issue especially when confronted with the possibility of hybrids in a site.

MORPHOLOGY

In the initial bone sorting of the ez Zantur sample at the excavation, camels were identified to species level following the morphological criteria presented in Steiger (1990). On this basis, all remains were attributed to the dromedary. It was decided to re-check this identification back in the laboratory, using both metric and morphological criteria as well as a larger reference collection. Because of the poor preservation that especially affects the porous camel long bones and the intentional fragmentation due to butchering, compact bones have survived better than long bones. Thus the most relevant and frequent anatomical element is the first phalanx, represented by 31 well-preserved bones. These were compared to the reference collection at the Museum of Geneva (three dromedaries from Jordan, one from Sudan, one from a zoo and six Bactrian camels from zoos). It is important to emphasize that this reference collection contains a minimum of 4 true dromedaries, all originating from semi-arid areas, which cannot be confused with hybrids, as could be the case for dromedaries derived from zoos. As noted by Köhler-Rollefson (1989, p. 146), dromedaries, being adapted to hot dry climates, are sometimes replaced in central European zoos by hybrids which are more resistant animals but resemble dromedaries having only one hump. Thus what may be considered to be a pure dromedary may in fact be a Bactrian-dromedary hybrid.

Morphological characteristics on the phalanges have been defined that clearly separate *Camelus dromedarius* from *Camelus bactrianus.* Dromedary first phalanges have a well-developed lip at the palmar border of the distal articulation (condyles), forming a clear edge between the articular surface and the diaphysis, instead of the flat surface forming a smooth slope that is characteristic of the Bactrian camel (*fig. 1a*). This morphological criterion was not described by Steiger (1990), but was recognised as a major distinction by Becker (2004). Even the unfused phalanges of a dromedary and a Bactrian camel from the Geneva reference collection, exhibit these characteristics. Another morphological difference is found on the border of the cranial surface of the first phalanx, but it is less evident. Re-examination of the ez Zantur sample confirmed the initial identification of all 31 first phalanges as those of dromedaries (*fig. 1b*).

a



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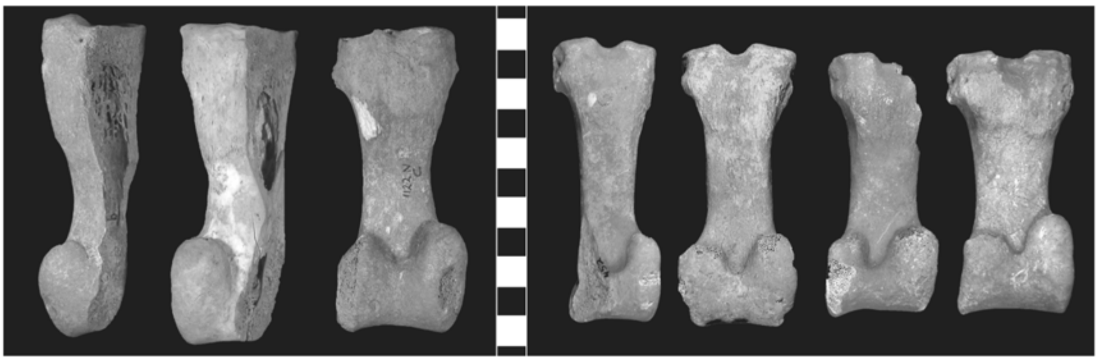

Fig. 1—First phalanges. a) Differences between dromedary (1, 4) and large (2, 5) and small (3, 6) Bactrian camel. Dromedary first phalanges present a well developed lip at the palmar border of the distal articulation, instead of the flat surface characteristic of a Bactrian camel, whatever their position (forelimb, hind limb) and their size. b) Some phalanges from ez Zantur (left-forelimb, right-hind limb). All first phalanges present the clear lip of a dromedary.

MEASUREMENTS

It is generally considered that dromedary bones are more slender than those of Bactrians camels (Lesbre 1903; Wapnish 1984; Köhler-Rollefson 1989; Steiger 1990; Uerpmann 1999; Peters 2001; Becker 2003, 2004). Comparing the measurements of the camel first phalanges from ez Zantur to other published data from reference collections or archaeological sites, indicates that they are very robust (*fig. 2*). The graph illustrating the greatest length and the smallest breadth of the posterior first phalanx shows that 5 of the 6 measurable bones from ez Zantur fall into the size range of the Bactrian camel. This is even more surprising, as the large sample of dromedary bones from Tell Hesban (von den Driesch, Boessneck 1995), a site situated about 200 km north of Petra, shows a similar size range for phalanx length to ez Zantur, but a smaller range for breadth. This difference is also evident in the anterior phalanges.

The discovery of camel bones from archaeological sites dating to periods as early as the 1st century BC, that are larger than the known range of modern dromedaries (based on osteological measurements from reference collections), has led researchers to interpret them as representing the more strongly built Bactrian camel or hybrids. Consequently, the surprisingly large camels from the Umayyad period found at Pella were interpreted as possible hybrids, bred for the purpose of carrying heavy burdens (Köhler-Rollefson 1989, p. 151). Similarly, two very large camel bones found in the early Islamic town of ar-Raqqa/ar-Rafiqa in northern Mesopotamia were considered by Becker (2003) to be those of hybrids. This identification was corroborated by morphological criteria. Uerpmann (1999) also identified three large camels from protohistoric graves at Mleiha in the Emirate of Sharjah as hybrids.

The species attribution of the ez Zantur phalanges is thus complex given their clear morphological attribution to dromedaries (*fig. 1*) and their metrical resemblance to Bactrians camels (*table 1, fig. 2*). Three possible explanations are offered: 1) the ez Zantur camels represent hybrids (Bactrian x dromedary), 2) they represent castrated dromedaries, 3) they represent an exceptionally robust dromedary breed.

From the literature (Bremaud 1969; Gauthiers-Pilters, Dagg 1981; Planchenault, Richard 1982; Hoste 1985), we know that there are different camel breeds, races or ecotypes, and that they are specifically bred to fulfil different functions, *e.g.* animals for racing/riding, meat or draught. The breeds differ greatly in the allometry of their limbs and overall body form. Very robust phalanges such as those found in the ez Zantur sample would not characterize a riding camel that is built for speed, such as those used by the Nabataean cavalry described by Strabo (Negev 1988). As illustrated by the Pella specimens, hybrids would be taller, *i.e.* they would have longer phalanges. However, the ez Zantur specimens are shorter than those from Pella, but just as broad, suggesting that they represent a heavily built dromedary breed or dromedary castrates used as beasts of burden.

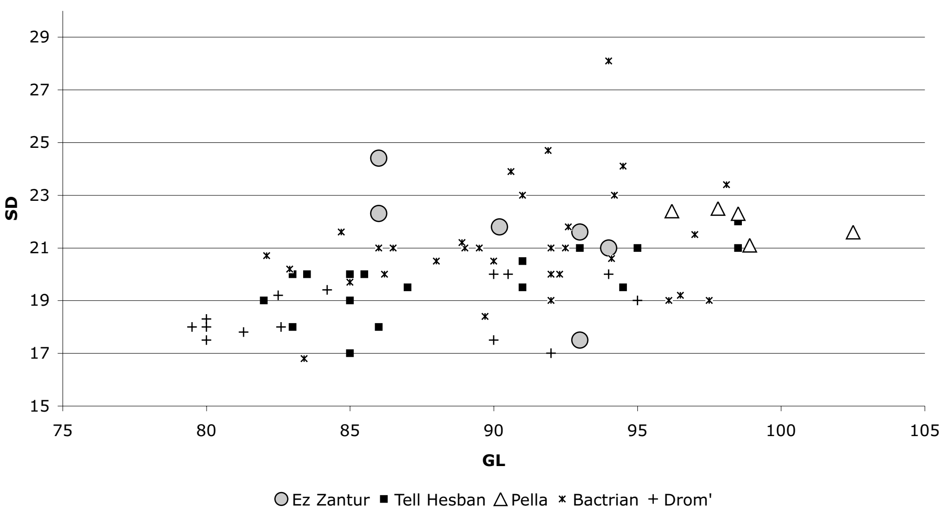

Fig. 2—Graph of camel first posterior phalanx.
GL = greatest length, SD = smallest diameter (von den Driesch 1976), in mm.

Site	Measurements GL	SD	Authors	Species
Pella (Jordan)	97.8	22.5	Köhler-Rollefson 1989	Camel (Hybrid?)
	98.9	21.1		
	96.2	22.4		
	102.5	21.6		
	98.5	22.3		
Ez Zantur (Jordan)	86.0	22.3	Studer	*C. dromedarius*
	93.0	17.5		
	93.0	21.6		
	86.0	24.4		
	90.2	21.8		
	94.0	21.0		
Tell Hesban (Jordan)	85.0	20.0	Weiler 1981	*C. dromedarius*
	86.0	18.0		
	85.0	17.0		
	94.5	19.5		
	93.0	21.0		
	87.0	19.5		
	91.0	20.5		
	85.5	20.0		
	83.5	20.0		
	83.0	20.0		
	98.5	21.0		
	98.5	22.0		
	95.0	21.0		
	91.0	19.5		
	85.0	19.0		
	83.0	18.0		
	82.0	19.0		

Reference collection	GL	SD		
MHNG MAMO 78.028	84.2	19.4	Studer	*C. dromedarius*
MHNG MAMO 78.028	82.5	19.2		
MHNG ARCO 1502.6	88.6	18.3		
MHNG ARCO 1502.6	86.6	19.0		
MHNG ARCO 1502.3	91.6	19.2		
Bristol 4162	81.3	17.8	Köhler-Rollefson 1989	*C. dromedarius*
Bristol 4162	79.5	18.0		
Cambridge 14,200-I	82.6	18.0		
Cambridge 14,200-I	80.0	18.3		

Reference collection	GL	SD		
IPM 1	94.0	20.0	Steiger 1990	*C. dromedarius*
IUT CA1	90.0	17.5		
IPM 6	80.0	18.0		
IPM 13	95.0	19.0		
IUT CA4	92.0	17.0		
LGP P2140	80.0	17.5		
IPM 2	90.0	20.0		
IPM 12	90.5	20.0		
MHNG MAMO 810.035	83.4	16.8	Studer	*C. bactrianus*
MHNG ARCO 1501.1	85.0	19.7		
MHNG ARCO 1501.1	82.9	20.2		
MHNG ARCO 1501.2	84.7	21.6		
MHNG ARCO 1501.2	82.1	20.7		
MHNG MAMO 1168.053	89.7	18.4		
MHNG MAMO 784.056	86.2	20.0		
MHNG MAMO 1063.089	98.1	23.4		
MHNG MAMO 1063.089	94.2	23.0		
IPM 5	86.5	21.0	Steiger 1990	*C. bactrianus*
IPM 8	91.0	23.0		
NBM 5918	92.0	19.0		
NBM 10390	89.0	21.0		
ZSM 1950/2	88.0	20.5		
ZSM 1950/3	97.5	19.0		
ZSM 1953/125	90.0	20.5		
IPM 3	86.5	21.0		
IPM 11	92.0	21.0		
NRS 18859	86.0	21.0		
ZSM 1922/52	89.5	21.0		
ZSM 1951/281	92.0	20.0		
ZSM 1954/150	92.5	21.0		
ZSM 1956/191	97.0	21.5		
BH(NH) 673 A	94.5	24.1	Köhler-Rollefson 1989	*C. bactrianus*
BH(NH) 673 A	90.6	23.9		
BH(NH) 673 A	91.9	24.7		
BH(NH) 673 A	94.0	28.1		
BH(NH) 1947.10.21.5	94.1	20.6		
BH(NH) 1947.10.21.5	96.5	19.2		
BH(NH) 1947.10.21.5	96.1	19.0		
BH(NH) 1947.10.21.5	92.3	20.0		
BH(NH) 75.2135	88.9	21.2		
BH(NH) 75.2135	92.6	21.8		

Table 1—Measurements of camel first posterior phalanx.
GL = greatest length, SD = smallest diameter (von den Driesch 1976), in mm.

CAMEL FREQUENCIES

Domestic mammals, primarily sheep and goats, but also pig, cattle, chickens, equids and camels, served as the mainstay of the Nabataean diet and animal economy and were supplemented by fish and hunted taxa (Studer 1996, 2002). Camel, cattle, horse and donkey represent the largest sized species identified in this bone assemblage. The identification of camel was based on all remains, including fragmented shafts, ribs and vertebrae using distinctive morphological characteristics that separate them from equids and bovids. Despite the poor bone preservation at the site, which especially affected the long bones of these large mammals, a total of 691 camel remains were identified representing a minimum number of 15 individuals.

The relative frequency of camels is shown in figures 3 (*table 2*) and 4 (*table 3*), which was calculated from the total number of identified specimen (NISP) of equids (horse and donkey), cattle and caprines (sheep and goat). Equids and cattle were chosen not only because they represent a similar-sized large mammal, but because they may have served a similar function—for transport and labour as well as food. As can be seen in figure 3, in both the Nabataean and Late Roman periods the assemblage from ez Zantur was dominated by sheep and goats (over 90% of the identified bones). The high percentage of caprines has been excluded from the histograms in order to more clearly represent the distribution of the large mammals. Despite their small proportion in the assemblage as a whole, there is a clear chronological shift in the representation of the three large herbivores. In the Nabataean period camels comprise a far higher percentage of this size class, with lower frequencies of equids and cattle than found in the Late Roman period (*fig. 3*). Comparison of the distribution of camels between the two Nabataean phases (*fig. 4*) shows that the highest frequencies fall in the earliest phase (1st century BC) followed by a dramatic reduction in the later phase (1st century AD). This pattern may reflect the decline of Nabataean trading-power and the end of their monopoly over the spice route.

Examination of camel skeletal elements shows that all body parts are represented in both the Nabataean and Late Roman periods, especially foot and cranial elements. This indicates onsite butchering, since these anatomical elements have little meat (*fig. 5, table 4*). Obviously, differences in bone mineral density have favoured the preservation of teeth and dense phalanges, tarsals and carpals relative to limb bones, biasing the pattern of skeletal element representation at the site.

A total of 48% of all camel bones from ez Zantur exhibit butchering marks, and the frequencies of butchering damage are similar for the Nabataean and Late Roman periods. This is an extremely high frequency compared to other sites such as Tell Jemmeh where Wapnish (1984) reported only 18% butchering marks on camel bones. Cut marks are found on both adult and juvenile bones at ez Zantur. Butchering marks are especially common on vertebrae, ribs and phalanges, evidence for the consumption of camel meat as well as exploitation of the skins. Indeed Herodotus describes the Nabataeans as having camel-skin water containers (Hackl *et al.* 2003, p. 462).

Ez Zantur		Nabataean		Late Roman	
		NISP	%	NISP	%
Camel	*Camelus dromedarius*	352	7.4	59	1.9
Equids	*Equus* sp.	20	0.4	42	1.4
Cattle	*Bos taurus*	25	0.5	31	1.0
Caprines	*Ovis aries, Capra hircus*	4331	91.7	2950	95.7
Total		4728	100	3082	100

Table 2—Ez Zantur: Frequency of camel, equids and cattle during the Nabataean (1st century BC-1st century AD) and Late Roman (4th century) periods. See fig. 3.

Ez Zantur		Nabataean 1		Nabataean 2	
		1st century BC		1st century AD	
		NISP	%	NISP	%
Camel	*Camelus dromedarius*	162	14.6	53	3.4
Equids	*Equus* sp.	6	0.5	8	0.5
Cattle	*Bos taurus*	18	1.6	1	0.1
Caprines	*Ovis aries, Capra hircus*	926	83.3	1473	96.0
Total		1112	100	1535	100

Table 3—Ez Zantur: Table of the frequency of camels, equids and cattle during the Nabataean period (1st century BC-1st century AD). See fig. 4.

Dromedary	Nabataean		Late Roman	
	NR	%	NR	%
Head		15.4		9.1
Cranium	22	5.9	2	3.6
Mandible	15	4.0	1	1.8
Teeth	19	5.0	2	3.6
Hyoid	2	0.5		0.0
Axial		27.1		29.1
Rib	37	9.8	4	7.3
Vertebra	65	17.3	12	21.8
Upper Forelimb		9.3		3.6
Scapula	8	2.1		0.0
Humerus	10	2.7	2	3.6
Radius	16	4.2		0.0
Ulna	1	0.3		0.0
Lower Forelimb		4.2		3.6
Carpal	13	3.4	1	1.8
Metacarpal	3	0.8	1	1.8
Upper Hindlimb		9.3		10.9
Pelvis	12	3.2	2	3.6
Femur	13	3.4	3	5.5
Tibia	10	2.7	1	1.8
Lower Hindlimb		5.3		9.1
Tarsal	13	3.4	5	9.1
Metatarsal	7	1.9		0.0
Metapodium		9.5		9.1
Metapodium	35	9.2	4	7.3
Sesamoid	1	0.3	1	1.8
Foot		19.9		25.5
First phalanx	36	9.6	9	16.4
Second phalanx	36	9.5	5	9.1
Third phalanx	3	0.8		0.0
Total	377	100	55	100

Table 4—Ez Zantur: Tables of the frequency of camel body parts.
See fig. 5.

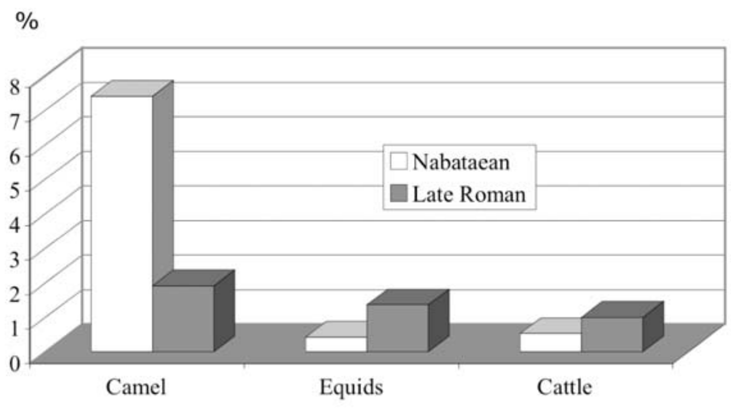

Fig. 3—Ez Zantur: Histogram of the frequency of camels, equids and cattle during the Nabataean (1st century BC-1st century AD) and Late Roman (4th century) periods.

The frequency is calculated from the total number of identified bones (NISP) of the most common mammals i.e. *goats and sheep, and the large herbivores found at ez Zantur—camels, cattle and equids. Caprines represent 92% in the Nabataean period and 95.7% in the Late Roman period. Whatever the period, camels are better represented than horses, donkeys or cattle. This difference ist most obvious during the Nabataean periods, when camel bones are 7.1% of the total number of bones and the other species comprise not even 1%. The importance of camels decreases with time, falling to about 2% of the total during the Late Roman period, when equids slightly increase (1.4%) as do cattle (1%).*

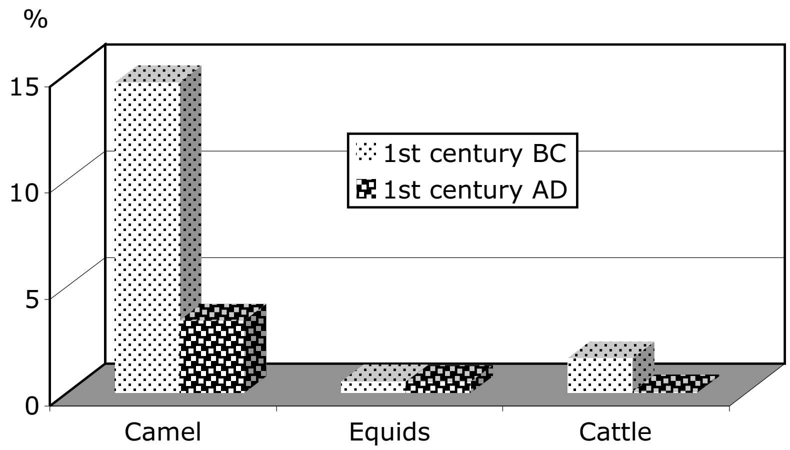

Fig 4—Ez Zantur: Histogram of the frequency of camels, equids and cattle during the Nabataean period (1st century BC-1st century AD). See caption for fig. 3. *In the 1st century BC, camels (15%) are much more abundant than in the 1st century AD (3.4%). The quantity of equids and cattle is insignificant relative to camels in the first phase of the Nabataean period.*

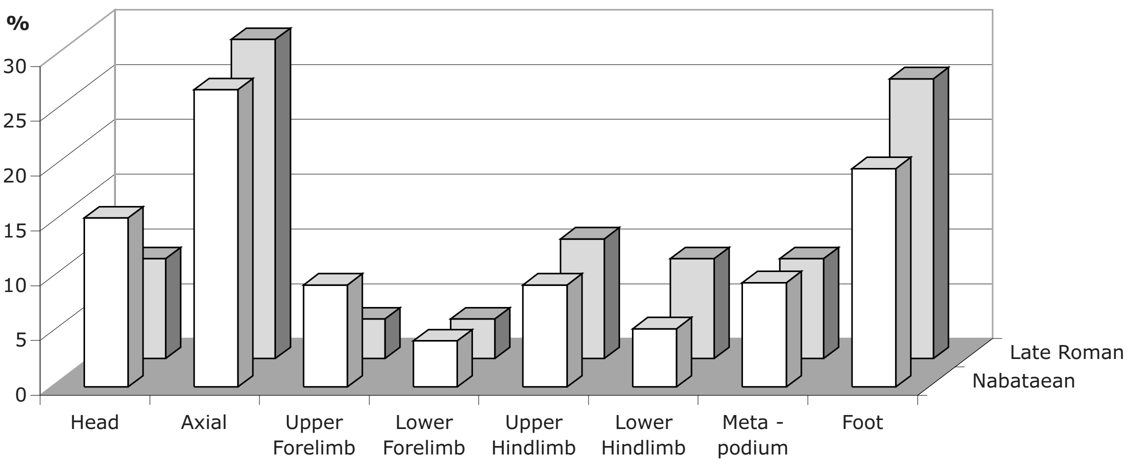

Fig 5—Ez Zantur: Histogram of the frequency of camel body parts. Although each camel bone cannot be attributed on a species level, we can assume that they all belong to the dromedary Camelus dromedarius.

AGE AT DEATH

The camel teeth from ez Zantur are too poorly preserved to provide data on the age of the animals, and only the post-cranial remains can offer information on this issue. However, the sequence of fusion times for the post-cranial skeleton of the dromedary and Bactrian camel has not as yet been formulated by zoologists, although it is known that camels mature quite late, reaching sexual maturity at the age of 4-5 years (Hoste 1985). Consequently, it is most probable that the complete fusion of epiphyses, except perhaps for the vertebrae, occurs by this age.

In the absence of a precise table of bone fusion rates for camels, and in order to obtain an overview of the structure of the camel population of ez Zantur, the bones have been listed according to their state of epiphyseal fusion (*table 5*) and compared to the age of fusion of cattle bones. Out of a sample of 162 camel leg bones, 117 bones (72%) have fused epiphyses, 2 bones (1%) are fusing and only 43 bones (27%) have an unfused extremity. If one considers that the latest age for the fusion of cattle leg bones corresponds to 4 years, it seems reasonable to propose that a large majority of the camels were already adult when slaughtered.

Ez Zantur	Camel Fused NISP	 Unfused NISP	*Cattle* *Epiphyseal fusion* *(age in months)*
Radius, proximal	2	0	*12-24*
Phalanx 2, proximal	40	18	*15-24*
Humerus, distal	7	0	*15-20*
Phalanx 1, proximal	33	11	*18-24*
Metapodium, distal	14	5	*18-36*
Tibia, distal	3	1	*24-30*
Calcaneus, proximal	3	2*	*36-42*
Femur, proximal	5	2	*36-42*
Radius, distal	3	1	*40-48*
Humerus, proximal	0	2	*42-48*
Ulna, proximal	2	0	*42-48*
Femur, distal	1	1	*42-48*
Tibia, proximal	4	2	*42-48*
Total	117	43+2*	
Vertebral centrum	21	16 + 8*	*54-108*
Decidious teeth	2**		
Carpal	2**		

* = fusing, ** = very young

Table 5—State of fusion of camel bones from ez Zantur. The corresponding ages for the fusion of cattle bones are given in the following references: Silver (1969), Schmid (1972), Habermehl (1975), Barone (1976).

An even more precise result is reached when restricting the analysis to the 102 camel phalanges. These elements fused at the latest around the age of 2 years in the case of cattle. If this age corresponds similarly to camel fusion times, then we would have 28% of juveniles aged less than 2 years old. The unfused bones are nearly all, similar in size to the fully fused ones. However, at least one very young animal is represented—as attested to by two small carpal bones as well as two deciduous teeth. The demographic profile is however slightly different when analysing the results provided by the vertebrae. Among the 45 fragments, 21 (47% of the vertebrae) are fused, 8 (18%) are fusing and 16 (35%) are unfused. The vertebrae are known to be the latest post-cranial elements to fuse, at about 7 years for cattle[3] (Habermehl 1975). In this case, the camels from ez Zantur are represented by 65% adults aged 7 years old or more.

Not only has the differential preservation of adult versus immature bones biased the age data, but also our ignorance of the real age and sequence of epiphysial fusion for camels is limiting. The ez Zantur assemblage does however give the impression of a mortality pattern dominated by mature animals older than 4 years, or possibly even older than 7 years. The sample also includes a significant proportion of

3. The earliest age of fusion of vertebrae for horses is about 4 years (Habermehl 1975).

immature individuals aged less than 2 or 3 years old, *i.e.* some years before the animals would reach their sexual maturity. It is interesting that no differences in age structure were found between the two periods.

The predominance of adult camels corresponds well to an age profile expected for pack animals, and in this regard it should be noted that the majority of donkeys from the site also represent adults. As for the camels, many equid bones also exhibit butchering marks (Studer 2007).

CAMEL BONE ARTEFACTS

Among the 237 modified bones from ez Zantur, 78 objects were made of camel bone, comprising 38% of all bone artefacts from the three inhabited terraces[4] (Schneider 2005). The large amount of camel bone is not surprising, since it was ubiquitous as a draught animal in Petra and, as discussed above, probably served as a dietary item as well.

Among the camel bone artefacts, two types will be presented which are not well known. First are scoops which were made from scapulae (*fig. 6*). A distinguishing feature of these scoops is the worked spina of the scapula, trimmed to increase the surface of the tool. No further working marks can be detected on these artefacts. This kind of object can be regarded as an *ad hoc* tool which was used particularly because of its size (Ayalon, Sorek 1999, fig. 8). A particular use for such tools can be seen in cattle scapulae from Horvat Raqit, Israel (Horwitz 2004, p. 303, fig. 1-2). There, the scoops were used to clear away the mush which accumulated during the crushing of olives for olive oil. This assumption may be confirmed by the scratch marks and the heavy polish evident on the underside of one scoop (*fig. 7*), which may have been caused by contact with the crushed olives. Such tools can of course be used for other activities such as loading grain or putting flour into sacks. Evidence for both work processes was found in the excavations at ez Zantur. In the house on terrace EZ I, a room was found with two millstones (Grawehr 2002, p. 25, fig. 60), and in the house on terrace EZ IV a large crushing basin broken in two had been built into a corner and its circular bedrock-base was found which originally formed an olive crushing device (Kolb, Keller 2000, p. 26-29). At Caesarea Maritima, Israel (Ayalon 2005, p. 116), and York, United Kingdom (MacGregor *et al.* 1999, p. 1974, fig. 929: 7065),[5] scoops perforated with numerous holes were found which were obviously used as sieves. As the crushing of olives to gain oil was an important economic factor in the Petra region, it can be assumed that a considerable amount of such tools were used. Due to their slight modification and their often fragmentary preservation, these *ad hoc* tools may often have been missed in the archaeological record.

A second peculiar feature of the bone artefacts from ez Zantur is the production waste for the manufacture of bone rings (*fig. 8*). The diaphyses of dromedary long bones which were ideal because of their size and solidity, were preferred for ring production. The joints of the long bones were removed by sawing; the inside of the bones remained rough except for some chisel marks for better fastening and alignment on the lathe. The long bone was fastened and worked on a lathe and rings were carved from it using different chisels (Dray 2005, fig. 2) (*fig. 9*). The kind of bone waste found at ez Zantur, which comes from ring production, is elsewhere in evidence only in a very few cases.[6] Among the finds from ez Zantur there are 17 pieces of such ring production waste. One of them was unambiguously identified as a camel bone and seven other pieces most probably belong to this species because of their size. The remaining pieces cannot be identified to taxon. It is noteworthy that finished rings of the size that would have been produced by this process, were not found at ez Zantur. The function of these rings is not clear, as they cannot have served as bracelets due to their small size. Perhaps they served as decorations for necklaces or clothing. It is also possible that they were used at a different location and are therefore absent in the ez Zantur assemblage.

4. The worked objects as well as the production waste are included in these numbers.
5. However, the finds from York are sheep/goat scapulae.
6. For the first time, P. Wapnish and Y. Dray have identified 54 objects of the same type from Caesarea Maritima as waste from ring production (Ayalon 2005, p. 236-237; Dray 2005, p. 247-250).

Fig. 6—Camel scapula from ez Zantur used as a scoop.

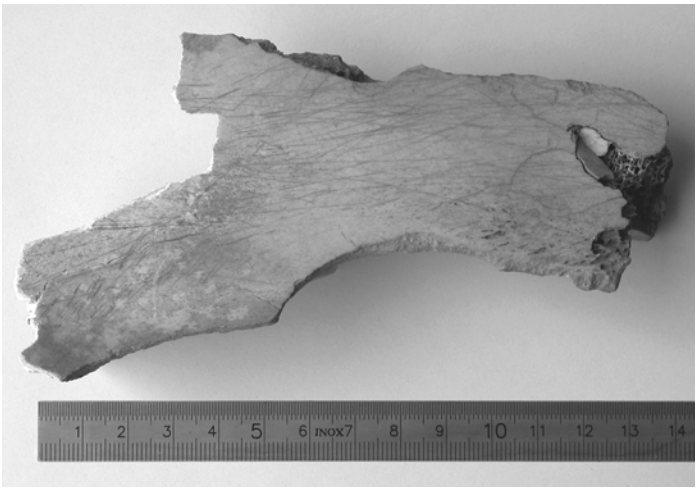

*Fig. 7—Camel scapula from ez Zantur used as a scoop.
The underside presents scratch marks on the surface.*

Fig. 8—Ez Zantur. Waste from ring production.

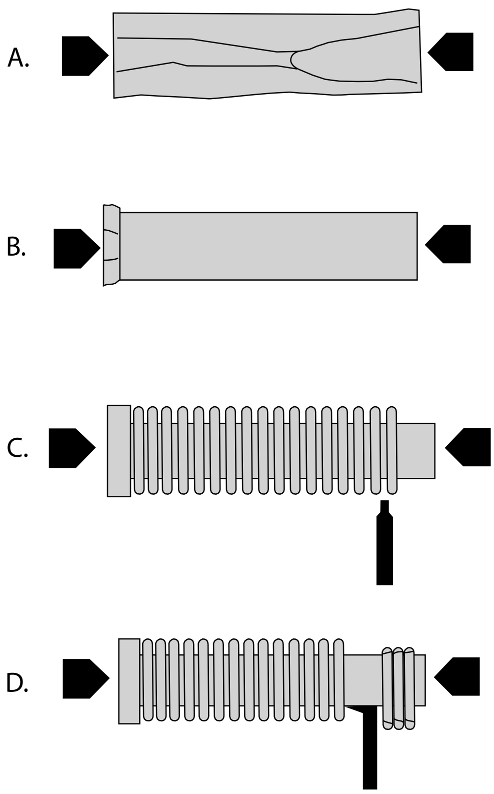

Fig. 9—Reconstruction of ring production after Dray.
The long bone was fastened and worked on a lathe and rings
were carved from it using different chisels
(Dray 2005, fig. 2. With the kind permission of the author).

This and other production waste clearly demonstrates that local bone artefact production took place on site. As the lathes used for the production of such rings were small and portable,[7] there is no direct evidence for the location of a permanent workshop at ez Zantur. However, because of the large amount of production waste found outside the northern corner of the house in EZ I, it can be assumed that this served as an area for bone production waste disposal, and it is even possible that bone artefacts were worked here (*fig. 10*). By examining the scoops and the ring production waste it becomes clear that camel bones were used in this process, because of their size, shape and solidity.

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7. Such portable lathes are still in use today in the souks of oriental towns.

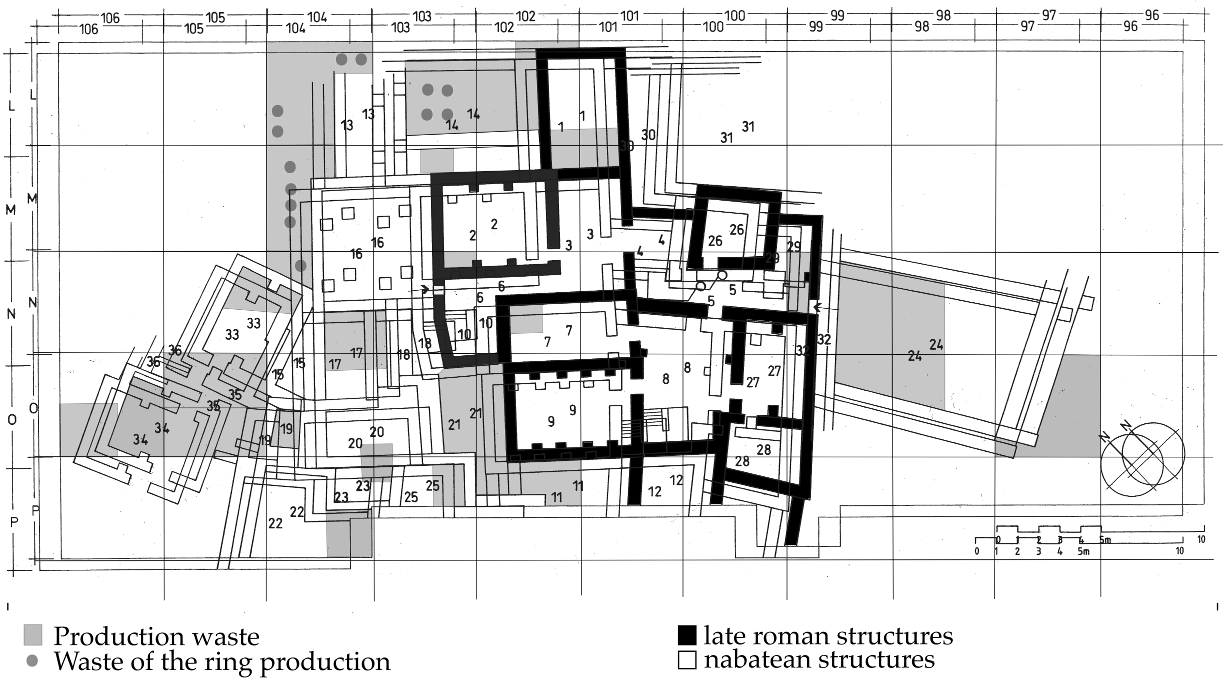

Fig. 10—Plan of ez Zantur I.
A large amount of production waste (shown as dots)
was found outside the northern corner of the house in EZ I.

ARTISTIC MOTIFS OF CAMELS

Camels are not a common motif in the monumental art of Petra and are rarely represented in the decorations of tombs, monuments or houses. However, some spectacular camel bas-reliefs were engraved on the rock wall of the Siq, the ceremonial entrance into Petra. Here, two larger than life-size animals are depicted being guided by a camel-driver as they walk in the direction of the town. A few meters farther, on the same rock face, is another group of a man and camels walking, in this case, outside the town. None of the camels are shown with a saddle. Another camel relief can be seen next to the sanctuary of the Deir at the other extremity of the town. The presence of these artistic representations of camels in such crucial locations outside the town signifies the important symbolic as well as the economic role played by these animals in Nabataean society.

Although camels do not appear regularly as architectural elements, they are relatively common among the terra cotta figurines found at the site (Bignasca 1993, p. 66). Here again, camels are not depicted as pack animals. On the contrary, they represent military elements and are decorated with a sword (*gladius*) and a shield (*phalera*), as part of the Nabataean cavalry. The only artistic representation of a working animal at Petra is shown in a Byzantine mosaic from the Great Church (Studer 2001). Therefore, artistic representations of camels at Petra appear to be rare and also do not portray them as beasts of burden. The cultural record clearly does not demonstrate the important role played by camels in the Nabataean, Roman and Byzantine economies. This contrasts with the contemporaneous town of Palmyra in north-eastern Syria where camels are a common artistic motif.

CONCLUSIONS

Horwitz and Rosen (2005, p. 129, table 3) outlined three different camel management strategies based on male-female ratio and age profile—one for milk, a second for meat and a third for transport/draught. Furthermore, they noted that camel herd composition is expected to differ between an urban site, a camel caravan and herds kept by nomadic camel herders. It was concluded however that these models are difficult to recognise in archaeozoological assemblages, not only because they require large bone samples, but also since the identification of an animal's sex relies on the preservation of particular elements (larger-sized male canines and pelvis shape). Furthermore, the absence of an established system for determining age in camels is a severe limitation in establishing the precise composition of a herd and hence the management goals.

For the ez Zantur camel assemblage, the age structure is dominated by mature animals but also includes juveniles. It is evident that camel meat was part of the local diet, especially during the Nabataean period where camels comprised 15% of the remains of domestic mammals during the first century BC. Chop and cut marks are very common on their bones and the presence of about $^1/_3$ unfused leg bones suggests the slaughter of young camels, possibly excess males. The presence of all parts of the camel skeleton in the house debris demonstrates that the inhabitants had access to complete carcasses. There is no evidence in either the Nabataean or Roman period for selection of parts of the camel carcass such as would be expected if joints were bought at a market. The animals appear to have been slaughtered, prepared and eaten on the three terraces of ez Zantur. The exploitation of camel bone in the production of artefacts provides further evidence for the complete exploitation of this species—in life and after death.

Some very large animals, corresponding either to dromedary castrates or a heavily built dromedary breed, are present in the ez Zantur assemblage, indicating that camels primarily served as transport or draught animals. This is corroborated by the predominance of remains of adults in the assemblage, since young camels are not fit to carry heavy loads (Gauthier-Pilters, Dagg 1981). Indeed, the image of a laden dromedary that decorates the mosaic floor of the Byzantine Great Church at Petra, is a realistic representation of how a camel may have been exploited at that time (Studer 2001, p. 277 and figure p. 312).

Together, these features illustrate that in the Nabataean and Roman periods, camels served as multi-purpose animals in the Petra region rather than having been bred or managed for a single purpose.

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We especially thank Cornelia Becker who kindly sent us her unpublished reports on camel bones from Dur-Katlimmu and ar-Raqqa and her personal notes about specific diagnostic criteria for the Bactrian camel and the dromedary. We are also very grateful to Liora Kolska Horwitz for her invaluable comments on this manuscript and her help with editing the English text, and to Daniel Keller who translated the bone artefact section.

BIBLIOGRAPHY

AYALON E. 2005, *The Assemblage of Bone and Ivory Artifacts from Caesarea Maritima, Israel, 1st-13th Centuries CE*, BAR International Series 1457, Archaeopress, Oxford.

AYALON E., SOREK C. 1999, *Bare Bones, Ancient Artifacts from Animal Bones*, Ertetz-Israel Museum Catalogue, Tel-Aviv.

BARONE R. 1976*, Anatomie comparée des mammifères domestiques*, Vigot (2 vol.), Paris.

BECKER C. 2003 (unpubl. manuscript), *Von Schafen, Kamelen, Mäusen und Mauerseglern-Knochenfunde aus ar-Raqqa/ar-Rafiqa*.

BECKER C. 2004 (unpubl. manuscript), *Die Tierknochenfunde aus Tall Šēh Hamad/Dur-Katlimmu-eine zoogeographisch-haustier-kundliche Studie*.

BIGNASCA A. 1993, "Die Terrakotten", in *Petra und die Weihrauchstrasse,* Exhibition Catalogue for "Le Point", Zurich, p. 65-67.

BIGNASCA A., DESSE-BERSET N., FELLMANN BROGLI R., GLUTZ R., KARG S., KELLER D., KRAMAR C., PETER M., SCHMID S.G., SCHNEIDER C., STUCKY R.A., STUDER J., ZANONI I. 1996, "*Petra, Ez Zantur I. Ergebnisse der Schweizerisch-Liechtensteinischen Ausgrabungen 1988-1992*", Terra Archaeologica II, Monographien der Schweizerisch-Liechtensteinischen Stiftung für Archaeologische Forschungen im Ausland (SLSA/FSLA), Von Zabern, Mayence.

BRÉMAUD O. 1969, "*Note sur l'élevage camelin dans les districts Nord de la République du Kenya"*, Rapport IEMVT, Maisons-Alfort (cited by Hoste 1985, p. 63).

DRAY Y. 2005, "The technology of bone and ivory crafting in Caesarea Maritima, Israel", *in* H. Luik, A.M. Choyke, C.E. Batey, L. Lougas (eds), *From Hooves to Horns, from Mollusc to Mammoth, Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present*, Proceedings of the 4th Meeting of the ICAZ Worked Bone Research Group, Muinasaja teadus 15, Tallinn, p. 247-252.

DRIESCH A. VON DEN 1976, *A Guide to the Measurement of Animal Bones from Archaeological Sites*, Peabody Museum Bulletins, Harvard.

DRIESCH A. VON DEN, BOESSNECK J. 1995, "Final report on the zooarchaeological investigation of animal bone finds from Tell Hesban, Jordan", *in* O.S. Labianca, A. von den Driesch (eds), *Hesban 13. Faunal Remains*, Andrews University Press, Berrien Springs, p. 65-108.

GAUTHIER-PILTERS H., DAGG A.I. 1981, *The Camel. Its Evolution, Ecology, Behavior, and Relationship to Man*, University of Chicago Press, Chicago.

GRAWEHR M. 2002, *Ausgewählte Gipse und Gusmäntel aus einer Bronzegiesserei in Petra (Jordanien),* unpubl. Lizentiatsarbeit.

HABERMEHL K.-H. 1975, *Die Altersbestimmung bei Haus- und Labortieren*, Paul Parey, Berlin and Hamburg.

HACKL, U., JENNI H., SCHNEIDER C. 2003, *Quellen zur Geschichte der Nabatäer: Textsammlung mit Übersetzung und Kommentar*, Universitätsverlag, Freiburg.

HORWITZ L.K. 2004, "Animal remains from Horvat Raqit", *in* S. Dar (ed.), *Raqit. Marinus Estate on the Carmel, Israel*, BAR International Series 1300, Archaeopress, Oxford, p. 303-308.

HORWITZ L.K., ROSEN B. 2005, "A review of camel milking in the Southern Levant", *in* J. Mulville, A.K. Outram (eds), *The Zooarchaeology of Fats, Oils, Milk and Dairying*, Proceedings of the 9th ICAZ Conference, Durham 2002, Oxbow Books, Oxford, p. 121-131.

HOSTE C. 1985, "Mode d'élevage", *in* D. Richard (ed.), *Le dromadaire et son élevage*, Études et synthèse de l'IEMVT 12, Maisons-Alfort, p. 55-66.

KÖHLER-ROLLEFSON I. 1989, "Zoological analysis of camel skeletons", *in* R. Houston Smith, L. Preston Day (eds), *Pella of the Decapolis, 2, Final report on the College of Wooster Excavations in Area IX, The Civic Complex, 1979-1985*, The College of Wooster, Wooster, p. 142-164.

KOLB B. 1998, "Swiss-Liechtenstein excavation at Az Zantur in Petra 1997", *Annual of the Department of Antiquities of Jordan* 42, p. 259-277.

KOLB B., GORGERAT L., GRAWEHR M. 1999, "Swiss-Liechtenstein excavations on az-Zantur in Petra, 1998", *Annual of the Department of Antiquities of Jordan* 43, p. 261-277.

Kolb B., Keller D. 2000, "Swiss-Liechtenstein excavation at ez Zantur, Petra. The tenth season", *Annual of the Department of Antiquities of Jordan* 44, p. 355-372.

Lesbre M.F.X. 1903, "Recherche anatomique sur les camélidés", *Archives du Muséum d'Histoire naturelle de Lyon* 8, p. 1-195.

MacGregor A., Mainman A.J., Rogers N.S. 1999, *Craft, Industry and Everyday Life: Bone, Antler, Ivory and Horn from Anglo-Scandinavian and Medieval York,* The Archaeology of York, vol. 17 (The small finds), York Council for British Archaeology, York.

Negev A. 1988, "Understanding the Nabateans", *Biblical Archaeology Review*, November/ December, p. 27-45.

Peters J. 2001, "Aspekte der Domestikations- und Kulturgeschichte des Dromedars (*Camelus dromedarius*)", *in* H. Buitenhuis, W. Prummel (eds), *Animals in the Past. Essays in honour of Dr. A.T. Clason emeritus professor of archaeozoology Rijksuniversiteit Groningen, the Netherlands*, ARC-Publicatie 41, Groningen, p. 330-341.

Planchenault D., Richard D. 1982, *Projet de développement de l'élevage dans le Niger Centre-Est. Production cameline*, Rapport de la quatrième mission et rapport de synthèse de la première année d'étude, Rapport de l'IEMVT, Maisons-Alfort, (cited by Hoste 1985, p. 63).

Potts D.T. 2004, "Camel hybridization and the role of *Camelus bactrianus* in the ancient Near East", *Journal of Economic and Social History of the Orient* 47 (2), p. 143-165.

Schmid E. 1972*, Knochenatlas*, Elsevier, Amsterdam, London, New York.

Schneider A. 2005, *Die Beinartefakte von ez Zantur, Petra (Jordanien)*, unpubl. Licence memoir.

Silver I.A. 1969, "The ageing of domestic animals", *in* D. Brothwell, E.S. Higgs (eds), *Science in Archaeology*, Thames and Hubson, London, p. 250-268.

Steiger C. 1990, *Vergleichend morphologische Untersuchungen an Einzelknochen des postkranialen Skeletts der Altweltkamele*, Inaugural-Dissertation, Tierärztlichen Fakultät der Ludwig-Maximilians Universität, München.

Studer J. 1996, "La faune romaine tardive d'Ez Zantur, à Petra", *in* A. Bignasca, N. Desse-Berset, R. Fellmann Brogli, R. Glutz, S. Karg, D. Keller, C. Kramar, M. Peter, S.G. Schmid, C. Schneider, R.A. Stucky, J. Studer, I. Zanoni (eds), *Petra, Ez Zantur I. Ergebnisse der Schweizerisch-Liechtensteinischen Ausgrabungen 1988-1992*, Terra Archaeologica II, Monographien der Schweizerisch-Liechtensteinischen Stiftung für Archaeologische Forschungen im Ausland (SLSA/FSLA), von Zabern, Mainz, p. 359-375.

Studer J. 2001, "Les mosaïques animalières", *in* Z.T. Fiema, Ch. Kanellopoulos, T. Waliszewski, R. Schick (eds), *The Petra Church*, American Center of Oriental Research, p. 271-293, fig. p. 306-327.

Studer J. 2002, "Dietary differences at Ez Zantur Petra, Jordan (1st century BC-AD 5th century)", *in* H. Buitenhuis, A.M. Choyke, M. Mashkour, A.H. Al-Shiyab (eds), *Archaeozoology of the Near East V*, Proceedings of the fifth international symposium on the archaeozoology of southwestern Asia and adjacent areas, ARC-Publicaties 62, Groningen, p. 273 -281.

Studer J. 2007, "Animal exploitation in the Nabataean world", *in* K.D. Politis (ed.), *The World of the Nabataeans*, Steiner Verlag, Stuttgart, p. 251-272.

Uerpmann H.-P. 1999, "Camel and horse skeletons from protohistoric graves at Mleiha in the Emirate of Sharjah (UAE)", *Arabian Archaeology and Epigraphy* 10, p. 102-118.

Wapnish P. 1984, "The dromedary and Bactrian camel in Levantine historical settings: The evidence from Tell Jemmeh", *in* J. Clutton-Brock, C. Grigson (eds), *Animals and Archaeology: 3. Early Herders and their Flocks*, BAR International Series 202, Oxford, p. 171-200.

Weiler D. 1981, "*Säugetierknochenfunde vom Tell Hesban in Jordanien*", Inaugural-Dissertation, Tierärztlichen Fakultät der Ludwig-Maximilians Universität, München.