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AND THE SURROUNDING ISLANDS

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Late Quaternary mammalian remains from Central and Eastern Sudan and their palaeoenvironmental significance

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ABSTRACT

The archaeozoological record of terminal Pleistocene to Middle Holocene sites in the Central Sudanese Nile and Upper Atbara regions is interpreted in terms of environmental change. On the basis of the species composition of the faunal assemblages, shifts in climate and vegetation can be observed. Using the present-day position of the vegetation zones, the extent of their north-south movements during the late Quaternary has been assessed. In view of this development, the introduction of livestock in Central and Eastern Sudan has been evaluated.

INTRODUCTION

Since the middle of this century, archaeological research in Central and Eastern Sudan focuses on the Nile and Atbara river valleys and their hinterlands (e.g. Arkell 1949, 1953; Shiner 1971; Haaland 1981; Caneva 1983; Geus 1983, Marks et al. 1985, 1987). Especially the Central Nile Valley north of Khartoum (Fig. 1, A, B) and the Upper Atbara region (Fig. 1, C) have been target areas for numerous archaeological projects. These resulted in a series of excavations that produced, besides artefacts, ceramics, polished stones etc., collections of animal bones. Some of these faunal samples have been analysed by colleagues, others have been dealt with by ourselves (cf. Table 1).

The faunal samples considered can be arranged in five groups on the basis of the location of the sites were they have been collected (cf. Table 1; Fig. 1, 2): (1) the Central Nile Valley between Khartoum and el Kadada; (2) its hinterland formed by the western Butana; (3) the junction of the Nile and the Atbara and the area north of it; (4) the Upper Atbara valley; (5) its hinterland comprising a

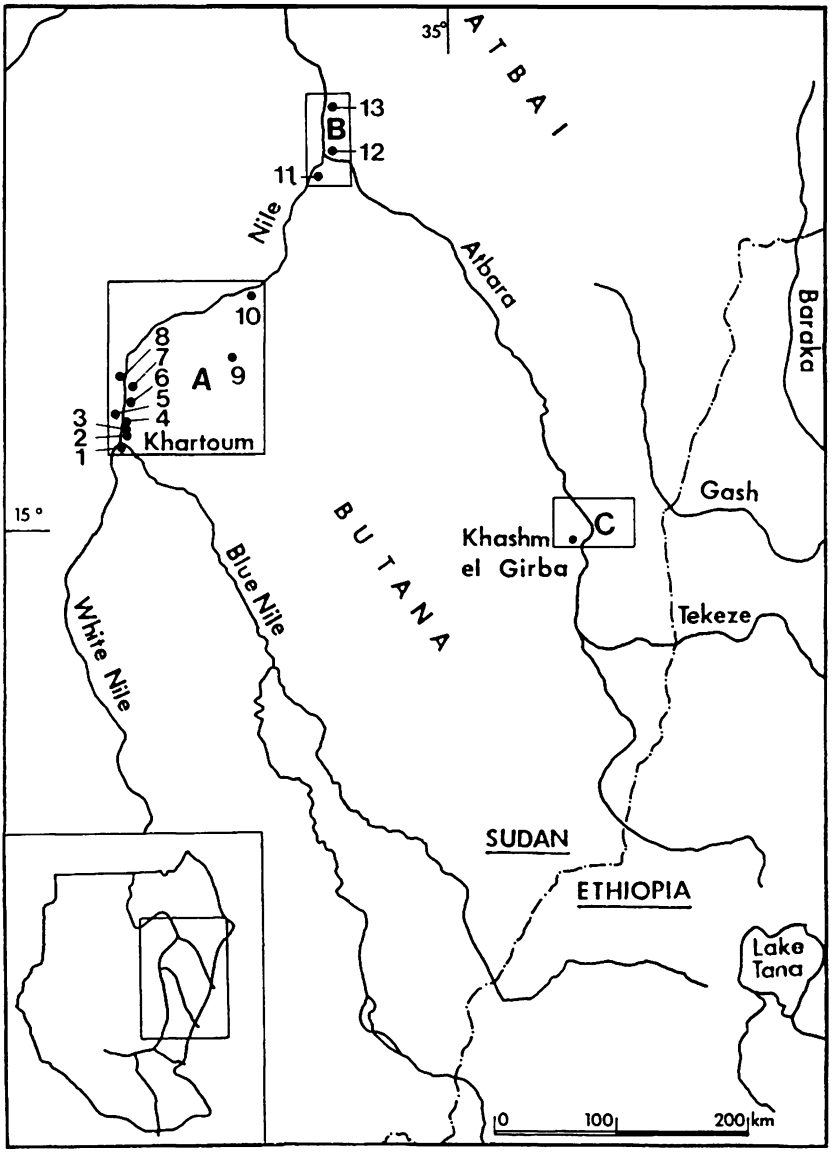

Figure 1. Map of the East Central Sudan. Inset shows map relative to the Sudan. Left rectangles show the Central Nile study areas. Right rectangle shows the Upper Atbara study area. Site numbers (1 to 13) correspond to the following locations: Khartoum Hospital, Umm Direiwa, El Kadero, El Zakyab, El Nofalab, Saggai, El Geili, Esh Shaheinab, Jebel Shaqadud, El Kadada, El Damer, Abu Darbein, Aneibis.

part of the Eastern Butana and the Southern Atbai, the latter stretching to the Ethiopian border (Fig. 1). In addition, we have classified the sites according to their radiocarbon ages into five periods. Table 1 summarizes the time division system used, the sites with faunal remains included in them, the location of the sites, and the author(s) who dealt with the faunal analysis.

Table 1. Time periods, site locations and sites considered in this study.

Period	Site location	Sites	Authors
ca. 11000 to 10000 BP	Upper Atbara valley	KG 15,16,73,7334	Peters 1986a; Marks et al. 1987
ca. 9000 to 7000 BP	Central Nile valley	Khartoum Hospital	Bate 1949; Peters 1986b; Gautier 1983
		Saggai 1	
	Central Nile hinterland	Jebel Shaqadud	Marks et al.1985; Peters 1989, in press
		S21	
	Nile/Atbara junction	El Damer	Peters in press
		Abu Darbein	Peters in press
		Aneibis	Peters in press
	Upper Atbara valley	KG 55,68,71	Peters 1986a; Marks et al. 1987
ca. 6500 to 6000 BP	Upper Atbara valley	KG 14	Peters 1986a
ca. 6000 to 4800 BP	Central Nile valley	Esh (El) Shaheinab	Bate 1953; Tigani el Mahi 1982,1988; Peters 1986b
		El Zakiab	Tigani el Mahi 1982, 1988
		Um Direiwa	Tigani el Mahi 1982, 1988
		El Nofalab	Tigani el Mahi 1982, 1988
		El Kadero	Gautier 1984, in press
		El Kadada	Gautier 1986
		El Geili	Gautier 1983, 1988
	Central Nile hinterland	Jebel Shaqadud	Marks et al. 1985; Peters 1989, in press
		S1-B	
	Upper Atbara hinterland	KG 10,13,28,94,104	Peters 1986a
ca. 4800 to 3500 BP	Central Nile hinterland	Jebel Shaqadud	Marks et al. 1985; Peters 1989, in press
		S1-A	
	Upper Atbara valley	KG 1,7,29,56	Peters 1986a
	Upper Atbara hinterland	KG 23	Peters 1986a

Setzer (1956), Happold (1967) and others describe the present-day wild fauna of the Khartoum Province, emphasizing that one has to distinguish between 'riverain' and 'desert' species. Larger game nowadays only includes dorcas gazelle (*Gazella dorcas*), thought it is likely that not so long ago, dama gazelle (*Gazella dama*), addax (*Addax nasomaculatus*) and maybe also oryx (*Oryx dammah*) still roamed the plains west of the Nile. Other 'desert' species occurring in the Khartoum Province are hare (*Lepus capensis*), sand fox (*Vulpes pallidus*), common jackal (*Canis aureus*), zorilla (*Ictonyx striatus*), wild cat (*Felis silvestris*), striped ground squirrel (*Euxerus erythropus*) and rock hyrax (*Procavia ruficeps*). Barbary sheep (*Ammotragus lervia*) have been re-introduced in the Sabaloka game reserve. Among the smaller rodents, species of the genera *Gerbillus*, *Meriones*, *Acomys* and *Jaculus* can be observed. 'Riverain' mammals include common genet (*Genetta genetta*), white-tailed mongoose (*Ichneumia albicauda*), serval (*Felis serval*) and Nile rat (*Arvicanthis niloticus*). It is clear that numerous bats and insectivores can be added to this list. Also, museum collections from the Khartoum Province suggest that, for example, leopards (*Panthera pardus*) and grivet monkeys (*Cercopithecus aethiops*) survived in the Central Sudan until the beginning of this century.

The present-day fauna of the Upper Atbara region is not well known. According to Mackenzie (1954), Setzer (1956) and others, most of the species known from the Central Sudan also occur here. Larger game includes, besides dorcas gazelle, only Soemmerring's gazelle (*Gazella soemmerringi*). However, the local extinction of giraffe (*Giraffa camelopardalis*) and hippopotamus (*Hippopotamus amphibius*) in the area may date back to this century. To the east of Khashm el Girba, in a mountain range close to the Ethiopian border, a troop of baboons (*Papio cynocephalus*) survives, feeding on the garbage dump of the town of Kassala.

Today, the Nile and Atbara valleys are occupied by (semi-)sedentary pastoralists. In addition, nomadic pastoral tribes move to the rivers during the driest parts of the year, wandering back to the Butana or the Atbai after the rains have come. In Jebel Shaqadud, a small resident population is engaged in rainfall farming and livestock herding. Most of the year they rely on deep wells to supply water for themselves and their flocks (Marks et al. 1985). The Southern Atbai is to a small extent farmed seasonally after the summer rains, but mainly provides pasture for livestock and dromedaries (Fattovich et al. 1984). Domestic animals kept by the pastoralist tribes in the study area include chicken, dog, sheep, goat, zebu cattle, dromedary, donkey and horse.

As stressed by many authors (e.g. Walter 1973); Wickens 1982; Gautier 1983; Fouad 1984), the fauna and flora of the Sudan have been seriously degraded during the last century as a result of an uncontrolled cutting and removal of trees and shrubs, cultivation methods, overgrazing with the destruction of perennial

grasses, hunting with fire arms, an increasing human and animal population etc. This makes it difficult to judge the game biomass and diversity which would characterize the area if the human factor were reduced drastically.

MAMMALIAN ASSOCIATIONS IN THE PAST

11 000 to 10 000 BP

Terminal Pleistocene sites are rare in Central and Eastern Sudan. Up to now, only a handful of preceramic sites that yield tools, usually associated with the end of the Palaeolithic, are known. They are located in an older Atbara floodplain and produced, besides artefacts, also some interesting faunal samples (Marks et al. 1987). The absence of a preceramic occupation in the Central Nile Valley is particularly strange, because of the rather extensive distribution of the younger

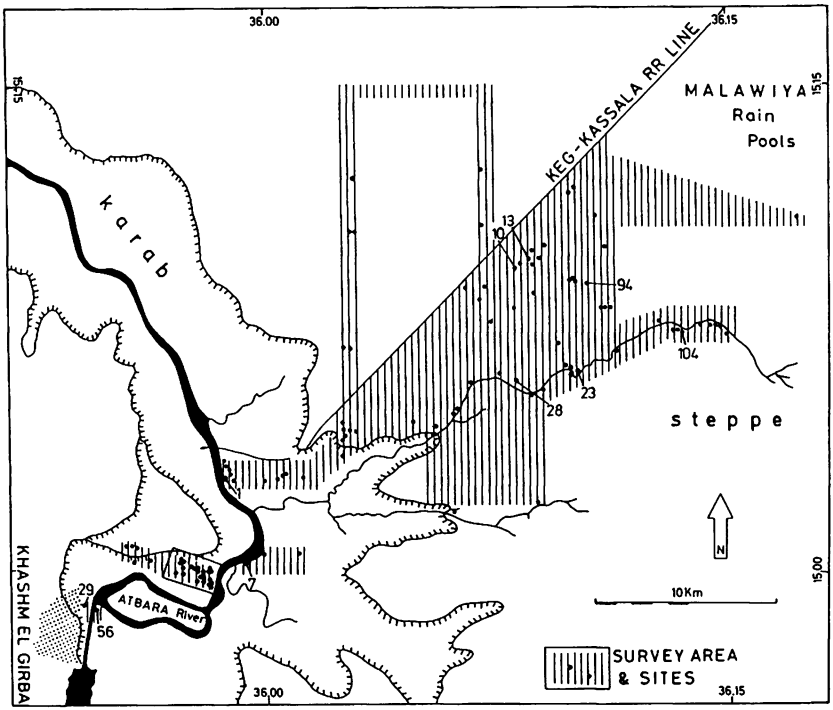

Figure 2. Map of the Uper Atbara study area, showing location of the sites mentioned in the text.

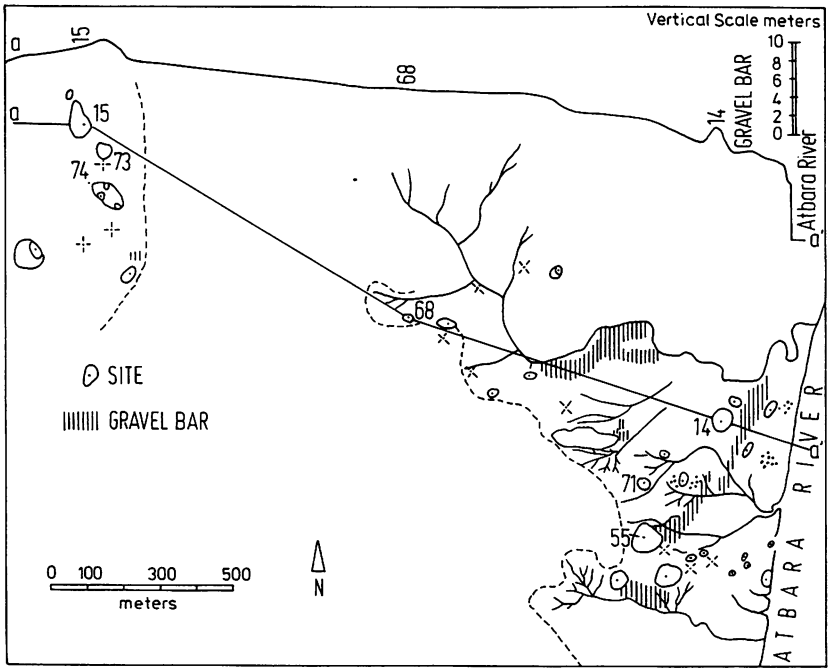

Figure 3. Map of the sites recorded from the depression to the northeast of the town of Khashm-el Girba. This map corresponds with the rectangle in Figure 2.

Khartoum Mesolithic-related sites with ceramics. Perhaps this part of the Nile valley did not see a significant Late Pleistocene occupation. However, it is not inconceivable that prehistoric people were present on the Central Nile floodplains during the later Pleistocene but that their sites have been eroded or covered by younger fluviatile sediments.

Thus, the faunal evidence for the end of the Pleistocene comes from a cluster of sites (KG 15, 16, 73, 74) near a bend of the Atbara river (Fig. 2). The samples show a preservation bias in favour of skeletal elements of larger mammals: North African porcupine (*Hysterix cristata*), African wild ass (*Equus africanus*), hippopotamus, dorcas gazelle, Soemmerring's gazelle, hartebeest (*Alcelaphus buselaphus*) and aurochs (*Bos primigenius*). We note that a typical Palaearctic element (*aurochs*) and a typical Aethiopian (*Soemmerring's gazelle*) element are present, as well as species that occur(ed) in both zoogeographical regions (porcupine, dorcas gazelle, hartebeest). The aurochs remains in these samples are quite unexpected because the nearest area where fossils of wild cattle have been found lies near Wadi Halfa, some 950 km to the northwest of Khashm el

Girba (Gautier 1968). However, their is no doubt about the identification of our specimens since the skeleton of aurochs and African buffalo (*Syncerus caffer*) exhibit clear osteomorphological differences (Peters 1986c, 1988). Moreover, the large spatial hiatus between the finds may reflect nothing more than the absence of known sites of comparable age.

9000 to 7000 BP

Early Holocene sites with faunal remains are present in the Central Nile region (i.e. the Khartoum Mesolithic-related sites) and on the Atbara floodplain (KG 55, 68, 70, 71, i.e. Pre-Atbai Ceramic Tradition sites). Table 2 summarizes the mammals that have been recognised in the samples. The spectrum can be described as a segment of the present-day Aethiopian fauna, with typical species such as marsh cane rat (*Thryonomys swinderianus*), African wild dog (*Lycaon pictus*), African civet (*Viverra civetta*), aardvark (*Orycteropus afer*), African elephant (*Loxodonta africana*) etc. The presence of a very small antelope, most likely Salt's dikdik (*Madoqua saltiana*), among the faunal remains from the sites located at the junction of the Nile and the Atbara is noteworthy.

7000 to 6000 BP

Up to now, the first half of the 7th millenium BP failed to produce sites with sufficient bone material. Samples from the Central Nile and Upper Atbara valleys as well as from the Upper Atbara hinterland are for the moment lacking. At Jebel Shaqadud, the lower levels of the midden deposits (S1-B/I) belong to this period, but unfortunately the faunal samples are too poor to allow any conclusion (Peters 1989, in press).

The picture for the second half of the 7th millenium is also very incomplete as only one site with a good faunal sample was excavated: KG 14, located on the Atbara floodplain (Fig. 2). This site represents an early stage of the so-called Atbai Ceramic Tradition. Table 3 lists the mammalian species we recognised. In contrast with the fauna of the Early Holocene site KG 68 nearby is the fact that at least one gazelle figures now among the hunted game animals.

6000 to 4800 BP

The Central Nile region witnessed during the first half of the sixth millenium BP the transition of the Khartoum Mesolithic to the Khartoum Neolithic (Marks et al. 1985). Faunal remains from sites in this part of the study area are relatively abundant and represent many species (Table 4). However, a comparison between these faunas and the Early Holocene spectrum reveals some differences. First of all, red-fronted gazelle (*Gazella rufifrons*) and a somewhat larger species (dama gazelle ?) are now present among the bone remains. Secondly, one ob-

Table 2. Mammalian associations in central and eastern Sudan between 9000 and 7000 BP.

Mammalian species/Site location	Central Nile valley	Central Nile hinterland	Nile/ Atbara junction	Upper Atbara valley
Primates:				
Baboon (*Papio cynocephalus*)	–	–	–	+
Small Cercopithecid (*Cercopithecus* sp.)	+	–	–	+
Rodentia:				
Striped ground squirrel (*Euxerus erythropus*)	+	–	–	–
Tatera gerbil (*Tatera* sp.)	+	–	–	–
Multimammate rat (*Praomys* sp.)	+	–	–	–
Nile rat (*Arvicanthis niloticus*)	+	–	–	–
North African porcupine (*Hystrix cristata*)	+	+	+	+
Cane rat (*Thryonomys swinderianus*)	+	+	–	+
Carnivora:				
Golden? Jackal (*Canis aureus*?)	+	–	+	+
Hunting dog (*Lycaon pictus*)	+	–	–	–
Banded mongoose (*Mungos mungo*)	+	–	+	–
African civet (*Viverra civetta*)	+	–	–	–
Striped hyaena (*Hyaena hyaena*)	+	–	–	–
Wild cat (*Felis silvestris*)	+	+	+	+
Caracal and/or serval (*Felis caracal/F.serval*)	+	–	+	–
Leopard (*Panthera pardus*)	+	–	–	–
Lion (*Panthera leo*)	+	–	–	–
Proboscidea:				
African elephant (*Loxodonta africana*)	+	+	+	+
Artiodactyla:				
Bush pig (*Potamochoerus porcus*)	–	–	–	+
Warthog (*Phacochoerus aethiopicus*)	+	+	+	+
Hippopotamus (*Hippopotamus amphibius*)	+	–	+	+
Giraffe (*Giraffa camelopardalis*)	+	+	+	+
Salt's dikdik (*Madoqua saltiana*?)	–	–	+	–
Oribi (*Ourebia ourebi*)	+	+	+	?
Bushbuck (*Tragelaphus scriptus*)	+	–	–	+
Sitatunga (*Tragelaphus spekei*)	+	–	–	–
Bohor reedbuck (*Redunca redunca*)	+	+	+	+
Kob (*Kobus kob*)	+	–	+	–
Greater kudu (*Tragelaphus strepsiceros*)	+	–	+	+
Waterbuck (*Kobus ellipsiprymnus*)	+	–	–	+
Topi and/or Hartebeest (*Damaliscus/Alcelaphus*)	+	+	+	+
Roan antelope (*Hippotragus equinus*)	+	+	+	+
African buffalo (*Syncerus caffer*)	+	–	+	+

Table 3. Mammalian associations in the Upper Atbara valley between 6500 and 6000 BP.

Mammalian species/Site location	Upper Atbara valley
Primates:	
Cercopithecid (*Cercopithecus* sp.)	+
Rodentia:	
Tatera gerbil (*Tatera* sp.)	+
Cane rat (*Thryonomys swinderianus*)	+
Carnivora:	
Golden? jackal (*Canis aureus*)	+
Wild cat (*Felis silvestris*)	+
Tubulidentata:	
Aardvark (*Orycteropus afer*)	+
Proboscidea:	
African elephant (*Loxodonta africana*)	+
Artiodactyla:	
Bush pig (*Potamochoerus porcus*)	+
Warthog (*Phacochoerus aethiopicus*)	+
Oribi (*Ourebia ourebi*)	+
Common Bush duiker (*Sylvicapra grimmia*)	+
Bushbuck (*Tragelaphus scriptus*)	+
Bohor reedbuck (*Redunca redunca*)	+
Soemmerring's gazelle (*Gazella soemmerringi*)	+
Topi and/or Hartebeest (*Damaliscus/Alcelaphus*)	+
Waterbuck (*Kobus ellipsiprymnus*)	+
African buffalo (*Syncerus caffer*)	+

serves that the abundancy of kob and topi, two antelopes frequenting riverine grasslands, has dropped considerably (see also Gautier 1989). However, the most important change is the fact that livestock have made their appearance in the Central Nile valley. The first domesticates introduced are cattle, sheep, goat and dog. The Khartoum Neolithic sites furthermore illustrate that cattle and small livestock were incorporated in appreciable quantities in the economy of the sites, so that towards the end of the 6th millenium, domestic herbivores make out about 80 % of the mammalian samples (Gautier 1984, 1989).

Outside the Central Nile Valley, the only evidence that illustrates this important change comes from the younger midden deposits at Jebel Shaqadud (S1-B). There, only one bone of a domestic animal (a goat radius-ulna) has been found in the levels related to the Khartoum Neolithic (Peters 1989, in press). Since only

Table 4. Mammalian associations in central and eastern Sudan between 6000 and 4800 BP.

Mammalian species/Site location	Central Nile valley	Central Nile hinterland	Upper Atbara hinterland
Wild mammals			
Primates:			
Grivet monkey (*Cercopithecus aethiops*)	+	+	–
Lagomorpha:			
Hare (*Lepus* sp.)	+	+	–
Rodentia:			
Striped ground squirrel (*Euxerus erythropus*)	+	+	+
Gerbil (*Gerbillus pyramidum*)	+	–	–
Tatera gerbil (*Tatera* sp.)	+	–	+
Nile rat (*Arvicanthis niloticus*)	+	+	–
North African porcupine (*Hystrix cristata*)	+	+	+
Carnivora:			
Golden? jackal (*Canis aureus*?)	+	–	+
Honey badger (*Mellivora capensis*)	+	+	+
Spotted-necked otter and/or Clawless otter (*Lutra/Aonyx*)	+	–	–
Genet (*Genetta* sp.)	+	+	–
African civet (*Viverra civetta*)	+	–	–
Slender mongoose (*Herpestes sanguineus*)	+	+	–
Ichneumon (*Herpestes ichneumon*)	+	–	–
Banded mongoose (*Mungos mungo*)	+	–	–
Striped hyaena (*Hyaena hyaena*)	+	–	–
Wild cat (*Felis silvestris*)	+	–	+
Caracal and/or Serval (*Felis caracal/F. caracal*)	+	+	+
Leopard (*Panthera pardus*)	+	–	+
Lion (*Panthera leo*)	+	–	+
Tubulidentata:			
Aardvark (*Orycteropus afer*)	+	–	+
Proboscidea:			
African elephant (*Loxodonta africana*)	+	–	+
Perissodactyla:			
Black rhinoceros (*Diceros bicornis*)	+	–	–
White rhinoceros (*Ceratotherium simum*)	+	–	–
Equid (*Equus* sp.)	+	–	–
Artiodactyla:			
Warthog (*Phacochoerus aethiopicus*)	+	+	+
Hippopotamus (*Hippopotamus amphibius*)	+	–	–
Giraffe (*Giraffa camelopardalis*)	+	+	–

Table 4. (Continued).

Mammalian species/Site location	Central Nile valley	Central Nile hinterland	Upper Atbara hinterland
Oribi (*Ourebia ourebi*)	+	+	+
Common bush duiker (*Sylvicapra grimmia*)	+	+	+
Bushbuck (*Tragelaphus scriptus*)	–	–	+
Bohor reedbuck (*Redunca redunca*)	+	+	+
Kob (*Kobus kob*)	+	–	–
Red-fronted gazelle (*Gazella rufifrons*)	+	+	+
Dama and/or Soemmerring's gazelle (*G.dama/ G.soemmerringi*)	+	–	+
Greater kudu (*Tragelaphus strepsiceros*)	+	+	+
Topi and/or Hartebeest (*Damaliscus/Alcelaphus*)	+	+	+
Roan antelope (*Hippotragus equinus*)	+	+	+
African buffalo (*Syncerus caffer*)	+	–	+
Domestic mammals:			
Carnivora:			
Dog (*Canis lupus* f. familiaris)	+	–	–
Artiodactyla:			
Sheep (*Ovis ammon* f. aries)	+	–	–
Goat (*Capra aegagrus* f. hircus)	+	+	–
Cattle (*Bos primigenius* f. taurus)	+	–	–

50 km separates this site from the Nile, we have difficulties to believe that domestic animals were not kept by Shaqadud's inhabitants. Most likely, livestock was incorporated in the (seasonal?) economy of the site, but played a minor role as a source of meat. Game could still be obtained sufficiently in the area and livestock was kept for secondary products.

The abrupt changes, observed in the faunal spectra from early Middle Holocene Central Sudanese sites do not have their parallels in the Upper Atbara region. Here, the inhabitants of the Saroba and Saroba/Kassala transition sites relied entirely on game for their animal proteins (Table 4). Small to large antelopes, including oribi (*Ourebia ourebi*), bohor reedbuck (*Redunca redunca*) and topi (*Damaliscus lunatus*) were frequently hunted, as were warthogs (*Phacochoerus aethiopicus*). As in the faunas from the Central Nile region, we note that two gazelles enter the scene.

4800 to 3500 BP

Post-Kanada sites located along the Central Sudanese Nile have been noticed

Table 5. Mammalian associations in central and eastern Sudan between 4800 and 3500 BP.

Mammalian species/Site location	Central Nile valley	Upper Atbara valley	Upper Atbara hinterland
Wild mammals			
Primates:			
Small Cercopithecid (*Cercopithecus sp.*)	–	–	+
Lagomorpha:			
Hare (*Lepus* sp.)	+	–	+
Rodentia:			
Striped ground squirrel (*Euxerus erythropus*0)	+	–	–
Nile rat (*Arvicanthis niloticus*)	–	–	+
North African porcupine (*Hystrix cristata*)	+	–	+
Carnivora:			
Hunting dog (*Lycaon pictus*)	–	–	+
Honey badger (*Mellivora capensis*)	–	–	+
Genet (*Genetta* sp.)	+	–	–
Striped hyaena (*Hyaena hyaena*)	+	–	–
Wild cat (*Felis silvestris*)	+	+	–
Leopard (*Panthera pardus*)	–	–	+
Tubulidentata:			
Aardvark (*Orycteropus afer*)	+	+	+
Proboscidea:			
African elephant (*Loxodonta africana*)	–	+	–
Artiodactyla:			
Warthog (*Phacochoerus aethiopicus*)	+	+	+
Hippopotamus (*Hippopotamus amphibius*)	+	+	–
Giraffe (*Giraffa camelopardalis*)	+	–	–
Oribi (*Ourebia ourebi*)	–	+	–
Red-fronted gazelle (*Gazella rufifrons*)	+	+	+
Soemmerring's gazelle (*Gazella soemmerringi*)	–	+	–
Greater kudu (*Tragelaphus strepsiceros*)	–	–	+
Roan antelope (*Hippotragus equinus*)	–	+	–
African buffalo (*Syncerus caffer*)	–	+	–
Domestic mammals:			
Carnivora:			
Dog (*Canis lupus* f. familiaris)	+	–	–
Perissodactyla:			
Donkey (*Equus africanus* f. asinus)	+	–	–

Table 5 (Continued).

Mammalian species/Site location	Central Nile valley	Upper Atbara valley	Upper Atbara hinterland
Artiodactyla:			
Sheep (*Ovis ammon* f. aries)	+	+	+
Goat (*Capra aegagrus* f. hircus)	–	+	+
Cattle (*Bos primigenius* f. taurus)	+	+	+

sporadically by archaeologists (I. Caneva, pers. comm.), but excavations have not been carried out yet. The paucity of such sites has been interpreted by Marks et al. (1985) as an indication for the absence of a significant occupation during the period concerned. It is only at the beginning of the 4th millenium BP that further to the north, the Nile valley witnesses the rise of towns such as Kerma (Bonnet 1986). As can be expected, cattle and small livestock dominate the bone samples from Kerma (Chaix 1988).

Faunal evidence from the Central Nile hinterland comes from the Jebel Shaqadud cave deposits (S1-A), which represent a continuous cultural sequence spanning the period from 4200 to 3600 BP. The faunal assemblage differs in two aspects from the one found in the midden deposits. First of all, cattle and small livestock remains increase to 10 to 15%. Secondly, hunting now concentrates on red-fronted gazelle and giraffe.

Contrary to the Central Nile Valley, the second half of the Middle Holocene witnesses an intense habitation in the Upper Atbara region. Marks and Sadr (1988) note the development of some new settlement pattern, with numerous small and a few very large sites. The lower levels of one of these larger sites (KG 23A/C), dated to about 4800 to 4700 BP, produced solely remains of wild mammals. The subsequent younger levels, about 4600 to 4500 years old (Marks & Sadr 1988), yield the first evidence for small livestock and cattle (Peters 1986a). However, the ratio livestock/game is still largely in favour of the second group. Only towards the end of the 5th millenium livestock acquires the status it achieved some 1500 years earlier in the Central Sudanese Nile valley. By then, livestock remains count for more than 50 % of the mammalian assemblage.

After 3500 BP

At the beginning of the third millenium, the Central Nile valley regains its archaeological importance with the development of Meroe as a large town prior to becoming the capital of the Kushite state (Shinnie 1955). The analysis of the faunal samples from Meroe by Carter and Foley (1980) revealed the abundancy of livestock remains as well as the incorporation of the dromedary in the

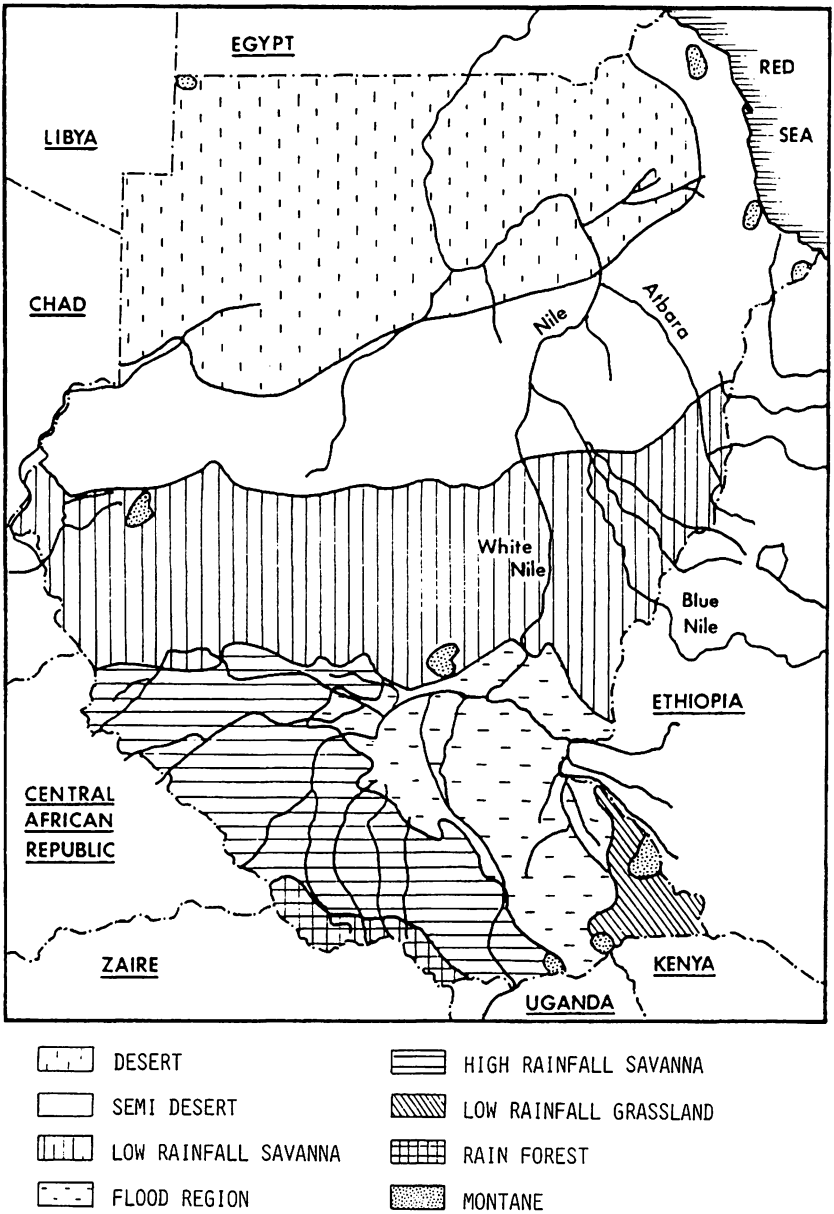

Figure 4. Present-day vegetation regions of the Sudan. (After Wickens, 1982. Fig. 3.4).

economy of the site. Up to now, the Central Nile hinterland did not produce faunal evidence from sites that are younger than 3500 BP.

During the second half of the fourth millenium, the Atbara region sees a new economic pattern, focusing on herding and farming, emerging (Marks & Sadr 1988). This can be inferred from the fact that most of the sites are small, with a few larger, more permanent residencies. This suggests that after 3500 BP a shift took place from village life towards a semi-nomadic life style. Faunal preservation is poor, owing to the limited depth of the site deposits. Most of the remains can be attributed to cattle (Peters 1986a).

From the middle of the third millenium onwards, the sites become ephemeral and even the larger ones consists of little more than a thin scatter of cultural materials. Bone fragments are rare but if identifiable they represent livestock. The settlement pattern, site conditions and the paucity of artifacts and faunal remains may imply that mobile herding had become the main subsistence activity.

PRESENT-DAY CLIMATE AND VEGETATION

The Central Nile and Lower Atbara valleys lie in the Sudanese arid zone, which has a mean annual precipitation of approximately 100 to 200 mm (Wickens 1982). The Upper Atbara region is situated on the northern border of the northern savanna *sensu* Delany and Happold (1979: 70). Sahelian living conditions prevail in the area, which receives a yearly precipitation of some 300 to 350 mm (Ireland 1948; Barbour 1963). Most rain falls during the summer months in few but heavy showers, as a result of the influx of moist, cool air from the Indian Ocean and the South Atlantic in an area with dry, continental northeastern winds coming partly from the Middle East. Both air masses meet each other at the Intertropical Convergence Zone, and are responsible for the precipitation, which is restricted from April to October (El Tom 1975: 18).

On the basis of the vegetation zones described by Harrison and Jackson (1958) and modified by Wickens (1975, 1982; cf. Fig. 4), it can be seen that the Central Nile region has a *semi-desert scrub and grassland* vegetation. The Upper Atbara region is included in a drier type of *low rainfall savanna* known as *thorn savanna and scrub*.

Semi-desert scrub and grasslands are characterised by an annual rainfall of 75-400 mm (Wickens 1975, 1982). However, the parental soil material also influences the distribution of plant species. Smith (1949) pointed out that species growing on sandy soils require a third less precipitation than their homologs on clay soils. For example, *Acacia senegal* needs some 400 mm on sandy soils but requires 600 mm rain on clay soils. With the exception of the Nile and its immediate surroundings, the Central Nile region considered here is characterized by sandy soils (Andrew 1948), and therefore needs an average rainfall of 75 to 250

mm to allow a scrub vegetation up to 2 m with *Acacia tortilis*, *Leptadenia pyrotechnica*, *salvadora persica* and *Aristida* spp.

The Upper Atbara region lies in the *thorn savanna and scrub*, though the soils are mainly clay. Hence, the somewhat higher precipitation, compared with the present-day Central Nile region, produces a more or less similar vegetation. The dominant species are acacias, especially *Acacia mellifera*, and a number of annual grasses (Wickens 1982).

The Butana and southern Atbai plains consist mainly of flat, dry grasslands with a scattering of *Acacia* trees. In spite of two major drainage systems, formed by the Atbara and Gash rivers, and a few outcrops of rocks forming inselbergs, the overall impression of this huge area is one of an unending, featureless plain.

TERMINAL PLEISTOCENE TO MIDDLE HOLOCENE ENVIRONMENTS

The ecological requirements of mammals recognised in fossil bone assemblages can be used to sketch prehistoric man's environment and to say something about past local climatic conditions. However, one should be aware that ecological data must be treated with caution. Prehistoric sites often occur in areas with favourable living conditions, for example near rivers or wells. There, the permanent availability of ground water allows floral and faunal elements to survive in climatic zones which are normally unsuitable for them. Until now, the ameliorating effect of rivers, lakes and swamps in dry areas has not been estimated quantitatively. Moreover, although studies dealing with the ecological requirements of African and other mammals are available, we are convinced that the adaptability of a number of species is not sufficiently known. Therefore, palaeoenvironmental reconstructions may suggest better living conditions than those that actually prevailed when the sites were occupied.

Table 1 shows that most sites are found close to the edge of the Nile and Atbara rivers. However, a few of the sites occur at considerable distances from these drainage systems, where the fauna was most likely less affected by their ameliorating effect. The faunal remains of the latter may allow more precise evaluations of the palaeoenvironment.

Terminal Pleistocene faunal samples from the Upper Atbara valley represent two ecological groups. Dorcas gazelle, Soemmerring's gazelle and African wild ass are inhabitants of open, arid to very arid environments, where they feed mainly on grasses. The presence of hippopotamus, wild cattle and hartebeest is linked with the Atbara valley itself. Hippopotamus suggests that the Atbara received enough water from the Ethiopian highlands to maintain at least some marshy areas and alluvial grassplains throughout the year. The game duo hartebeest-aurochs, commonly found in Palaeolithic sites in the Nile valley north of Wadi Halfa (Gautier 1987, Peters 1990), indicate that alluvial grassplains with

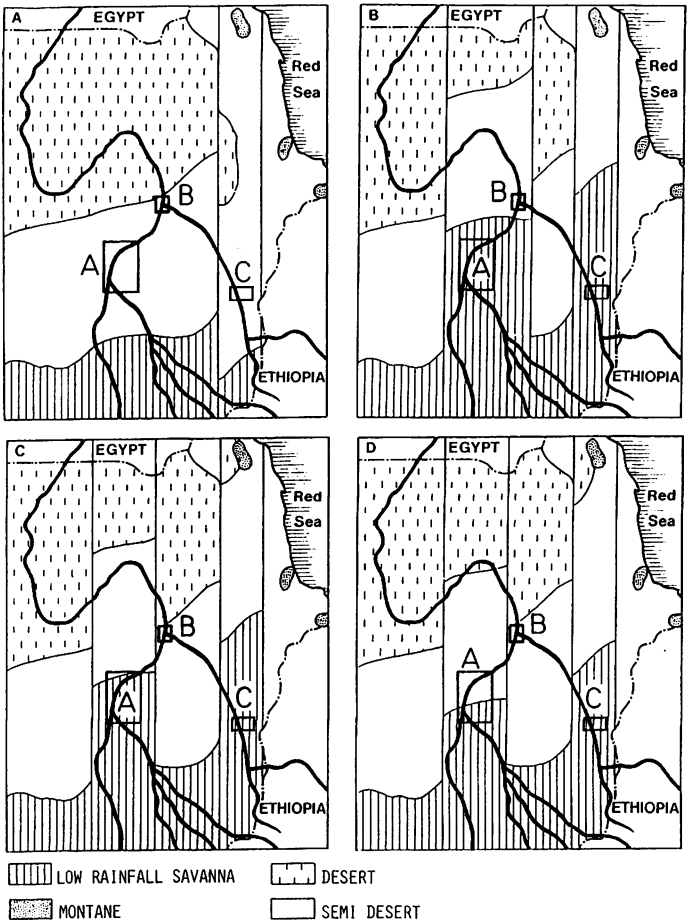

Figure 5. Hypothetical late Quaternary vegetation regions in central and eastern Sudan: (A) terminal Pleistocene; (B) Early Holocene; (C) early Middle Holocene; (D) late Middle Holocene. The small rectangles show the study areas.

clusters of trees and shrubs were present along the Atbara. The floral picture that emerges for the Upper Atbara region at the end of the Pleistocene is one of a poor, open grassland away from the river valley and alluvial grassplains with stands of woody species and some marshy areas along the Atbara. Furthermore, the fact that wild cattle could migrate so far southwards suggests that the mean annual temperature must have been lower than in later periods. We therefore assume that at the end of the Pleistocene, the Upper Atbara region witnessed a dry and cool climate with an annual rainfall of about 150 to 250 mm.

Early Holocene sites produced a broad spectrum of mammals that nowadays inhabit savannic environments. The Central Nile valley faunas that are dated to 9000 to 7000 BP point to *deciduous savanna woodland* conditions. However, most of the mammals found at Jebel Shaqadud are already encountered in the southern *thorn savanna and scrub* belt, the only exception being marsh cane rat which is confined to the *deciduous savanna woodland.* Further to the north, at Aneibis, Ed Damer and Abu Darbein, this large rodent is absent in the extensive faunal samples from these sites (Peters in press). This indicates that during the 8th millenium BP Jebel Shaqadud was situated in the transitional zone between *thorn savanna and scrub* and *deciduous savanna woodland*, respectively characterised by 280 to 400 mm and 450 to 1300 mm of annual rainfall on sandy soils. Therefore in the 8th millenium BP, Jebel Shaqadud as well as the Central Nile valley may have received a yearly precipitation of some 450 to 500 mm. The much higher precipitation estimate by Bate (1949; 800 mm) for a faunal assemblage from Khartoum Hospital was based on the presence of Nile lechwe (*Kobus leche*) among the remains. A re-analysis of the lechwe remains indicates that they pertain to kob (*Kobus kob*; Peters 1986b).

At the junction of the Nile with the Atbara and somewhat further to the north, the terrestrial mammals of the three sites suggest some mixed vegetation cover, most likely with *thorn savanna and scrub* along the watercourses and a *semi-desert scrub and grassland* outside the river valleys. We therefore place this study area in the latter vegetation zone (Fig. 5B) and assume it received some 300 mm of rain annually.

The faunal samples from the Upper Atbara region suggest an open savanna vegetation with trees and shrubs during the Early Holocene. It is remarkable that the KG 68 spectrum resembles closely that from present-day Dinder National Park (Eastern Sudan, 12°30' NB, 35° OL) as described by Cloudsley-Thompson (1966). Dinder National Park with its clayey soils receives ca. 800 to 850 mm of rain pro year, and we there fore assume that during the Early Holocene, the Upper Atbara region may have received more or less the same amount of precipitation.

The 7th millenium BP is not well known from the faunal point of view. On the basis of the remains from KG 14, we assume comparable living conditions as those prevailing when KG 68 was inhabited. However, the presence of gazelles in the assemblage indicate a somewhat drier environment outside the river valley, and may suggest an annual precipitation for the Upper Atbara region between 650 and 750 mm pro year during the period represented by KG 14 (second half of the 7th millenium).

The 6th millenium faunal spectra, as observed at Esh Shaheinab and related sites, suggest that the area was exposed to somewhat drier living conditions. This can be inferred from the decreasing numbers or disappearance of swamp-inhabiting and alluvial grassplain loving species such as marsh cane rat, bohor reedbuck, kob and topi, and the appearance or increasing numbers of inhabitants of

drier environments, including giraffe and gazelles. Outside the Central Nile valley, similar trends separate the faunal spectra from S 21 and S1-B at Jebel Shaqadud.

Similar aged sites from the Upper Atbara region are limited to the southern Atbai plain. The faunal spectra from sites dated to about 5500 BP are comparable with the one from KG 14, be it that the species linked with the Atbara are lacking. However, towards the beginning of the 5th millenium, we observe that three territorial, water-dependent antelopes, bohor reedbuck, bushbuck and topi have disappeared. For the moment, we cannot explain this phenomenon exclusively by assuming that the climate had become drier, since a second factor may be involved. In their brief summary of the Holocene geomorphic history of the Southern Atbai, Sadr (1988) and Marks and Sadr (1988) note that the Gash river, originally flowing in the Atbara, probably altered its course to form an inland delta during the Middle Holocene. Having a very shallow bed, however, and alternating from a completely dried out river bed to a massive flooding caused by summer rains in Ethiopia, the Gash has been characterized by much meandering and extensive lateral overbank inundation. As the Gash delta silted up and moved toward its present north-northwesterly course, the area of seasonal inundation would have moved with it. Therefore, the changes in fauna we noted may be linked with the fact that the inundations did not reach this part of the Southern Atbai anymore.

From the foregoing we can deduce that faunal samples from the first half of the Middle Holocene indicate that the Early Holocene open savanna with some deciduous trees has been replaced by a *thorn savanna with trees and shrubs*. Toward the middle of the 6th millenium BP, the Central Nile region received likely some 350 to 450 mm of rain annually, while the Upper Atbara region had a yearly precipitation of some 600 to 700 mm.

If we compare the late Middle Holocene fauna from Jebel Shaqadud with the early Middle Holocene one, we see that antelopes such as oribi, greater kudu, roan and topi, today confined to the southern, moister part of the *thorn savanna and scrub*, have disappeared. The importancy of red-fronted gazelle and giraffe has increased considerably. Since the cave inhabitants at Jebel Shaqadud hunted a good deal, the absence of the four antelope species mentioned can be due to the fact that they were not encountered in the area anymore. The faunal spectrum of similar aged sites in the Upper Atbara region also show a decrease of savanna-bound species in favour of animals that are adapted to sahelian environments. Thus, the drying trend already observed for the first half of the Middle Holocene also continues during the second half of this period. We therefore assume that at the beginning of the 4th millenium BP the vegetation between the Central Nile valley and the Ethiopian border consisted of a drier *thorn savanna and scrub*. Such a vegetation would require an annual precipitation of some 300 to 350 mm in the Central Nile region, and ca. 550 to 650 mm in the Upper Atbara region.

If we accept that in the past the isohyets and the corresponding vegetation zones moved alternatively north and south, more or less parallel to their present-day positions, the following deductions can be made. A dry, open grassland in the Upper Atbara region at the end of the Pleistocene would correspond with a minimum southward shift of the present-day vegetation zones of ca. 100 to 200 km (Fig. 5A). The Early Holocene spectrum, respectively indicating a mixed floral pattern of *thorn savanna and scrub* and *deciduous savanna woodland* in the Central Nile and Upper Atbara regions, and of *thorn savanna and scrub* and *semi-desert scrub and grassland* to the north of the Nile/Atbara junction, would correspond with a 300 to 400 km northward shift of the present-day vegetation zones (Fig. 5B). Towards the middle of the 6th millenium BP, the study areas A and C would have been incorporated in the southern part of the *thorn savanna and scrub*; this implies a northward shift of some 250 to 300 km of the actual zones (Fig. 5C). Finally, the beginning of the 4th millenium witnessed a vegetation comparable with the somewhat drier *thorn savanna and scrub*, that nowadays occurs some 150 to 250 km to the south of the study areas A and C (Fig. 5D). Palaeobotanic (Wickens 1975, 1982; Neumann 1989) and geomorphologic (Warren, 1970; Pachur et al. 1990) research in other parts of the Sudan produced results that compare well with ours.

THE INTRODUCTION OF LIVESTOCK IN CENTRAL AND EASTERN SUDAN

The archaeozoological study of Holocene sites may help to answer certain questions about the appearance of domesticates in a particular region, such as for example *which* animals are present; *when* have they been introduced; *what* types of breeds were present, etc. However, one of the most intriguing questions arising is the reason *why* people changed their way of living to become pastoralists.

For the Central Nile valley, it is known that its Neolithic inhabitants had adopted normal sized breeds of cattle, sheep and goat at 5500 BP. Contrary to BATE's belief (1953), no osteological arguments support her idea of two different goat breeds at Esh Shaheinab, a normal sized and dwarf breed (Peters 1986b).

The fact that towards the end of the 6th millenium BP livestock makes up about 80 % of the mammalian assemblage at El Kadero (Gautier 1984) may imply that livestock reached the Central Nile valley considerably earlier, possibly at about 6000 BP. However, livestock keeping may have become very rapidly a major substistence activity. If so, this important change in lifestyle happened during the first half of the 6th millenium BP.

The reasons for the introduction of livestock in the Central Nile region are no doubt complex and not yet well understood. It is not the purpose of this paper to

discuss this topic in full, but the information on past environments obtained from faunal samples may throw some light upon the problem. Several archaeological studies (Arkell 1949; Caneva 1983, and others) illustrate that the Early Holocene hunter-gatherers were acquainted with a diversified set of pottery, including vessels which are hardly transportable because of their size. Such large pots were probably left behind when the hunter-gatherers abandoned their camp for whatever reason they may have had. But pots do generally suggest a decrease in mobility of the human groups using them. This in turn may allow an increase in human population. Another point is that faunal evidence suggests a climatic deterioration during the 7th millenium BP. Furthermore, the excavations at Jebel Shaqadud reaffirm the developmental continuity of the Khartoum Mesolithic and the Khartoum Neolithic (Marks et al. 1985). From the foregoing we can tentatively deduce that the autochtonous population was not replaced by pastoralists from elsewhere and that the change in lifestyle from hunting-gathering to herding may have been triggered by worsening climatic conditions combined with demographic pressure.

Livestock was introduced decidedly later in the Upper Atbara region, and it is only towards the end of the 5th millenium BP that it acquires the status it achieved some 1500 years earlier in the Central Nile valley. The cattle represents a normal sized breed but the small livestock samples are too small to allow size estimates (Peters 1986a). Anyhow, archaeological and archaeozoological results may again help to solve the question why people changed their life style. As said, Marks and Sadr (1988) note that at the beginning of the Middle Holocene, sites tend to be small and most likely only occupied for a short period. This pattern changes abruptly towards the second half of the Middle Holocene, when two kinds of sites can be recognised. The majority are rather small, no larger than about a hectare, while three sites are between 8 and 10 hectares. At the smaller sites the deposits are shallow and at the most ca. 35 cm thick. The large sites have cultural materials to a depth of 2 m or more. It is in the younger levels of one of the larger sites that we found the first evidence for livestock in the area. Prior to the formation of these deposits, the area witnessed an important shift in its wild life spectrum caused by changes in the location of the Gash river and/or by worsening climatic conditions. The changed settlement patterns may be related to an increasing population density while the drastic changes in the local environment were perhaps significant enough to reduce the game biomass. Thus demographic pressure and a reduction of the ecosystem's carrying capacity through environmental change may again have been two of the more decisive factors which count for the adoption of livestock by the Southern Atbai inhabitants.

SUMMARY AND CONCLUSIONS

The paper interpretes the now available archaeozoological record from termi-

nal Pleistocene to Middle Holocene prehistoric sites in the Central Nile and Upper Atbara regions in terms of environmental change. The terminal Pleistocene fauna along the Upper Atbara suggests dry and cool climatic conditions and a floral pattern that may correspond with a southward shift of the present-day vegetation zones of ca. 100 to 200 km. Early Holocene faunas indicate that the study areas A and C had a mixed vegetation of *thorn savanna with trees and shrubs* and *deciduous savanna woodland*, whereas to the north of the Nile/Atbara junction (area B), a mixed cover of *thorn savanna and scrub* and of *semi-desert scrub and grassland* must have been present. This implies a 300 to 400 km northward shift of the present-day vegetation zones. The early Middle Holocene assemblages suggest a somewhat drier environment and indicate that towards 5500 BP the study areas A and C were incorporated in the moister southern part of the *thorn savanna and scrub*; this would correspond with a northward shift of some 250 to 300 km of the actual vegetation zones. Finally, the second half of the Middle Holocene witnessed climatic conditions that allowed a somewhat drier *thorn savanna and scrub*, which nowadays occurs some 150 to 250 km to the south of the Central Nile and Upper Atbara study areas.

On present evidence, it seems that livestock made its appearance in the Central Nile valley as early as 6000 years ago. In the Upper Atbara region, however, the introduction of livestock is much more recent, perhaps some 1500 year later. The important shift from the hunter-gatherers way of life towards pastoralism has been triggered no doubt by a causal network of factors, of which two can be postulated on the basis of archaeological and archaeozoological evidence: worsening climatic conditions and an increase in population density. Further research in Central and Eastern Sudan is necessary to trace with greater precision the relations between prehistoric man and his floral and animal environment, and to verify the explanations proposed here.

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