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INHOUD :

FAUNAL REMAINS AND ENVIRONMENTAL CHANGE IN CENTRAL AND EASTERN SUDAN FROM TERMINAL PLEISTOCENE TO MIDDLE HOLOCENE TIMES

BY

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1. 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, 2) and the Upper Athara region (Fig. 1, 3) have been target areas for numerous archaeological projects. These resulted in a series of excavations that produced besides worked flint, ceramics, polished stones etc., collections of animal bones. Several faunal samples have been analysed by colleagues (cf. Table 1), others have been studied by ourselves within the frame of our Ph. D. programm (Peters, 1986a).

In this paper we will try to sketch the environmental changes that took place in the two areas indicated on the map (Fig. 1, A and B) from terminal Pleistocene to Middle Holocene times, and this on the basis of differences observed between the subsequent mammalian assemblages.

The faunal samples considered here can be arranged in four groups on the basis of the location of the sites where they have been collected (Table 1, Fig. 1-3) : (1) the Central Nile Valley between Khartoum and El Kadada ; (2) its hinterland formed by the western Butana ; (3) the Upper Atbara valley ; (4) its hinterland comprising a part of the eastern Butana and the southern Atbai, the latter stretching to the Ethiopian border (Fig. 1). In addition, we can classify the sites according to their radiocarbon ages and group the sites into periods. Table 1 summarizes the time division system used, the sites with faunal remains included in them, the location of the sites and the authors who dealt with the faunal analysis.

In the following, we will discuss the present-day and past faunal associations of the study area, the present-day climate and vegetation, and climate and vegetation from terminal Pleistocene to Middle Holocene times. To end, we will deal with two factors that might have triggered the shift towards pastoralism in our study area.

2. PRESENT-DAY FAUNA

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*), though 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

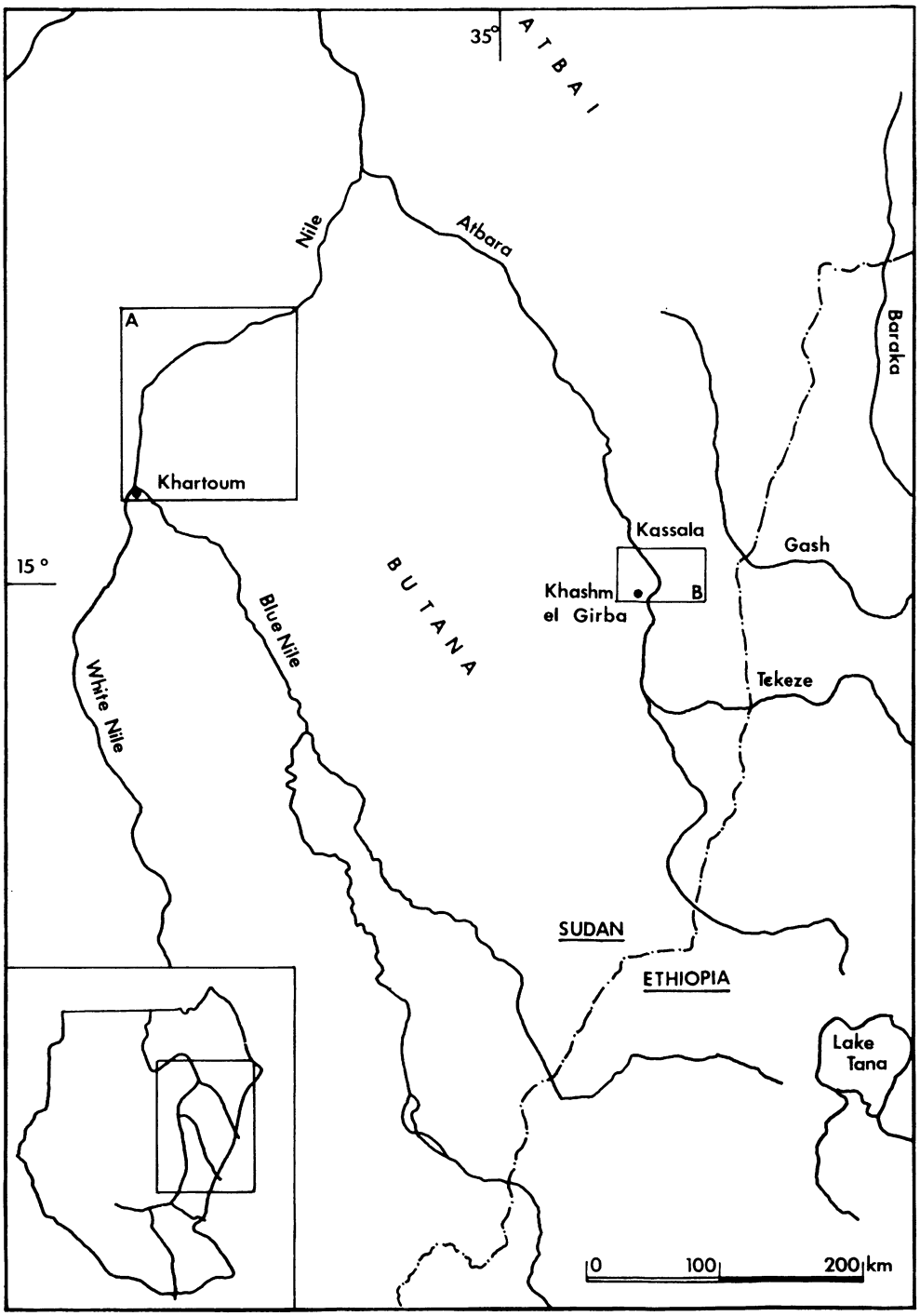

Fig. 1. – Map of the east central Sudan. Inset shows map relative to the Sudan. Left rectangle shows the Central Nile study area. Right rectangle shows the Upper Atbara study area.

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, 74	PETERS, 1986a ; MARKS *et al.*, 1987
ca. 9000 to 7000 BP	Central Nile valley	Khartoum Hospital	BATE, 1949, Peters, 1986b
		Saggai 1	GAUTIER, 1983
	Central Nile hinterland	Jebel Shaqadud S 21	MARKS *et al.*, 1985 ; PETERS, 1986a, 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
		Umm 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 S1-B	MARKS *et al.*, 1985 ; PETERS, 1986a, in press
	Upper Atbara hinterland	KG 10, 13, 28, 94, 104	PETERS, 1986a
ca. 4800 to 3500 BP	Central Nile hinterland	Jebel Shaqadud S1-A	MARKS *et al.*, 1985 ; PETERS, 1986a, in press
	Upper Atbara valley	KG 1, 7, 29, 56	PETERS, 1986a
	Upper Atbara hinterland	KG 23	PETERS, 1986a

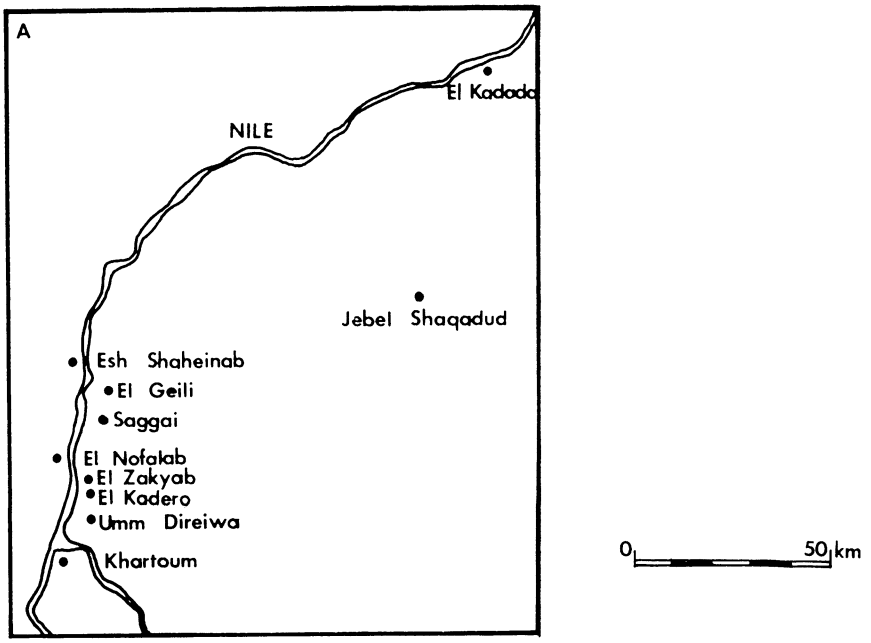

Fig. 2. – Map of the Central Nile study area, showing location of the sites mentioned in the text.

(*Ictonyx striatus*), wild cat (*Felis silvestris*), striped ground squirrel (*Euxerus erythropus*) and rock hyrax (*Procavia ruficeps*). Barbary sheep (*Ammotragus lervia*) has been re-introduced in the Sabaloka game reserve. Among the smaller rodents, species of the genera *Gerbillus, Meriones, Acomys* and *Jaculus* are often 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 should be added to the species mentioned above. 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 listed above also occur here. Larger game animals still include dorcas gazelle and Soemmerring's gazelle (*Gazella soemmerringi*), while the extinction of giraffe (*Giraffa camelopardalis*) and hippopotamus (*Hippopotamus amphibius*) in the area may date back to this century. In the Kassala Mountains close to the Ethiopian border, a troop of baboons (*Papio cynocephalus*) survives nowadays near Kassala, feeding on the garbage dump of that town.

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

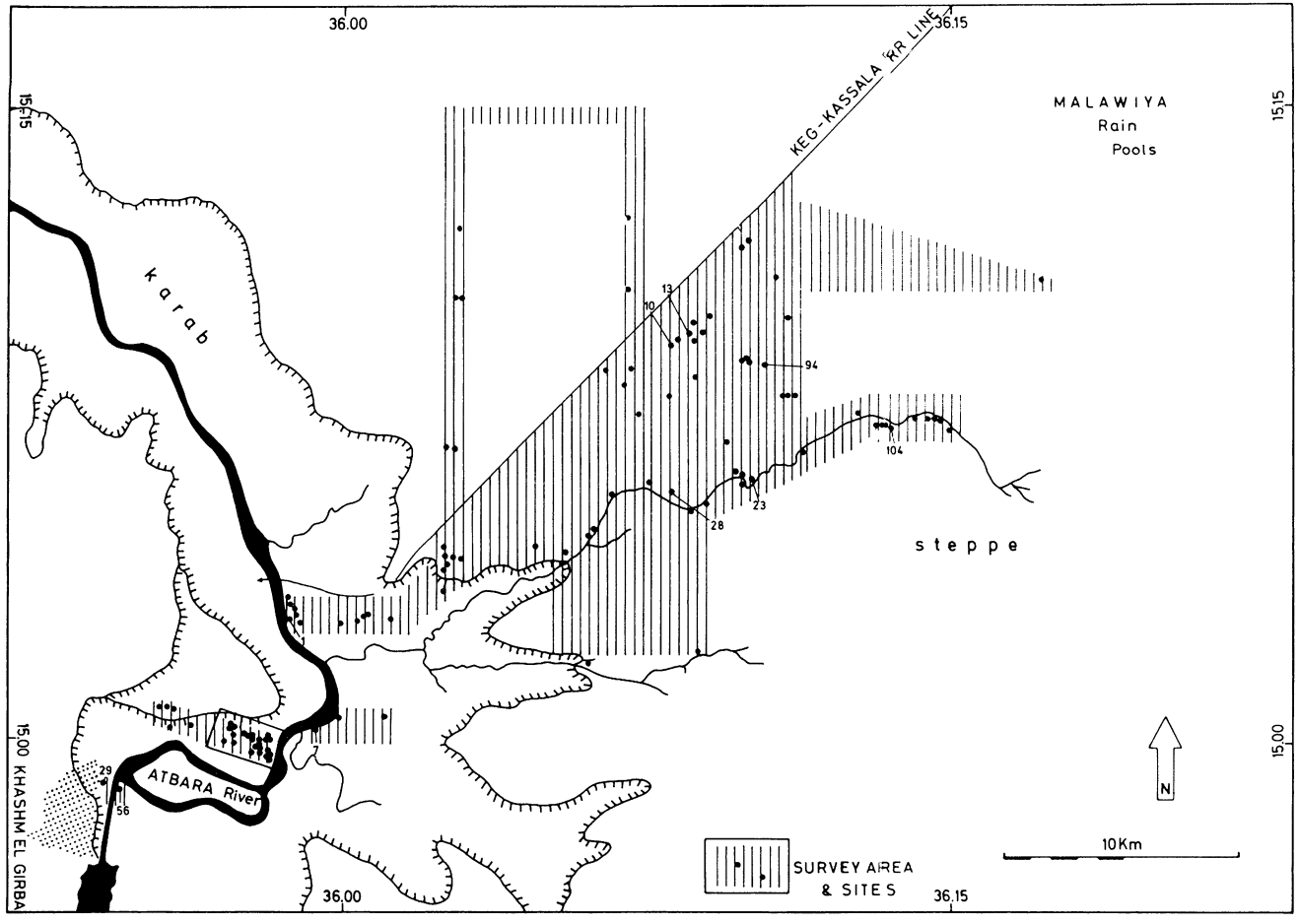

Fig. 3. – Map of the Upper Atbara study area, showing location of the sites mentioned in the text.

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 (cf. Walter, 1973 ; Wickens, 1982 ; Gautier, 1983 ; Fouad, 1984), the fauna and flora of our study area 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, 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.

3. 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 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. 4). The samples show a preservation bias in favour of skeletal elements of larger mammals : North African porcupine (*Hystrix 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 element (Soemmerring's gazelle) 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

TABLE 2

Mammalian associations in Central and Eastern Sudan between 9000 and 7000 BP

Mammalian species/Site location	Central Nile valley	Central Nile hinterland	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*)	+	+	+
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*)	+	-	+

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). 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.

– *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, 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. 4). 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 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 (cama gazelle ?) are now present. Secondly, one observes that the abundancy of kob and topi, two antelopes frequenting riverine grasslands, has dropped considerably (see also Gautier, in press a). However, the most important change is the fact that livestock has made its

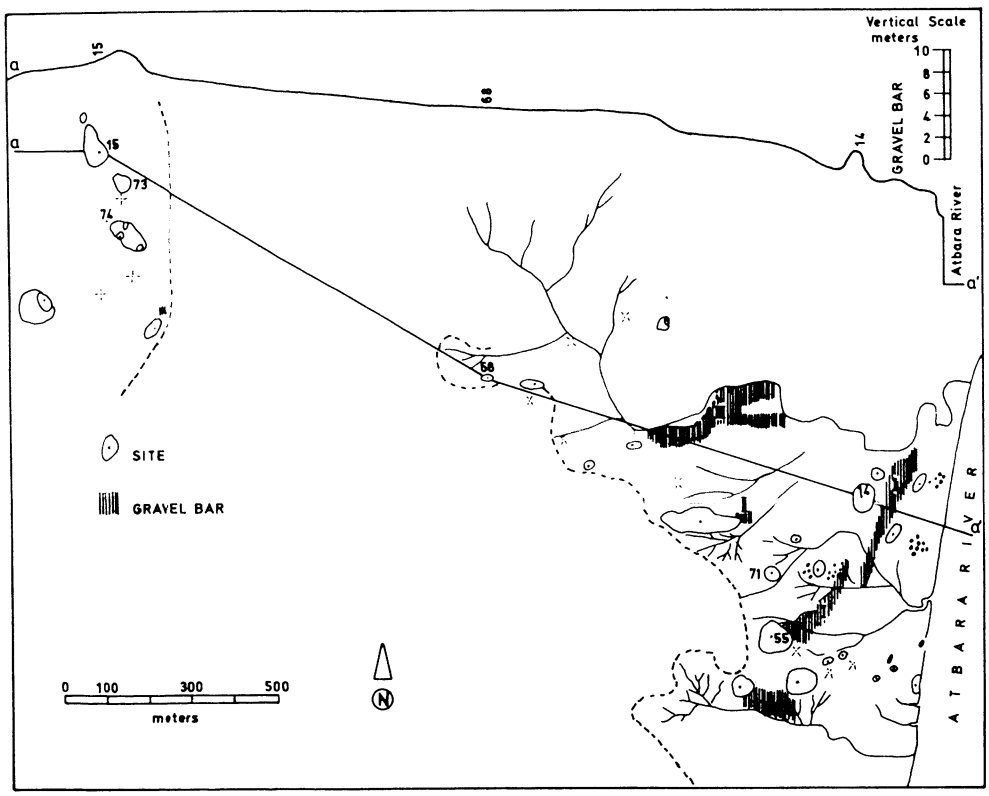

Fig. 4. – Map of the sites recorded from the depression to the northeast of the town of Khashm-el Girba. This map corresponds with the rectangle in Fig. 3.

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, in press b).

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, in press). Since only 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 sufficiently be obtained in the area and livestock was kept for milk and hair.

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,

TABLE 3

Mammalian association 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*)	+

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 (Table 4).

– *4800 to 3500 BP*

Post-Kadada sites, located along the Central Sudanese Nile, have been noticed sporadically by archaeologists (I. Caneva, pers. comm.), but excavations have not been carried out yet. This paucity of 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 expected, cattle and small livestock dominate the faunal samples from Kerma (Chaix, 1988).

Faunal evidence from the Central Nile hinterland comes from the Jebel Shaqadud cave deposits (S1-A), which contain 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, suggesting a reduced game spectrum (Table 5).

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, *o.c.*), 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 importancy with the development of Meroe as a large town prior to becoming the capital of the Kushite state (Shinnie, 1967). 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 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, *o.c.*). 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 (Marks & Sadr, *o.c.*). Faunal preservation is poor, owing to the limited depth of the site deposits. Up to now, most of the remains can be attributed to cattle (Peters, 1986a).

From the middle of the 3rd millenium onwards, the sites become ephemeral, and even the larger ones consist 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 indeed become the main subsistence activity.

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*)	+	+	-
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 aegragus* f. hircus)	+	+	-
Cattle (*Bos primigenius* f. taurus)	+	-	-

TABLE 5

Mammalian associations in Central and Eastern Sudan between 4800 and 3500 BP

Mammalian species/Site location	Central Nile hinterland	Upper Atbara valley	Upper Atbara hinterland
WILD MAMMALS			
PRIMATES :			
Small Cercopithecid (*Cercopithecus* sp.)	-	-	+
LAGOMORPHA :			
Hare (*Lepus* sp.)	+	-	+
RODENTIA :			
Striped ground squirrel (*Euxerus erythropus*)	+	-	-
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)	+	-	-
ARTIODACTYLA :			
Sheep (*Ovis ammon* f. aries)	+	+	+
Goat (*Capra aegagrus* f. hircus)	-	+	+
Cattle (*Bos primigenius* f. taurus)	+	+	+

4. PRESENT-DAY CLIMATE AND VEGETATION

The Central Nile valley lies in the Sudanese arid zone. It 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, 1964). 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 ; see Fig. 5), 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* (Fig. 5).

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. (Wickens, *ibid.*)

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, *ibid.*).

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.

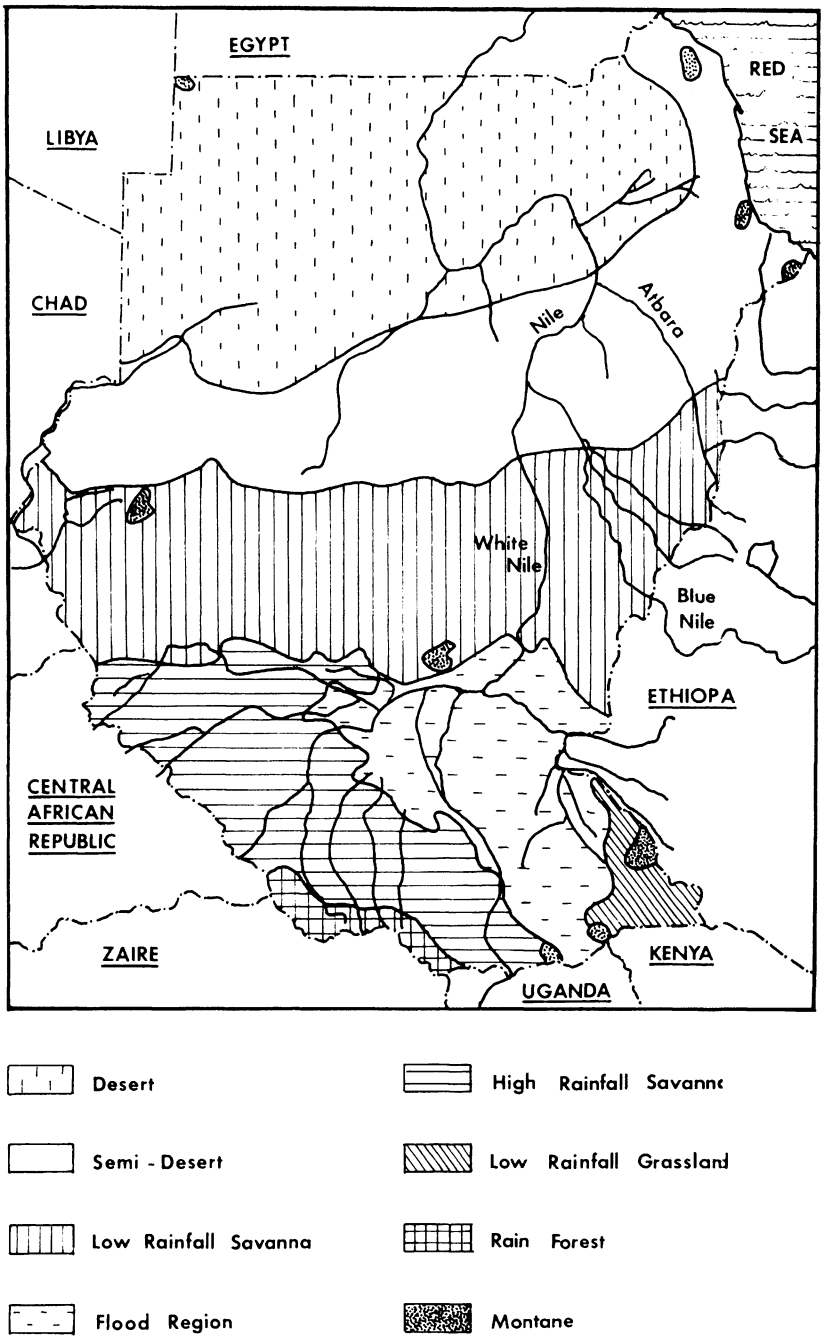

Fig. 5. – Present-day vegetation regions of the Sudan (After Wickens, 1982 Fig. 3.4).

5. TERMINAL PLEISTOCENE TO MIDDLE HOLOCENE CLIMATE AND VEGETATION

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 cannot be 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 too well known. Therefore, palaeoenvironmental reconstructions may suggest better living conditions than those that actually prevailed when the sites were occupied.

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

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), indicate that alluvial grassplains with 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 a wetter kind of *low rainfall savanna* known as *deciduous savanna woodland.* 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 wetter parts of the *low rainfall savanna.* This

suggests to us 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 supposed presence of Nile lechwe (*Kobus leche*) among the remains. A re-analysis indicates that the remains in question pertain to kob (*Kobus kob* ; Peters, 1986b).

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 therefore 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 indicates a somewhat drier environment outside the river valley, and suggests an annual precipitation between 650 and 750 mm pro year for the Upper Atbara region and 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 somewhat drier living conditions in the Central Nile valley. 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 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.

Contemporaneous sites from the Upper Atbara region are limited to the southern Atbai plain. The faunal spectra from sites dated to about 5 500 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 from the plains. For the moment, we cannot explain this phenomenon solely by assuming that the climate had become drier ; a second factor may be involved. In their brief summary of the Holocene geomorphic history of the Southern Atbai, Marks and Sadr (1988) note that the Gash river, originally flowing in the Atbara, probably altered its course during the Middle Holocene to form an inland delta. Having a very shallow bed, however, and subject to massive flooding following the summer rains in Ethiopia, the Gash was characterized by extensive meandering

and 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 a replacement of the Early Holocene open savanna with some deciduous trees 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 Arbara 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 no longer in the area. The faunal spectrum of broadly contemporaneous 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 requires an annual precipitation of 300 to 350 mm in the Central Nile region, and of 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. 6A). The Early Holocene spectrum, indicating a mixed floral pattern of *thorn savanna and scrub* and *deciduous savanna woodland,* would correspond with a 300 to 400 km northward shift of the present-day vegetation zones (Fig. 6B). Towards the middle of the 6th millenium BP our study area 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. 6C). 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 our study area (Fig. 6D). Palaeobotanic (Wickens, 1975, 1982; Neumann, 1989) and geomorphologic (Warren, 1970) research produced results that compare well with ours.

6. THE INTRODUCTION OF LIVESTOCK IN CENTRAL AND EASTERN SUDAN : SOME CONSIDERATIONS

The archaeozoological study of Holocene faunas 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 and became 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 one and a dwarf breed. Our revision of the Shaheinab material also revealed the presence of dog remains derived from a medium sized 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 subsistence activity. If so, this important change in lifestyle may date to 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, which in turn may allow an increase in human population. Another point is that faunal and other evidence suggest a climatic deterioration during the 7th millenium BP. Furthermore, the excavations at Jebel Shaqadud reaffirm the developmental continuity of the Khartoum Mesolithic and 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 ; 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 were 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.

A final remark. If our deductions about the introduction of livestock in the Central Nile valley and Upper Atbara region are correct, it would appear that part of the present-day problem of ecological stress with catastrophic results for men and their flocks, observed in our study area and known from other parts of the Sahel zone, may date back to the Middle Holocene, when, as a consequence of demographic pressure and deteriorating climatic conditions, people changed their life style and became pastoralists.

7. SUMMARY AND CONCLUSIONS

The paper interpretes the now available archaeozoological record from terminal Pleistocene to Middle Holocene prehistoric sites in the Central Nile and Upper Atbara regions. The terminal Pleistocene fauna along the Upper Atbara suggests dry and cool climatic conditions and a floral pattern that may correspond with a minimum southward shift of the present-day vegetation zones of ca. 100 to 200 km. Early Holocene faunas indicate that the study area resembled a mixture of *thorn savanna with trees and shrubs* and *deciduous savanna woodland*; this implies a 300 to 400 km northward shift of the present-day vegetation zones. The early Middle Holocene assemblages point to a somewhat drier environment and indicate that towards 5 500 BP the study area was 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. On present

evidence, it seems that livestock made its appearance in the Central Nile valley probably as early as 6000 years ago. In the Upper Atbara region, however, the introduction of livestock is much more recent, perhaps 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.

8. SAMENVATTING

Archeologische opgravingen, uitgevoerd in Centraal en Oost-Soedan tijdens de tweede helft van deze eeuw, leverden omvangrijke archeologische stalen met faunaresten op. Het doel van deze studie bestaat erin, de dierlijke resten die verscheidene onderzoekers tot hiertoe gedetermineerd hebben, vanuit paleoëcologisch en paleoklimatologisch oogpunt te evalueren. Bovendien gingen we ook na in hoeverre er een samenhang bestaat tussen klimaatsverschuivingen en de introduktie van huisdieren in de centraalsoedanese Nijlvallei en in de streek rond de Boven-Atbara. De ouderdom van de in deze studie opgenomen vindplaatsen, die zich langsheen de Midden-Nijl, aan de Boven-Atbara en in de aangrenzende gebieden bevinden gaat van het einde van het Boven-Pleistoceen tot en met het Midden-Holoceen.

Voor het einde van het Boven-Pleistoceen, dat we alleen kennen van sites langsheen de Boven-Atbara, suggereert de fauna een open grasland met een koel en droog klimaat. De fauna's van de sites die tot het Onder-Holoceen behoren vertonen een spectrum dat typisch is voor een licht beboste savanne, wat een relatief vochtig en warm klimaat impliceert. Voor de eerste helft van het Midden-holoceen weerspiegelen de fauna's een lichte uitdroging van de omgeving in vergelijking met die tijdens het Onder-Holoceen. Rond 5500 BP lag het studiegebied waarschijnlijk in een vochtigere doornsavanne met struiken. De fauna's van de jongere middenholocene sites suggereren een verschuiving van een vochtigere naar een drogere doornsavanne met struiken.

Indien we aannemen dat de isohyeten, en bijgevolg ook de vegetatiezones, zich in het verleden noord- en zuidwaarts, parallel aan hun huidige posities bewogen hebben, dan kunnen we de verschuivingen van deze zones reconstrueren. Ter hoogte van de Boven-Atbara bedroeg de neerslag op het einde van het Pleistoceen ca. 150 à 250 mm per jaar, wat overeenkomt met een zuidwaartse verschuiving van de huidige vegetatiezones van minimum 100 à 200 km. De vroegholocene fauna en flora langsheen de Midden-Nijl en aan de Boven-Atbara suggereren een gemiddelde neerslag van respectievelijk ca. 450 à 500 en ca. 800 à 850 mm per jaar. Dit zou corresponderen met een noordwaartse verschuiving der huidige vegetatiezones van

300 à 400 km. De vochtige doornsavanne met struiken tijdens de eerste helft van het Midden-Holoceen wijst op een jaarlijkse neerslag van ca. 350 tot 450 mm langsheen de Midden-Nijl en van ca. 600 tot 700 mm in het Boven-Atbaragebied, wat overeenkomt met een noordwaartse verschuiving van 250 tot 300 km van de huidige vegetatiezones. Naar het einde van het Midden-Holoceen neemt de neerslag blijkbaar nog verder af, en bedroeg waarschijnlijk voor de Midden-Nijl en de Boven-Atbara respectievelijk ca. 300 tot 350 en 550 tot 650 mm. De hiermee gepaard gaande vegetatiezone bevindt zich momenteel 150 tot 250 km ten zuiden van het studiegebied.

Tenslotte gingen we na of onze studie meer inzicht verschaft met betrekking tot de introduktie van de huisdieren in Afrika. Uit de analyse van faunaresten uit centraalsoedanese vindplaatsen konden we afleiden dat in het gebied langsheen de Midden-Nijl huisdieren zoals hond, rund, schaap en geit reeds meer dan 6000 jaar gekend zijn. In Oost-Soedan aan de Boven-Atbara heeft de introduktie van deze dieren waarschijnlijk ca. 1500 jaar later plaatsgevonden. De belangrijke verschuiving in levenswijze van (rondtrekkende) groepen van jagers-verzamelaars naar pastoralisten is zonder twijfel een zeer gecompliceerd fenomeen waarbij een hele reeks faktoren meegespeeld hebben. Op grond van archeologische en archeozoölogische gegevens menen we twee der beslissende faktoren te achterhalen die bij de introductie van de huisdieren een rol gespeeld hebben : de verslechterende klimaatsomstandigheden en een toenemende bevolkingsdensiteit.

Verder onderzoek in Centraal en Oost-Soedan is noodzakelijk om een beter beeld te krijgen van de relaties tussen de prehistorische mens en zijn omgeving, en om de voorgestelde werkhypothesen te staven.

9. BIBLIOGRAPHY

ANDREW, G., *Geology of the Sudan*, in : "Agriculture in the Sudan", J. D. TOTHILL (ed.), London, 1948, p. 84-128.

ARKELL, A. J., *Early Khartoum*, London, 1949.

ARKELL, A. J., *Shaheinab*, London, 1953.

BARBOUR, K. M., *The Republic of the Sudan : A Regional Geography*, London, 1964.

BATE, D. M. A., *The Vertebrate Fauna*, in : "Early Khartoum", A. J. ARKELL, London, 1949, p. 16-30.

BATE, D. M. A., *The Vertebrate Fauna*, in : "Shaheinab", A. J. ARKELL, London, 1953, p. 11-19.

BONNET, Ch., *Les fouilles archéologiques de Kerma*, in : "Genava", n.s., t. 34, 1986, p. 5-20.

CANEVA, I. (ed.), *Pottery using Gatherers and Hunters at Saggai (Sudan) : Preconditions for Food Production*, in : "Origini", vol. 12, 1983.

CARTER, P. L., FOLEY, R., *A Report on the Fauna from the Excavations at Meroe, 1967-1972*, in : "The Capital of Kush I", P. L. SHINNIE, R. J. BRADLEY (eds), Berlin, 1980, p. 298-312.

CHAIX, L., *Le monde animal à Kerma*, in : "Sahara", vol. 1, 1988, p. 77-84.

CLOUDSLEY-THOMPSON, J. L., *Fossil site at Saqqai*, in : "Kush", vol. 16, 1966, p. 328-330.

DELANY, M. J., HAPPOLD, D. C. D., *Ecology of African Mammals*, New York, 1979.

EL-TOM, M. A., *The Rains of the Sudan*, Khartoum, 1975.

FATTOVICH, R. *et al.*, *The Archaeology of the Eastern Sahel, Sudan*, in : "African Archaeological Review", vol. 2, 1984, p. 173-188.

FOUAD, N. I., *Ecological Imbalance in the Republic of the Sudan – with Reference to Desertification in Darfur*, in : "Bayreuther Geowissenschaftliche Arbeiten", Bd. 6, 1984.

GAUTIER, A., *Mammalian Remains of the Northern Sudan*, in : "The Prehistory of Nubia", F. WENDORF (ed.), Dallas, 1968, p. 80-99.

GAUTIER, A., *Animal Life along the Prehistoric Nile : the Evidence from Saggai I and Geili (Sudan)*, in : "Pottery using Gatherers and Hunters at Saggai (Sudan) : Preconditions for Food Production", I. CANEVA (ed.), Origini, vol. 12, 1983, p. 50-115.

GAUTIER, A., *The Fauna of the Neolithic Site of Kadero (Central Sudan)*, in : "Origin and Early Development of Food-producing Cultures in North-Eastern Africa", L. KRZYZANIAK, M. KOBUSIEWIECZ (eds), Poznan, 1984, p. 317-319.

GAUTIER, A., *La faune de l'occupation néolithique d'el Kadada (secteurs 12-22-32) au Soudan Central*, in : "Archéologie du Nil Moyen", t. 1, 1986, p. 59-111.

GAUTIER, A., *Prehistoric Men and Cattle in North Africa : A Dearth of Data and a Surfeit of Models*, in : "Prehistory of Arid North Africa. Essays in Honor of Fred Wendorf", A. E. CLOSE (ed.), Dallas, 1987, p. 163-187.

GAUTIER, A., *Notes on the Animal Bone Assemblage from the Early Neolithic at Geili (Sudan)*, in : "El Geili. The History of a Middle Nile Environment 7000 B.C.-A.D. 1500", I. CANEVA (ed.), BAR International Series 424, 1988, p. 57-63.

GAUTIER, A., *A General Review of the Known Prehistoric Faunas of the Central Sudanese Nile Valley* (to be published in "Late Prehistory of the Nile Basin and the Sahara", L. KRZYZANIAK, M. KOBUSIEWICZ (eds), Poznan).

GAUTIER, A., *The Fauna of Kadero* (to be published in "Report on the Excavations of Kadero", L. KRZYZANIAK (ed.), Poznan).

GEUS, F., *Rapport annuel d'activité, 1980-1982*, in : "Direction générale des Antiquités et des Musées nationaux du Soudan, Section française de recherche archéologique", Presses de l'Université de Lille III, 1983.

HAALAND, R., *Seasonality and Division of Labour : A Case Study from Neolithic Sites in the Khartoum Nile Environment*, in : "Norwegian Archaeological Review", vol. 14, 1981, p. 44-59.

HAPPOLD, D. C. D., *The Natural History of Khartoum Province : Mammals*, in : "Sudan Notes and Records", vol. 48, 1967, p. 111-132.

HARRISON, M. N., JACKSON, J. K., *Ecological Classification of the Vegetation of the Sudan*, "Ministry of Agriculture, Forests Bulletin 2", Khartoum, 1958.

IRELAND, A. W., *The Climate of the Sudan*, in : "Agriculture in the Sudan", J. D. TOTHILL (ed.), London, 1948, p. 62-81.

MACKENZIE, P. Z., *Catalogue of the Mammals of the Sudan occurring in the Natural Orders Artiodactyla and Perissodactyla*, "Sudan Museum (Natural History)", Publ. 4, Khartoum, 1954.

MARKS, A. E. *et al.*, *The Prehistory of the Central Nile Valley as Seen from its Eastern*

Hinterlands : Excavations at Shaqadud, Sudan, in : "Journal of Field Archaeology", vol. 12, 1985, p. 261-278.

MARKS, A. E. *et al., Late Pleistocene and Early Holocene Occupations in the Upper Atbara River Valley, Sudan*, in : "Prehistory of Arid North Africa, Essays in Honor of Fred Wendorf", A. E. CLOSE (ed.), Dallas, 1987, p. 137-161.

MARKS, A. E., SADR, K., *Holocene Environments and Occupations in the Southern Atbai, Sudan : A Preliminary Formulation*, in : "Prehistoric Cultures and Environments in the Late Quaternary of North Africa", J. BOWER, D. LUBELL (eds), BAR International Series 405, 1988, p. 69-90.

NEUMANN, K., *Holocene Vegetation of the Eastern Sahara : Charcoal from Prehistoric Sites*, in : "African Archaeological Review", vol. 7, 1989, p. 97-116.

PETERS, J., *Bijdrage tot de Archeozoölogie van Soedan en Egypte* (Unpublished Doctoral Thesis), Gent, 1986a.

PETERS, J., *A Revision of the Faunal Remains from Two Archaeological Sites : Khartoum Hospital and Esh Shaheinab*, in : "Archaeozoologia, Mélanges publiés à l'occasion du 5e Congrès International d'Archéozoologie, Bordeaux, Août 1986", 1986b, p. 11-35.

PETERS, J., *Osteomorphology and Osteometry of the Appendicular Skeleton of African Buffalo, Syncerus caffer (SPARRMAN, 1779) and Cattle, Bos primigenius f. taurus BOJANUS, 1827*, "Occasional Papers, Laboratorium voor Paleontologie, Rijksuniversiteit Gent", No. 1, 1986c.

PETERS, J., *Osteomorphological Features of the Appendicular Skeleton of African Buffalo, Syncerus caffer (SPARRMAN, 1779) and of Domestic Cattle, Bos primigenius f. taurus (BOJANUS, 1827)*, in : "Zeitschrift für Säugetierkunde", vol. 53, 1988, p. 108-123.

PETERS, J., *The Fauna of Jebel Shaqadud* (to be published in "The Prehistory of the Eastern Sahel, Vol. I : Jebel Shaqadud", A. E. MARKS (ed.), Dallas).

SETZER, H. W., *Mammals of the Anglo-Egyptian Sudan*, in : "Proceedings of the United States National Museum", vol. 106, 1956, p. 447-587.

SHINER, J., *The Prehistory and Geology of Northern Sudan, Part II*, "Report to the National Science Foundation, Grant GS 1192, Washington D.C.", 1971.

SHINNIE, P. L., *Meroe*, London, 1967.

SMITH, J., *Distribution of Tree Species in the Sudan in Relation to Rainfall and Soil Texture*, "Sudan Government Ministry of Agriculture", Bull. 4, Khartoum, 1949.

TIGANI EL MAHI, A., *Fauna, Ecology and Socio-economic Conditions in the Khartoum Nile Environment, Case Study from Four Neolithic Sites in Central Sudan* (Unpublished Doctoral Thesis), Bergen, 1982.

TIGANI EL MAHI, A., *Zooarchaeology in the Middle Nile Valley, A Study of Four Neolithic Sites near Khartoum*, BAR International Series 418, 1988.

WALTER, A., *Die Vegetation der Erde* (2 Vols.), Stuttgart, 1973.

WARREN, A., *Dune Trends and their Implications in the Central Sudan*, in : "Zeitschrift für Geomorphologie", Suppl. 10, p. 154-180.

WICKENS, G. E., *Palaeobotanical Speculations and Quaternary Environments in the Sudan*, in : "A Land between Two Niles", M. A. J. WILLIAMSON, D. A. ADAMSON (eds), Rotterdam, 1982, p. 23-50.

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