THE LECH KRZYŻANIAK EXCAVATIONS IN THE SUDAN
KADERO

# The fauna of Kadero and the arrival of pastoralism in the Nile Valley of Central Sudan

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## 1. Introduction

El Kadero or Kadero for short has been excavated for many seasons and is now known as the most important Early Neolithic or Khartoum Neolithic site on the east bank of the Nile, some 20 km north of Khartoum. Radiocarbon dates available in 1984 suggest that the occupation of the southern part of the site might be a few centuries older than that of the northern part (Krzyżaniak 1984). In a later publication the site is dated to 4850-4250 BC (Krzyżaniak 1991). In 1977 Sobociński published a short report on the faunal remains collected in the site during the 1$^{st}$ to 4$^{th}$ campaign (1972-75), mostly in the southern part of the site (Kadero S, KS), focussing on the domestic herbivores. Several years later a second short paper followed (Gautier 1984), based on the material analysed by Sobociński and finds of later excavations in the southern midden as well as in the northern midden (KN); it contained a preliminary re-appraisal of Sobociński's conclusions and a revised list of the wild fauna. The detailed study was completed in 1985 but for various reasons it never reached the printer. Meanwhile the excavation campaigns in 1989, 1991, 1993 and 2001, mainly in the northern midden, produced an appreciable amount of faunal remains. These finds have been incorporated in the present, revised version of the 1985 paper. A short preliminary paper read at the International Symposium "Archaeology of the Earliest Northeastern Africa" in September 2003 precedes the present text (Gautier 2006). As known, revising a paper one has written considerable time ago, is a frustrating business. One feels an urge to do over the whole analysis on which the text is based and write a new paper more in accordance with the experience and knowledge one thinks one has gained meanwhile. The foregoing being impossible, the authors hope that their revision covers the most important points and ask for some leniency from the reader. The manuscript was completed and sent to the editors in April 2007.

The first author analysed most of the material in Poznan during several visits there between 1978 and 2003. Problematic specimens, the fish and most of the wild vertebrates were sent or brought to Belgium, where they were analysed with the aid of the comparative material available in the Research Unit Palaeontology, Ghent University and in the Royal Museum of Central Africa, Tervuren. The first author concentrated on the general fauna, while the fish were studied in detail by the second author. The authors had access to already studied archaeozoological material from Saggai, Geili (Gautier 1983; 1988) and El Kadada (Gautier 1986) and to part of the material from other sites along the Nile (Early Khartoum, Esh Shaheinab, El Nofalab, etc. (Tigani El Mahi 1982; 1988; Peters 1986; Gautier et al. 2002; Caneva & Gautier 1994), from Shaqadud (Peters 1991) and from the region of Khasm-el-Girba and Mahal Teglinos (Marks et al. 1987; Gautier & Van Neer 2006). Apart from osteomorphological and osteometric criteria, ecological and biogeographical data on present-day mammalian game were used as circumstantial evidence for the identifications. These data can be found in Setzer (1950); Meester & Setzer (1971-78); Dorst & Dandelot (1972); Haltenorth & Diller (1979); Osborn & Helmy (1980) and Kingdon (1997). In the case of fish, zoogeographical and other biological data were considered from Sandon (1950), Daget (1954), El Hakeem (1970) and Froese & Pauly (2005).

The material was collected by hand from the trenches or recovered by dry sieving on screens with a mesh of 4 mm. This does not allow complete recovery of the microfauna, but practical considerations generally precluded the use of more refined sampling methods. Moreover one tends to forget that part of the microfauna consists of small intrusives such as amphibians, lizards and rodents, which have restricted palaeoecological significance because of the persistence of their microhabitats even when the overall environment changes quite markedly. The recovery of fish remains may have been less adequate. Dry sieving on 4 to 5 mm screens appears to be by now a standard procedure applied by most archaeologists working in Central Sudan. Therefore no major sampling bias affects our comparisons with the majority of the other Central Sudanese archaeofaunas.

In total some 36,000 bone remains were collected. They are generally much fragmented and coated with a calcareous matrix with fine clastics. Specimens that are cemented together occur but are rare. Most of the fragmentation appears to be due to weathering cracks, representing stage 1 sensu Behrensmeyer (1978) of the sequence leading to total degradation in bones exposed of the surface. In general, the preservation of the material compares fairly well with that of the material excavated in Early Khartoum, Shaheinab, Umm Marrahi and Saggai. The matrix renders sorting difficult and no doubt some ill defined or heavily coated specimens ended up erroneously in the pile of the not identifiable remains. In the biogeographical notes we use the term Sudano-sahelian belt as defined by Zonneveld (1980): the geographical area extending from West Africa to the Pacific Ocean between the 100-200 mm and the 500 mm isohyets. We use the term Central Sudan as defined by Hinkel (1977) for the historical-cultural area between approximately Sennar and Dongola. For more information on Kadero, the reader is referred to the general presentation of Kadero and other papers in this publication.

The bulk of the material is stored in the Muzeum Archeologiczne in Poznan. A few specimens of wild fauna, some problematic specimens and a sample of cattle remains have been included in the collections of the Research Unit Palaeontology, Ghent University under number P3564.

**Tab. 1.** The fauna of Kadero (specimen counts) (a).

| Animal group | Species | Provenance | | |
|---|---|---|---|---|
| | | KS | KN | Totals |
| Marine molluscs | *Nerita polita* (b) | - | - | R |
| | *Cypraea turdus*? | 1 | - | 1 |
| | *Engina mendicaria* (b) | - | - | F |
| | marine bivalve (b) | - | - | 1 |
| Freshwater molluscs | small gastropods (*Cleopatra bulimoides*/*Melanoides tuberculata*) | R | - | R |
| | *Pila wernei* | F | F | F |
| | *Lanistes carinatus* | R | R | R |
| | small bivalves (*Corbicula consobrina*) | R | R | R |
| | *Chambardia* spp. | R | R | R |
| | *Etheria elliptica* | R | R | R |
| Landsnails | *Limicolaria caillaudi* | F | F | F |
| | *Zootecus insularis* | R | R | R |
| Freshwater fish (c) | | 39 | 60 | 99 |

| Animal group | Species | Provenance | | |
|---|---|---|---|---|
| | | KS | KN | Totals |
| Amphibians | | 5 | 6 | 11 |
| Reptiles | crocodile (*Crocodylus niloticus*) | - | 4 | 4 |
| | Nile monitor (*Varanus niloticus*) | 60 | 104 | 164 |
| | lizard | - | 1 | 1 |
| | rock python (*Python sebae*) | 18 | 29 | 47 |
| | small snake(s) | 6 | 23 | 29 |
| Birds (d) | | 16 | 4 | 20 |
| Wild mammals | hedgehog (*Atelerix albiventris*?) | - | 1 | 1 |
| | small monkey, probably grivet monkey (*Cercopithecus aethiops*) | - | 1 | 1 |
| | hare, probably Cape hare (*Lepus capensis*) | 11 | - | 11 |
| | ground squirrel (*Euxerus erythropus*) | 5 | - | 5 |
| | tatera gerbil (*Tatera robusta*?) | 4 | 2 | 6 |
| | multimammate rat (*Mastomys* sp.)? | - | 1 | 1 |
| | lesser jerboa (*Jaculus jaculus*) (e) | ±30 | - | ±30 |
| | unidentified smaller rodents | F | 9 | F |
| | porcupine (*Hystrix cristata*) | 3 | 1 | 4 |
| | canid, probably golden jackal (*Canis aureus*) | 27 | - | 27 |
| | honey badger (*Mellivora capensis*) | 11 | - | 11 |
| | medium sized viverrid (*Herpestes ichneumon* or *Atilax paludinosus*) | 1 | - | 1 |
| | small carnivores | 2 | 1 | 3 |
| | wild cat (*Felis silvestris*) | 13 | 2 | 15 |
| | medium sized felid, probably caracal (*Felis caracal*) | 10 | P | 10 |
| | aardvark (*Orycteropus afer*) | 1 | - | 1 |
| | elephant (*Loxodonta africana*) | 1 | 1 | 2 |
| | warthog (*Phacochoerus aethiopicus*) | 5 | 4 | 9 |
| | hippopotamus (*Hippopotamus amphibius*) | 8 | 7 | 15 |
| | giraffe (*Giraffa camelopardalis*) | 5 | 6 | 11 |
| | medium sized bovids, mainly red-fronted gazelle (*Gazella rufifrons*) | 5 | 2 | 7 |
| | larger antelopes (f) | 30 | 26 | 56 |
| | medium sized antelope, probably kob (*Kobus kob*) | 11 | 9 | 20 |
| | small antelopes, mainly oribi (*Ourebia ourebi*) | 166 | 38 | 204 |
| Domestic or wild | small bovid (antelope or small livestock) | 73 | 39 | 112 |
| Domestic mammals | cattle (*Bos primigenius* f. taurus) | 1028 | 498 | 1526 |
| | goat (*Capra aegagrus* f. hircus)/sheep (*Ovis ammon* f. aries) | 151 | 77 | 228 |
| Total vertebrates | | ±1746 | 961 | ±2707 |
| Total not identified vertebrates | | ±30000 | 6300 | ±36300 |

(a) F: frequent; R: rare; P: present but not counted, e.g., rib or vertebrae other than atlas or axis; (b) Only found in the graves; (c) See Table 2; (d) For a account of some of the birds see text; (e) Also present in a coprolite, see text; (f) Tiang, greater kudu etc., see text. KN - Northern Midden, KS - Southern Midden

## 2. The animals encountered

Table 1 summarises the faunal assemblages of KN, KS and the combined assemblage. In the following descriptions, we will most often not repeat the references on recent African animals given above to avoid repetition. For the same reason, the reader is invited to consult previous and already cited papers for more information on certain aspects of Sudanese archaeofaunas. Table 2 gives the inventory of the fish available for study.

Tab. 2. Fish remains from Kadero (fragment counts)

| Specimen | KS | KN | Totals |
|---|---|---|---|
| lungfish (*Protopterus aethiopicus*) | 9 | 1 | 10 |
| bichir (*Polypterus* sp.) | - | 1 | 1 |
| heterotis (*Heterotis niloticus*) | 1 | 3 | 4 |
| aba (*Gymnarchus niloticus*) | - | 1 | 1 |
| characin (*Alestes* or *Brycinus*) | 1 | 1 | 2 |
| carp (*Cyprinidae* indet.) | - | 1 | 1 |
| moon fish (*Citharinidae*) | - | 2 | 2 |
| clariid catfish (*Clarias* sp.) | 11 | 27 | 38 |
| bagrid catfish (*Bagrus* sp.) | - | 3 | 3 |
| mochokid catfish (*Synodontis* sp.) | 10 | 7 | 17 |
| large siluroid | 1 | 2 | 3 |
| tilapia (*Tilapiini*) | - | 1 | 1 |
| Nile perch (*Lates niloticus*) | 6 | 4 | 10 |
| unidentified fish | - | 6 | 6 |
| total fish | 39 | 60 | 99 |

***Molluscs***

*Nerita polita* (Pl. 1. 1)

Three specimens of this smaller marine gastropod were found in several graves together with *Engina mendicaria* beads and other kinds of beads. They were identified with the aid of the late Mr. T. Pain (London). The apex of the shells has been perforated, no doubt by rubbing on an abrasive surface, as Arkell (1950) described; afterwards the shells were used as beads. Comparable beads are known from some other prehistoric sites in the Central Sudanese Nile region. Such a bead is also illustrated from an A-group grave in Nubia (Nordström 1972: Pl. 196) and indicates that their use was not restricted to the Central Sudan. The first author also identified worked specimens of the species in a dynastic grave at Elkab in Egypt (Gautier 2005). *N. polita* is a typical species of the Red Sea and Indian Ocean.

Cowry (*Cypraea turdus*?)

One cowry was collected on the surface of KS and may hence be an intrusive, later element. The shell wall opposite the slit-like aperture has been removed to make the shell into a bead, as is still done today when cowries are strung together for ornamental purposes. The shell is smoothed either by use wear or by wind action. As it is, it compares well with a specimen from Kadada identified through the courtesy of the late Mr. T. Pain (London) as *Cypraea turdus*. A second cowry, modified into a bead is a surface find of unknown provenance. No effort was made to identify the species and it has not been incorporated in Table 1. Cowries occur in several sites in the Central Sudanese Nile region and point to some form of connection with the east coast of Africa, since cowries are typical molluscs of the Red Sea and Indian Ocean.

*Engina mendicaria* (Pl. 1. 5)

Several graves yielded large amounts of *Engina mendicaria* used as beads to make complex ornaments for personal use. As already explained elsewhere the shells are perforated on the last whorl opposite the peristome and the perforation appears to be the result of planing on an abrasive surface. The outer and the columellar walls of the peristome appear to be planed in a similar fashion. Comparable shells have been found in several prehistoric sites in the Central Sudanese Nilotic region, but are frequent only in Neolithic contexts where their association with burials is clear. *E. mendicaria* is a typical intertidal species found in the Red Sea and Indian Ocean. Its ornamental use in former times is not restricted to the Sudan and the first author found it also in archaeological sites in Asia (Gautier 1978). Many of the shells collected in grave 5 show a bluish discoloration.

***Marine bivalve***

In grave 5 a small fragment of a shell represents a bivalve species, most likely of the family Pectinidae

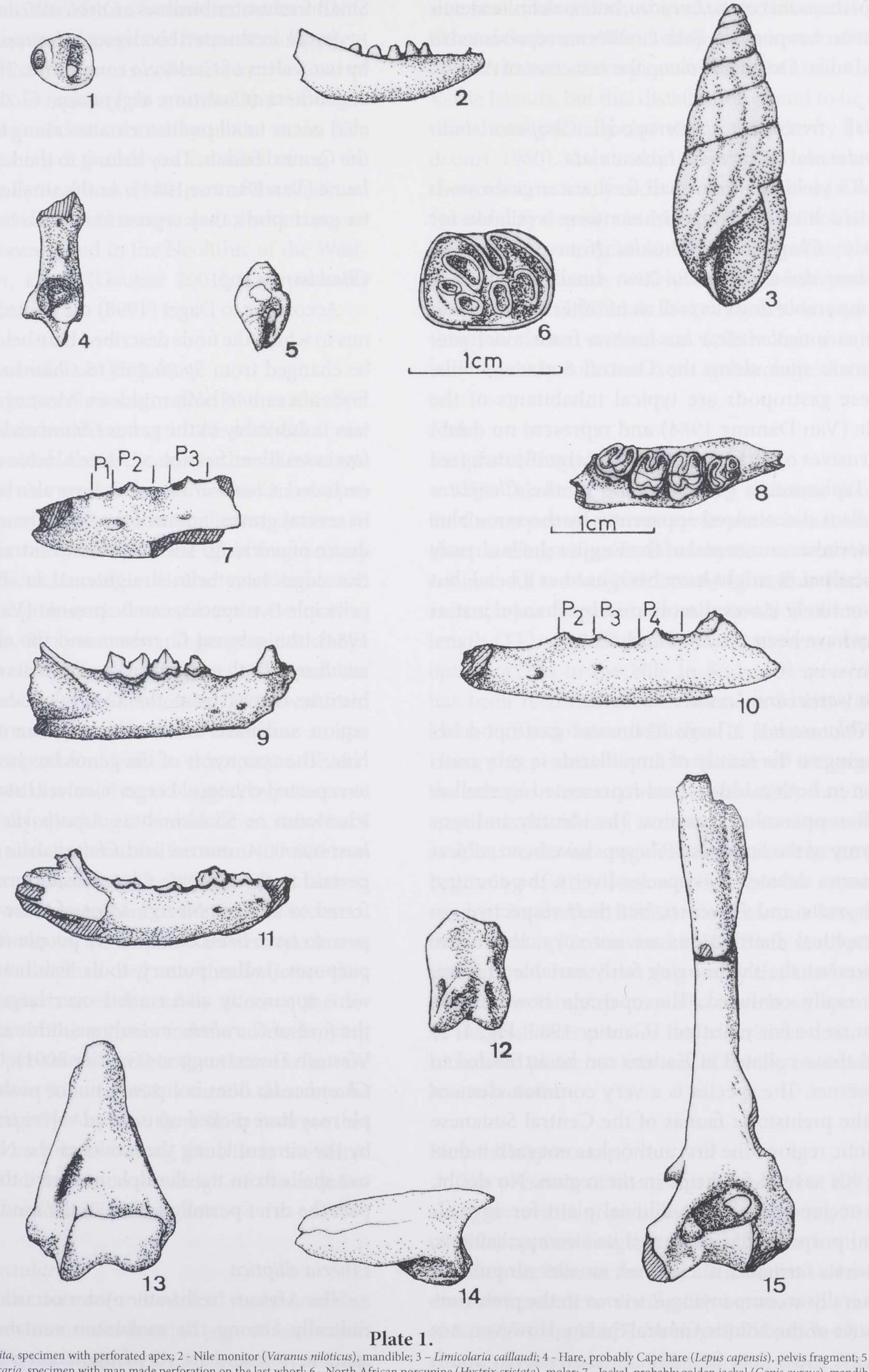


**Plate 1.**

1 - *Nerita polita*, specimen with perforated apex; 2 - Nile monitor (*Varanus niloticus*), mandible; 3 – *Limicolaria caillaudi*; 4 - Hare, probably Cape hare (*Lepus capensis*), pelvis fragment; 5 - *Engina mendicaria*, specimen with man made perforation on the last whorl; 6 - North African porcupine (*Hystrix cristata*), molar; 7 - Jackal, probably golden jackal (*Canis aureus*), mandible fragment; 8 - Ground squirrel (*Euxerus erythropus*), mandible; 9 - Wild cat (*Felis silvestris*), mandible; 10 - Jackal, probably golden jackal (*Canis aureus*), mandible fragment; 11 - Medium sized viverrid, either Egyptian mongoose (*Herpestes ichneumon*) or water mongoose (*Atilax paludinosus*), mandible fragment; 12 - Warthog (*Phacochoerus aethiopicus*), second phalanx; 13 - Larger felid, probably caracal (*Felis caracal*), distal humerus; 14 - Aardvark (*Orcyteropus afer*), third phalanx; 15 - Honey badger (*Mellivora capensis*), incomplete humerus

or perhaps that of the Limidae, but no definite identification was possible. Both families are represented in the Indian Ocean and along the east coast of Africa.

Small freshwater gasteropods: *Cleopatra bulimoides* and *Melanoides turberculata*

KS yielded a few small freshwater gastropods of which only six specimens were available for study: *Cleopatra bulimoides* (four specimens), *Melanoides tuberculata* (two small specimens). Comparable finds as well as of other species (*Bellamya unicolor* etc.) are known from most prehistoric sites along the Central Sudanese Nile. These gastropods are typical inhabitants of the Nile (Van Damme 1984) and represent no doubt intrusives of little archaeological significance (see 3. Taphonomic groups). One of the *Cleopatra* shells is discoloured apparently by the same blue material as are several of the Engina shells already described. It might have been used as a bead, but more likely it was discoloured by chance, just as may have been the *Engina* shells.

*Pila wernei* and *Lanistes carinatus*

*Pila wernei*, a large freshwater gastropod belonging to the family of ampullarids is very common in both middens and represented by shell as well as operculum remains. The identity and synonymy of the Sudanese *Pila* spp. have been subject to some debate. Two species live in the country: *Pila ovata* and *P. wernei*, but their respective geographical distributions are not very clear to us. Moreover the shells, being fairly variable in form, are easily confused. The opercula however appear to be fairly distinct (Gautier 1983: Fig. 1, 3) and those colleted at Kadero can be attributed to *P. wernei*. The species is a very common element of the prehistoric faunas of the Central Sudanese Nilotic region. The first author has not seen it during his several fieldtrips in the region. No doubt, the reclamation of the alluvial plain for agricultural purposes has destroyed its swampy habitats. *Lanistes carinatus* is a second, smaller ampullarid generally accompanying *P. wernei* in the prehistoric sites of the Nilotic Central Sudan. However, it is always much less frequent. It occurs today south of Khartoum in the White Nile and has ecological preferences resembling closely those of *Pila* spp.

Small freshwater bivalves : *Corbicula consobrina*

Small freshwater bivalves are represented only by two valves of *Corbicula consobrina*. This species and others (*Coelatura aegyptiaca*, *C. teretiuscula* etc.) occur in all prehistoric sites along the Nile in the Central Sudan. They belong to the normal Nile fauna (Van Damme 1984). As the smaller freshwater gastropods, they represent intrusives.

*Chambardia* spp.

According to Daget (1998) the name for the genus to which the finds described here belong, has to be changed from *Spathopsis* to *Chambardia*. Such finds are rare in both middens. Most of them pertain indubitably to the genus *Chambardia*, but in a few cases identification as *Mutela dubia* can not be excluded. *Chambardia* valves have also been found in several graves. Some of the finds show clear evidence of working. Their anterior, ventral or posterior edges have been straightened or serrated. In principle two species can be present (Van Damme 1984): the suboval *C. rubens* and the elongate *C. wahlbergi*. Both are typical components of the prehistoric faunas from the Central Sudanese Nile region and have been collected from the recent Nile. The synonymy of the genus has been subject to repeated changes. Larger bivalves listed at Early Khartoum or Shaheinab as *Aspatharia wahlbergi hartmanni*, *A. marnoi* and *Chambardia locardi* all pertain to the elongate *Chambardia* form here referred to as *C. wahlbergi*. Most of these shells appear to have been collected by people for various purposes (ladles, pottery, tools, fish hooks). They were apparently also traded over large areas, as the find of *C. rubens* in early neolithic sites in the Western Desert suggest (Gautier 2001). Collecting *Chambardia* does not pose a major problem. People may have picked up isolated valves transported by the current along the banks of the Nile or dug out shells from the floodplain, where the animals pass the drier periods buried in the mud.

*Etheria elliptica*

The African freshwater oyster occurs only sporadically among the molluscan remains and all specimens found are very fragmentary. Dr. D. Adamson (in litt. to Dr. Krzyżaniak) also found only a few fragments of this species in the samples which he analysed. The African freshwater oyster or Nile oyster is a typical, though not frequent component of the prehistoric faunas collected in the Central Sudanese Nile region. It is an inhabitant of larger water bodies and occurs today in the main Nile channel, where it builds its colonies along the banks. The central and dense part of the shell can be modified into small receptacles, of which examples have been found in the Neolithic of the Western Desert, Egypt (Gautier 2001), and probably other artefacts.

*Limicolaria caillaudi* (Pl. 1. 3)

This larger, easily recognisable land snail is frequent in both middens, but in the material at our disposal we could not check whether *Limicolaria* or *Pila* was the most frequent molluscan component, because shells were not collected systematically; moreover quantifying the often fragmentary shells is difficult. *L. cailliaudi* is the typical land snail found in the prehistoric faunas from the Central Sudanese Nile. Its synonymy and geographical range are discussed by Crowley & Pain (1970) and the shells referred to as *L. flammata* or *L. kambeul* from Early Khartoum, Shaheinab or elsewhere in the Sudan belong undoubtedly to this species. Several authors have discussed its ecological requirements and generally speaking it would be an inhabitant of the savannah with rainfall between 400-500 mm and 800 mm (Tothill 1948; Williams & Adamson 1980). However, members of the French Archaeological Mission in the Sudan collected specimens near Shendi; they had died only shortly before they were discovered, as evidenced by traces of the decomposition of the animals and the accompanying smell. The previous statement that these shells were collected alive (Gautier 1983) should therefore be modified slightly. Anyhow, these finds indicate that the species may survive along the Nile in the semi-arid belt and that our knowledge of the requirements of *L. cailliaudi* is incomplete.

*Zootecus insularis*

The collection submitted for study contains only six specimens of this small pupoid land snail. Dr. D. Adamson (in litt. to Dr. Krzyżaniak) records also a few specimens in the molluscan samples which he analysed. *Z. insularis* is a typical intrusive snail found in most prehistoric faunas of the Central Sudanese Nile. Today it has a wide distribution in semi-arid regions from India to the Cape Verde Islands, but this distribution is said to be artificial and partially due to human activity (Verdcourt 1960). As already emphasized elsewhere, there are now many records of the species in later Quaternary deposits in North Africa (Nile Valley; Western Desert; Acacus, Libya) and perhaps the species was already widely distributed in prehistoric times. Its life habits are poorly known and we therefore do not understand well the fact that it is very regularly collected from archaeological sites.

***Fish***

Lungfish (*Protopterus aethiopicus*)

This fish has a poorly ossified skeleton, except for the very characteristic tooth plates in a form of sharp cutting ridges made of dentine covered with enamel. All ten lungfish remains found at Kadero are such jaw fragments from animals with a total length (TL) of 20-60 cm. Today *Protopterus aethiopicus* occurs in the Nile in Sudan; *P. annectens* has been recorded only in Western Sudan, from khors in Kordofan and Darfur (El Hakeem 1970). Using the present day distribution of the genus, the remains were attributed to *P. aethiopicus*. This species is found only occasionally in deep water as it has to surface regularly for breathing. At the beginning of a dry season and before the exposed mud of its shallow habitat hardens, this lungfish burrows in it (Greenwood 1968). Such aestivating animals may have been dug out by the inhabitants of Kadero. Lungfish may also have been speared in the shallower parts of the main river or in the inundated plain, but this way of fishing is certainly less successful.

Bichir (*Polypterus* sp.)

The presence of this genus is attested at KN by a single vertebra of an individual measuring 30-40 cm SL (standard length, i.e., the distance from the snout to the base of the tail). This skeletal element does not permit to distinguish between the three species (*P. senegalus*, *P. bichir* and *P. endlicheri*) occurring in the Sudanese Nile (Sandon 1950). These fish prefer shallow waters with sandy bottoms and abundant vegetation, and are capable of taking up atmospheric oxygen thanks to their accessory breathing organs (Poll 1939). They can be found in slow running or standing water on the floodplain or in marginal areas of the Nile. Bichirs are a regular but not frequent member of Sudanese archaeological ichthyofaunas.

Heterotis (*Heterotis niloticus*)

This species is represented at KS by a single vertebra of a small individual measuring 20-30 cm SL, in KN three vertebral centra occur of somewhat larger specimens (40-50 cm SL). Heterotis prefer a muddy substrate and abundant vegetation and can survive in poorly oxygenated waters (Daget 1954). Spawning takes place in swampy areas of the floodplain and involves the construction of large (1 to 1.5 m in diameter), floating, circular nests made from plants. Due to the parental care adult animals are extremely vulnerable to human predation during the reproduction season.

Aba (*Gymnarchus niloticus*)

A single vertebra of this species was found in KN and belongs to an individual that must have measured between 100 and 120 cm. Like the preceding species, it is mainly an inhabitant of swampy environments with abundant vegetation. It also constructs very conspicuous floating nests at the beginning of the flood season, using plant stalks (Daget 1954; Reed et al. 1967).

Tetra (*Alestes or Brycinus*)

A precaudal vertebra in KN and a caudal one in KS belong to the Alestiidae, a family that includes the tigerfish (genus *Hydrocynus*) and smaller tetras such as *Alestes* and *Brycinus*. The morphology of the vertebral centra excludes an identification as *Hydrocynus*, whereas the reconstructed sizes (30-40 and 20-30 cm SL, respectively) exclude some of the smaller species of the two other aforementioned genera. The following species occurring in the present day Sudanese Nile attain sizes (cf. Froese & Pauly 2005) also seen in the archaeological specimens: *Brycinus macrolepidotus* (max. 53 cm SL), *Alestes baremoze* (max. 43 cm TL) and *Alestes dentex* (55 cm TL) These fish are rarely found in archaeological context which is surprising given the important economic role they play nowadays. It is unclear if this is an effect of differential preservation or sampling bias, or if the available fishing techniques played a role. Maybe the pelagic habits of the tetras precluded their efficient capture in prehistoric times.

Carp (*Cyprinidae* indet.)

A single caudal vertebra of an individual measuring 30-40 cm SL is the only indication for the exploitation of carps at Kadero. Of all the cyprinids living in the Sudanese Nile only species of the genera *Barbus* and *Labeo* reach the size seen in the archaeological specimen. They are found in the main Nile, but usually thrive on the floodplain as well. Larger cyprinids are regularly found in Sudanese archaeofaunas, but are never very frequent.

Moon fish (*Citharinidae*)

Two caudal vertebrae, one of an individual measuring 20-30 cm SL and another one of 30-40 cm SL were found at KN. The poor preservation of the specimens does not allow the discrimination between *Citharinus* and *Distichodus*, the two relevant genera of larger size occurring in the Sudanese Nile. Species of the two genera can occur in open water, some prefer flowing waters, others are found in more vegetated areas. Citharinidae are a regular but not frequent member of Sudanese ichthyofaunas.

Clariid catfish (*Clarias* sp.)

These catfish are the best represented fish taxon at Kadero and also in other sites along the Sudanese Nile they are usually the most common group. Two cranial roof fragments, five pectoral spines and four vertebrae occur at KS, whereas at KN these catfish are represented by a single cranial roof fragment, a quadrate, a cleithrum, four pectoral spines and 19 vertebrae. Strictly speaking these remains should be classified as "Clariidae", but both osteomorphological and zoogeographical data indicate that they probably all belong to the genus *Clarias*. Besides *Clarias* also *Heterobranchus* may have occurred at Kadero, but the latter genus is rare today in Sudan (Sandon 1950). This probably was also the case in Neolithic times as is indicated by the articulating part of the pectoral spines found: their shape is typical of *Clarias* (cf. von den Driesch 1983). Clariids have air-breathing habits and can therefore occur in much deoxygenated waters with high carbon dioxide content. Theoretically the clariids can be caught all year round, but the easiest way to do so is during their spawning runs at the beginning of the inundation. They can also easily be harvested in residual ponds left on the floodplain when the Nile recedes (Van Neer 2004). The reconstructed body lengths of the catfish indicate that they were captured during both seasons.

The specimens of less than 20 cm were no doubt immature fish that must have been taken from residual pools and this may also have been the case for at least part of the specimens up to 40-50 cm. The largest individual has a reconstructed body size of about 120 cm SL and must represent a fish captured during spawning at the beginning of the floods.

Bagrid catfish (*Bagrus* sp.)

Remains of bagrids have only been found in KN and consist of a pectoral spine and a caudal vertebra of specimens measuring 20-30 cm SL, and of a dorsal spine of a very large individual. The spine must have belonged to an animal of almost 1 m standard length. Today *Bagrus bajad* and *Bagrus docmak* are found in Sudan (Sandon 1950), but the skeletal elements do not allow a specific identification. According to Sandon (ibid.), both named catfish are widely distributed but prefer open water; their habitats and habits would be fairly similar to those of *Lates niloticus*. The oxygen dissociation curves of the haemoglobin given by Fish (1956), however, demonstrate that the blood-pigment of *Bagrus* is saturated at low oxygen tensions while *Lates* needs relatively high tensions for complete saturation. Hence *Bagrus* can live in waters where *Lates* only seldom occurs.

Mochokid catfish (*Synodontis* sp.)

Pectoral spines are the best represented skeletal element of these catfish, both at KS (9 spines) and at KN (5) At the latter part of the site also a coracoid and a Weberian apparatus were found. At KS the humeral process of the only cleithrum that was found has the typical sharp, triangular shape of *Synodontis schall*. Seven species of *Synodontis* occur in the Nile near Khartoum today. Three of them are rare, while S. schall is said to be the most abundant of all catfish, occurring in the area throughout the year (Sandon 1950). Unless there is association with other open water fish, the presence of *Synodontis* on a site cannot be related unequivocally to the exact place of capture since some species can occur in all facies of a river basin. *Synodontis* migrates laterally into the flood plain to spawn, but in case the plains are of limited extent or absent, spawning takes place in shallow parts of the main channel (Iltis 1965). The reconstructed body lengths vary between less than 10 cm SL and 30-40 cm SL, showing that both juvenile and adult specimens were captured. This also means that at least part of the fish (the small ones) must have been taken from the floodplain.

Tilapia (*Tilapiini*)

Tilapia are only represented by a single vertebra of an animal measuring 25-30 cm SL. The three species that occur in the Sudanese Nile, *Oreochromis niloticus*, *Tilapia zillii* and *Sarotherodon galilaeus* cannot be distinguished on the basis of their vertebrae. These fishes may theoretically have been taken from the main channel or from the inundated plain. During the flood season tilapia breed repetitively in shallow water and are vulnerable to predation by man (Elster 1959). This fish may also have been captured in residual ponds where it can survive thanks to its low oxygen needs (Balarin 1979). Unlike *Clarias* and *Protopterus*, tilapia do not have accessory breathing organs, but their haemoglobin has a high affinity for dissolved oxygen (Fish 1956).

Nile perch (*Lates niloticus*)

This species is represented by several vertebrae (four at KS, two at KN). In addition a dentary and a gill raker were found at KS, and a preopercular and a fin ray at KN. The reconstructed sizes show that two vertebrae belonged to individuals of about 30 cm SL and three other vertebral centra are derived from fish of more than 1 m SL All the other remains belonged to Nile perch of 50-100 cm SL. Lates are found only in well aerated waters as they are very sensitive to low oxygen concentration and high carbon dioxide tensions. The young occur everywhere in well oxygenated parts of river-basins, but the large adults prefer deeper parts of the main channel, which they will not leave or for very short periods only (Copley 1952; Blache

1964). The size of Nile perch can give indications of the place where they were captured. Occasionally spawning takes place on the flood plain (Copley ibid.), but the adults will probably not stay there for long, as they are very sensitive to turbidity and deoxygenation. Usually spawning occurs in the main channel close to the river-banks (Blache ibid.) and the fry migrates into the flood plain where it can grow rapidly thanks to the large food supply. When the young return to the main channel after their first growth period, they may attain sizes of up to 25 cm SL (Daget 1964.). Although juveniles may occasionally remain in persistent residual pools during the whole dry season (Daget ibid.), we consider the specimens of more than 25 cm SL to be taken from the main river. The large size of the other specimens found at Kadero clearly show that Nile perch fishing was practised in the main river. The depth at which larger animals stay hampers their capture, thus requiring rather sophisticated fishing techniques.

***Amphibians***

A few postcranial remains represent frogs or toads in both middens. No effort was made to identify further these intrusive remains. No other finds are known from Central Sudanese archaeofaunas.

***Reptiles***

Crocodile (*Crocodylus niloticus*)

In the older collection no crocodile remains were found, but the later KN assemblages yielded a jaw fragment with a tooth in place, a separate tooth and two dermal plates. The jaw and the tooth derive probably from the same, quite large animal. One of the dermal plates also comes from a large animal; the other one represents a small, young individual. The crocodile is a regular but not frequent member of Sudanese archaeofaunas. In the past, it was widespread in Africa from its northern to southern coasts (Guggisberg 1972).

Nile monitor (*Varanus niloticus*) (Pl. 1. 2)

Some cranial remains, many vertebrae and some limb bone fragments can be ascribed to varanids. The specific identification of this material is based on biogeographical and palaeosynecological considerations. Two varanid species occur in North Africa: the desert monitor (*Varanus griseus*) in the Sahara and the Nile monitor (*V. niloticus*) along the Nile and other riverine situations as this species is amphibious (Lambert 1984). Varanid remains, no doubt attributable to Nile monitor, occur in all prehistoric sites of the Central Sudanese Nile region and may be fairly frequent, since a few animals can provide an appreciable number of easily recognizable vertebrae, the most commonly found skeletal element.

Rock python (*Python sebae*)

Some small vertebrae collected in KS pertain to small pythons. They allow no more precise identification, but on the basis of biogeographical considerations the material can be attributed to the rock python or *Python sebae*. According to Grzimek and collaborators (1973), three python species occur in Africa: the rock python (*Python sebae*) with a subsaharan distribution; the royal python (*P. regius*) in West and Central Africa; the Angola python (*P. anchieta*) in Angola and south-western Africa. Major shifts would have occurred in the distribution of these snakes, if our material did not belong to the first named species. Python remains, attributed to rock python, occur in most prehistoric sites of the Central Sudanese Nile region. As in the case of the Nile monitor, a few animals may account for many finds, as identifications are mainly based on the vertebrae.

Snakes

Some small vertebrae in the 1989 collection and later assemblages were kept separate, because they do not seem to exhibit the characteristic features of python. No effort was made to identify them to genus or species.

***Birds***

Mrs. D. Matthiesen (Gainesville, Florida) accepted to analyse the avian remains of the early samples and provided a preliminary note (in litt. 13 September 1982), which we quote verbatim.

> "There are 13 specimens from at least six avian families. Number of specimens is given below in parentheses; minimum number of individuals equals seven, two within the Phasianidae and one each in the other families.

Ciconiidae: Mycteriini:
*Anastomus lamelligerus*, Open-billed Stork: 1
Threskiornithidae:
sp. indet., ibis/spoonbill: 1
Anatidae: Anatinae: Anatini:
*Anas querquedula/crecca*, Garganey/Green-winged Teal: 1
Accipitridae?:
sp. indet., raptor?: 1
Phasianidae: Numidinae:
cf. *Numida meleagris*, Helmeted Guineafowl: 5
Gruidae: Balearicinae:
*Balearica pavonina*, Crowned Crane: 1
Aves : sp. indet.: 3

These remains represent species presently inhabiting the Sudan in the region of the Nile. All of these species are linked most closely to the river environment and could be present regardless of the degree of aridity of the surrounding country. This is true of even the guinea fowl, for although they are typical of acacia forest and savannah, they are seldom found far from water. All of the species identified are essentially resident except for the Palaearctic teal, which is a passage migrant and winter visitor (October to March, to as late as May). If the poorly-ossified guinea fowl specimens are indeed of immature birds, summer occupation of the site is also indicated, for these birds breed from July through September."

The few avian remains from the later excavations have not been identified; they include birds of varying size.

### *Mammals*

The measurements correspond to those proposed by von den Driesch (1976). In case several measurements pertain to the same specimen, the first measurement in a column of such measurements is preceded by an asterisk.

Hedgehog (*Atelerix albiventris*?)

A fragmentary mandible in KN represents a small hedgehog with a jugal teeth row length of about 16 mm. Two hedgehog species occur in the Sudan: *Atelerix albiventris* or the white-bellied hedgehog and *Hemiechinus aethiopicus* or the desert hedgehog. Their ranges overlap but *A. albiventris* has a more southern distribution than *H. aethiopicus*. The vernacular name of the latter species indicates that it prefers desert country and therefore the find is tentatively attributed to *A. albiventris*. This is the second record of hedgehog in the Sudanese archaeofaunas. The first comes from the Khartoum Mesolithic site El Damer on the east bank of the Nile near its confluence with the Atbara; it was also tentatively attributed to *A. albiventris* (Peters 1995). Desert hedgehog is a fairly regular member of the faunal assemblages from the Neolithic at Bir Kaseiba and El Nabta in the Western Desert, Egypt (Gautier 2001).

Small monkey, probably grivet monkey (*Cercopithecus aethiops*)

A fragmentary calcaneum collected in KN is derived from a small cercopithecid. It is about 0.4 times smaller in linear dimensions than its homolog in a large male baboon (*Papio cynocephalus*) in the Ghent comparative collection. Therefore it should represent a very small animal, presumably a female of the grivet monkey (*Cercopithecus aethiops*), a species still occurring in Central Sudan as far north as Dongola. Small monkey remains, all identified tentatively as grivet monkey, occur in several prehistoric sites of the Central Sudanese Nile region, but are always rare. The species has a wide distribution in subsaharan Africa. It is a rather tolerant, small primate found in wooded savannas, gallery forests, wooded mountainous terrain and land under cultivation.

Hare, probably Cape hare (*Lepus capensis*) (Pl. 1. 4)

A lagomorph is represented in KS by a skull fragment and some postcranial fragments. Few of these remains could be measured (Tab. 3).

**Tab. 3.** Hare (*Lepus capensis*). Measurements

| Bone specimen | Measurement | |
|---|---|---|
| Radius, TR.D. diaph. | 6.0 | |
| calcaneum, H. | 25.9 | |
| Mt, TR.D. dist. | 4.9 | 5.2 |

The measurements indicate a rather small lagomorph, of the size of European wild rabbit (*Oryctolagus cuniculus*). Most probably the material represents the brown or Cape hare (*Lepus capensis*) which has a wide distribution in the Old World, including Sudan. Whyte's or Crawshay's hare (*L. whytei*) has a comparable size, but occurs only in the southernmost part of Sudan. Until now hare has been recorded mainly in later prehistoric faunas from the Central Sudanese Nile region. Cape hares are typical inhabitants of open terrain, but otherwise ecologically very tolerant animals as indicated by their wide distribution. Whyte's hare is restricted to the subsaharan savannas and less adapted to dry conditions.

Striped ground squirrel (*Euxerus erythropus*) (Pl. 1. 8)

Remains of a large sciurid collected in KS include a fragmentary mandible and some postcranial remains. Four measurements follow (Tab. 4).

The measurements suggest a sciurid about 1.5 times larger in linear dimensions than the common European squirrel (*Sciurus vulgaris*). The only large squirrel occurring in the Sudan appears to be the striped, western or Geoffroy's ground squirrel (*Euxerus erythropus*). Larger squirrel remains attributable to this species are known from several prehistoric sites in the Central Sudanese Nile region. It is a burrowing rodent typical for the Sudano-sahelian belt, occurring also in open biotopes within the northern rainforest belt. The bite of this animal would provoke septicemia and its meat would be of mediocre quality (Malbrant 1952). Therefore it may be an intrusive faunal element without direct relation to human occupation.

**Tab. 4.** Striped ground squirell (*Euxerus erythropus*). Measurements

| Bone specimen | Measurement |
|---|---|
| Mandible, L.M1-M3 | 13.0 |
| femur, TR.D. prox. | *11.8 |
| TR.D. prox | 9.8 |
| tibia, TR.D. dist. | 6.9 |

Tatera gerbil (*Tatera robusta*?)

A small rodent is represented in both KS and KN by four mandibles and two upper jaws. Each jaw contains three radiculate molars with a simple occlusal pattern comparable to that of comparative material from Congo (*T. valida*) and in Rosevear (1969: 18, fig. 3). Three measurements follow (Tab. 5)

**Tab. 5.** Tatera gerbil (*Tatera robusta*?). Measurements

| Bone specimen | Measurement | |
|---|---|---|
| upper jaw, L. M1-M3 | 6.2 | |
| lower jaw, L. M1-M3 | ±6 | 6.1 |

Two tatera gerbils occur in the Sudan : *Tatera robusta* which has a wide distribution in the country and T. valida, restricted to the southern part (Meester & Setzer 1971-78 Part 6.4: 3). The two species cannot be separated easily, but in *T. valida* the molars would be more lightly built than in *T. robusta*. On the basis of the relative width of the teeth, which appears decidedly less than in the Congolese tatera gerbil (60% instead of 80% of the tooth row length); we are inclined to include our material in *T. robusta*. The absolute size of the tooth rows does not help much, because in this respect our specimens are situated at the upper size limit of *T. robusta* if we rely on the data in Setzer (1956; upper molar rows *T. robusta* : 5.5-6.0 mm; idem *T. valida* : 5.9-6.7 mm). Tatera gerbils are known from a few prehistoric faunas in the Central Sudanese Nile region. No doubt these finds represent intrusive animals, but whether they are penecontemporaneous or later intrusives is not always immediately clear. The Kadero material consists most likely of late intrusives, because of the excellent preservation and the absence of a calcareous coating on it. Today tatera gerbils are found in most of the non-forested regions of Africa and of parts of Asia. Their habitats may differ somewhat, but generally they prefer sandy soils and relatively open, well-drained areas to dig their complex burrows.

Multimammate rat (*Mastomys* sp.) ?

A mandible fragment with the first and second molar from KN compares well with its homologs from Eheima, identified as multimammate rat or *Mastomys* with a question mark (Gautier & Van Neer 1997). *Mastomys natalensis* has been tentatively recorded from Early Khartoum. Several multimammate rat species have been described; they are found in savannahs and wood lands but also in fields and houses in subsaharan Africa. Apparently they ranged further north in prehistoric times.

Lesser jerboa (*Jaculus jaculus*)

A jerboa is represented by several upper and lower jaws and postcranial bones. These elements were compared with material of the greater jerboa (*Jaculus orientalis*) obtained in Algeria. Their linear dimensions are approximately 30% smaller than those of the comparative material. The finds shows little damage; the colour of the bones is pale yellow and most of them are not coated by calcareous matter. This indicates that most, if not all, of the jerboa remains are late intrusives. A rodent captured alive on the site during the 1973 excavation campaign (Fig. 1) has all the characteristics of the lesser jerboa as visible on the photograph in Osborn & Helmy (1980:341, fig. 105). The creature confirms that the site is nowadays visited by jerboas.

Unidentified small rodents

KS yielded a small sample of postcranial material of small rodents, which could not be identified as adequate comparative material was not available. It probably includes postcranial remains of the small intrusive rodents already described and perhaps of other species.

North African porcupine (*Hystrix cristata*) (Pl. 1. 6)

This larger very typical rodent is represented by a mandible fragment with a molar, two molar fragments and a fragmentary incisor in KS; KN yielded another molar. On the basis of size, palaeosynecological and biogeographical considerations this material can be attributed to the North African porcupine or *Hystrix cristata*. The African brush-tailed porcupine (*Atherurus africanus*) is smaller and confined to the rainforests and gallery forests of West and Central Africa. The Cape porcupine (*Hystrix africaeaustralis*) has the same size as the North African porcupine, but is essentially restricted to subequatorial Africa. North African porcupine is a typical, but not very frequent element of prehistoric faunas in the Central Sudanese Nile region and a very tolerant species mainly found in various open biotopes, but also entering the rainforest.

**Fig. 1.** Lesser jerboa (*Jaculus jaculus*) at Kadero (photograph L. Krzyżaniak, 1973).

Jackal, probably golden jackal (*Canis aureus*) (Pl. 1. 7 and 10)

Canids are represented in KS by two mandible fragments and various postcranial remains. Some measurements follow; (a) means alveolar (Tab. 6).

**Tab. 6.** Jackal, probably golden jackal (*Canis aureus*). Measurements

| Bone specimen | Measurement | |
|---|---|---|
| Premaxilla, prosthion-posterior alveolar rim C | 19.2 | |
| mandible, L. P1-P3(a) | *±24.0 | |
| L P2-P3 (a) | ±19.0 | *16.5 |
| L. P2-P4 (a) | - | 25.5 |
| H. between P2 and P3 | 13.0 | ±12.5 |
| idem P4/M1 | - | ±13.5 |
| scapula, AP.D .neck | ±20.0 | |
| pelvis, D. acetabulum | 14.8 | 15.0 |
| femur, TR.D. dist. | 25.0 | ±26 |
| Ph. 1, L. | *19.2 | |
| TR.D. prox | 8.2 | |

Most of the measurements point to canids with linear dimensions 1.1 to 1.3 times larger than those of European red foxes (*Vulpes vulpes*). They can therefore represent jackals. Two jackal species are still found in the Sudan: the golden jackal (*Canis aureus*), widely distributed in North Africa, part of the Sudano-sahelian zone and East Africa and the striped jackal (*Canis adustus*), a typical inhabitant of the Sudano-sahelian belt and much of subsaharan Africa. *Canis aureus* still roams everywhere in the Sudan, while the striped jackal is restricted to the southern part of the country. Both species have a comparable size and prefer open terrain with some cover. They are quite versatile carnivores, of which the golden jackal appears the less demanding from the environmental view point.

On biogeographical grounds the Kadero material might be attributed to the golden jackal, but it is not excluded that some of the remains represent dogs, especially since the jaw fragments exhibit some deviating characteristics. The larger jaw (Pl. 1. 7) for example has a clear diastema (±3 mm) between P2 and P3, resulting in a exceptional alveolar length of P2-P3. Comparable diastemas occur more often in domestic dog than in wild canids. In our case, however, its extension may have been increased by a slight periodontal infection. The second jaw fragment (Pl. 1. 10) appears to be smaller and more slender; moreover it lacks the alveole for P1. Unfortunately, the specimen is not well preserved and has suffered from too vigorous cleaning with dilute acid. As it stands, it can be matched with jaws of large red fox (*Vulpes vulpes*). This fox penetrates into Sudan towards Khartoum. Taken into account that red foxes are no doubt rare in Sudan and that the specimen has suffered vigorous cleaning, we put the second jaw on record as derived from a slender female jackal with a dental anomaly perhaps acquired during life. The dogs identified in Shaheinab (Peters 1986) and in Kadada (Gautier 1986) appear to be somewhat larger than the remains described here. A dog in a postmeroitic grave at Berber near Meroe measures 48 cm at the shoulders (Gautier 1992). Canids identified tentatively as golden jackal or recorded in open nomenclature are found in most prehistoric faunas of the Central Sudanese Nile region.

Honey badger (*Mellivora capensis*) (Pl. 1. 15)

This medium sized carnivore is represented in KS by two fragmentary canines, a mandible fragment and eight postcranial bones. As one easily distinguish the skeleton of the honey badger or ratel from that of other medium sized carnivores, the identification of this mustelid poses no problems. Some measurements follow (Tab. 7).

Until now honey badger remains have been found only in a few prehistoric faunas from the Central Sudanese Nile region. The species is widely distributed in subsaharan Africa and very tolerant; it has been recorded in the rainforest as well as in the desert.

**Tab. 7.** Honey badger (*Mellivora capensis*). Measurements

| Bone specimen | Measurement |
|---|---|
| Axis, TR.D.prox. | 25.0 |
| humerus, TR.D.dist. | ±32.5 |
| radius, L. | * 97.2 |
| TR.D. prox | ±15 |
| TR.D. dist. | 19.5 |
| tibia, TR.D. dist. | 20.9 |

Medium sized viverrid, Egyptian mongoose (*Herpestes ichneumon*) or water mongoose (*Atilax paludinosus*) (Pl. 1. 11)

A medium sized viverrid is represented in KS by a fragmentary jaw with dental formula 3.1.3.2. The alveolar length of the P2-M2 row is about 32 mm. On the basis of the size and the absence of P1, the mandible can be attributed to the water mongoose or *Atilax paludinosus*. However, the P1 may be lacking in the Egyptian mongoose also (Ewer 1956). This mongoose is generally comparable in size with the water mongoose, but in many cases it can be distinguished from it by its relatively smaller lower M2 (Rosevear 1974; Ewer ibid.). In the poorly preserved Kadero jaw the M2 alveole appears to be quite small as in *Herpestes ichneumon*, but a definite identification is impossible. Medium sized viverrids attributable to the Egyptian mongoose or the water mongoose are common but not frequent elements of prehistoric faunas in the Central Sudanese Nile region. The Egyptian mongoose is widely distributed along the Nile Valley and in subsaharan Africa in various biotopes, preferably in the vicinity of water. The water mongoose has a subsaharan distribution and would still occur north of Khartoum; it lives in marshes and riverine biotopes.

Small carnivores

Not identified small carnivores are represented by two jaw fragments in KS. One of these seems to be derived from a slender jawed animal and can be matched with the mandible of small common genet (*Genetta genetta*) in the comparative collections. The other is somewhat larger and would rather pertain to a small herpestine form with more robust jaws such as *Herpestes sanguineus* or lesser mongoose, or as *Mungos mungo* or banded mongoose. A definite attribution of the material is impossible. A distal tibia from KN represents another and larger viverrid. Small carnivores attributable to the lesser mongoose, banded mongoose and common genet have been recorded in the known prehistoric faunas from the Central Sudanese Nilotic region. Most of these forms occur still today in the Sudan and are generally fairly tolerant as to their ecological requirements. They prey on various smaller animals and need but restricted vegetation cover.

Wild cat (*Felis silvestris*) (Pl. 1. 9)

A small felid is represented in KS by a mandible, two mandible fragments and 14 postcranial fragments, among which four lumbar vertebrae apparently represent the backbone of one animal. A proximal radius and a sacrum from KN complete the sample. Some measurements follow (Tab. 8).

**Tab. 8.** Wild cat (*Felis silvestris*). Measurements

| Bone specimen | Measurement |
|---|---|
| Lower jaw, L. P3-M1 | 21.5 |
| humerus, TR.D. dist. | ±17.0 |
| radius, TR.D. prox. | 7.4 |
| cubitus, A-P.D. at the processus anconaeus | 12.0 |
| pelvis, L. acetabulum | ±12.5 |
| astragalus, H. | 16.9 |

The measurements indicate that we are dealing with a cat 1.1 to 1.25 larger in linear dimensions than average sized European domestic cats. Therefore the remains can be ascribed to the wild cat Felis silvestris, a very common smaller felid occurring everywhere in Africa, except in the Sahara and heavy rainforest. Biogeographical and palaeosynecological considerations exclude the sand cat (*Felis margarita*) as a possible identification; this cat is an inhabitant of the Western Sahara and the Arabian Peninsula. In Sobociński (1977) some of the remains described here are attributed to domestic cat. Our own osteometric data and the general context make the presence of domestic cat at Kadero very unlikely.

Medium sized felid, probably caracal (*Felis caracal*) (Pl. 1. 13)

A medium sized felid is represented in KS by a mandible fragment, a fragmentary axis and eight postcranial bones. Several vertebrae apparently all derived from one animal and collected in KN also represent a larger felid. Three measurements follow (Tab. 9).

**Tab. 9.** Medium sized felid, probably caracal (*Felis caracal*). Measurements

| Bone specimen | Measurement |
|---|---|
| Mandible, H. condyle-angular process | ±18 |
| humerus, TR.D.dist. | 28.5 |
| tibia, TR.D.prox.: | 31.1 |

The remains are derived from felids between 1.6 and 1.8 times larger than the European domestic felids adduced for size comparison. They may represent caracal (*Felis caracal*) or serval (*F. serval*). The serval is a high legged, slender inhabitant of savannahs with high grass and trees but can also be found in gallery forests. The caracal is somewhat smaller and less slender; it occurs generally in more open biotopes. It lives still in northern Sudan, while its high legged cousin is restricted to the south. On the basis of size and the palaeosynecological context, we are inclined to attribute the Kadero material to caracal. Medium sized felids are a common element of the carnivore faunas in the Central Sudanese prehistoric Nile region. In most cases they have been tentatively attributed to caracal. Some of the material described here was attributed to cheetah (*Acinonyx jubatus*) by Sobociński (1977). This attribution is based on a comparison of the measurements of the humerus with its homolog of cheetah as figured in Gromova (1950:Pl. 60, Fig. 1a and b). The cheetah humerus however appears to be somewhat different in form. Its *foramen supracondylare* is suboval, while in the caracal, also figured by Gromova (ibid. figs. 3a and b) this foramen appears to form a slit, also seen in the distal humerus from Kadero (Pl. 1. 13). Therefore we do not retain the identification proposed by Sobociński, although no ecological or biogeographical reasons exclude the cheetah as a possible member of the prehistoric fauna in Central Sudan. The species was formerly distributed from the Mediterranean to the Cape, mainly in dry savannas.

Aardvark (*Orycteropus afer*) (Pl. 1. 14)

A somewhat fragmentary phalanx, measuring about 35 mm, represents this peculiar mammal in KS. The morphology of the bone is so typical that no identification error is possible. Aardvark is not a common element of prehistoric archaeofaunas from the Central Sudanese Nile region. Until now it has been recorded only in Zakiab and in Saggai. The Saggai find was discovered among a small lot of bones erroneously assigned to fish, after the Saggai fauna was published. Today aardvark occurs in southern Sudan. It appears to be a very tolerant species ranging over most of subsaharan Africa, wherever its major food, termites, is available and burrows can be made.

Elephant (*Loxodonta africana*)

The only trace of elephant in KS is a tiny fragment of a tooth lamella. In KN the excavators collected a poorly preserved cuboid measuring some 95 mm across. In several graves the animal is represented by ivory cut into armlets (Fig. 2). Elephant is a regular though never frequent member of prehistoric archaeofaunas in the Central Sudanese Nile region. It is still present in southern Sudan and its general distribution includes most of subsaharan Africa, from dense rainforest to discontinuous dry savannah.

Warthog (*Phacochoerus aethiopicus*) (Pl. 1. 12)

This common African suid is represented by some jugal teeth fragments, two humerus fragments and a poorly preserved second phalanx. Warthog is a typical though not frequent faunal element in the prehistoric sites along the Nile in Central Sudan. Today it is restricted to southern Sudan. Its general distribution includes the Sudano-sahelian belt and much of Africa below this belt. It would prefer open savannah.

Hippopotamus (*Hippopotamus amphibius*) (Pl. 2. 16)

KS produced a tusk fragment, a skull fragment and some terminal leg fragments. Two tusk fragments and some other terminal leg fragments from KN complete the collection. Two measurements follow (Tab. 10).


**Fig. 2.** Armlets cut from the ivory of elephant tusks from burial 78; the lower specimen is falling apart
(photograph archives Archaeological Museum Poznan)

The second phalanx is badly worn and Sobociński (1977) mistook it for that of a wild ass, *Equus africanus*. Equids are virtually absent in the known prehistoric archaeofaunas from the Sudanese Nile; hippopotamus on the contrary is regularly found. Today hippopotamus occurs only in the southern Sudan. Formerly it was widely distributed in Africa, but man has reduced its range drastically. Its typical habitat is riverine, preferentially along flat banks with grassland and restricted swamp vegetation.

**Tab. 10.** Hippopotamus (*Hippopotamus amphibius*). Measurements

| Bone specimen | Measurement |
|---|---|
| Ph. 1, L. | *±71.0 |
| TR.D.prox | ±42.5 |
| TR.D.dist. | ±32.0 |
| Ph. 2, L. | *±37.0 |
| TR.D.prox | ±32.0 |
| TR.D.dist. | ± 31.0 |

Giraffe (*Giraffa camelopardalis*) (Pl. 2. 17)

Sobociński (1977) identified two second phalanges and a poorly preserved astragalus from KS as African buffalo (*Syncerus caffer*) on the basis of their size. On morphological as well as osteometric grounds these specimens have to be included in giraffe. Other finds from KS and KN are also derived from the feet. Some measurements follow (Tab. 11).

**Tab. 11.** Giraffe (*Giraffa camelopardalis*). Measurements

| Bone specimen | Measurement | | |
|---|---|---|---|
| astragalus, H. | *81.0 | | |
| TR.D.dist | ±62.0 | | |
| mp, TR.D.dist. | 85.0 | | |
| Ph. 1, L. | *60.0 | *±69.0 | *70.0 |
| TR.D.prox. | 42.9 | 48.0 | 50.0 |
| TR.D.diaph. | 36.7 | 40.0 | 38.0 |
| TR.D.dist. | 39.0 | 43.0 | 42.0 |

Giraffe is a regular but not frequent member of the prehistoric sites from the Central Sudanese Nile. It is still found in southern Sudan and was formerly widely distributed over the Sudano-sahelian belt and many parts of subequatorial Africa. The various types of savannah with tree cover and gallery forests, especially those with acacias are its preferred biotopes.

Medium sized antelope, mainly red-fronted gazelle (*Gazella rufifrons*) (Pl. 2. 18)

A medium sized antelope is represented in KS by three rather poorly preserved upper molars, a distal half of a radius and a fragmentary distal half of a tibia. A distal cannon bone fragment and a slender first phalanx complete the sample. A few measurements follow (Tab. 12).

**Tab. 12.** Medium sized antelope, mainly red-fronted gazelle (*Gazella rufifrons*). Measurements

| Bone specimen | Measurement | |
|---|---|---|
| upper M1 or M2, L | 11.2 | 12.0 |
| radius, TR.D.dist. | 27 | |
| mp, TR.D.dist. | ±20 | |
| Ph.1, L. | 41.9 | |

The teeth have the simple occlusal pattern of gazelle. The cannon bone and the phalanx exhibit clearly the slender habitus of gazelle and compare with their homologs in *G. rufrifrons*. The radius may derive from another medium sized bovid such as reedbuck (*Redunca redunca*). Therefore most, if not all of the material, represents *G. rufifrons*. In the paper dealing with the Saggai fauna (Gautier 1983), remains of this gazelle were erroneously attributed to bushbuck (*Tragelaphus scriptus*). The red-fronted gazelle is a regular but not frequent member of the known prehistoric faunas from the Central Sudanese Nile. It is a typical species of the Sudano-sahelian belt adapted to dry savannas. Today it does no longer occur north of Khartoum. Reedbuck is also not encountered frequently in the known prehistoric faunas. It prefers more humid environments than gazelle and is now restricted to the south of Sudan.

Large antelopes, mainly tiang (*Damaliscus lunatus*) or hartebeest (*Alcelaphus buselaphus*) and greater kudu (*Tragelaphus strepsiceros*) (Pl. 2. 19, 20 and 21)

Large antelopes are represented by some dental remains and various, mostly poorly defined postcranial remains including a fragmentary scapula, a distal tibia, a distal cannon bone and various phalanges. A lower molar fragment is definitely derived from a tragelaphine; it exhibits the simple angular outline of the occlusal periphery, the much reduced, simple central islands and is fairly brachyodont. A second smaller fragment is less convincing. Both were found among the molar fragments identified by Sobociński as derived from domestic cattle; this fact illustrates the difficulties of separating fragmentary jugal bovid teeth. The best preserved specimen compares with molars of recent sitatunga (*Tragelaphus spekii*; shoulder height : 75-125 cm) but is about 1.2 to 1.3 times larger in linear dimensions. On the basis of this size difference and palaeosynecological considerations the specimen can be ascribed to the greater kudu or *T. strepsiceros* (shoulder height 120-150 cm). The collection contains also a third lower molar (L.: 26.5) of a smaller alcelaphine, definitely attributable to tiang, *Damaliscus lunatus*, but its provenance is not clear.

Measurements on some of the better preserved post-cranial specimens follow. Letters a, a? and k indicate definite or tentative attributions to either an alcelaphine or greater kudu as explained below; s means subadult (Tab. 13).

**Tab. 13.** Large antelopes, mainly tiang (*Damaliscus lunatus*) or hartebeest (*Alcelaphus buselaphus*) and greater kudu (*Tragelaphus strepsiceros*). Measurements

| Bone specimen | Measurement | | | | |
|---|---|---|---|---|---|
| Scapula, TR.D. glenoid cavity | ±34 | | | | |
| tibia, TR.D.dist. | 43.2a? | | | | |
| astragalus, H. | 58k? | 64.0 | | | |
| naviculocuboid, TR.D | 45.5 | | | | |
| mt, TR.D.dist.<br>A-P.D.dist. | *39.1k<br>29.2 | | | | |
| Ph.1, L.TR.D.prox.<br>TR.D.dist. | *19.9a?<br>±19 | | | | |
| Ph. 2, L.<br>TR.D.prox.<br>A-P.D.prox.<br>TR.D.dist. | 32.6a?s<br>13<br>±22<br>11.6 | *37.0a?<br>17.4<br>21.2<br>15.0 | *37.2a?<br>18.0<br>-<br>14.2 | *38.9a?<br>17.4<br>-<br>15.6 | *38.9<br>19.6<br>24.0<br>16.4 |
| Ph.3, L. sole<br>TR.D.articular surface<br>A-P.D.idem | *45.5k<br>13.2<br>24.5 | *51.1k<br>13.5<br>25.0 | *51.2a<br>16.1<br>20.0 | | |

The measurements indicate animals in the size range of alcelaphines such as tiang (100-130 cm), hartebeest (*Alcelaphus buselaphus*, 120-145cm) and probably greater kudu. Several of the measured specimens agree morphologically with their homologs in alcelaphines. However, the distal metatarsus (Pl. 2. 21) appears to be very compressed, while the third phalanges fall into two distinct categories (Pl. 2. 19 and 20); a relatively broad alcelaphine type and a much more compressed type, which furthermore does not carry a processus dorsalis and compares with third phalanges of the small tragelaphine *Tragelaphus scriptus* and of the bongo, *T. euryceros* (Van Neer 1989:Pl. 66). This second type is represented by three specimens two of which were measured; the alcelaphine type by one specimen only. The second phalanges would all be of the alcelaphine type, for none exhibits the broad *torus palmaris* which appears typical for the tragelaphines. Therefore the postcranial material confirms the presence of alcelaphine antelopes and greater kudu in our sample, but their specific ratio cannot be established. The material is moreover too restricted to suggest whether both tiang and hartebeest are present. Both alcelaphines as well as greater kudu appear to be regularly present in small numbers in prehistoric sites along the Central Nile. Roan antelope, *Hippotragus equinus* has also been recorded and the large astragalus measured falls in the size range of this species.

All the antelopes mentioned are still found in southern Sudan. Tiang is a typical species of the Sudano-sahelian belt and East Africa preferring the lush environment of alluvial and swampy plains. Hartebeest has a comparable distribution but would be less particular about its grazing grounds. The greater kudu is found from Chad to Ethiopia and in most open country in subsaharan Africa. It would generally prefer dry savannah and woodland; in the lowland it seems to prefer the acacia belts along the rivers. Roan antelope prefers thinly treed grasslands with few other competing herbivores.

Medium sized antelope, probably kob (*Kobus kob*) (Pl. 2. 22)

Another medium sized antelope, somewhat larger than the one identified mainly as red-fronted gazelle is represented by a lower premolar (P2) and a few poorly preserved postcranial remains in both KS and KN. One dP4 compares well with available deciduous molars of kob. Two measurements follow (Tab. 14)

**Tab. 14.** Medium sized antelope, probably kob (*Kobus kob*). Measurements

| Bone specimen | Measurement |
|---|---|
| Astragalus, H. | ±46.5 |
| Ph.1, TR.D.prox. | 15.9 |

In size the measured specimens agree with kob (*Kobus kob*) of which an extensive series of specimens from Saggai is available. This species is also known from most other prehistoric sites along the Nile in the Central Sudan. Kob is still found in great numbers in the southern Sudan. It is a typical species of the Sudano-sahelian belt and East Africa, preferring grassland with some cover not far away from water.

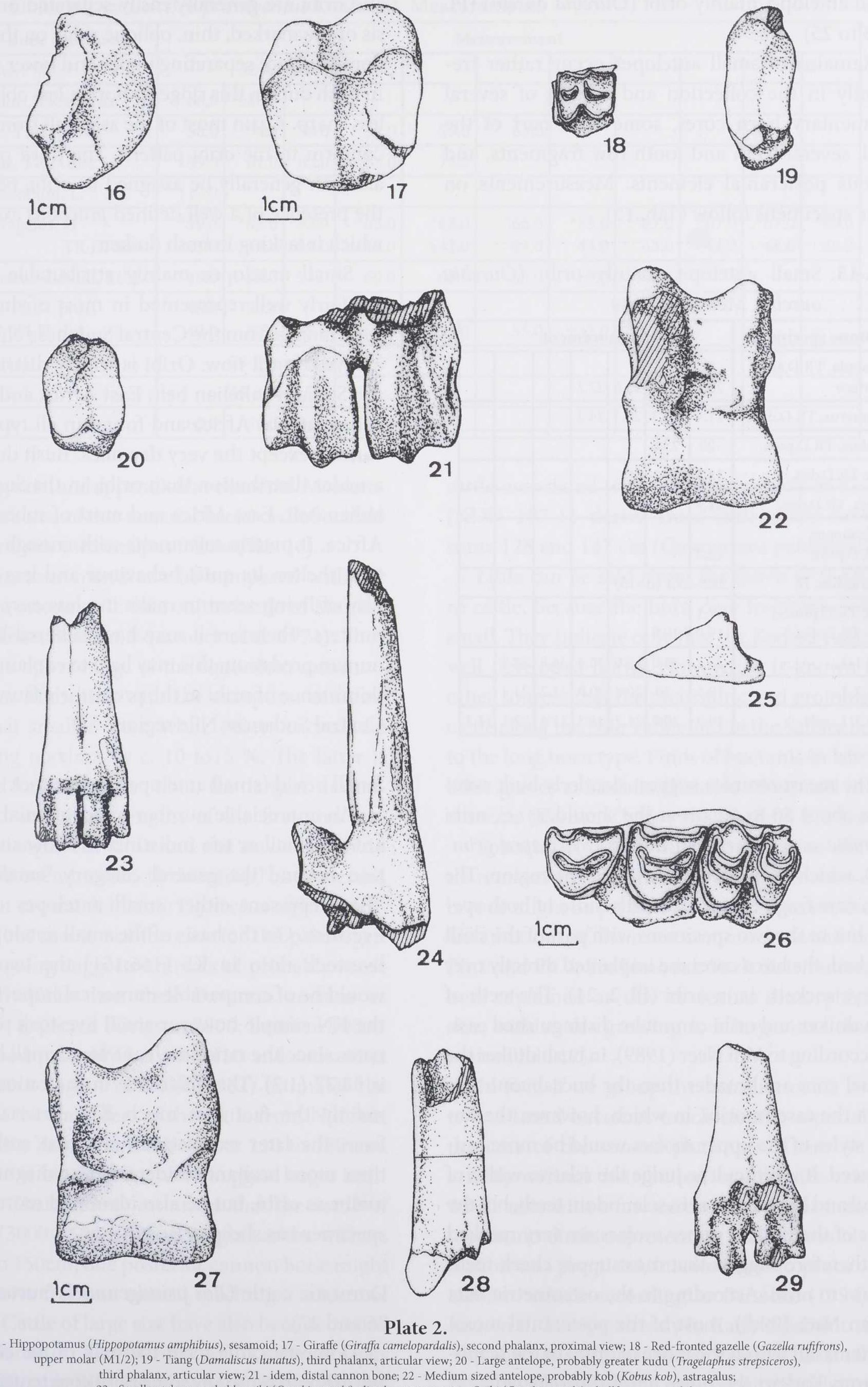


**Plate 2.**

16 - Hippopotamus (*Hippopotamus amphibius*), sesamoid; 17 - Giraffe (*Giraffa camelopardalis*), second phalanx, proximal view; 18 - Red-fronted gazelle (*Gazella rufifrons*), upper molar (M1/2); 19 - Tiang (*Damaliscus lunatus*), third phalanx, articular view; 20 - Large antelope, probably greater kudu (*Tragelaphus strepsiceros*), third phalanx, articular view; 21 - idem, distal cannon bone; 22 - Medium sized antelope, probably kob (*Kobus kob*), astragalus; 23 - Small antelope, probably oribi (*Ourebia ourebi*), distal metatarsus; 24 - Oribi (*Ourebia ourebi*), skullfragment with horncore; 25 - idem, third phalanx; 26 - Domestic cattle (*Bos primigenius f. taurus*), maxilla with P2-M1; 27 - idem, astragalus; 28 - Domestic goat (*Capra aegagrus f. hiccus*), horncore fragment; 29 - idem, distal metatarsus.

Small antelope, mainly oribi (*Ourebia ourebi*) (Pl. 2. 23 to 25)

Remains of small antelopes occur rather frequently in the collection and consist of several fragmentary horn cores, some with part of the skull, several teeth and tooth row fragments, and various postcranial elements. Measurements on some specimens follow (Tab. 15).

**Tab. 15.** Small antelope, mainly oribi (*Ourebia ourebi*). Measurements

| **Bone specimen** | **Measurement** | | | | | | |
|---|---|---|---|---|---|---|---|
| Scapula, TR.D.art. surface | 23.3 | ±24 | 25.5 | 27.2 | | | |
| humerus, TR.D.dist. | 21.4 | 22.3 | 22.3 | 24.2 | | | |
| radius, TR.D.prox. | 20. | 23.6 | | | | | |
| mc TR.D.dist. | 18.5 | | | | | | |
| tibia, TR.D.dist. | 21.9 | | | | | | |
| calcaneum, TR.D.prox. | 12.2 | | | | | | |
| astragalus, H. | 22.9-29.1 (n=15) | | | | | | |
| mt, TR.D.prox.<br>TR.D.dist. | 17.1<br>19.0 | 19.9 | | | | | |
| Ph.1, L. | 33.2 | 34.0 | 35.0 | 36.4 | 36.8 | 38.3 | |
| Ph.2, L. | 19.6 | 20. | 20.6 | 20.9 | 21.2 | 21.4 | |
| Ph.3, L. sole | 19.9 | 20.0 | 21.2 | 21.3 | 21.6 | 22.1 | 24.3 |

The measurements suggest slenderly built antelopes about 50 to 60 cm at the shoulder; i.e., oribi (*Ourebia ourebi*) or bush duiker (*Sylvicapra grimmia*), which both have occurred in the region. The horn core fragments match with those of both species, but in the two specimens with part of the skull attached, the horn cores are implanted directly over the eye sockets, as in oribi (Pl. 2. 24). The teeth of bush duiker and oribi cannot be distinguished easily. According to Van Neer (1989), in bush duiker the lingual coni are broader than the buccal coni; this is not the case in oribi, in which, however, the lingual styles of the upper molars would be more pronounced. It is difficult to judge the relative width of buccal and lingual cones in selenodont teeth, but the styles of the Kadero upper molars are very marked and therefore suggest that most upper cheek teeth pertain to oribi. According to the osteometric data of Van Neer (ibid.), most of the postcranial measurements fall within the range of oribi. In the scapulae from Kadero the *tuberculum superglenoidale* is well separated as in oribi. Astragali of bushduiker and oribi are generally easily separated on the basis of the marked, thin, oblique ridge on the medial dorsal surface separating upper and lower trochlea. In bush duiker, this ridge is shorter, less oblique and less sharp. Again most of the astragali from Kadero conform to the oribi pattern. The third phalanges also can generally be assigned to oribi, because of the presence of a well defined *processus extensorius* which is lacking in bush duiker.

Small antelopes mainly attributable to oribi are fairly well represented in most of the prehistoric faunas from the Central Sudanese Nile region analysed until now. Oribi is widely distributed in the Sudano-sahelian belt, East Africa and parts of subequatorial Africa and found in all types of savannah except the very dry ones. Bush duiker has a wider distribution than oribi, in the Sudano-sahelian belt, East Africa and most of subequatorial Africa. It prefers savannahs with enough cover to take shelter. Its quiet behaviour and less exposed way of living seem to make it a less easy prey for hunters. Therefore it may have suffered less from human predation; this may help to explain the predominance of oribi in the prehistoric faunas of the Central Sudanese Nile region.

Small bovid (small antelopes or livestock)

An appreciable number of postcranial remains are too small or too indistinct to allow an attribution beyond the general category "small bovid". They represent either small antelopes or small livestock. On the basis of the small antelope/small livestock ratio in KS (166:151) the two groups would be of comparable numerical importance; in the KN sample however small livestock predominates since the ratio small antelope/small livestock is 38:77 (1:2). The difference in the ratios reflects mainly the fact that much KN material comes from the later excavations; the first author was then more hesitant to identify less diagnostic remains as oribi, but he also identified more readily specimens as sheep or goat.

Domestic cattle (*Bos primigenius* f. taurus) (Pl. 2. 26 and 27).

Domestic cattle form the bulk of the collection and are represented by some horn core remains, various skull fragments, and many postcranial remains,

**Tab. 16.** Domestic cattle (*Bos primigenius* f. taurus). Measurements

| Bone specimen | Measurement | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lower M3, L. | 32-40 (n=5) | | | | | | | | | | |
| radius, TR.D.prox. | 66.0 | ±86.0 | | | | | | | | | |
| mc, TR.D.prox. | 50.0 | 54.0 | 56.0 | 57.0 | 59.0 | 63.0 | | | | | |
| tibia, TR.D.dist. | 59.0 | 61.0 | 62.0 | 65.0 | 72.0 | | | | | | |
| calcaneum, L. | 117.0 | | | | | | | | | | |
| astragalus, H<br>TR.D. dist | *59.0<br>41.0 | *62.0<br>39.0 | *63.0<br>39.0 | *63.0<br>40.0 | *63.0<br>±42.0 | *65.0<br>43.0 | *65.0<br>43.0 | *67.0<br>43.0 | *67.0<br>44.0 | *67.0<br>48.0 | *69.0<br>45.0 |
| naviculocuboid, TR.D. | 48.0 | 53.0 | 54.0 | 60.0 | 63.0 | 63.0 | 69.0 | | | | |
| mt, TR.D. prox.<br>TR.D. dist. | 43.0<br>49.0 | 50.0<br>50.0 | <br>53.0 | <br>54.0 | <br>55.0 | <br>55.0 | <br>±57.0 | <br>±58.0 | | | |
| Ph.1, L. | 56-69 (n=31) | | | | | | | | | | |
| Ph.2, L. | 36-49 (n=56) | | | | | | | | | | |
| Ph.3, L. | 60.0 | 63.0 | 64.0 | 67.5.0 | | | | | | | |

including axial and appendicular elements. Measurements on some of this material based on Sobociński (1977) and our own analysis follow (Tab. 16).

The measurements can be compared with the extensive osteometric data on the cattle of Manching (La Tène, Bavaria; Boessneck et al. 1971). They fall in the upper range of the equivalent measurements for Manching with the exception of a few somewhat smaller ones, while others exceed the Manching maxima by c. 10 to15 %. The latter is the case for the largest tibia, the largest naviculocuboid and many lengths of the first and second phalanges.The tibia and the naviculocuboid may have been incorrectly identified as cattle and represent savannah buffalo (*Syncerus caffer brachycerus*), but that is not the case for the phalanges. The foregoing suggests animals of probably more slender habitus than their Bavarian cousins as was to be expected (Grigson 2000; Laudien 2000). They stood probably between 110 and 145 cm at the withers. Tigani El Mahi (1982) estimates the height at the shoulders of the cattle from Nofalab, Shaheinab, Zakiab and Direiwa at 110 to 130 cm, but some of his measurements suggest larger individuals. Chaix (1994) estimates that the cattle of Kerma (3000-1500 BP) had heights at the withers of 130 to 150cm; one posterior cannon bone might even derive from an animal reaching a stature of 154cm. Cattle of large size have also been recorded from Meroe (c. 380 BC-400 AD; Carter & Foley 1980: 307, table BII) and from Soba (6th to 9th century AD; Chaix 1998). Leg elements from several cattle associated with a Meroitic tomb at Kadada (KDD 107-1) derive from individuals between some 128 and 147 cm (Gautier not published).

Little can be said about the horns of the Kadero cattle, because the horn core fragments are too small. They indicate only that the Kadero cattle had well developed horns. However, it is known from other sources that the prehistoric and protohistoric cattle along the Nile Valley and in the Sahara belong to the long horn type. Finds of bucrania in late neolithic graves at Kadada (Reinold 1982) and in later contexts (Kerma; Chaix 1994) confirm this fact.

Sobociński (1977) suggested that as the cattle remains fall into two size categories, two cattle breeds might be present at Kadero. Indeed, the size distributions of the most commonly found bones, Ph.1 and Ph.2, are bimodal. Such distributions are best explained as due to sexual dimorphism in size, with males growing to a larger size than females (Tab. 17).

In fact, if we group the measurements two by two, a trend becomes much clearer, especially in the case of the second phalanges. There we find a fairly normal distribution around size category 40-41 mm with a few exceptional larger measurements, no doubt representing males. Possibly castration was practised, but we have no proof of the custom, which according to Benecke (1994) was known in Europe already in Early Neolithic times. The Nuer of southern Sudan castrate most of their bulls to avoid fighting and other disturbances in their herds (Evans-Pritchard 1974).

**Tab. 17.** Domestic cattle (*Bos primigenius* f. taurus). Measurements

| Bone specimen | Measurement | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ph.1, L. | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 |
| Number | 1 | - | 2 | - | 4 | 4 | 2 | - | 2 | 1 | 2 | 2 | 3 | 1 |
| Ph.2, L | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 |
| Number | 1 | 5 | 5 | 3 | 11 | 10 | 3 | 7 | - | - | 1 | 2 | 2 | 1 |

One first phalanx of a small individual (L.: 56) in KN shows pathological modifications. Bone excrescences occur on the lateral margin of the proximal articular end and the articular surface is grooved. The animal apparently suffered from osteoarthritis of the metacarpus/first phalanx joint. Osteoarthritis of the feet is common in cattle (Baker & Brothwell 1980:117).

Cattle are now known from all the neolithic sites in the Central Sudanese Nile region including Shaheinab where it was originally confused with small buffalo of the forest type (Bate 1953; Tigani El Mahi 1982; 1988; Peters 1986). As already indicated above, there is a chance that some ill defined remains of savannah buffalo are mixed in the collection of the postcranial bones attributed to cattle. Buffalo figures among the Mid-Holocene fauna of the Central Sudan. However, none of the well preserved remains from Kadero which we studied in detail, has the typical traits of buffalo as illustrated by Peters (1988). Therefore and as game forms only a small part of the fauna, the number of erroneous attributions is probably restricted and will not affect seriously our calculations.

Sheep and goat (*Ovis ammon* f. aries/*Capra aegagrus* f. hircus) (Pl. 2. 28 and 29)

Remains of small livestock occur fairly frequently in both middens and include all parts of the skeleton. Sobociński (1977:Table 2) made preliminary identifications of the material of the southern midden, but some of the specimens ascribed by him to small livestock should be included in the small antelope group; they are characterized by a more slender habitus, small size, generally more clear cut and somewhat different morphological features. A separation of sheep and goat on the basis of the criteria established by Boessneck and collaborators (1964) was attempted; for KS, the result is 21:6 (3.5:1), for KN 7:2 (3.5:1). Apparently, sheep were at least three times as frequent as goats.

Some measurements follow; sheep are indicated with an s, goats with a g. (Tab. 18).

We can again compare the measurements with the extensive osteometric data on the sheep and goats from Manching (Boessneck et al. 1971). Generally our measurements fall within the lower range of the sheep and goats from that site. This does not necessarily imply that both sheep and goat were relatively small, for our measurements are mainly transverse diameters. Moreover the present day sheep of the region north of Khartoum

**Tab. 18.** Sheep and goat (*Ovis ammon* f. aries/*Capra aegagrus* f. hircus). Measurements

| Bone specimen | Measurement | | | |
|---|---|---|---|---|
| Mandible, L. P2-M3 | 63 | | | |
| scapula, A-P.D.articular end<br>A-P.D.neck | *25.5s<br>16.5 | -<br>\Vs | *31s<br>19.5 | |
| humerus, TR.D.dist. | ±32s | | | |
| radius, TR.D.prox.<br>TR.D. dist. | 26.0s<br>28.0s | <br>26.8g | <br>27.8g | <br>27.9g |
| mc, TR.D.prox. | 19.9s | 20.2s | | |
| tibia, TR.D.dist. | 21.9 | 22.8 | 25.0 | 27.0 |
| astragalus, H. | 29.5s | 30.4s | | |
| mt, TR.D.dist. | 20.5g | 26.5s | | |

belong to the savannah type of the thin tailed hair sheep, which would be characterized by exceptionally long legs (Ryder 1983), suggesting a slender habitus of this breed with respect to others such as the one found in Manching. As to the present day goats found in the Kadero area they pertain essentially to the Sudanese Nubian goat, again a fairly large, long legged animal (Epstein 1971:299). Be it as it may, our osteometric data certainly do not point to dwarfed animals.

The collection contains no diagnostic skull fragments with the exception of a fragmentary goat horn core. It is relatively small and has an irregular almond cross section because it is slightly twisted and is not distinguishable from recent horn cores of the Sudanese Nubian goat the first author collected somewhat north of the site. No doubt it derives from a female with poorly developed horns. The fact that our fairly extensive sample in which sheep predominate does not contain any ovine horn cores, suggests that female sheep were hornless. In the thin tailed hair sheep found today north of Khartoum, horns are generally restricted to the rams (Ryder 1983).The ewes of Kerma, no doubt belonging to the same breed, may also have been hornless (Chaix & Grant 1987). Small livestock is known from the neolithic sites in the Central Sudanese Nilotic region. As already pointed out elsewhere, Shaheinab does not contain a dwarf goat (Peters 1986).

*Trace fossils*

A few elongate tubular concretions with beige or greyish beige colour seem to represent carnivore coprolites. Closer inspection reveals the presence of desiccation cracks and degassing holes. Moreover the substance making up the concretions reveals in places a fluidal structure. In one example two upper molar teeth of a lesser jerboa were found. The combined evidence confirms that the objects described are indeed coprolites and not some strangely formed kunkar concretions. Comparable remains found in Saggai were also identified as coprolites on the basis of morphology, colour and the presence of teeth of a tatera gerbil.

At Saggai it was assumed that the coprolites were produced by jackals, as dogs seem to be lacking in this pre-neolithic site and jackals are known to include gerbils in their diet. The situation appears somewhat different in Kadero, where dogs may have been present as some traces discussed in the next paragraph suggest. Many lesser jerboa remains appear to be fairly recent and one may ask whether the coprolite containing teeth of this animal is also not a late intrusive. As the coprolite does not differ from the other ones collected, it provides circumstantial evidence that lesser jerboa is present at the site not only as a late intrusive but also as a penecontemporaneous one.

The fragmentary nature of the finds and the calcareous matrix adhering to them preclude a detailed study of traces on the bones. A few bones have been gnawed by rodents, but the traces have been somewhat obliterated and therefore suggest probably gnawing by penecontemporaneous intrusive rodents. A few small bones (astragali, distal epiphyses of small livestock) show the typical features of bones that passed through the digestive system of a carnivore. Comparable bones occur at Kadada, where dogs are known, but not at Saggai. Therefore we think these etched bones represent circumstantial evidence for the presence of dogs feeding on offal on the site. Dogs may have arrived in the Central Sudan together with livestock (see 5. The adoption of pastoralism).

## 3. Taphonomic groups

As in most sites the fauna has a mixed origin and three major taphonomic groups, i.e., groups of animals with comparable death-to-discovery history occur (Gautier 1987). We will discuss these groups only briefly, as they have been dealt with more thoroughly in other publications.

Many animals were used by the site occupants for various purposes. This is qualitatively and quantitatively the largest group comprising fish, reptiles, birds, most game animals and domestic stock. Carnivore coprolites and bones etched during a stay in the digestive tract of a carnivore provide indirect evidence for dogs as another segment of this group. A clear division between the animals used as food and for other purposes is not always feasible because of our lack of knowledge concerning food preferences of prehistoric people, their taboos, the use of all kinds of perishable animal materials etc. Fish was no doubt primarily a food group. Birds appear also to have been on the menu but their feathers may have been used for adornment. Nile monitor and python were maybe killed for their skins only, because articulated strings of their vertebrae occur in several Central Sudanese sites, as if skinned carcasses were discarded as such. However, the meat of both reptiles is of excellent quality and tight articulations and tendons keep their vertebrae together even after removal of the flesh. In the case of the carnivores, it is easier to accept that they were killed mainly for their skins and some other body parts such as claws. Among the freshwater shells, *Pila wernei* was no doubt collected for food. A related species was, at least until recently, harvested during certain seasons by tribesmen of the north-eastern former Belgian Congo (Pilsbry & Bequaert 1927). The use of *Pila* as bait for fishing is questionable, because *Pila occurs* as frequently in sites with few fish remains as in sites with ample evidence of fishing. *Lanistes carinatus*, another swamp loving shell, was no doubt collected together with *Pila*. *Chambardia* shells could also be collected in comparable environments or as transported dead shells along the river channel(s), mainly for tool making. Some valves of *Etheria elliptica* may also have been picked up along the river; the use of this shell as raw material is known from other sites.

The animal remains deposited intentionally in the graves either modified or not can be grouped as a special taphonomic category in the group of the animals used. Most of these have already been discussed in the descriptions of the animals encountered. The category includes the marine gastropods brought in from the east coast that were modified into beads. A small fragment of a marine bivalve (grave 5) suggests that occasionally marine bivalves may also have been adapted for personal adornment. Large freshwater bivalves in the graves are represented by Chambardia, not modified and modified into pottery tools. Ostrich is represented by egg shell beads, but bone beads seem to be rare. Bangles were made of ivory of elephant (Fig. 2) and the canines and incisors of hippopotamus. Various other artefacts such as harpoons and large "points" were made of bone of medium sized to large mammals. The most striking find is a rib, most likely of hippopotamus, with transverse grooves; it may have been used as a musical instrument (grave 264). This find allowed the identification of a small, grooved fragment found during the analysis of the older collection (grave 68) as what is left of a comparable artefact.

Penecontemporaneous intrusive are animals that lived on or in the site at the time or approximately at the time of its occupation. The group includes *Limicolaria caillaudi*, probably at least part of *Zootecus insularis*, some of the small rodents which left gnawing marks on the bones later obliterated by weathering processes. The remains of small snakes may fit in the same category. The inclusion of *Limicolaria caillaudi* in the group is based on the fact that the taphocoenosis contains juveniles and individuals with an epiphragm. Moreover the extraction of the animal from its elongate shell is rather difficult. *Limicolaria* may however have been an emergency food as the former use of *L. caillaudi* during famine periods in Faradji (Democratic Republic of Congo) suggests (Crowley & Pain 1970). The single find of a hedgehog might be another intrusive or a small addition to the menu: Blench (2000) records the capture of the white-bellied hedgehog (*Atelerix albiventris*) and its fattening in Nigeria.

The smaller freshwater gastropods and bivalves form another group of intrusives, which were no doubt brought to the site by the river and probably reworked in the archaeological deposits. Some of these shells may, of course, also have been transported to the site by people for unknown reasons. Generally speaking, the group is of little importance.

Animals that died on or in the site at an appreciable time after its occupation are late intrusives. Some *Zootecus insularis* and the fresh looking remains of small rodents, mainly lesser jerboa, belong here. The cowry *Cypraea turdus*? may also be a late addition related to a use of the site in later times.

## 4. Palaeoecology and palaeoeconomy

### *General composition of the fauna*

As already said, Table 1 summarizes the qualitative and quantitative composition of the fauna separately for both KS and KN; a third column gives the composition for KS and KN combined. It should be clear that there exist no fundamental differences between the assemblages KS and KN. Most differences are no doubt due to the fact that the KN sample is much smaller (c. 23% of KS) and poorly represented game animals may be absent in it by chance. The quantitative differences between the major faunal components (game versus livestock; large versus small livestock) are evaluated below and appear also to be of no importance.

It is difficult to gauge the frequency of shells in Kadero, since most shells were discarded in the field. However, the excavators submitted some samples taken in 1976 to Dr. D. Adamson who provided a small report with descriptions of the contents in a letter to Dr. L. Krzyżaniak. According to this report, it would seem that the samples are dominated by *Limicolaria*, but *Pila* is quite common. Detailed information on shell quantities at Kadero and other sites is lacking. People at Kadero were apparently collecting *Pila* in appreciable quantities, but how much with respect to sites such as Shaheinab etc. remains an open question. As to the fish, the reptiles and the birds, they form but a very small part of the assemblage of the animals used.

### *Livestock versus game*

A parameter of major interest is the percentage of livestock in comparison with the total assemblage of used mammals. Separate results are given for the two parts of the site and for the combined assemblages. The second computations are based on the assumption that the "small bovid (antelope or small livestock)" are all small livestock remains. The "exact" percentages of livestock would hence lie somewhere between the two results, but these differ less than 1% (Tab. 19).

**Tab. 19.** Kadero. Livestock versus game

| Specimen | Percentages | | | |
|---|---|---|---|---|
| KS domestic animals | 1179 | 78.9% | 1212 | 79.9% |
| game | 315 | 21.1% | 315 | 20.1% |
| totals | 1494 | | 1567 | |
| KN domestic animals | 575 | 85.3% | 614 | 86.1% |
| game | 99 | 14.7% | 99 | 13.9% |
| totals | 674 | | 713 | |
| Total domestic animals | 1754 | 80.9% | 1866 | 81.8% |
| Game | 414 | 19.1% | 414 | 18.2% |
| Totals | 2168 | | 2280 | |

According to the radiocarbon dates available to us, the southern part of the site may be somewhat older than the northern part and the calculated percentages might indicate that in the course of a few centuries pastoralist activities declined. As already pointed out many KN samples come from later excavations and the first author may in later analyses have attributed more readily small bovid bones to livestock. He may also have been more willing to add poorly preserved material to the domestic cattle pile.

### *Large versus small livestock*

Again separate results for each assemblage and for the combined assemblages are given. The second computations takes into account the unidentified small bovid remains assuming that they represent mainly small livestock. The differences between the results for the two parts of the site are negligible. The "real" percentage of cattle would lie somewhere between the two results obtained, i.e., between 82 and 87% for the total site (Tab. 20).

**Tab. 20.** Kadero. Large versus small livestock

| Livestock | Percentage | | | |
|---|---|---|---|---|
| KS cattle | 1028 | 87.1% | 1028 | 82.1% |
| small livestock | 151 | 12.8% | 224 | 17.9% |
| totals | 1179 | | 1252 | |
| KN cattle | 498 | 86.6% | 498 | 81.1% |
| small livestock | 77 | 13.4% | 116 | 18.9% |
| totals | 575 | | 614 | |
| Total cattle | 1526 | 87.0% | 1526 | 81.8% |
| small livestock | 228 | 13.0% | 340 | 18.2% |
| totals | 1754 | | 1866 | |

### *The Neolithic environment*

Kadero lies within the same general region as Saggai and Geili, of which we already sketched elsewhere the climate, vegetation and wild fauna. The region is semi-arid with a hot summer, little rainfall and a dry relatively cool winter. The average annual precipitation, restricted to the period from April to October, with a peak in July and August, amounts to about 150 mm. It generally comes under the form of heavy rains with thunderstorms. The discharge of the Nile peaks between August and November. The vegetation consists of grasses, herbs, bushes, scrubs and often stunted trees, mainly acacia, forming a more or less continuous cover only after the wet season or in privileged localities. Wickens (1975; 1982) includes the region in his *Semi Desert scrub and grassland* (75-400 mm), which corresponds more or less to the *Acacia Desert Scrub* belt drawn by Andrews (1948:34, fig. 1). As to the restricted wild fauna, it would include dorcas gazelle (*Gazella dorcas*), oryx (*Oryx algazel*), addax (*Addax nasomaculatus*), Barbary sheep (*Ammotragus lervia*; jebels), jackals, some smaller carnivores, hare, various rodents, and hyrax (Delany & Happold 1979). During his various visits to the area, the only evidence of wildlife the first author saw, includes the tracks of jackal and various rodents as well as the latter animals themselves. No doubt, the present day flora and fauna have been seriously degraded, especially since the last two centuries, as a result of not controlled hunting, overgrazing, agriculture and expanding settlement. Domestic mammals include appreciable numbers of dromedaries, sheep, goats and zebu cattle; dogs and cats are also well represented. We find it difficult to imagine what kind of landscape, which game animals and how many of them we would find today in the area, if the human factor were drastically reduced.

In assessing the ecological parameters of the Early Neolithic of the Central Sudanese Nile, the difficulties are compounding by the arrival of livestock. Its disastrous effects on ecosystems in precarious equilibrium may have reinforced ecological changes due to climate and other factors in mid-Holocene times. Barakat (1995) analysed charcoal from Kadero and describes the landscape around the site as a thorn scrub savannah sensu Wickens (1882) already under strong human impact through controlled fires, felling and grazing. Restricted pollen spectra from the Early Khartoum sites Sheikh Mustafa and El Mahalab, and Early Neolithic Sheikh el Amin suggest an "open savannah grassland" with acacias already strongly affected by the named anthropic factors, but the samples contain later intrusives (Lopez Saez & Lopez Garcia 2003).

It is also not easy to gauge the mid-Holocene climate on the basis of prehistoric game faunas. As known, the major difficulty is our incomplete knowledge of the ecological tolerance of many wild animals. The buffering effect of the Nile and its floods is also difficult to evaluate. The first author nevertheless tried to produce quantitative data on the climate and environment of Saggai. He concluded that the site may have been situated in the drier low rainfall sensu Wickens (1972) belt, characterized by an annual rainfall of 500 mm or somewhat less, corresponding to a northward shift of climatic belts of some 400 km, but he added that these estimates were perhaps too high. Research on the prehistoric faunas from Shaqadud (Peters 1989, 1991) suggests that the 8th millennium B.P. was characterized by precipitation about 450-500 mm and a northward shift of climatic belts of 350-400 km. In the late 6th millennium a slight decrease would be manifest, while later (late 5th millennium) the precipitation would have approached 350 mm.

In the palaeoecological evaluation of the Kadada fauna (Gautier 1986) attention was drawn to some changes in the game fauna between Saggai and Kadada. The same changes characterize Kadero with respect to Saggai: virtual disappearance of kob, with as a result much increased importance of other antelopes; disappearance of marsh cane rat and appearance of hare. The other known assemblages from the Early Neolithic period do not contradict these observations but are not always well documented (see Table 4 and comments). The disappearance of kob may be due to the effect of the desiccation of the Nile Valley, to competition with livestock and to overexploitation of this species which appears to be fairly simple, as kob is a very territorial antelope not easily driven away by human activities (Gautier 1983). How these factors have reinforced or relayed each other remains open to question. The disappearance of the marsh cane rat can be linked to that of its preferred habitats, i.e., dense riverine vegetation or high grassland and dense undergrowth in wooded areas. As to the appearance of hare, a general decrease of wild game biomass could have led people to include this small creature regularly in their hunters' bag. The desiccation of the Nile Valley can be seen as the combined result of a decrease of the precipitation and a concomitant decrease of the annual floods. Many data obtained in the Sudan and adjacent countries indicate that the earlier Holocene is characterized by a humid climate and that in the later Holocene the climate changed towards the one prevailing today ( Wickens 1975; Haynes et al. 1971; Gasse et al. 1980; Belluomini et al. 1980; Neumann 1989 and others). Kadero and other Early Neolithic sites dated between approximately 6000 and 5000 B.P. would mark the end of the humid phase of the Upper Holocene.

***Subsistence spectrum, seasonality and husbandry***

From the assessment in section 3, it would appear that the Kadero people exploited a broad spectrum of animal resources, we should add to this spectrum various plants: sorghum, watermelon (*Citrullus* sp.), African hackberry (*Celtis* *integrifolia*), dom palm (*Hyphaena thebaica*) and others (Klichowska 1984; Stemmler 1990; see also elsewhere in this volume). As in the case of Saggai (Gautier 1983) and other Sudanese Nilotic sites, we can put Kadero, within the focal-diffuse adaptation model sensu Cleland (1976), on the side of the diffuse exploitation strategies; these normally call for a careful scheduling to maximize the yield of the various resources and are typical for diversified environments. In other words, the Kadero people probably performed certain subsistence activities during specific periods of the year in relation to the flood-and-rain season and the corresponding cycles of plants and animals.

The faunal remains provide some indications for seasonality. The first author has already assumed in previous papers that *Pila* collecting would be essentially a dry season activity. Pilsbry & Bequaert (1927:178) refer to observations by H. Lang according to which tribes in the former Belgian Congo collected *Pila* in great quantity for food purposes "at certain seasons", but the periods of intensive collecting are not specified. The same observer informed the authors that *Pila* occurs mainly in permanent swamp areas "largely overgrown with aquatic plants and connected with the larger streams. Most of the mollusks stay but a few inches and seldom more than a foot below water level, and are often imbedded in the softer surface mud". That *Pila* can be collected from the mud is confirmed by Arkell (1945), who describes jackals digging out *Pila* from dried out alluvium in Wadi Howar. No doubt, people could collect *Pila* most easily when the swamps were low or even drying out during the dry season. That *Pila* may be very abundant, is illustrated by comments from Owen (1966:46). This author found high concentrations of *P. ovata* in hippopotamus wallows in East Africa; the density of the species is apparently kept in check by the numerous open-billed storks (*Anastomus lamelligerus*) feeding on them. This stork is present at Kadero.

Fishing was also a seasonal activity, probably to a large extent comparable to the practices of the Nilotic tribes in the south who would mainly fish in the dry season. Evans-Pritchard (1974: 70) records that with the Nuer "fishing is consistently productive throughout the drought", with two peaks, one when the dry season has advanced thus far that pools and shallow water bodies in the flood plain can trap fish and one when, with the next flood, the first fish move into shallow waters in the flood plain. The Kadero ichthyofauna yields evidence for these two peaks in fish exploitation. Among the most common fish taxon - the clariid catfish - sexually mature animals occur that were caught during their spawning at the beginning of the floods, as well as juvenile specimens captured later on within the flood season when residual pools had formed. This seasonal exploitation of shallow water fish is well documented since the Late Palaeolithic in the (Egyptian) Nile Valley and continued into historic times (Van Neer 2004). Other typical flood plain dwellers at Kadero were the lungfish, the tilapia and cyprinids, albeit the latter two taxa are poorly represented. The lungfish may have been dug out from their burrows in the season when *Pila* shells were collected. Some fish taxa such as the *Polypterus*, *Gymnarchus* and *Heterotis* show that well vegetated swampy areas of the flood plain were also exploited, most likely during the reproduction season of the fish. The presence of Nile perch, bagrid catfish and Synodontis catfish indicates that fishing was also practised in the main channel, most probably when the water level of the Nile was its lowest, i.e., in the period before the arrival of the floods. This means that, if some kind of fish drying was practised, fish may have been a food resource almost throughout the year.

The avifauna of Kadero is very poor and most of the birds found are resident species, except for the green-winged teal if present. This is a passage migrant and winter visitor to be found in the Sudan from October to as late as May and indicates dry season occupation of the site. Some poorly ossified guinea fowl remains, on the other hand, could represent immature birds indicating summer occupation. Fowling would hence have been practised in a haphazard fashion all year round. The wild mammals do not yield evidence for seasonality, mainly because the numbers of antelopes such as kob which may concentrate near the river during the dry season is too low to permit any speculations.

As to the livestock, especially cattle, we can hypothesize transhumance movements between the alluvial plain and the hinterland. The flood and rain may cause grazing grounds to be no longer available or so wet that the animals can not stay on them for long periods without contracting diseases of the hooves. Moreover during the wet season, insects, including perhaps tabanid flies (Wickens 1982) may make life intolerable for both man and his flocks. At the end of the dry season, reasonably good grazing may have become restricted to privileged localities in the alluvial plain near the river and along wadis. Haaland (1981a; 1981b) and Tigani El Mahi (1981; 1982; 1988) already suggested seasonal movements of cattle and even divided sites as Kadero and comparable occurrences into permanent settlements and a seasonal camp on the basis of various criteria (see next section). Cattle were no doubt involved in some transhumance movements but what was their magnitude? First we have little or no idea about the size of the herds possessed by our neolithic pastoralists. Secondly, the transhumance patterns advocated by the authors cited may rely unconsciously too much on what we know about transhumance as traditionally practised by the Nilotic tribes of southern Sudan. These people however have to cope with very high precipitation (500 to 1000 mm) and marked floods; along the Central Sudanese Nile precipitation in Neolithic times may already have descended below 500-400 mm and floods may have been quite restricted. Moreover the typical lifestyle of pastoralists in southern Sudan with its focus on cattle, the so-called cattle complex, may have evolved after the introduction of zebu cattle, which are more resistant to physiological stress (Marshall 1989). Evidence for the appearance of humped cattle in the southern Sudan was found at Dhang Rial (9°N; 28°21'E), a mound near one of the western tributaries of the Bahr el Ghazal in Dinka territory. There figurines of humped cattle replace earlier taurine ones in the later Iron Age ($12^{th}$-$15^{th}$ century AD) (David et al. 1981). According to Grigson (1991), Sanga cattle would be the original autochthonous African cattle derived from the African aurochs, but they interbred with incoming zebus to various degrees. In an older zootechnical dictionary (Mason 1969: 80 & 45), Sanga cattle are defined as zebu × Hamitic longhorn, the latter being the autochthonous cattle of

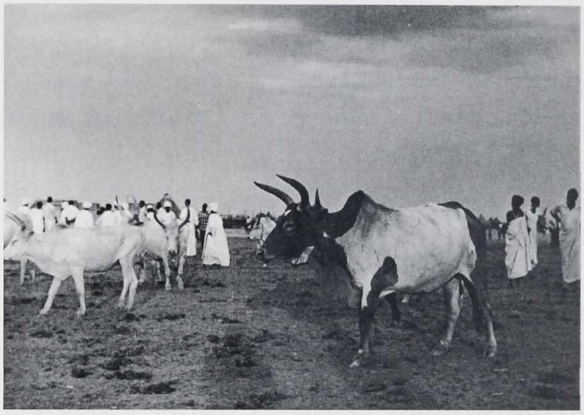

Fig. 3. Sanga cattle of the Nuer in Malakal
(photograph L. Krzyżaniak, 1976)

Africa as known from Ancient Egypt and probably derived from the African aurochs. Sanga cattle are the traditional, "Nilotic" cattle of the Nuer (Fig.3) and Dinka (Epstein 1971:342, Fig. 386), but Nuer said to Evans-Pritchard (1974:20) that Sanga cattle with a very large hump pointed to an origin with their south-eastern neighbours; the Beir or Murle, who raise zebus (Epstein ibid.), while very long horns were evidence of Dinka stock. Summing up, traditional Nilotic cattle would not have a pure autochthonous origin. Therefore they are not completely comparable with the cattle of Kadero and other "pre-zebu" sites, where we assume the original African cattle is present. A comparable reasoning was advanced for the sites of Debbat el Eheima (1600-1000 BC) and Debbat Bangdit (400-100 BC) along the White Nile north of Malakal in which cattle appear not to be very prominent: people had not yet adopted the traditional "Nilotic" lifestyle which may have developed after the introduction of zebu and its genes (Gautier & Van Neer 1997).

As to the way in which livestock was exploited as a provider of meat, the available material could not be analysed in detail. It would seem that, as in the case at Kadada (Gautier 1986), more young sheep or goat were killed than cattle. Based on eruption data, the Kadero people would have slaughtered twice as often younger sheep or goat as nearly adult or adult animals. For cattle the proportions would approach 2:3. If our rapid evaluation is correct, the observed tendency suggests that small livestock was more readily sacrificed than large livestock. The Nilotic tribes of southern Sudan show a comparable "bias", for and as already said, with them cattle have acquired a special status. Moreover, the slaughtering of small livestock makes more sense economically if only restricted quantities of meat are required.

***Comparison with other Early Neolithic sites of the Central Sudan***

Table 21 summarizes the faunal spectra established for the other Early Neolithic sites of which faunas have been studied, be it not always in the same way. The older Shaheinab collection, originally studied by Bate (1953) and re-analysed by Peters (1986), is a selective sample. The collections from the new excavations at Shaheinab, the excavations at Nofalab, Zakiab and Umm Direiwa (Tigani El Mahi 1982; 1988) yielded small samples, of which the analysis is incomplete since the author had no access to extensive comparative material. The assemblage collected at Geili is said to show marked taphonomic bias due to preferential preservation of larger game animals and preferential burial of

**Tab. 21.** Faunal assemblages from other Khartoum Neolithic sites (a)

| Animal group | SH1 | SH2 | NOF | ZAK | DIR | GEI | SEA(b) |
|---|---|---|---|---|---|---|---|
| *Engina mendicaria* | - | - | - | - | 1 | 1 | - |
| *Cypraea moneta* | - | - | - | - | - | 1 | - |
| *Bellamya unicolor* | FF | | | | | R | |
| *Cleopatra bulimoides* | FF | F | P | F | 1 | R | - |
| *Pila wernei* | FF | F | FF | FF | R | F | 87 |
| *Lanistes carinatus* | F | F | F | P | R | R | 2 |
| *Melanoides tuberculata* | R | - | - | - | - | - | - |
| *Corbicula consobrina* | RR | - | - | - | - | - | - |
| *Caelatura aegyptiaca/teretiuscula* | R/F | - | - | - | - | - | 12 |
| *Chambardia rubens/wahlbergi* | FF/F | R/? | R/? | ? | -/- | R/R | 15 |
| *Mutela dubia* | RR | RR | R | - | - | R | 4 |
| *Etheria elliptica* | FF | RR | RR | RR | R | R | 2 |
| *Limicolaria caillaudi* | FF | F | F | F | R | F | 8 |
| *Zootecus insularis* | FF | F | F | F | R | R | 1 |
| freshwater fish | FF | 710 | 224 | 1052 | 28 | 389 | 1 |
| crocodile (*Crocodylus niloticus*) | P | 1 | - | 5 | - | 7 | 16 |
| Nile monitor (*Varanus niloticus*) | P | 17 | 2 | 14 | 23 | 40 | 1 |
| *Engina mendicaria* | - | - | - | - | 1 | 1 | - |
| *Cypraea moneta* | - | - | - | - | - | 1 | - |
| python (*Python sebae*) | P | 9 | 4 | 60 | 29 | 8 | 1 |
| soft-shelled turtle (*Trionyx triunguis*) | P | - | - | - | - | 9 | - |
| other turtles | ? | - | - | - | - | 25 | - |
| small snakes | ? | 6 | 4 | - | - | - | - |
| unidentified reptiles | P | 78 | 53 | 143 | 47 | 4 | - |
| birds (c) | 118 | - | - | 2 | - | 1 | 1 |
| ostrich (*Struthio camelus*) (d) | ? | ? | ? | 7 | ? | F | ? |
| grivet monkey (*Cercopithecus aethiops*) | 5 | - | - | - | - | - | - |
| hare (*Lepus capensis*?) | 10 | - | - | - | - | - | - |
| ground squirrel (*Euxerus erythropus*) | 4 | - | - | - | - | - | - |
| porcupine (*Hystrix cristata*) | 20 | - | - | - | - | - | 3 |
| small rodents | 2 | - | - | - | 32 | - | 1 |
| jackal (*Canis aureus*?) | 4 | - | - | - | - | 2 | 6 |
| honey badger (*Mellivora capensis*) | 4 | 1 | - | - | - | 1 | - |
| otter (*Lutrinae indet.*) | 2 | - | - | - | - | - | - |

| Animal group | SH1 | SH2 | NOF | ZAK | DIR | GEI | SEA(b) |
|---|---|---|---|---|---|---|---|
| viverrids (e) | 5 | - | - | - | - | 1 | 1 |
| wild cat (*Felis silvestris libyca*) | 1 | - | - | - | - | - | - |
| caracal (*Felis caracal*) | - | - | - | - | 1 | - | 1 |
| leopard (*Panthera pardus*) | 2 | - | - | - | - | - | 7 |
| lion (*Panthera leo*) | 4 | - | - | - | - | - | - |
| striped hyena (*Hyaena hyaena*) | 1 | - | - | - | - | - | - |
| carnivores (f) | - | - | - | 14 | - | - | 2 |
| aardvark (*Orycteropus afer*) | - | - | - | 2 | - | 1 | - |
| elephant (*Loxodonta africana*) | 13 | - | - | - | - | 3 | - |
| Burchell's zebra/wild ass (g) | - | - | - | 2 | 1 | - | - |
| black/white rhinoceros (h) | 79 | 2 | - | - | - | - | - |
| hippopotamus (*H. amphibius*) | 20 | 11 | 2 | 2 | - | 14 | 2 |
| warthog (*Phacochoerus aethiopicus*) | 23 | 3 | - | 8 | 55 | - | 40 |
| giraffe (*Giraffa camelopardalis*) | 72 | 4 | - | - | - | 11 | 36 |
| buffalo (*Syncerus caffer*) | - | - | - | - | - | 7 | - |
| dorcas Gazelle (*Gazella dorcas*) | - | - | - | - | - | - | 38 |
| red-fronted gazelle (*G. rufifrons*) | 5 | - | - | - | - | 9 | 1 |
| dama gazelle (*G. dama*) | 4 | - | - | - | - | - | - |
| greater kudu (*Tragelaphus strepsiceros*) | 10 | - | - | - | - | 3 | - |
| hartebeest (*Alcelaphus buselaphus*) | - | - | - | - | - | - | 15 |
| tiang (*Damaliscus lunatus*) | - | - | - | 1 | - | 8 | - |
| roan antelope (*Hippotragus equinus*) | 2 | 2? | - | 1 | - | - | - |
| large antelopes (i) | 15 | 1 | - | 12 | 1 | 3 | - |
| kob (*Kobus kob*) | - | 2? | - | 3 | 1? | 10 | - |
| bohor reedbuck (*Redunca redunca*) | 2? | 3? | - | - | - | - | 2 |
| oribi/common duiker (j) | 11 | 3 | 11 | - | 11 | 13 | - |
| large bovids (k)) | - | - | - | - | - | 34 | 54 |
| small bovids (l) | - | - | 1 | - | 53 | 27 | 87 |
| jackal or dog | 12 | - | - | - | 10 | - | 2 |
| dog (*Canis lupus* f. familiaris) | 8 | - | - | - | - | - | - |
| cattle (*Bos primigenius* f. taurus) | 148 | 32 | 12 | 172 | 106 | 13 | 41 |
| sheep/goat (m) | 59 | 1 | 11 | 37 | 23 | 14 | 7 |
| total vertebrates | 671+ | 886 | 324 | 1528 | 421 | 622 | 369 |
| Unidentified | FF | 5664 | 3363 | 15123 | 9572 | ±2500 | 2467 |
| total vertebrates | FF | 6550 | 3687 | 16651 | 9993 | ±3100 | 2836 |

(a) Counts of fragments or specimens, see note Table 1; SH1: Shaheinab 1; SH2: Shaheinab 2, NOF: Nofalab, ZAK: Zakiab; DIR: Umm Direiwa; GEI: Geili; SEA: Sheikh el Amin; (F)F: (very) frequent; (R)R: (very) rare; P: present, but no counts available; ?: perhaps present; +: more remains present than counted; ±: estimate; (b) Some 67 small fragments of bivalves not included; probably mainly *Chambardia* or *Etheria elliptica*; (c) SH1: mainly guinea fowl (*Numida meleagris*); ZAK: African fish eagle (*Haliaeetus vocifer*); GEI: guinea fowl; (d) only egg shell fragments, probably present in all the sites; (e) Including genet (*Genetta* sp.) and African civet (*Civetta civetta*); (f) Size range of jackal to striped hyena; (g) *Equus burchellii/E. africanus*; in DIR perhaps intrusive domestic donkey (*E. africanus* f. asinus); (h) *Diceros bicornis/Ceratotherium simum*; (i) Size range of the listed large antelopes; (j) *Ourebia ourebi/Sylvicapra grimmia*; (k) Large antelope, buffalo or cattle; (l) Small antelopes (oribi/common duiker?) or sheep/goat; (m) *Ovis ammon* f. aries/ *Capra aegagrus* f. hircus.

**Tab. 22.** Some archaezoological and archaeological parameters of Early Neolithic sites along the Nile in Central Sudan (a)

| | SH(b) | NOF | ZAK | DIR | GEI | KAD | SEA |
|---|---|---|---|---|---|---|---|
| *Pila ovata* | F | F | F | R | F | F | F |
| % fish/total vertebrates | F | 69.1 | 68.9 | 6.7 | 62.5 | 0.04 | 0.3 |
| % lungfish/total fish | P | 0 | 66.3 | 53.6 | 0 | 10.8 | 0 |
| % livestock/total mammals | 39.7 | 62.2 | 82.3 | 64.5 | (23.9) | 81.7 | 23.8 |
| %cattle/total livestock | 75.0 | 52.1 | 82.3 | 82.2 | (51.9) | 82.3 | 85.4 |
| Distance from Nile (c) | 0.5 | 0.5 | 3 | 9 | 2.5 | 6.5 | 38 |
| Fishing gear | F | F | F | R | R | A | A |
| Grinding equipment | F | F | R | F | F | F | F |
| Size of the site | L | L | S | L | L | L | L |
| Burials | A | one | A | A | A | F | A |

(a) Based on previous tables and references in the text; (b) SH1 and SH2 combined; (c) in km and very approximate, as the locations on the available maps are not very precise; F/P/R/A: frequent/present/rare/absent; L/S: large/small. Note: at Kadero two harpoons were found in grave 66, but as far as we know, none occurs in the middens.

smaller remains such as those of fish (Gautier 1983; 1988). Sheikh el Amin is situated some 38 km from the Blue Nile ((Fernandez et al. 2003:204, fig; 2) and there also the analyst provided only a general identification of many finds (Chaix 2003).

As it stands, Table 22 clearly shows that all the sites reflect basically an adaptation to the various resources found at Kadero. On the basis of size, the presence of grinding and fishing equipment, and human burials Haaland (1981a; 1981b) and Tigani El Mahi (1981; 1982; 1988) identify Kadero and Umm Direiwa as permanent base camps, while Zakiab would be a dry season fishing and herding camp because of its small size, the absence of grinding equipment and the high frequency of lungfish. Table 22 brings together the mentioned parameters and some others for all the sites in an attempt to differentiate them. Following the mentioned authors most of the sites can probably be interpreted as permanent base camps. For reasons already given, Zakiab may indeed be a dry season fishing and herding camp, but we find it strange that the occupants of the site would have killed so many cattle: in the pastoral camps of the Late Neolithic near the Wadi el Kenger livestock is barely visible (Caneva & Gautier 1994). Maybe Zakiab was a base camp occupied for a short period only, with as a result limited size and few finds of grinding equipment. Differences in the catchment areas of the sites may explain changes in the importance of *Pila* and fish, particularly lungfish. People at Sheikh el Amin lived too far from the Nile and fish is virtually lacking in their diet, but they could gather *Pila*, from the lower wadi Soba. The same reasoning can be applied in the case of Kadero, situated some 6.5 km from the Nile. As to Umm Direiwa, here people had apparently no access within reasonable distance to *Pila* and fish except some lungfish, while at Zakiab they could easily fish and harvest lungfish.

Regarding the west or left bank sites, we have the impression that the inhabitants of Shaheinab and Nofalab hunted more than their relatives on the east or right bank and that they kept more small livestock. If we accept that the west bank sites are permanent sites, the presumed faunal differences would again reflect merely differences in site catchment. Indeed the Nile had probably already acquired more or less its present day configuration during the Neolithic period and the east bank sites are situated on a plain several kilometres wide composed of late Quaternary alluvia. The west bank sites on the contrary lie on a narrow strip of such deposits banked against sandstones and related deposits of the Nubia Formation forming the fairly steep slope of the Nile Valley to the land some thirty meters above the actual Nile stretching west (Arkell 1953; Tigan El Mahi 1982; Haaland 1981:4, Fig. 1; Marcolongo 1983:45, map between p. 40 and p. 41). Therefore, on the west bank, good grazing land on alluvial soils within the valley was restricted. The hilly slopes rising to the flat land above Shaheinab and Nofalab probably provided grazing of much poorer quality because of the topography and the fact that the Nubia Formation is highly permeable to rainfall (Marcolongo ibid.). The development of pastoralism may have been more restricted than on the east bank, with a greater emphasis on small livestock. As to the low frequency of livestock at Sheikh el Amin, it may not reflect differences in the catchment area of the site; according to Chaix (2003) the inhabitants of this site may not yet have adopted pastoralism to the degree found to the north, assuming that this lifestyle spread from that direction.

As to the putative wet season herding camps away from the Nile valley, no good evidence is available. At Shaqadud, about 40 km east of the Nile, sites are known covering the so-called Khartoum Mesolithic and Khartoum Neolithic periods (Marks et al. 1985; Marks & Mohammed-Ali 1991). It has been suggested that the Neolithic occupation at Shaqadud would represent a wet season camp used by pastoralists coming from the Nile Valley (see for example Haaland 1981a). The detailed faunal analysis by Peters (1991) does not permit to decide whether Shaqadud was used seasonally by Nilotic or Butana-based groups, but other archaeological finds indicate that we are dealing with an independent cultural phenomenon, be it that it has been affected markedly by contacts with cultural traditions of the Sahara and from along the Central Sudanese Nile (Caneva & Marks 1990).

We like to stress that the foregoing comparisons between the Early Neolithic sites in order to define their function, is an exercise based on data which do not have comparable significance. This is best illustrated by the data from Geili. It is very difficult, if not impossible, to correct for taphonomic bias in the much degraded faunal spectrum of that site. Also, the identification categories "small bovids" and "large bovids" pose problems not only for Geili but also for several other sites. More precise data are necessary to verify the hypotheses concerning the status and the catchment areas of the sites put forward.

### *The adoption of pastoralism*

The Holocene pre-pastoralists of the Central Sudan exploited the same wild animal resources as the Early Neolithic people; this is shown by the faunal analysis of Saggai and other sites (Gautier 1983; Caneva et al. 1993; Peters 1995). Caneva (2003) divides these pre-pastoralist sites into two distinct groups on the basis of their contents, function and distribution. The first and older group was left by autochthonous hunter-gatherers descending from yet unknown epipalaeolithic people and produced wavy line (WL) pottery: the so-called Khartoum Mesolithic or Early Khartoum culture from the period of c. 9500 to 6100 bp. Immigrants from the Sahara retaining some of their adaptations to desert conditions would have introduced dotted wavy line (DWL) pottery in Central Sudan around 6100 bp, but adopted the wild animal resources of the WL people, as evidenced by the fauna from Kabbashi A (Caneva et al. 1993). During the Early Neolithic period, roughly between 6000 and 5000 bp, pastoralism came to Central Sudan, that is, very soon after the DWL immigrants. The first author thought that these immigrants might have brought with them some and therefore easily overlooked livestock. He re-analysed the Kabbashi A fauna but found no trace of livestock. As to the Early Neolithic sites, these cannot be put in a precise chronological sequence and give the impression that pastoralism was important from the very beginning of the period. Thus, the available, admittedly limited evidence suggests that pastoralism came to Central Sudan with people who were already full pastoralists or that a quick shift to full pastoralism followed the introduction of livestock. Bringing cattle and small livestock to Central Sudan does not put a chronological problem. Early experiments in cultural control of captive wild cattle would have started during the Early Neolithic of the Western Desert, while sheep, goat and probably dog came to North Africa in the 7$^{th}$ millennium bp (Gautier 2001, 2002).

Adoption of full pastoralism, be it combined with the continuing exploitation of the available wild animal resources of the Central Nilotic Sudan, may in the view exposed in the previous paragraph not necessarily have occurred in response to the Mid-Holocene climatic deterioration of the region, but may have been the opportunistic response to the availability of better pastures than in the regions from where the livestock was brought to the Central Sudan. Whatever is the case, livestock no doubt had a deleterious effect on the landscape and wild life, re-enforcing the regional climatic deterioration. In the large Late Neolithic settlement of Kadada, livestock amounts to some 76% of the mammalian fauna and cattle reaches some 70% of the combined livestock. The increase to 30% of the small livestock has been ascribed to the ongoing deterioration of the climate, most likely in combination with the effects of overgrazing (Gautier 1986). In the Late Neolithic sites at Wadi el Kenger, livestock is barely visible, because these sites would be pastoral camps (Caneva & Gautier 1994).

Recently we completed the analysis of various sites in Ghana (Gautier & Van Neer 2005). Although people in Ghana possessed livestock since the Neolithic, they kept relying heavily on the various wild animal resources in their environment, even in historical times. No doubt, in quality and quantity the biomass of their woodland and forested environment outweighs markedly that of the much drier environment of Central Sudan. The foregoing contrast suggests that full pastoralism may have been a strategy very welcome to people in Central Sudan.

## 5. Summary and conclusions

Kadero yielded a diversified fauna consisting of molluscs, fish, reptiles, birds and mammals (Table 1). It can be divided in various taphonomic groups: (1) animals used by the site occupants (*Pila*, *Chambardia*, fish, reptiles, birds, game, cattle, sheep and goat); (2) exotic marine shells brought from the Red Sea or the Indian Ocean; (3) penecontemporaneous intrusives, including animals that lived on the site (*Limicolaria*, *Zootecus*, small rodents) and geological intrusives i.e. small fossil freshwater molluscs from the alluvial deposits on which the site formed; (4) late intrusives (*Zootecus*, some small rodents including lesser jerboa, *Jaculus jaculus*). The animals used by the site occupants indicate the exploitation of a broad spectrum of animal resources with apparently an emphasis on cattle pastoralism. Such a diffuse exploitation strategy *sensu* Cleland (1976) is normally characterized by careful scheduling to maximize the yield of the resources. *Pila* collecting and flood plain fishing were probably dry season activities pointing to occupation in the dry season. Fishing may have been practised in the early and late flood season on the alluvial plain and in the main channel mainly in the pre-flood season. The possible presence of a migratory bird, the green winged teal (*Anas crecca*) is also indicative of dry season occupation, but the guinea fowl (*Numida meleagris*) remains thought to be immature, point to summer occupation. Other archaeological parameters also indicate that the site was used all year round. This does not exclude transhumance of cattle away from the Nile in the wet season, but its extent is unknown. Some faunal changes with respect to Saggai, also seen elsewhere, suggest that the climate had become drier since the Early Khartoum period. This climatic deterioration may have played a role in the adoption of livestock; another scenario links these domesticates with the immigration of pastoralists from less favourable western regions as a results of the deterioration of the climate there and possibly a rapid opportunistic development of pastoralism in the Central Sudan. Anyhow, the adoption of full pastoralism no doubt re-enforced the ecological degradation through overgrazing and the competition of domestic and wild herbivores. A comparison with other Early Neolithic sites along the Nile suggests all these sites had probably comparable functions as permanent base camps and the differences in the composition of their faunas can be explained as differences in catchment areas. People on the left bank may have relied less on cattle, because good grazing land was mainly situated on the right bank with its much broader alluvial plain. As a general conclusion we would like to emphasize that archaeozoology is a comparative discipline. More precise data on archaeofaunas from the Central Sudanese Nile and elsewhere are needed to evaluate the significance of Kadero and related sites in the adoption process of cattle pastoralism by Central Sudanese prehistoric people. Close comparisons with the traditional cattle pastoralists of southern Sudan may be misleading.