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PATHOLOGICAL LESIONS ON PREHISTORIC ANIMAL REMAINS FROM SOUTHWEST ASIA

László Bartosiewicz[1]

Abstract

Animal remains showing pathological changes rarely occur in excavated bone assemblages. While most such specimens have been published from Europe, archaeozoological research at sites in Southwest Asia has also yielded specimens of interest. Reviewing some of them shows that the frequency of lesions reflects differences between the basic composition of animal bone materials from Europe and Southwest Asia. While the preponderance of certain domesticates (usually sheep and goat in Southwest Asia) tends to mirror the habitat preferences of animals kept most successfully, these species also display more lesions for statistical reasons: large assemblages contain pathological bone specimens from dominant species with greater probability.

Résumé

Les restes animaux qui permettent de suivre les modifications pathologiques restent rares dans les assemblages osseux. Alors que la plupart des cas ont été publié pour l'Europe, les recherches archéozoologiques pour l'Asie du Sud Ouest apportent également des cas intéressants. La révision de certains d'entres eux montre que la fréquence des lésions reflète des différences entre la composition du matériel osseux animal de l'Europe et de l'Asie du Sud Ouest. Alors que la prédominance de certaines espèces domestiques a tendance à donner une image des habitats les plus adaptés pour les animaux les plus élevés, ces espèces montrent également plus de lésions pour des raisons statistiques ; les grands assemblages contiennent avec une plus grande probabilité des cas d'ossements pathologiques des espèces dominantes .

Key Words: Pathological animal bones, Southwest Asia, Sampling bias, Secondary exploitation

Mots Clés: Ossements animaux pathologiques, Asie du Sud Ouest, Biais d'échantillonage, Exploitation secondaire

Introduction

Palaeopathology is a discipline devoted to the pathology of ancient humans and animals. It is rooted in palaeontological research, with little or no attention paid to the cultural aspects of the identified animal disease even in archaeological assemblages. Archaeozoopathology is defined here as the study of animal remains affected by disease, recovered from archaeological sites, i. e. *cultural deposits*. The term, coined for the purposes of this paper, however, is not intended to be just another tongue breaker in the jargon ridden vocabulary of archaeology. In decent English terms, this single word translates into "*Animal Diseases in Archaeology*", actually, the title of the pioneering book by Baker and Brothwell (1980). This word is not expected to revolutionize the terminology of zoological studies in archaeology. It is important, however, that it unambiguously defines the topic in a single, even if complicated word.

Considering the distinguished attention paid to the question of domestication and ancient food production in the Near East, it is somewhat surprising that relatively few pathological cases have so far been reported from this region. This scarcity is not a result of ignorance or poor individual judgment by the respective authors. It reflects reality, in as much as archaeozoopathological data are rare as well as sporadic, and appear in publications in a most haphazard manner. It is also noteworthy that, "modifications and pathologies" are listed under the umbrella term of domestication by Reitz and Wing (1999: 321-326). In comparison to their wild ancestors, there is an indisputably spectacular increase of morbidity in domesticates. However, this classification also reflects the less prominent role that pathological studies have played in archaeozoology.

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Material and methods

The animal bone assemblages whose pathological bone specimens are discussed in this brief review include:

- *Arslantepe* (Central eastern Anatolia, Turkey) is a large tell site with a stratigraphic sequence beginning in the middle Chalcolithic and ending in early historic times (Bartosiewicz 1998). It is located along the upper reaches of the Euphrates River, approximately halfway between the Mediterranean and Black Sea coasts. To date, 14,627 identifiable bones from its predominantly Early Bronze Age I (VIA; 3350-3000 BC) layers have been available for study. Pathological modifications were found on only 12 of them.
- *Horum Höyük* (Southern Anatolia, Turkey) is a largely late Chalcolithic tell site located along the Euphrates River, north of the Syrian border. Rescue excavations at this tell brought to light 4,306 identifiable bones from the Chalcolithic layers with 8 pathological specimens. Phasing and faunal analysis at this site are still in progress.
- *Shahr-i Sokhta* (Sistan, Iran) is a Bronze Age proto-urban settlement in southern Central Asia in the former delta of the Hilmand River. Its Periods II (2700-2500 BC) and III (2400-2100 BC) from the Early Bronze Age, yielded 9,615 bones identified by Sándor Bökönyi. Another 4,820 identifiable bones originated from mixed provenance (for details see: Bökönyi and Bartosiewicz 2000: 128). In this assemblage a total of 43 pathological cases occurred, 6 from mixed contexts.
- *Tel Dor* (Israel) is a Late Bronze Age to Roman Period port city situated on the Mediterranean coast south of Haifa. A larger Iron Age (c.a. 1000-925 BC; 1,866 identifiable bones) and a smaller Roman Period (1st-2nd c. AD; 120 bones) sample were available for study. The faunal assemblages included four and two pathological specimens respectively. Faunal analysis at this site is still in progress.

In addition to these original data, a sample of pathologically modified bones (from mostly prehistoric sites), published in the literature, was also considered. These sites included:

- Bastam, Northwest Azerbaijan, Iran: 2200-700 BC, 7th c. BC, AD 9-14th c. (Krauß 1975)
- Demircihüyük, Northwest Anatolia, Turkey: 2700-400 BC (Rauh 1981)
- Hassek Höyük, Southwest Anatolia, Turkey: Chalcolithic, EBA 4-3th millennia BC (Stahl 1989)
- Kamid el-Loz, Southern Lebanon: LBA (Bökönyi 1990)
- Lidar Höyük, Southwest Anatolia, Turkey: 3000-2000 BC, 2000-1600 BC, 1600-1200 BC, 6th-5th c. BC, AD 4th-13th c. (Kussinger 1988)
- Takht-i Suleiman, Azerbaijan, Iran: 4th c. BC-AD10 c., 11th-12th c., 13-14th c. (Steber 1986)

Grouping pathologically modified bones is among the most complicated issues in archaeozoology. The *geographical* scope of this paper is (somewhat arbitrarily) defined in the title. Classification by *chronological periods* seems to be least reasonable, partly because such finds are relatively rare to begin with, and partly because apart from major differences manifested in the structure of animal husbandry (especially the relative importance of species and the emergence of secondary exploitation), little diachronic difference may be expected in the skeletal evidence of animal disease. Fortunately, most data under discussion here represent a relatively late phase of Prehistory, so that little distortion may be expected in this regard. On the other hand, it would be illusory to pursue a precise *aetiological* classification given the incomplete nature of phenomena observed on disarticulated bone finds. Reviewing pathological lesions only by animal *species or skeletal region* would have yielded a similarly rigid frame of reference.

Human palaeopathologists (e. g. Regöly-Mérei 1962; Ortner and Putschar 1981) have developed empirical groupings based on the osteological manifestation of diseases. Most recently, Miller et al. (1996: 222) have set up seven general categories of disease in human palaeopathology, each of which have recognizable, although often non-specific, hallmarks in dry bone specimens which are fundamental in archaeological identification (they include: anomaly, trauma-repair, inflammatory/immune, circulatory/vascular, metabolic, neuromechanical and neoplastic pathologies).

Given the greater variety of species and the resulting multitude of forms in the study of animal exploitation, this detailed scheme would be rather difficult to follow in archaeozoology. A classical empirical system was proposed by Angela von den Driesch (1975: 167) in which three main categories of pathological modifications were distinguished:

1. Dental anomalies
2. Lesions caused by overwork and mistreatment
3. Traumatic lesions

This practical classification, however, incorporates three different paradigms which, ideally, should all be considered simultaneously:

Ad 1 *Taxonomic-anatomical:* teeth tend to be well preserved, easily identifiable animal remains. Their shapes and sizes make detailed ageing and sometimes even sexing possible. Within the context of these data, evaluating anomalies is often more meaningful than the analysis of lesions in other parts of the skeleton.

Ad 2 *Aetiological-deductive:* osteological symptoms of overwork often coincide with those of ageing. In addition, animals kept under miserable conditions tend to "age" faster. Distinguishing between these two phenomena, therefore, is very difficult in the case of disarticulated, individual bones. In addition, overwork may also be manifested in the form of chronic trauma, thereby overlapping with the next dimension included in the classification by von den Driesch.

Ad 3 *Direct empirical:* with the exception of extremely complicated cases, trauma is relatively easily identified on excavated animal bones. Although the direct causes are rarely evident, the symptoms often look familiar and relatively uncomplicated, since most of them tend to be localized in the skeleton. The appearance of traumatic lesions, however, is not always easily explained by the form of animal exploitation (e. g. Uerpmann 1970: 84).

As a compromise between the system suggested by von den Driesch and a need to somewhat more finely define pathological lesions in the material under discussion here, the three categories have been refined using a slightly modified version of the grouping used by Bökönyi (1990: 120, Abb. 61) at the site of Kamid el-Loz: (Table 1).

Table 1. Connections between the six categories of pathological lesions used in this study.

Oral cavity		**Keeping/working**		**Trauma**	
Dental anomaly	Gingvitis	Metabolic	Arthropathia	Periostitis	Fracture

Naturally, this classification also contains conceptual overlaps (such as gingvitis related to keeping or fractures resulting from working), however, it was considered detailed enough for the grouping of the relatively few pathological specimens discussed here. A detailed overview of the material available for study is presented by site, animal species and these categories in Table 2.

Results

The occurrence of lesions at archaeological sites is influenced by a number of variables. In addition to effects of the local environment and the technical level of animal husbandry, sampling and assemblage characteristics also have a bearing on the presence of the usually small number of pathologically modified animal remains.

Table 2. Summary of pathological specimens in the discussed assemblages.

Arslantepe, EBA I	**Dental**	**Gingvitis**	**Metabolic**	**Arthropathia**	**Periostitis**	**Fracture**
cattle	pointed tooth			coxarthrosis		sternum
caprinae	3 pointed teeth	M3 lost *intra vitam* mandibula, swollen				
goat			2 horn core depressions	phalanx I, distal exostosis		
dog						radius, simple fracture
brown bear				radius proximal lipping		
Horum Höyük, Ch.	**Dental**	**Gingvitis**	**Metabolic**	**Arthropathia**	**Periostitis**	**Fracture**
cattle				phalanx I, proximal/lateral lipping phalanx II, ringbone		
sheep		swollen mandibula			axis, osteope- trosis	
goat				humerus distal, eburnation metacarpus proximal, exostoses		ulna cracked, fused to radius
pig		mandibular fistula				
Shahr-i Sokhta, II	**Dental**	**Gingvitis**	**Metabolic**	**Arthropathia**	**Periostitis**	**Fracture**
cattle		swollen mandibula		calcaneus (spavin?) metacarpus distal, exostoses phalanx II proximal, exostosis cervical vertebra, caudal exostosis 2 thoracic vertebrae, ankylosed		rib with callus
caprinae	4 pointed teeth	2 mandibular fistula 2 *intra vitam* tooth loss maxillar fistula		4 ulna, exostoses radius proximal, exostoses metacarpus, exostosis 2 phalanx I, exostosis		ramus mandibulae 4 ribs ulna proximal, callus metatarsus, callus
aurochs				metacarpus dorsal, exostosis		
Tel Dor, Iron Age	**Dental**	**Gingvitis**	**Metabolic**	**Arthropathia**	**Periostitis**	**Fracture**
cattle						hip joint luxation
sheep				metatarsus distal exostosis	metacarpus diaphysis	
pig				metatarsus proximal, fistula		
horse						metacarpus II, cracked
Tel Dor, Roman	**Dental**	**Gingvitis**	**Metabolic**	**Arthropathia**	**Periostitis**	**Fracture**
cattle	I2, neck worn			metatarsus distal, asymmetric		

Assemblage size

While no statistically significant correlation was found between the number of identifiable bone specimens and that of pathological lesions, Figure 1 (based on our own data pooled with those from the literature as cited) displays the tendency that more than ten pathological bone specimens may be expected to occur only in assemblages that contain over ten thousand (!) identifiable bone specimens. This clearly illustrates the aforementioned extreme rarity and sporadic occurrence of pathologically modified remains in excavated assemblages.

The number of pathological remains for each of the studied sites, plotted against the decimal logarithm of the number of all identifiable specimens (NISP) indicates that Shahr-i-Sokhta has far more pathological specimens relative to assemblage size than any of the other sites available for study.

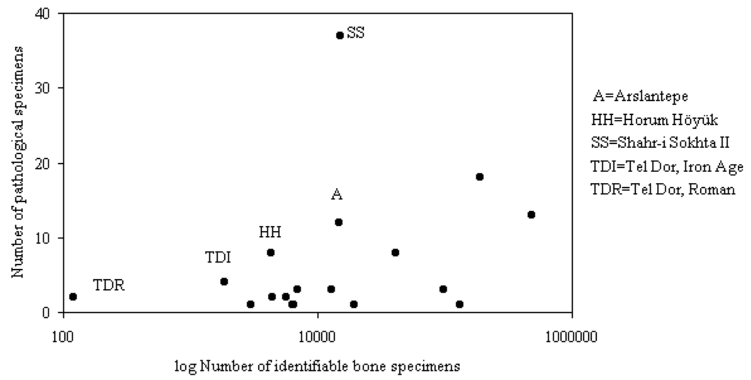

Fig. 1. Relationship between assemblage size and the number of pathological lesions.

Taxonomic composition

While taxonomic composition is expressed in species diversity, which is a function of assemblage size, it is evident that animal taxa represented by greater numbers of identifiable specimens tend to contribute more bones with pathological lesions to the material. The overwhelmingly prehistoric assemblages under discussion here are characterized by high percentages of domesticates (the same holds true for the Roman Period component of Tel Dor). This is also reflected in the taxonomic composition of the *pathologically modified* animal bones available for study (Table 3).

Table 3. The taxonomic distribution of pathological bones by site.

	Cattle	**Sheep**	**Goat**	**S/G**	**Pig**	**Horse**	**Dog**	**Aurochs**	**Bear**	**Total**
Arslantepe, EBA	1		3	5			1		1	**11**
Horum Höyük, Ch.	2	1	4		1					**8**
Shahr-i Sokhta, II-III	8	3		25				1		**37**
Tel Dor, Iron Age	1	1		1	1	1				**5**
Tel Dor, Roman	2									**2**
Total	**14**	**5**	**7**	**31**	**2**	**1**	**1**	**1**	**1**	**63**
Grouped	**Cattle**	**Sheep and goat**			**Pig**	**Horse**	**Dog**	**Game**		
% of total	22.2	68.2			3.2	1.6	1.6	3.2		100

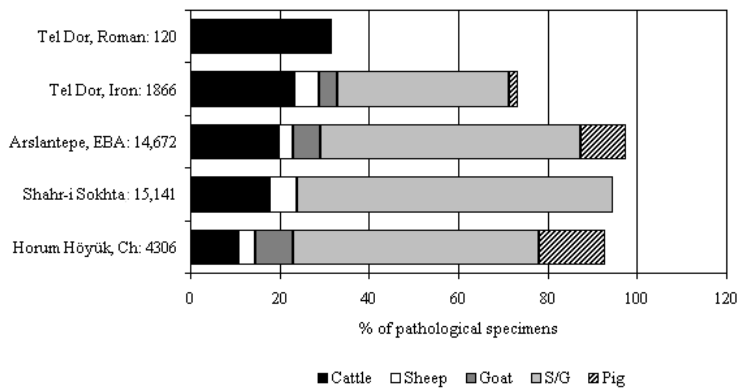

Fig. 2. The total percentage of major domestic taxa (NISP) represented in the pathological material.

The conspicuously great number of bone lesions found on the bones of sheep (*Ovis aries* L. 1758) and/or goat (*Capra hircus* L. 1758) is also a reflection of the importance of Caprinae (i. e. sheep and/or goat= S/G) in the economy of many ancient cultures in Southwest Asia. While pathological cattle (*Bos taurus* L. 1758) bones are relatively few, they show the significance of this domesticate, at least in comparison to the rest of the animals. The contribution of the most important domesticates to the assemblage of pathological bones is shown in Figure 2.

The remains of horse (*Equus caballus* L. 1758) and dog (*Canis familiaris* L. 1758) tend to be rare in the assemblages under discussion here, thus, the number of their bones displaying pathological anomalies is also small. The fact that wild animals are represented only by aurochs (*Bos primigenius* Boj. 1827) and brown bear (*Ursus arctos* L. 1758), clearly illustrates (even in this small material) that chronic physical conditions are more likely to develop in large game with only a few natural predators. The presence of these bones among archaeological finds shows in and of itself that aurochs or bear had practically no enemy other than humans (Table 4).

Table 4. The frequency of major types of lesions by animal taxa (data in Table 1, pooled with data from the literature).

	Dental	**Gingvitis**	**Metabolic**	**Arthropathia**	**Periostitis**	**Fracture**	**Total**
Cattle	10	2	4	11	30		**57**
Sheep		4	1	2	5	1	**13**
Goat	3		2		7	3	**15**
S/G	12	14	2	11	16		**55**
Pig		3	2	8	2		**15**
Horse	1			1	1		**3**
Donkey		1		1			**2**
Dog	4			2	1		**7**
Aurochs					1		**1**
Bear				1			**1**
Weasel				1			**1**
Total	**30**	**24**	**11**	**38**	**63**	**4**	**170**
Grouped	**Oral cavity**		**Keeping/working**		**Trauma**		
% of total	31.8		28.8		39.4		100

Relevant to the previous discussion of morbidity in wild animals is the phenomenon shown in Table 4, that over a quarter of all pathological lesions observed on the bones of these (largely domesticated, prehistoric) animals may be related to keeping or even draught exploitation. The three "cuckoo's eggs" in this group are the bones of aurochs and bear, which remain the only wild specimens, in addition to

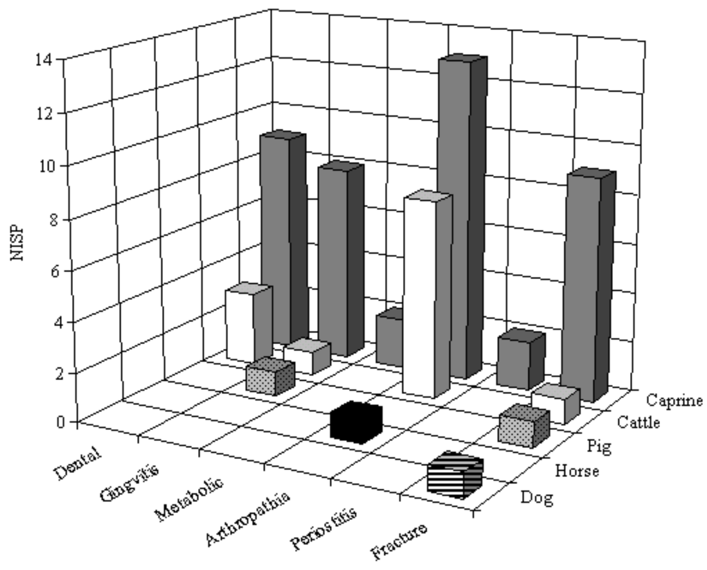

Fig. 3. The taxonomic distribution of lesions among domesticates observed in the five assemblages studied.

a Late Bronze Age weasel (*Mustela nivalis* L. 1758) published by Bökönyi (1990: 122). This small carnivore would have been less exposed to predation than a rodent of comparable size.

The morbidity of domestic animals at the four sites under discussion here is summarized in Figure 3. Among these assemblages directly available for study, remains of sheep and goat, dominate this chart which makes the manifestations of even relatively rare conditions (e. g. periostitis) possible among caprines. The remarkably high incidence of arthropathies in these two species may be related to old age and thus secondary exploitation, possibly for wool. At Shahr-i Sokhta, direct evidence for wool processing is available in the form of textile remains dated to Phase 6 (Compagnoni and Tosi 1978: 97, Figs. 4A-B). Mesopotamian sheep shearing lists are known from the turn of the 3rd-2nd millennia BC (Kraus 1966: 121).

The proportionally higher frequency of arthropathies in cattle must be the combination of draught exploitation and the functional longevity of working animals. In more rarely occurring species, only "the tip of the iceberg" is visible. Single meat purpose pigs (*Sus domesticus* Erxl. 1777) are also slaughtered at younger ages, so that only conditions with rapid histories have time to develop. Rare horse bones exhibit some evidence of overworking, while commensal dogs obviously ran a greater risk of being injured around humans.

In spite of the fact that the animal-related specifics of various lesions influence their manifestations in different assemblages, the largely prehistoric materials under discussion here have numerous characteristics in common: the dominance of Caprine bones, at least partially work-related symptoms in cattle and the negligible representation of wild animals. These shared features make the gross comparison of assemblages possible (Table 5).
Since data in this table were not pooled with those in the literature, the totals are smaller, and the percentual distribution of lesions is also somewhat different from those listed in Table 4. This latter phenomenon deserves attention. When the 106 cases from the literature are separated from the 63 pathological specimens discussed in this study, a percentual comparison between the three major groups of lesions displays a comparable trend (Figure 4). The only apparent difference lies in the greater contribution of traumatic lesions to assemblages published in the literature. According to a Chi^2 test performed on the observed and expected frequency data summarized in Table 6, the distribution of traumatic lesions is not homogeneous between these two sets (Chi^2=12.785, df=2), and this difference is significant on the P≤0.010 level of probability. (Table 6).

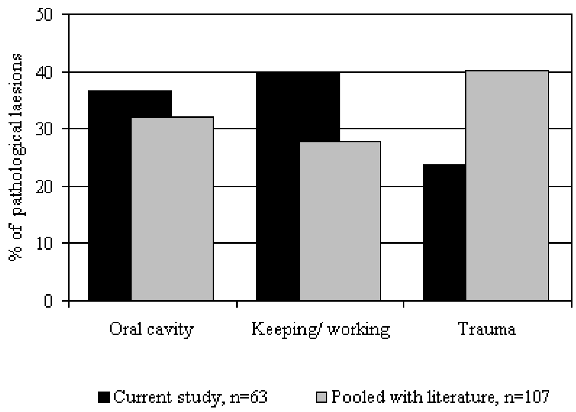

Fig. 4. The proportion between groups of lesions in this study and in the literature.

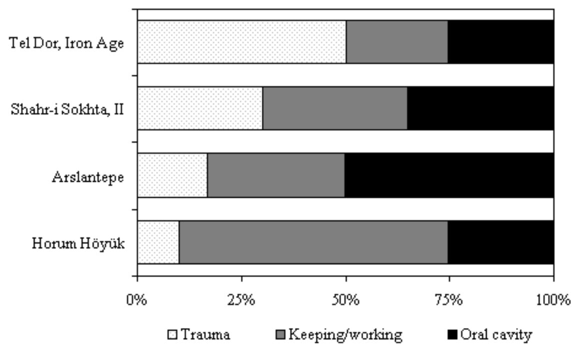

Fig. 5. The distribution of major categories of lesions in prehistoric assemblages.

Table 5. The frequency of major types of lesions by assemblage.

	Dental	**Gingvitis**	**Metabolic**	**Arthropathia**	**Periostitis**	**Fracture**	**Total**
Arslantepe, EBA I	4	2	2	2		2	**12**
Horum Höyük, Ch.		2		5	1		**8**
Shahr-i Sokhta, II-III	7	6		14		10	**37**
Tel Dor, Iron Age		1		1	1	1	**4**
Tel Dor, Roman	1			1			**2**
Total	**12**	**11**	**2**	**23**	**2**	**13**	**63**
Grouped	**Oral cavity**		**Keeping/working**		**Trauma**		
% of total	36.5		39.7		23.8		100

Table 6. The observed and expected values of lesions in the three major groups of pathologies.

Source	**Oral cavity**		**Keeping/working**		**Trauma**		**Total**
	observed	expected	observed	expected	observed	expected	
Current data	23	*23.3*	25	*20.3*	15	*29.4*	73
Literature	31	*33.9*	24	*29.5*	52	*42.7*	107
Total	54		49		67		170

Owing to the fact that there are no systematic regional/chronological differences between the two sets of assemblages, one may only conclude that more visible traumatic lesions (especially fractures) have been published more consistently in the literature. Unfortunately, the number of cases is not sufficiently great to test this hypothesis using a further sub-division of categories.

Gross percentual contributions by the major pathological groups under discussion in this study are shown in Figure 5. The Roman Period component of Tel Dor was not considered owing to both small sample size (n=2) and chronological disparity. The remaining sites were sorted by the decreasing proportion of traumatic lesions.

Traumatic lesions such as periostitis or, in graver cases, fractures, seem to be rather randomly distributed between the prehistoric assemblages under discussion here. The relatively constant symptoms of keeping and working occur more commonly only in the Chalcolithic assemblage from Horum Höyük, where sheep and goat remains were found in great numbers. Lesions in the oral cavity, including gingvitis, dominate at Arslantepe, although they are also common at the site of Shahr-i Sokhta.

Discussion

This chapter is devoted to the detailed evaluation of pathological lesions in light of relevant cases found in the archaeozoological literature.

1 Dental anomalies

The most commonly described manifestation of dental anomalies is irregular toothwear (*exsuperantia dentis*), caused by the lack of functional harmony between the upper and lower toothrow. In some cases, it may be traumatic in origin, when toothwear is retarded on teeth whose matching opposite is lost (Van Wijngaarden-Bakker and Krauwer 1979: 42, Fig. 2-3). Gingvitis related tooth loss may result in a comparable "overgrowth" of the remaining teeth. Most commonly, however, the presence of pointed teeth and other types of crown malformation may be related to inherited asymmetry or intra-uterine distortion of the head which precludes the even erosion of occlusal surfaces. Sometimes, the entire toothrow may be worn in an undulating fashion (Tamás ed. 1987: 106, Figs. 139-140);(Table 7).

Table 7. Dental anomalies in caprines.

Site	Period	Date	NISP	Caprine %	Lesion
Arslantepe	EBA I	3350-3000 BC	14,672	58.5	M^1 pointed wear
Arslantepe	EBA I	3350-3000 BC	14,672	58.5	M_2 pointed wear
Arslantepe	EBA I	3350-3000 BC	14,672	58.5	P_4 pointed wear
Shahr-i Sokhta	3-5	2500-2100 BC	515	75.1	M_1 worn, M_2-P_4 oblique
Shahr-i Sokhta	6	2600-2500 BC	3,070	78.6	M_2 sharp toothwear
Shahr-i Sokhta	6	2600-2500 BC	3,070	78.6	P_4 sharp toothwear
Shahr-i Sokhta	7-8	2900-2600 BC	56	48.2	M_2 sharp toothwear
Shahr-i Sokhta	mixed		4,813	80.6	P_3-P_4 crowded, adult
Shahr-i Sokhta	mixed		4,813	80.6	M_2-M_3 sharp wear

As is shown by these data, irregular toothwear is especially common among sheep and goat (von den Driesch 1972: Taf. 15/Abb. 58-59; another frequently affected species, horse is underrepresented at the sites under discussion here). At Arslantepe, a pointed cattle M_2 tooth was also recovered (cattle: 19.8% of NISP=14,672). Three such specimens (all M^3) were recorded in the Late Bronze Age assemblage of Kamid el-Loz (cattle: 32.2% of NISP=10,232).

Crowded teeth, observed in a Late Bronze Age caprine (64.2% of NISP=10,232) mandibula from Shahr-i Sokhta, was also noted at Kamid el-Loz (Bökönyi 1990: 120). In dogs especially, this phenomenon is interpreted as resulting from the relative shortening of the viscerocranium through domestication. In the case of sheep or goat, however, it may be grouped with other dental anomalies caused by a degree of inbreeding in general.

A different type of dental anomaly, the narrow wear around the neck of an I_2 tooth in cattle (31.6% of NISP=120) was found in the Roman Period assemblage of Tel Dor. This phenomenon is widely believed to have been caused by the animal's grazing habits, when vegetable fiber "flosses" into the dentine below the crown as the animal tears up the blades of grass (Müller 1990: 150-151, Abb. 5-6). A neolithic example of this disorder in cattle was mentioned by Cavallo (1997: 77) from Tell Sabi Abyad in Syria.

As is shown by these examples, not all dental anomalies can be considered explicitly pathological, although many of them may be related to trauma and disease.

2 Gingvitis

Gingvitis or paradentitis, the chronic inflammation of gums that eventually distorts the alveoli and can lead to *in vivo* tooth loss, is usually explained by a variety of infections, often by facultatively pathogenic microorganisms that normally inhabit the oral cavity. Although the multicausality of this condition is evident, overgrazing is usually considered the main background factor that leads to gingvitis. Since animals understandably graze in a preferential order, good quality grass tends to be eaten first, its place being taken over by hardier, often thorny weeds. Mouth injuries caused by these plants, in combination with nutritional stress caused by poor graze, can lead to the general deterioration of stocks that is clearly manifested in gingvitis and related disorders.

Owing to the significant contribution of sheep and goat bones, typical of many sites in Southwest Asia, this condition is manifested most commonly in the lower toothrow of subadult-mature sheep (Table 8).

Table 8. The cases of gingvitis observed on caprine mandibular fragments.

Site	Period	Date	NISP	Caprine %	Lesion
Arslantepe	EBA I	3350-3000 BC	14,672	58.5	2 swollen mandibular alveoli
Arslantepe	EBA I	3350-3000 BC	14,672	58.5	paradentitis, M_3 missing
Horum Höyük	Ch.		4,306	sheep 3.9	paradentitis at lower alveoli
Shahr-i Sokhta	5	2500-2400 BC	3,428	78.7	P^4-M^1 abscess with cavity*
Shahr-i Sokhta	6	2600-2500 BC	3,070	78.6	paradentitis at P_3-M_3
Shahr-i Sokhta	6	2600-2500 BC	3,070	78.6	swollen alveoli with fistula
Shahr-i Sokhta	mixed		4,813	80.6	swollen, M_1 lost *in vivo*
Shahr-i Sokhta	mixed		4,813	80.6	M_1-M_2 lost *in vivo*
Literature**					
Hassek Höyük	EBA	3200-2750 BC	12,962	25.8	swollen alveolus M_1 lost
Demircihüyük	EBA	2700-2400 BC	41,374	55.4	2 alveolar periostitis
Lidar Höyük	MBA	2000-1600 BC	190,934	43.4	3 paradentitis at P_3 and M_1
Demircihüyük	mixed		6,947	21.9	paradentitis, P teeth missing
Demircihüyük	mixed		6,947	21.9	swollen with fistula at P_{2-3}

* maxilla fragment

** Stahl 1989: 64; Kussinger 1988: 53; Rauh 1981: 46.

Although cattle is relatively less common at the sites under discussion here than caprines, Phase 3-4 (c.a. 2400-2100 BC) at Shahr-i Sokhta yielded a mandible fragment with a swollen *fossa mandibularis* (cattle: 21% of NISP=515). Phase 6 (2600-2500 BC) at the same site yielded a mandible fragment from a young cattle, whose P_2 was aborally distorted by the swollen alveolus (cattle: 16.2% of NISP=3070). These two cases may, to some extent, be explained by the declining state of pastures at a site where the importance of cattle decreased and caprines assumed an ever more dominant role (Bökönyi and Bartosiewicz 2000: 130, Fig. 8).

Gingvitis is common in pig as well. Owing to the lower relative frequency of these animals in the Near East, however, it is observed less frequently. Greater percentages of pig remains (NISP) as well as large samples result in the occasional manifestation of this condition. The fistula identified on the buccal side of a pig (14.9% of NISP=4306) mandible at the Chalcolithic site of Horum Höyük is evidently related to the chronic inflammation of alveoli. Less grave examples published in the literature include alveolar periostitis in the M_2 region (EBA pig: 51.3% of NISP=12,962) at Hassek Höyük (Stahl 1989: 37), or the gingvitis in the M_2-M_3 region of a Middle Bronze Age (2000-1600 BC) pig (19% of NISP=190,934) at Lidar Höyük (Kussinger 1988: 82).

3 Metabolic conditions

Bone malformations associated with metabolic disorders are represented by two left horn cores only from adult goats, recovered from the EBA I component at Arslantepe (goat: 3.3% of NISP=14,672). Both of them show oval-shaped, shallow “impressions” on the medial side. Another such goat horn core was found in one of the Neolithic layers at Hajji Firuz Tepe, Iran (Meadow 1983). Of the Anatolian sites under discussion in this paper, impressions on a Chalcolithic goat horn core were identified from Hassek Höyük (goat: 5.8% of NISP=2972; Stahl 1989: 64). She also reported the same phenomenon on a sheep horn core from a mixed Chalcolithic/Bronze Age layer (sheep: 4.4% of NISP=4444) at the same site. Hypothetical explanations for such impressions, well known in primitive sheep throughout Europe, include malnutrition and reproductive stress. To some extent, their archaeological appearance in goats may be explained by the greater importance and relative frequency of that species in many parts of Southwest Asia.

An unusual case of osteopetrosis was observed on a goat (8.2% of NISP=4306) epistropheus from the Chalcolithic site of Horum Höyük. It affected the cranio-ventral quarter of the bone, leading to the thickening of the “collar-shaped” *processus articularis cranialis* and the disappearance of the *crista ventralis*. Osteopetrosis is an extreme change in the composition of osseous tissue, characterized by radically increasing bone mass, while the proportion between inorganic and organic compounds in the bone oscillates around the normal level (Baker 1978: 108, Figure 35). While undoubtedly related to metabolic disorders affecting the formation of bone tissue, the aetiology of this condition remains unknown.

Naturally, many other conditions, such as arthropathies, may have a robust metabolic component in their aetiology. It is however, more difficult to separate these phenomena in dry archaeological specimens from the aforementioned effects of age and overworking (that naturally act through metabolic changes).

4 Arthropathies

While exostoses are rare in cervical vertebrae, they occurred around the *fossa caudalis* in cattle at Shahr-i Sokhta in the sub-assemblage dated to 2600-2500 BC (16.2% of NISP=3,070). Similarly, the *fossa caudalis* of a lumbar vertebra showed pathological erosion in the Middle Bronze Age assemblage of Kamid el-Loz (cattle: 15.9% of NISP=573; Bökönyi 1990: 121). Two fused thoracic vertebrae from cattle came to light from a mixed deposit at Shahr-i Sokhta (cattle: 14.5% of NISP= 4,813). A similar ankylosis between two thoracic vertebrae was reported from a Middle Bronze Age (2000-1600 BC) level at Lidar Höyük (cattle: 26.3% of NISP=190,934; Kussinger 1988: 25). In modern cattle, spondylotic deformations occur much more commonly in the vertebrae of bulls than cows (Bane and Hansen 1962: 371). In this example, however, the possibility of sex related inheritance and the selective longevity of sires cannot be distinguished from each other.

Vertebral deformations in cattle are difficult to interpret as a sign of draught use in and of themselves. Supporting evidence for this latter form of exploitation, however, is available in the form of the arthritic distal articular surface of a metacarpus from 2600-2500 BC at Shahr-i Sokhta. The ambiguity of this symptom (as to draught exploitation) is shown by a coeval aurochs left metacarpus from Shahr-i-Sokhta. This bone is covered by, probably age related, exostoses on the anterior (dorsal) surface of its diaphysis (aurochs: 0.2% of NISP=3,070).

The fusion of bones in the carpal and tarsal joints (often referred to as spavin in the hock) is a special case of chronic arthroses. It was observed on the fragment of the left cattle calcaneus from the aforementioned 2600-2500 BC assemblage from Shahr-i Sokhta. While very complex in terms of aetiology, spavin is to a great extent caused by repetitive strain injury in working animals. Spavin-like exostoses were observed, for example, around the articular surface of a metatarsus from a medieval cattle (27.3% of NISP=6,292; 11th-12th century) at Takht-i Suleiman (Steber 1986: 72). At the Lidar Höyük tell, Sonja Kussinger (1988: 24-25) identified this condition in all chronological sub-assemblages, although the relative frequency of these finds was very low (Table 9).

Table 9. The occurrence of cattle spavin in various periods of Lidar Höyük (Kussinger 1988)

Period	Date	NISP	Cattle %	Spavin
Middle Bronze Age	2000-1600 BC	190,934	26.3	1
Iron Age	6th-5th century BC	97,111	23.8	1
Hellenistic to medieval	4th-13th century	486,256	39.9	3

Although horse bones are relatively rare in settlement materials. The 2nd metacarpus was found fused to the proximal end of the 3rd in the Iron Age assemblage from Area D2 at the site of Tel Dor (horse: 0.2% of NISP=1866). This fusion is probably the a result of an inflamed minor injury.

Another condition often associated with strain in beasts of burden is the development of ringbone, formed by heavy periarticular exostoses between the proximal (I) and median (II) phalanx. Although best known in horse, given sufficiently large assemblages, ringbone may be considered relatively common in cattle, as in the Near Eastern assemblages under discussion here. Two such cases were identified in the material from Horum Höyük (cattle: 10.8 % of NISP=4306). An anterior proximal phalanx showed lateral lipping of the proximal articular surface, while fully developed ringbone occurred in the form of a major deformation on a burnt median phalanx from the same site. Smaller exostoses occurred on the proximal end of another median phalanx in the Phase 7 assemblage from Shahr-i Sokhta (cattle: 19% of NISP=594). A single phalanx I with ringbone was reported from the Early Bronze Age (2700-2400 BC) deposit of Demircihüyük (Rauh 1981: 23). At Lidar Höyük, a phalanx I and II, both with ringbone, were identified. Draught exploitation may be one, but not the only reason behind this type of lesion.

Most forms of arthritis discussed here are probably multicausal. In addition to work-related strain, they may also be caused by old age and disproportionately large body weight. A metapodial deformation, most characteristic of working oxen, the increased asymmetry of the distal end in the metacarpus (Bartosiewicz *et al*. 1993), was identified in a small Roman Period sample (cattle: 31.6% of NISP=120) from Area H1 at Tel Dor, Israel. Five such broadened distal metapodia were also recorded at Kamid el-Loz (cattle: 32.2% of NISP=10,232; Bökönyi 1990: 122). It is remarkable that the same, small Roman Period assemblage from Tel Dor yielded a small *acetabulum pelvis* fragment, showing nearthrosis following luxation of the hip joint. The edge of the acetabulum is deformed by exostoses. The concentration of such deformities at any site may be considered a symptom of draught exploitation in cattle, as would be expected within the catchment area of a large urban settlement by the Roman Period.

Of the five criteria used in diagnosing arthritis by Baker and Brothwell (1980: 115), grooving of the articular surface, eburnation as well as exostoses around the periphery of the bone occurred on the distal end of a goat (8.2% of NISP=4306) humerus dated to 2600-2500 BC at the site of Horum Höyük. An even more grave case of *arthropathia deformans et ankylopoetica* from the Middle Bronze Age (2000-1600 BC) was observed at the distal end of a caprine (43.4% of NISP=190,934) right humerus from Lidar Höyük (Kussinger 1988: 53).

5 Exostoses

Less grave exostoses indicative of arthritis were found more commonly on the bones of the forearm at the site of Shahr-i Sokhta (Table 10).

Table 10. Symptoms of arthritic inflammation on the forearm bones of caprines.

Site	Phase	Date	NISP	Caprine %	Lesion
Shahr-i Sokhta	5-6	2600-2400 BC	1,458	72.8	ulna proximal exostosis
Shahr-i Sokhta	6	2600-2500 BC	3,070	78.6	ulna proximal exostosis
Shahr-i Sokhta	mixed		4,813	80.6	radius diaphysis exostosis
Shahr-i Sokhta	mixed		4,813	80.6	ulna proximal exostosis
Shahr-i Sokhta	mixed		4,813	80.6	ulna diaphysis exostosis
Literature*					
Hassek Höyük	Ch.-EBA		4,444	sheep 4.4	radius, periostitis
Demircihüyük	EBA	2700-2400 BC	41,374	sheep 5.7	radius distal periarthritis

*Stahl 1989: 64; Rauh 1981: 46.

As is shown by the aforementioned arthropathies, the elbow joint is rather susceptible to inflammation. Distal exostoses on the radius and ulna, are indicative of inflammations in the wrist joint, also visible on the proximal end of metacarpal bones (similar exostoses on the metatarsus show arthritis in the hock joint; Table 11).

The proximal phalanx of a goat (3.3% of NISP=14,672) from the EBA at Arslantepe was deformed by a massive distal exostosis. Large exostoses were also observed on two proximal phalanges of sheep in the mixed material from Shahr-i Sokhta (caprine: 80.6% of NISP=4813). Two similar cases included sheep proximal phalanges in the Late Bronze Age assemblage of Kamid el-Loz (caprine: 64.2% of NISP=10,232; Bökönyi 1990: 122). A ridge-like outgrowth was also observed at the distal end of a Middle Bronze Age (2000-1600 BC) goat proximal phalanx from Lidar Höyük as well (caprine: 43.4% of NISP=190,934; Kussinger 1988: 53). Massive exostoses developed on the proximal end and plantar surface of a goat proximal phalanx in a 3rd millennium BC goat from the site of Kalba-Sarjah

Table 11. Exostoses observed on caprine metapodia, indicative of arthropathies.

Site	Date	NISP	Caprine %	Lesion
Shahr-i Sokhta	2500-2400	3,428	78.7	metacarpus prox. anterior exostosis
Horum Höyük		4,306	goat 8.2	metacarpus prox. exostosis
Tel Dor D2		1,866	sheep 4.3	metatarsus prox. exostosis
Tel Dor D2		1,866	38.5	metacarpus prox. periostitis, thickened diaphysis
Literature*				
Lidar Höyük	2000-1600 BC	190,934	sheep 26.3	metacarpus prox. periarticular exostosis
Lidar Höyük	2000-1600 BC	190,934	goat 43.4	metacarpus prox. periarticular exostosis

*Kussinger 1988: 53.

(United Arab Emirates). At this settlement both hunting and animal keeping were practiced and goat remains were more numerous than those of sheep (Mosseri-Marlio, personal communication). A crest developed on the edge of the distal articular surface on an Early Bronze Age (2700-2400 BC) sheep middle phalanx from Demircihüyük (sheep: 5.7% of NISP= 41,374; Rauh 1981: 46).

Since the probability of such lesions increases with age, exostoses in the autopodium may be related to milking in goat and wool production in sheep: in most forms of secondary exploitation, the animal's life-span is longer. On the other hand, the proportion of such disorders is difficult to judge in hand-collected assemblages owing to the small size of caprine phalanges.

A different reason for longevity is evidently behind another manifestation of arthritis, observed in the elbow joint of a brown bear (brown bear: 0.2% of NISP=14,672) from Arslantepe. This right radius fragment showed lipping at the edge of the proximal articular surface. In wild animals, such an advanced condition could develop only in exceptionally strong, top carnivores, not jeopardized by other predators (except humans). A tiny version of the same condition was identified at Kamid el-Loz by Bökönyi (1990: 122), who reported the inflammation of the elbow joint (proximal epiphyses of both the radius and ulna) in a Late Bronze Age weasel (0.002% of NISP=10,232).

6 Fractures

Although traumatic lesions seem to be least specific as to the taxonomic affiliation of domesticates, their anatomical distributions potentially mirror differences in anatomical makeup and sometimes even between forms of exploitation.

Broken horns occur relatively rarely in archaeozoological assemblages. A right sheep horn core with a distorted tip, from an adult ewe was identified in Phase 5 at Shahr-i Sokhta (sheep: 78.7 % of NISP=3428). It is a question whether this distortion is a result of direct trauma, especially since ewes rarely fight with their horns. The only comparable find came to light from the Early Bronze Age (3200-2750 BC) layers of Hassek Höyük. This horn core fracture in a cow (cattle: 12.7% of NISP=12,962), however, seems unambiguous and was healed into a small stub (Stahl 1989: 17).

A relatively rare type of head trauma, a broken *processus coracoideus* in a caprine mandible occurred in the chronologically non-identifiable prehistoric sub-assemblage from the Shahr-i Sokhta assemblage (caprine: 80% of NISP=4,813). This type of fracture is more frequent in longer living, non-meat purpose animals. Based on several decades of modern veterinary records, broken mandibulae made up only 4.88% of all fractures in horse and 5.44% in dogs (Tamás ed. 1987: 44). An archaeological parallel to this trauma, a healed fracture along the right *ramus mandibulae* on a medieval (13-14th century) domestic ass (*Equus asinus* L. 1758) from Takht-i Suleiman (ass: 0.4% of NISP=5,669), was published by (Steber 1986: 93, Taf. 1/Abb. 1/b). Notably, however, ramus fractures in small ruminants are not mentioned in the archaeozoological reports chosen for study. The presence of this trauma at Shahr-i Sokhta may be related to the unusually great reliance on caprines that increased the statistical probability for the manifestation of even rare phenomena. A left pig mandibula, broken in the P_4 region, and healed with a massive callus was observed at the site of Kamid el-Loz (pig: 0.93 of NISP=10,232: Bökönyi 1990: 120).

A case of arthritis and periarthritis ossificans resulting from a poorly healed pelvis fracture in a sheep or goat (43.4% of NISP=190,934) was identified in the Middle Bronze Age (2000-1600 BC) component of Lidar Höyük (Kussinger 1988: 53). However, this type of fracture seems rare in excavated materials (another, European example was found at the Iron Age/Early Viking Period site of Eketorp on Öland: Boessneck and von den Driesch 1979: 375, Abb. 318). It is possible that the prognosis of pelvis fractures was bad without constant veterinary care and therefore only a few cases actually had a chance to heal. According to several decades of veterinary statistics in Hungary, on the other hand, pelvis fractures occur commonly in all modern domesticates (Tamás ed. 1987: 331).

Excavations at Lidar Höyük (Kussinger 1988: 53) also yielded two cases of Hellenistic to medieval (4th-13th century) suine coxarthroses. One of them showed classical nearthrosis following the luxation of the hip joint. The acetabulum was deformed by exostoses. The other case was alternatively attributed to either degenerative processes in old age or a secondary coxarthrosis after luxation and dysplasia (pig: 29.2% of NISP=486,256; Kussinger 1988: 83). This condition is better known in small ungulates, whose lower body weight (and non-draught exploitation) probably helped such disadvantaged animals to survive.

Rib fractures, often healed with heavy callus formation, are also among the most common injuries in modern ungulates (Tamás 1987). Therefore, they are frequently identified in caprines as was the case in several phases at Shahr-i Sokhta (Table 12).

Table 12. The occurrence of healed caprine rib fractures in various periods at Shahr-i Sokhta.

Phase	Date	NISP	Caprine %	Rib fracture
3	2300-2100 BC	514	75.1	1
5	2500-2400 BC	3,428	78.7	1
5-6	2600-2500 BC	1,458	72.8	2
8	2900-2700 BC	596	65.8	1

A similar type of fractured sheep rib with a heavy callus was found in the 2700-2400 BC strata of Demircihüyük (sheep: 55.4% of NISP=41,374; Rauh 1981: 46).

Among the relatively few cattle bones (19% of NISP=594), a healed rib fracture was identified in the small material from Phase 7 (2700-2600 BC) at Shahr-i Sokhta. Similar cases were described in two Middle Bronze Age (2000-1600 BC) cattle at Lidar Höyük (cattle: 26.3% of NISP=190,934) and the mixed strata of Demircihüyük (cattle: 21.9% of NISP=6,947; Rauh 1981: 22). A healed fracture, observed on a large ungulate sternum fragment in the EBA assemblage from Arslantepe (NISP=14,672) in all probability belongs to cattle as well.

Limb fractures also occur most commonly among the numerous bones of caprines. A broken Chalcolithic goat radius (goat: 8.2% of NISP=4306), healed with a slight dislocation and a heavy callus, was identified at Horum Höyük. Another forearm bone fracture, that of a left sheep ulna, was recorded in the mixed material (caprine: 80.6% of NISP=4,813) from Shahr-i Sokhta.

Phase 6 at Shahr-i Sokhta (2600-2500 BC) yielded a sheep metatarsus with a heavy callus across the diaphysis (sheep: 78.6% of NISP=3,070). This is aetiologically similar to the broken metacarpus that healed with a callus at the proximal end of a 13-14th century medieval sheep (40.3% of NISP=5,669) from Takht-i Suleiman (Steber 1986: 23). Bones of the autopodium tend to be more exposed to external trauma than more proximally located extremity segments from the zygo- or stylopodium.

A healed radius fracture in an EBA dog from Arslantepe (dog: 2.1% of NISP=14,672) should be considered less of a rarity. Although the radius and ulna often break together in the distal third of the forearm in dogs (Tamás ed. 1987: 299), the chances of recovery are far better in domestic carnivores, in part owing to the smaller body weight of these animals.

No healed extremity fractures in cattle were found in the material under discussion here. This is not only a matter of sampling (caprine bones dominated at most sites available for study). As mentioned in the context of luxations, the prognosis of leg fractures is usually bad in large ungulates, whose substantial body weight tends to hinder or even prevent good recovery. Even in Europe, where archaeozoopathological research has been more extensive, healed metacarpus fractures are rare, for example, in horse (e. g. von den Driesch 1989: 651, Fig. 12; Bökönyi 1994: 203, Fig. 142). A 11th-12th metacarpus from a calf, broken and healed in its distal third, was published by Steber (1986: 72) from the site of Takht-i Suleiman (cattle: 23.2% of NISP=1,317). In this case, however, both the young age and the concomitant small live weight of the individual must have improved the chances of recovery.

Inflammations in the metapodial region were observed in a Roman Period pig (1.8% of NISP=1,866) at the site of Tel Dor, Area D2. Inflammation caused the development of a fistula in the proximal half of a 3rd metatarsus. Periostosis was described on the axial side of a fourth metatarsus of a Hellenistic to medieval (4th-13th century) pig (29.3% of NISP=486,256) from Lidar Höyük by Kussinger (1988: 84) who hypothetically linked it with tethering. That type of commonly occurring injury, however, is more typical on the tibiae of pig. In addition to innumerable examples (summarized by Benecke 1994), some Near Eastern examples include two healed tibia diaphysis fractures with a heavy muff-like, fusiform callus from Early Bronze Age (2700-2400 BC) Demircihüyük (pig: 8.5% of NISP=41,374; Rauh 1981: 87) and another case of "tethering" from the 9-14th century Armenian layers of Bassam (pig: 0.6% of NISP=6479; Krauß 1975: 85). Metapodium deformations are commonly thought to be related to tying the animal below its hock joint, while ethnographic examples show that tethering damages tissue above (proximally from) the pig's hock: the photograph of a pig thus tethered in Ecuador was, in fact, published by von den Driesch (1983: 42, Abb. 18).

Conclusions

While most trends outlined in this study hold true for all archaeozoological assemblages, regardless of their geographical position, the faunal composition of the sites under discussion here has an obvious bearing on what conditions are manifested in the material. Late prehistoric sites in Southwest Asia are characterized by the overwhelming dominance of bones from domesticates, especially sheep and goat, while the contribution of wild animal remains is usually negligible (For example, the massive dominance of caprines in the overall assemblage from Shahr-i Sokhta corresponds to the greater contribution of pathological specimens to that sample).

Many of the deformations discussed are arthropathies and deformations in the oral cavity observed in sheep and goat. This high frequency of periodontal disease is indirectly indicative of a harsh, possibly overgrazed environment. Pig is best represented at Horum Höyük, and indeed contributes importantly to the site's pathological record. Sites with higher percentages of cattle, on the other hand, yielded several specimens, possibly deformed during draught exploitation.

These examples illustrate that (similarly to better known sites in Europe) pathological bones may provide complementary environmental and culture historical evidence to archaeologists in this region.

Meanwhile extreme caution must be taken since, given the small absolute number of such finds, testable hypotheses can rarely be formulated. Never-the-less, many of the phenomena observed are fundamentally statistical in nature. One should, therefore, be very prudent in interpreting individual archaeozoopathological observations. Symptoms may be multi-causal and analogous. For example, not all arthropathies are necessarily related to work such as carrying or traction, and pathological lesions in a wild animal do not necessarily mean a life spent in captivity. Only the systematic accumulation of such rare information will offer a reliable view of animal disease in the archaeozoology of Southwest Asia.

While the dominance of certain domesticates (usually caprines in Southwest Asia) tends to mirror the habitat preferences of animals kept most successfully, these species also display more lesions for statistical reasons: large samples are more likely to contain rare specimens, including pathologically modified bone.

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