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History hidden in bones: Holocene environmental change in northwestern Sudan

Abstract

This short report compiles data on the fauna of the northwestern part of Sudan obtained from archaeological excavations. With the aid of these data, Holocene faunal changes and environmental history are reconstructed for the time span that is covered by the archaeological finds.

Keywords: Archaeozoology, fauna, palaeoenvironment, environmental change, Holocene, Sudan

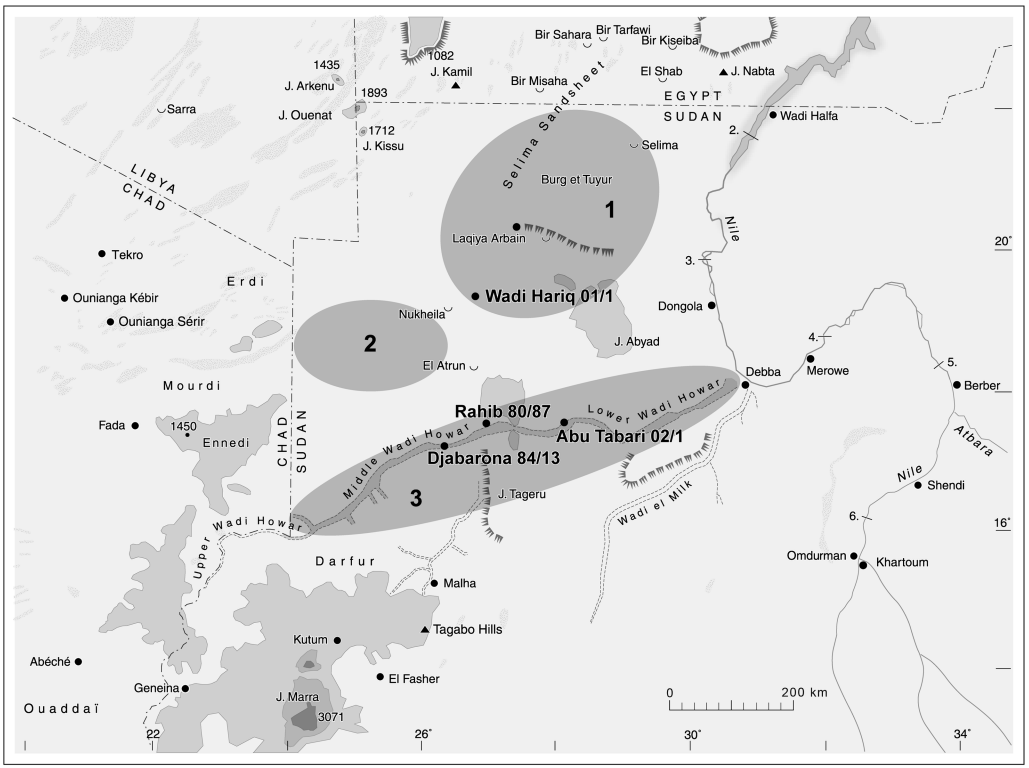
Introduction

Reconstructing the environment of past epochs and retracing the way of life of the prehistoric inhabitants of northern Sudan is like putting together a jigsaw puzzle: there are many very different pieces and every single one has to be set in its correct place. The big problem with this jigsaw is that we have to find the pieces first and when putting them together we already know that we do not have all of them. Besides hydrological, climatic, geographical and cultural approaches, palaeobotany and archaeozoology provide many of the pieces. Here I will discuss the archaeozoological contribution.

Faunal remains will, in principle, only represent a section of the wildlife spectrum once present in the landscape around a site because the samples are biased by human selection of the animals hunted or killed and deposited at the site, by different factors of preservation, and by the filter of archaeological methods. Therefore the picture is always fragmentary. But considering all the biasing factors, the interpretation of the spectrum of animals helps us to get near to the past situation. This report focuses on the bones of wild animals, as they provide the deepest insights into the past environments of the region, even though the analysis of the bones of domestic animals could also contribute to a certain extent.

The spatial, chronological, and cultural frame

The sites within the whole region were grouped into three research areas **(Fig. 1)**: The Laqiya – Selima Sandsheet area, the Ennedi Erg, and the Wadi Howar. The analysis of



1 Laqiya – Selima Sandsheet; 2 Ennedi Erg; 3 Wadi Howar.

Fig. 1 Map of northwestern Sudan showing research areas and sites mentioned in the text.

the archaeological material, in particular pottery, has resulted in the definition of three main occupation phases **(Fig. 2)** (Hoelzmann et al. 2001: 205 ff.): The Dotted Wavy-Line/Laqiya horizon, the Leiterband/Halbmondleiterband horizon, and the Handessi horizon.

The presence of prehistoric people in the research area started around 5000 BC, c. four millennia after the onset of the Holocene wet phase. These first inhabitants were hunters, fishers and gatherers. The period is named after the characteristic pottery styles, Dotted Wavy-Line and Laqiya (Jesse 2003). Judging from the density of finds at the sites, these hunter-gatherer groups are thought to have lived at least semi-sedentary lives (Jesse 2004a). Therefore environmental conditions were obviously favourable for a foraging way of life.

A fundamental and abrupt socio-economic change occurred in the 4th millennium BC when livestock keeping was introduced into northwestern Sudan. The bone samples associated with Leiterband and Halbmondleiterband pottery mainly consist of cattle

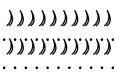
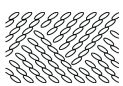
	Laqiya / Selima Sandsheet	Ennedi Erg	Wadi Howar	Economy	Time scale calBC
 Handessi B	•		•	Cattle and small livestock pastoralism, occasional hunting	c. 1500
 Handessi A	•		•		c. 1800
 Halbmond-leiterband	•	•	•	Cattle pastoralism	c. 2000
 Leiterband	•	•	•		c. 3000
 Laqiya		•	•	Foraging (hunting, fishing, gathering)	c. 4500
 Dotted Wavy-Line		•	•		c. 5000

Fig. 2 Archaeological pottery and economic sequences for northwestern Sudan (after Hoelzmann et al. 2001: Fig. 9).

bones (Keding 1997). The subsistence of these people was almost exclusively based on cattle keeping. Up to now, no transitional inventories have been found that would allow us to study the process of this fundamental change from a foraging to a producing way of life. Thus we do not know whether pastoralism was introduced by people migrating into this part of the Libyan Desert or the autochthonous people of this region adopted the new way of life. Hunting wild game did not contribute significantly to the diet as shown by the scarcity of wild animal bones. Fishing, however, was practised as the large

amounts of fish bones at some sites suggest. Cattle pastoralism in this region west of the Sudanese Nile Valley is a relatively young phenomenon compared to the Nile Valley, where cattle bones have been found at sites of the 5th millennium BC or even earlier (Jesse 2004b).

The geometric ceramic patterns were the reason for calling the last phase of prehistoric occupation in northwestern Sudan the Handessi horizon, *handessi* being the Arabic word for geometric (Jesse 2006b). During the 2nd millennium BC pastoralists diversified their flocks by adding goats and sheep. Small livestock are better adapted to arid climate than cattle. For example, their drinking intervals are five to ten times longer (Smith 1980). Different feeding habits are a second reason for this diversification. Since goats are browsers, they will not compete with cattle which mainly feed on grass. Moreover, resource broadening seems to have been general and also encompassed game. Apart from the general diversification of resource exploitation, the pastoral way of life was modified by adopting a new pattern of movements. The uncertain availability of water especially in the northern part of the region forced the pastoralists to include more distant regions with permanent water supply in their annual cycle of movements, for example the Nile Valley. After the rainy season the pastoralists and their herds left their retreat areas and frequented remote territories, which provided sufficient pasture and ephemeral pools. Sites of those transhumant groups were found in the Laqiya – Selima Sandsheet region (Jesse et al. 2004). Towards the end of the 2nd millennium BC conditions deteriorated to such an extent that even those highly mobile pastoralist groups abandoned the region. Only when camels were introduced from southwestern Asia did resettlement of the area become possible.

Material

The number of bones analysed up to now amounts to hundreds of thousands of fragments from more than 2,000 sites. Due to the bad state of preservation, however, only a small fraction could be identified to the family, genus or even species level. This holds especially true for mammal bones since the majority of them belong to medium-sized to large bovids. In Africa bovids are the mammal family with the largest variety of species of similar size and morphology. They are difficult to distinguish when the bones are disintegrated as is the case with faunal remains from sites in arid regions.

Assemblages with statistically meaningful numbers of identifiable bones are relatively scarce. Large and therefore important inventories come from the following sites: Rahib 80/87 and Djabarona 84/13 in the Middle Wadi Howar; Abu Tabari 02/1 in the Lower Wadi Howar; and Wadi Hariq 01/1 in the Laqiya – Selima Sandsheet area (**Tab. 1**; for locations see **Fig. 1**). The first site dates to the first occupation phase, the Dotted Wavy-Line/Laqiya horizon, and yielded a diverse fauna of at least 20 aquatic

and terrestrial taxa (Jesse 2003). The second and third sites belong to the Leiterband/Halbmondleiterband phase. Both sites are characterised by high find frequencies but much more by their numbers of identified taxa. At Djabarona 84/13, 30 different taxa could be identified among 40,000 fragments (Van Neer & Uerpmann 1989; unpublished data). The fauna of Abu Tabari 02/1 comprises about 24,000 fragments, representing more than 50 taxa (Pöllath 2007). Apart from the number of taxa as such, the species composition of the latter two sites is outstanding. In both cases the bulk of bones pertain to domestic species, more precisely to cattle. A few bones of wild herbivores and an impressive list of aquatic taxa illustrate the diversity of former wildlife around the sites. Although the faunal assemblage of the Handessi site Wadi Hariq 01/1 is quite small (less than 3,500 fragments) and almost exclusively comprises domestic species (more than 95 %), the few bones of wild animals give an impression of the wildlife present in the vicinity of the site when it was visited by the pastoralist groups (Jesse et al. 2004). This site, however, is much more important with regard to its surprising accumulation of bones pertaining to very young calves and small livestock.

These inventories allow us to study specific man – environment interactions. However, significantly more data from a range of additional sites are necessary for drawing a general picture of the faunal development during the early and middle Holocene. A presence/absence analysis is sufficient for reconstructing the former distribution of species in different periods. Therefore a net of sites as spatially and chronologically dense as possible is required. Albeit comprehensive material is also desirable for this kind of qualitative investigation, the number of finds is much more important in a quantitative analysis. Due to the poor conditions of preservation in the region only a few sites provided a sufficient quantity of identifiable bones. Unfortunately, the distribution and density of sites in the three research areas and over the three occupation phases is rather uneven. In the Wadi Howar dune habitats are a major type of site. They were frequented for longer periods or even inhabited more or less permanently as evidenced by the archaeological material pertaining to different phases and periods (Jesse 2006a). Whereas the chronological differentiation of archaeological material, especially of pottery, is possible even for single specimens, the dating of faunal remains is only feasible when they are clearly associated with datable archaeological material from a single phase. However, at long-term habitation sites such as the dune habitats the layers of all occupation phases are mixed to a certain extent. Although more recent finds tend to occur closer to the surface and older materials further down, a clear separation of bones from older and younger phases is impossible. Bone assemblages from the first occupation phases are scarce or even almost absent, for example in the Lower Wadi Howar, although a number of sites were discovered and investigated. Another restricting factor is the reduced hunting activity of pastoralists. But in spite of these limitations a reconstruction of the environmental history of the Wadi Howar region is possible and will be outlined below.

	Rahib 80/87	Djabarona 84/13	Abu Tabari 02/1	Wadi Hariq 01/1
Mammals				
Hippopotamus amphibius	F	-	R	-
Phacochoerus aethiopicus	R	-	R	-
Giraffa camelopardalis	-	R	R	R
Oryx dammah	-	-	-	R
Hippotragus equinus	R	-	R	-
Redunca redunca	-	-	R	-
Damaliscus lunatus	-	-	R	-
Gazella dama	R	-	R	R
Gazella dorcas	-	-	-	R
Gazella sp.	F	R	R	R
Syncerus/Pelerovis	R	-	-	-
Loxodonta africana	R	-	R	-
Orycteropus afer	-	-	R	-
Lepus capensis	-	R	R	-
Small fox (fennec, sandfox)	-	-	R	-
Fox	-	R	-	-
Hyaena hyaena	R	-	-	-
Caracal caracal	-	-	R	-
Felid	R	-	-	-
Viveridae	R	-	-	-
Mustelid (*Ictonyx/Poecilictis*)	-	-	R	-
Hedgehog (*Paraechinus/Erinaceus*)	-	-	R	-
Rodent / Rodentia indet.	-	R	-	R
Birds				
Buteo buteo	-	-	R	-
Francolinus sp.	-	-	R	-
Small dove (cf. *Streptopelia senegallensis*)	-	-	R	-
Ducks	R	-	-	-
Rallus aquaticus	R	-	-	-
Haliatus vocifer	R	-	-	-
Amphibians				
Anura	R	R	-	-
Reptiles				
Colubridae indet.	-	-	R	-
Pelusios adansoni	-	-	F	-
Pelusios sp. (cf. *P. castaneus*)	-	-	R	-
Cyclanorbis sp.	-	-	R	-
Varanus niloticus	-	-	R	-
Varanus sp.	-	-	R	-
Crocodylus niloticus	R	-	R	-
Trionyx triunguis	R	-	-	-
Cerastes cerastes	-	-	-	R
Fish				
Polypterus sp. (cf. *P. bichir*)	-	-	R	-
Polypterus sp.	-	R	F	-
Heterotis niloticus	-	R	R	-
Hyperopisus bebe	-	-	R	-
Mormyridae indet.	-	R	R	-
Gymnarchus niloticus	-	-	R	-

	Rahib 80/87	Djabarona 84/13	Abu Tabari 02/1	Wadi Hariq 01/1
Characidae indet.	-	R	R	-
Hydrocynus sp.	-	-	R	-
Distichodus sp.	-	-	R	-
Citharinidae indet.	-	R	R	-
Labeo sp.	-	R	R	-
Siluriformes indet.	-	-	F	-
Bagridae indet.	-	-	R	-
Bagrus sp.	-	R	R	-
Auchenoglanis sp.	-	R	R	-
Clarotes laticeps	-	-	R	-
Chrysichthys sp.	-	R	R	-
Schilbeidae indet.	-	R	R	-
Clariidae indet.	F	FF	FF	-
Clarias sp.	-			-
Heterobranchus sp.	-	-		-
Synodontis sp.	F	FF	FF	-
Synodontis frontosus	-	-		-
Synodontis membranacaeus	-	-		-
Synodontis schall	-	-		-
Lates niloticus	R	R	F	-
Tilapiini indet.	F	FF	FF	-
Tetraodon fahaka	R	-	R	-
Alestes sp.	-	R	-	-
Barbus bynni	-	R	-	-
Cyprinidae indet.	-	R	-	-
Clarotes laticeps	-	R	-	-
Hemichromis fasciatus	-	R	-	-
Molluscs				
Chambardia sp.	-	R	F	-
Chambardia wahlbergi	-	-		-
Chambardia rubens	-	R	-	-
Gabiella senaariensis	-	-	R	-
Lanistes carinatus	F	R	R	-
Melanoides tuberculata	F	R	-	-
Bulinus truncatus	F	-	-	-
Biomphalaria pfeifferi	F	-	-	-
Gyraulus sp.	R	-	-	-
Valvata nilotica	R	-	-	-
Bulinus forskali	R	-	-	-
Etheria elliptica	(R)	-	-	-
Pila sp.	-	R	-	-
Cleopatra bulimoides	-	R	-	-
Coelatura aegyptiaca	-	R	-	-
Zootecus insularis	-	-	-	R

R – rare; F – frequent; FF – very frequent; in brackets ( ) – maybe introduced

Tab. 1 Faunal composition and relative frequencies of taxa found at sites with large animal bone assemblages.

Reconstruction of palaeoenvironments

Taking into account all the data available with regard to habits and biology of the species present at a site, one may deduce the hydrological situation, the vegetation, and the setting of the landscape within the site's catchment area during the relevant period. For this one needs to know whether an animal is sedentary or migratory, whether a herbivore feeds preferably on grass, herbs or leaves, whether it needs to drink daily or may go without water for longer periods. The last characteristic is the most important one when investigating the development in a region where rainfall is unpredictable. Such data are compiled in **Tab. 2** for species present in the bone assemblages of northwestern Sudan (Haltenorth & Diller 1977; Happold 1987). Sedentary animals living in aquatic habitats or requiring water daily indicate permanent bodies of water. Hippopotamus and crocodile are good examples of this. Less useful in this respect are migratory species, since they might have frequented the area for only short periods and perhaps only due to temporary exceptional conditions such as droughts in their usual habitats or extraordinary rainfalls in regions where migratory species usually cannot survive. But seen in context, even migratory species may contribute to our puzzle, for example, when an assemblage exclusively yields remains of mobile animals that are independent of surface water. This would indicate that only such species were able to survive in the area and that conditions were not good enough for more demanding species. Similarly, fish are certainly an indicator of water. But the mere presence of fish bones is not necessarily indicative of permanent water, since some species of the Nilo-Sudanese ichthyofauna, such as clariid catfish, migrate into inundated plains to spawn and will afterwards return into their original habitats (Pöllath & Peters 2003). Moreover, clariids and members of other taxa such as the tilapiini and *Synodontis* species tolerate rather poor water conditions with low oxygen contents, high water temperatures, and high salinity. The presence of these taxa may therefore be the result of exceptional rainfalls and only indicate ephemeral pools. Other species with high demands on water quality, such as the Nile perch (*Lates niloticus*) or some mormyrids, indicate permanent and relatively deep and well-oxygenated water (Peters et al. 2002). Ubiquitous animals, however, are less helpful for the reconstruction of past environments due to their great adaptability. The brown hare (*Lepus capensis*) is one such animal occurring in all more or less open biotopes. The constitution of domestic livestock herds may also contribute to such environmental reconstructions, since size and stature are dependent on factors such as availability of water, food, and health.

Considering only the relevant species, the faunal repertoire of the three research areas under consideration introduced above illustrates the environmental setting at specific points in the past. As mentioned above, the oldest archaeological sites in northwestern Sudan date to the Dotted Wavy-Line/Laqiya horizon. Our example, Rahib 80/87, exemplifies the situation in the eastern part of the Middle Wadi Howar at

	Movements	Feeding type	Water requirements	Habitat	
Dorcas gazelle *Gazella dorcas*	migratory	mixed feeder	none	desert, semi-desert	desert to semi-desert
Scimitar oryx *Oryx dammah*	migratory	mixed feeder	none	semi-desert	
Barbary sheep *Ammotragus lervia*	sedentary	mixed feeder	none	desert, semi-desert	
Fennec *Vulpes zerda*	sedentary	small vertebrates, insects, fruits	none	desert to semi-desert	
Warthog *Phacochoerus aethiopicus*	sedentary	grazer	for weeks without water	open grassland	dry savanna to bush savanna
Giraffe *Giraffa camelopardalis*	migratory	browser	for weeks without water	dry grassland with bushes & trees	
Red fronted gazelle *Gazella rufifrons*	migratory	mixed feeder	for weeks without water	open grassland, thorn bush savanna	
Topi *Damaliscus lunatus*	mostly sedentary	grazer	for weeks without water	semi-desert to open grassland	
Giant eland *Taurotragus derbianus*	mostly sedentary	mixed feeder	for weeks without water	woodland, forested savanna	bush savanna to open woodland
Roan antelope *Hippotragus equinus*	mostly sedentary	mixed feeder	almost daily	open woodland, bush savanna	
African buffalo *Syncerus caffer*	mostly sedentary	grazer	daily, never far from water	savanna, forests	
Flap shell turtles Cyclanorbinae, and Mud turtles *Pelusios* sp.	sedentary	invertebrates, small vertebrates	daily	rivers, lakes, pools	aquatic species
Nile crocodile *Crocodylus niloticus*	sedentary	fish, almost all mammals	daily	rivers, lakes, pools	
Nile monitor *Varanus niloticus*	sedentary	small mammals, fish, reptiles	daily	rivers	
Cane rat *Thryonomys* sp.	sedentary	grass, reed	daily	wetlands, rain forest	
Hippopotamus *Hippopotamus amphibius*	sedentary	grazer	daily	permanent water-bodies	

Tab. 2 The biology and habitat requirements of the species identified in faunal assemblages from north-western Sudan.

that time (**Tab. 1**). Roan antelope *(Hippotragus equinus*) and buffalo (*Syncerus/Pelerovis*) need open woodlands and bush savannas with daily access to open water. Extensive bodies of water are furthermore proved by the presence of hippo (*Hippopotamus amphibius*), aquatic reptiles such as the Nile crocodile (*Crocodylus niloticus*) and the African softshell turtle (*Trionyx triunguis*), and by a significantly large amount of fish bones and mollusc shells. Albeit water must have been available at least for most time of the year the predominance of less demanding mollusc and fish species (e.g. *Lanistes carinatus*, clariids, tilapiini) shows that the water was relatively shallow and standing (lentic). Bones of gazelles, especially those of the Dama gazelle (*Gazella dama*), indicate decidedly drier habitats.

With the help of these data the landscape around this particular site can be visualised. But to see the situation in a larger region the results for all contemporaneous sites need to be summarised **(Fig. 3)**. Open woodland and bush savannas, e.g. indicated by Giant eland (*Taurotragus derbianus*) or buffalo (*Syncerus/Pelerovis*), characterised large parts of the Wadi Howar region and the Ennedi Erg. The presence of hippo, crocodile and fish indicate large and permanent bodies of water. Arid grassland species, such as giraffe, and (semi-)desert dwellers like dorcas, addax, and oryx, however, were also found at the same sites. Therefore arid habitats must have existed in their vicinity. This suggests oscillating climatic conditions in a transitional zone between desert and savanna, leading to a mosaic of habitats with a tendency to more savanna-like or more desert-like vegetation depending on the rainfalls. This mosaic of habitats must have existed within the site's catchment area, here defined as the area within a 10 km radius around the site, corresponding to an average distance covered by a hunter in a 2 hours' walk (Higgs & Vita-Finzi 1972). Recent ethnographic studies among foraging groups, however, showed that the hunting area might be decidedly smaller. In the case of the Hadza, a modern foraging population in East Africa, O'Connell et al. (1992) found that the butch-ering stands were less than 5 km from the base camp, no more than a walk of 70 minutes; the area of hunting activity measures about 20 km^2 (O'Connell et al. 1992: Fig. 4).

The woodland most likely only existed very close to the lake(s) and in riverine gallery forest areas, most probably surrounded by grassland grading into desert. At contemporaneous sites of the Laqiya – Selima Sandsheet region species inhabiting arid grassland dominate. Finds of African buffalo, however, also suggest at least some locations with more favourable conditions. But those were presumably scarce. Comparison of faunal records clearly show a north-south gradient with more favourable conditions towards the south.

In the Leiterband/Halbmondleiterband period this gradient is still detectable: The faunal records of sites in the Laqiya area mainly consist of taxa living in (semi-)desert environments. Giraffes, being present in these samples, were most likely only occasional visitors to the region in years with exceptional rainfalls. Bones of wild species are scarce in assemblages from the Ennedi Erg region where at that time animal protein was

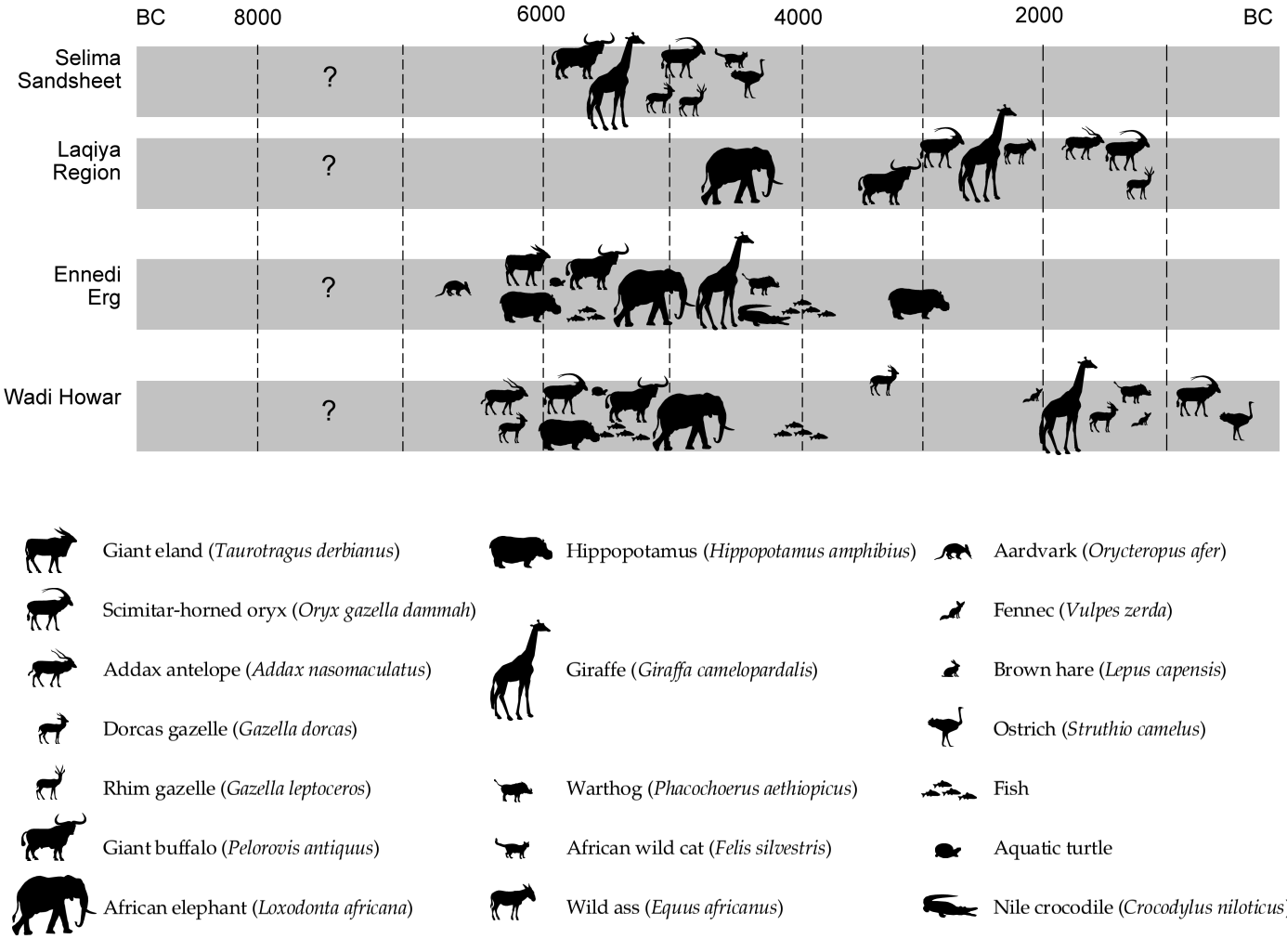


Fig. 3 Holocene faunal history of the research areas in northwestern Sudan.

almost exclusively provided by livestock, predominantly cattle. But occasional finds of hippo and fish remains prove the existence of permanent water bodies in this region. In the middle and lower sections of the Wadi Howar a rich aquatic fauna with hippopotami, crocodiles, fish, and water turtles is attested, for example at Djabarona 84/13 in the Middle Wadi Howar and at Abu Tabari 02/1 in the Lower Wadi Howar (**Tab. 1**; Van Neer & Uerpmann 1989; Pöllath 2007). The terrestrial fauna of the latter site also shows a mixture of habitats with desert-like (e.g., Dama gazelle, *Gazella dama*), and savanna-like biotopes as well as open woodland close by, e.g. roan antelope (*Hippotragus equinus*) or Bohor reedbuck (*Redunca redunca*). The scarcity of wild herbivores such as bovids or giraffes along with the abundance of aquatic animals in the sample indicates two things: (1) hunting prey did not play a major role in the diet of the people, and (2) wild bovids avoided that area, which may have been the reason for (1). The record of water-dependent and aquatic species, however, certainly documents the permanent availability of water, despite the predominance of species with low requirements as to water quality. The scarcity or even absence of terrestrial herbivores most likely has to be seen in connection with the presence of human groups and their flocks in the area of Abu Tabari (Pöllath & Peters 2007).

In the course of the 2nd and 1st millennia BC (Handessi horizon), conditions deteriorated in all three regions to such an extent that only desert-adapted animals, such as dorcas, oryx, or addax, could survive in the Laqiya – Selima Sandsheet and the Wadi Howar region. In the Ennedi Erg no sites dating from this period were found, an indication that conditions there were already too bad for prehistoric people to frequent this area. The faunal record of Handessi sites shows that the subsistence of the pastoralists was almost exclusively based on their livestock. The assemblages of Wadi Hariq 01/1 in the Laqiya – Selima Sandsheet region provided only scarce evidence of wild game, exclusively pertaining to desert dwellers such as the two gazelle species and the scimitar-horned oryx (**Tab. 1**; Jesse et al. 2004). However, giraffe, a migratory species with a large range, shows that this area still attracted more demanding species at least in some years.

Concluding remarks

Faunal assemblages are significant in providing a general picture of past environments around archaeological sites. The faunal record may provide major types of data: (1) on the horizontal distribution of habitats, and (2) on chronological changes within given regions. In mid- to late Holocene northwestern Sudan we can detect a north-south gradient of improving climate conditions in each archaeological phase on the one hand, and a general drying-up of the landscape over time. Furthermore the animals present at the sites show that the landscapes were not uniform but more like patchworks of

different habitats. The bone analyses also attest strong connections between environmental changes and the socio-economic development of prehistoric societies in this part of Africa.

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