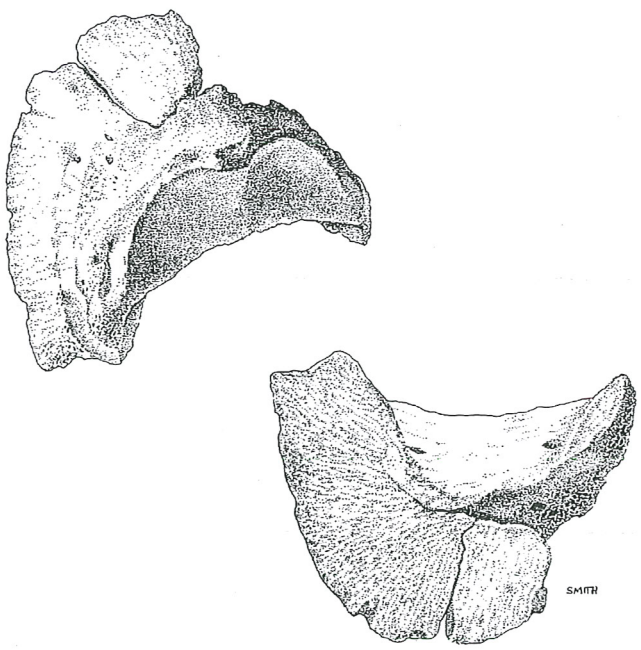
ARCHAEOZOOLOGY OF THE NEAR EAST III

Proceedings of the third international symposium on the archaeozoology of southwestern Asia and adjacent areas

edited by

H. Buitenhuis, L. Bartosiewicz and A.M. Choyke



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Cover illustration: Dorsal and palmar aspects of a
Bronze Age horse phalanx from Arslantepe, Turkey,
identified by Sándor Bökönyi.
Courtesy by the artist, Patricia Smith (Reduction: 64%).

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Preface

This publication is the result of the third international symposium on archaeozoology of southwestern Asia and adjacent areas, held in Budapest, Hungary from 2 - 5 September 1996. The editors would like to thank all colleagues of the Working Group who helped with the translation of abstracts. Financial support for the publication was given by the Acker Stratingh Stichting, Groningen, The Netherlands.

Participants of the 3rd ASWA Conference, Budapest 1996
(Photo: Péter Komjáthy, Aquincum Museum)

Standing, left to right: B. De Cupere (Belgium), G. Bar Oz (Israel), H. Buitenhuis (The Netherlands), R. Rabinovich (Israel), L. Leblanc (New Zealand), N. Benecke (Germany), H. Hongo (Japan), N. Russell (USA), J. Speth (USA), A. Patel (India), E. Stephan (Germany), C. Cavallo (The Netherlands), W. Van Neer (Belgium), A.T. Clason (The Netherlands), T. Dayan (Israel), L. Van Es (The Netherlands), C. Becker (Germany), R. Meadow (USA), M. Mashkour (France), F. Poplin (France), E. Vila (France), Mrs. Poplin (France), L. Bartosiewicz (Hungary), E. Pellé (France), P. Ducos (France).
In front, left to right: E. Tchernov (Israel), L. Martin (Great Britain), A. Choyke (Hungary), I. Zohar (Israel).
Participants not shown in picture: D. Carruthers (Great Britain), D. MacHugh (Ireland), S. Whitcher (Great Britain).

Contents

RECENT FAUNAL ANALYSES AT SHIQMIM, ISRAEL: A PRELIMINARY ANALYSIS ON THE 1993 ASSEMBLAGE

Sarah E. Whitcher[1], Caroline Grigson[2] and Thomas E. Levy[3]

Résumé

Les analyses préliminaires de 1558 ossements d'animaux du site Chalcolithique de Shiqmim dans le nord du desert du Negev en Israel sont presentées plus bas. Trois importants animaux domestiques, mouton, chêvre et bétail, forment la majorité de la faune rassemblée lors des fouilles de 1993. L'importance de l'utilisation de l'animal pour viande, ou pour des produits secondaires tels que lait, laine, toison et pour le travail, est discussé. Les preuves de production artisanal (bobines et bidons) suggerent que ces produits secondaires ont bien été exploités à Shiqmim. L'assemblage de la faune d'une part reflete d'abord l'économie à base de viande de l'animal. Pourtant, il y a peu de signes de produits á usage secondaire, tel que le maintien légèrement plus long du mouton par rapport à la chêvre, et le metapodial d'un bétail avec des blessures probablement dût à l'attelage. La conclusion est que l'exploitation animal à Shiqmim pour temps largement basé sur la viande n'était pas exclusivement basé sur la production de viande, mais probablement impliqué à certaine part aux produits secondaires en usage.

Introduction

The following paper is based on a poster presentation given at the meeting of the Archaeozoology of Southwest Asia working group (ASWA) of the International Council for Archaeozoology (ICAZ), held in Budapest from September 1-4, 1996. It presents the results of the analysis of the archaeological animal bones from the 1993 excavation season at Shiqmim, a Chalcolithic village in the northern Negev Desert, Israel (Fig. 1). Excavations at Shiqmim were carried out for seven seasons, the first being in 1979 (Levy, 1987).

The excavations at Shiqmim were co-directed by Thomas Levy and David Alon under the auspices of the University of California, San Diego and the Hebrew Union College, Jerusalem. The aim of these excavations focused on examining some of the processes which led to the rise of early social complexity in the northern Negev Desert during the late 5th and early 4th millennium BC (Levy, 1987; 1995). The principal archaeozoologist for Shiqmim is Caroline Grigson, who has published numerous papers presenting various aspects of her work on the Shiqmim faunal material (Grigson 1987a, 1989, 1995). The present study should not be taken to represent the full body of data from the complete excavations at Shiqmim. It is the preliminary analysis of one portion of a much larger body of archaeozoological information which will be presented by Grigson in a comprehensive study of the site of Shiqmim.

Methodologies

Identification of the bones from the 1993 season at Shiqmim was undertaken by Sarah Whitcher in the archaeozoology laboratory in the Department of Evolution, Systematics and Ecology at the Hebrew University of Jerusalem under the general supervision of Caroline Grigson. As the bones could not be taken out of the country, analysis was limited to five weeks during the summer of 1995. Laboratory analyses focused on the basic variables of archaeozoological identification, with any unusual

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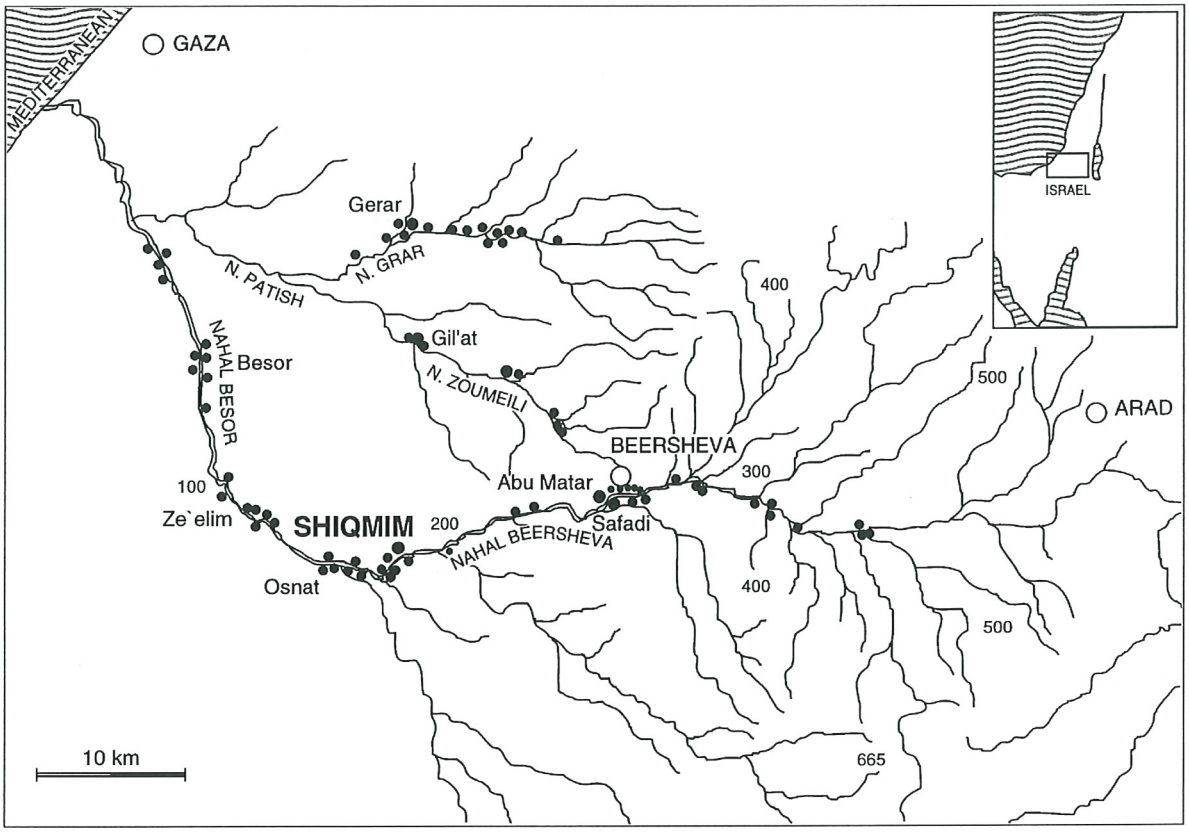

Figure 1. Map of the study area, showing the location of Shiqmim along the Nahal Beersheva in Israel's northern Negev desert.

features being noted. Each bone was given an identification number and entered into an Excel spreadsheet, where the following characteristics were recorded: species, element, fragmentation, side, fusion data, age data, sex, evidence of burning, cut marks, measurements, and contextual data including locus numbers, basket numbers, context description, volume and stratum. The bones were individually numbered in the spreadsheet, but numbers were not written on the bones due to time constraints. After analysis, each group of bones was returned to its original packaging, and the identification numbers of the bones contained within were noted on the outside[4].

The bones from Shiqmim 1993

In the 1993 faunal assemblage, the species present and their relative percentages are consistent with those previously noted by Grigson (1987a) for the earlier excavations at Shiqmim. Of the 1558 bones and bone fragments identifiable to species and element, the majority (96.9%) represents domesticates: sheep, goat, cattle, horse (2 bones), and dog (4 bones). The remaining 3.1% of the collection is comprised of remains from wild animals such as gazelle, fox and rodent, as well as a few bones of cat, fish, bird and frog. As in the previous years, no pig bones were found in the 1993 assemblage, the signifcance of which has been discussed at length by Grigson (1989, 1995). Table 1 shows the numbers of bones for each species present in the 1993 collection. A discussion of the various species follows.

[4] Laboratory facilities were generously provided by Prof. Eitan Tchernov, head of the Department of Evolution, Systematics and Ecology at the Hebrew University. The bones from the 1993 excavations at Shiqmim are housed in storage facilties at the Hebrew University/s Givat Ram campus.

Species	Number	% of Total	
Domestic Species			*% of Domestic Species*
Sheep/Goat (*Ovis aries/Capra hircus*)	1324	85%	87.7%
Cattle (*Bos taurus*)	180	11.5%	12%
Dog (*Canis familiaris*)	4	0.26%	0.2%
Horse (*Equus caballus*)	2	0.13%	0.1%
TOTAL Domestic Species	*1510*	*96.9%*	*100%*
Wild Species			*% of Wild Species*
Gazelle (*Gazella* sp.)	12	0.8%	25%
Rodent	10	0.7%	21%
Bird (*Aves sp.)*	9	0.6%	19%
Hare (*Lepus sp.)*	6	0.4%	13%
Cat (*Felis sp.)*	5	0.3%	10%
Frog	3	0.2%	6%
Fish	2	0.1%	4%
Fox (*Vulpes vulpes*)	1	<0.1%	2%
TOTAL Wild Species	*48*	*3.1%*	*100%*
TOTAL	**1558**	**100%**	

Table 1. Animal species represented in all identified bones and bone fragments at Shiqmim, 1993.

Sheep/goat bones

The sheep/goat distinction

Sheep and goat together comprise 88% of the domestic ungulate bones, and cattle the other 12%. This ratio seems to be typical of the Chalcolithic on the desert fringe, as is shown in Table 2. Differentiating sheep and goat is difficult unless the bones are very well-preserved and the diagnostic parts are present. Due to the highly fragmented state of the Shiqmim bones, sheep and goat are generally lumped together into the category "sheep/goat." When distinction was possible, it was made according to criteria set out in Boessneck (1969) and was attempted only in the instance of bones with well-preserved diagnostic features.

The 1993 sample included a total of 118 bones identified as sheep and 99 as goat, suggesting that, based on the 1993 sample, the average ratio of sheep to goat at Shiqmim was 1.2:1.

SITE	No. Sh/G	% of Total	No. Cattle	% of Total	Total Bones
Horvat Hor	91	91%	9	9%	100
Jawa	2206	91%	217	9%	2423
T. Ghassoul	126	76%	41	24%	167
Abu Matar	153	92%	12	8%	165
Horvat Beter	156	89%	17	11%	173
Safadi	3167	90%	314	10%	3481
Shiqmim 82/83	458	88%	57	12%	515
Shiqmim 93	***1324***	***88%***	***180***	***12%***	***1504***

Table 2. Representation of sheep/goats and cattle in Chalcolithic sites on the desert Fringe (adapted from Grigson, 1995). Percentages are based on the total number of sheep/goat and cattle bones from each site.

Given the small sample size and the statistically insignificant predominance of sheep[5], we can presume that this ratio reflects a more or less equal number of sheep and goat at the site. Redding (1984) suggests that a ratio between 1:1 and 1.7:1 reflects a herding strategy focused primarily on "herd security". Such a strategy involves the constant maintenance of a breeding population and the minimization of losses due to environmental changes or epidemics, and the assurance of a secure source of meat or other products. Although sheep in general provide more meat than goats, goats are better adapted to an arid environment and have a higher reproductive capacity (Zeder, 1991). It is not surprising, then, that in the arid environment of the northern Negev, the sheep to goat ratio at Shiqmim is nearly equal. This ratio suggests that, in this marginal environment, the inhabitants of Shiqmim aimed their sheep and goat exploitation at securing food rather than maximizing meat or secondary products production.[6]

It is worth mentioning that this nearly equal ratio of sheep to goats is not consistent across the site. In areas E and Z, two of the smaller areas situated on the edge of the site, the sheep to goat ratio is almost 9:1. Whether or not the predominance of sheep in these areas reflects some kind of differential animal exploitation cannot be determined because of the small sample on which this ratio is based (approx. 30 bones).

Sheep/goat age distribution

The age of death of the sheep and goats at Shiqmim was determined through an examination of 31 posterior mandible fragments and mandibular teeth, using criteria established by Payne (1973). Results are shown in a histogram (Fig. 2), where we can see a high kill-off of young animals (0-2 years). Two thirds of the teeth with determinable wear patterns were from animals killed at two years or younger. 40% of the group was killed in the first year of life. Of the remaining animals, almost 50% were killed in the second year, leaving one third of the original sample to survive beyond two years of age.

To confirm the validity of the mandibular tooth eruption data, another method was used to determine the age of death of the sheep/goat from the 1993 assemblage. Using Silver's (1969) epiphyseal fusion age data as a guideline, the various sheep/goat elements for which fusion information could be noted were divided into age categories (Table 3). The numbers of fused and unfused bones in each age category were counted. The percentages of fused and unfused bones in each age category, when listed in ascending order of age (Fig. 3), show a striking resemblance to the kill-off pattern reflected by mandibular tooth eruption (Fig. 2); that is, a high kill-off (over 70%) of the animals under about 2 years of age, with about 30% of the sample being maintained over 2 years.

Many scholars consider the Chalcolithic to be the earliest period with evidence for intensive secondary products usage. Evidence for the exploitation of secondary products is found during the Chalcolithic in artifacts such as the numerous ceramic churns from this time which are seen as evi dence for milking, and spindle whorls which are thought to have been used for spinning fibers (see Sherratt, 1983, Grigson, 1995 and Levy, 1983 for a discussion of secondary products exploitation in the southern Levant). In light of this, the sheep/goat kill-off distribution at Shiqmim might be interpreted as the use of the majority of the animals for meat, while a few females were kept to an older age for reproduction and possibly milking. However, a lack of bones which could be identified as male or female makes it impossible to determine what the sex ratio is in the kill-off distribution from Shiqmim 1993.

A high kill-off of young animals suggests that the economy did not involve the *intensive* production of milk and wool, in the case of which we would find evidence for a larger number of individuals surviving into older years. The inhabitants of Shiqmim may still have produced milk and wool,

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[5] A chi-squared test performed on the data, with an expected sheep to goat ratio of 1:1, showed the 0.2 difference to be statistically insignificant.

[6] A secondary product is one which can be taken from the animal while it is alive, such as milk, fibers, and labor.

Age Category	# Fused	# Unfused
10 months (distal humerus, proximal radius, distal scapula)	65	19
13-16 months (1st phalanx, 2nd phalanx)	88	38
1.5-2.25 years (distal tibia, distal metacarpus, distal metatarsus)	27	51
2.5-3 years (calcaneum, distal radius, proximal femur)	26	64
3-3.5 years (proximal humerus, distal femur, proximal tibia)	18	40

Table 3. Numbers of fused and unfused sheep/goat elements in each age category (adapted from Silver, 1969),

Figure 2. Age of death in sheep/goat at Shiqmim '93 (based on tooth eruption and wear, following the method of Payne, 1973).

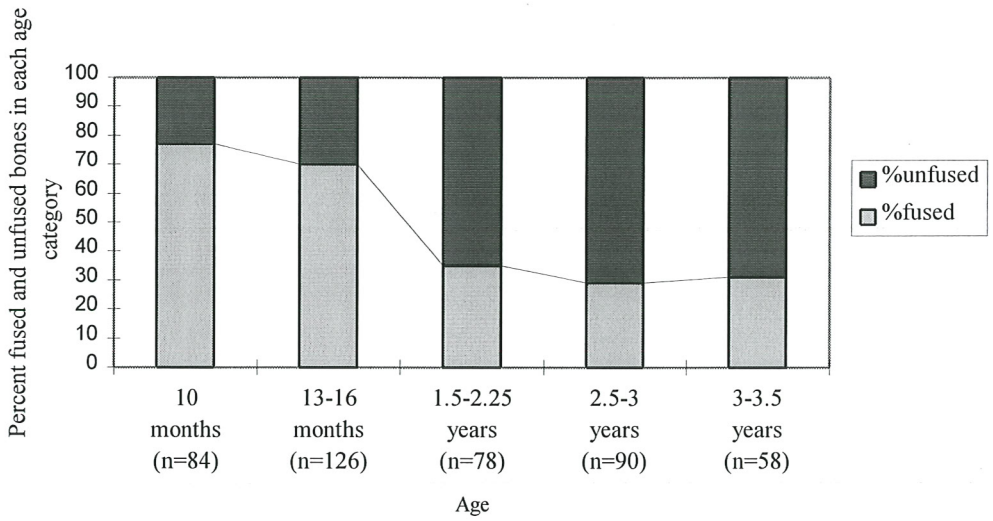

Figure 3. Age of death in sheep/goat, based on epiphysial fusion (fusion ages taken from Silver, 1969).

but based on this study, such secondary product exploitation was less intensive than some scholars believe. Support for this interpretation is found in Davis' (1984) discussion of the Kermanshah faunal sequence. He claims that an economy based on secondary products exploitation (milk and wool) would have a more or less even age distribution, and one based on meat would have a high kill-off of

young animals at their peak of meat yield, as is seen in the Shiqmim 1993 teeth and epiphyseal fusion data.

Thus, the predominance of young animals in the age distribution suggests that the sheep/goat at Shiqmim were used primarily for meat. However, we cannot rule-out the possibility of the preservation of some animals for secondary products usage (the presence of cattle at the site reminds us that cows may have been an additional source of milk). In his studies of modern culling strategies in Asvan, Turkey, Payne (1973) found that, in a meat *and* milk economy, males are killed as lambs, and if not, then in their second year, with only a few kept for breeding. Females are mostly maintained, although some are killed in their second year. So, the majority of the meat animals are culled in their second year, the rest being saved for reproduction and milking. In light of Payne's study, the pattern displayed in the Shiqmim 1993 mandibles and epiphyseal fusion data probably reflects meat *and* milk exploitation, not exclusively one or the other.

Horwitz and Smith (1991) gathered metrical evidence for secondary products usage through studies of sheep and goat metapodials from Israel and the West Bank. Their studies show that there was a major decrease in cortical thickness of the bones from the Chalcolithic to the Early Bronze Age. As a decrease in cortical thickness can be thought to reflect an intensification of milk exploitation, it would appear that an increase in milking occurred toward the end of the Chalcolithic or the beginning of the Early Bronze Age. Likewise, culling strategies for the Early Bronze Age show closer to 80% of the sheep/goat surviving into adulthood (Horwitz and Tchernov, 1989), as opposed to only 30% surviving beyond two years of age in the Chalcolithic at Shiqmim 1993. This change in culling practices indicates that in the Early Bronze Age a higher percentage adults were being maintained, possibly for more intensive milk exploitation than was practiced in the Chalcolithic. The culling strategy for sheep/goat at Shiqmim also supports the proposition that *intensive* milking was not practiced in the Chalcolithic in this area, but rather, that the sheep/goat were exploited for a number of products on a less intensive scale.

Sheep as wool providers

Archaeological evidence suggests that people exploited sheep for wool during the Chalcolithic; however, as with milking, the degree of intensification is difficult to determine. A few wool products such as those found (though not in such abundance as linen products) at the Late Chalcolithic site of Nahal Mishmar (Bar-Adon, 1980) provide evidence for wool production at this time. The abundance of spindle whorls from this period might also reflect the exploitation of sheep for their wool, although it is also possible that spindle whorls were used for processing hair, flax or other light, fibrous materials. In her analysis of the sheep and goat bones from Bir es-Safadi, Grigson (1987: Table 1) presents a graph of bone fusion patterns, and uses them to argue that more sheep than goats were kept to old age, probably for milking and wool-production. Figure 4 shows the sheep and goat bone fusion data from Shiqmim, graphed in ascending order of fusion ages (fusion stages taken from Silver, 1969). The inhabitants of Shiqmim probably killed sheep at slightly older ages than goats (a pattern similar to that observed in the Bir es-Safadi data). This marginal preference may suggest the maintenance of sheep for wool production.

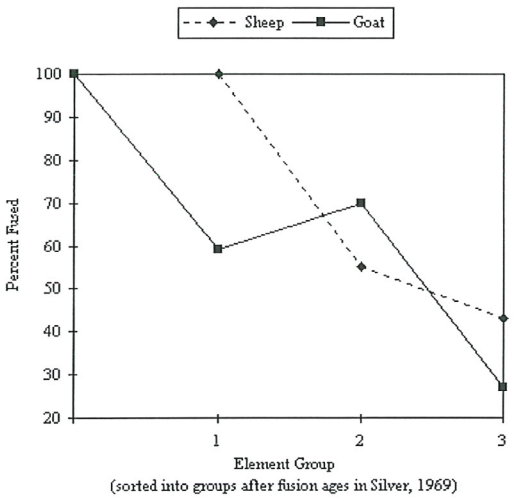

Figure 4. Differential kill-off patterns for sheep and goat (data from Table 4).

Element Groupings	Raw data sheep		Raw data goat		sheep/goat		Adjusted sheep		Adjusted goat		Percent fused sheep	Percent fused goat
	F	U	F	U	F	U	F	U	F	U		
1. distal scapula, distal humerus, proximal radius	12	0	11	3	39	18	32	0	30	21	100%	59%
2. proximal and middle phalanges	12	6	23	6	28	23			41	18	55%	70%
3. distal tibia, distal metapodials	4	3	2	3	21	42	18	24	9	24	43%	27%
4. calcaneum, distal radius, proximal femur	3	2	1	1	17	24	16	26	5	0	38%	100%
5. proximal humerus, distal femur, proximal tibia	6	5	1	1	14	33	18	33	3	7	36%	32%

Table 4: Differential sheep and goat bone fusion patterns at Shiqmim[7]

Discussion of the age data at Shiqmim

There are a number of complications which must be taken into consideration when making analyses based on the age data from Shiqmim 1993. One is the differential preservation and excavation of bones and teeth. The teeth of younger animals are less likely to preserve due to the fact that they are not as strong as adult teeth. Additionally, they are less likely to be recovered by the archaeologist in excavation due to their small size. Similarly, the bones of adult animals are more likely to survive than the unfused bones of juveniles: unfused or recently fused bones will disintegrate more quickly or be fragmented due to their porous and friable nature. These biasing factors imply that juvenile individuals may be under-represented in the bone assemblage. The prospect that there are even more juveniles from Shiqmim than we see in the present assemblage is a further indication that the economy was primarily meat-based.

Another complication to keep in mind is that the bones and teeth do not come from one context, but from across the entire site and from various loci. This means that the bones and teeth come from deposits of varying antiquity. Therefore the conclusions reached here are general characterizations of caprine exploitation spanning the Late Chalcolithic chronological sequence across the entire area of Shiqmim excavated in 1993. It is thus impossible to paint an exact picture of caprine exploitation at any one point in space and time. While it seems likely that, in general, the inhabitants of Shiqmim did not practice intensive secondary products production, there may be as yet undetected trends toward more milk and wool production throughout the period. Future research based on larger, stratigraphically distinct samples may detect such changes in Shiqmim's chronological sequence.

[7] Grigson (1987b) stresses the importance of including the fusion data from the bones identified only as sheep/goat because there are more unfused bones in this category. The following formula was used to make proportional adjustments to the Shiqmim data: a+[(a/(a+b))*c]. As an example, we will calculate the adjusted number for Element Group 2 fused sheep bones, where a= the number of fused sheep Group 2 bones, b= the number of fused goat Group 2 bones, and c= the number of fused sheep/goat Group 2 bones. Thus the equation is: 12+[(12/(12+23))*28] = 22 fused sheep bones. Element Groups 4 and 5 have not been included in Fig. 4 due to the negligible number of goat bones in each group.

Sheep/goat Pathologies

Of the 1324 sheep/goat bones, 27 show signs of pathology, primarily oral pathologies. Sixteen sheep/goat teeth have swollen root tips, probably due to a chronic low-grade infection (Baker and Brothwell, 1980). It is thought that periodontal disease such as this is a result of over-grazing, poor nutrients, or crowded grazing conditions where infection spreads easily. It must be mentioned, however, that most of the teeth with swollen roots came from older individuals, suggesting that the infection is related to old age.

A calculus (tartar) build-up was noted on a number of sheep/goat teeth, as reflected in a gold metallic luster on the buccal and/or lingual sides of the teeth. Such calculus may reflect the health and functioning of the teeth (Baker and Brothwell, 1980). Tartar build-up may also mirror the signs of poor grazing conditions (overcrowded or lacking in nutrients) reflected by the swollen roots.

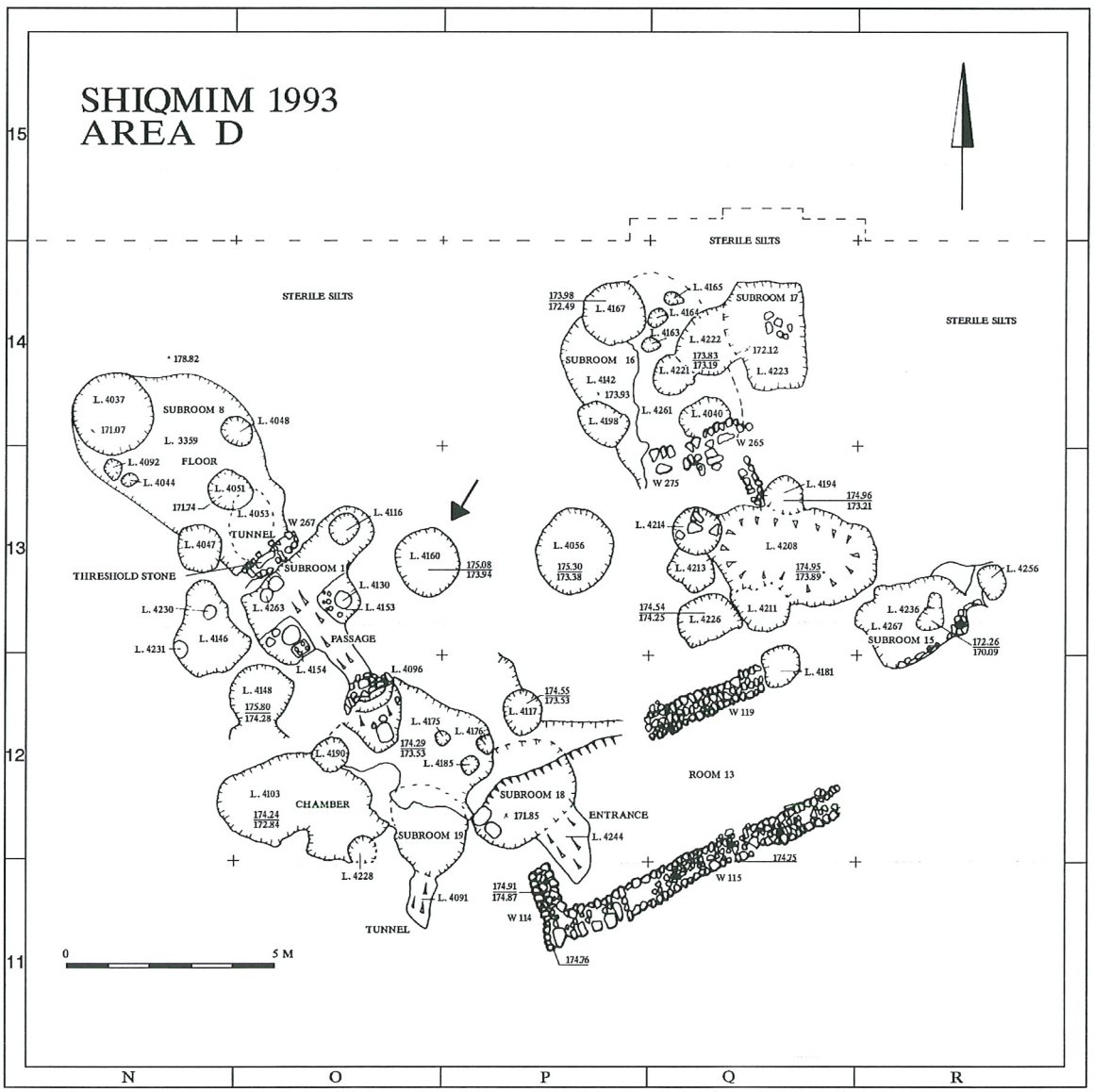

Figure 5. Plan of Area D, the largest excavated area in the 1993 season, indicating the pit (L.4160) in which were found articulating elements of at least four individual sheep/goat and an anthropomorphic bone figurine (see Fig. 6).

Figure 6. Figurine found in L.4160 among articulated remains of at least four individual sheep/goat. The style of this bone figurine, probably made from a cattle scapula, reflects a synthesis of two Chalcolithic traditions: the violin-shape figurine of the Nahal Patish and Lower Jordan Valley, and the ivory statuettes of the Beersheva Valley culture (Levy and Golden, 1996).

Element representation across the site

The sheep/goat bone elements represented indicate that whole carcasses were present at the site, since the bone assemblage contains a large representation of both meat-bearing bones (long bones, vertebrae and ribs) and non-meat-bearing bones (cranial bones and extremities). The same type of skeletal area representation is seen in the cattle remains. Cattle are outnumbered by sheep/goat by a ratio of 9:1 in most loci. As the bones were found in similar proportions across the site (that is, most loci produced elements from all regions of the skeleton, both meat-bearing and non-meat-bearing), no distinct meat-processing or discard areas could be defined.

The majority of the animal bone collection from 1993 was found in pits. This is not surprising, as there were a large number of pits found at the site, and we would expect that these pits would be filled with debris, either from discard during occupation, or after the particular feature was abandoned. A characteristic feature of the architecture at Shiqmim is its many subterranean and semi- subterranean rooms. A small number of bones came from the floors and fills of these subterranean rooms and the pits within them.

Almost no bones were found in the tunnels and passageways associated with the subterranean rooms. The fact that so few bones were found in the subterranean rooms may simply result from natural processes of alluvial deposition after abandonment and not to cultural deposition through garbage disposal. During the inhabitation of the site, the rooms might have been used strictly for storage (perhaps of grains) and so would not have been filled with the refuse of food-processing activities. Similarly, if the underground rooms were inhabited by people, they would have been kept clean because household rubbish would only smell and attract flies in the confined area. The tunnels probably remained bone-free because they were used for coming and going, and not for food-processing or discard.

The species and element representation in the pits is fairly even in most loci. There is an average ratio of 9:1 sheep/goat to cattle, all skeletal areas are represented, and most bones within any given context do not clearly articulate. Interestingly, the contents of one pit, L.4160, produced a more distinctive assemblage of bones (see Fig.5, indicating pit L.4160's location in Area D). Over 80 bones were found in this pit, all of which were sheep/goat except for one hare and one rodent bone. The complete or partial remains of at least four individual sheep/goat were found. One adult sheep is represented by long bones, and was over the

age of 3-3.5 years at death (aged by a fused proximal tibia). A juvenile or adult goat is represented by articulating phalanges. Two fetal or neo-natal sheep/goat were also found, one represented by a nearly complete skeleton, and another by various entirely unfused hind leg bones. It is of interest that this unique assemblage came from the same pit as the complete anthropomorphic bone figurine described by Levy and Golden (1996);(Fig. 6). This unusual assemblage consisting of articulated individual sheep/goat bones, no cattle bones (which are common in all other contexts), and an anthropomorphic bone figurine, possibly resulted from some kind of ritual activity. The Chalcolithic site of Gilat had a circular "burial monument" which contained nine human skeletons buried above a layer of animal bones (Levy, 1995). However, a lack of data pertaining to the relationship of animal bones to features and architecture at other Chalcolithic sites in the southern Levant makes it difficult to make inter-site comparisons.

The Shiqmim cattle: meat-providers or beasts of burden?

There is tentative evidence from Chalcolithic sites in the southern Levant for the use of cattle for products other than meat. A sandal made from cow-hide found in a Late Chalcolithic deposit at Nahal Mishmar (Bar-Adon, 1980) attests to the use of cattle for the primary product of leather at this time. As for secondary products, the "churns" found at many northern Negev sites may be interpreted as vessels for sheep/goat milk as well as cow milk. If sheep/goat were being milked, then it would have been logical to milk cattle as well for, as Grigson (1995) has stressed, one cow produces much more milk than one sheep/goat. Excavations at Ein Gedi yielded artistic evidence relating cattle to milk products in the form of a ceramic bull with a churn on its back (Ussishkin, 1980). This figurine attests to some kind of relationship between cattle and milk products, as well as the use of cattle for labor. So it seems that, during the Chalcolithic, cattle were, indeed, exploited in a number of ways: they provided primary products such as meat and leather, as well as secondary products such as milk and labor. Unfortunately, the small size of the Shiqmim cattle bone assemblage (180 bones) makes it difficult to derive definitive archaeozoological evidence as to how cattle were exploited.

Cattle as meat providers

Although the sample size of Shiqmim cattle bones is small, we attempted an analysis of age and body part representation. This type of analysis can help in assessing whether or not cattle were culled for meat or maintained for other purposes. If cattle were being raised solely for meat, we would see a kill-off pattern similar to sheep/goat; that is, many animals being killed young at their peak of meat-yield and a select few being kept alive for breeding. An assessment of the epiphyseal fusion of the cattle bones in the Shiqmim 1993 collection (Fig. 7, Table 5) reveals that a majority of the cattle was killed by 3.5 to 4 years of age (only 25% of the represented individuals in this bracket have fused bones). There is a significant drop in the percentage of fused bones from 2.5 to 3.5 years, implying the slaughter of cattle at their peak of meat-yield, with very few individuals maintained to older ages. This indicates that cattle were not used exclusively or even primarily for labor (in which case we would see a much higher percentage of mature animals) but were more likely butchered for meat and skins.

The most convincing evidence for cattle being used for meat at Shiqmim is seen in cut marks on an articulating group of limb bones (calcaneum, astragalus, centroquartal and metatarsal) found in a pit. The calcaneum and astragalus have heavy cut marks on the lateral side, indicating an attempt to sever the extremity from the meat-bearing upper limb. The unfused calcaneum reveals that the animal was less than three years old when it died, suggesting that it was intentionally killed at a young age.

Cattle as beasts of burden

The cattle bone fusion patterns, body part representation, and butchery marks discussed above imply that cattle were used primarily as meat animals at Shiqmim. Additionally, because of their size, cattle can provide up to 9 times the meat of sheep/goat (based on meat-weight calculations in Clark and Yi, 1983; Grigson, 1995). Thus, if cattle at Shiqmim were being raised primarily for meat, they would have actually provided more meat than the sheep/goat in the sample. However, in a marginal environment such as that of the Negev fringe, maintaining cattle solely as a source of meat is not as practical as maintaining sheep/goat. Sheep/goat are better adapted to arid environments (especially goat), they are smaller and less meat-yielding, and so could be immediately eaten without requiring preparation for long-term storage. Relying on sheep/goat as a main source of meat is a more practical solution than investing in a high-maintenance population of cattle which would be difficult to maintain with limited water and grazing space. This leads us to consider the possibility that cattle were maintained for some purpose in addition to meat-production which would make raising them a worthwhile investment.

Cattle offer a unique and substantial secondary product, that of labor, as animals for carrying loads or pulling ploughs. Archaeological evidence for cattle being used for labor is seen in such artifacts as the ceramic bull from Ein Gedi carrying two churns, mentioned earlier in the text. Evidence is found in the assemblage of animal bones from Shiqmim 1993 in the form of a distal metacarpal with an expanded articulation and lesions caused by abrasion with the proximal phalanx. A similar metapodial with osteoarthritis was identified by Grigson from an earlier season of excavation at Shiqmim (Grigson, 1987a, 1989; Levy *et al*, 1991: 408). Although pathologies such as this could simply result from old age, they might also be a result of strain brought on by cattle being used to pull or carry heavy loads. The tentative osteological evidence for cattle as beasts of burden is outweighed in this case by the bone fusion data, which imply that cattle were primarily used for meat (and skins). However, it is an indication that cattle might have been exploited for labor as well, although not to an extent which can thus far be detected in the bone remains.

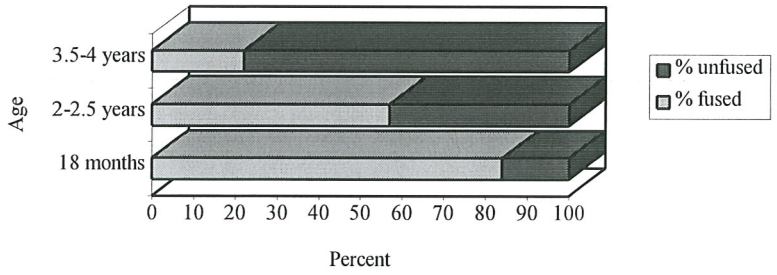

Figure 7. Age of death in cattle, based on epiphysial fusion (fusion ages taken from Silver, 1969).

Age of Fusion		# Fused	# Unfused
18 months	(proximal radius, 1st phalanx, 2nd phalanx)	16	3
2-2.5 years	(distal metapodials, distal tibia)	4	3
3.5-4 years	(calcaneum, proximal femur, proximal humerus, distal radius, proximal ulna)	2	7

Table 5: Numbers of fused and unfused cattle elements at Shiqmim 1993 (based on Silver, 1969).

It must be remembered that the preceding discussion is based on a relatively small number of cattle bones, from which no certain conclusions can be drawn. The ideas put forth can merely be considered *suggestions* as to the economic uses of cattle at Shiqmim, a topic which might be further elucidated by an analysis of the entire assemblage of cattle bones from the cumulative years of excavations at Shiqmim.

Other species

Gazelle

The 12 gazelle bones from the 1993 excavations were not concentrated in any particular area or locus. They were not identified to species level, but are most likely of the desert species *Gazella dorcas*. All the bones identified are from the head (mandibles and a horncore from the outlying site of Metzad Aluf), ankle (astragalus) and feet (a metacarpal and phalanges). There are too few gazelle bones in the 1993 assemblage to suggest that the head and lower-limb bones were brought to the site in the form of skins. Most likely, the lack of meat-bearing bones is due to difficulties encountered with the distinction of broken vertebrae and limb bones of gazelle, from those of sheep/goat. A much larger sample of gazelle bones is needed in order to make any conclusions about the role of gazelle at Shiqmim. The presence of bones of gazelle and other wild animals suggests that a certain degree of hunting or trading was being practiced at Shiqmim, but according to the small number, the skins and meat of hunted animals were not critical economic factors.

Horse

It has been argued that domestic horses were already present in the Negev in the fourth millennium (Grigson, 1993), and new finds from Shiqmim 1993 give further support to this suggestion. Although no bones of other equid species were found, two horse (*Equus caballus*) bones were in the 1993 sample. One radius was interred in a stratum I deposit (topsoil), and so its antiquity is not certain. Another bone, a proximal humerus, was found in a secure stratum IIa locus among articulated sheep/goat bones, suggesting it had remained relatively undisturbed since its deposition. The humerus has a Bp (proximal breadth) of 92.8mm, a similar size to the proximal humerus of a horse identified by Grigson in Shiqmim 1989, whose Bp is 92.6mm. We can only guess what the function of horses in the Chalcolithic might have been. It is thought that cattle were used before horses for draught, and that horses were not used to pull vehicles until the late third millennium (Sherratt, 1983), and were not ridden until the first millennium BC (Clutton-Brock, 1987; Grigson, 1995). The presence of horse in such small numbers at Shiqmim suggests that the horse was not yet common, and may have even been an item of prestige because of its rarity. Unfortunately, the few remains give us no clues as to their use. The horse remains of this period, however infrequent, raise important questions as to the timing, mechanism and route of the arrival of a small number of horses (perhaps some of the earliest domestic horses, originating in the steppes of central Asia) into the southern Levant during this period.

Conclusions

The bones from Shiqmim 1993 reflect an economy based on sheep/goat and cattle, mainly for meat, but possibly also for secondary products such as milk, labor, hair and wool. Redding (1984) argues that a sheep to goat ratio of between 1:1.7 and 1:1 indicates that the herd was structured for herd security, and that optimal kill-off to promote herd security is between 0.5-2 years of age. The sheep to goat ratio at Shiqmim 1993 is 1.2:1, and the kill-off of the majority of animals is under 2 years, suggesting that the structure of herds at Shiqmim was mainly directed toward promoting herd

security. The sheep/goat cull pattern at Shiqmim 1993 indicates that these animals were exploited mainly for their meat. However, ceramic evidence (churns and spindle whorls) suggests that the inhabitants of Shiqmim did exploit their livestock to some degree for milk and wool production, but given the archaeozoological evidence discussed here, the scale of secondary products exploitation was not intensive. In light of the present evidence from the 1993 animal bone collection, sheep/goat exploitation was not focused exclusively on meat, milk or wool production, but combined all three products and emphasized herd security.

Bone fusion data suggest that cattle were also used mainly as a source of meat. Cut marks on a small number of cattle bones provide evidence for the butchery of certain individuals for food. However, the presence of ceramic "churns" in the Chalcolithic and such zoomorphic representations as a figurine of a cattle laden with churns, imply that cattle may have been used for milk production. The discovery of cattle metacarpals with lesions possibly resulting from forelimb strain gives *some* support to the hypothesis that cattle were used as beasts of burden. However, as in the case of sheep/goat, intensive secondary products exploitation seems unlikely, given the cattle bone fusion data. The inhabitants of Shiqmim probably raised cattle with multiple and generalized purposes in mind.

Although the Shiqmim 1993 faunal bone assemblage is relatively abundant, it will be most useful incorporated into a study of spatial and chronological changes throughout the entire human occupation of Shiqmim. This discussion has touched on archaeozoological issues such as the relative importance of sheep versus goat at Shiqmim and the nature and extent of secondary products exploitation of sheep/goat and cattle during the Late Chalcolithic in the northern Negev Desert. The noted absence of bone refuse in tunnels and subterranean rooms, as well as the unusual contents of a pit consisting of articulated bones of individual sheep and goats and an anthropomorphic bone figurine, encourages the further study of taphonomic processes and potentially ritual human activities at Shiqmim. Finally, the discovery of another proximal humerus of a horse at Shiqmim merits further research into the role of the horse in Chalcolithic society and economy. Future archaeozoological studies will enhance these preliminary observations, which deal with but a few of the key economic issues having to do with the rise of social complexity in the northern Negev Desert at this time.

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