

ARCHAEOZOOLOGY OF THE NEAR EAST VI

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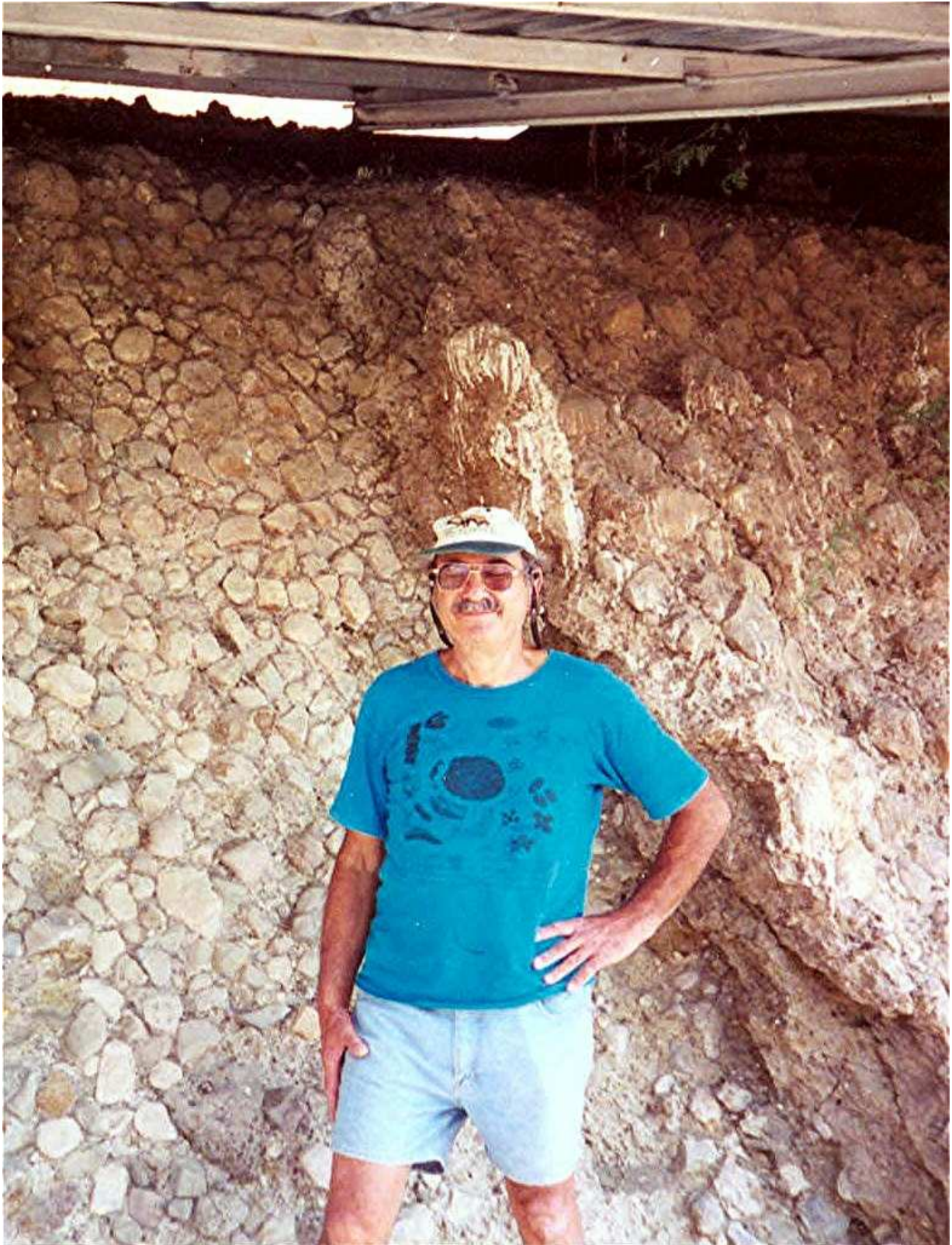
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Prof.Dr. Eitan Tchernov

This volume is dedicated to the memory of Prof. Dr. Eitan Tchernov, in fond memory of his enthusiasm and support to many in the field of archaeozoology.

Preface

The ASWA VI meeting was held at the Institute of Archaeology, University College London, from 30th August-1st September 2002, timetabled to follow on the heels of the ICAZ meeting in Durham, UK. Over 55 participants attended the meeting, travelling from 13 countries, bringing the latest research results from our field. As usual, it was a pleasure to see so many doctoral students presenting their research – a sign for a very healthy future for zooarchaeology in south west Asia. It is still unfortunate, however, that colleagues from some Middle Eastern countries were unable to attend due to financial and political constraints.

Presentations were organized into the following six themes, which highlight the scope of the ASWA membership: Animals in Palaeolithic and Epipalaeolithic Levant; Neolithic Patterns of Animal Use; Animals in Neolithic Anatolia; Animals in the Chalcolithic and Bronze Ages; Iron Age, Nabatean and Roman Patterns of Animal Use; Animals in Ancient Egypt. There was also a poster session, and contributors were invited to submit papers to this volume.

As always with the ASWA forum, the meeting served to welcome new scholars to the group, but was also very much a reunion of old friends and colleagues who have been sharing new information and discussing issues of joint interest for many years now. In this vein, it is a great sadness that ASWA VI was the last international meeting attended by Prof. Eitan Tchernov, an original founder of the group and mentor and inspiration to so many. For many of us, it was the last time we saw Eitan, and experienced his usual incisive comment, unstoppable enthusiasm for the subject, and warm friendship. He will be greatly missed.

ASWA VI was supported by the Institute of Archaeology, UCL, who provided facilities and financial and administrative help. In particular, the organizing team was aided greatly by the administrative assistance of Jo Dullaghan at the Institute. ARC bv (Archaeological Research and Consultancy, Groningen, The Netherlands) once again shouldered the finances of the publication of the proceedings, and we are extremely grateful for their continuing support. Many thanks are also due to the post-graduate student helpers from the Institute of Archaeology who made the meeting run so smoothly: Banu Aydinoğlugil, Jenny Bredenberg, Chiori Kitagawa, Peter Popkin, and Chris Mosseri-Marlio (who also produced the logo reproduced on the frontispiece of this volume).

Many thanks to all the participants for making the meeting such a success!

Louise Martin
London 2005



Participants of the 6th ASWA Conference, held at the Institute of Archaeology, University College London.

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PIG PRODUCTION AND EXPLOITATION DURING THE CLASSICAL PERIODS IN THE SOUTHERN LEVANT

Liora Kolska Horwitz¹ and Jacqueline Studer²

Abstract

In this paper we discuss the archaeozoological evidence for the production, management and consumption of domestic pig during the Roman and Byzantine periods in the Southern Levant.

In the Byzantine period the frequency of domestic pigs increased markedly in all phytogeographic zones and has been attributed to a combination of four factors: (1) the growth of Christian communities in the region who exhibited a preference for pork, (2) climatic amelioration especially notable in the desert regions, (3) improved hydraulic technology which facilitated a more reliable and extensive water supply especially in the arid zones and, (4) reduced frequency of cattle in the northern region due to culturally induced degradation and loss of pasture to cultivation. The pig, an omnivore and efficient supplier of animal protein then provided a cheap and reliable meat substitute for beef.

Thus, a combination of anthropogenic and environmental factors appear to have determined pig exploitation during the Classical periods in this region.

Résumé

Ce travail présente et discute les données archéozoologiques concernant la production, la gestion et la consommation du porc au Proche-Orient, à l'époque romaine et byzantine.

À l'époque byzantine, la fréquence du porc est en nette progression dans toutes les zones phytogéographiques. Cette augmentation est attribuée à la combinaison des 4 facteurs suivants: 1) un développement des communautés chrétiennes qui apprécient la viande de porc, 2) une amélioration du climat, qui se marque avant tout dans les régions désertiques, 3) un développement des technologies hydrauliques qui facilite la distribution de l'eau dans les régions arides, 4) une diminution de la fréquence des bœufs dans les régions du nord liée à la dégradation des pâturages et à l'expansion des terres agricoles. Omnivore et efficace fournisseur de protéine, le porc sera alors préféré au bœuf, offrant une viande plus économique.

Il semble ainsi que l'exploitation du porc au cours des périodes classiques soit influencée par une combinaison de facteurs anthropiques et environnementaux.

Key words: Near East, Southern Levant, domestic pig (*Sus domesticus*), cattle (*Bos taurus*), Roman, Byzantine.

Mots clés: Proche-Orient, Levant Sud, porc (*Sus domesticus*), bœuf (*Bos taurus*), Romain, Byzantin.

Introduction

In a recent paper Hesse and Wapnish (1998: 132) stated that “*beginning at least as early as the Bronze Age, the Near Eastern pig was burdened with potential and contradictory meanings. Depending on when and where one looks, dichotomies in meaning constructed on ecological, social, political, economic and religious grounds structured the use of the animals and produced a matrix of symbolic possibilities available for mobilisation*”. Hesse (1990) and Hesse and Wapnish (1996, 1998) have outlined several “pig principles” which individually or together, may have guided past production and exploitation practices of this species in the Levant. They are based on ideas developed by these authors as well as those expressed by other researchers such as Diener and Robkin (1978), Harris (1985), Crabtree (1989), Grigson (1995), Redding (1991) and Zeder (1996). The principles may be summarised as follows:

- a. The “Initial Colonisation” approach which views the pig as an ideal animal for settlers entering a new territory. This, as pigs have an extremely high reproductive turnover (as many as 10 to 14 piglets in a litter and 1-26 litters per reproductive life), grow faster than any other herd animal (Ranj-han 1997) and provide a large quantity of high quality protein (70% of original body weight). Furthermore, as they are omnivorous, they can consume a wide range of foods and recy-

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cle waste. Pig herding requires only a small investment of energy for herding as they can either be kept in a sty or left to forage for themselves. These features make them a cost-effective animal to raise.

- b. the “Agricultural” perspective postulates that the abundance of swine will fluctuate according to the intensity of agriculture; with low frequencies in societies which produce quantities of cereals which offer little sustenance for pigs. This is due to the pigs inability to consume crude fibre, such as the coarse fodders derived from cereals, as efficiently as ruminants (Ranjhan 1997). Furthermore, as cereal cultivation intensifies, land-use patterns shift and both pigs and sheep become less common while cattle and goat herding, which complements cultivation, increases. Pig keeping in particular is incompatible with intensive agriculture in that they rob crops and their rooting activities are destructive.
- c. the “Centralised Political” paradigm argues that pig production will flourish in times of decentralised political control and decrease in times of centralised administration as it is a single resource animal providing only meat and fat unlike caprines and cattle who also provide milk and its related products as well as wool and hair. Thus pigs have a limited potential for taxable remuneration.
- d. the “Class” model contends that societies where meat consumption reaches a particularly high level e.g. urban commercial centres, pig production may be encouraged as the profit to be gained from meat production versus that of secondary products from caprines and cattle, is exceeded. In direct contrast, some Near Eastern literary texts indicate that pork consumption was associated with lower status communities e.g. workers. This may be related to the reproductive capacity of pigs which facilitates a relatively rapid supply of meat compared to beef or mutton.
- e. The “Ethnic Identity” theory perceives pig keeping and exploitation as a reflection of a choice exercised by a community based on their cultural or ideological identity. The prohibition on the consumption of pork by Jews and Muslims exemplifies the manifestation of group identity in food selection. Furthermore, there are claims, based on ancient texts, that pigs were specifically selected for use in religious rituals by certain Near Eastern communities.
- f. The “Biological” approach sees pig production in arid regions and/or in a nomadic context as limited by the specific physiological and behavioural characteristics of this species. Compared to caprines and cattle, pigs are ill-adapted to long distance herding as a result of their temperament and short legs. They will therefore be extremely rare if not absent in nomadic economies. Moreover, their high daily water requirements (8-12 litres per day at 100 kgs body weight – Ranjhan 1997), make them poorly adapted to the arid regions of the Near East. Indeed, with reference to the distribution of pigs in 5th millennium (Chalcolithic) sites in the desertic areas of the Southern Levant, Grigson (1987, 1995) has suggested that pig keeping may have been non-viable in areas which received less than 300mm of rainfall per annum unless, as suggested by Klenck (quoted in Toplyn 1994) and Hesse and Wapnish (1996), a sufficient supply of water was guaranteed through investment in special hydraulic systems. There is some discussion in the literature as to the extent of heat tolerance in pigs, and although many researchers acknowledge that they are sensitive to high temperature, it has been suggested that providing they have sufficient access to water, heat per se may not have been the prime factor in determining their distribution in the past. A further issue to be considered is that in the arid regions of the Levant there is limited availability of suitable natural foods for pigs as the natural vegetation cover is quite coarse and dry and ranges from Irano-Turanian steppe to desertic Saharo-Arabian vegetation in the drier zones (Danin 1983; Shehadeh 1985).

The present paper aims at evaluating the archaeozoological evidence for swine production, management and consumption in the Southern Levant during the Roman and Byzantine periods with respect

to the main factors outlined above. Although this topic has been touched upon in several previous studies (Hesse 1990; Toplyn 1994; Grantham 1996; Hesse and Wapnish 1998), we now have at our disposal a larger corpus of data from a wider geographic area, with which to assess this issue. Furthermore, in contrast to Hesse and Wapnish who have given equal weight to the different factors implicated in pig management/consumption, it is contended here that the specific physiological needs of this species which enable it to survive and reproduce, first need to be met before others can be considered. Biological factors such as access to water then play a critical role. It is further proposed, that pig management and use cannot be examined in isolation from exploitation practices of other herd species recovered in an assemblage. Thus, trends in caprine and cattle exploitation are integral to understanding the choices and constraints of pig exploitation at a given time.

Materials and Methods

For this study, we have drawn upon published and unpublished data from 33 Byzantine and Roman sites from Israel, the West Bank and Jordan; 17 assemblages are located in the northern, Mediterranean region and 16 in the desertic southern regions (Table 1a, b; Fig. 1). This geographic division is based on Grigson's (1987, 1995) 200 mm isohyete 'pig boundary'. Many of the sites have yielded assemblages dating to both the Roman and Byzantine periods and as such offer an excellent opportunity to examine diachronic changes in pig exploitation.

For this study we followed the classic work of King (1984, 1999) on Romano-British and Romano-Continental Roman assemblages, and calculated for each assemblage the total number of identified bones (NISP) only for the 4 major herd animals which characterise Near Eastern sites: sheep, goat, cattle and pig (Table 1a, b). The relative frequency of each species was then calculated. We felt that this data set, rather than frequencies based on Total NISP counts for each assemblage, would most closely reflect the shifting emphases between these taxa. This approach ensures that we exclude animals that may occasionally have been consumed but were primarily used for other purposes such as the camel, donkey and dog as well as hunted taxa and other species that may represent chance inclusions such as reptiles, small rodents, birds and small carnivores.

The samples presented here range in size from those with less than 50 identified bones to those with several thousand. Assemblages with an NISP of less than 50 bones were not included in the quantitative analyses but appear in the graphs in order to provide as complete a picture of the available data sets as possible. Sample size does not appear to have influenced the frequency of pig remains as there are small samples with high frequencies and large samples with low frequencies as well as vice versa (Table 1a, b). Comparisons between assemblages were carried out using chi square tests as we could not assume that the samples were normally distributed. Where Roman and Byzantine periods were not present in the same site, sites located close together were paired (Table 2 and 3).

A problem encountered in this study was that for many sites it is unclear whether the pig bones include those of wild boar or only those of domesticates. Wild boar are still found in the Mediterranean regions of northern Jordan and Israel, although limited in number and distribution by hunting and habitat destruction. They inhabit the well-watered thickets, forests and riverine habitats of this region especially the Golan Heights and the Jordan Valley. They are found in the marshy area at the southern-most tip of the Dead Sea (Qumsiyeh 1996; Mendelsohn and Yom-Tov 1999). Historical records from the early 1900's document the presence of wild boar in the Negev around Beersheva and as far west as Gaza, but not further south (Qumsiyeh 1996). However, Mendelsohn and Yom-Tov (1999) suggest that the pigs observed in the Besor region near Gaza, probably represent hybrids.

Although the presence of wild boar is often noted in the archaeological reports used in this study, in only a few cases has their contribution been quantified due to the absence in most samples of sufficient morphometrical information with which to separate them from domestic pigs. Thus, in most cases it has not been possible to assess the relative proportion of wild swine in many of the sites referred to here.

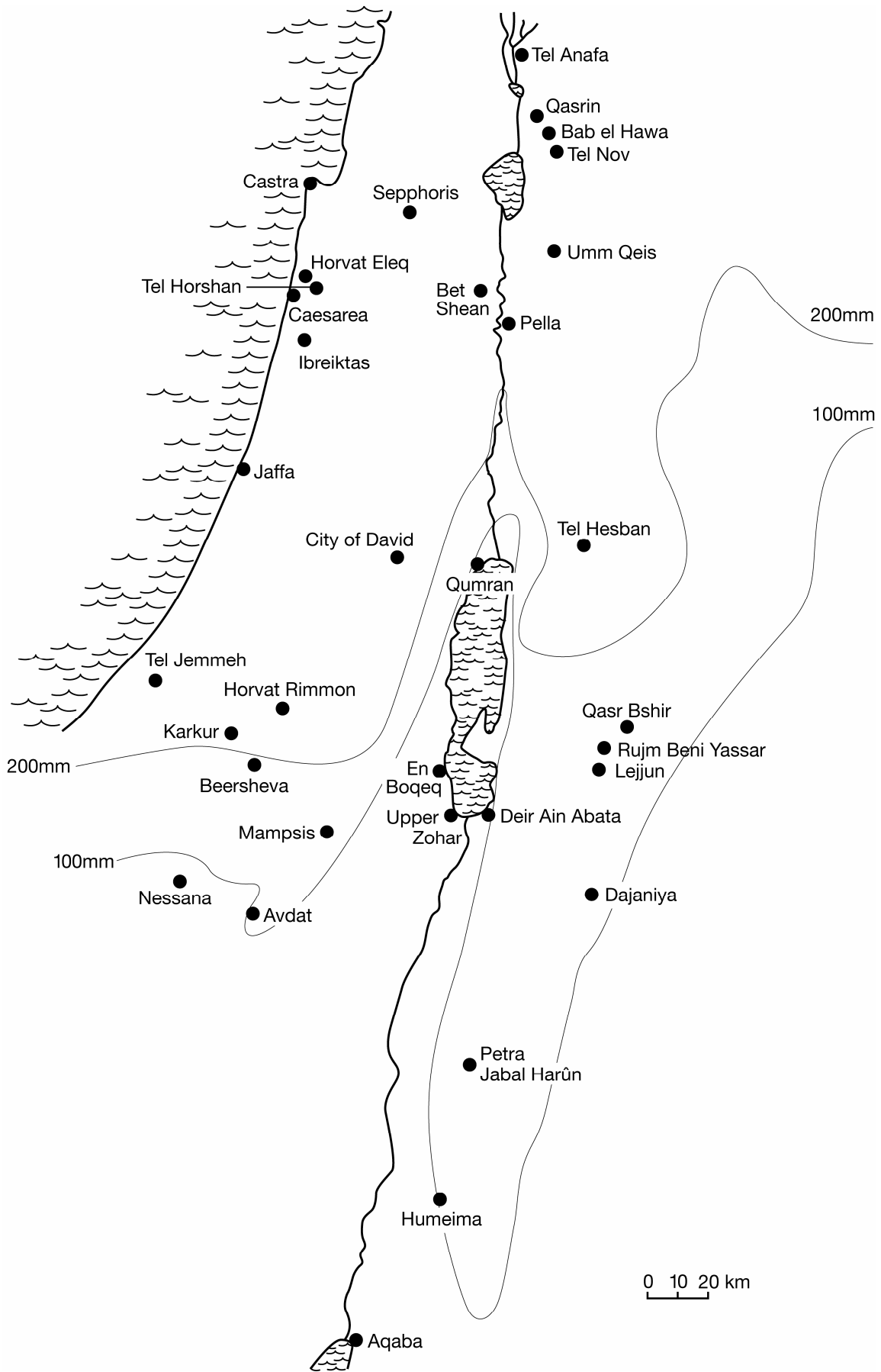


Fig. 1. Map showing the location of Roman and Byzantine sites referred to in this paper, and rainfall

Table 1a: Roman sites used in this study ordered by site type
 * NISP calculated as a total of identified bones of sheep, goat, cattle and pig

	TYPE	TOTAL NISP*	NISP PIG	% PIG	REFERENCE
NORTHERN SITES					
Umm Qeis	urban	1241	864	69.6	Rielly quoted in Beech in press
Sepphoris	urban	349	16	4.6	Grantham 1996
Caesarea	urban	706	408	57.8	Cope 1997, 1998
Pella (Al Husn)	urban	272	14	5.1	Rielly 1993
City of David	urban	972	0	0	Horwitz 1996
Tel Hesban	urban	3575	226	6.3	LaBianca 1990; von den Driesch & Boessneck 1995
Tel Anafa	rural	638	138	21.6	Redding 1994
Qasrin	rural	161	6	3.7	Grantham 1992
Tel Nov	rural	46	3	6.5	Horwitz 2000a
Tel Horshan	rural	170	3	1.8	Marder 1996
Horvat Eleq	rural	353	8	2.3	Horwitz 2000b
Ibreiktas	rural	74	1	1.4	Horwitz & Mienis 1998
Horvat Rimmon	rural	93	1	1.1	Horwitz 1998
SOUTHERN SITES					
Tel Jemmeh	urban	7	0	0	Wapnish & Hesse 1979
Petra	urban	2313	66	2.9	Studer 2002
Qumran	rural	477	0	0	Horwitz n.d.
Lejjun	military	1636	54	3.3	Toplyn 1994
Qasr Bshir	military	272	1	0.4	Toplyn 1994
En Boqeq	military	1285	18	1.4	Sade 2000
Rujm Beni Yassar	military	21	0	0	Toplyn 1994

For the purposes of this investigation it has been assumed that, unless otherwise stated, the pig remains represent domestic animals, this as in most instances the authors note that they are of small size and predominantly immature animals.

The latter is often considered to be characteristic of culling of a domestic herd. For example at the site of Lejjun, 70% of swine were slaughtered by 1 year of age, while at Mampsis only 10% of animals were over 3.5 years (Toplyn 1994: 241 ff).

Finally, the Roman and Byzantine periods in the Near East may each be divided into early and late phases (see Fiema 1991; Safrai 1994; Patrich 1995; Parker 1999, Freeman 2001 and Watson 2001 for discussions of local chronology). However, as not all bone assemblages can be precisely dated to either phase, we have used here only a general chronological division into Roman or Byzantine periods.

Findings

Geographic Variation in Pig Frequencies

The Roman-Byzantine period in the Southern Levant is associated with a dramatic rise in human population size and density, with peak population size in the Byzantine period (Broshi 1980; Issar and Guvrin 1991; Fiema 1991; Safrai 1994; Tsafirir 1995; Rubin 1996; Rosen 2000). In the Mediterranean region this is associated with a marked increase in site density, while in the desert regions this is characterised by an expansion into areas previously unoccupied or scarcely occupied. Here large-scale sedentary communities based on agro-pastoralism and trade developed; for example the Negbite towns and villages of Elusa, Ruheiba (Rehovot), Subeita (Shivta), Nessana (Nizzana), Oboda (Avdat) and Mampsis (Mamshit or Kurnub) (Fig. 1). In addition, numerous small villages and farmsteads were established in the surrounding region (Kedar 1967; Evenari *et al*, 1982; Shershfski 1991, Rosen 2000; but see Nevo 1991 for an alternative view of the character of Negbite settlement). Exca-

Table 1b: Byzantine sites used in this study ordered by site type

* NISP calculated as a total of identified bones of sheep, goat, cattle and pig

	TYPE	TOTAL NISP*	NISP PIG	% PIG	REFERENCE
NORTHERN SITES					
Sepphoris	urban	145	11	28.3	Grantham 1996
Castra	urban	162	39	24.1	Horwitz in press
Caesarea	urban	1884	962	51.1	Cope 1997, 1998
Bet Shean	urban	201	27	13.4	Manor <i>et al.</i> 1997
Pella (Al Husn)	urban	1433	150	10.5	Rielly 1993
Pella	urban	1883	740	39.3	Kohler-Rollefson in Toplyn 1994
Jaffa	urban	140	58	41.4	Sade 1997
City of David	urban	20	0	0	Horwitz 1996
Tel Hesban	urban	1330	130	9.8	Labianca 1990; von den Driesch & Boessneck 1995
Qasrin	rural	3377	6	0.2	Grantham 1992
Bab el Hawa	rural	2853	210	7.4	Raphael & Lernau 1997
Tel Horshan	rural	404	6	1.5	Marder 1996
Horvat Rimmon	rural	356	1	0.3	Horwitz 1998
SOUTHERN SITES					
Tel Jemmeh	urban	23	0	0	Wapnish & Hesse 1979
Avdat	urban	170	10	5.9	Klenck in Toplyn 1994
Mampsis	urban	442	75	17.0	Klenck in Toplyn 1994
Nessana K	urban	426	43	10.1	Klenck in Toplyn 1994
Nessana A	urban	247	21	8.5	Horwitz & Rabinovich 1991
Petra	urban	264	74	28.0	Studer n.d.
Humeima	urban	961	17	1.8	Oleson 1997
Lejjun	military	4158	158	3.8	Toplyn 1994
Qasr Bshir	military	244	3	1.2	Toplyn 1994
Upper Zohar	military	5318	671	12.6	Clark 1995
Rujm Beni Yas-sar	military	2	0	0	Toplyn 1994
Dajaniya	military	136	23	16.9	Toplyn 1994
Horvat Karkur	ecclesiastical	163	8	4.9	Horwitz 2004a
Deir Ain Abata	ecclesiastical	5829	555	9.5	Beech in press
Jabal Harūn	ecclesiastical	936	18	1.9	Studer 2001

vations in the Negev desert and the southern and eastern desertic regions of Jordan have yielded faunal samples from many sites which include quantities of pig remains (Table 1a, b; Fig. 2).

The northern boundary of the Negev desert lies along the 200 mm isohyete but most of the desert receives less than 50 mm rain annually (Orni and Efrat 1980; Danin 1983) while the desertic eastern and southern extremities of Jordan get a similar low annual rainfall (Shehadeh 1985; Oleson 2001). Bones of pigs have been recovered from sites which lie adjacent to or even below the present day 100 mm isohyete: for example the sites of Nessana and Humeima (Fig. 1) which receive 80-100 mm of rain per annum and hence lie even further south and in more arid conditions than any of the Chalcolithic sites studied by Grigson (1987, 1995). Given the water needs and heat sensitivity of pigs, how can we account for the presence of swine in sites located in such an arid zone ?

A possible explanation is that their meat was imported from sites in the north, where the natural climatic conditions were more amenable to their being bred and raised. This is especially pertinent when considering the extensive trade links and transport system that existed during the Romano-Byzantine period (Sperber 1978; Sidebotham 1989; Safrai 1994; Patrich 1995; Parker 1999; Watson 2001). However, when the archaeozoological data from these sites is investigated (Toplyn 1994; Studer 1996, 2001, 2002, n.d.; Oleson 1997; Sade 2000; Beech in press; Horwitz and Rabinovich 1991), this explanation is less feasible as:

Table 2. Chi-square table for pig.

$\chi^2 = 310.8$ d.f. = 8 P = 0.000				$\chi^2 = 235$ d.f. = 3 P = 0.000		
Northern Sites		Roman	Byzantine	Southern Sites		Byzantine
Qasrin	Obs	6	6	Lejjun	54	158
	Exp	3.6	8.3		28.2	183.8
Bab el Hawa / Tel Nov	Obs	3	210	Qasr Bshir	1	3
	Exp	65.4	147.5		0.5	3.4
Sepphoris	Obs	16	41	Petra	66	74
	Exp	17.5	39.4		18.6	121.3
H. Eleq / Castra	Obs	8	39	Upper Zohar / En Boqeq	18	671
	Exp	14.4	32.5		91.6	597.3
T. Horshan	Obs	3	6			
	Exp	2.7	6.2			
Caesarea	Obs	408	962			
	Exp	420.8	949.1			
Pella / Al Husn	Obs	14	150			
	Exp	50.3	113.6			
Tel Hesban	Obs	226	130			
	Exp	109.3	246.6			
H. Rimmon	Obs	1	1			
	Exp	0.6	1.3			

Table 3. Chi-square table for cattle.

$\chi^2 = 2039.0$ d.f. = 9 P = 0.000				$\chi^2 = 78.27$ d.f. = 4 P = 0.000		
Northern Sites		Roman	Byzantine	Southern Sites		Byzantine
Qasrin	Obs	49	1010	Tel Jemmeh	2	4
	Exp	381.8	677.1		1.1	4.8
Bab el Hawa / Tel Nov	Obs	21	496	Lejjun	51	275
	Exp	186.4	330.6		63.1	262.9
Sepphoris	Obs	129	15	Qasr Bshir	3	3
	Exp	51.9	92.0		1.1	4.8
H. Eleq / Castra	Obs	215	23	Petra	21	4
	Exp	85.8	152.1		4.8	20.1
T. Horshan	Obs	99	193	Upper Zohar / En Boqeq	7	64
	Exp	105.2	186.7		13.7	57.2
Caesarea	Obs	177	402			
	Exp	208.7	370.2			
Pella / Al Husn	Obs	56	234			
	Exp	104.5	185.4			
City of David	Obs	284	2			
	Exp	103.1	182.8			
Tel Hesban	Obs	417	162			
	Exp	208.7	370.2			
H. Rimmon	Obs	11	49			
	Exp	21.6	38.3			

- we find large quantities of bones (Table 1a, b) indicative of extensive exploitation and consumption of pigs as well as other species (cattle, caprines, equids, chickens etc.).
- pigs are ill-suited to being herded over long distances so they would have had to be conveyed as cooked/smoked/salted provisions. This is not viable as we find all bodyparts in the sites indicative of on-site slaughter and consumption.
- finally, for all species, including pigs, the remains include those of males and females as well as a wide range of age groups, although predominantly immature animals (including neonatal animals), which suggests local breeding and exploitation.

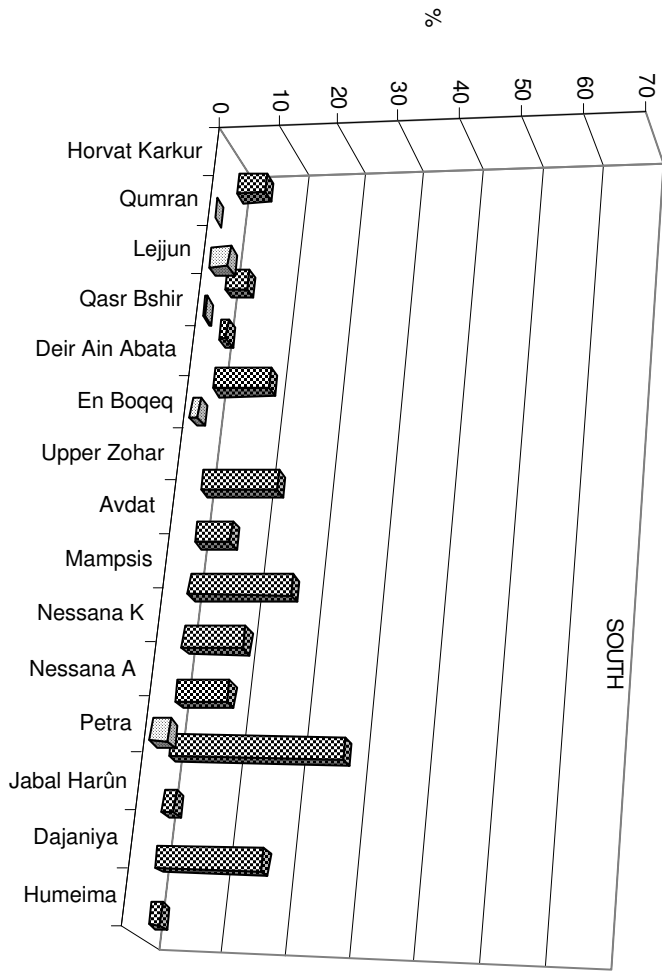
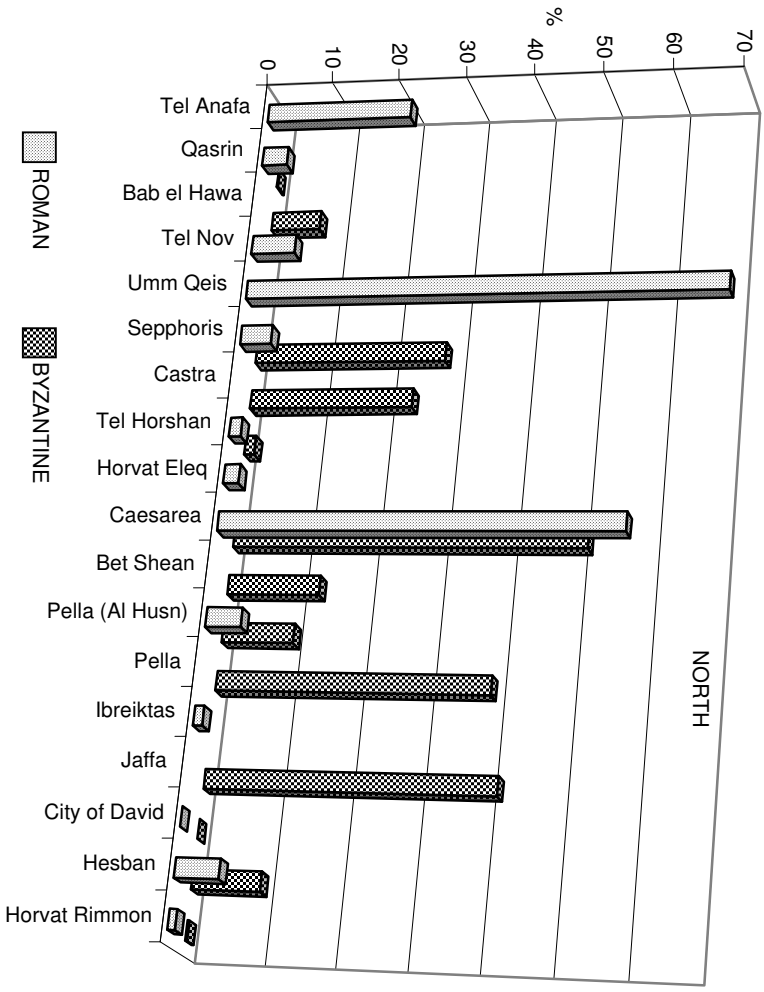
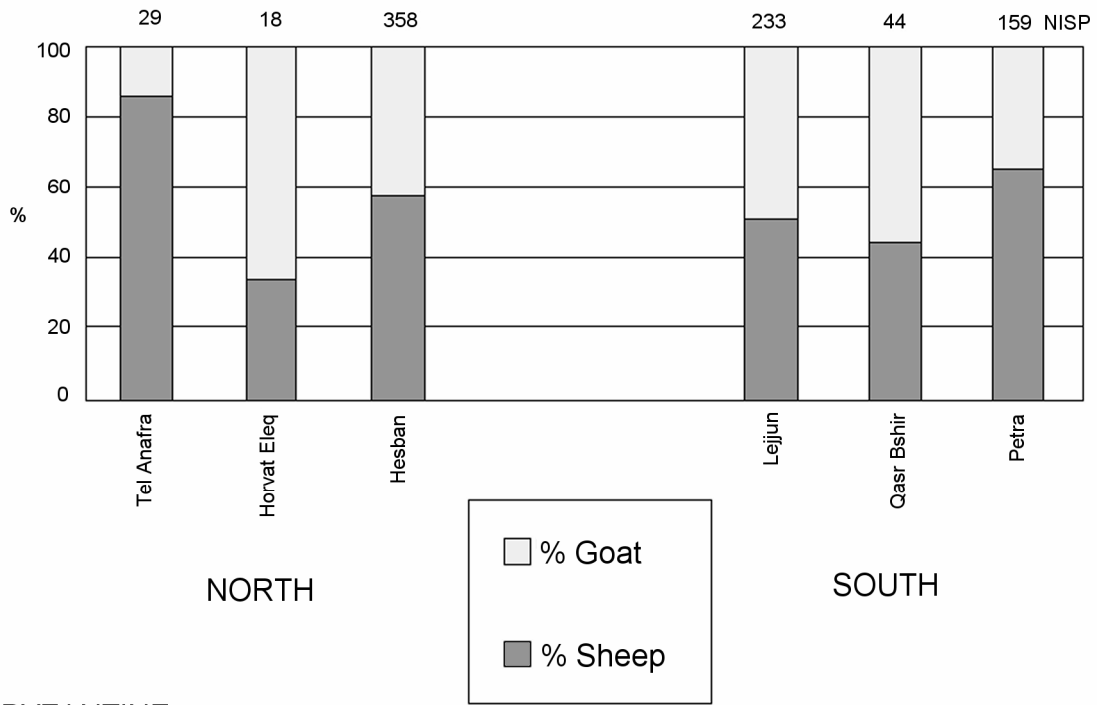


Fig. 2. Frequency of pigs in sites located in the northern and southern regions.

ROMAN



BYZANTINE

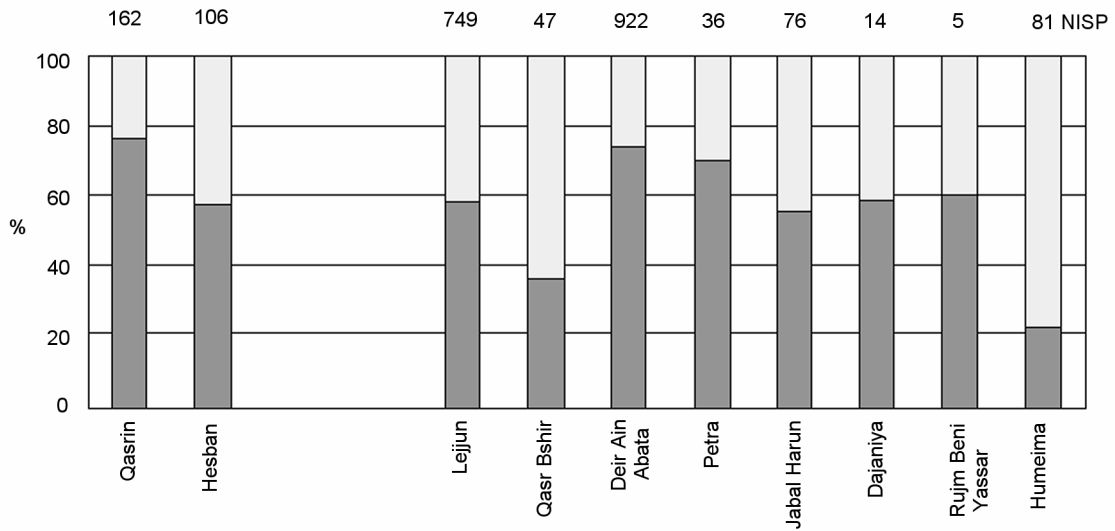


Fig. 3. Bar diagrams showing relative frequencies of sheep to goats.

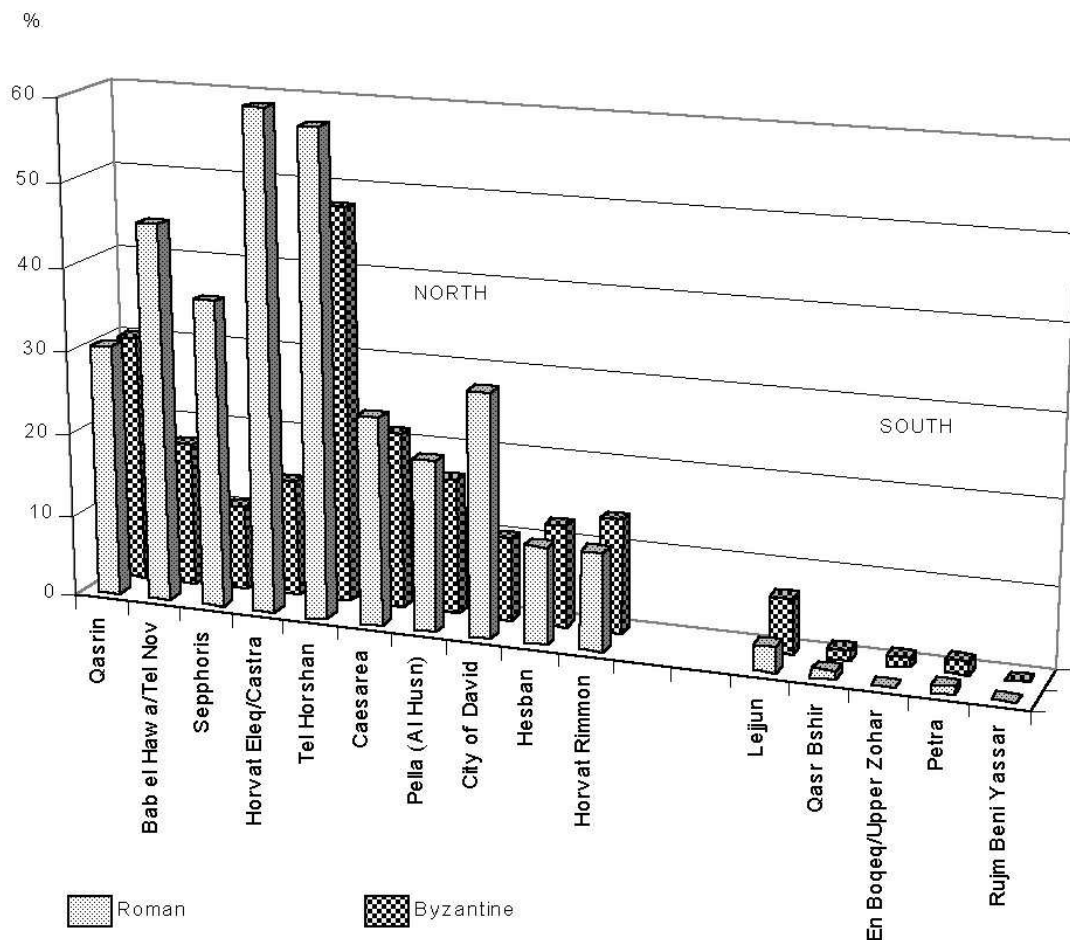


Fig. 4. Frequency of cattle in sites located in the northern and southern regions.

Additional sources of evidence are literary sources including the Mishnah which document very few instances of livestock being imported into Palestine from neighbouring regions (Safrai 1994).

It appears then that pigs were locally produced and exploited even in sites located in the extremely arid reaches of the Southern Levant. Support for this hypothesis is that in these same sites we find remains of sheep and cattle which, like pig, have high water (and pasture) requirements. Examination of sheep to goat frequencies, as shown in Fig. 3, indicates a slightly higher frequency of sheep in most sites examined, irrespective of their geographic location. This is particularly interesting given that in the absence of sufficient moisture in their pasture sheep require direct access to drinking water especially in the summer months (Lancaster and Lancaster 1991). Cattle are more heat sensitive and have even greater water requirements than sheep (Schmidt-Nielsen 1979), such that their presence in sites adjacent to or below the 100 mm isohyte is greatly surprising (Fig. 4).

A convincing explanation for the presence of these temperature sensitive and water-dependent taxa in the arid areas is that in the Classical periods the local climatic conditions were less harsh. Palaeoenvironmental data presented in Shehadeh (1985), Goldberg (1986, 1994), Bruins (1994), Issar (1998) and Bar-Matthews *et al.* (1998) convincingly demonstrate a more temperate and wetter climate than today. In the Nabataean and Early Roman period (final centuries BC and first two centuries AD) the region experienced a climatic optimum with a colder, relatively wet and more humid climate than today. According to Bruins (1994) this wet phase peaked circa 90 AD, while the subsequent Roman-Byzantine transition and Byzantine period was characterized by more arid conditions (Bruins, 1994; Issar 1998). This scenario is corroborated by microfauna derived from Roman military sites in

eastern Jordan. These sites have yielded remains of three Mediterranean species which do not inhabit the area today (Tchernov cited in Toplyn 1994: 590 ff). Several researchers (such as Rosen 2000; Nevo 1991; Bruins 1994) have noted that paradoxically the peak settlement of the southern arid zones occurred in the Byzantine period which was characterized by drier conditions than the Roman period. We may then question the role played by climatic amelioration in facilitating not only the establishment and maintenance of large, urban communities in desert regions, but large-scale herding of livestock with high water requirements.

Firstly, the precise chronology of the climatic shifts experienced in the region has not yet been refined and more research is required to corroborate findings from the different fields of research. Secondly, a climate change of considerable magnitude would have been required to transform the Roman-Byzantine sites that are presently on or below the 200 mm isohyete into viable, large-scale pig raising areas or make them capable of supporting orchards and vineyards i.e. an average annual rainfall at least close to double that at present. Even for the maximum phase of climatic amelioration in the Roman period, estimates put the mean yearly increase in precipitation for the region at not more than 50 mm with a slight rise in the number of rainy days per annum (Rubin 1989; Patrich 1995). For the central Negev region, Nevo (1991: 4) cites a 10-15% increase in rainfall which translates into 100-105mm compared to the 88mm per annum received at present in this area. Thus, despite some evidence for cooler and wetter climatic conditions, there is no basis to assume an increased annual precipitation of great magnitude.

The answer appears to be that the natural carrying capacity of the region was greatly increased through the local development of a unique and inventive form of water management, many of whose features may first have been developed by the Nabataeans (Evenari *et al* 1982; Lindner 1987; Fiema 1991; Oleson, 1997, 2001; Huotari, 2002; see Nevo, 1991 for a different interpretation of many of these finds). The Roman-Byzantine landscape in the desert regions of the southern Levant is characterised by the presence of numerous installations for the conservation and exploitation of water. This entailed construction on the wadi flood plain and on the alluvial terraces of reservoirs, pools, dams, dykes, aqueducts, drainage channels, sluice gates, cisterns and support walls to control the drainage catchment (Mayerson 1962; Evenari *et al* 1982; Oleson 2001; Huotari 2002; but see Nevo 1991 for a different interpretation of many of these installations). The extent and size of these installations are unparalleled in the archaeological record of this region and attest to a sophisticated and large-scale form of water conservation and exploitation. Data presented by Evenari *et al* (1982: 95 ff.) indicates that through this method of run-off agriculture, an average rainfall of 100 mm could be transformed into an effective rainfall of 400 mm for cultivation. This system of water management would have enabled large-scale pig breeding year-round, as well as extensive cultivation of orchards, vineyards and cereals (Evenari *et al* 1982; Rubin 1996). Indeed, some 25% of entries in the Nessana papyrus, dating to the 6-7th centuries AD, deal with agricultural issues and attest to cultivation of wheat and barley (Mayerson 1962), while archaeological installations include wine and olive presses implying local cultivation of these plants. Bruins (1994) has however claimed that given the evidence for aridity combined with a large sedentary population during the Byzantine period, local run-off farming would not have been able to meet the demands for food. Consequently, importation of supplementary food supplies from outside the region would have been necessary combined with imperial subsidies for agriculture. However, as already discussed above (section on *Geographic Variation in Pig Frequencies*) there is ample archaeozoological evidence to indicate that pigs were raised locally. Thus, the physical conditions necessary for swine raising in the desert zones of the southern Levant, appear to have been met from the early Roman period onwards.

Based on the data presented in Table 1a, b and Fig. 2, it is clear that there is a geographic component to the abundance of pig remains in archaeological sites, with many more remains recovered from sites located in the more mesic northern, Mediterranean zone than in sites situated in the arid east or south. This is undoubtedly related to the physiological requirements of this species, with the Mediterranean region more amenable to pig keeping than the arid regions, despite increased rainfall and improved hydraulic technology.

Site Function and Pig Frequencies

The impact of both the “Centralised Political” and the “Class” model on pig exploitation in the past may be assessed through examination of pig frequencies in sites of different size and function. In order to examine these issues and to maintain sample sizes at a viable level, the sites used in this study were divided into broad functional categories (Table 1a, b): *urban sites* which includes both cities and towns; *rural sites* which pertains to a wide diversity of rural settlement types - villages and farms- which differ in size, type and internal composition (see Safrai 1994 and Hirschfeld 1997 for a definition of the different settlement types); *military sites* which refer to forts, garrisons and watch-towers; *ecclesiastical sites* which comprise monasteries and church complexes.

It is claimed that the diet of Roman soldiers in the provinces was usually richer in meat than that of the local population (King 1984; Safrai 1994; Toplyn 1994). This as they represent both an elite class, as well as not being directly involved in supplying markets. In contrast to the model, in both the Roman and Byzantine periods the military forts of the *Limes Arabicus* in eastern Jordan (Lejjun, Qasr Bshir, Rujm Beni Yassar) and En Boqe along the Dead Sea have low numbers (less than 4%) of pig remains (Table 1a, b). With respect to the Jordanian sites, Toplyn (1994) concluded pigs constituted only a supplementary meat source and were probably bred in order to provide surplus meat with caprines providing the bulk of animal protein. However, the Byzantine fort of Upper Zohar, also on the Dead Sea, yielded 13% pig remains while the fort of Dajaniya in eastern Jordan yielded 17% (Fig. 2), such that there is a large degree of intra-site variation in this feature.

Historical sources attest to the fact that during the Byzantine period pigs were raised in Palestinian monasteries (Avi Yonah 1958). However based on the three ecclesiastical sites which fall in this category, it is evident that few pigs are represented (less than 10%) (Table 1a, b). Moreover, pig frequencies vary between samples and constitute 9.5% at Deir Ain Abata and 1.9% at Jabal Harun both representing monasteries, and 4.9% at Horvat Karkur, a Negbite church and its associated structures (Fig. 2).

In contrast to the subsistence base of the western part of the Romano-Byzantine empire which was founded on large agricultural estates, the eastern provinces such as the southern Levant, were predominantly composed of rural settlements. The latter constituted villages and small farms. Following the “Centralised Political hypothesis” outlined by Hesse and Wapnish (1996; 1998), one would perhaps expect to find a high frequency of pig remains in rural sites. However, rural and urban sites in the southern Levant show a similar broad range of variation in this parameter (Table 1a, b). For example, in Byzantine urban settlements, swine remains range from 0% (City of David) to 28% (Petra and Sepphoris) of the assemblage, while Roman period sites range from 0% (City of David) to 69.6% (Umm Qeis) (Fig. 2). Even when urban sites with different functions are compared such as Sepphoris and Bet Shean which according to Classical literary sources engaged in agriculture, as opposed to Jerusalem (City of David) and Caesarea which were large commercial centres with most of the produce being imported (Safrai 1994), no consistent pattern is found. Thus agricultural producers such as Byzantine Sepphoris has 28% pigs compared to 13% at Bet Shean while in the same period the commercial port of Caesarea yielded 51% pigs and the City of David none (Fig. 2). These results are surprising considering that these prosperous urban centres, with their cosmopolitan populations, would have served as equally fertile ground for cultural assimilation and the adoption of Roman and subsequently Byzantine culture (Toplyn 1994). These data indicate that site function *per se* did not play a critical role in determining the extent and nature of pig keeping/ consumption in the sites and periods under discussion.

Diachronic Changes in Pig Frequencies

As illustrated in Fig. 2, in both the northern Mediterranean and arid southern zones there is a significant increase in the frequency of pigs in the Byzantine period relative to the preceding Roman period ($P < 0.00$) (Table 2). Given that the climate during the Roman period was supposedly wetter than the Byzantine period, and hence more amenable for the raising of swine, this result is unexpected. Furthermore, pig exploitation in the Roman period is expected to have been high as archaeo-zoological

research indicates that the Romanization of the colonies was associated with increased pork consumption (e.g. White 1970; Bökönyi 1974; King 1984, 1999; Peters 1998). According to King (1984) this was due both to the physical presence of Romans and Roman armies in the region as well as through 'dietary emulation' by local communities wishing to be acculturated. It is beyond the scope of this paper to examine the extent of pig consumption in pre-Roman periods in the Levant. However the significantly higher levels of pork consumption in the Byzantine period needs to be accounted for.

Climatic factors such as increased rainfall need to be discounted as there is no documentary evidence to support this, and if anything, the Byzantine period was drier than the preceding one (Nevo 1991; Bruins 1994; Issar 1998; Rosen 2000). Similarly, improved hydraulic technology is characteristic of both the Roman and Byzantine Levantine communities (Mayerson 1962; Evenari *et al* 1982; Huotari 2002; Rosen 2000; Oleson 2001). Finally, site function does not appear to have played a role as a similar increase in pig frequencies is observed for all Byzantine sites irrespective of type or size (Table 1a, b). Indeed, Toplyn (1994) noted that compared to Roman military sites in Europe, those in the Levant have markedly lower pig frequencies. One of the factors raised by Toplyn to account for this is that the military force occupying these forts may have been composed of "indigenous ethnic Arabs" who are known to have served on the eastern front but appear not to have consumed pork (Toplyn 1994: 651).

During the Roman and Byzantine periods, the population of the southern Levant was extremely diverse and comprised people of different ethnic backgrounds - both colonials and a variety of local communities, as well as people of different religious persuasions - pagans, Christians and Jews (Sperber 1978; Safrai 1994; Patrich 1995; Parker 1999; Freeman 2001; Watson 2001). Toplyn (1994: 653) cites several textual sources, such as Pliny and Saint Jerome, which discuss the absence of pigs in the diet of pre-Islamic Arab communities in the region. This is clearly stated in a quote from the fifth century Church historian Sozomen on the origins of the Saracens - "they practice circumcision like the Jews (and) refrain from the use of pork" (quoted in Toplyn 1994: 653). Thus, it is possible that despite official attempts to disseminate Roman culture in the southern Levant, local prohibitions against consumption of pigs (for Jews) and the absence of pigs in nomadic pre-Islamic economies, curtailed swine exploitation in the region (Toplyn 1994: 652-3; Safrai 1994). The relatively low number of pigs in the Roman period is reflected in the high price it commanded at this time; 8 *maneh* for beef compared to 10 *maneh* for pork (Sperber 1978).

During the Byzantine period, the Levant became the focus of religious activities which included the erection of churches and monasteries accompanied by the influx of Christians into the region (Avi-Yonah 1958; Tsafrir 1995; Broshi 1980; Parker 1999; Watson 2001). Thus, increased consumption of pig in the Byzantine period may be primarily attributed to the growth of Christian communities in the area and is a reflection of their food preferences. Unlike Jews, they were permitted to consume pork following doctrinal innovations by St. Paul (e.g. The Acts 21: 21 "*thou teachest all the Jewsto forsake Moses, saying that they ought not to circumcise their children, neither to walk after the customs*"). It should be noted that in the south, aside from the ecclesiastical sites such as Deir Ain Abata and Jabal Harun, many of the Byzantine towns (Nessana, Avdat and Mamphis) were Christian in character (Shershetski 1991; Rubin 1996). The augmented number of pig remains in these sites may then be perceived as an ethnic stamp.

Safrai (1994: 172-173) notes that although the Old Testament forbids the consumption of pork by Jews, it was the Rabbis who forbade its breeding in Palestine. There is evidence from the Roman period that Jews did engage in swine herding due to Talmudic and other texts that deal with their breeding, sale and claims for compensation following damage caused by pigs (Safrai 1994: 172-173). Sites identified as containing a predominantly Jewish population often contain few or no pig remains, for example the City of David, Qumran, Qasrin (Table 1a, b) and the rural sites of Sumaqa and Horvat Raqit on Mount Carmel which contain mixed Roman/Byzantine material (Horwitz 1999, 2004a), which implies that although pigs may have been raised in some Jewish settlements, they were seldom if ever consumed.

It is clear then that ethnic considerations played a critical role in determining pig abundance during the Byzantine period in the Levant. Did this affect the exploitation patterns of other domestic species and if so in what manner? Sperber (1978) notes that breeding of sheep and goats was especially lu-

crative in the Roman period, while Broshi (1986) cites sources which state that cattle raising in Roman Palestine was minimal. Reasons for this are cited by him as due to shortages of grazing area and fodder, increased population size and the prohibition on slaughtering calves issued by Emperor Valens in order to protect cattle for agriculture labour. In this study we compared the abundance of cattle in the Roman and Byzantine periods (Table 3; Fig. 4) and found that in the southern sites they follow a similar trend to pigs with their frequencies increasing in all Byzantine sites ($P < 0.000$). An opposite trend is observed in the northern sites where the frequency of cattle decreases in the Byzantine period (Table 3). How can we account for this inverse trend ?

It is probable that as for pigs, even marginally improved climatic conditions together with sophisticated water management strategies in the southern regions facilitated cattle-keeping even in sites currently located in extremely arid areas. This trend began in the Roman period and increased in efficiency and hence scale in the Byzantine period. In contrast, in the northern Mediterranean zones “ the ecological equilibrium maintained by the ancient village system was superseded by the demands of an urban socio-economy generated by the expanding cities of the region” (Watson 2001: 463). Watson cites evidence for :

1. increased degradation of the land due to population growth and increased intensity of land-use resulting in erosion
2. maximal use of land and occupation of new marginal areas
3. encroachment upon traditional pasture zones which were converted for cultivation
4. deforestation of highland areas. For example at Pella and Deir Alla there is a shift from use of forest species for fuel to cultivated trees or ones growing naturally in the wadi's.

A similar thesis was developed by Fall (1990) and Toplyn (1994), who cite evidence for the abuse of natural resources in the Byzantine period such as deforestation and erosion. Furthermore, based on the large size of sheep from the Roman military sites along the eastern frontier of (Jordan), Toplyn (1994) advanced the idea that specialised breeds were imported into the region, a process which accelerated overgrazing and denuded the landscape.

It is argued here, that the observed decrease in cattle frequencies in most northern sites is associated with this environmental crisis which began in the Roman period and resulted in a loss of open grazing areas at the expense of agricultural land. Consequently, fewer cattle were kept in the Byzantine period. This contradicts Reddings model (1991) where intensified investment in agriculture is expected to be accompanied by an increase in cattle frequencies due to their use as beasts of burden in agriculture. It is proposed here that in the Byzantine period equids, especially donkeys, probably fulfilled this role, while in sites located in the arid regions, camels may have substituted. Sheep and goat numbers remain relatively constant in both periods and these species continued to serve as the primary sources of meat, milk, wool and hair. The keeping of greater numbers of pigs offered a solution to the environmental crisis as this species is an even more efficient supplier of animal protein and requires less pasture area than cattle, and may consume a broader variety of resources.

During the Romano-Byzantine period, meat was expensive and hence a luxury item. According to Dauphin (1999), in the Byzantine period the high cost of red meat may be directly related to the scarcity of cattle. Fish and poultry, which increased markedly in importance in the Byzantine period - as well as pork for non-Jews - may then have filled this vacuum (Broshi 1986; Dar 1995; Dauphin 1999). Literary sources indicate that only wealthy Jews could afford to consume meat even on the Sabbath and on festivals, and the majority of people subsisted on a vegetarian diet comprising cereals (especially bread), legumes, olive oil, vegetables and fruit (Broshi 1986; Dar 1995; Dauphin 1999).

Based on the data presented here it is evident that pig exploitation in the Classical era was determined by a range of inter-related factors: geographic, ideological and economic. The diachronic increase in importance of swine illustrated in all sites in the region was associated with the specific convergence in the Byzantine period of several factors: slightly higher rainfall than at present and the wide-scale application of hydraulic technologies, development of large urban centres, increased numbers of Christians in the region as well as reduced pasturage and concomitant decrease in the number of cattle in the Mediterranean region.

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