Mammals in the economy of ancient Porphyreon (Lebanon)

Joanna Piątkowska-Małecka
Institute of Archaeology, University of Warsaw

Abstract: An archaeozoological analysis of mammal remains recovered from the dwelling units and streets of ancient Porphyreon excavated in 2009, 2010 and 2012, gives insight into the importance of mammals for the residents of this quarter in succeeding periods: from the Iron Age through the Persian and Hellenistic periods to Byzantine times. Husbandry lay at the base of the animal economy and was supplemented with hunting various species of gazelle. Cattle, sheep and goat were the most numerous livestock species represented in the archaeological record. The high percentage of cattle observed in Iron Age deposits could have resulted from the agricultural lifestyle of the population. Starting from the Persian period, sheep and goat played the most prominent role in the animal economy, implying a pastoral model of husbandry. Raising goats for meat was more significant initially; from the Hellenistic period onwards, the number of sheep reared for milk and wool increased. Pigs constituted a minor percentage of the livestock. The presence of equid remains, including horse and donkey, was confirmed for the Persian period, when these animals were used for transportation.

Keywords: Levant, archaeozoology, animal husbandry, hunting, pastoralism

The town of Jiyeh is located on the coast of the Mediterranean Sea, halfway between Berytus and Sidon. Ruins of an ancient city identified as Porphyreon on the grounds of archaeological evidence and written sources, are located in the central part of the modern town. Its convenient location and favorable climate conditions enhanced settlement, from the Bronze Age through the 7th century AD (Waliszewski and Wicenciak 2015).

The first archaeological exploration of the site was conducted in the second half of the 19th century and in the first half of the 20th century (Renan 1864: 513; Contenau 1920: 295). Studies were undertaken again in 1975 by a team from the Lebanese Directorate General of Antiquities under the supervision of Roger Saidah (1977). After a break of two decades, the work was resumed in 1997 as an archaeological project of the Polish Centre of Mediterranean Archaeology of the University of Warsaw conducted in cooperation with the Lebanese Directorate General of Antiquities; the project is headed by Tomasz Waliszewski from the Institute of Archaeology, University of Warsaw and

is still in progress (Waliszewski et al. 2008). The research over the last 20 years has involved four sectors: a residential quarter (sector D), basilica (sector Q), necropolis (sector A) and an area where pottery was produced (sector B) (Waliszewski et al. 2008; Waliszewski and Gwiazda 2015) [*Fig. 1*]. Excavations have yielded a rich assemblage of finds, including animal remains, which are the subject of this paper. The archaeozoological analysis of this material has served as a base for reconstructing the meat diet as well as the activities involved in the animal economy in terms of mammal husbandry and hunting in ancient Jiyeh from the Iron Age to the Byzantine period.

Fig. 1. Plan of the residential quarter (sector D), marking rooms which yielded faunal remains; inset, location of the site in modern Jiyeh (PCMA Jiyeh Project/drawing M. Puszkarski, J. Juchniewicz, M. Gwiazda)

MATERIAL AND METHODS

Post-consumption animal bone remains and teeth constituted the material for analysis. The post-consumption nature of the assemblage is implied by the state of preservation as well as surface marks. The bones are in the form of flaky fragments and show extensive marks associated with the preparation of meat for consumption and culinary processing. They were recovered from cultural layers identified in the late ancient residential quarter (sector D) in the course of excavations conducted in three seasons: 2009 (Waliszewski, Juchniewicz, and Gwiazda 2012), 2010 (Waliszewski and Gwiazda 2013) and 2012 (Waliszewski et al. 2015). Remains from earlier seasons (1997, 1998 and 2004) were not associated with particular periods, and the remains unearthed in 2013 and 2014 have not been identified yet.

The bone material was collected manually. This may well have influenced the relatively low number of remains of small animals and fishes as the significance of fishing, estimated solely based on the number of ichthyological remains, does not appear to reflect the actual situation. The location of the site in the immediate vicinity of the Mediterranean Sea and close to rivers, Nahr Damour in the north and Nahr Awwali in the south, flowing into the sea, suggests a bigger share in the general animal economy of the site, as do the artifacts connected with fishing that have been recovered from the site (Szulc-Kajak 2013; Gwiazda 2014: 37).

Sparse fish and bird remains were omitted from the analysis even as mammal bones from contexts of established chronology were included.[1] They were discovered in the area of the residential quarter, in several rooms numbered 4, 20, 23, 47, 72 and 101, and two streets, 115 and 116 [see ***Fig. 1***]. The remains were assigned to stratigraphic units of established chronology. Four horizons were distinguished: Iron Age (8th–7th century BC), Persian (6th–4th century BC), Hellenistic (3rd–2nd/1st century BC) and Byzantine (5th–6th/7th century AD). Part of the material came from mixed layers, representing a widely distributed chronology; they were included in the general statistics [***Table 1***] but ignored in the detailed studies. Each distinguished period was analysed separately and then the results were compared to trace possible changes of mammal significance in the economy over time. A planigraphic analysis was not possible due to the generally low number of remains associated with particular periods and their recovery from different areas.

Animal remains were identified to the level of species and skeletal elements. Identification of species involved association of fragments with particular animal species. For each of the four periods, the number of remains was estimated using the NISP method. The number of identified bone fragments was counted and within this group the bones of wild mammals, equids which could include domesticated and/

[1] Dr. Mariusz Gwiazda assigned identifiers of the bone material to the stratigraphic units distinguished at the site and thus identified the chronology of particular assemblages. I would like to thank him for that effort; without his work and patience in answering my questions, this analysis would not have been possible.

Table 1. Animal remains discovered in the residential district at Jiyeh

Context	Street 115	Street 116		Room 4			Room 20		Room 23		Room 47	Room 72			Room 101
Chronology	BYZ	BYZ	MIX	IA	BYZ	MIX	IA	PER	HEL	MIX	MIX	PER	HEL	MIX	BYZ
Cattle	–	6	17	–	–	1	50	5	19	3	14	20	16	1	–
Sheep/goat	5	33	61	–	1	84	39	19	104	14	215	81	73	11	13
Sheep	–	–	2	–	–	1	1	2	2	1	7	9	2	–	–
Goat	–	–	3	–	–	4	1	1	2	–	8	14	–	–	1
Pig	–	4	10	4	–	–	8	–	1	–	24	11	1	–	2
Equid	1	–	–	–	–	–	–	6	–	–	2	–	–	–	–
Donkey	–	–	1	–	–	–	–	–	–	–	10	10	–	–	–
Gazelle	1	–	–	–	–	–	1	1	2	–	13	1	2	–	–
Bird	1	6	8	–	–	1	1	–	3	–	7	1	3	3	1
Fish	–	5	–	–	1	1	2	–	10	–	6	8	3	–	1
Turtle	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Shell	–	–	1	1	–	2	–	1	–	–	2	–	–	–	2
Unidentified	–	26	58	3	–	280	15	6	36	5	127	82	52	9	11

Key: IA – Iron Age, PER – Persian, HEL – Hellenistic, BYZ – Byzantine, MIX – mixed layers

or wild forms, and domestic species were distinguished. Percentages of bones of cattle, of sheep and goat counted together, as well as pig, were calculated for the group of domestic animals, providing grounds for estimating the importance of particular groups and species in husbandry and hunting. Small ruminant bones were distinguished as a joint group of sheep/goat due to problems with identification, although certain diagnostic elements can be used to identify species as set down by Z. Schramm (1967) and by Melinda Zeder and Heather Lapham (2010), permitting some differential identification.

Anatomical identification involved attribution of fragments of particular species to indicated skeletal elements. In the case of remains of small ruminants recovered from layers dated to the Persian and Hellenistic periods, anatomical distribution was also analysed. For this purpose, elements were combined into groups of similar value for consumption. Carcass parts of low value for consumption include the head (skull, mandible and teeth[2]), and distal parts of the forelimb and hind limb (carpal, metacarpal and metatarsal bones, as well as phalanges, which constitute a separate group). Parts of carcass of high value include osteological elements forming the thorax, i.e., vertebrae and ribs, as well as proximal parts of the forelimb (scapula, humerus, and radius with ulna) and hind limb (pelvis, femur, tibia with fibula). Percentages were calculated for each group and compared with the standard distribution, i.e., the one actually found in the skeleton (Lasota-Moskalewska 2008). The low number of remains (below 100) of each species did not allow the anatomical distribution of sheep and goat, as well as cattle and pig remains from other periods to be analyzed.

The age of the animals was established on the basis of epiphyseal fusion and teeth development (Kolda 1936; Lutnicki 1972; Silver 1969). For each species, bones and teeth of animals killed at a young age, before they reached morphological maturity, i.e., younger than 3.5–4 years old, were distinguished. In some cases, it was possible to identify bones and teeth of very young animals, younger than one year of age. If the number of remains of a species exceeded 100 in a given chronological phase, the ratio of bones of juvenile individuals to all individuals was calculated. This criterion was met in the case of bones of small ruminants recovered from layers dated to the Persian and Hellenistic periods.

The sex of animals was established on the basis of distinctive features: the shape and size of horncores in the case of sheep (Lasota-Moskalewska 2008: 166). Measurements were taken according to a method presented by von den Driesch (1976). The results of some measurements were exploited for a reconstruction of the morphology of livestock species. A 100-point scale was used for cattle; the values of breadth measurements of some bones were plotted against calculated point values (Lasota-Moskalewska 1984). Additionally, the withers height of sheep was calculated on the basis of Teichert's (1975) coefficients. Marks found on the surfaces of some bones were examined and analyzed.

[2] Teeth do not belong to the skeleton but were subjected to archaeozoological analysis nonetheless.

ASSEMBLAGE

The total number of bone remains and teeth discovered in the course of three seasons in the residential quarter at Jiyeh was 1940. Of these, 1230 (63.4%) were identified to the level of species and skeletal element. The preservation of the material was rather poor; many fragments were devoid of features indicative of species or place in the skeleton. Apart from that, a significant number came from mixed layers with a very broad chronology [see ***Table 1***]. The identified fragments were categorized according to four chronological horizons: Iron Age, Persian, Hellenistic and Byzantine. The representation of bone remains in these groups differed in number, thus affecting the reliability of the results. Layers from the Persian and Hellenistic periods yielded the most data, which made it possible to reconstruct the importance of mammals in diet and economy. The least information came from layers dated to the Byzantine period. As a consequence, the results are relatively uncertain and should be treated with caution until confirmed by further research.

IRON AGE (8TH–7TH CENTURY BC)

The layers from this period, found in rooms 4 and 20, contained 122 osteological fragments, out of which 104 (85.2%) were identified. All remains, except for a gazelle tibia, belonged to domesticated species. Cattle bones were the most numerous (48.5%), followed by small ruminant bones (39.9%), and pig bones the lowest of all (11.7%) [***Table 2***]. The remains represented various anatomical parts [***Table 3***], but their low number overall excluded an anatomical distribution.

Nearly half of the remains of cattle belonged to animals slaughtered before the age of four (22 out of 50 fragments). Slightly different proportions were observed in the case of small ruminants: bones of young individuals constituted approximately a fourth of all the remains of these species (11 out of 41 fragments).

Table 2. Species composition of animal remains discovered in the residential district at Jiyeh

Taxon	Iron Age		Persian		Hellenistic		Byzantine	
Cattle	50	48.5%	25	11.0%	35	15.1%	6	9.2%
Sheep/goat	39	37.9%	166	72.8%	185	79.7%	52	80.0%
Sheep	1	1.0%	11	4.8%	4	1.7%		0.0%
Goat	1	1.0%	15	6.6%	2	0.9%	1	1.5%
Pig	12	11.7%	11	4.8%	6	2.6%	6	9.2%
Livestock (total)	**103**	**100.0%**	**228**	**100.0%**	**232**	**100.0%**	**65**	**100.0%**
Equid	–	–	16	–	–	–	–	–
Gazelle	1	–	2	–	4	–	1	–
Unidentified	18	–	88	–	88	–	37	–

Almost all of the relatively sparse pig bones came from young animals, between one and four years old (10 out of 12 fragments). It was not possible to establish the sex of the animals.

Two measurements of the distal end of metatarsal cattle bones were taken and plotted on a 100-point scale, the resulting values correspond to 6 and 25 points [*Table 4*]. This means that the individuals represented little variety. Withers height of sheep, calculated on the basis of the length of a metacarpal bone, reached 55.2 cm. This value indicates a small form of the sheep.

Table 3. Skeletal elements of animal remains in the Iron Age and Persian period layers at Jiyeh

	Iron Age				Persian				
Skeletal element	**Cattle**	**Sheep/goat**	**Pig**	**Gazelle**	**Cattle**	**Sheep/goat**	**Pig**	**Equid**	**Gazelle**
Horncore	–	–	–	–	1	9	–	–	–
Cranium	3	–	3	–	2	4	3	–	–
Mandible	3	5	–	–	1	9	1	1	–
Teeth	2	2	1	–	1	9	–	5	–
Vertebrae	6	5	2	–	6	30	–	–	–
Ribs	12	11	1	–	3	45	3	1	–
Scapula	1	4	–	–	2	14	–	1	–
Humerus	–	2	1	–	–	7	–	2	–
Radius	2	–	1	–	1	14	–	1	1
Ulna	2	–	–	–	–	2	–	–	–
Carpals	2	–	–	–	1	–	–	–	–
Metacarpals	1	2	–	–	1	1	–	–	–
Pelvis	1	–	–	–	–	3	1	–	–
Femur	1	5	1	–	–	16	1	1	–
Tibia	3	4	–	1	4	10	–	1	–
Fibula	–	–	–	–	–	–	–	–	–
Talus	1	–	–	–	–	–	–	1	–
Calcaneus	1	–	–	–	2	5	–	–	–
Tarsus	2	–	–	–	–	–	–	–	–
Metatarsals	2	–	–	–	–	3	–	–	–
Phalanx I	–	1	–	–	–	3	2	1	1
Phalanx II	2	–	–	–	–	–	–	–	–
Phalanx III	2	–	–	–	–	1	–	–	–
Metapodium	1	–	2	–	–	7	–	1	–
Long bone	–	–	–	–	–	–	–	–	–
Total	**50**	**41**	**12**	**1**	**25**	**192**	**11**	**16**	**2**

Table 4. Measurements of animal remains discovered at Jiyeh

Chronology	Species	Anatomical elements	Measurement	mm	Points	WH (cm)
Iron Age	Cattle	Metatarsal	Bd	40, 47	6, 25	–
	Sheep	Metacarpal	GL-Bp-Bd-SD	113-23-18-14	–	55.2
Persian period	Cattle	Phalanx I	GL-Bp-Bd	62-26-25	55	–
		Metacarpal	Bd	54	40	–
	Sheep	Horncore	circumference	115	–	–
		Scapula	SLC	30	–	–
		Humerus	Bd-BT	34-33, 37-35	–	–
		Radius	Bp	21	–	–
		Radius	Bd	29	–	–
		Pelvis	LA	27	–	–
		Tibia	Bd	30	–	–
		Phalanx III	DLS-Ld-HP	38-34-22	–	–
	Goat	Scapula	SLC	21	–	–
		Radius	Bp	32, 34	–	–
		Tibia	Bd	28	–	–
	Donkey	Talus	GB-GH	40-41	–	–
	Horse	Humerus	Bp	56	–	–
		Phalanx I	GL-Bp-Bd-SD/DD	98-45-42-24/26	–	–
	Gazelle	Radius	Bd	36	–	–
Hellenistic period	Cattle	Metatarsal	Bd	48	60	–
		Phalanx I	GL-Bp-Bd	42-27-23	5	–
		Phalanx II	GL	36	–	–
	Sheep	Scapula	SLC	18	–	–
		Humerus	Bd-BT	38-35	–	–
		Radius	Bp	39	–	–
		Talus	GLI-GLm-Bd	29-29-19	–	65.7
		Phalanx I	GL	38, 38, 40	–	–
	Goat	Humerus	Bd-BT	35-34	–	–
		Talus	GLI-GLm-Bd	31-29-20, 29-28-29	–	–
		Phalanx I	GL	39	–	–
	Gazelle	Talus	GLI-GLm-Bd	26-25-18	–	–
		Phalanx I	GL	46	–	–

PERSIAN PERIOD (6TH–4TH CENTURY BC)

The material dated to the Persian period was recovered from two rooms, units 20 and 72. The total number of remains reached 334 bone fragments and teeth, out of which 246 (73.6%) were identified. Most of the material came from livestock species (92.7%); relatively few fragments belonged to different species of gazelles (0.8%) and equids (6.5%). The latter included bones of two species that differed in terms of size, most likely donkey and horse [see ***Table 2***]. Most of the domestic animals represented were small ruminants (84.2%), with slightly more goats than sheep. Cattle were the second most represented species (11.0%), and pig the third (4.8%).

Various parts of the skeleton were found in the material [see ***Table 3***]. In the case of sheep and goat remains, it was possible to perform an analysis of anatomical distribution. All skeletal elements were represented, including phalanges. Bones that are associated with high yields of meat were the most numerous. In comparison with the standard distribution, bones of the proximal parts of both limbs were overrepresented (forelimb 19.3%, hind limb 15.1%) and phalanges were underrepresented (2.1%). Other elements were found in proportions corresponding to the standard distribution [***Table 5***].

Cattle and pig bones included four fragments which came from individuals slaughtered at a young age. The percentage of remains of young individuals among sheep and goat reached 15.6%. Two fragments of equid bones belonged to animals that died before the age of four. The sex was established in one case, based on a sheep horncore belonging to a female.

Table 5. Anatomical distribution of sheep and goat remains (counted together) recovered from the Persian and Hellenistic period layers at Jiyeh

Anatomical part	Persian		Hellenistic		STANDARD
Head	31	16.1%	39	20.4%	20%
Thorax	75	39.1%	85	44.5%	43%
Forelimb, proximal part	37	19.3%	26	13.6%	5%
Forelimb, distal part	6	3.1%	4	2.1%	8%
Hind limb, proximal part	29	15.1%	23	12.0%	3%
Hind limb, distal part	10	5.2%	8	4.2%	7%
Phalanges	4	2.1%	6	3.1%	14%
Total	**192**	**100.0%**	**191**	**100.0%**	**100%**

Key:
Bd – greatest breadth of the distal end, GL – greatest length, Bp – greatest breadth of the proximal end, SD – smallest breadth of diaphysis, SLC – smallest length of the Collum scapulae, BT – greatest breadth of the trochlea, LA – length of the acetabulum including the lip, DLS – greatest diagonal length of the sole, Ld – length of thedorsal surface, HP – height in the region of the extensor process, GB – greatest breadth, GH – greatest height, DD – smallest depth of the diaphysis, GLI – greatest length of the lateral half, GLm – greatest length of the medial half, WH – withers height

More than ten bone fragments were measured [see *Table 4*]. The measurements of the length of phalanx I and the breadth of the proximal end of a metacarpal bone of cattle were plotted on a 100-point scale, which yielded 55 and 40 points respectively. It means that the individuals that they came from were middle-sized.

HELLENISTIC PERIOD (3RD–2ND/1ST CENTURY BC)

Rooms 23 and 72 contained layers from the Hellenistic period with faunal remains; 324 bone fragments and teeth were recovered. Of these, 236 (72.8%) pieces were identified to the level of species and skeletal element. Apart from fragments of a humerus, talus, metatarsal and phalanx I of an unidentified gazelle species, all other remains came from domesticates. Bones of small ruminants constituted a significant majority (82.3%) [see *Table 2*], with more sheep than goat. Cattle bones were much less represented (15.1%), and pig remains were very sparse (2.6%).

Domestic species were represented by various anatomical elements [*Table 6*]. An analysis of anatomical distribution was performed for sheep and goat remains [see *Table 5*]. It can be concluded from the results of the analysis that the assemblage of small ruminant bones comprised all parts of the body, including phalanges. The latter were underrepresented in comparison with the standard distribution (3.1%). Moreover, the proximal parts of the forelimb (13.6%) and hind limb (12.0%) were overrepresented. The remaining parts of the body were found in percentages comparable to the standard distribution.

There were no bones of young animals among the cattle and pig remains. The percentage of remains of young sheep and goat slaughtered before reaching the age of four reached 5.7%. The sex was not established.

Measurements of two fragments of cattle bones (breadth of the proximal end of the metacarpal and length of phalanx I) were taken, and the values were plotted on a 100-point scale, corresponding with 5 and 60 points [see *Table 4*]. It implies that the animals were of small or medium size. The withers height of sheep was calculated on the basis of the length of a talus bone which reached 65.7 cm.

BYZANTINE PERIOD (5TH–6TH/7TH CENTURY AD)

Bone material from layers dated to the Byzantine period was recovered from rooms 4 and 11, as well as streets 115 and 116. In total, there were 103 fragments of bones and teeth; 66 items (64.1%) were identified to the level of species and skeletal element. Among the identified remains, there was a fragment of the shaft of a gazelle radius and bones of domestic mammals, mainly sheep and goat (81.5%), with fewer fragments of cattle and pig (9.2% each) [see *Table 2*]. Various parts of the skeleton of domestic animals were represented [see *Table 6*]. Sheep, goat, cattle and pig remains included bones of young individuals: four fragments in each case. There was no further data to be gleaned from an examination of this material.

Table 6. Skeletal elements of animal remains in the Hellenistic period and Byzantine period layers at Jiyeh

	Hellenistic				Byzantine			
Skeletal element	**Cattle**	**Sheep/goat**	**Pig**	**Gazelle**	**Cattle**	**Sheep/goat**	**Pig**	**Gazelle**
Horncore	–	–	–	–	–	1	–	–
Cranium	3	9	1	–	–	3	1	–
Mandible	–	10	–	–	–	1	–	–
Teeth	1	20	1	–	1	6	1	–
Vertebrae	7	21	–	–	2	6	1	–
Ribs	10	64	1	–	1	19	–	–
Scapula	3	10	–	–	1	3	–	–
Humerus	1	6	–	1	–	–	1	–
Radius	4	10	–	–	1	4	–	1
Ulna	1	–	1	–	–	–	–	–
Carpals	–	1	–	–	–	–	–	–
Metacarpals	–	2	–	–	–	–	–	–
Pelvis	–	4	–	–	–	–	–	–
Femur	1	7	1	–	–	2	–	–
Tibia	–	12	–	–	–	4	–	–
Fibula	–	–	–	–	–	–	1	–
Talus	–	4	–	1	–	1	–	–
Calcaneus	–	–	–	–	–	–	–	–
Tarsus	–	1	–	–	–	–	–	–
Metatarsals	1	3	–	1	–	2	–	–
Phalanx I	1	5	1	1	–	1	1	–
Phalanx II	2	1	–	–	–	–	–	–
Phalanx III	–	–	–	–	–	–	–	–
Metapodium	–	1	–	–	–	–	–	–
Long bone	–	–	–	–	–	–	–	–
Total	**35**	**191**	**6**	**4**	**6**	**53**	**6**	**1**

SPECIES COMPOSITION

Remains of livestock species constituted a majority in the four chronological horizons. Only sparse, isolated bone fragments belonged to wild mammals, in this case some unidentified species of gazelles and antelopes. Remains of equids, which included horse and donkey bones, were found exclusively in layers from the Persian period. In all chronological phases, livestock species were mainly represented by sheep and goat bones, reaching approximately 80%. Cattle remains were the second most numerous in the material, amounting to approximately 12%. Pigs were the rarest among livestock, with approximately 8% of all remains. The Iron Age was the only exception to this tendency with nearly half of the material being composed of cattle bone fragments, sheep and goat remains were the second most represented and pig bones were found in the lowest number [*Fig. 3*]. Nevertheless, it must be remembered that Persian and Hellenistic period material delivered the most reliable data. No significant differences in the distributions of the species between these chronological phases were noted.

MARKS ON BONES

Some anatomical elements recovered from layers associated with different chronological horizons, mostly belonging to domestic animals, but not excluding wild species, bore consumption-related marks. These were, above all, chopping and cutting marks, most likely connected with the division of carcass into smaller fragments

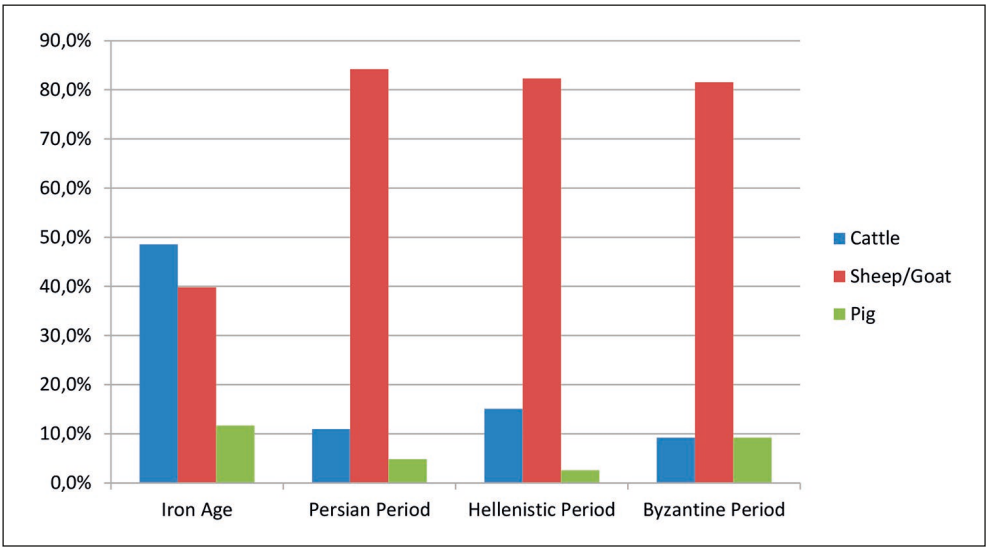

Fig. 3. Comparison of percentages of livestock species in different periods

Fig. 4. Consumption-related marks on bones: top left, fragment of a cattle humerus with chopping marks across the shaft above the distal end, cut marks on the surface of the distal; top right, fragment of the distal end of a sheep or goat metapodium with cut marks; bottom, fragment of a goat horncore with marks of chopping off from the skull (PCMA Jiyeh Project/photos M. Bogacki)

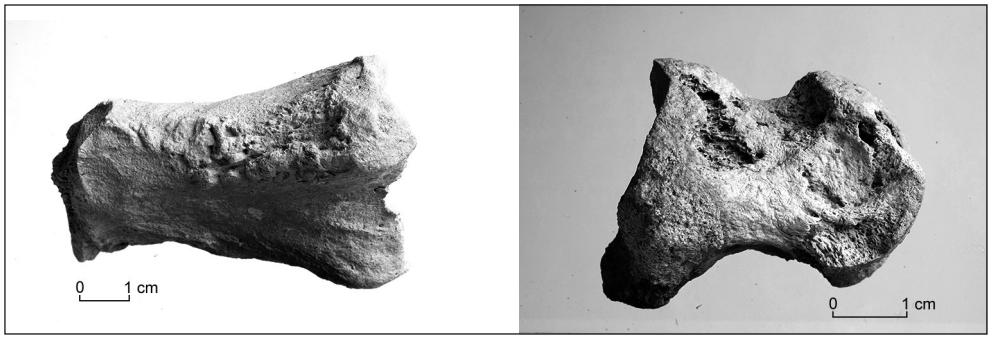

Fig. 5. Marks on bones: left, pathological changes on the shaft of a horse phalanx I; right, marks of demineralization on a cattle phalanx II (PCMA Jiyeh Project/photos M. Bogacki)

in the course of preparation (of meat) for consumption. Long bones were chopped longitudinally and transversely, across the shafts. Marks of this provenance were relatively frequently found on rib fragments and long bones representing proximal parts of the forelimb and hind limb [***Fig. 4*** top left]. They were observed much less often on other anatomical elements, such as cranial bones and distal parts of the limbs [***Fig. 4*** top right]. This type of marks was also noticed on horncores of small ruminants, which were cut off the skulls [***Fig. 4*** bottom]. Apart from cutting and chopping, some bone fragments, together with meat, were subjected to thermal processing, roasting in this case as attested by the black color of some of the long bones.

Pathological changes were also observed. Increased growth of bone tissue on the shaft near the proximal end was noted on phalanx I of a horse [***Fig. 5*** left]; it constituted most probably remains of a so-called osteophyte. A growth of this type usually emerges as a consequence of an injury or uneven distribution of pressure on the limbs (Lasota-Moskalewska 2008). Its development involves bleeding from the injured periosteum and production of a scarring substance, which forms an osteophyte after healing. A pathology of this kind might lead to lameness and locomotor dysfunction. Decreased bone porosity observed on a cattle phalanx II [***Fig. 5*** right] from the Persian period layers could also be associated with pathological changes, formed most likely as a result of strong demineralization of the bone, although various depositional factors could have also had an influence. Were this so, however, it should have been observed on a higher number of bone fragments, hence seems less likely.

The bone remains showed no marks of gnawing by carnivorous animals. This suggests that kitchen waste was collected and deposited in waste pits or middens and buried without much ado.

IMPORTANCE OF MAMMALS IN THE ECONOMY

Domestic species, particularly livestock, constituted the base of the animal economy in ancient Porphyreon from the 8th/7th century BC to the 6th/7th century AD. Hunting wild animals to supplement the meat supply was of marginal importance. Unidentified species of gazelle (no horncores or cranial bones in the record precluded specific identification) were hunted and it is reasonable based on species recorded historically (see Horwitz, Tchernov, and Dar 1990; Bökönyi 1990; Vila 2004) to expect remains of Dorcas gazelle (*Gazella dorcas*), mountain gazelle (*Gazella gazella*) and goitered gazelle (*Gazella subgutturosa*). They differ in terms of body size and weight, as well as the size and shape of the horncores. The first two species are approximately 55–65 cm tall and weigh 15–20 kg, the third one is taller, reaching a withers height of 80 cm and weighing approximately 35–40 kg. Differently sized bones indicate the presence of diverse species (Harrison 1986; Tchernov, Dayan, and Yom-Tov 1986).

The mountain gazelle inhabited various biotopes; it was found in the mountains and foothills, and additionally on the coastal plains. This species, therefore, seems particularly available to the inhabitants of Porphyreon, a site on the coast of the Mediterranean Sea, yet close to the

Lebanese mountains, with a stretch of land approximately 2 km wide, used for agriculture. Polybius (5.69.1) describes the area adjacent to the site in the following manner: "At this part of the coast it is reduced by the slopes of Libanus to a small and narrow zone, and across this itself runs a steep and rocky ridge, leaving only a very narrow and difficult passage along the sea shore." It is surprising that the possibility of hunting wild mammals was exploited so sporadically and that the range of hunted animals was limited to different species of gazelle. Hunting habitually played an auxiliary role in the animal economy, but the range of hunted species was much broader at other sites. Apart from gazelles, other even-toed ungulates, such as red deer, roe-deer and fallow deer, as well as wild boar and bear were hunted (e.g., Horwitz, Tchernov, and Dar 1990; Bökönyi 1990), and thus more diverse natural environments were exploited. Remains of other species, for instance, hippopotamus (Davis 1985) and lion (Wapnish 1997), can be found sporadically.

Ruminants, that is, sheep, goats and cattle, played a major role in animal husbandry. The two species of small ruminants functioned as the most important livestock group in the Persian, Hellenistic and Byzantine periods. Earlier, in the Iron Age, these animals were the second most represented group of livestock after cattle. The superior role of cattle is usually associated with well-developed agricultural practices and the use of these animals for traction in the course of farming procedures (see, e.g., Rosen 1986; Grigson 1995). The limited amount of archaeozoological data concerning the age of cattle, based on the bones from Jiyeh, and the absence of data on their sex, prevent drawing definite conclusions regarding the husbandry model at Jiyeh. There is no direct evidence indicating that cattle were raised to an advanced age or that they were exploited for secondary products. Archaeological and archaeobotanical data do not confirm a particularly sophisticated model of agriculture and land cultivation. Preliminary results of plant material analysis confirm the presence of cereal crops, including barley whose remains were deposited in the Iron Age and Hellenistic period layers, as well as wheat, recovered from layers dated from the Persian to the Byzantine period (Badura et al. 2016). The cattle raised at Jiyeh was of small or medium size typically. The dominant role of cattle was noted also in the case of the nearby site at Sidon, although for Bronze Age layers (Vila 2004; Chauhoud and Vila 2012).

The change in animal husbandry practices, which occurred in the Persian period as evidenced by the decrease in the percentage of cattle remains and a rise in the number of sheep and, to a greater degree, goat bones, might have been caused by either environmental or cultural factors. Climate change in the Iron Age did not take a drastic form (Weiss and Bradley 2001). However, locally it could have led to decreased precipitation levels and more acute aridification. Environmental factors may have induced adjustments in the husbandry model and resulted in sheep and goat raising taking on increased importance compared to cattle breeding. Goats especially are better adapted to dry conditions (Horwitz, Tchernov, and Dar 1990; King 1999) and constituted the base for animal husbandry from the Bronze Age to the Islamic period at most sites located in the Levant. These species are best adapted for life in conditions of that region. Cultural

factors should also be considered as inducing modifications in the economy. The results of archaeological research indicate that the area was reoccupied in the Persian period. New buildings were erected applying different construction techniques from those used in the preceding period, that is, in the Iron Age (Waliszewski and Gwiazda 2015: 334). It is possible then that this society preferred a different model of the animal economy based on pastoralism.

It is often emphasized in the literature that a higher representation of sheep than goat is connected with a more specialized economy model, since this species provides more secondary products such as milk and wool (Davis 1984). There are even some claims that the preference for sheep was associated with a higher social status and economic standard among the inhabitants of a given area (Zeder 1998). Written sources also indicate that goats were raised for milk and sheep for wool (Safrai 1994: 177). In the case of the site at Jiyeh, the highest representation of sheep and goat remains was observed as of the Persian period. Goat remains were more numerous in the Persian period. At that time, the species was raised mainly for meat, which is confirmed by a considerable percentage, exceeding 15%, of individuals killed at a young age (before reaching morphological maturity). In the Hellenistic period, this situation changed: sheep remains were found in higher numbers than goat remains and the share of young individuals fell from over 15% to below 6%. It seems that the animal economy shifted focus from production of high amounts of meat to a more balanced model, that is, the proportion of animals killed for meat and those kept for further development of the herd and secondary products, in this case milk and wool, was adjusted to favor the latter type of economy.

It seems that small ruminants were slaughtered and the carcasses divided, at least partly, in a different location from the place of consumption. It is implied by the underrepresentation of phalanges of these animals in the material found in the explored rooms. Phalanges constitute useless elements of the carcass and they are usually left behind at the butchering spot. The absence or a low number of these elements at the site suggests that the animals were slaughtered elsewhere and that skinned carcasses were delivered to the area of the settlement. It is impossible to indicate the place where the killing took place. Apart from the lower number of phalanges, a slight overrepresentation of the proximal parts of the forelimb and hind limb was observed in the case of sheep and goat remains dated to the Persian and Hellenistic periods. It most likely resulted from the division of these parts of carcass, which are highly valued for consumption and bear significant amounts of palatable meat, into smaller fragments later subjected to culinary processing. Division of bones into smaller pieces is also confirmed by numerous chopping marks observed along and across shafts of long bones that form the proximal parts of the limbs. This is additionally implied by the state of preservation of the material. It has been noted that the state of preservation of the osteological material from layers dated to the Persian and Hellenistic periods was slightly poorer than in the case of remains from the preceding period, i.e., the Iron Age. The percentage of identified bones somewhat exceeded 70% in the case of the Persian and Hellenistic periods, while in the latter case it was more than 85%.

This difference might have been caused by culinary processing and division of bones, together with meat, into smaller elements. It appears that people from the area of Jiyeh usually cooked meat by stewing and simmering; it was much less frequently roasted, as suggested by a very low percentage of bones bearing burning marks.

Information concerning morphology of small ruminants is rather sparse. Some data were collected solely for sheep. Withers height of the few individuals whose remains were recovered from layers dated to the Iron Age and Hellenistic period fell in the range between 55.2 and 65.7 cm. These values show that the sheep represented a small form, similar to mouflon, i.e., the direct ancestor of the domestic sheep.

Pork marginally supplemented the diet based on ruminants. The percentage of pig remains was low, below 5%, only slightly exceeding 11% in the Iron Age. Regardless of chronology, the animals were kept as an additional source of meat for consumption. It is possible that a higher share of pig remains resulted from a different strategy of herd management than in later periods. The most prominent role of cattle at that time, most likely used also for secondary products, generated the necessity to produce more meat for consumption. Pigs are the best candidates for this purpose, since they can have young twice a year and thus deliver a high number of animals that could be killed and processed for consumption within a relatively short period. These animals practically do not deliver any secondary products. Meat-oriented management is confirmed by data on the age of death of the animals. Most pig bone remains from various periods belonged to individuals killed at a young age, younger than four years old. Moreover, a high share of cattle with associated pig remains imply a sedentary instead of pastoral lifestyle. The size of the remains indicates that the animals belonged to the fully domesticated form, however, it cannot be confirmed whether they came from a local population or from other regions. The possibility of local domestication of pig was corroborated in the case of archaeozoological studies at the site of Kamid el-Loz (Bökönyi 1990). In addition to that, sources frequently suggest the relationship between the presence of pig remains and societies representing low social and economic status (Hesse and Wapnish 1997; 1998; Zeder 1998). With respect to pig remains, explanations referring to the ban on eating pork, as well as correlations between the presence of remains of these animals at archaeological sites and the ethnicity of the population, namely Philistines and Israelites in the case of the Iron Age, are often presented (see Sapir-Hen et al. 2013; Sapir-Hen, Meiri, and Finkelstein 2015, see more references there). The latest research added the results of DNA analysis to the existing set of archaeological and archaeozoological data. They imply that at least some pigs were delivered to the region of the southern Levant from other areas, including the Aegean Islands.

Remains of equids have been found only in layers from the Persian period. It is impossible to state conclusively on the basis of the skeletal elements whether they belonged to wild or domesticated forms. The sparse remains found at Jiyeh came from forms which differed in terms of size. It can be stated with high probability that there were some bones of donkey and even

fewer of horse. The situation is similar at other sites in the region, where donkeys were the most popular animals used for transportation (Safrai 1994: 289). Camel bones have been found at some sites, however, it is assumed that this species was exploited for long-distance transportation (Grigson 2012). Very few were discovered at Jiyeh, but not connected with any particular context. The use of horses and donkeys for transportation is indirectly confirmed by data on their age. Very few fragments belonged to animals slaughtered at a young age; a great majority came from adult, but not old individuals. It can be concluded that horses and donkeys were kept for a long time and used as pack animals. An osteophyte was observed on a horse phalanx I, which might have emerged due to overloading of this individual with heavy burdens. Pathological marks on faunal remains from Levantine sites are not very frequently described. They mostly involved pathological changes associated with injuries, infections and dentition defects observed on bones and teeth of cattle, sheep and goat from eight sites situated in Israel, dated to various periods from the Neolithic to the Middle Ages (Sapir-Hen et al. 2008).

Summing up, it may be said that the population of ancient Porphyreon from the 7th/6th century BC to the 6th/7th century AD based the animal economy mostly on mammal husbandry, marginally supplemented with hunting various species of gazelles. Cattle, sheep and goat were the most represented livestock species. Cattle played a more prominent role in the Iron Age, then its significance decreased in favor of small ruminants. As a consequence, the economic model changed from a typically sedentary one, associated with a population that mostly deals with land cultivation, to a more mobile one, connected with pastoralism. The Persian period was a time when goats were the most represented species, raised mainly as source of meat. From the Hellenistic period, sheep played the most important role. They were raised not only for meat, but also for secondary products, such as milk and wool. Apart from ruminants, pigs constituted a marginal part of the livestock at Jiyeh; they had the highest share in the Iron Age, and then the percentage fell. The low significance of pig is typical of a pastoral model of the economy. This species was raised for meat exclusively. The use of horses and donkeys as pack and draft animals is confirmed for the Persian period.

Joanna Piątkowska-Małecka
Institute of Archaeology, University of Warsaw
00-497 Warsaw, Poland, ul. Krakowskie Przedmieście 26/28
jmalecka@uw.edu.pl

REFERENCES

Primary sources
Polybius, *The histories,* transl. by W.R. Paton, Cambridge, MA: Harvard University Press, 1960

Secondary sources

Badura, M., Rzeźnicka, E., Wicenciak, U., and Waliszewski, T. (2016). Plant remains from Jiyeh/Porphyreon (Lebanon), seasons 2009-2014: preliminary results of archaeobotanical analysis and implications for future research. *PAM*, 25, 487–510

Bökönyi, S. (1990). *Kamid el-Loz XII. Tierhaltung und Jagd: Tierknochenfunde der Ausgrabungen 1964 bis 1981* [=*Saarbrücker Beiträge zur Altertumskunde 42*]. Bonn: R. Habelt

Chahoud, J. and Vila, E. (2012). The role of animals in ancient Sidon: an overview of ongoing zooarchaeological studies. *Archaeology & History in Lebanon*, 34–35, 259–284

Contenau, G. (1920). Mission archéologique a Sidon (1914). *Syria*, 1(4), 287–317

Davis, S.J.M. (1984). The advent of milk and wool production in western Iran: some speculations. In J. Clutton-Brock and C. Grigson (eds), *Animals and archaeology III. Early herders and their flocks* [=*BAR IS* 202] (pp. 265–278). Oxford: B.A.R.

Davis, S.J.M. (1985). The large mammal bones. In A. Mazar, *Excavations at Tell Qasile II. The Philistine sanctuary: various finds, the pottery, conclusions, appendixes* [=*Qedem* 20] (pp. 148–150). Jerusalem: Institute of Archaeology, Hebrew University of Jerusalem

Grigson, C. (1995). Plough and pasture in the early economy of the southern Levant. In T.E. Levy (ed.), *The archaeology of society in the Holy Land* (pp. 245–268). London: Leicester University Press

Grigson, C. (2012). Camels, copper and donkeys in the Early Iron Age of the southern Levant: Timna revisited. *Levant*, 44(1), 82–100

Gwiazda, M. (2014). Economy of Hellenistic, Roman and Early Byzantine settlement in Jiyeh (Porphyreon), Lebanon. *Archeologia*, 62–63, 31–44

Harrison, D.L. (1968). *The mammals of Arabia.* London: Ernest Benn

Hesse, B. and Wapnish, P. (1997). Can pig remains be used for ethnic diagnosis in the ancient Near East? In N.A. Silberman and D.B. Small (eds), *The archaeology of Israel: Constructing the past, interpreting the present* [=*Journal for the Study of the Old Testament. Supplement Series* 237] (pp. 238–270). Sheffield: Sheffield Academic Press

Hesse, B. and Wapnish, P. (1998). Pig use and abuse in the ancient Levant: ethnoreligious boundary-building with swine. In S.M. Nelson (ed.), *Ancestors for the pigs: pigs in prehistory* [=*MASCA Research Papers in Science and Archaeology* 15] (pp. 123–135). Philadelphia, PA: Museum Applied Science Center for Archaeology, University of Pennsylvania Museum of Archaeology and Anthropology

Horwitz, L.K., Tchernov, E., and Dar, S. (1990). Subsistence and environment on Mount Carmel in the Roman-Byzantine and mediaeval periods: the evidence from Kh. Sumaqa. *Israel Exploration Journal*, 40(4), 287–304

King, A. (1999). Diet in the Roman world: a regional inter-site comparison of the mammal bones. *JRA*, 12, 168–202

Kolda, J. (1936). *Srovnávací anatomie zvířat domácích se zřetelem k anatomii člověka* [Comparative anatomy of domestic animals with regard to human anatomy]. Brno: Novina [in Czech]

Lasota-Moskalewska, A. (1984). Morphotic changes of domestic cattle skeleton from the Neolithic Age to the beginning of the Iron Age. *Wiadomości Archeologiczne*, 45(2), 119–163

Lasota-Moskalewska, A. (2008). *Archeozoologia: ssaki* [Archaeozoology: mammals]. Warsaw: Wydawnictwa Uniwersytetu Warszawskiego [in Polish]

Lutnicki, W. (1972). *Uzębienie zwierząt domowych* [Dentition of domestic animals]. Warsaw: PWN [in Polish]

Renan, E. (1864). *Mission de Phénicie*. Paris: Imprimerie impériale

Rosen, B. (1986). Subsistence economy of Stratum II. In I. Finkelstein, *Izbet Ṣarṭah: An early Iron Age site near Rosh Ha'ayin, Israel* [=*BAR IS* 299] (pp. 156–185). Oxford: B.A.R.

Safrai, Z. (1994). *The economy of Roman Palestine.* London–New York: Routledge

Saidah, R. (1977). Porphyréon du Liban: une Pompéi byzantine enfouie sous le sable. *Archéologia,* 104, 38–43

Sapir-Hen, L., Bar-Oz, G., Gadot, Y., and Finkelstein, I. (2013). Pig husbandry in Iron Age Israel and Judah: new insights regarding the origin of the "taboo." *Zeitschrift des Deutschen Palästina-Vereins*, 129(1), 1–20

Sapir-Hen, L., Bar-Oz, G., Hershkovitz, I., Raban-Gerstel, N., Marom, N., and Dayan, T. (2008). Paleopathology survey of ancient mammal bones in Israel. *Veterinarija ir Zootechnika*, 42(64), 62–70

Sapir-Hen, L., Meiri, M., and Finkelstein, I. (2015). Iron Age pigs: new evidence on their origin and role in forming identity boundaries. *Radiocarbon*, 57(2), 307–315

Schramm, Z. (1967). Różnice morfologiczne niektórych kości kozy i owcy [Morphological differences of some goat and sheep bones]. *Roczniki Wyższej Szkoły Rolniczej w Poznaniu*, 36, 107–133 [in Polish]

Silver, I.A. (1969). The ageing of domestic animals. In D. Brothwell and E. Higgs (eds), *Science in archaeology: A survey of progress and research* (pp. 283–302). London: Thames and Hudson

Szulc-Kajak, A. (2013). Fishing gear from Jiyeh (Porphyreon). Preliminary report. *PAM*, 22, 334–340

Tchernov, E., Dayan, T., and Yom-Tov, Y. (1986). The paleogeography of *Gazella gazella* and *Gazella dorcas* during the Holocene of the Southern Levant. *Israel Journal of Zoology*, 34(1–2), 51–59

Teichert, M. (1975). Osteometrische Untersuchungen zur Berechnung der Widerristhöhe bei Schafen. In A.T. Clason (ed.), *Archaeozoological studies: Papers of the Archaeozoological Conference 1974, held at the Biologisch-Archaeologisch Institut of the State University of Groningen* (pp. 51–69). Amsterdam–Oxford–New York: North-Holland Publishing Company; American Elsevier Publishing Company

Vila, E. (2004). The fauna of early Bronze Age Sidon. *Archaeology & History in Lebanon,* 19, 92–105

von den Driesch, A. (1976). *A guide to the measurement of animal bones from archaeological sites* [=*Peabody Museum Bulletin* 1]. Cambridge, MA: Peabody Museum of Archaeology and Ethnology, Harvard University

Waliszewski, T., Antos, M., Jaworski, P., Makowski, P., Romaniuk, M., Solecki, R., and Szymczak, A. (2015). Preliminary report on the 2012 and 2013 excavation seasons at Jiyeh (Porphyreon): Work in Sector D (residential quarter). *PAM*, 24/1, 453–474

Waliszewski, T. and Gwiazda, M. (2013). Preliminary report on the 2010 excavation season at Jiyeh (Porphyreon). *PAM*, 22, 321–333

Waliszewski, T. and Gwiazda, M. (2015). Porphyreon through the ages: The fading archaeological heritage of the Lebanese coast. *Journal of Eastern Mediterranean Archaeology & Heritage Studies*, 3(4), 330–348

Waliszewski, T., Juchniewicz, K., and Gwiazda, M. (2012). Preliminary report on the 2008 and 2009 excavation seasons at Jiyeh (Porphyreon). *PAM*, 21, 423–445

Waliszewski, T. and Wicenciak, U. (2015). Jiyeh (Porphyreon). Nouvelles découvertes sur le territoire de Sidon à l'époque hellénistique. *Topoi Supplément*, 13, 155–179

Waliszewski, T., Wicenciak, U., El-Tayeb, M., Domżalski, K., Witecka, A., Wagner, M., Herbich, T., Noureddine, I., Woźniak, M., Kotlewski, K., and Żukowski, R. (2008). Jiyeh (Porphyreon). Hellenistic, Roman and Byzantine settlement on the southern coast of Lebanon. Preliminary report on the 1997 and 2003–2005 seasons. *Bulletin d'archéologie et d'architecture Libanaise*, 10, 5–80

Wapnish, P. (1997). Lions. In E.M. Meyers (ed.), *The Oxford encyclopedia of archaeology in the Near East III* (pp. 361–362). New York: Oxford University Press

Weiss, H. and Bradley, R.S. (2001). What drives societal collapse? *Science*, 291(5504), 609–610

Zeder, M.A. (1998). Pigs and emergent complexity in the ancient Near East. In S.M. Nelson (ed.), *Ancestors for the pigs: pigs in prehistory* [=*MASCA Research Papers in Science and Archaeology* 15] (pp. 109–122). Philadelphia, PA: Museum Applied Science Center for Archaeology, University of Pennsylvania Museum of Archaeology and Anthropology

Zeder, M.A. and Lapham, H.A. (2010). Assessing the reliability of criteria used to identify post-cranial bones in sheep, Ovis, and goats, Capra. *Journal of Archaeological Science*, 37(11), 2887–2905