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TAPHONOMIC ANALYSIS OF THE LATE EARLY PLEISTOCENE BONE REMAINS FROM BUIA (DANDIERO BASIN, DANAKIL DEPRESSION, ERITREA): EVIDENCE FOR LARGE MAMMAL AND REPTILE BUTCHERING

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Abstract. The Early Pleistocene sedimentary succession of the Dandiero (Buia) Basin (Danakil Depression, Eritrea) has preserved a rich paleontological, paleoanthropological, and archaeological record circa one million years old. Fieldwork undertaken between 1995 and 2003 led to the collection of fossil vertebrate remains now stored at the National Museum of Eritrea. Bones were recovered in different localities of the Dandiero Basin, where abundant archaeological and paleontological remains outcrop from the eroded sediments. The faunal collection of 436 animal bones from the Buia Basin, mostly derived from Uadi Aalad area, have undergone taphonomic analysis. Eventhough bone surfaces are poorly preserved due to abrasion, our work demonstrates carcass exploitation. Some specimens, mostly representing *Hippopotamus gorgops* and medium- to large-sized bovids, show traces of butchering left by stone tools. We also document, as far as we know for the first time, a single case of butchering involving a femur of a crocodile.

Riassunto. La successione sedimentaria del Pleistocene inferiore del bacino del Dandiero (Buia, Dancalia, Eritrea) ha conservato ricche testimonianze paleontologiche, paleoantropologiche e archeologiche datate ad un milione di anni. Indagini di terreno condotte tra il 1995 e il 2003 hanno permesso il recupero di una ampia collezione faunistica conservata presso il Museo Nazionale dell'Eritrea. I reperti sono stati raccolti in differenti località del bacino del Dandiero ove sono presenti concentrazioni di fossili e strumenti litici. L'analisi delle superfici dei resti ossei animali è stata condotta su 436 reperti provenienti in gran parte dai siti dell'area di Uadi Aalad. Lo studio, nonostante la conservazione non ottimale dei resti in quanto interessati da fenomeni di abrasione, ha permesso di documentare lo sfruttamento da parte dell'uomo delle carcasse degli animali. Su alcuni resti ossei, infatti, sono state rinvenute tracce di macellazione prodotte con strumenti litici. Queste tracce sono state rinvenute soprattutto su reperti di *Hippopotamus gorgops* e di bovidi di media e grossa taglia. Tracce di macellazione sono presenti anche su un femore di coccodrillo che, al meglio delle nostre conoscenze, rappresenta il primo caso riportato in letteratura di sfruttamento di questo animale.

Introduction

Geological and paleontological field research carried out since 1994 in the northern part of the Danakil (Afar) Depression of Eritrea resulted in the discovery of several Early Pleistocene vertebrate and archaeological sites within a thick fluvio-lacustrine composite succession outcropping near to the village of Buia, about 100 Km south of Massawa (Abbate et al. 1998). Current reconstructions point to an alternate sequence in the investigated area of fluvio-deltaic, swampy, and lacustrine paleo-environments (Abbate et al. 2004). The magnetostratigraphic record, biochronology, and fission-track dating indicate that the archeological localities

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are chronologically restricted around one million years (Abbate et al. 1998; Albianelli & Napoleone 2004; Bigazzi et al. 2004; Martínez-Navarro et al. 2004). Lithic tool assemblages (Olduwan and Acheulean modes) are also widespread through the sedimentary basin (Martini et al. 2004). Fieldwork undertaken between 1995 and 2003 led to the collection, mainly devoted to biochronological assessment, of a number of fossil vertebrate remains. Bones were recovered in different localities in the basin, where abundant archaeological and paleontological remains outcrop from the eroded sediments.

Prehistoric archaeological localities are defined by the combination of lithics and animal skeletal remains. These elements, however, are often not found in direct relation and their connection might only be the result of natural processes and of secondary deposition (Voorhies 1969; Behrensmeyer & Hill 1980; Behrensmeyer 1982, 1990; Frostick & Reid 1983; Isaac 1984; Badgley 1986; Potts 1986; Lyman 1994; Fiore & Tagliacozzo 2004). Carnivores can bring bones to human sites and humans can leave traces in the carnivore lairs (Brugal 1994). One way to evaluate the basin's taphonomic processes is to look carefully at outcrop microfeatures where fossil bone is found. This stategy promotes evaluation of the factors leading to bone accumulation. A variety of agents, including human and carnivore activity and geological processes, can leave traces on bone surfaces. Surface analysis coupled with the study of the spatial distribution of the specimens, the orientation of the bone remains, the frequency of the skeletal elements, and the degree of fragmentation help in the reconstruction of the processes of site formation (Bonnichsen 1989; Lyman 1994). This approach cannot be completely applied to the Buia bone assemblages since they result from a nonrandom collection of surface finds. Therefore, this study focuses on analyses that have provided clues regarding the modes of formation of the archaeological record, and the access to, and exploitation of, the animal carcasses by late Early Pleistocene *Homo*.

Materials

An analysis of bone surfaces and breakages was made on 436 mammal and reptile specimens stored at the National Museum of Eritrea, Asmara. This surface collection was performed during field campaigns in the period 1995-2003. Among this sample, 349 specimens (80%) are from the Uadi Aalad area, while 87 (20%) come from Uadi Dandiero area; 87% of the bones are taxonomically determined while the remaining 13% mostly consists of undetermined diaphyseal fragments of medium-large mammals. Hippopotamidae (*Hippopotamus gorgops* Dietrich, 1926 and less frequently *Hexaprotodon* sp.) and Bovidae (*Tragelaphus*, *Pelorovis*, *Hippotragus*, *Kobus*, *Gazella*) represent the majority of the sample. Rarer are Primates (*Theropithecus* cf. *oswaldi* (Andrews, 1916)), Equidae (*Equus* cf. *E. grevyi* Oustalet, 1882), Suidae (*Kolpochoerus olduvaiensis* (Leakey, 1942), *Kolpochoerus majus* (Hopwood, 1934), *Metridiochoerus* aff. *M. modestus* (Van Hoepen & Van Hoepen, 1932)), and Giraffidae (*Giraffa* cf. *G. jumae* Leakey, 1965). Carnivores were not found but their occurrence is documented by a bone showing traces of gnawing from a large carnivore, and by some coprolites, probably of *Crocuta* (Martínez-Navarro et al. 2004). Some reptiles were found as well, mostly crocodiles and a few chelonids (Delfino et al. 2004).

In this nonrandom sample, cranial elements predominate, along with numerous isolated teeth and maxillary and mandibular fragments. In the Dandiero area, cranial remains amount to 56.5% (31.8% are isolated teeth), while in Uadi Aalad to 32.1% (17.9% are isolated teeth). Limb remains are also present, ranging from 7 to 12%.

All fragments observed show abraded surfaces. Degrees of abrasion range from moderate to strong, the latter being most common. Very few specimens show only moderately abraded surfaces.

Methods

Striae were analyzed directly on bones at the Geo-Paleontological Laboratory set at the National Museum of Eritrea, Asmara, with an optical microscope 40x and by SEM microscopy in Rome with a Leo 420 scanning electron microscope. SEM analysis was performed on both negative surface replicas made by silicon elastomers (Provil Novo) and on positive, high resolution casts produced from the negative replicas using epoxy resin (Araldite LY-554 and hardener Hy 956) (Giacobini 1995; Anconetani et al. 1996; Cilli et al. 2000).

Results

Five of the remains from Uadi Aalad and two from Dandiero show cut marks; three from hippos, two from bovids, one from a medium-large sized mammal, and one from a crocodile (Tab. 1).

All bones with cutmarks show surface erosion, which reduced the possibility of detailed quantification. In fact, the abrasion affects the walls and bottoms of the striae. Nevertheless, the macroscopic characteristics (functional localization, context, quantity, orientation, etc.) helped in corroborating the diagnosis of some of the marks (Binford 1981, Shipman & Rose 1983, 1984; Olsen & Shipman 1988; Lyman 1994; Fisher 1995).

	Taxonomic attribution	Anatomical region	Action
DAN-102	Bovidae indet. (large size)	Occipital	Dismembering
DAN-190	*Kobus* cf. *K. ellipsiprymnus*	Second phalanx	Skinning
UA-336	*Hippopotamus*	Proximal femur	Defleshing
UA-89	*Hippopotamus gorgops*	Distal tibia	Dismembering
UA-40	*Hippopotamus gorgops*	Calcaneus	Dismembering
UA-397	Medium sized mammal	Innominate	Defleshing
UAHS-931	*Crocodylus*	Distal femur	Defleshing

Tab. 1 - Summary of the bones with cut marks individuated within the studied sample.

DAN-102

The specimen is a fragment of bovid occipital condyle from Dandiero. It shows numerous scratch lines on the margin of the concavity between the condyle and the base of the jugular process. These are of different lengths, oriented mostly obliquely to the long axis of the bone, and sometimes intersected. The features are strongly marked, relatively deep, with well-defined entry points; their width is constant throughout their extension. Even though they show abrasion, because of their (micro)morphology as a whole, they must have been made by a lithic tool (Fig. 1) likely used to disarticulate the cranium from the vertebral column.

DAN-190

This is a second phalanx of a *Kobus* cf. *K. ellipsiprymnus* (Ogilby 1833). The specimen shows different groups of scratch lines, localized on its posterior aspect (Fig. 2). The marks are short, straight, slightly oblique in reference to the major axis of the bone, sub-parallel, and show sharp margins at the entrance points. They are interpreted as cutmarks produced by a lithic tool (Fig. 2B). Butchering related to skinning is the most likely functional interpretation for their morphology and anatomical location.

UA-336

On this small hippopotamus right femur different groups of scratch lines are localized on the posterior face at the level of the small trochanter and at the base of the greater trochanter (Fig. 3). The marks are numerous, long and deep, and follow a transverse and slightly oblique course. SEM analysis shows that in some cases their walls and bottoms are eroded, but many striae still retain the typical characteristics of cuts produced by a lithic tool, notably a V shaped section and the presence of secondary striae inside the main groove. These cut-

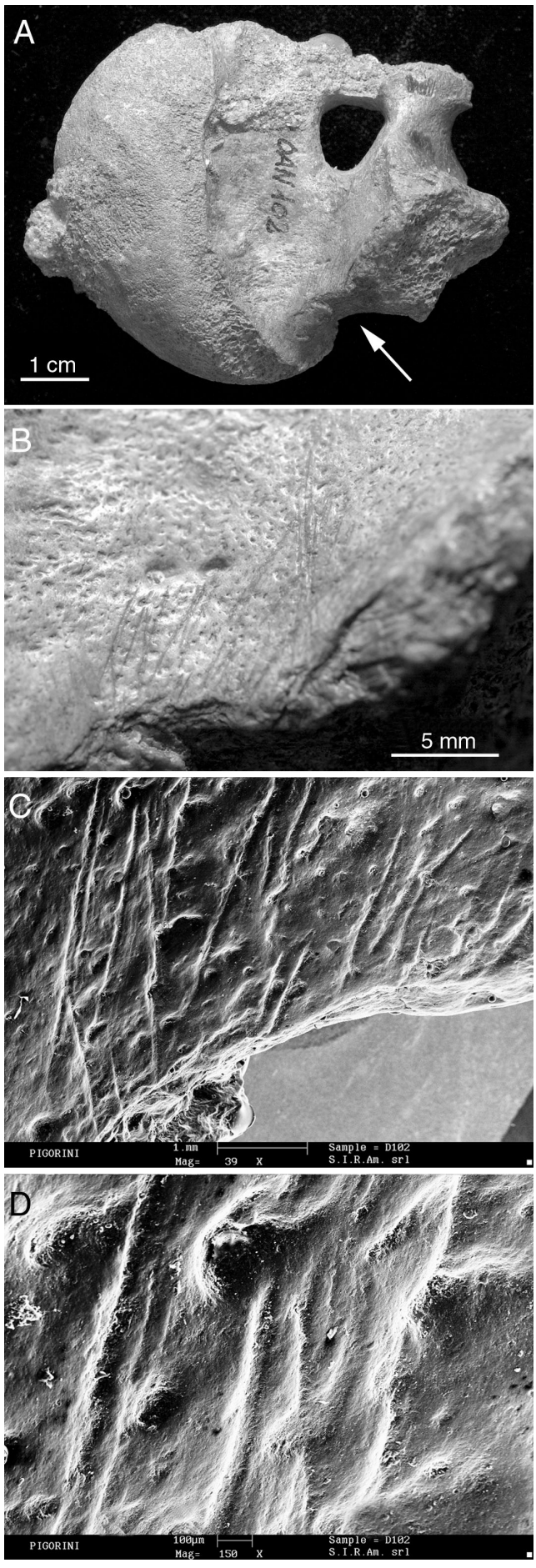

Fig. 1 - DAN-102. A) middle size Bovid occipital condyle; B) lithic-tool cutmarks; C-D) SEM details of rectilinear and curved repeated striae, probably related to the cranium detachment.

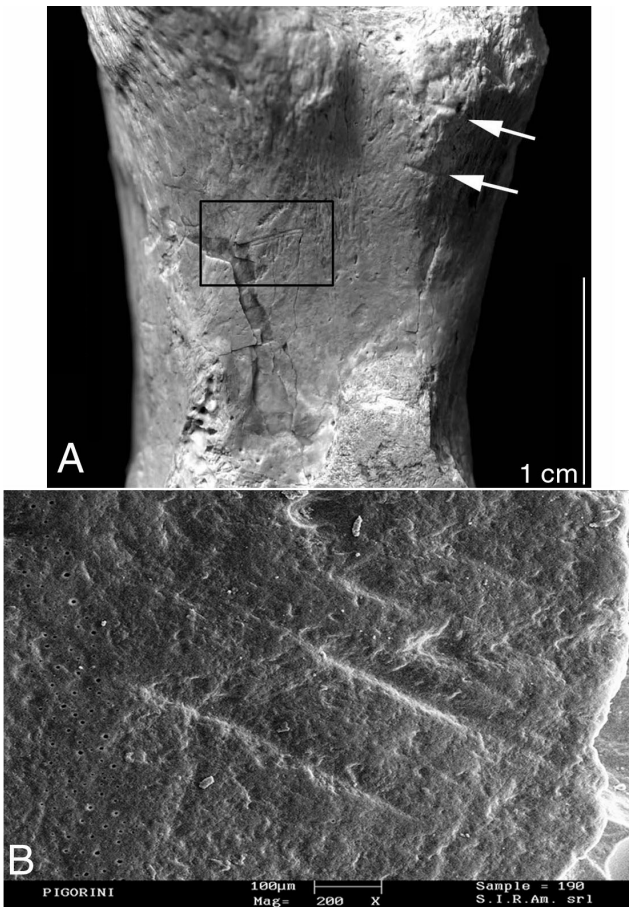

Fig. 2 - DAN-190. A) medium size bovid (*Kobus* cf. *K. ellipsiprymnus*) 2nd phalanx; B) SEM detail of two rectilinear worn striae.

marks, likely represent an attempt to detach the massive leg, are located in the region where ligaments held the femur in place.

UA-89

This specimen, carrying three scratch lines, is a hippo distal right tibia. Marks are localized on the anterior face and are short, packed, arched, and slightly oblique in reference to the major axis of the bone (Fig. 4). Complicating their interpretation are flakes of recent origin that interrupt the striae courses. The grooves have an ancient patina and are partially abraded, but the longer central stria (Fig. 4B and 4C) show a constant width and secondary striae are present in its terminal part. These characteristics suggest that surface modification by a stone tool, despite the difficulty in identifying the butchering action(s) which caused it. Nevertheless, disarticulation can be assumed as the main causal activity.

UA-40

Six notches are present on this hippo right calcaneum. Five are located on the dorsal-lateral face and

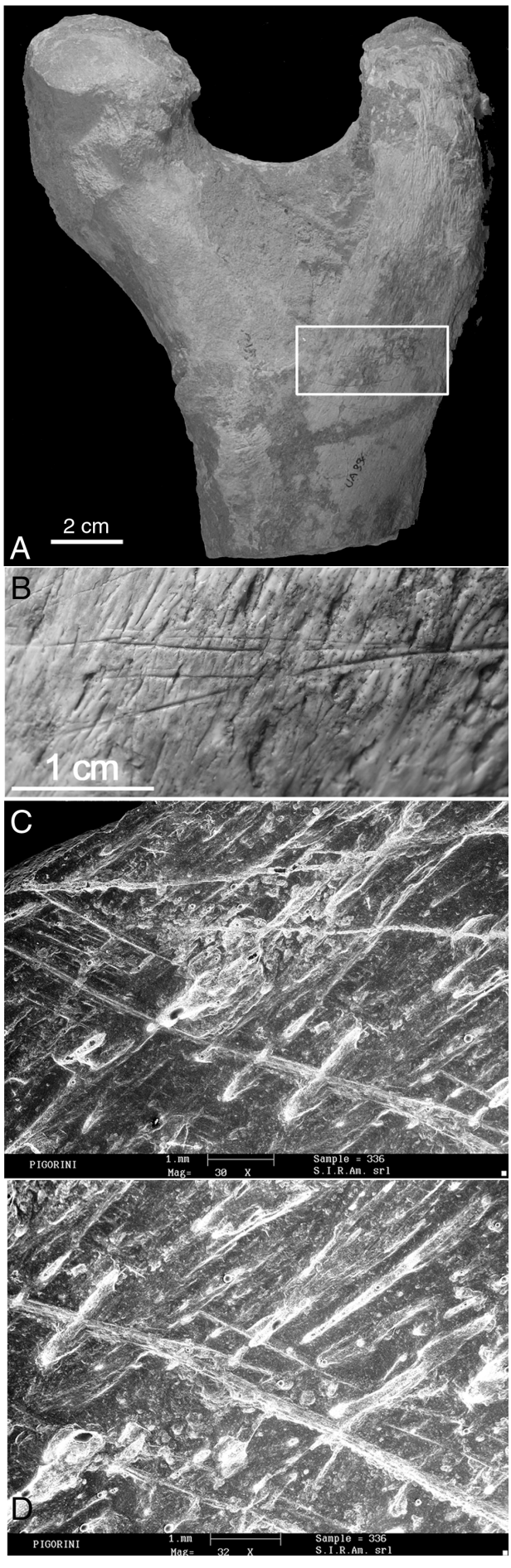

Fig. 3 - UA-336. A) Hippo proximal femur fragment; B) lithic-tool cutmarks; C-D) SEM details of rectilinear, sub-parallel striae.

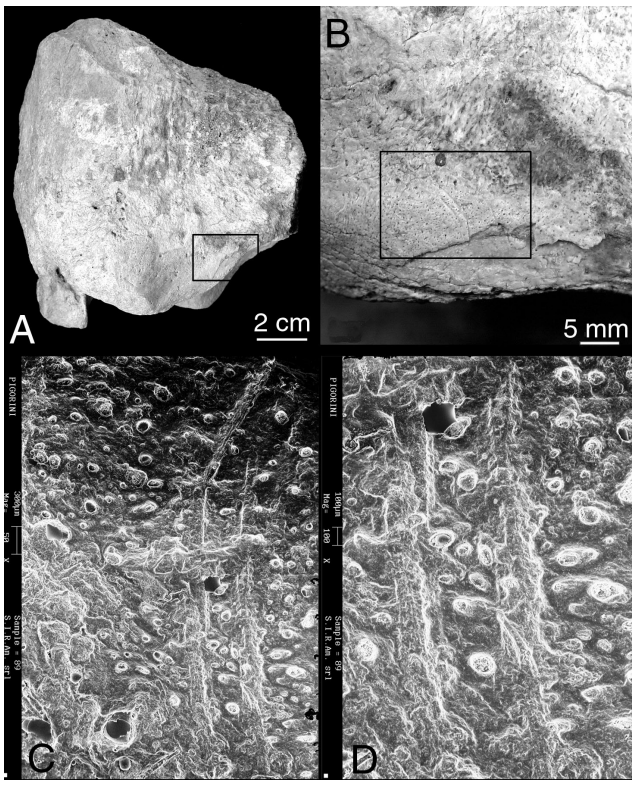

Fig. 4 - UA-89. A) *Hippopotamus* fragmentary distal tibia; B) lithic-tool cutmarks; C-D) SEM details of three curved, sub-parallel striae.

only one on the dorsal-medial aspect (Fig. 5). These features are oblique and sharp and some show compact margins (Fig. 5D). They show an ancient patina which is compatible with the whole surface. The notches could result from percussion, while the position on the anatomical element could be interpreted as being related to carcass dismembering.

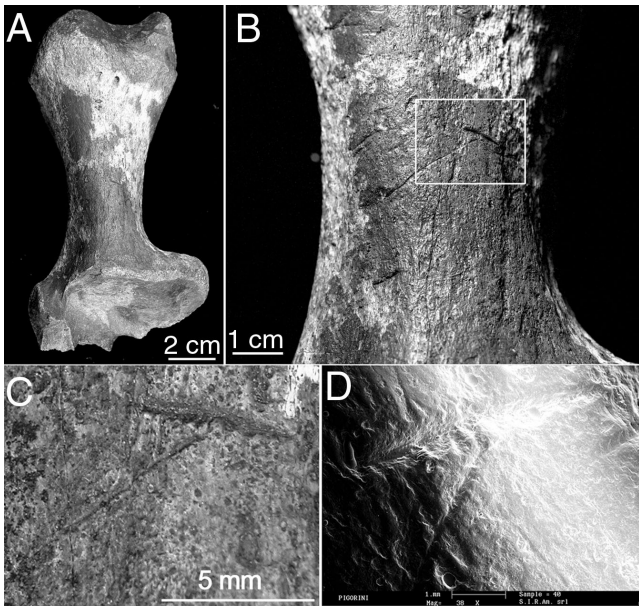

Fig. 5 - UA-40. A) *Hippopotamus* fragmentary proximal calcaneum; B-C) lithic-tool notches magnification; D) SEM details of lithic-tool notches.

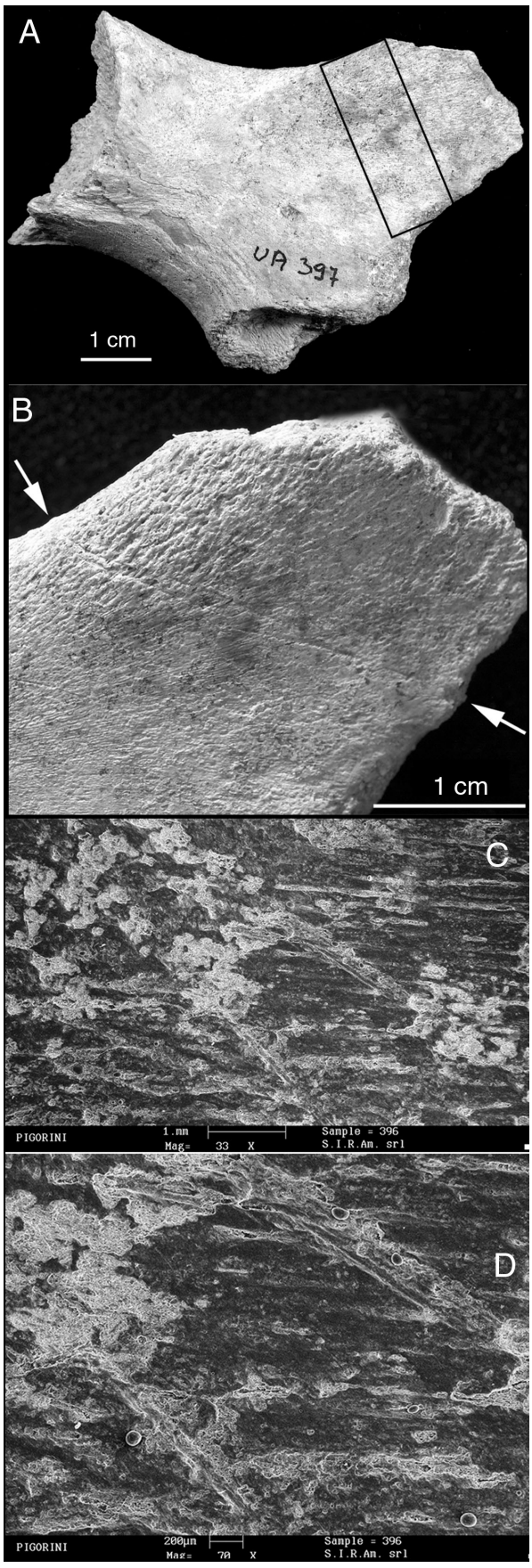

Fig. 6 - UA-397. A) undetermined middle size mammal coxal fragment; B) lithic-tool cutmarks; C-D) SEM details of rectilinear, sub-parallel striae; numerous secondary striae are noticeable.

UA-397

This is a hip pelvis fragment of a medium sized mammal exhibiting numerous long oblique scratch lines macroscopically traceable on its dorsal aspect (Fig. 6). The marks are eroded but in some parts they preserve clear traces of secondary striae running inside the main ones (Fig. 6C and 6D). Since the striae are virtually identical to those found on the hippopotamus tibia (UA-89, Fig. 4), erosion which has affected these two finds should have been the same. The position, orientation and length of the striae suggest defleshing activity.

UAHS-931

This is a distal femur fragment of a small crocodile (recovered in November 2003) showing some unambiguous cutmarks. The marks are numerous, localized and repeated, oblique in reference to the shaft axis, straight and concentrated in a restricted area (Fig. 7). The analysis under stereomicroscope shows that, even if filled with sediment and abraded, the scratches are well defined and it is possible to detect weak residues of secondary striae. The alternative diagnosis of "scraper marks" due to the action of the sediments (Shipman & Rose 1984; Olsen & Shipman 1988) can be excluded on the basis of the amount of striae. Disarticulation/defleshing is the most likely functional interpretation. As far as we know, this is the first reported example of crocodile exploitation by hominids.

Activity of the carnivores

As already pointed out, the fossil fauna collection from Buia kept at the National Museum of Eritrea does not yet include remains of carnivores. Nevertheless, carnivores are indirectly documented here by the presence of coprolites and by traces of carnivore teeth on a cranium of the suid *Kolpochoerus* (UA-20). The latter shows bite marks on the nasals and the palate, which can be tentatively assigned, because of their size, to the gnawing of a *Crocuta*. The specimen is still in preparation and has not yet been described in detail.

Traces from sediment abrasion

Various isolated scratch lines were observed on a first whole phalanx of a *Kobus* (UA-50), one of which is on its internal face. The mark is oblique, not deep, and trapezoidal in section. The entry and exit points are broad and traces show constant width along their whole length (Fig. 8). This kind of streak can be misinterpreted as traces left by a lithic tool. However, taking into account a number of diagnostic criteria, it is possible to identify the causal factor in the abrasive action of sediment particles (cf. Olsen & Shipman 1988). As observed on UA-50, abrasion streaks are normally single, isolated, and located on anatomical segments which are not functional for butchering. Such streaks also generally show large entrance and exit points, produced by the sliding of the particle on the bone surface, and are wider than deep (Fig. 8C, 8D and 8E).

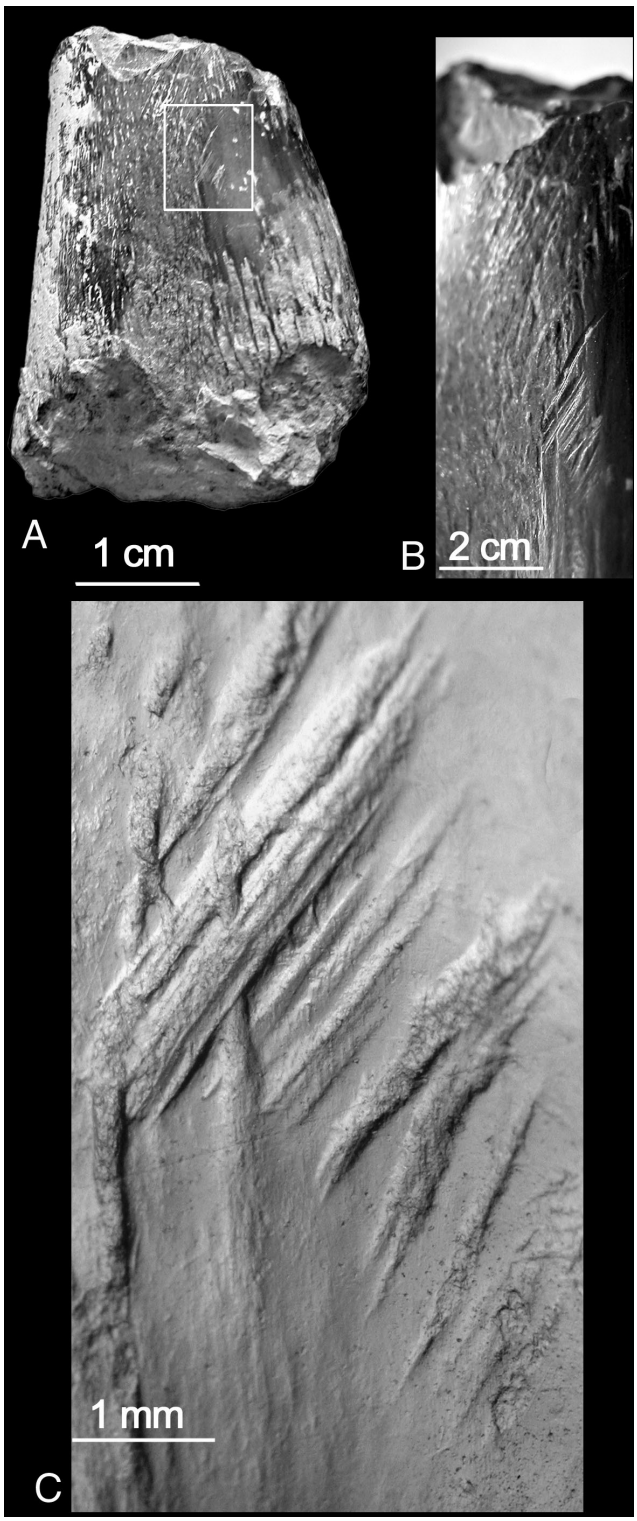

Fig. 7 - UAHS-931. A) Crocodile distal femur; B) lithic-tool "scraper marks"; C) magnification of the "scraper marks".

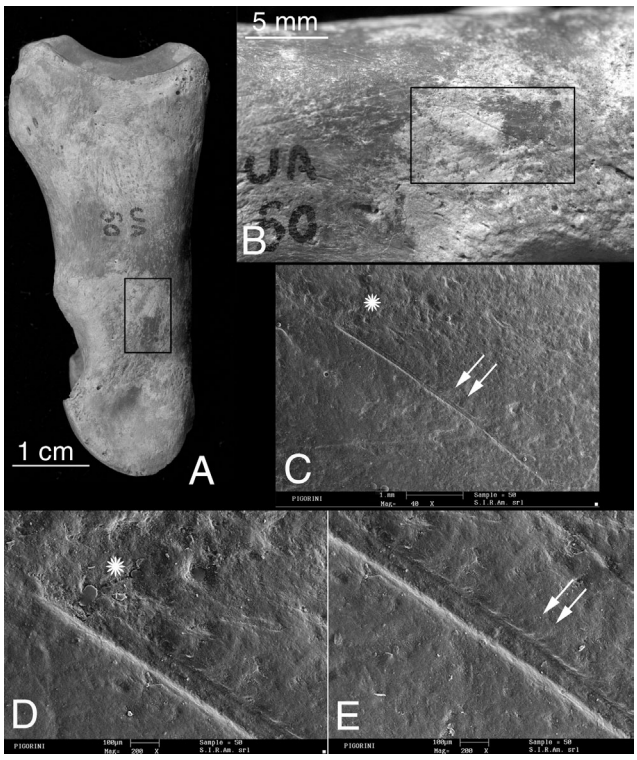

Fig. 8 - UA-50. A) *Kobus* 1st phalanx; B) details of stria; C) SEM detail of the stria trapezoidal section; D) magnification of the stria in the area of Asterisk in C; E) magnification of the stria in the area of the two arrows in C.

Natural grooves

A detailed surface analysis has been made on the incomplete fossil human hip bone discovered at Uadi Aalad (UA-405, right acetabulum and partial ischium). As reported in detail by Macchiarelli et al. (2004), SEM and optical microscope analysis has revealed two striae which are deeply affected by the taphonomic history of the specimen. While the central portion of one line displays secondary striae in its central groove, thus suggests the possible mechanical action of a lithic tool, others portions of both striae distinctly show a number of features which more likely relate to a vascular groove (Fiore et al. 2003). The presence of secondary striae can be possibly attributed to the action of an abrasive particle, channeled along the furrow and responsible for the width variation (see fig. 11, in Macchiarelli et al. 2004).

Analysis of fractures of the skeletal finds

Analysis of the bony fractures was not really informative on our sample since the majority of the observed cases were represented by transverse-oblique breakages with irregular margins mostly due to post-depositional dynamics. Recent fractures are also common. In only two cases (UA-32, distal portion of a *Kobus* metatarsal, and UA-46, fragmentary distal metacarpus of *Pelorovis*) it was possible to find evidence consistent with breaks on fresh bone; nonetheless, the lack of evident impact points does not allow an unequivocal diagnosis of intentional breakage (Johnson 1985; Agenbroad 1989).

Discussion

The surface (micro)analysis of the late Early Pleistocene faunal collection from the Buia Basin, Danakil Depression of Eritrea, has led us to recognize a number of different taphonomic agents which contributed to the formation of the bone scatters. Even though the finds are poorly preserved because of diffuse abrasion, the microscopic investigation allowed us to discriminate a number of unambiguous butchery mark cases from scratch lines related to the action of sediment particles (abrasion striae), and from vascular grooves (which may resemble cutmarks, when abraded).

Our analyses demonstrate that late Early Pleistocene *Homo* in Buia was responsible for the cutmarks and other related functional signs left for carcass exploitation. However, because of the nature of the investigated sample, at present we cannot determine if they scavenged, or if they were hunting (Blumenschine 1987, 1995; Lupo 1994; Potts 1994; Dominguez Rodrigo 1997).

The documentation of large mammal bone modification in the Buia assemblage broadly fits the record from other Plio/Pleistocene sites (Dominguez-Rodrigo & Pickering 2003), including Olduvai Bed II (Monahan 1996), Koobi Fora (Bunn 1994), Peninj (Dominguez-Rodrigo et al. 2002) and Daka (Asfaw et al. 2002). Evidence of butchery demonstrate that the Buia hominids exploited carcasses, especially those of hippopotamus and there is a significant resemblance of dismembering activity on hippo femurs between the specimen UA-336 and the one previously reported from Koobi Fora from geologic horizons dating 1.6 Ma (Bunn 1994).

A peculiar evidence from the Buia record is the butchering on reptiles such as crocodiles, an activity not documented until now from other penecontemporary sites.

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