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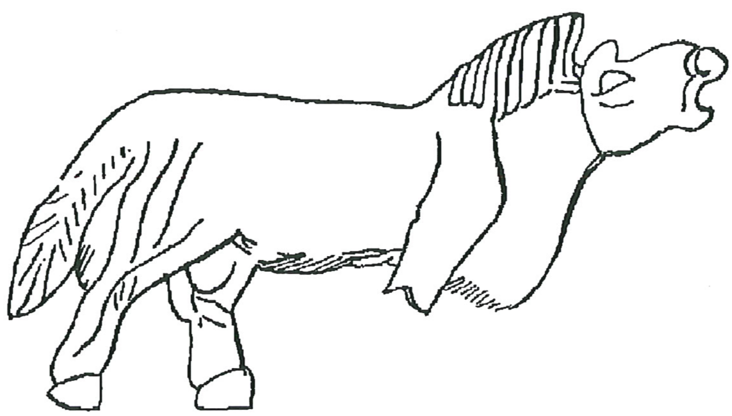

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Contents

VOLUME B

Contents

VOLUME A

A REVIEW OF ANIMAL REMAINS FROM SHAHR-I SOKHTA (EASTERN IRAN)

Sándor Bökönyi[1] † and László Bartosiewicz[2]

Abstract

This article is an analysis of identifications by the senior author whose preliminary observations were tested against a major body of data showing the dominance of domesticates, especially sheep, at this largely 3rd millennium BC site. A diachronic decrease in beef consumption and an increasing contribution by goat parallel the emergence of this urban settlement. Results from previous faunal analyses are also reviewed.

Résumé

Cet article est une analyse des identifications faites par le premier auteur, dont les observations ont été testées par rapport à un corpus de données montrant la prédominance des animaux domestiques, en particulier celle du mouton, sur ce site du 3^{e} millénaire BC. Chronologiquement, une baisse de la consommation du bœuf apparaît, parallèlement à une augmentation de la chèvre, au moment de l'émergence de cet établissement urbain. Les résultats des précédentes analyses sont aussi reconsidérés.

Key Words: Animal Keeping, Environmental Deterioration, Prehistoric Sistan, Protourbanism

Mots Clés: Élevage d'animaux, Déterioration environnementale, Sistan préhistorique, Proto-urbanisme

1. Introduction*[3]

Neglecting analyses abandoned for a variety of reasons is the rarely admitted last stage of taphonomic loss, rendering useless the animal remains from sites irreversibly destroyed by excavations. Posthumous publication and continuation of research work by the late Sándor Bökönyi has taken many forms, ranging from simple technical editing and proof reading (Bökönyi 1995a-b, 1998) to overall analyses of his identifications available in the form of only raw data (Bökönyi and Bartosiewicz 1997, 1999). In one case, it was even possible to report on new comparative results as a continuation of his previous research work (Bartosiewicz 1998a).

The situation with the ambitious project at Shahr-i Sokhta in eastern Iran has been particularly difficult owing to an unfortunate interplay between negative, often tragic circumstances. By the early 1980s, political turmoil had driven out foreign archaeologists from many countries in the region of the "Fertile Crescent": Afghanistan, Iran and Iraq (Bartosiewicz 1998b: 13). This broke the momentum of the "thorough evaluation of the mammal bone material" planned by Sándor Bökönyi (1985) long before his actual death in late 1994.

Nevertheless, the patchwork of data briefly summarized here contains valuable information which, even in an incomplete form, should be made available to fellow archaeozoologists and thus become an integral part of public knowledge concerning prehistoric animal exploitation in the Middle East.

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[1] This article is the posthumous compilation of Sándor Bökönyi's preliminary remarks and raw identification data analyzed and edited by the second author.

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[3] Indispensable complementary sections and comments, written entirely by the second author, are distinguished by asterisks throughout the text.

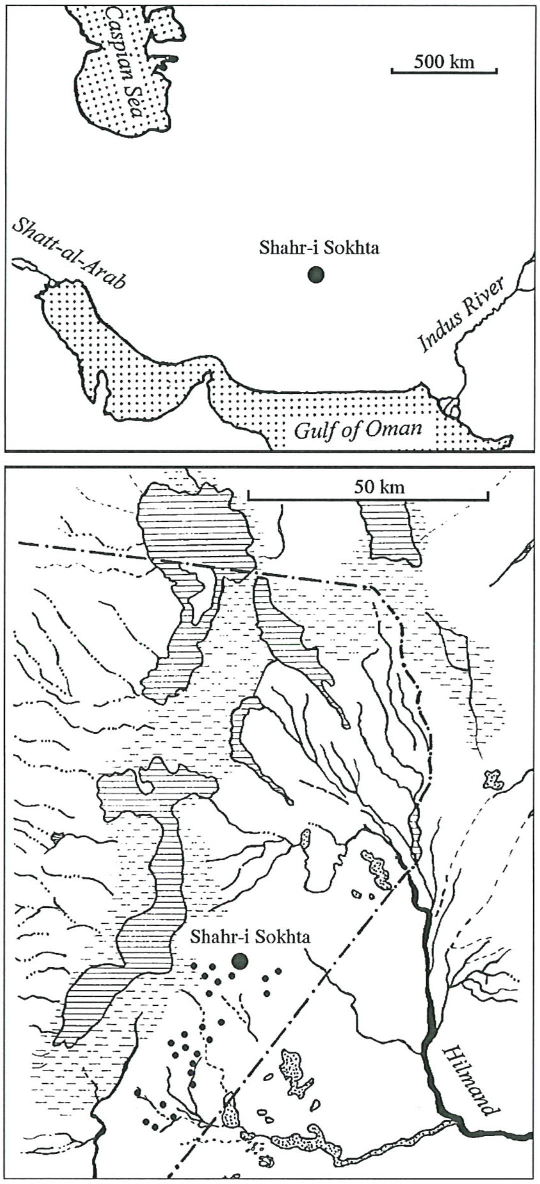

Fig. 1. The location of Shahr-i Sokhta in relation to regional hydrogeographic features in Central Asia (top) and in the reconstructed prehistoric landscape of Sistan (bottom). Smaller dots stand for 3rd millennium settlements as indicated by Lamberg-Karlovsky and Tosi (1973: Map 5)

2. Previous research at the site

Starting in 1967, the ten-year long excavation by the *Missione Archaeologica Italiana* of the sand-buried town of Shahr-i Sokhta in Sistan, discovered by Sir Aurel Stein in 1916, yielded one of the largest Bronze Age animal bone assemblages in the Middle East. In fact, Shahr-i Sokhta being located in Central Asia, falls very much to the east of the Near Eastern sites represented by the best known animal bone assemblages (cf. Clason and Buitenhuis 1998: 234, Fig. 2; Uerpmann 1987: summary maps).

Following the excavations, short reports on the fish finds (Tortonese 1977), together with preliminary reports dealing with the avifauna (Cassoli 1977) and the mammals (Caloi and Compagnoni 1977), all based on a selected part of the assemblage, were published. Subsequently, somewhat more detailed reports described the mammalian fauna in general (Caloi *et al.* 1978), the remains of camel (Compagnoni and Tosi 1978), half-ass (Compagnoni 1978a), gazelle (Compagnoni 1978b), wild sheep (Compagnoni 1980) and cattle (Caloi and Compagnoni 1981) in detail, although these studies were still based on the aforementioned incomplete selection of bones. The systematic identification and study of this large assemblage began in 1984 after having been formally entrusted to the author (Bökönyi 1985: 426). The first step was the revision of all previous identifications and the measurement of the already identified animal remains. After this had been done, the next step was the identification of the entirely untouched bone assemblage from the previous field seasons (1972-1976) in the settlement area of the site.

The results presented here are based on most of the previously not analyzed data, transformed into computer files during 1988-1989. Approximately 8% of the records were lost during the last decade due to damage to floppy disks, however, substantial information can still be obtained, especially on the mass of domestic animal remains not discussed in detail during earlier analyses.

The proliferation of preliminary reports often poses a danger that the steam will be taken out of comprehensive, in-depth analyses. However, in addition to the numerous short papers that have already explored the most exciting aspects of faunal information from Shahr-i Sokhta, the quantitative analysis of the remaining "bulk" is of help in drafting an academically proper, synthetic picture of animal exploitation at this proto-state urban settlement that reached such a remarkable level of development.

3. The location and environment of Shahr-i Sokhta*

During the 1970s, when Shahr-i Sokhta was thoroughly investigated, a number of detailed studies were published. Here only a few highlights can be provided that facilitate the appreciation of patterning in the zoological remains.

Sistan, the region under discussion here, largely corresponds to the ca. 270,000 km^2 delta region of the Hilmand River, within the 350,000 km^2 area of the land-locked Hilmand Basin, one of the most important internal basins in southern Central Asia. It lies at an average altitude of 500 m asl (Tosi 1968: 11; this is in contrast with the high mountains around the basin, some of which are more than an entire order of magnitude higher, well over 5000 m). One tenth of Sistan falls within the territory of present-day Iran, where the western frontier of Iran (dashed line in Fig. 1, bottom) juts out, north of the meeting-point of the borders between Afghanistan, Iran and Pakistan.

At 30° 39' of N latitude and 61° 22' of E longitude, Shahr-i Sokhta lies as the crow flies, approximately 1000 km (SE) from the Caspian Sea, over 600 km (W and N) from the Indus River as well as the Gulf of Oman respectively, and at least 1500 km (E) from Mesopotamia, i.e. the confluence of the Tigris and Euphrates Rivers forming the Shatt-al-Arab (Fig. 1, top). These geometrical distances are further enhanced by topographic features. According to Raikes (1983: 68), Shahr-i Sokhta must always have had access to a route along the Hilmand River towards the east, a seasonal route southwards along the high border between modern-day Iran and Pakistan, and an easy seasonal and possibly all-year round route through the mountains of Khorasan to Turkmenistan. He also points out, however, that "*there appears to be no feasible route, and there are no obvious archaeological links, to the west*" (Raikes 1983: 68).

Environmental investigations suggest that the climate in the territory where Shahr-i Sokhta was located was probably arid and continental, generally indistinguishable from today's. The Hilmand River basin forms part of the ever broadening dry belt that separates the temperate and tropical zones (Uerpmann 1987: 133). Prehistorically, this location was inhabited because the relatively humid environment of the Hilmand River delta may have favored sedentism or even irrigation agriculture (Raikes 1983: 68). The Hilmand, flowing east to west, is one of the four rivers that carry water from seasonal precipitation in the Hindu Kush Mountains into the river's two terminal lakes in Sistan, forming an integral part of the virtually closed ecosystem of Sistan. Today this ecosystem is characterized by a slow rate of regeneration and a dynamic interaction between three subsystems and the same number of intermediate belts (Costantini 1979: 100):

1. the well-watered branches of the delta into which the main course of the Hilmand splits;
2. the terminal lakes fed by the two major branches of the delta;
3. the diaphragms/marginal belts of the predesertic steppe basin.

The main course of the Hilmand River has turned almost 90° northwards during the last 5000 years (Fig. 1, bottom). Its now lesser branch, whose last section runs 70 km toward the east, once irrigated an estimated area of about 400 km^2 in the immediate vicinity of Shahr-i Sokhta (Costantini and Tosi 1978: 174-175). However, the southernmost of the large terminal lakes that lay west of Shahr-i Sokhta in Fig. 1, has turned into reed swamps and areas only periodically flooded by lakes and not even its prehistoric outline can be recognized on the satellite picture of Sistan (Basaglia et al. eds. 1977: 297, Photo 1). Present-day cultivated land, dependent on active deltaic fans, therefore falls north of the prehistoric settlement area (Costantini 1979: 101, Fig. 23).

The level of lakes into which the different branches of the Hilmand delta flow, varies considerably during the year and from year to year, depending on complex climatic effects within the broader area. This has caused devastating droughts throughout history. Tosi (1968: 12) characterizes present-day Sistan as a "*pre-desert steppe area*", in contrast to Iranian and Islamic sources predating the AD 15th century, which speak of fertile land and rich inhabitants in this region. He also refers, however, to a historical trend of catastrophic deterioration in the natural environment. In addition to a major drought recorded in AD 835, others occurred in 1870/1871, in the 1920s, 1944 and 1970/1971 (Jux

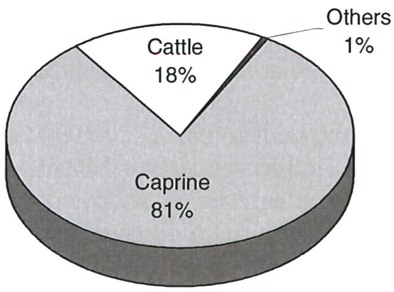

Fig. 2. The gross percentual composition of mammalian remains (NISP=15,040)

and Kempf 1983: 11). It seems therefore that the water supply was possibly the Achilles heel of large-scale human settlement in this area.

The water discharge of the Hilmand River depends on the amount of precipitation (esp. melting snow) in the mountains that surround the basin. The discharge is not increased by new tributaries across its long basin east of Sistan and there is a continuous decrease in the quantity of water owing to evaporation in the arid climate (Jux and Kempf 1983: 9). The prevailing north/north-western winds not only exacerbate evaporation but also tend to cause extensive crop damage (Costantini and Tosi 1978: 172). Although from a gross climatic point of view, this small section of Iran is very similar to Mesopotamia (Tosi 1969: 284), the large river basins opening to the sea that facilitated the emergence of different, complex communities along the Euphrates and Tigris/Shatt-al-Arab (or Indus, in the east) Rivers are missing. Hydrologically speaking, the land-locked basin of Central Asia is a closed system (Tosi 1983: 3). This also leads to increasing salination in the Hilmand delta area.

Shahr-i Sokhta itself is an approximately 20 m high *tepe* rising above the plain formed by neogene alluvial deposits in the Hilmand River delta (Tosi 1969). Its overall extent (in all periods) was approximately 150 ha (Caloi *et al.* 1978: 88). Most small settlements spread along the protohistoric river delta date to this time as well, i.e. when the territorial expansion of Shahr-i Sokhta peaked, supporting the hypothesis that Shahr-i Sokhta developed into some sort of coordinating center. During the more than 1000 years of its greatest extent (c. a. 3200 to 1800 BC; 4 cultural periods sub-divided into 11 structural phases), this large site, characterized by urban architecture, covered a maximum area of about 80 ha during its protostate phases between 2400 to 2200 BC (Period III; Tosi 1977: 54, Fig. 5).

4. The taxonomic composition of the animal bone assemblage

Together with previous identifications, the composition of the major sample presented in this paper (Fig. 2) has corroborated the main characteristics of the domestic and wild animal remains from this site as already outlined in a preliminary study (Bökönyi 1985: 426). The very high ratio of domestic mammals versus wild ones, in concrete terms, refers to 99% of 15,040 identifiable animal bones, even when all Canid and Equid bones are assumed to originate from wild species. During Periods II and III, best represented in the material and characterized by expanding human settlement, this ratio corresponds to the virtual lack of subsistence hunting in the meat provision of an emerging urban community. The overwhelming dominance of sheep and goat is not only a prehistoric phenomenon in the broader region. During the second half of this century, 28.7% of the livestock in Iran was made up by cattle, while sheep and goat contributed 54.4% and 23.6 % respectively (Corti *et al.* 1963).

4.1. Sheep and goat

The overwhelming majority of Caprinae (Gill 1972), particularly sheep, reaches 81% of the aforementioned number of identifiable specimens, which somewhat even exceeds the first estimate of 78.5% published by Caloi *et al.* (1978: 87).

Compromising between Zalkin's (1951) assertion concerning the monophyletic origins of domestic sheep (*Ovis aries* L. 1758) and the plethora of wild ancestors described in the literature, two possible ancestors of this domestic ruminant have been recognized by Uerpmann (1987: 126) for the purposes of his review of ungulates in the Middle East. The Asiatic mouflon (*Ovis orientalis* Gmelin

1774) is different from urial (*Ovis vignei* Blyth 1814) in having 54 rather than 58 pairs of chromosomes (Bunch and Foote 1977: 11). In addition, argali (*Ovis ammon* L. 1758) has also been considered a potential ancestor. Although the argali is distributed as far to the southeast as Baluchistan (Harris 1968: 342), the Transcaspian area and northern Iran, urials make their home in this area (Bökönyi 1993b: 348). The, at least sporadic, occurrence of wild sheep bones in the Shahr-i Sokhta material therefore most probably represent urial (cf. Compagnoni 1980).

A great variety of domestic sheep (*Ovis aries* L. 1758) horn cores were identified in all major phases of occupation. These include fragments of large specimens, one of them even reminiscent of the wild form. The conventional terms, "turbary" (Rütimeyer 1861: 191) and "copper" (Duerst 1904: 17) sheep denote domestic forms with short, untwisted and large, spirally twisted horn cores respectively. The straight, and twisted "*Zackel*" type horn form is known from Mesopotamia in the 4th millennium BC (Zeuner 1963: 187). Finally, the hornless (polled) variety is considered a Bronze Age product in Central and Eastern Europe (Bökönyi 1974: 158). Some non-specific but twisted horn core fragments were classified separately. The stratigraphic distribution of 41 of the classifiable horn cores/frontal bones was as follows:

Phase	"Wild"	Large	Turbary	Copper	Zackel	Polled	Twisted	Total
3-4					1		1	2
5		5	2		1			8
5-6	1		2			1	1	5
6		1	8	1		3		13
7							1	1
Phase unknown		4		1		4	3+1 sheath	12
Total	1	10	12	2	2	8	6	41

This variability in horn shape is in accordance with the fact that sheep was the most important domestic animal in the life of Shahr-i Sokhta during the 3rd millennium BC. Morphological studies on skull fragments at this site suggest that the urial had a tendency to develop more horizontally extended horns than the Asiatic mouflon (Bökönyi 1993a: 7). Following domestication, breeders seem to have, perhaps unconsciously, selected for strongly twisted large horns. In this way, a horizontal, corkscrew-shaped horn very soon occurred in Southwest Asia in domestic sheep. This richness of horn forms is remarkable, even if sexual dimorphism in horn conformation is reckoned with. In fact, the large, as well as the horizontally oriented and twisted "*Zackel*" type horn cores represent rams and may point to these animals having been native to the area. Ewes sometimes have "turbary" type horn cores, although the majority of female horn cores tend to be short, even rudimentary, triangular or even twisted in cross-section. The overwhelming majority of females, however, were certainly horned, and only eight skull fragments in this large sample pointed to hornless individuals.

In the case of goat, it is a very important characteristic that the cross-section of the horn in the wild ancestor becomes flat and almond-shaped while the scimitar-shaped horn develops an outward [*heteronymous**] curve (Bökönyi 1974: 192). Twisted horn cores occur at a very early stage of domestication, e.g. in the case of specimens found in the Kermanshah Valley in Iran (Bökönyi 1977: 18). Markhor (*Capra falconeri* Wagner 1858) is a wild goat with twisted horns. Its horn conformation, however, may be distinguished from that of domestic goat by its opposite twist (Benecke 1994: 239), in contrast to the form that has emerged under domestication. Markhor bones have been identified only at the protohistoric site of Loebanr III in neighboring Pakistan (Caloi and Compagnoli 1976: 39) in the region. Since markhor is a mountain species, its remains were not expected to occur in the Hilmand floodplain area.

Among the horn cores, a Phase 5 specimen was described as being of "*aegagrus*" type. The remaining horn core fragments could be classified into three categories:

Degree of heteronymous twisting	Slight	Medium	Strong	Total
4		3 sheaths		3
5		4+1 sheath		5
5-6			3	3
6	1	3	2	6
6-7			2	2
7		1		1
8		2		2
Phase unknown		3	2	5
Total	1	17	9	27

Owing to its extreme robusticity, a Phase 5 metacarpus fragment was identified as probably originating from wild, "bezoar" goat (*Capra aegagrus* Erxl. 1777), distributed toward the southeast as far as Baluchistan and possibly Afghanistan, although eastern populations of ibex (*Capra ibex* L. 1758) also reach as far as Cashmeer and the Northern Punjab (Harris 1968: 335).

4.2. Cattle

At Shahr-i Sokhta, there is evidence for humped and hornless cattle as well as the light-backed and horned species (Caloi and Compagnoli 1981). Of the various 140 thoracic vertebra fragments (Table 1) *spina bifida* was observed in six cases (eg. Bökönyi 1997: 651, Fig. 4), representing Phases 5 (2 specimens), 5-6, 6 and 8. One of these finds had no chronological affiliation. While this morphological phenomenon may also occur in humpless cattle, it is associated with greater probability with zebu.

Among the domestic cattle horn cores, five fragments were described as very thin-walled (without chronological identification). Three fell into the thin-walled category (Phases 5, 6 and a non-identifiable specimen). Another cattle horn core was medium thick, and only one was thick and curved with "ridges" i. e. furrows as mentioned by Caloi and Compagnoni (1981: 182). A domestic cattle skull fragment from Phase 5-6 indicated a large horn core base as well. Finally, a frontal bone with a wavy intercornual ridge was found in a Phase 5 deposit.

In addition to a phalanx media with heavy exostoses dated to Phase 7, a proximal phalanx with no chronological affiliation was similarly deformed. Exostoses on the articular surface of a calcaneus dated to Phase 6 may be considered an early stage of spavin* (Bartosiewicz *et al.* 1997d: 58).

The horn sheath and horn core fragments (Bökönyi 1985: 428) exhibit characteristics of the Indian subspecies of aurochs (*Bos primigenius namadicus* Falconer; Pilgrim 1939; Requate 1957) to which direct comparisons were possible. This is of interest firstly because the westernmost range of the distribution of Indian aurochs may have been in Sistan. The horn cores attributed to the wild form at Shahr-i Sokhta are smaller than those of European aurochs. Their form is less curved with oval cross-sections and conspicuously thick walls that distinguish them from the domestic form. They also reveal several longitudinal furrows and every horn core is characterized by a distinctive keel, on the dorsal and the ventral sides respectively (Bökönyi 1997: 652, Figs. 7-8). Shahr-i Sokhta certainly lay within the distribution area of Indian wild cattle as proposed by Epstein (1971: 511), and one may hypothesize that domestication actually took place in this region. On the basis of recent DNA analyses, it has been suggested that the taurine and zebu clades diverged from each other some 600,000 years ago (MacHugh *et al.* 1997; 1998: 137), long before the domestication of cattle. The aforementioned keels on the horn cores firmly link the aurochs horn cores from Shahr-i Sokhta to those of Indian aurochs. One of the robust horn core fragments could be attributed to a bull.

Postcranial bones of wild cattle were also recognized, especially in the sub-assemblages representing Periods I and II. An aurochs calcaneus of unknown chronological position had its tuber cut off. A Phase 5 scapula fragment was burnt, while a thoracic vertebra and distal tibia were gnawed by dogs.

Table 1. The anatomical distribution of mammalian bones

	sheep	goat	wild sheep	wild goat?	Caprinae	gazelle	cattle	aurochs	red deer	horse	hemione?	ass?	Equidae	pig	dog	hare	Carnivora	Mustelidae	Total
horn sheath	3	6					1												10
processus cornualis	44	95			4	6	39	1											189
os frontale	44	13			10		10								1				78
os occipitale							2												2
os temporale					7		6												13
os zygomaticum					20		5								1				26
os nasale							1												1
maxilla	2	2			327		44												375
os incisivum					1		4												5
mandibula	2	4			993		64	2										1	1066
ramus mandibulae	3				278		47												328
incisivus					25		2												27
caninus															2				2
lower cheektooth					462		94						1						557
upper cheektooth					633		44		1										678
cheektooth fragment					11		3												14
neurocranium	36	5			404		60									1			506
viscerocranium					45		24												69
cranium	6				162		78												246
os hyoidale					1		1												2
atlas	9	4			91	1	18	3											126
axis	43	16			36		8												103
vertebra cervicalis		3			349		102	1											455
vertebra thoracalis	3	1			482		140	1							2				629
vertebra lumbalis		6			463		138												607
os sacrum					47		12												59
vertebra caudalis					11		38												49
rib	6	1			818		509	1					1				2		1338
sternum							1												1
scapula	30	22	1		453		88	7											601
humerus	88	33	1		556		94	2											774
radius	90	48			540		83	1					1	1					764
ulna	9	16			260		58						1						344
carpalia	11				88		78	1											178
metacarpus	285	113	5	1	54		47	2											507
phalanx proximalis	7	4			336	2	114												463
phalanx media	4	1			114		62												181
phalanx distalis	23	7			29		37					1							97
os sesamoideum	12						15						2						29
pelvis	3	4			542		115										1		665
femur	23	5			630	1	110	1					1						771
patella	1				27		7												35
tibia	16	3			879	1	93	2		1	1		3						999
calcaneus	46	4			91		59	2											202
astragalus	15	15			30	3	41	1											105
os centrotarsale	2	2			63		22												89
tarsalia	1				9		10												20
metatarsus	362	110			89	2	90	1							1				655
total NISP	**1229**	**543**	**7**	**1**	**10470**	**16**	**2718**	**29**	**1**	**1**	**1**	**1**	**10**	**1**	**7**	**1**	**3**	**1**	**15040**

Although the environment in the Hilmand Basin would not have been an ideal habitat for European aurochs, the subspecies *namadicus* was, however, adapted to the savanna, similar to the Sistan parkland zone. Therefore it is reasonable to assume that some connection exists between the Indian aurochs and the humped domestic cattle or zebu, because the earliest zebu finds came to light from within the distribution area of Indian wild cattle (Meadow 1984: 322; Bökönyi 1990: 39). As far as Shahr-i Sokhta is concerned, there is ample coeval iconographic evidence of zebu cattle ranging from northern Baluchistan to Mesopotamia (Bökönyi 1997: 653). Although the possibility of interbreeding between wild and domestic cattle at Shahr-i Sokhta cannot be ruled out, especially during the early phases, by the time of the studied time interval the primary domestication of cattle has already been accomplished.

4.3. Equids

The revision and partial re-evaluation of bones revealed new information on Equids. Five or six bones and teeth representing this family could possibly be horse bones given their form, size and/or enamel patterns. Most of them originate from Period I, i.e. 3000 and 2800 BC. Since no wild horse remains have been found in the region from earlier periods, it appears that these remains originate from domestic horse (*Equus caballus* L. 1758). If this proves to be a valid assumption, they will represent some of the earliest domestic horses in both Sistan and in the Middle East in general. Chronologically speaking, these horses would be coeval with the famous pictographic evidence represented by the Proto-Elamite tablet from Susa (Bökönyi 1985: 427, Fig. 10). Should this hypothesis hold true, such late Chalcolithic horses at Shahr-i Sokhta may have come from stock domesticated in Central Asia which reached Sistan through the Transcaucasian region. Contacts with southern Turkmenia are well documented in Period I (Biscione 1973; Sarianidi 1983). As far as the introduction of horse and ass into Sistan is concerned, the presence of these two species at the site of Dahan-i Ghulaman restricted the period to between 1800 and 600 BC (Compagnoni 1980: 27). Therefore, the early horse find from Shahr-i Sokhta is of special interest. Identifications since the 1985 preliminary report, however, have yielded only a calcaneus of dubious chronological position that could be assigned to horse (Tables 1 and 3). The same holds true for a distal phalanx, possibly originating from domestic ass (*Equus asinus* L. 1758).

Less surprising is the discovery of an additional tibia fragment from hemione (*Equus hemionus* Pall. 1775) at Shahr-i Sokhta. Almost two dozen bone fragments convincingly attributed to this species were published by Compagnoni (1978a: 105). Although extinct in the region today, from a zoogeographical point of view it is plausible that this form of wild ass inhabited the broader region of Sistan. Two other Equid tibia fragments from Phase 6 with strongly striated caudal surface morphology may also be assigned to this species. Without detailed measurements, however, these identifications are as convincing as the taxonomic identification of fragmented clay figurines boldly described as “wild ass” (Tosi 1969: Fig. 145-147). A distal phalanx with a broken distal rim was tentatively identified as originating from donkey (*Equus cf. asinus* L. 1758).

4.4. Other ungulates

Among the gazelle remains a small, very slender horn core, does not seem to belong to the goitered or Persian gazelle (*Gazella subgutturosa* Güldentstädt 1780), probably identified at Shahr-i Sokhta (Compagnoni 1978b: 119), whose easternmost range may extend as far as Baluchistan. As a second gazelle species in Iran, Lay (1967) mentioned mountain gazelle (*Gazella gazella* Pall. 1766). Morphologically, however, the gracile Shahr-i Sokhta specimen under discussion here seems closer to Dorcas gazelle (*Gazella dorcas* L. 1758). This question needs further careful consideration, since mountain gazelle has also been re-classified as a subspecies of Dorcas gazelle (Groves 1969; Lange 1972), a species whose numerous varieties occur throughout Eurasia as well as North Africa (e.g. Nurkin 1978).

While the recently analyzed data contained only a single deer (*Cervus cf. elaphus* L. 1758) upper premolar tooth, a left distal tibia fragment and a calcaneus of an adult red deer turned up during the revision of osteological finds from earlier excavations (Bökönyi 1985: 428). These deer bones are extremely important finds that have the potential of fundamentally altering our perception of the environment in prehistoric Sistan, because the typical habitat for red deer is more-or-less dense forest and not just the riparian vegetation along watercourses. Therefore, the occurrence of red deer remains at Shahr-i Sokhta is possibly indicative of forests within the relative proximity of the site. In fact, among the tree species identified at Shahr-i Sokhta, maple (*Acer* sp.), hackberry (*Celtis* sp.) and to some extent, pistachio (*Pistacia* sp.), represent steppe forest formations that spread over the mountain ridges around the Sistan Basin, a habitat completely different from floodplain areas (Costantini 1979: 103) and probably preferred by red deer. Alternatively, the importation of deer dry limb bones may be hypothesized (e.g. from mountainous northwestern Baluchistan) either in association with preserved meat (Bökönyi 1985: 428) or even hides.* Another molar fragment, probably originating from deer, also came to light at Tal-i-Iblis in the nearby, hilly Kerman region (Bökönyi 1967).

The actual lack of both wild and domestic pigs is noteworthy (a single radius fragment from a subadult pig was identified from Period II-III), in spite of the favorable marsh habitat dominated by *Populetea* associations (including poplar, ash and elm; Costantini 1979: 103), and the appearance of several Suids (at least 4%) among the zoomorphic clay and terracotta figurines. The preferred habitat of wild boar (*Sus scrofa* L. 1758) is forest with dense undergrowth or reed jungles from which it will forage afield in agricultural land, and occasionally even into semi-desert terrain (Harris 1968: 375). This game, therefore, may have been sighted but not hunted by the inhabitants of prehistoric Shahr-i Sokhta.

4.5. Non-ungulate taxa

Other, sporadically occurring animal remains include two small canid ribs. In addition to a few dog remains, red fox (*Vulpes vulpes* L. 1758) was also identified at Shahr-i Sokhta (Caloi 1978: 129). A pelvis fragment from Phase 5 may be tentatively assigned to jungle cat (*Felis cf. chaus* Güldenstädt 1776) which inhabits riverine thickets, reeds and crop fields in Central Asia, including Baluchistan and Afghanistan (Harris 1968: 294). Smaller felid bones from Phases 5 and 6 have been identified as possibly originating from domestic cat (*Felis cf. catus* L. 1758) by Caloi (1978: 130). Along with increasing assemblage size, an occurrence of additional carnivores such as panther (*Felis pardus* L. 1758) had been expected by Bökönyi (1985: 428). Although the varied environment would have justified the presence of this extremely adaptable carnivore, a single reference to this species (Jarrige and Tosi 1981: 122, Table 1) could not be reconfirmed on the basis of the osteological record available for study.

Aside from fish remains, largely representing the carp family (Tortonese 1977; Costantini and Tosi 1978), and not identified to species in this paper, evidence of direct exploitation of the riverine environment is present in the form of a tortoise shell (*carapax*) fragment with cutmarks recovered from a Phase 6 deposit. The only unquestionably river-bound mammal at Shahr-i Sokhta otter (*Lutra lutra seistanica* Birula 1912), was identified in the material of Phase 7 (Caloi 1978: 129). Another bone representing the wild fauna is a Phase 6 neurocranium fragment that originates from hare (*Lepus* sp.), a commonly occurring species in cultivated grassland.

5. Domestication

A special model of domestication may be outlined from the central part of Iran through Sistan, Baluchistan and Pakistan as far east as India. This so-called Irano-Indian model does not differ from the others (in Anatolia/Mesopotamia, Arabia and Europe; cf. Bökönyi 1993a: 9, Fig. 1) in the domesticated species. It is, however, based on subspecies available in this broad region.

The complex history of domestic forms at Shahr-i Sokhta stems from the fact that while domestication models (including the Irano-Indian) have been mainly determined by both environmental and cultural factors, the settlement itself has a special zoogeographical position. It is located slightly west of the north to south boundary between the present-day Palaearctic and Oriental regions, near the point where a minor, east-west faunal divide also occurs within the former area (Uerpmann 1987: 134, Fig. 61).

Of the wild ungulates whose remains were recovered at Shahr-i Sokhta, there are at least three whose local domestication may be considered. Urial, bezoar goat and wild cattle of the *namadicus* form are the local ancestral forms of the most important domesticates that comprise 99% of the animal remains at this site. Although domestication evidently did not stop after the acquisition of the first domestic animals (Bökönyi 1993b: 355), its importance probably diminished parallel with that of hunting alongside urban development at Shahr-i Sokhta. Owing to the small number of wild animal remains, neither the primary (numerous individuals of transitional size) nor the secondary (sex ratios) osteological manifestations of the domestication process were marked in this assemblage.

6. Anatomical composition

In addition to the taxonomic inventory, the anatomical distribution of mammalian bones (except rodents) is also documented in Table 1. Regrettably, the data presented here could not be evaluated in sufficient stratigraphic detail, in the absence of annotated provenance information.[4] In principle, however, species distributions by skeletal element do have the potential of illustrating meat consumption at the level of individual households. Although no traces of monumental architecture were discovered in the sectors of Shahr-i Sokhta from which animal remains were analyzed (Tosi 1977: 61), differences in food refuse indicated different meat consumption patterns in richer residential areas and the quarters inhabited by craftspeople at the 3rd millennium BC tell site of Altyn depe in southern Turkmenistan (Masimov 1970). At Shahr-i Sokhta, food refuse from a craftsperson's house dated to Phase 5 contained masses of fish bone and egg shells, which dominated over the remains of "real meat" from caprines (Ligabue 1977: 239).

The figures listed for domestic ruminants in Table 1, were pooled by body regions as proposed by Kretzoi (1968: 61). Elements of the head, trunk, upper and dry limb, as well as terminal extremities (incl. caudal vertebrae) each may be perceived as meat value categories. Although this strictly utilitarian classification may not always correlate with the culturally idiosyncratic appreciation of various carcass cuts (Bartosiewicz 1997a), the analysis of meat values has been successfully used in the fine-grained reconstruction of prehistoric lifeways (most recently: Becker 1998).

In the case of the current study, distributions by Kretzoi's meat value categories offer at least general technical information. The relatively high number of trunk elements from large-bodied cattle may be indicative of specialized (possibly peripheral) butchering places, where some of the bones associated with less nutritive value (e.g. dry limb) were left behind. Caprines may have been butchered at a household level, thus resulting in a more even distribution of bones from all body regions over the habitation area.

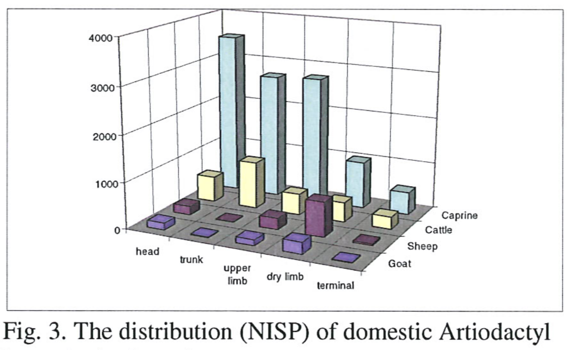

Fig. 3. The distribution (NISP) of domestic Artiodactyl bones by body region

In Fig. 3, columns for sheep, goat and non-identifiable caprines complement each other. This phenomenon, however, is attributable to differential identifiability rather than prehistoric human behavior: the overwhelmingly dominant, high number of dry limb bones for sheep and goat is explained by the easy identification of their metapodia. Skull fragments, on the other hand, are usually not identifiable beyond the subfamily level, with the exception of a few special diagnostic features such as horn cores. The same holds true for trunk elements including most vertebrae and especially ribs.

[4] Efforts at corresponding with the excavator, M. Tosi, have remained characteristically unilateral.*

7. Forms of exploitation

The intensification of urban settlement at Shahr-i Sokhta postdates the so-called "*secondary products revolution*" whose onset was dated to approximately the 4th century BC (Sherratt 1981: 262). By the early 1980s, the idea that inferences can be drawn from bones concerning the exploitation of more than meat had emerged from a decade of archaeozoological research (Bökönyi 1994: 21). In addition to the fact that the urban environment may be hypothetically linked with increased levels of specialization for all three domestic ruminants most characteristic of the Shahr-i Sokhta assemblage, these could have been exploited for secondary products: both iconographic and chemical evidence from coeval Egypt and Mesopotamia suggest that cows and perhaps goats may have been milked in Shahr-i Sokhta by the 3rd millennium BC. Draught cattle may also have been of fundamental importance in transport and tillage. In addition to the possibility of milking, sheep probably was also a provider of wool, a product well known from among other things, animal figurines recovered from sites in Iraq and Iran (e.g. Tepe Sarab, Tell al-Rimah: Bökönyi 1994: 24, Abb. 2-3). Sheep shearing lists, dated to the turn of the 3rd-2nd millennia BC, are known from Mesopotamia (Kraus 1966: 121). At Shahr-i Sokhta, direct evidence for wool processing is available in the form of textile remains dated to Phase 6, which contain an admixture of sheep wool and camel hair (Compagnoni and Tosi 1978: 97, Figs. 4A-B).

In a general sense, secondary exploitation is best expressed by an unusually high ratio of animals slaughtered at an adult age (Bökönyi 1994: 21). Thus, the analysis of age profiles lends itself to interpretations concerning the ways animals had been used at a particular site. Osteological evidence *per se* shows that all domestic ruminants at Shahr-i Sokhta were exploited for both primary (meat, hide and bone) and secondary (milk, wool, labor and probably dung) products.

While the evaluation of age profiles by period would have radically reduced individual subsample sizes, survival curves drawn for the pooled sample (predominantly Periods II and III anyway), display remarkably different patterns for domestic ruminants. The heterogeneity between the age classes of various domestic ruminants was verified carrying out χ^2 tests in two different arrangements in order to guarantee sufficiently great sample sizes.*

Table 2.The homogeneity of age distributions (O=observed, E=expected)

Age group	Caprine		Cattle		Total
	O	*E*	*O*	*E*	
embryo/neonatal	12	24	16	4	28
juvenile	738	816	218	140	956
subadult	1324	1222	168	210	1432
adult	1863	1866	324	321	2187
mature	373	330	14	57	387
senile	17	17	3	3	20
Total	**4327**		**743**		**5070**

1. First, all age classes of pooled caprines (including identifiable sheep and goat) were contrasted against those of cattle in Table 2 (Total NISP=5070). Especially in the younger age groups, an opposite trend is apparent: fewer caprines and more cattle were slaughtered at very young ages than expected on the basis of the total variance of the sample. The inverse of this situation is apparent in the case of subadults, young cattle being especially underrepresented in the food refuse. Relatively few bones from mature cattle were recovered. This tendency is highly significant (χ^2=147.906, degree of freedom =5; p≤0.001) in formal statistical terms.
2. In the second case, only the most numerous *juvenile, subadult* and *adult* age classes were tested, since taxonomic groups have been subdivided to identifiable sheep, goat and cattle bones (Total NISP=1394, non-identifiable caprine bones were not included). Heterogeneity was similarly significant (χ^2=122,826 degree of freedom =4; p≤0.001) within this data set.
3. The aforementioned significant results give credibility to the survival curves constructed for the domestic ruminants involved (Fig. 4). Aside from the fact that juvenile sheep bone is rather prone to taphonomic loss, a higher number of sheep seem to have survived to at least subadult or even adult age. An evenly decreasing, convex survival curve is typical for the sample of 499 sheep

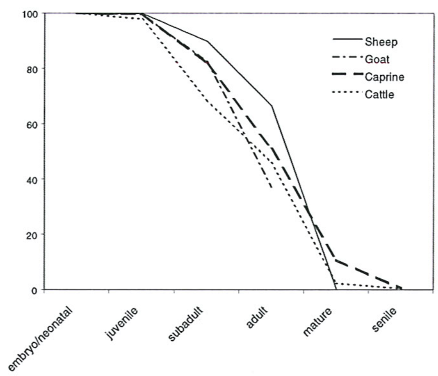

Fig. 4. Survival (%) curves of the domestic Artiodactyls

bones that may be indicative of most animals kept until they are older for the purposes of wool exploitation. Ageable goat bones, occurring in the smallest numbers (188), show an even more steeply declining curve with the advancement of age. This, as well as the curve calculated on the basis of 3657 caprine bones (without precise, species level identification) suggest that but a few individuals survived until adulthood. The 743 ageable cattle bones display a remarkable "depression" in the subadult age group, somewhat reminiscent of Payne's "A" model, characteristic of males in meat-purpose herds of modern-day caprines in Turkey (Payne 1973). The relatively high proportion of remains from "excess juvenile" and adult specimens may be indicative of the slaughter of young calves and older animals beyond the optimum age for secondary exploitation. Two forms of this latter may include milking and traction.

8. Chronological distributions

Using a combination of absolute and relative (stylistic) dating, the almost 1.5 millennium long life span of the settlement (3200 to 1800 BC) could be sub-divided into 11 phases (10 to 0: numbering decreasing through time) that represent four major cultural periods (I to IV: numbering increasing through time; Caloi *et al.* 1978: 88-89, Table 1). The general definition of cultural periods is as follows (Costantini 1979: 90, Table 1):

Period I	3200-2700 BC	archaic phases with proto-literary evidence
Period II	2700-2400 BC	proto-urban phases with maximum long distance trade
Period III	2400-2100 BC	proto-state phases with maximum settlement expansion
Period IV	2100-1800 BC	late or post-urban phases

On the basis of the information available, over two thirds of the 15,141 animal remains could be classified into one of the first three periods at Shahr-i Sokhta (no bones were available from Period IV corresponding largely to the 2nd millennium BC). Numbers of identifiable bone specimens within the relevant time interval are listed in Table 3. These figures show that the diachronic distribution of bone remains was heterogeneous even between Phases 9 to 4-3, from which zoological materials were studied.

Fig. 5 shows that while human habitation reached its greatest extent (c.a. 80 ha) during Period III, the majority of bones under discussion in this paper represent Periods II and the transition to Period III, that is, the proto-urban and early proto-state phases (characterized by most intensive long distance trade and greatest settlement expansion respectively). This slight chronological discrepancy means that these animal remains will primarily illustrate meat consumption during the proto-urban interval characterized by increasing urbanism, centralization and hypothetical prosperity. "Proto-urbanism" was defined by Tosi (1981) as a term integrating society and political economy, emphasizing the spatial over the institutional aspect. There is a conceptual overlap between this term and the early state as defined by Claessen and Skalnik (1973).

Table 3. The chronological sub-division of animal remains

Period	I			II				II-III	III					
Phase	9	8	8-7	7	7-6	6	6-5	5	5-4	4	4-3	3	Non-id.	Total
Year, BC	3000-2900	2900-2700		2700-2600		2600-2500		2500-2400		2400-2300		2300-2100		
Taxon														
sheep	3	36	3	43	20	218	58	222		7	63		556	1229
goat	1	10		28	9	97	81	109		6	17		185	543
wild sheep		1		1		1		4						7
wild goat?						1								1
Caprinae	4	354	24	399	326	2195	1002	2471	3	51	323		3318	10470
gazelle						2	1	7					6	16
cattle	47	190	28	113	105	498	311	593	3	25	108		697	2718
aurochs		1	1	1	1	6	2	9			2		6	29
red deer								1						1
horse													1	1
hemione?							1							1
ass?													1	1
Equidae				1		4	1	4						10
pig						1								1
dog		2				3		1					1	7
hare						1								1
Mustelidae													1	1
Carnivora								1			1		1	3
Rodentia				1		5							13	19
bird non-id.		1		6		28		3					13	51
fish non-id.						9							20	29
Chelonia						1								1
Crustacea													1	1
Total	**55**	**595**	**56**	**593**	**461**	**3070**	**1457**	**3425**	**6**	**89**	**514**		**4820**	**15141**

Diachronic trends apparent in the data will be less reliable in the earliest Period I as well as in Period III, after which a radical decline in human habitation can be observed. Since the overwhelming majority of bones originate from Period II, they will best illustrate the emerging trend between these two points in the life of Shahr-i Sokhta. The relatively small number of animal bones from Period I is probably the logical consequence of the limited nature of the excavations at this small early settlement. The area of occupation during Period IV was small to begin with. Between the drastic reduction in the habitation surface and subsequent erosion, no bones were available from this part of Shahr-i Sokhta.

9. Diachronic changes in taxonomic richness*

As a result of the stochastic relationship between the number of identifiable bones recovered and the number of animal species thus recognized, comparing assemblages of varying sizes in percentual

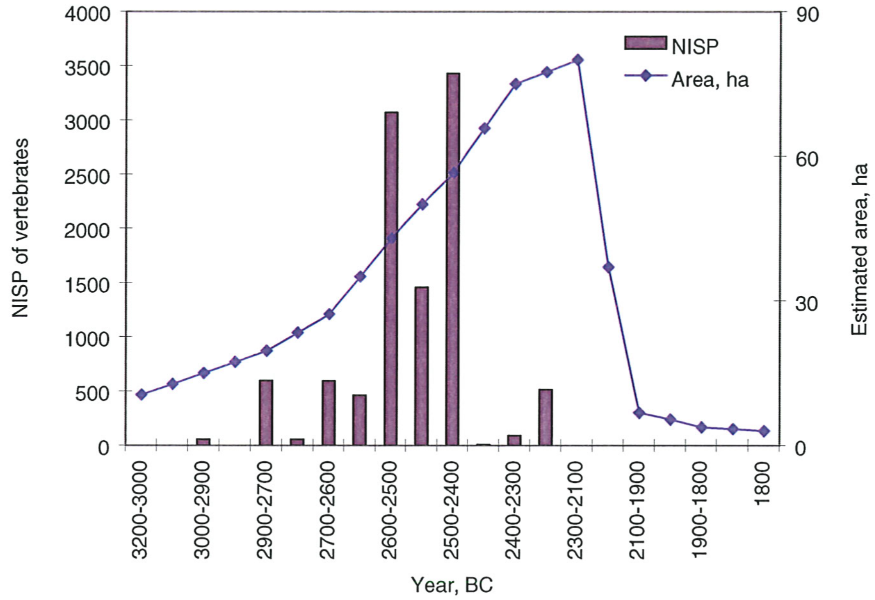

Fig. 5. Relationship between the estimated habitation area and animal finds available for study

terms may be misleading. The relationship between NISP and taxonomic richness, however, is not linear (Grayson 1984: 137). While rarely recovered species have a greater statistical probability of occurring only in large assemblages, increasing assemblage size is followed by the discovery of new taxa in a degressive manner. When decimal logarithms of these two variables are plotted against each other by chronological phase, a largely linear trend may be expressed by the regression equation in Fig. 6. The b=0.299 regression coefficient ("slope") is not only highly significant in formal statistical terms ($p \leq 0.001$), but suggests that there were relatively few animal species exploited at Shahr-i Sokhta comparable to, say, civilian settlements in Roman Period Pannonia (b=0.257, Bartosiewicz 1990-1991: 109). Crabtree (1990: 160) illustrated the same trend using prehistoric examples from the Middle East, but also emphasized the apparently great variability in species diversity.

This line of thought implies the research hypothesis that at the emerging, proto-urban settlement of Shahr-i Sokhta, the relatively greater number of species identified in the best represented phases is a product of sample size, i.e. that the unquestionable dominance of sheep remains is indicative of an increasingly monotonous pattern of animal exploitation. This hypothesis is apparently supported by the chronological distribution of "less well represented" macromammalian finds published by Caloi *et al.* (1978: 89, Table 2), 62% (NISP) of which are concentrated in Periods II and II-III, best represented in the assemblage under discussion here. All 7 "rare" mammals occurred within this time interval.

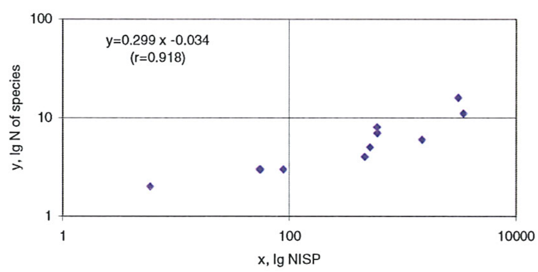

Fig. 6. The relationship between assemblage size and taxonomic richness

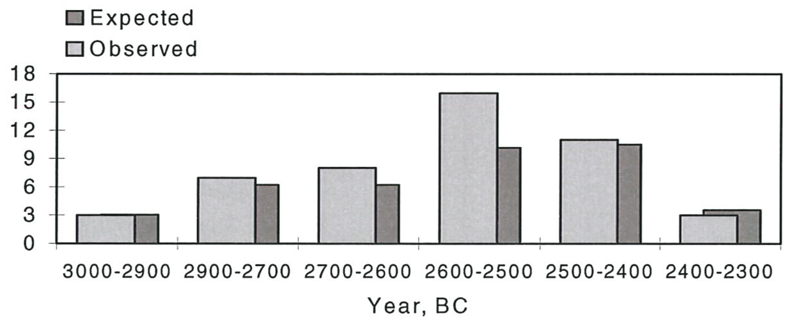

Fig. 7. Diachronic changes in the number of species identified

Substituting NISP values listed in Table 3 into the regression equation shown in Fig. 6, however, has partially disproved this research hypothesis. A comparison between the number of species actually observed (Table 3) and expected on the basis of the statistically significant linear trend (Fig. 6) shows that in Phase 6 (at the end of the proto-urban period), an unusually great number of species were found, regardless of assemblage size (Fig. 7): in addition to the full range of ruminants (exc. deer), this sample included pig, dog and hare as well as rodents, birds and fish (not identified to species). This greater taxonomic diversity, however, gradually declines with the advancement of site expansion, urban reliance on nothing but the basic domestic ruminants, reduced the number of species to an even greater extent than would be expected on the basis of NISP.

10. The changing roles of domestic ruminants at Shahr-i Sokhta*

The gross observation that over 80% of the animal bones at Shahr-i Sokhta originated from caprines, while the remaining ca. 20% came almost completely from cattle (Fig. 2) could be fine-tuned on the basis of the larger chronological sub-assemblages. Evident differences between the NISP values of cattle, and [identifiable] sheep and goat (Table 3) observed throughout the chronological sequence of the settlement were quantified by using an additional χ^2 test. This calculation was based on material from Phases 8 to 4, ranging from the late phase of Period I to the earliest phase of Period III (other sub-assemblages were simply too small to be included in the calculation).

Hypothesized changes in species composition are evidenced by the statistically significant ($p \leq 0.001$) heterogeneity in the diachronic distribution of bones from sheep, goat and cattle among the five phases studied ($\chi^2=35.699$, degrees of freedom = 8). The directions of these changes are outlined in Fig. 8. In this graph, expected values (100% for each species) stand for the NISP that *should have been obtained* in the case of diachronically homogeneous distribution between the three species compared here.

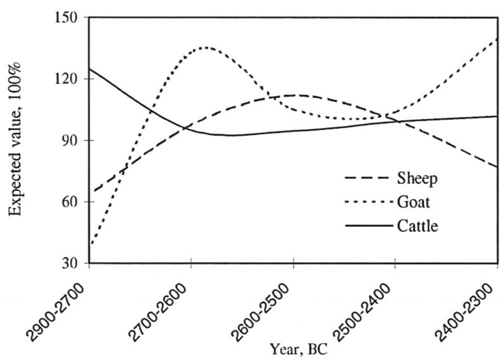

Fig. 8. Diachronic changes in the observed NISP relative to the expected value (100%) calculated for each species

The curves obtained clearly show the relatively high contribution of cattle in the earliest, archaic Phase 8 (sub-samples predating that time were too small for this type of calculation). Deviation from the expected values of cattle remains was considerably less dramatic for the rest of Period II and III. In spite of a slight increase, beef consumption at the settlement (as evidenced by bone remains) never returned to Period I levels.

The number of sheep bones increases steadily relative to the expected value until the beginning of Period III. Following this peak a gradual decline follows (Fig. 8). This trend seems to somewhat predate the decrease in

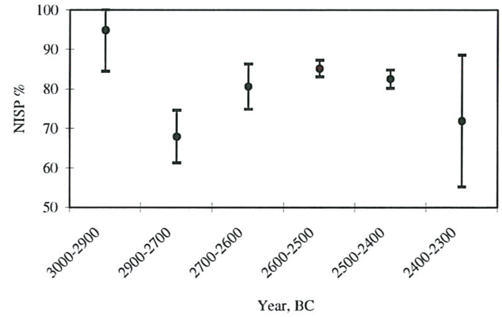

Fig. 9. The 95% confidence intervals of caprine NISP among all domestic ruminants

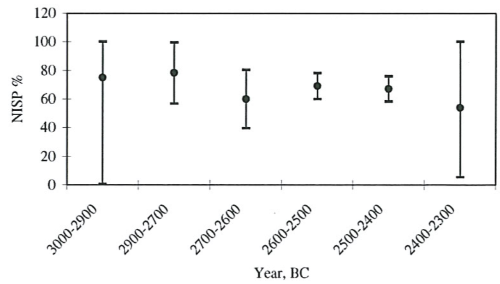

Fig. 10. The 95% confidence intervals of sheep NISP among all identifiable caprines

settlement area (Fig. 5). Nevertheless, this "rise and fall" does not contradict the overwhelming dominance of sheep remains throughout the chronological sequence.

Finally, identifiable goat remains (smallest in number) vary most capriciously between Phases 8 and 4. While the role played by this species seems negligible at the end of Period I (when cattle bones abound), goat bones occur in unexpectedly high numbers at the beginning of Period II. During that period, goat bones are as frequent as expected on the basis of homogeneous diachronic distribution (near 100% in Fig. 8). At the beginning of proto-state Period III, however, goat remains again start occurring in unexpectedly great numbers.

For logical reasons, caprine bones (non-identifiable) either as sheep or goat, had to be left out from tests of homogeneity. In light of the evident changes that took place during the 3rd millennium, all bones in this category (pooled with those of identifiable sheep and goat) were compared to percentual values of cattle. The result, i. e. the percentual contribution of sheep/goat to all remains from domestic ruminants is shown with 95% confidence intervals in Fig. 9. A high ratio of caprines is characteristic of the earliest, archaic Phase 9, but this percentual value is based only on a NISP=55 sample. In subsequent periods, however, percentages mirror the gross tendency displayed by sheep remains in Fig. 8: an increase and decline in the contribution of [pooled] caprine bones. Finally, bones in Phase 4 (at the onset of Period III), fit this overall trend with broad error margins owing to small assemblage size (NISP=89; within the 95% confidence intervals, the ratio of caprine bones may have varied anywhere between 55 to 90%). In Fig. 9, the difference between Phases 8 and 7 seems most convincing.

Although pooling all caprine remains had a beneficial effect on sample size, it potentially masked differences between sheep and goat resulting from different modes of exploitation. Comparisons between these two species in Fig. 10 indicate a gradual increase in the mean percentage of goat at the expense of sheep. However, with the possible exception of a drop inbetween Phases 8 and 7, most of these differences are swamped by broad confidence intervals (especially in the small Period I and III assemblages). From Period II onwards, 50 to 80% of identifiable caprine remains originated from sheep and, correspondingly, 50 to 20% came from goat.

11. Images of animals at Shahr-i Sokhta*

It is worth appraising the place of animals in the cognitive mindscape of the inhabitants of Shahr-i Sokhta in light of the osteological evidence evaluated in this paper. The iconographic treatment of animals may, in part, reflect their real-life importance. On the other hand, for a number of cultural reasons, certain animals may be overrepresented in the iconographic record, while others may be completely ignored. From the viewpoint of diffusion, both animals and their representations may be localized to varying degrees:

1. The intensity by, and the distance to which domestic animals spread is determined by their physiological makeup. Camel or horse may be taken to far away countries, while pigs are notoriously difficult to herd over long distances, especially in dry environments.
2. The circulation of iconographic evidence is determined by the material and medium of representation. High quality, decorative ceramics may carry the image of animals far beyond the borders of their zoological distribution, while less durable unfired clay figurines tend to be far more localized.
3. A special group of archeozoological finds is that of raw materials or processed animal remains circulated by traveling and trade (Choyke 1995), which thereby acts as part of the *sensu lato* taphonomic process. This category is somewhat more convincingly illustrated by the 21 species of marine shells identified at Shahr-i Soktha (Durante 1979: Table 1), than by the hypothesized import of a deer's leg (Bökönyi 1985: 428). A study of manufacturing and trade, however, is beyond the scope of the present study.

A seal imprint on a Period II-III sherd from Shahr-i Sokhta (Lamberg-Karlovsky and Tosi 1973: Fig. 48) shows a big horned and possibly woolly sheep (with a tail pointing downward), while a series of ram-like creatures decorate a Period IV canister jar as well (Tosi 1973: Fig. 64). Typical goat representations appear on Black-to-brown surface ware (Tosi 1968: Fig. 15/b and d). Of the wild animals, long-eared "onagers" were depicted on a Buff Ware sherd (Tosi 1983: 141, Fig. 2), while an antlered beast, probably a stag, occurs on a Period II-III on a Buff Ware pear-shaped beaker (Tosi 1969: Fig. 28/a).

Zoomorphic figurines occur in even greater numbers at Shahr-i Sokhta, and some have been listed by Compagnoni and Tosi (1978: 96, Table 2) in relation to a Phase 7 bone fragment tentatively identified as a dromedary. In the absence of clear, qualitative morphological traits, however, the "zoological" identification of artwork often remains dubious. Although no position can be taken on this particular specimen, the percentual distributions of other animal species among clay/terra-cotta figurines were compared to the contribution of relevant bones in the assemblage under discussion here in Fig. 11.

The number of cases included in this graph was taken as 100% for bones and figurines, respectively. Due to the overwhelming dominance of cattle in particular, for purely heuristic reasons, the decimal logarithms of percentages were plotted along each axis representing one of the eight animals (This means that in Fig. 11, -2, 0 and 2 stand for 0.01, 1 and 100% respectively). Discrepancies between the resulting polygons show that while commonly occurring [identifiable] sheep/goat, gazelle and birds appear relatively infrequently in figurines, cattle is represented most "fairly" among these artifacts. Aside from equids (comparable to gazelle), relatively frequently depicted canids and especially pig are underrepresented in the osteological assemblage.

The configuration in Fig. 11 shows that extreme care must be taken when inferences are made on the basis of even the localized artistic representation of animals. On the other hand, the negligible contribution of canids (obviously not exploited for meat) to the faunal material is complemented by numerous gnawing marks on the refuse bone.

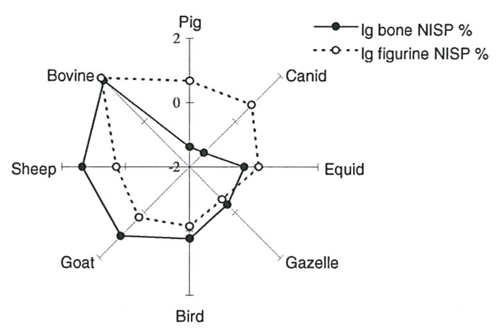

Fig. 11. Decimal logarithms of the percentage of bone NISP and figural representations in Phases 5 to 8

Among the resources available to craftspeople, organic materials at Shahr-i Sokhta supposedly included wild boar ivory, denoted as "rare" in one of the archeological reports (Jarrige and Tosi 1981: 122, Table 1). Such precious finds, however, are often arbitrarily separated from the zoological material and retained among the "*Kleinfunde*" by archaeologists. This information, therefore, could not be verified on the basis of the animal bone assemblage available for study

Strictly speaking, the parallel bands painted on the flanks of the Period II figurine of a "young boar" (Tosi 1983: PLXX, Fig. 64) could equally reflect an atavism possibly present in unimproved domestic pig (cf. Bartosiewicz on Egyptian pig in this volume). In the case of Shahr-i Sokhta, accepting the argument that scarcity of bone remains is evidence against domestication (Uerpmann 1987: 55), the identification as wild pig for both this figurine and the single pig radius found at the site, is more plausible, although precise (metric) identification is limited by two factors:

1. the dimensions of bones from subadult animals, unless extremely large, are not an acceptable basis for determining the wild/domestic status of suids.
2. While size ranges for the bones of subfossil European wild pig (*Sus scrofa scrofa* L. 1758) have been established (Bökönyi 1995: 7-8), they are not necessarily valid for the oriental subspecies (*Sus scrofa cristatus* Wagner 1839) that may have inhabited the marshlands of Sistan.

From the viewpoint of zebu keeping it is of interest that (in addition to the osteological evidence of bifid thoracic vertebrae) over 3/4 of a total of 192 bovine figurines identified from Phases 8-5 at Shahr-i Sokhta seem to depict this form (Compagnoni and Tosi 1978: 96, Table 2). Meanwhile, not only were forward-pointing taurine horns depicted on an animal with a slight hump (Tosi 1968: Fig. 64), but humpless figurines were also found (1.7 %). A rare, theriomorphic vase from Period II may also be interpreted as showing a bull, however, the mouth of this vessel is exactly in the region of the withers (Lamberg-Karlovsky and Tosi 1973: Fig. 141), thereby making the discussion of a hump rather difficult. Should the hump and dewlaps indeed have developed as a result of selective breeding prior to Harappan times (Mason 1963: 18; Meadow 1979: 307), an endless debate might be opened as to whether humpless figurines represent the wild ancestor or taurine type domestic cattle.

Only the remains clearly identifiable as those of sheep or goat were used in the comparison seen in Fig. 11: the inclusion of all caprine bones (2/3 of total NISP) would have tipped the visual pattern off balance. The mundane character of this general group, however, is also shown by their presence in burials. The number of graves available for study after the 4th, 1976 excavation season, amounted to 202 out of the estimated 22,000 burials in the graveyard of Shahr-i Sokhta (Piperno 1979: 123). Evidence for juvenile caprines ("kids") was observed in 17 graves. In eleven burials, dated to Periods I-II (Phases 9 to 7), complete skeletons of these animals were found near the skull of the deceased. Among these, the human skeleton was disturbed in six cases, which led to the conclusion that these offerings were buried following the interment of the human (Piperno 1979: 135). While the author published no zoological detail on these animals, the sacrifice of young lambs/kids, easily available among domestic stocks, is a notable phenomenon in and of itself.

12. Metric properties of sheep and cattle limb bones

Aside from the comment by Caloi and Compagnoli (1981: 181) that most bones, being food remains, were generally very fragmented, no direct information (bone weight, fragment length) is available on bone preservation. Poor state of preservation would be very typical of intensive habitation, often accompanied by trampling and multiple redeposition. The 25 cattle and 117 sheep/goat long bones preserved in full length correspond exactly to 1% of all bones in either of these two taxonomic groups, which does not express the differential fragmentation usually characteristic for animals of unequal sizes (Binford and Bertram 1977; Bartosiewicz 1991: 202).

Univariate statistics for each of the measurements available for study (in essence, corresponding to the international standard; von den Driesch 1976) are listed in Tables 4 (sheep) and 5 (cattle), in order to facilitate comparisons with other assemblages. Selected transversal extremity bone measurements are presented in the form of bivariate plots in this study, each accompanied by a regression equation numerically expressing the relationship between the two bone measurements concerned.

Table 4. Statistical parameters of sheep bone measurements (mm)

Humerus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	1	145.0							
Diaphysis breadth	55	15.9	1.6	12.0	18.5	15.4	16.3	-0.2	-0.5
Distal breadth	273	31.8	2.3	26.5	40.0	31.6	32.1	0.3	0.2
Diaphysis depth	4	16.7	1.7	13.0	20.0	16.2	17.1	0.1	-0.6
Distal depth	273	27.9	2.1	21.0	33.0	27.6	28.1	-0.1	0.1
Radius	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	13	159.1	8.0	145.0	169.0	154.2	163.9	-0.3	-1.1
Proximal breadth	219	32.8	2.2	28.0	39.0	32.5	33.1	0.2	-0.3
Diaphysis breadth	40	16.0	1.1	13.5	18.0	15.7	16.4	-0.4	-0.6
Distal breadth	53	30.1	2.0	26.0	35.0	29.5	30.6	0.3	-0.4
Proximal depth	219	16.8	1.2	14.0	21.0	16.7	17.0	0.4	0.7
Diaphysis depth	92	9.2	0.8	7.5	11.0	9.1	9.4	-0.2	-0.5
Distal depth	53	20.5	2.0	9.5	24.0	20.0	21.0	0.1	0.0
Metacarpus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	40	137.9	8.6	121.0	153.0	135.2	140.7	0.0	-0.8
Proximal breadth	207	24.5	1.9	13.5	29.0	24.3	24.8	-1.5	8.7
Diaphysis breadth	99	13.8	1.1	11.7	17.2	13.6	14.1	0.0	-0.5
Distal breadth	256	26.2	1.8	23.0	33.0	26.0	26.5	0.9	1.5
Proximal depth	207	17.9	1.3	9.0	21.5	17.7	18.1	-1.2	8.9
Diaphysis depth	177	9.7	0.8	8.0	13.0	9.6	9.8	0.6	1.0
Distal depth	255	17.4	1.2	12.0	27.0	17.2	17.5	1.9	14.8
Femur	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	1	160.0							
Proximal breadth	18	46.3	3.2	42.0	52.0	44.7	47.9	0.2	-1.3
Diaphysis breadth	5	16.8	1.6	15.0	18.8	14.8	18.7	0.4	-2.0
Distal breadth	4	39.7	3.8	36.0	45.0	33.6	45.7	1.2	2.3
Proximal depth	18	23.8	1.6	21.0	27.0	22.9	24.6	0.4	-0.6
Diaphysis depth	4	17.2	1.3	16.0	19.0	15.1	19.2	1.4	2.4
Distal depth	4	40.6	12.1	22.5	48.0	21.3	59.9	-2.0	3.9
Tibia	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	8	211.8	21.2	186.0	242.0	194.1	229.4	0.5	-0.8
Proximal breadth	3	42.3	5.8	39.0	49.0	28.0	56.7	1.7	
Diaphysis breadth	8	14.8	1.6	13.0	17.3	13.4	16.1	0.8	-0.7
Distal breadth	8	26.3	2.7	23.0	30.0	24.1	28.5	0.4	-1.1
Proximal depth	3	43.7	3.2	40.0	46.0	35.7	51.7	-1.5	
Diaphysis depth	7	11.7	1.0	10.2	13.0	10.8	12.7	0.0	-0.7
Distal depth	8	20.3	1.6	18.0	22.5	19.0	21.6	0.0	-1.3
Astragalus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	11	30.1	1.7	27.0	32.0	29.0	31.2	-0.5	-0.8
Distal breadth	11	21.5	1.8	18.0	24.5	20.3	22.7	-0.3	0.6
Distal depth	11	16.8	1.6	14.0	19.0	15.7	17.9	0.0	-0.9
Calcaneus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	190	57.7	3.7	47.0	66.5	57.2	58.2	0.2	0.0
Distal breadth	134	21.3	1.6	16.0	27.0	21.0	21.5	0.4	2.0
Distal depth	143	23.3	1.6	18.5	27.5	23.1	23.6	-0.1	1.0
Metatarsus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	29	150.5	11.0	126.0	170.5	146.4	154.7	-0.4	-0.2
Proximal breadth	132	21.3	1.4	18.5	27.0	21.1	21.6	0.7	1.2
Diaphysis breadth	84	12.0	1.1	9.5	15.0	11.8	12.2	0.4	0.5
Distal breadth	261	24.7	1.4	20.5	28.0	24.6	24.9	-0.1	-0.3
Proximal depth	131	21.7	1.3	18.5	25.0	21.5	21.9	0.2	0.1
Diaphysis depth	199	10.0	0.8	7.8	12.5	9.9	10.1	0.1	0.1
Distal depth	262	17.2	1.1	14.0	21.8	17.0	17.3	0.2	1.0

Table 5. Statistical parameters of cattle bone measurements (mm)

Humerus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Proximal breadth	1	101.0		101.0	101.0				
Diaphysis breadth	3	39.8	5.5	33.5	43.0	26.2	53.5	-1.7	
Proximal depth	1	107.0		107.0	108.0				
Diaphysis depth	3	46.7	7.1	39.0	53.0	29.0	64.3	-0.8	
Distal depth	11	83.5	7.8	75.0	98.0	78.2	88.7	0.5	-0.9
Radius	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	2	314.5	4.9	311.0	318.0	270.0	359.0		
Proximal breadth	33	129.1	14.3	113.0	155.0	118.1	140.1	0.6	-0.6
Diaphysis breadth	6	42.9	3.0	39.0	47.0	39.7	46.1	-0.1	-1.3
Distal breadth	16	77.2	7.8	66.0	92.0	73.0	81.4	0.7	-0.2
Proximal depth	33	46.3	4.2	36.0	53.0	44.9	47.8	-0.5	-0.3
Diaphysis depth	9	25.2	2.2	22.0	28.0	23.6	26.9	-0.3	-1.6
Distal depth	16	47.8	4.9	43.0	58.0	45.2	50.3	1.1	-0.1
Metacarpus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	16	216.4	7.7	205.0	230.0	212.3	220.5	0.3	-1.0
Proximal breadth	39	61.7	4.2	55.5	76.0	60.4	63.1	1.2	2.4
Diaphysis breadth	23	34.5	4.3	28.0	42.0	32.6	36.3	0.1	-1.1
Distal breadth	54	64.4	5.7	55.0	76.0	62.8	66.0	0.4	-1.2
Proximal depth	40	38.4	3.2	33.0	50.0	37.4	39.4	1.3	3.9
Diaphysis depth	36	24.7	2.3	20.5	29.5	23.9	25.4	0.3	-0.5
Distal depth	56	35.0	2.8	31.0	42.0	34.3	35.7	0.8	-0.1
Femur	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Proximal breadth	9	129.1	14.3	113.0	155.0	118.1	140.1	0.6	-0.6
Diaphysis breadth	3	36.7	6.4	32.0	44.0	20.7	52.6	1.5	
Distal breadth	11	86.3	8.9	76.0	100.0	80.3	92.2	0.3	-1.7
Proximal depth	10	78.1	12.9	60.0	96.0	68.9	87.3	0.2	-1.6
Diaphysis depth	3	39.7	3.8	37.0	44.0	30.3	49.1	1.6	
Distal depth	1	121.0		121.0	121.0				
Tibia	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	1	357.0		357.0	357.0				
Proximal breadth	9	97.9	6.7	90.0	107.0	92.7	103.0	0.4	-1.5
Diaphysis breadth	11	40.0	4.5	34.0	47.5	37.0	42.9	0.3	-1.0
Distal breadth	48	66.2	5.8	56.0	82.0	64.5	67.9	0.6	-0.1
Proximal depth	9	91.6	5.9	84.0	101.0	87.0	96.1	0.3	-0.8
Diaphysis depth	12	30.3	3.4	25.0	37.0	28.1	32.5	0.4	0.2
Distal depth	48	50.5	4.6	41.5	62.0	49.2	51.8	0.3	-0.5
Astragalus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	56	72.5	3.4	66.0	80.0	71.6	73.4	0.4	-0.4
Distal breadth	56	49.0	2.9	44.0	56.0	48.2	49.8	0.6	-0.3
Distal depth	50	39.5	2.3	34.0	45.5	38.8	40.1	0.3	0.1
Calcaneus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	19	140.4	8.3	126.0	156.0	136.4	144.4	0.4	-0.5
Distal breadth	17	48.2	5.1	39.0	61.0	45.5	50.8	0.7	1.3
Distal depth	17	58.9	4.2	55.0	71.0	56.7	61.0	1.6	3.4
Metatarsus	**N**	**Mean**	**SD**	**Min.**	**Max.**	**-95%**	**+95%**	**Skewness**	**Kurtosis**
Greatest length	6	248.7	6.8	240.0	257.0	241.5	255.8	-0.1	-1.7
Proximal breadth	20	48.8	3.2	44.0	55.0	47.3	50.3	0.5	-0.5
Diaphysis breadth	10	27.0	1.5	25.0	29.0	25.9	28.1	0.2	-1.6
Distal breadth	49	59.1	4.3	50.5	70.0	57.9	60.3	0.5	0.1
Proximal depth	19	47.9	3.2	43.0	54.0	46.4	49.5	0.4	-0.6
Diaphysis depth	29	26.9	2.0	21.0	30.0	26.1	27.7	-0.9	1.4
Distal depth	50	34.1	2.1	30.0	38.0	33.5	34.7	0.3	-0.6

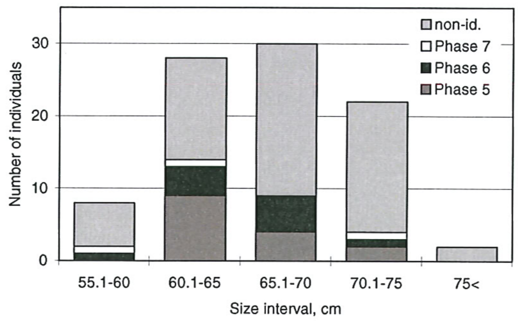

Fig. 12. The distribution of withers heights estimated for sheep

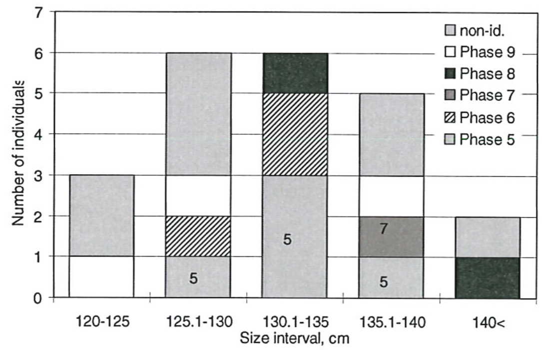

Fig. 13. The distribution of withers heights estimated for cattle

12.1 Statures of sheep and cattle*

Withers height estimates for sheep, calculated using coefficients for long bones developed by Teichert (1975), are presented by phase in Fig. 12. Most animals represented by the surviving long bones fall within a size range (65-70 cm) that would be considered relatively tall by European prehistoric standards (cf. Bökönyi 1974: 171, 49). Considering the state of advanced domestication of sheep at Shahr-i Sokhta, this large size could, at least partly, be attributed to favorable living conditions rather than to direct relationship to the large urial living in the area. The relatively small number of measurable bones does not display a diachronic difference in size distribution. As far as goat is concerned, the greatest withers height estimate for goat, 74.5 cm (Caloi and Compagnoni 1977: 207), is also relatively high and corresponds to that of small Bezoar goats.

Similar calculations for cattle, based on metapodium lengths using the coefficients of both Zalkin (1962) and Matolcsi (1977), showed an even more varied picture, probably owing to the presence of various forms in the material (Caloi and Compagnoni 1981: 181). Similarly to sheep, however, cattle seem to have had a relatively large stature (130-140 cm) at this site (Fig. 13). The majority of values in Fig. 13 exceed the *maximum* of 131 cm recorded in present day Sistan (Corti *et al.* 1963). The size range of prehistoric cattle is even comparable to the modern-day standard for unimproved Hungarian Grey cows (135 cm: Bartosiewicz 1997b: 54, Table 3), although the slenderness of the Shahr-i Sokhta bones indicates that these animals were very "leggy" individuals. Leg conformation may also be a source of bias when coefficients deduced from taurine reference collections are used in the estimation of stature: since the distal extremity segments tend to be relatively shorter in modern European cattle (Bökönyi 1997: 649), their metapodia may somewhat overestimate the withers height of zebu. Fortunately, the unimproved breeds studied by both Zalkin (1962: Kalmyk cattle) and Matolcsi (1977: Hungarian Grey cattle) are similarly leggy. One may thus conclude that the lakeshore environment, in which most prehistoric cattle grazing must have been practiced, was certainly favorable for this species.

12.2 Sheep bone measurements

The measurements of long bone epiphyses and calcaneus of sheep are plotted against each other in Figs 14 to 18. While humerus and radius show no noteworthy clustering, some large individuals may be identified on the basis of distal metacarpus and proximal metatarsus measurements. The broadening of metacarpus especially, reflects increased body mass and may thus indicate the presence of older rams among the sheep culled for meat (this, to some extent, is also suggested by the proximal radius measurements plotted in Fig. 5). The relative proportion of such individuals seems also approximately 1/4 on the basis of metatarsalia, although this difference is better manifested in the case of proximal measurements (sufficiently large numbers of femur and tibia measurements

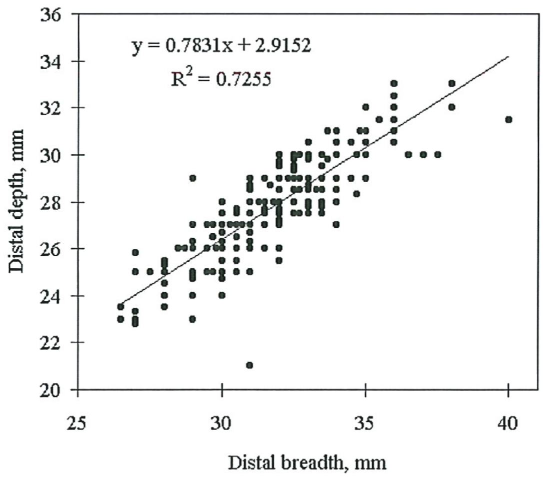

Fig. 14. Pooled distal humerus measurements of sheep

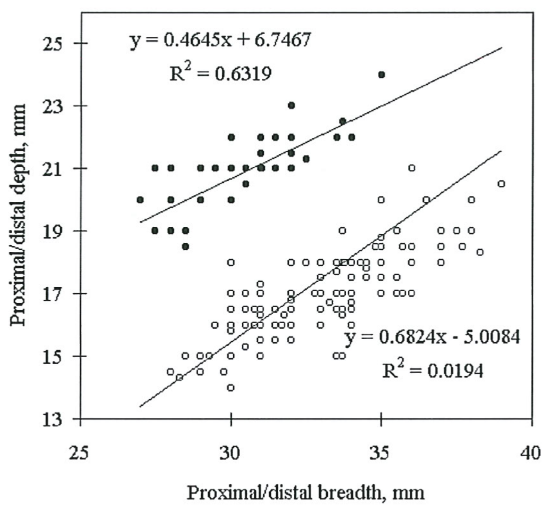

Fig. 15. Pooled sheep radius measurements

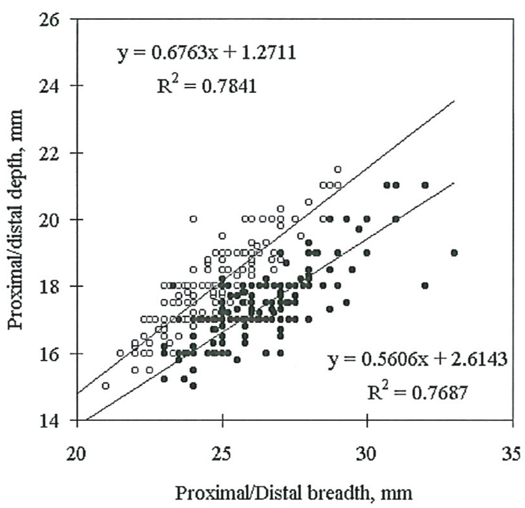

Fig. 16. Pooled sheep metacarpus measurements

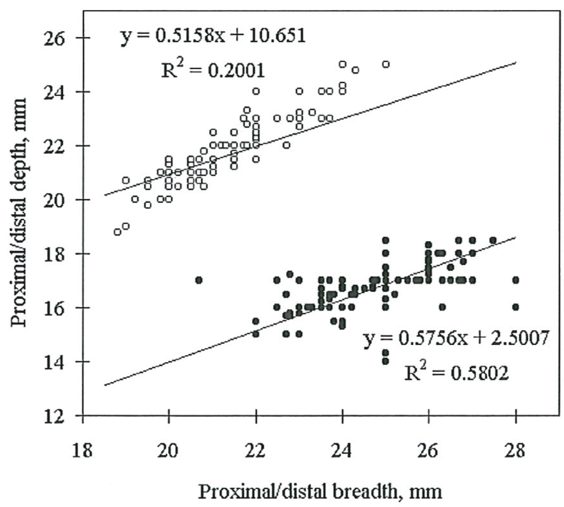

Fig. 17. Pooled sheep metatarsus measurements

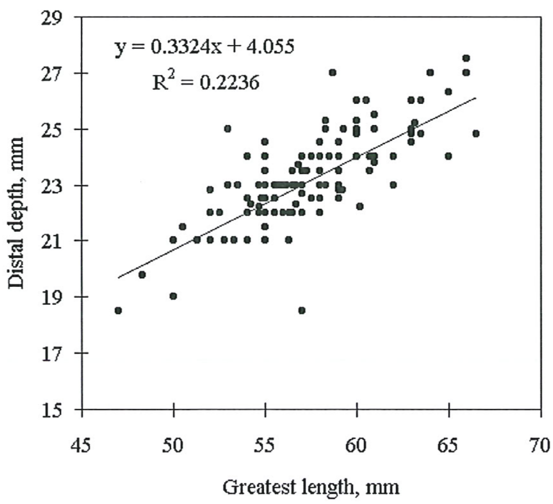

Fig. 18. Pooled sheep calcaneus measurements

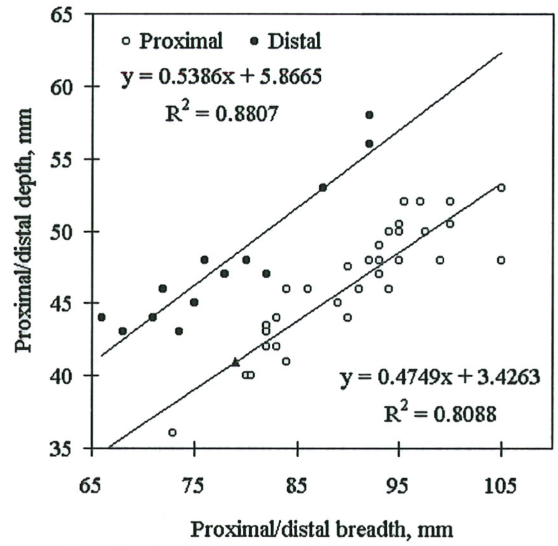

Fig. 19. Pooled cattle radius measurements
('zebu' marked by triangle)

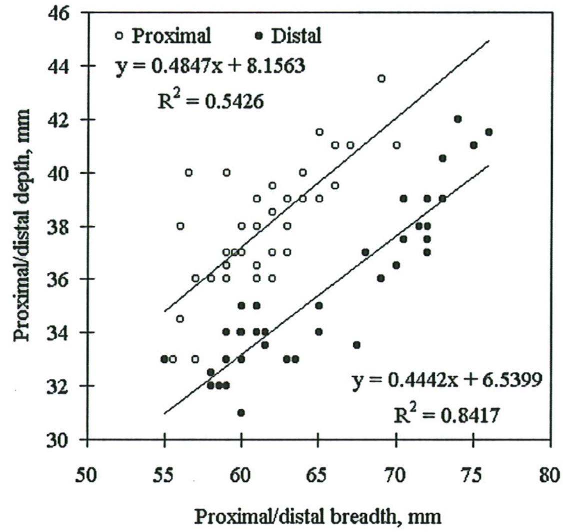

Fig. 20. Pooled cattle metacarpus measurements

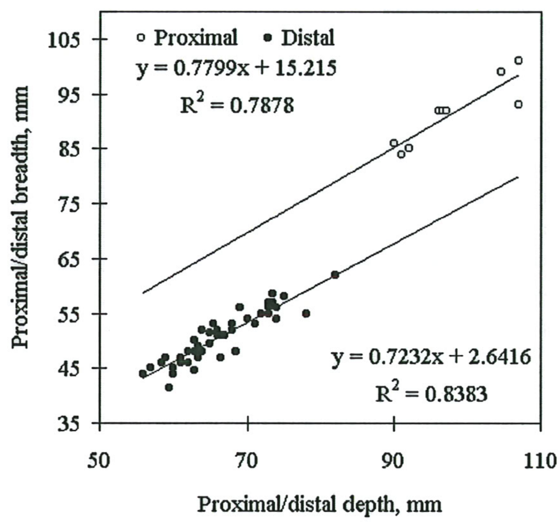

Fig. 21. Pooled cattle tibia measurements

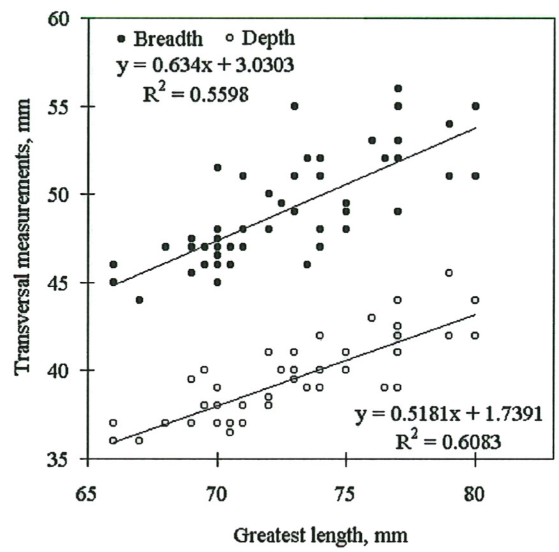

Fig. 22. Pooled cattle astragalus measurements

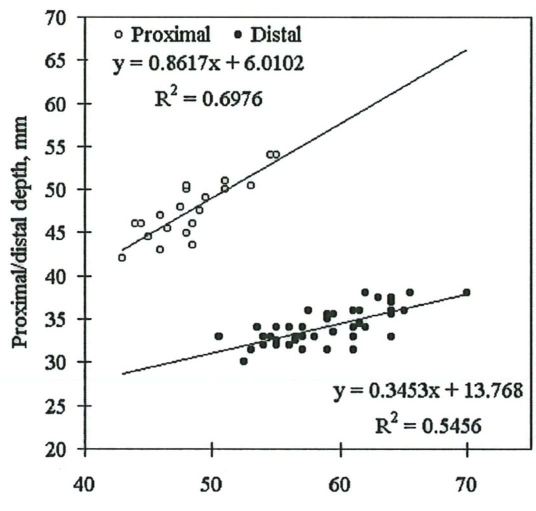

Fig. 23. Pooled catle metatarsus measurements

were not available for such comparisons). One may speculate whether, although young males may have been killed for meat, a more equal proportion between sexes was kept in order to maximize wool production. Such rams, naturally, may also have been castrated in order to facilitate management. Calcaneus measurements again only vaguely display grouping within the material. It may also be speculated that the variability manifested in horn conformation is blurred in extremity measurements, simply as a result of overlaps between *de facto* existing groups that in no way can be linked to those expressed in horn core shapes. Sexual dimorphism and age dependent variability in transversal epiphysis measurements may further complicate this complex picture.

12.3 Cattle bone measurements

The measurements of long bone epiphyses as well as those of the astragalus and calcaneus of cattle are plotted against each other in Figs 19 to 23. In part owing to the smaller number of cases, a group of smaller and larger individuals can be distinguished on the basis of late fusing epiphyses (esp. distal radius and proximal tibia) whose adult size is more directly influenced by the secretion of sexual hormones (Bartosiewicz 1984a). One of the smallest proximal radius epiphyses was denoted as originating from zebu (?) in the original record*. Distal metacarpus measurements show distinct broadening in approximately half of all cases: regression equations show that 1 mm mediolateral growth is accompanied only by a 0.4 mm increment in the dorsopalmar direction (the corresponding dorsopalmar growth is 0.6 mm in sheep: cf. Fig. 16). Beyond the natural trend of allometric growth in animals with large live weight, this difference may also be a sub-pathological change caused by draught exploitation. The ratio of such large bones is greater than the number of adult bulls required for reproductive purposes which indirectly indicates that they may originate from oxen, a hypothesis consonant with the relatively high number of very thin-walled horn core fragments in the material from Shahr-i Sokhta. While clustering and a tendency toward greater mediolateral growth are less clearly expressed in the rest of the cattle bone measurements, the distribution of distal metacarpus measurements is somewhat reminiscent of that of phalanx distalis dimensions from Shahr-i Sokhta (Caloi and Compagnoni 1981: 184, Fig. 4), although that set of data apparently includes more small specimens which may originate from young individuals whose age is more difficult to identify than is the case with metacarpalia with distinct epiphysis fusion lines (Bartosiewicz 1984b).

13. Discussion*

The exact NISP from Shahr-i Sokhta is unknown. Presuming that the 3,687 cattle remains published by Caloi and Compagnoni (1981) indeed correspond to the estimated 21.5% of the assemblage studied prior to the involvement of Sándor Bökönyi (Caloi *et al.* 1978: 87), one may reckon with an assemblage of ca. 17,000 identifiable bones before the "entirely untouched" bones from the 1972-1976 settlement excavations were studied (Bökönyi 1985: 426). Even if Bökönyi's revision of the former identifications creates an overlap between that assemblage and the over 15,000 bones available for study in this paper, one can safely say that our knowledge of the Shahr-i Sokhta fauna is based on at least 30,000 identifiable specimens (apparently, none of the special finds, such as camel, re-appeared during the conversion of Bökönyi's hand-written data into computer files). These arguments fall in line with Bökönyi's estimate that "*only about 60 per cent of the animal remains has been identified so far*" (Bökönyi 1985: 428). On the other hand, a more recent figure of 50,000 cited by Bökönyi (1993a: 7) may be somewhat exaggerated. In any case, such a large body of data should be sufficient for drafting at least a bird's-eye view of animal exploitation at Shahr-i Sokhta, on the level of information available at the time of Sándor Bökönyi's death in 1994. High resolution studies, however, would require direct familiarity with the osteological material as well as professional involvement with the archeological evaluation, both of which are hopeless in the present constellation. Lacking any hands-on experience with the Shahr-i Sokhta material, it is even more difficult to either support or refute the sometimes bold statements found in the original record, such as the taxonomic affiliation of gazelles or Equids and especially the domestic status of horse remains.

Lamberg-Karlovsky and Tosi (1973: 22) proposed the following scenario that can serve as an interpretive framework for the faunal remains under discussion here. They claim that six features testify to the possibility that in Sistan to accumulate and concentrate surplus with a parallel increase in animal and human populations what would be needed are:

1. an extensive irrigated prairie with clayey soil suitable for land-use, with an average rainfall of 150-200 mm;
2. a general tendency to concentrate services and administrative power in a single nuclear centre;
3. the close proximity of mountains to the west with zones of limited mineral exploitation;
4. a relatively accessible communication route with the Hindu Kush foothills upstream from the Hilmand;
5. the presence of the lake, suitable for cattle herding, with concentrations of wild flora and fauna;
6. a very delicate bio-anthropic equilibrium, as the only supply of sweet water is that guaranteed by the Hilmand River.

Archaeozoological information contributes in varying degrees to the fine-tuning of these general characteristics. On the basis of identifications by numerous experts, including Sándor Bökönyi, the following comments can be made:

Apropos of 1): Land cultivation

The presence of arable land and possibility of irrigation under the extremely continental climate of Shahr-i Sokhta offered a possibility for autumn cereal cultivation (varieties of wheat and barley), which are the only type of crops that flourish in modern Sistan (Costantini and Tosi 1978: 171). Indian dwarf wheat (*Triticum sphaerococcum*), a South Asian variety that can be grown with inundation moisture and little rain (Percival 1974: 321) was not present at Shar-i Sokhta before Period III, when the Indus civilization affected the entire region (Costantini 1977: 164). Prehistoric cattle bones from Shahr-i Sokhta are directly relevant to this point. There may be a variety of complex reasons why limb bones of domestic cattle became arthrotic (Bartosiewicz *et al.* 1997e). This condition, often manifested in the bones of the autopodium, may be a natural consequence of old age, which on the other hand is in and of itself associated with secondary exploitation (Bökönyi 1994: 21). One such possibility is draught work either in transport or tillage, which exacerbates sub-pathological deformations in the feet of older animals. Such finds at Shahr-i Sokhta belong to Period II, when increasing population density may have encouraged the use of cattle in large scale land cultivation. Complementary osteological evidence is available in the form of extreme medio-lateral broadening of metacarpalia, as well as thin-walled horn cores, symptomatic of castration, used to produce large but docile draught oxen. In addition to osteological evidence a special, "Y" shaped implement (Phase 7) carved from sisoo wood (*Dalbergia sissoo*) is reminiscent of a Middle Kingdom yoke described from Egypt (Costantini 1979: 117, 119, Fig. 38). While this tree probably grew in the river valleys of prehistoric Sistan, it was a highly valued import commodity in Mesopotamia (Costantini 1979: 117; Pettinato 1972: 86).

It must be added that, as the wild equivalent of domestic cereals, vegetation would comprise monocotyledons including halophile genera such as canary-grass (*Phalaris*), ryegrass (*Lolium*) and brome (*Bromus*) that grow without irrigation in marginal areas characterized by even lower relative humidity and less annual precipitation (Costantini 1977: 166).

Apropos of 2-3): Centralization

Although discussing these points would be far beyond the scope of a zoological report, it must be noted, that calorie intake from grain consumption and caprine keeping tend to strongly correlate in 27 present-day developing countries (Bartosiewicz 1984c: Fig. 3). In addition to meat, these animals provide a surplus of secondary products (milk and esp. wool) and they are easily controlled (with very little labor investment) in flocks much larger than those of pig (Akkermans 1990: 245-249; Diener and Robkin 1978). Sheep and goat are well suited for the systematic accumulation of wealth. In fact, keeping sheep and goat can be a key element in the development of a centralized management system. In addition to the aforementioned wool find, certain pegs made of tamarisk wood as well as a possible shuttle and large comb, both carved from poplar, may indicate that horizontal ground looms, commonly used by present-day sedentary nomads in Baluchistan, were typical tools in textile manufacturing at this site (Costantini 1979: 111, Fig. 27).

Today, caprine (and camel) herders live in semi-permanent encampments along the immediate borders of cultivated areas (Lamberg-Karlovsky and Tosi 1973: 22). Caprines could utilize not only marginal grassland but stubble as well, following harvests. Their seasonal presence in the fields may have represented a form of spontaneous manuring. The complementary exploitation of cereals and caprines in this volatile environment must have been instrumental in supporting the population of the single nuclear center attested by extensive architectural features and evidence of non-agrarian production at Shahr-i Sokhta.

Apropos of 4): Communications

As far as communication and trade are concerned, perhaps as a notable coincidence, camel bones originate from Period II, that is the proto-urban Phases 7 and 6, characterized by a peak in long distance trade. Caloi *et al.* (1978: 88) prudently point out that "*Because of the sporadic presence of small wild herds, the camel was perhaps always a rare animal until it was possible to increase its numbers by means of symbiosis with the human community. We believe that it is this early stage that we have documented at Shahr-i Sokhta...*". Uerpmann (1987: 55), on the other hand, raises the possibility that these bones may originate from wild camel (*Camelus ferus* Przewalski 1883) citing the small number of finds (5 camel bones). This may indeed be evidence against the domestic status of ordinary meat-purpose animals. Beasts of burden, however, represent a functionally different category. Their remains in archaeological assemblages may be underrepresented for purely taphonomic reasons (Bartosiewicz 1993: 105; most camel remains in Europe are sporadic but represent the domestic form anyway: cf. Morales Muñiz et al 1995). Domestic camels (and to a lesser extent horse) are valuable animals whose primary meat exploitation would have been rather unlikely, owing to their slow reproduction and often high status (Dahl and Hjort 1976). Moreover, due to their special form of secondary exploitation in long distance transport, even when dead, many of these animals must have been deposited off-site, along the road (Bartosiewicz 1996: 450).

Unfortunately, this alternative interpretation of *negative* evidence is of little help in scientific identification. There is agreement, however, that the recovery of Phase 6 camel hair mixed with sheep wool at Shahr-i Sokhta suggests camel domestication (Caloi *et al.* 1978: 97, Fig. 4A; Uerpmann 1987: 55).

During the present analysis, the identification of the left calcaneus as originating from Bactrian camel (Caloi *et al.* 1978: 91) could be supported at least on the basis of measurements of the distal femur fragment and second phalanges (both anterior and posterior) published by Caloi *et al.* (1978: 101, Table 5). Reference data by Steiger (1990: 97 and 104), gathered on the corresponding bones of modern Bactrian camel (*Camelus bactrianus* L. 1758; pooled measurements of 7 males and 7 females) were used to define the range against which standardized measurements of the Shahr-i Sokhta specimens, as well as those of modern dromedaries (*Camelus dromedarius* L. 1758), were plotted following the logic of "Size Index" calculations proposed by Uerpmann (1982: 18). According to Fig. 24, the measurements from Shahr-i Sokhta, correspond to the maxima of modern male dromedaries, which (within the size range of more robust Bactrian camels) may be interpreted as the Shahr-i Sokhta bone finds originating from average size, two humped individuals. This identification is also favored, since unimproved early dromedaries may have been somewhat smaller than the individuals whose measurements were listed by Steiger (1990).

Additional external evidence supporting identifications as Bactrian camel is the geographical location of Shahr-i Sokhta within the former range of wild camels as far south as Iran and Afghanistan (Mason 1984: 108). Naturally, the potential presence of coeval wild camels in the area leads back to the fruitless speculations concerning the domestic status of this species.

Along the line of this argument, the presence of a single horse tibia (Bökönyi 1985: 427) is similarly open to discussion, since "*osteological discrimination of the various Old World equids is an uncertain pursuit... species determination can only be made on the basis of trends within a collection as a whole*" (Zeder 1986: 407). While horse is less efficient in long-distance communication than camel, it is still one of the most mobile of the domestic animals. A wild horse relic population seems to have existed in north central and eastern Anatolia until the 4th millennium BC (Uerpmann 1987: 142), predating the Shahr-i Sokhta finds.

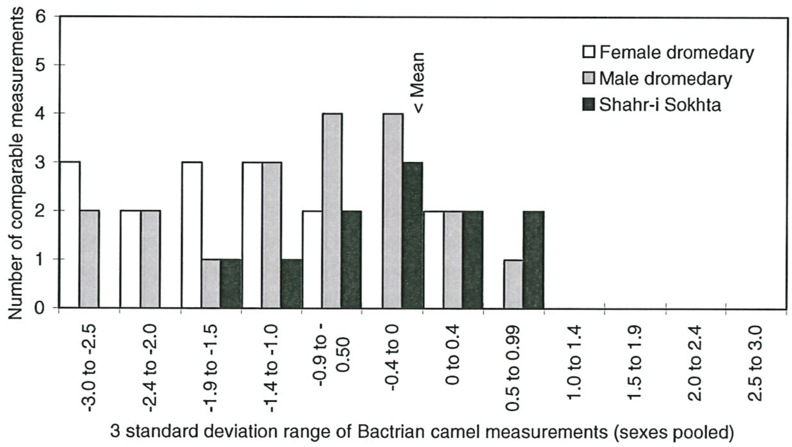

Fig. 24. Standardized camel femur and phalanx media measurements

Apropos of 5): Lakeshore environments

Even in the 20th century, cattle herders have been concentrated on the eastern side of the lakes in Sistan. A small, resistant type of zebu graze in the water plant associations dominated by reed (*Phragmites* sp.) and bulrush (*Typha* sp.) throughout the year (Costantini and Tosi 1978: 179). Osteological evidence shows, however, that a significant number of prehistoric cattle were *not* small at Shahr-i Sokhta. The other important feature is that the contribution of beef to the diet markedly declined along with the intensification of urban settlement. It may be presumed that new, lacustrine areas were allocated for the purposes of cereal production. Thus a fall in cattle keeping is possibly analogous to a decrease in wild boar remains at the Gonur Tepe (2000-1750 BC) in SE Turkmenistan, attributed to the transformation of thickets in the river delta into agricultural areas (Moore *et al.* 1994: 423).

Although, in a regional sense, the wild fauna was probably indeed concentrated in the lacustrine vegetation, with the exception of (wild?) pig, the bones of ungulates as well as of hare represent more of a grassland habitat and possibly that of the nearby foothill area. This means that as much as hunting was practiced at all, it took place in or beyond the outskirts of the settlement. Mountain gazelle as well as wild caprines prefer habitats with varied topography. Equids (regardless of their taxonomic position or wild/domestic status) inhabit open grassland with a hard substrate. Dorcas gazelle is even adapted to desert environments (Compagnoni 1978b: 119). The remains of wild carnivores at Shahr-i Sokhta may result from the opportunistic killing of these animals, which prefer the thickets along the lakeshore.

It is worth noting that an inverse pattern was observed in the exploitation of avifauna, represented by 2,614 identifiable specimens (Cassoli 1977: 180). The assemblage of bird bones is dominated by the remains of two aquatic species, coot (*Fulica atra* L. 1758, 60%, characteristically called "water-crow" in Scotland) and Anserids (32.3%), mostly pochard (*Aythya ferina* L. 1758, 16.3%). Strangely disregarding Cassoli's 1977 publication, Costantini and Tosi (1978: 181-182) claim that Cassoli had identified only 29 bird species from the material of the 1967-1972 campaigns. Of these, they provide a list of 28 (!) names, eight of which were not listed among the 41 (Cassoli 1977: 180). Most importantly, they added partridge (*Perdix perdix* L. 1758), and rock partridge (*Alectoris graeca* Meian.) to Persian partridge (*Ammoperdix griseogularis* Br.), two species that represent the other extreme habitat near Shahr-i Sokhta, the pre-desert environment. The rest of the bird bones originate from aquatic species or wading birds. The evidence of eggshell in archaeological deposits also points to the exploitation of marshland habitats. Of the 41 species listed by Cassoli (1977: 180) only black vulture (*Aegypius monachus* L. 1758), raven (*Corvus corax* L. 1758) and stock dove (*Columba livia* Gmelin) may be considered commensal within the context of this settlement.

Similarly to bird bones, an assemblage of entomological finds from Shahr-i Sokhta (Costantini *et al.* 1977: 257) contained the remains of insects from aquatic families such as water crickets (Corixidae), water beetles (Dytiscidae) and water scavenger beetles (Hydrophilidae). In addition, fragments of ground beetles (Carabidae, including the genus *Salzuferläufer/Pogonus*), and two genera (*Calandra, Salicornia*) of the weevil family (Curculionidae) indicate brackish marshland. Only a few remains of mealworm beetles (Tenebrionidae) and scorpions (Scorpionida) show connections with dry and subdesertic zones. Aside from this clear-cut dichotomy of natural habitats, some insect remains were clearly indicative of anthropogenic activity. For example, dermestid beetles (Dermestidae, including carpet beetle/*Attagenus*), spider beetles (Ptinidae) such as hump beetle (*Gibbium psylloides* Cz.), as well as a rich sample of Cyclorraphous flies (Cyclorrapha), must have been attracted to human habitation areas by unusually great concentrations of decaying organic refuse.

All three rodent species, Indian gerbil (*Tatera indica*), bandicoot rat (*Nesokia indica*) and house mouse (*Mus musculus* L. 1758) identified at Shahr-i Sokhta by Caloi and Compagnoni (1977: 189) are typical commensal animals as well. The authors correlated a slight size increase in the Indian gerbil between Periods I and II/III with proto-urban expansion during that time interval.

Not surprisingly for the aquatic environment in the river delta, the most typical fish caught at Shahr-i Sokhta represent the carp family (Cyprinidae). The genera identified include *Barbus* L. 1758, *Cyprinion* Heckel 1843 and possibly *Capoeta* Güldenstädt 1773 (*syn. Varicorhinus*; Tortonese 1977: 172) as well as *Discognathus* Heckel 1843 and *Schizothorax* Heckel 1838 (Costantini and Tosi 1978). Within Iran, however, relatively little is known of the fish fauna of Sistan, and the sub-generic nomenclature is sometimes contradictory and manifold (Coad 1995: 11-17). Tortonese's (1977: 172) length estimates, ranging between 11 to 30 cm, indicate net fishing.

Most carps, a fish family usually living in quiet waters, tolerate high temperatures and concomitant low relative oxygen contents (Bartosiewicz 1997c). According to the ecological classification developed by Harka (1993), sections of rivers crossing temperate plain environments (*metapotamon*) do not exceed a speed of 0.5 m/s and at 25°C their oxygen concentration is approximately 0.4-0.5 % (vol.). Downstream, in the river mouth (*hipopotamon*) section, waters become almost stagnant. The present-day average thermal range in this semi-desert area is 4 to 40°C (Ligabue 1977: 241). Once temperatures rise above 25 °C, the oxygen content falls below 0.004 % (vol.). Moreover, with increasing salination in the Hilmand Basin, one may reckon with the early development of brackish waters.

The genus *Schizothorax* (Mirza 1991: 339), of which *Schizothorax intermedius* (McClelland 1842) has been listed from Sistan (Coad 1995: 20), stands out from this gross environmental picture. According to Nelson (1994) "Schizothorax ... and its relatives, known as snow trout, occur at high elevation...". This Cyprinid genus thus may be indicative of the small rivers that run into the terminal lakes of Hilmand from the mountains located along their western shores (Fig. 1, bottom). Importantly, this points to the possibility of fishing in the lakes, not only in the delta area.

Apropos of 6): Bio-anthropic equilibrium

The very delicate balance between the natural environment and human settlement observed in the area today is the result of a long process. On the basis of largely 19-20th century records, Jux and Kempf (1983: 11) have concluded that extreme droughts in Sistan may occur at intervals of 20-30 years. It seems, however, that the present-day drastic effects of these droughts are magnified by centuries of accelerating environmental deterioration.

Environmentalism, with its now pivotal role in mid-20th century western thought, has directed attention to irreversible damage caused by deforestation. In the case of Shahr-i Sokhta, human settlement evidently competed with forests for the most livable habitat in the river valley. Flood plain forests in the Hilmand delta thus may have been first occupied and gradually destroyed by humans. This also means that eventually, land cultivation directly competed with forests for easily irrigable land. In Sistan, owing to the needs of the best investigated proto-urban economy, based on profits derived from surplus-producing farming, human activity must have lead to the most radical changes in the floodplain of the Hilmand delta. It is probably in this area where, owing to the generous availability of water, arboreal species were concentrated. Poplar (*Populus* sp.), tamarisk (*Tamarix* sp.), ash (*Fraxinus* sp.) and grape-vine (*Vitis vinifera* L. 1758) are typical taxa in riparian associations that parallel rivers in the Near and Middle East (Costantini 1979: 100-102). The extent of this few dozen meters wide tree belt underwent variations in width and taxonomic composition, adapting to climatic effects, especially variations in precipitation. Many-sided economic growth during the proto-urban period, until approximately Phase 6, probably led to the ruthless exploitation of all natural resources by the end of Period II that also included the destruction of forests as the settlement expanded to 80 ha.

Even the partial removal of the tree cover as well as of shrubs in the prehistoric Hilmand delta laid fields open to deflation that would have lead to the increased drying and gradual decomposition/removal of the soil cover anyway. In addition to direct protection by shade, the albedo of woodland is smaller than that of barren desert, thus microclimatic warming resulting from deforestation exposed the surface to increasing evaporation. Therefore, the intensification of human settlement may have exacerbated natural drying caused by a slow natural shift in the course of the Hilmand River.

A decline of beef in the diet (Figs 8 and 9) may be the first, indirect indication of agricultural cultivation possibly taking over parkland pastures, partly owing to the ever increasing demand posed by uncontained absolute population growth. Hypothetically, a concomitant relative increase in goat meat consumption (Fig. 8) may even reflect an effort to offset declining dairy production by supplies of goat milk during the first half of Period II; however, direct evidence for milking is also available. It must also be mentioned that this trend is characteristic of Bronze Age towns throughout the Near East (Clason and Buitenhuis 1998: 240).

Meanwhile, as is shown by the dominance of mutton in the diet, sheep keeping began to flourish and reached a status of almost monoculture by the turn of Periods II-III (Fig. 8). This obviously fell in line with the socioeconomic prosperity of Shahr-i Sokhta. Whether herds were owned and managed centrally or surplus was collected in the form of taxes from satellite settlements, the revenue contributed to the accumulation of wealth from other sources, such as the exploitation and trade of minerals (e.g. flint, carnelian, copper, calcite; Tosi 1977: 50, Fig. 2) in the settlement's vicinity. Extensive grazing, however, not only competed with cereal production, of vital importance in a limited space, but probably also added to soil destruction by trampling.

A second upswing in goat keeping by Period III (Fig. 8) may already be a sign that many grazing areas were becoming exhausted. Goats have always been present among the sheep of Shahr-i Sokhta, as probable providers of milk (in addition to meat) and possibly flock leaders (this form of use is known throughout Southern Europe; Bartosiewicz 1999; Moreno García 1999). In addition, modern-day kill-off rates for goats are higher (an average 0.368 per animal in stock) than for sheep (0.295 per animal in stock; Bartosiewicz 1986: 43, Table 4), which indicates a more efficient exploitation for meat. Although a steady percentual increase in goat remains at Shahr-i Sokhta suggested by Caloi and Compagnoni (1977: 199; based on some 2,000 bones) could not be reconfirmed in statistically significant terms on the basis of our data (Fig. 10), the occurrence of goat remains in numbers far greater than expected indeed falls in line with the suggestion of long term salination, related to the chronic desiccation of Sistan through history. In fact, neighboring Afghanistan was characterized by the greatest contribution of goat to its national livestock statistics among 27 Middle Eastern and North African countries during the 1970s (Bartosiewicz 1984a). In temperate Europe, the annual requirement of salt supplements for dairy goats may reach 8-10 kg (Várkonyi and Áts 1984:139). Goats are thus not only "omnivorous" but also survive on brackish water that sheep or cattle could not drink (Bökönyi 1998: 99).

Given the extensive peripheral zones occupied by expanding cultivation and grazing, considerable energy may have been expended hunting wild ungulates, since most non-domestic animal remains reflect the more immediate availability of marshland resources. At Shahr-i Sokhta, sporadically occurring wild ungulate remains correspond to the species regularly hunted throughout the Orient during the Bronze Age (Clason and Buitenhuis 1998: 237). Approximately 25 of the hemione bones mentioned by Caloi and Compagnoni (1977: 209; 1978: 89, Table 2) belonged to Period I, when hunting may have played a greater role. In later periods, it may also be hypothesized that at least some wild ass and gazelle were sporadically killed in the form of *Schutzjagd* (Uerpmann 1977), to prevent crop damage in the increasingly precarious situation.

14. Conclusions*

Lamberg-Karlovsky and Tosi (1973: 23) concluded that "*the crisis and collapse of this system could have been as rapid as the growth... owing to the instability of its hydrological supply*". One should not, however, overestimate changes in the physical environment as the single causal element behind the development of new structural relationships between inhabitants of the settlement and their broader, natural habitat. While the overall validity of the drought theory is supported by direct archaeological evidence at Shahr-i Sokhta, the process must have been far from simple, as is also illustrated by the animal remains discussed in this study. In order to avoid environmental determinism, therefore, demographic as well as behavioral variables of the human population must be taken into consideration in addition to the gross environmental variables responsible for generating new pressures on the community (Binford 1968: 325). In a more recent evaluation, Lamberg-Karlovsky (1994: 401) fine-tuned the aforementioned statement suggesting that Bronze Age settlements in the region were a scene of intense competition between "*distinctive groups contending for control of land and water*". It seems that Shahr-i Sokhta began to be abandoned possibly in relation to transformations in its socio-economic context brought about by competing socio-political entities unable to adapt to the continuing steady desertification of southern Sistan (Biscione *et al.* 1977: 79-102).

Manifestations of crisis in the animal bone assemblage

A shift in the Hilmand River delta literally pulled the rug out from under the sophisticated economy of this urban settlement by resulting in the drying up of agricultural lands of vital importance in the outskirts of Shahr-i Sokhta. It seems, however, that the growth of this settlement took at least twice as long as its relatively rapid collapse. It is the interval of steady urban expansion (Periods I to III) that is illustrated by the animal bones discussed in this paper. The urban development of this settlement was more gradual than its collapse: animal remains analyzed in this study represent 700 years of steady settlement expansion (3000 to 2300 BC). However, even the radical fall of Shahr-i Sokhta took centuries (the habitation area shrunk to less than 10% of its maximum in ca. 300 years). This dozen human generations of decline may have triggered a variety of socio-economic and political reactions, which either exacerbated or temporarily buffered the effects of gradual desertification. It is also important to note that the decline characteristic of the early 2nd millennium BC may also be detected on a regional level, beyond the Hilmand Basin.

Along a major dimension, productive economy, shifts in animal exploitation may be considered symptomatic of changes within this process. What could have been the reaction of an apparently complex proto-state society to a lurking environmental catastrophe which was slowly taking over? The bone material permitted the following hypotheses to be tested on the level of middle-range theory:

1. Although it would be highly misleading to treat domestic animal remains as environmental indicators, the development of a crisis is, at least partially, illustrated by the diachronic decline in beef consumption (and aurochs hunting) at Shahr-i Sokhta. Not only is cattle more dependent on relatively lush grazing than caprines, its slaughtering is also more of a luxury when meat becomes

scarce. While remains of aurochs are present until the end of Period II, together with cattle, this large game lost significance by Period III, that of the greatest areal expansion.

2. Increasing mutton consumption is not a sign of catastrophe in and of itself. The trend toward gradual specialization in animal husbandry, however, took place at the expense of diversity in animal exploitation, characteristic until Phase 6 in Period II. The taxonomic richness of chronological sub-assemblages starts declining from that phase onwards. This should be added to the observation that there was a trend toward volatility in the economy of Shahr-i Sokhta. The contribution of wild animal remains, as is shown *grosso modo* by changes in taxonomic richness, was negligible in quantitative terms at this site.
3. A relative upsurge in goat keeping at a time when the equilibrium of the local subsistence basis may already have been disturbed by overpopulation and droughts (Phase 4, Period III), possibly catalyzed further environmental deterioration. The apparently reasonable short-term solution that goats fare better in harsh, salinated environments evidently contributed to a long term disaster. In retrospect, pig keeping seems to have been a "rational" alternative, however, for whatever reason, it was not part of the local tradition (de Planhol 1959: 58). The cultural inertia of this complex, urbanized community posed obvious limitations on adequately flexible responses to this formidable environmental challenge.
4. Reaction to the environmental crisis at Shahr-i Sokhta may have included other decisions geared toward short-term benefits that may have lead to the mismanagement of agriculture (restructuring land and/or herd ownership, interference with rights to the ever-shrinking grazing area etc.), all to the detriment of continuous central provisioning and surplus accumulation. Statistically significant, diachronic oscillations in the exploitation of domestic ungulates may be symptomatic of such decisions, intangible to the archaeozoologist.
5. While the majority of the few wild mammals identified in this study represent the pre-desertic steppe zone, the presence of bird bones reflects the exploitation of the neighboring marshland. Most insect remains, especially those from aquatic species, show that the settlement itself was located in a relatively humid environment.

Hypotheses for future research

The assemblage under discussion here does not include bones from Period IV, the time of radical collapse at the site of Shahr-i Sokhta. For the purposes of future research, however, at least two testable hypotheses may be put forward.

Firstly, in eastern Anatolia, a revival of cattle and pig keeping during the second half of the 3rd millennium BC, has been interpreted as a sign of more generalized subsistence strategies in relation to the increasing self-sufficiency of individual households (cf. Diener and Robkin 1978), possibly related to reduced centralization and specialization in animal husbandry (Frangipane and Siracusano 1998: 244). The research hypothesis would state that (currently unknown) major assemblages from some satellite settlements, and perhaps from Period IV at Shahr-i Sokhta, would contain at least sporadic bones from wild/domestic pigs. Should the search for such remains prove fruitless, one may presume that not even extreme hardship would have encouraged pork consumption by the remaining population or that pig habitats had been irreversibly reduced in the area.

Secondly, as is characteristic of most Bronze Age sites in the Near East (Clason and Buitenhuis 1998: 237), subsistence hunting during this period played a negligible role at urban settlements. Since it was of more importance at rural sites (e.g. in southern Turkmenia: Ermolova 1970), one may hypothesize that it was practiced at the satellite settlements of Shahr-i Sokhta. The meat of game, however, hardly ever made it into the urban redistribution system in charge of provisioning the central settlement. A significant increase in taxonomic richness for Period IV (mammalian) assemblages, would additionally support the hypothesis of self-reliance, as has been observed at marginalized military settlements, when central meat provisions dwindled in the province of Pannonia in parallel with the fall of the Roman Empire (Bartosiewicz 1990-1991).

Whether tested at the site of Shahr-i Sokhta itself or at comparable sites in the region, clarifying these questions will usefully complement the information summarized in this paper.

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16. References

Akkermans, P.M.M.G., 1990. *Villages in the Steppe*. Amsterdam, Universiteit van Amsterdam.

Bartosiewicz, L., 1990-1991. Animal bones as indicators of continuity at Roman provincial sites. Budapest, *Antaeus* 19-20: 103-342.

Bartosiewicz, L., 1991. Faunal material from two Hallstatt Period settlements in Slovenia. *Arheološki Vestnik* 42: 199-206.

Bartosiewicz, L., 1984a. Sexual dimorphism of long bone growth in cattle. *Acta Vet. Hung.* 32/3-4: 135-146.

Bartosiewicz, L., 1984b. Interrelationships in the formation of cattle long bones. Jena, *Zoologischer Anzeiger* 215: 252-262.

Bartosiewicz, L., 1984c. Az állatállomány faji összetételének összefüggése a lakosság étrendjének energiatartalmával néhány fejlödö országban (Correlations between herd composition and the per capita energy consumption the human population in developing countries). *Állattenyésztés és Takarmányozás* 33/3: 193-203.

Bartosiewicz, L., 1986. Egyes háziállatok hústermelésben betöltött szerepének kapcsolatai néhány fejlödö országban (Relationships between the meat exploitation of some domestic animals in developing countries). *Tudomány és Mezögazdaság* XXIV/1: 39-46.

Bartosiewicz, L., 1993. Beasts of burden from a classical road station in Bulgaria. In: H. Buitenhuis and A.T. Clason (eds), *Archaeozoology of the Near East I. Proceedings of the first international symposium on the archaeozoology of SouthwesternAsia and adjacent areas.* Leiden, Universal Book Services, Dr. W. Backhuys: 105-109.

Bartosiewicz, L., 1996. Camels in Antiquity: The Hungarian connection. *Antiquity* 70/268: 447-453.

Bartosiewicz, L., 1997a. This little piggy went to market... An archaeozoological study of modern meat values. *Journal of European Archaeology* 5(1): 170-182.

Bartosiewicz, L., 1997b. The Hungarian Grey cattle: a traditional European breed. Roma, FAO, *Animal Genetic Resources Information* 21: 49-60.

Bartosiewicz, L., 1997c. *Early history of fish exploitation in Hungary and the Lower Danube Region.* Paper delivered at the 9th Meeting of the ICAZ Fish Remains Working Group 1997, Panamá City – Chitré, Panamá.

Bartosiewicz, L., R. Demeure, I. Mottet, W. Van Neer and A. Lentacker 1997d. Magnetic resonance imaging in the study of spavin in recent and subfossil cattle. *Anthropozoologica* 25-26: 57-60.

Bartosiewicz L., W. Van Neer and A. Lentacker, 1997b. *Draught cattle: Their osteological identification and history.* Tervuren, Koninklijk Museum voor Midden-Afrika, Annalen, Zoologische Wetenschappen Vol. 281.

Bartosiewicz, L., 1998a. Interim report on the Bronze Age animal bones from Arslatepe (Malatya, Anatolia). In: H. Buitenhuis, L. Bartosiewicz and A. M. Choyke (eds.), *Archaeozoology of the Near East III. Proceedings of the third international symposium on the archaeozoology of SouthwesternAsia and adjacent areas.* Groningen, ARC Publication 18: 221-232.

Bartosiewicz, L., 1998b. Sándor Bökönyi: Portrait against a scientific background. In: P. Anreiter, L. Bartosiewicz, E. Jerem and W. Meid (eds.), *Man and the Animal World. Studies in memoriam*

Sándor Bökönyi. Budapest, Archaeolingua Kiadó: 11-16.
Bartosiewicz, L., 1999. The role of sheep versus goat in meat consumption at archaeological sites. In: Bartosiewicz L. and H. Greenfield (eds.), *Transhumant pastoralism in Southern Europe*. Budapest, Archaeolingua Kiadó: 47-60.
Becker, C., 1998. Can animal bones reflect household activities? In: P. Anreiter, L. Bartosiewicz, E. Jerem and W. Meid (eds.), *Man and the Animal World. Studies in memoriam Sándor Bökönyi*. Budapest, Archaeolingua Kiadó: 79-86.
Benecke, N., 1994. *Der Mensch und seine Haustiere.Die Geschichte einer jahrtausendealten Beziehung*. Stuttgart, Konrad Theiss Verlag GmbH and Co.
Binford, L.R. and J.B. Bertram, 1977. Bone frequencies and attritional processes. In: R. L. Binford (ed.), *For theory building in archaeology*. New York, Academic Press: 77-152.
Binford, L. R., 1968. Post-Pleistocene adaptations. In: L. R. Binford and S. Binford (eds.), *New Perspectives in Archaeology*. Chicago, Aldine: 313-342.
Biscione, R., 1973. Dynamics of early South Asian urbanization: The first period of Shahr-i Sokhta and its connections with South Turkmenia. In: N. Hammond (ed.), *South Asia Archaeology*. London: 105-118.
Biscione, R., S. Salvatori and M. Tosi, 1977. Shahr-i Sokhta: l'abitato proto-storico e la sequenza cronologica. In: P. Basaglia *et al.* (eds.), *La Città Bruciate del Deserto Salato*. Venezia-Mestre, Erizzo: 77-112.
Bökönyi, S., 1967. The prehistoric vertebrate fauna of Tal-i-Iblis. In: J. R. Caldwell (ed.), *Investigations at Tal-i-Iblis*. Springfield, Ill., Illinois State Museum, Preliminary Report 9: 309-317.
Bökönyi, S., 1974. *History of domestic mammals in Central and Eastern Europe*. Budapest, Akadémiai Kiadó.
Bökönyi, S., 1977. *Animal remains from the Kermanshah Valley, Iran*. Oxford, British Archaeological Reports, Suppl. Ser. 34.
Bökönyi, S., 1985. Preliminary results of a thorough evaluation of the mammal bone material from Shahr-i Sokhta. *East and West, N.S.*, 35 (4): 426-429.
Bökönyi, S., 1990. *Kamid el-Loz. 12. Tierhaltung und Jagd. Tierknochenfunde der Ausgrabungen 1964 bis 1981*. Bonn, Saarbrücker Beiträge zur Altertumskunde 42.
Bökönyi, S., 1993a. Domestication models: the Anatolian-Mesopotamian and the others in Southwest Asia. In: H. Buitenhuis and A.T. Clason (eds.), *Archaeozoology of the Near East I. Proceedings of the first international symposium on the archaeozoology of Southwestern Asia and adjacent areas*. Leiden, Universal Book Services, Dr. W. Backhuys: 4-9.
Bökönyi, S., 1993b. Hunting in Arslantepe, Anatolia. In: M. Frangipane, H. Hauptmann, M. Liverani, P. Matthiae, and M. Melling (eds.), *Between the rivers and over the mountains*. Archaeologia anatolica et mesopotamica Alba Palmieri dedicata. Roma, Università di Roma «La Sapienza»: 341-359.
Bökönyi, S., 1994. Über die Entwicklung der Sekundärnutzung. In: M. Kokabi and J. Wahl (eds.), *Beiträge zur Archäozoologie und Prähistorischen Anthropologie*. Stuttgart, Landesdenkmalamt Baden-Württemberg, Konrad Theiss Verlag: 21-28.
Bökönyi, S., 1995a. The development of Stockbreeding and herding in medieval Europe. In: Del Sweeney (ed.), *Agriculture in the Middle Ages. Technology, practice and representation*. University of Pennsylvania Press, Philadelphia: 41-61.
Bökönyi, S., 1995b. Problems with using osteological materials of wild animals for comparisons in archaeozoology. *Anthropológiai Közlemények*, 37: 3-11.
Bökönyi, S., 1997. Zebus and Indian wild cattle. *Anthropozoologica* 25-26: 647-657.
Bökönyi S. and Bartosiewicz L., 1997. Tierknochenfunde. In: S. Hiller and V. Nikolov (eds.), *Österreichisch-bulgarische Ausgrabungen und Forschungen in Karanovo*. Wien, Verlag Ferdinand Berger and Söhne Ges. m. b. h.: 385-424.
Bökönyi, S., 1998. Animal husbandry, hunting and fishing in the Ras al-Junayz area: a basis of the human subsistence. In: H. Buitenhuis, L. Bartosiewicz and A. M. Choyke (eds.), *Archaeozoology of the Near East III. Proceedings of the third international symposium on the archaeozoology of Southwestern Asia and adjacent areas*. Groningen, ARC Publication 18: 103-116.

Bökönyi S. and L. Bartosiewicz, 1999. IX. Analyse de la faune (Diconche). *Mémoire de la Société Préhistorique Française* 1998/1: 137-156.
Bunch, T.D. and W.C. Foote, 1977. Cytogenetic evidence on the ancestral stock of domestic sheep. *Ethnozootechnie* 21: 11-15.
Caloi, L. and B. Compagnoni, 1976. Bone remains from Loebanr III (Swat, Pakistan). *East and West, N.S.*, 26(1-2): 31-43.
Caloi, L., B. Compagnoni and M. Tosi, 1978. Preliminary remarks on the faunal remains from Shahr-i Sokhta. In: R. Meadow and M. Zeder (eds.), *Approaches to faunal analysis in the Middle East.* Peabody Museum Bulletins 2: 87-90.
Caloi, L., 1978. The bone remains of small wild carnivores from Shahr-i Sokhta. In: R.H. Meadow and M.A. Zeder (eds.), *Approaches to faunal analysis in the Middle East.* Peabody Museum Bulletins 2: 129-132.
Caloi, L. and B. Compagnoni, 1977. I mammiferi. In: P. Basaglia *et al.* (eds.), *La Città Bruciate del Deserto Salato.* Venezia-Mestre, Erizzo: 183-203.
Caloi, L. and B. Compagnoni, 1981. Preliminary remarks on the Bovine remains at the archaeological site of Shahr-i Sokhta (Iranian Sistan) (3200—1800 B. C.). In: H. Härtel (ed.), *South Asian Archaeology1979.* Berlin, Dieter Reimer Verlag: 181-190.
Cassoli, P., 1977. L'avifauna. In: P. Basaglia *et al.* (eds.), *La Città Bruciate del Deserto Salato.* Venezia-Mestre, Erizzo: 173-182.
Choyke, A.M., 1995. Worked bone and antler from the Avar Period cemetery at Budakalász - Dunapart. *Acta Arch. Hung.* 47: 221-240.
Claessen, H.J.M. and P. Skalnik (eds.), 1973. *The early state.* The Hague, Paris, New York.
Clason, A.T. and H. Buitenhuis, 1998. Patterns in animal food resources in the Bronze Age in the orient. In: H. Buitenhuis, L. Bartosiewicz and A.M. Choyke (eds.), *Archaeozoology of the Near East III. Proceedings of the third international symposium on the archaeozoology of Southwestern Asia and adjacent areas.* Groningen, ARC Publication 18: 233-242.
Coad, B.W., 1995. Freshwater fishes of Iran. *Acta Sc. Nat. Brno* 29/1: 1-64.
Compagnoni, B., 1978a. The bone remains of *Equus hemionus* from Shahr-i Sokhta. In: R.H. Meadow and M.A. Zeder (eds.), *Approaches to faunal analysis in the Middle East.* Peabody Museum Bulletins 2: 105-118.
Compagnoni, B., 1978b. The bone remains of *Gazella subgutturosa* from Shahr-i Sokhta. In: R. Meadow and M. Zeder (eds.), *Approaches to faunal analysis in the Middle East.* Peabody Museum Bulletins 2: 119-128.
Compagnoni, B. and M. Tosi, 1978. The camel: its distribution and state of domestication in the Middle East during the third millennium B. C. in light of finds from Shahr-i Sokhta. In: R.H. Meadow and M.A. Zeder (eds.), *Approaches to faunal analysis in the Middle East.* Peabody Museum Bulletins 2: 91-103.
Compagnoni, B., 1980. The Equids of the Achaemenian town of Dahan-i Ghulaman (Sistan, Iran). *East and West* 30 (1-4): 17-30.
Corti, L. N., M.A. Bella and A. Merigo, 1963. *L' allevamento del bestiame nel sud-est iraniano* I. Roma, Report of the Organizzazione Tecnica Internazionale.
Costantini, L. and M. Tosi, 1978. The environment of Southern Sistan in the third millennium B. C., and its exploitation by the proto-urban Hilmand Civilization. In: W. C. Brice (ed.), *The environmental history of the Near and Middle East since the last Ice Age.* London, 165-183.
Costantini, L., 1977. Le piante. In: P. Basaglia *et al.* (eds.), *La Città Bruciate del Deserto Salato.* Venezia-Mestre, Erizzo: 159-171.
Costantini, L., M. Tosi and A. Vigna Taglianti, 1978. Typology and socioeconomical implications of entomological finds from some ancient Near Eastern sites. *Paléorient* 3: 247-258.
Costantini, L., 1979. Wood remains from Shahr-i Soktha: a source of information for the ancient environment in protohistoric Sistan. In: M. Taddei (ed.), *South Asian Archaeology 1977.* Naples, Vol. 1. Istituto Universitario Orientale, Seminario di Studi Asiatici SM VI: 87-122.
Crabtree, P., 1990. Zooarchaeology and complex societies: some uses of faunal analysis for the study of trade, social status and ethnicity. In: M.B. Schiffer (ed.), *Archaeological method and theory,*

Volme 2. Tucson, The University of Arizona Press: 155-205.
Dahl, G. and Hjort, A., 1976. *Having herds. Pastoral herd growth and household economy.* Stockholm, University of Stockholm, Studies in Social Anthropology 2.
Diener, P. and E.E. Robkin, 1978. Ecology, evolution and the search for cultural origins: the question of Islamic pig prohibition. *Current Anthropology* 19/3: 493-540.
Driesch, A. von den 1976. *Das Vermessen von Tierknochen aus vor- und frühgeschichtliche Siedlungen.* München, Institut für Paläoanatomie, Domestikationsforschung und Geschichte der Tiermedizin der Universität München.
Duerst, U.J., 1904. Über ein neues prähistorisches Hausschaf (*Ovis aries studeri*) und dessen Herkunft. *Vierteljahresschrift der Naturforschende Gesellschaft in Zürich* 49: 17-34.
Durante, S., 1979. Marine shells from Balakot, Shahr-i Sokhta and Tepe Yahya: their significance for trade and technology in ancient Indo-Iran. In: M. Taddei (ed.), *South Asian Archaeology 1977.* Naples, Vol. 1. Istituto Universitario Orientale, Seminario di Studi Asiatici SM VI: 317-344.
Epstein, H., 1971. *The origin of domestic animals in Africa* I. Leipzig, Edition Leipzig.
Ermolova, H.M., 1970. (Ермолова, Х.М.) Новые материалы по изучению остатков млекопитанщких из древнихпоселнии Туркмении (New materials for the study of mammalian remains from ancient settllements in Turkemenia). *Каракумские Древносты* III: 205-232.
Frangipane, M. and G. Siracusano, 1998. Changes in subsistence strategies in East Anatolia during the 4th and 3rd millennium BC. In: P. Anreiter, L. Bartosiewicz, E. Jerem and W. Meid (eds.), *Man and the Animal World. Studies in memoriam Sándor Bökönyi.* Budapest, Archaeolingua Kiadó: 237-246.
Grayson, D.K., 1984. *Quantitative Zooarchaeology.* New York, Academic Press.
Groves, C.P., 1969. On the smaller gazelles of the genus *Gazella* de Blainville, 1816. *Zeitschrift für Säugetierkunde* 34: 38-60.
Harka, Á., 1993. A folyóvizek halrégiói (The fish regions of rivers). *A természet* XLIV/5: 85-87.
Harris, D.L., 1968. *The mammals of Arabia* II. London, Ernest Benn Limited.
Houlihan, P.F., 1996. *The animal world of the pharaohs.* London, Thames and Hudson.
Jarrige, C. and M. Tosi, 1981. The natural resources of Mundigak. Some observations on the location of the site in relation to its economic space. In: H. Härtel (ed.), *South Asian Archaeology 1979.* Berlin, Dieter Reimer Verlag: 115-142.
Jux, U. and K.E. Kempf, 1983. Regional geology of Sistan (Southwest Afghanistan). In: M. Tosi (ed.), *Prehistoric Sistan* 1. Roma, Istituto Italiano per il Medio ed Estremo Oriente: 5-60.
Kraus, F.R., 1966. *Staatliche Viehhaltung im altbabylonischen Lande Larsa.* Amsterdam, Mededelingen der Koninklijk Nederlandse Akademie van Wetenschappen. AFD Letterkunde 29/5.
Kretzoi, M., 1968. Étude paléontologique. In: M. Gábori and V. Csánk. (eds.), *La station du paléolithique moyen d'Érd, Hongrie.* Budapest, Akadémiai Kiadó: 59-104.
Lamberg-Karlovsky, C.C. and M. Tosi, 1973. Shahr-i Sokhta and Tepe Yahya: tracks on the earliest history of the Iranian Plateau. *East and West, N.S.*, 19 (3-4): 21-58.
Lamberg-Karlovsky, C.C., 1994. The Bronze Age khanates of Central Asia. *Antiquity* 68/259: 398-405.
Lange, J., 1972. Studien an Gazelleschädeln. Ein Beitrag zur Systematik der kleineren Gazellen, *Gazella* (De Blainville, 1816). *Säugetierkundliche Mitteilungen* 20: 193-249.
Lay, D.M., 1967. *A study of the mammals of Iran resulting from the Street Expedition of 1962-63.* Chicago, Filediana: Zoology 54.
Ligabue, G., 1977. L'alimentazione a Shahr-i Sokhta. In: P. Basaglia *et al.* (eds.), *La Città Bruciate del Deserto Salato.* Venezia-Mestre, Erizzo: 231-250.
MacHugh, D.E., M.D. Shriver, R.T. Loftus, P. Cunningham and D.G. Bradley, 1997. Microsatellite DNA variation and the evolution, domestication and phylogeography of taurine and zebu cattle (Bos taurus and Bos indicus). *Genetics* 146: 1071-1086.
MacHugh, D.E., R.T. Loftus, C.S. Troy and D.G. Bradley, 1998. DNA analysis and the origins and history of domesticated cattle. In: H. Buitenhuis, L. Bartosiewicz and A.M. Choyke (eds.), *Archaeozoology of the Near East III. Proceedings of the third international symposium on the archaeozoology of Southwestern Asia and adjacent areas.* Groningen, ARC Publication 18: 135-

144.
Massimov, I., 1970 (Масимов, И.) Раскопы ремсленного квартала эпохи бронзы поселении Алтын-депе (Excavations of the craftmen's quarters at the Bronze age settlement of Altyn Depe) *Каракумские Древносты* III: 51-63.
Mason, I.L., 1963. The hump of the zebu. In: A. E. Mourant and F. E. Zeuner (eds.), *Man and cattle*. London, Royal Anthropological Institute, Occasional Paper 18: 17-18.
Mason, I.L., 1984. Camels. In: I. L. Mason (ed.), *Evolution of domesticated animals*. London and New York, Longman: 106-115.
Matolcsi, J., 1970. Historische Erforschung der Körpergrösse des Rindes auf Grund von ungarischem Knochenmaterial. *Zeitschrift für Tierzüchtung und Züchtungsbiologie* 63: 155-194.
Meadow, R.H., 1979. Prehistoric subsistence at Balakot: Initial consideration of the faunal remains. In: M. Taddei (ed.), *South Asian Archaeology 1977*. Naples, Vol. 1. Istituto Universitario Orientale, Seminario di Studi Asiatici SM VI: 275-316.
Meadow, R.H., 1984. Animal domestication in the Middle East: a view from the eastern margin. In: J. Clutton-Brock and C. Grigson (eds.), *Animals in Archaeology 3. Early herders and their flocks*. Oxford, BAR International Series 200: 269-287.
Mirza, M.R., 1991. A contribution to the systematics of the Schizothoracinae fishes (Pisces: Cyprinidae) with description of three new tribes. *Pakistan J. Zool.* 23(4): 339-341.
Moore, K.M., N.F. Miller, F.T. Hiebert, and R.H. Meadow, 1994. Agriculture and herding in the early oasis settlements of the Oxus civilization. *Antiquity* 68/259: 418-427.
Morales Muñiz, A., J.A. Riquelme and C. Liesau von Lettow-Vorbeck, 1995. Dromedaries in antiquity: Iberia and beyond. *Antiquity* 69: 368-375.
Moreno García, M., 1999. Ethnographic observations of transhumant husbandry practices in Spain and their applicability to the archaeological sample. In: L. Bartosiewicz and H. Greenfield (eds.), *Transhumant pastoralism in Southern Europe*. Budapest, Archaeolingua Kiadó: 159-179.
Nelson, J.S., 1994. *Fishes of the World*. New York, John Wiley and Sons.
Nurkin, G., 1978. *The faunal remains from East Karnak. A preliminary report on the first three seasons 1975-1977*. manuscript, University of Toronto.
Payne, S., 1973. Kill-off patterns in sheep and goats: the mandibles from Aşvan Kale. *Anatolian Studies* 23: 281-303.
Percival, J., 1974. *The wheat plant. A monograph*. London, Gerald Duckworth and Co Ltd.
Pettinato, G., 1972. Il commercio com l'estero della Mesopotamia meridionale nel III millennio a. C. luce delle fonti letterarie e lessicali sumeriche. *Mesopotamia* VII: 43-166.
Pilgrim, G.E., 1939. *The fossil Bovidae of India*. Palaeontologia Indica, NS 26, 1.
Piperno, M., 1979.Socio-economic implications from the graveyard of Shahr-i Sokhta. In: M. Taddei (ed.), *South Asian Archaeology 1977* Naples, Vol. 1. Istituto Universitario Orientale, Seminario di Studi Asiatici SM VI: 123-140.
Planhol, X. de, 1959. *The world of Islam*. Ithaca N.Y., Cornell University Press.
Raikes, R.L., 1983. Environmental studies at Shahr-i Sokhta. In: M. Tosi (ed.), *Prehistoric Sistan* 1. Roma, Istituto Italiano per il Medio ed Estremo Oriente: 61-72.
Requate, H., 1957. Zur Naturgeschichte des Ures (*Bos primigenius* Bojanus 1827), nach Schädel- und Skelettfunden von Schleswig-Holstein. *Zeitschrift für Tierzüchtung und Züchtungsbiologie* 70: 297-338.
Rütimeyer, L. 1861. *Die Fauna der Pfahlbauten der Schweiz. Untersuchungen über die Geschichte der wilden und der Haus-Säugetiere von Mittel-Europa.* Neue Denkschrift der Allgemeine Schweizerische Gesellschaft der ges. Naturwissenschaft. 19.
Sarianidi, V., 1983. The pottery of Shahr-i Sokhta I and its southern Turkmenian connections. In: M. Tosi (ed.), *Prehistoric Sistan* 1. Roma, Istituto Italiano per il Medio ed Estremo Oriente: 183-198.
Sherratt, A., 1981. Plough and pastoralism: aspects of the secondary products revolution. In: I. Hodder, G. Isaac and N. Hammond (eds.), *Pattern of the past: studies in honour of David Clarke*. Cambridge, Cambridge University Press.
Steiger, C., 1990. *Vergleichende morphologische Untersuchungen an Einzelknochen des postkranialen Skeletts der Altweltkamele*. München, Inaugural Dissertation, Institut für Paläoanatomie,

Domestikationsforschung und Geschichte der Tiermedizin der Universität München.
Teichert, M., 1975. Osteologische Untersuchungen zur Berechnung der Widerristhöhe bei Schafen. In: A.T. Clason (ed.), *Archaeozoological studies*. Amsterdam - New York, North Holland and American Elsevier: 51-69.
Tortonese, E., 1977. I Pesci. In: P. Basaglia *et al.* (eds.), *La Città Bruciate del Deserto Salato*. Venezia-Mestre, Erizzo: 172.
Tosi, M., 1968. Excavations at Shahr-i Sokhta, a Chalcolithic settlement in the Iranian Sistan. Preliminary report on the first campaign, October-December 1967. *East and West, N.S.*, 18 (1-2): 9-66.
Tosi, M., 1969. Excavations at Shahr-i Sokhta. Preliminary report on the second campaign, September-December 1968. *East and West, N.S.*, 19 (3-4): 283-386.
Tosi, M., 1977. The archaeological evidence for protostate structures in Eastern Iran and Central Asia at the end of the 3rd millennium BC. In: *Le Plateau iranien et l'Asie Centrale des origines à la conquête islamique*. Paris, Colloques Internationaux du C.N.R.S. N° 567: 45-66.
Tosi, M., 1981. Domestication and hydrotechnology: aspects of technology for the transformation of nature. P. Mortensen and P. Sørensen (eds.), *Early agriculture and metallurgy*. Copenhagen, Scandinavian Institute of Asian Studies.
Tosi, M., 1983. Development, continuity and cultural change in the stratigraphical sequence of Shahr-i Sokhta. In: M. Tosi (ed.), *Prehistoric Sistan* 1. Roma, Istituto Italiano per il Medio ed Estremo Oriente: 127-182.
Uerpmann, H.P., 1977. Betrachtungen zur Wirtschaftsform neolitischer Gruppen in Südwestdeutschland. *Fundberichte aus Baden-Württemberg* 3: 144-161.
Uerpmann, H.P., 1982. Faunal remains from Shams Ed-Din Tannira, a Halafian site in Northern Syria, *Berytus Archaeological Studies* 30: 3-52.
Uerpmann, H.P., 1987. *The ancient distribution of ungulate mammals in the Middle East.* Wiesbaden, Beihefte zum Tübinger Atlas des Vorderen Orients, Reihe A: Naturwissenschaften No. 27.
Várkonyi, J. and E. Áts, 1984. *A kecske tenyésztése* (Goat breeding). Budapest, Mezögazdasági Kiadó.
Zalkin, B., 1951. (Залкин, Б.) *Горные бараны Европы и Азии.* (The mountain sheep of Europe and Asia). Москва, Бюллетень Московского Общества Испытателей Природы LVI.
Zalkin, B., 1962. (Залкин, Б.) *К истории животноводства и охоты в восточной Европе* (On the history of animal breeding and hunting in Eastern Europe). Материалы и исследования по археологии СССР. No. 107. Москва, Издателство Академии Наук СССР.
Zeder, M.A., 1986. The equid remains from Tal-e Malyan, Southern Iran. In: R. H. Meadow and H.P. Uerpmann (eds.), *Equids in the Ancient World.* Wiesbaden, Beihefte zum Tübinger Atlas des Vorderen Orients, Reihe A: Naturwissenschaften No. 19/1: 366-412.
Zeuner, F.E., 1963. *A history of domesticated animals*. London, Hutchinson.