



Taphonomy of *Palaeoxodon antiquus* at Castel di Guido (Rome, Italy): Proboscidean carcass exploitation in the Lower Palaeolithic

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ABSTRACT

Field investigations at Castel di Guido revealed a Middle Pleistocene open-air site containing macro-faunal remains associated with Acheulean industry. The large majority of the remains lay at the bottom of a depressed area, which probably evolved into a low energy freshwater basin after the deposition of the assemblage.

To quantify the importance of the natural processes compared to the anthropogenic ones in the formation of the site, a full taphonomic analysis of the macromammal assemblage was carried out. A geoarchaeological study, together with a taphonomic analysis of the lithic and bone implements, is ongoing.

This paper discusses the results of the study of elephant bones. The taphonomic analysis has documented traces of different modifying agents on the specimens, indicating the important role of syn- and post-depositional factors in the accumulation and modification of bones. Nevertheless, evidence of utilization of carcasses for subsistence and for tool production was detected. The study provides new data for the exploitation of elephants by hominins during the Lower Palaeolithic.

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1. Introduction

Lower Palaeolithic Proboscideans are abundant at various sites in Africa and Europe, but their relationship with humans is still a matter of debate (Fosse, 1998; Gaudzinski and Turner, 1999; Gaudzinski et al., 2005; Haynes, 2005; Villa et al., 2005; Mussi and Villa, 2008). Particularly in fluvial environments, natural factors strongly influence the faunal assemblage. This is the case at Castel di Guido, an open-air site that represents a complex palimpsest of repeated frequentations by hominins, and natural processes with *in situ* reworking of the materials (Radmilli and Boschian, 1996; Boschian and Saccà, 2010).

The remains lay at the bottom of an erosion surface, interpreted as a gully (Boschian and Saccà, 2010), shaped by an ephemeral stream in the underlying soft sediments. When the stream was moderately active or inactive, this shape was probably a sort of seep around which animals and humans gathered for water and other subsistence purposes. The elephant is a good example of a water dependent species, and the occurrence of carcasses around water points is not uncommon at modern southern African sites, because of accidents such as getting stuck in mud or drowning (Haynes, 1991, 2005, 2006). This pattern was also detected in fossil

Proboscidean bone assemblages, as the nearby and coeval site of La Polledrara di Cecanibbio where the excavation brought to light some elephants trapped in marshy areas (Anzidei et al., 2011).

2. Castel di Guido: the site and the faunal assemblage

The open-air site of Castel di Guido was the object of systematic excavations between 1980 and 1991 (Longo et al., 1981; Barbattini et al., 1982; Fornaciari et al., 1982; Pitti and Radmilli, 1983a,b, 1984, 1985; Radmilli, 1984, 1988, 1992; Mallegni and Radmilli, 1988; Radmilli and Boschian, 1996). The site is located approximately 20 km WNW of Rome, at 73 m a.s.l., on the southern side of the Sabatini volcanic complex, a landscape shaped by low and smooth hills dissected by wide and shallow valleys with flat bottoms (Fig. 1A).

The excavations produced about 7500 archaeological remains, these were found at the bottom of a small erosion feature (about 1200 m²) included within a succession of lacustrine and fluvial units with pyroclastic inputs and intercalations (about 7 m thick). The sequence is closed by a compact brown silt level, partly disturbed by recent ploughing (Fig. 1B; Radmilli and Boschian, 1996; Boschian and Saccà, 2010).

The 4858 bones were associated with a local facies of the Acheulean including stone artefacts (flake tools, handaxes and chopper on pebbles) and bone tools (Radmilli and Boschian, 1996;

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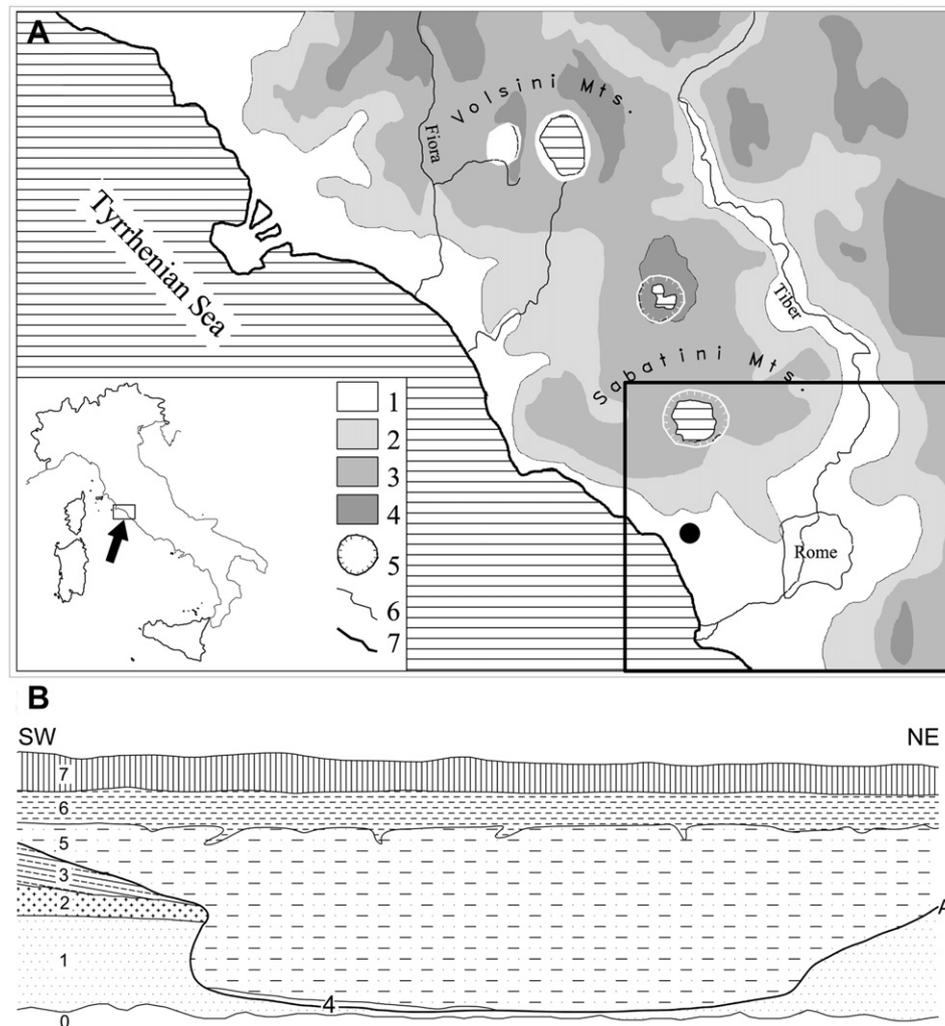


Fig. 1. The site of Castel di Guido A. General situation within the Lazio volcanic region. 1: 0–100 m; 2: 100–200 m; 3: 200–300 m; 4: 300–500 m; 5: calderas; 6: rivers; 7: coastline. B. Stratigraphic sequence; transversal profile across the erosion feature. The entire sequence is about 3 m thick. From the base to the top: 0 – yellowish clay loam; 1 – aeolian sand; 2 – welded pyroclastic rock; 3 – diatomaceous silt; 4 – sand with mud balls; 5 – diatomaceous poorly sorted sandy loam; 6 – brown silt; 7 – ploughed horizon. “A”: erosion surface upon which most of archaeological remains were found.

Boschian and Tozzi, in press). Few human bone fragments, ascribed at that time to *Homo erectus* (now probably *Homo heidelbergensis*), were found in the ploughed horizon (Radmilli et al., 1980; Mallegni et al., 1981, 1983; Fornaciari et al., 1982; Longo et al., 1982; Radmilli and Mallegni, 1984; Mallegni and Radmilli, 1987, 1988; Radmilli and Boschian, 1996; Mariani-Costantini et al., 2001).

The Castel di Guido sample includes 8 taxa consisting mainly of herbivores (3239 remains; 99.82% of the NISP), whereas carnivores are very scarce and represent 0.15% of the NISP (Table 1; Saccà, 2010). 416 other specimens, mostly shaft and vertebrae fragments, have been classified on the basis of the dimensions and bone thickness, into Small, Medium, Large and Very Large size animals; the classes correspond to large rodents/lagomorphs, red deer, aurochs/horse and elephant respectively (NRDa in Fig. 2). Only 376 are unidentified bone fragments (ND in Fig. 2). According to the NISP and to the MNE, the large mammals assemblage is dominated by *Bos primigenius* and *Palaeloxodon antiquus*; a smaller number of remains of *Equus ferus* and *Cervus elaphus cf. rianensis* represent respectively 16 and 12 individuals; the other taxa are represented by a single find (Table 1).

Considering the dominant species, almost all skeletal portions of aurochs, elephant and horse, even if strongly fragmented, are well

represented. On the other hand, red deer cranial remains are far more abundant than postcranial remains: antlers are particularly frequent (16 are shed antlers and 22 are unshed) (Fig. 3). The scarcity of red deer postcranial elements is probably due to natural

Table 1

Composition and quantification of the faunal assemblage of Castel di Guido (NISP: Number of Identified Specimens; MNE: Minimum Number of Elements; MNI: Minimum Number of Individuals).

Taxa	NISP	%	MNE	%	MNI		
					Juv	Adult	% Tot.
<i>Bos primigenius</i>	1399	43.11	966	56.82	1	42	49.43
<i>Palaeloxodon antiquus</i>	1381	42.56	388	22.82	1	10	12.64
<i>Equus ferus</i>	385	11.86	302	17.76	1	15	18.39
<i>Cervus elaphus cf. rianensis</i>	71	2.19	35	2.06		12	13.79
<i>Cervidae</i>	2	0.06	2	0.12		1	1.15
<i>Stephanorhinus cf. hundsheimensis</i>	1	0.03	1	0.06		1	1.15
<i>Canis sp.</i>	1	0.03	1	0.06		1	1.15
<i>Panthera (Leo) cf. spelaea</i>	4	0.12	4	0.24		1	1.15
<i>Lepus sp.</i>	1	0.03	1	0.06		1	1.15
Tot.	3245		1700			87	

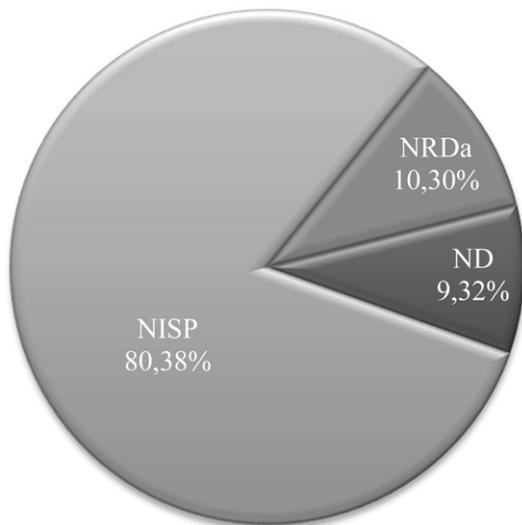


Fig. 2. Percentages of determination of the faunal sample (Nr total 4037; NISP = taxonomically and anatomically identified bones; NRDa = anatomically identified remains; ND = unidentified bone fragments) (abbreviations from Brugal et al., 1994).

processes of loss by water transport. The high proportion of elephant long bone shaft fragments may result from their use as raw material in tools manufacturing, in addition to food procurement.

The combined U/Th and ESR dates on aurochs teeth indicate an age between 327 and 260 ka (Michel et al., 2001, 2009). In accordance with geological data, biochronological studies, the faunal assemblage can be ascribed to the early stages of the Aurelian Mammal Age (Torre in Pietra F.U., OIS 9; Gliozzi et al., 1997; Milli and Palombo, 2005). A palaeoecological reconstruction suggests an environment dominated by steppe-like open areas with wooded patches, developed in a moderately fresh and rather dry climate (Barbi, 1994; Sala and Barbi, 1996).

3. Materials and methods

Through quantitative and qualitative analyses of the remains and using actualistic studies, ethnographic observations and experiments (Haynes, 1980, 1983, 1988, 1991, 2005; Binford, 1981; Olsen and Shipman, 1988; Lyman, 1994a), the taphonomic study of the bone remains has aimed at understanding the processes that

were involved in the formation of the faunal assemblage. More generally, these studies, if integrated with the analysis of the stratigraphic and sedimentary context (for preliminary results see Boschian and Saccà, 2010) and into the taphonomic observations on the lithic and bone tools (not yet available), will be able to provide a more complete picture of the history of the site of Castel di Guido.

Quantification of the remains has been carried out using several parameters along with NISP (Number of Identified Specimens). MNI (Minimum Number of Individuals; Lyman, 1994b) and MNE (Minimum Number of Elements; Binford, 1984) have also been calculated. MNE is used in the calculation of percentage of survivorship and intensity of fragmentation. Percentage of survivorship is calculated with the equation $([MNEi]100)/[MNI[\text{number of times } i \text{ occurs in one skeleton}]]$, where i represents a skeletal part or portion (Brain, 1969, 1976).

The intensity of fragmentation is inferred by calculating the NISP:MNE ratio. The more anatomically complete the specimens, the less the difference between NISP and MNE. If NISP = MNE, samples consist exclusively of complete skeletal elements; a NISP > MNE ratio instead indicates a more or less intense fragmentation of the sample (Lyman, 1994b).

Long bone fragmentation has been analysed following the criteria suggested by Villa and Mahieu (1991), in order to distinguish between fractures on green bones and those that occurred later, on dry bones. The “fracture edge” attribute was not used, because fracture edges are often rounded and abraded. According to the authors, this attribute is not useful for discriminating whether the bone was fractured when still green or when dry (Villa and Mahieu, 1991, p. 40). The bone fracture study was completed by observing traces of intentional percussion (impact points, flake scars; Capaldo and Blumenshine, 1994; Blumenshine, 1995).

The macroscopic investigations have been integrated with the analysis of the bone surface at high magnification using a Leica MZ 125 stereomicroscope. A representative sample was selected for SEM (Scanning Electron Microscope Jeol JSM-5600 LV) observation with the aim of revealing the presence of traces of butchery (cut marks; Olsen, 1988; Olsen and Shipman, 1988), and to evaluate the effect of taphonomic nonhuman factors on the bone assemblage. These modifications occur during the transition from living animal to fossil or archaeological assemblage and are caused by various agents which can act simultaneously or consecutively.

Modifying agents can be of a biological nature, such as root etching and carnivore gnawing. The first is characterized by multiple thin and shallow lines into the surface of bones caused by acids associated with plant roots that have grown against the bone (Andrews and Cook, 1985; Fisher, 1995). Carnivore gnawing produces

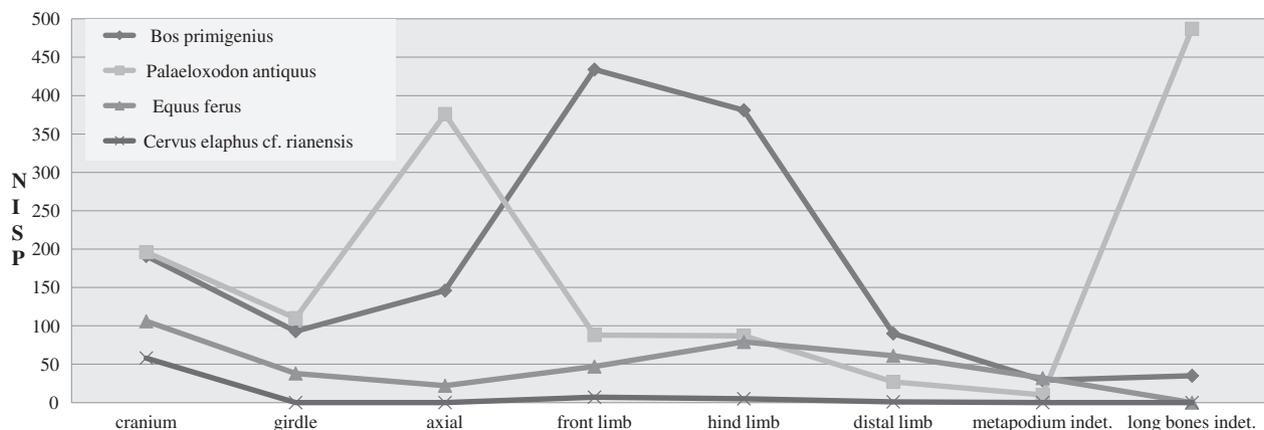


Fig. 3. Frequency of skeletal parts in the dominant species.

scores, pits, punctures and furrows (Haynes, 1980, 1983; Binford, 1981; Blumenshine, 1988; Villa and Bartram, 1996). Carnivore bone breakage can generate spiral fracture, conchoidal flake and flake scar that can be confused with human activity. In actualistic field studies of African elephants, these features were observed on limb bones with unfused epiphyses and they were created both by carnivore gnawing and by trampling (Haynes, 1988, 1991). Attributes that can help to eliminate ambiguity regarding the identity of the effect are: pitting, scoring, or other tooth-imparted damage that often accompanies carnivore-produced conchoidal flakes. Trampling can impart polish and abrasion striations on the bone (Fisher, 1995). Striations in general occur in high numbers. They are shallow with great variation in size and orientation, even on a single bone. Isolated marks may superficially resemble butchery marks (Olsen and Shipman, 1988; Shipman and Rose, 1988).

It is not established that bone modifications left by trampling can be reliably distinguished from other forms of pedoturbation, as

those features can also result from long incorporation in sandy water flow (Behrensmeyer, 1982; Olsen and Shipman, 1988). Four classes were defined according to the degree of surface consumption: fresh (unabraded); slightly abraded; abraded; and strongly abraded. The degree of abrasion was analysed considering the amount of preserved bone on the cortical surfaces and articular ends, degree of fracture edges rounding (Villa et al., 1999).

Exposure to weathering agents results in cracking, splitting and exfoliation, because of a combination of physical and chemical processes operating on the bone *in situ*, either on the surface or within the soil zone (Behrensmeyer, 1978). Diagenetic factors such as the presence of elements associated with soil contamination cause mineral impregnations of the bone (Stephan, 1997).

The taphonomic analysis was completed with thematic distribution maps built using GIS technology (Burrough, 1986), showing the position of the remains on the excavation surface, classified by categories of taphonomic alteration.

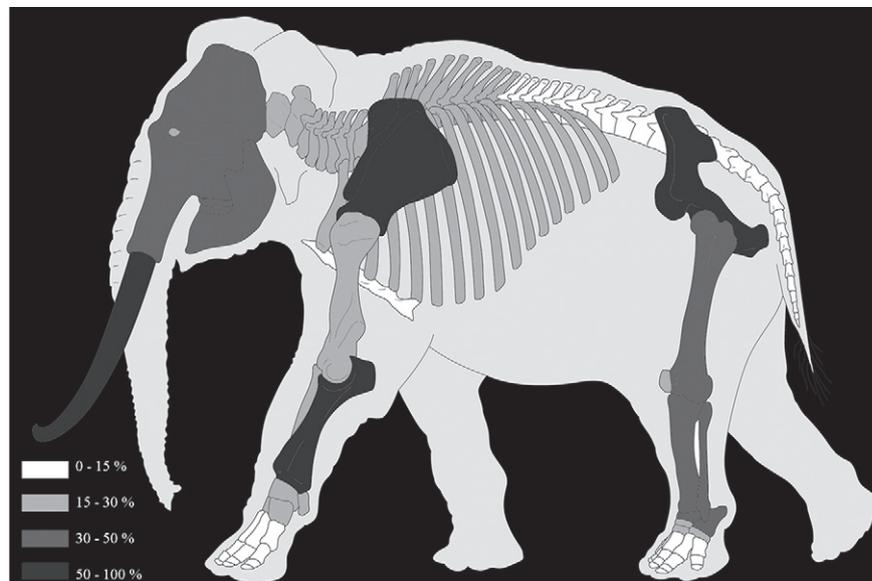
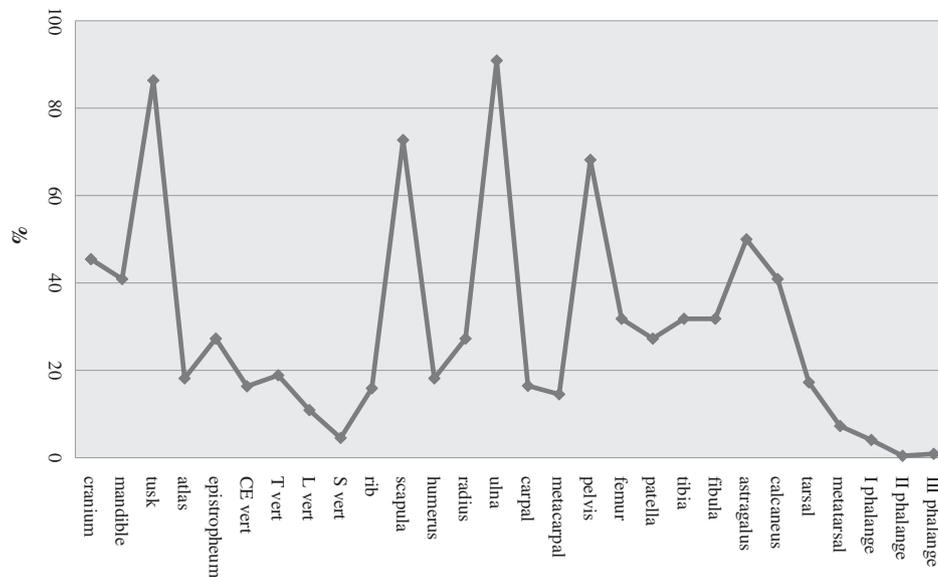


Fig. 4. Percentage survival of *Palaeoloxodon antiquus* body parts, presented both in a graph (above) and a skeletal representation (below) (drawing by C. Beauval, <http://www.archeozoo.org/en-article134.html>).

4. Results and discussion

4.1. Skeletal composition

Paleoloxodon antiquus is the second most abundant species according to number of identified remains. The MNE totals 388 remains (22.82% of the total; Table 1), giving a much lower number compared to the NISP value (1381, corresponding to 42.56% out of the total; Table 1). Numerous fragments of diaphysis and various bones, generically classified as long, flat and short bones, have not been included in the MNE calculation. At least 11 individuals are represented, including one juvenile. This is the lowest MNI of the dominant species (12.64% of the total; Table 1). Adults are represented by 10 left proximal ulnas, with fused epiphysis, which can all be aged to older than 20–25 years. These individuals, however, were not very old, as suggested by the presence of third molars, which did not show excessive wear (35–40 years). The presence of at least one juvenile individual (2–3 years) is indicated by one maxillary third deciduous premolar. Proposed age profiles were extracted from the work by G. Haynes on *Loxodonta*, the modern African elephant (Haynes, 1991, pp. 321–353) and are based on Craig’s system of age determination (Haynes, 1991, tab. A2, p.330).

All of the skeletal parts belonging to straight-tusked elephants are present, except caudal vertebrae (Fig. 4). Cranial elements consist mainly of isolated and mostly fragmented molars, complete and fragmented tusks; the presence of mandibular and maxillary bone fragments together with some occipital condyle fragments indicate that crania were initially present on the site. Postcranial elements are mainly represented by girdle bones and, among long bones, by ulna. The axial skeleton remains are scarce, mostly represented by cervical and thoracic vertebrae, and short bones occur even more sporadically. This result is even more apparent when comparing the skeletal frequencies observed on the basis of MNE and those expected on the basis of MNI (Fig. 5). Survival of different body parts, although influenced by human decisions relating to consumption and/or function, depends in large part on their structure and robustness and on pre- and post-depositional taphonomic factors which were involved in the site formation process (Lyman, 1994a; Milli and Palombo, 2005).

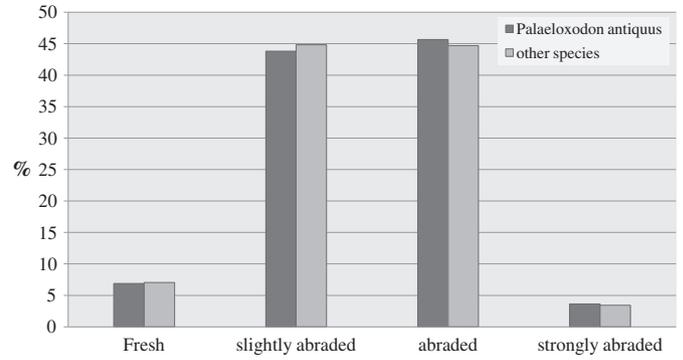


Fig. 6. Degree of abrasion observed on straight-tusked elephant bones and on the other species at Castel di Guido.

4.2. Bone preservation and natural surface modifications

The state of preservation of the sample is varied, but in general the bone surfaces are not well preserved.

Almost all the specimens have undergone important mechanical attrition: the specimens show variable degrees of surface abrasion (Fig. 6). Scratches, together with the smoothing and polishing of the surface and edge of bone fragments are very common, and some mimic cut marks and use-wear traces (Andrews and Cook, 1985; Behrensmeyer et al., 1986; Olsen and Shipman, 1988; Campetti et al., 1989). Striations commonly occur in high numbers on single bones. They are shallow, of various lengths and widths without a defined orientation or a particular placement relative to anatomical features, so that it could be possible to infer that they result from the effects of natural sedimentary abrasion. The abrasion and polishing may be due to the transport of bone in water flow, with sandy suspended loam, or due to low to medium sandy water flow, acting on stationary remains (Behrensmeyer, 1982; Andrews, 1995). It is likely that the quartz grains of the reworked aeolian sand produced wider scratches, while the thinner scratches and the polished surfaces are the result of gentler abrasion by the diatomaceous silt of the overlying sediment (Boschian and Saccà, 2010). Near water sources, bones could become scratched and polished by the action of animal trampling (Andrews

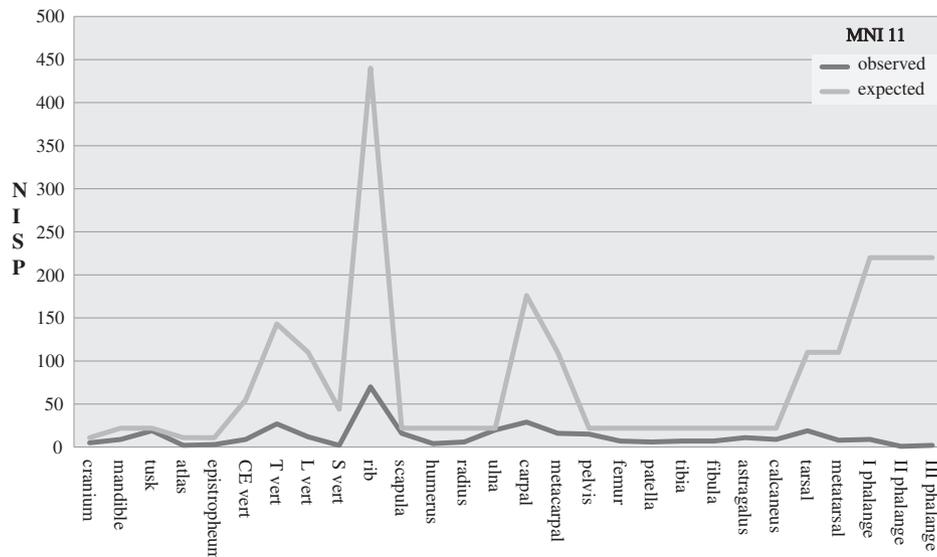


Fig. 5. Skeletal frequencies observed (based on MNE) and expected (based on MNI).

and Cook, 1985; Behrensmeyer et al., 1986; Haynes, 1988). Trampling may fracture bones through static loading. Sediment pressure is not considered to be an important factor in the breakage of elephant limb bones in sandy or silty deposits (see section 4.4).

Thematic maps of the position on the excavation surface of different preserved bones (*i.e.*, degree of surface consumption) show that 'slightly abraded' and 'abraded' elements are the most numerous, and that they are distributed across the whole excavated area, particular clusters are not visible (Fig. 9B–C). 'Fresh' (unabraded) material is less common and is mainly located in the central and eastern areas of the erosion feature (Fig. 9A). On the other hand, remains that are 'strongly abraded' are more sporadic. They are almost completely absent from the central area, where the erosion channel becomes larger and lower, corresponding to the area where the best-preserved remains have been recovered (Fig. 9D).

The marks on the tip of the tusks and in the midsection were most likely produced during the elephant's life (Fig. 7). Similar striations were observed on tusks from the Acheulean sites of

Ambrona and Torralba, in Spain (Villa and d'Errico, 2001; Villa et al., 2005). A broken tusk tip, listed among the bone tools (Radmilli and Boschian, 1996, Fig. 68, p. 163), is now considered a pseudo-point (Boschian and Saccà, 2010; Saccà, 2010). The morphology is similar to the ivory points from Ambrona and Torralba (Villa and d'Errico, 2001; Haynes, 2005) and the collections of naturally broken tusk tips of Haynes' modern series (Haynes, 1991). Actualistic data of modern elephants in Africa provide useful information about the use of tusks in a variety of activities, such as digging for tubers and water or stripping bark from trees (Haynes, 1991).

Taking into account the abrasive action of grains of sediment on weathered bone surfaces (Andrews, 1995; Fernández-Jalvo and Andrews, 2003), evaluating bone weathering on the sample is problematic. In a few cases, primary weathering can be distinguished from sedimentary abrasion. Bones that show cracking and exfoliation of the surfaces correspond to a low-medium degree of weathering (from 1 to 2–3 of stages proposed by Behrensmeyer, 1978). Their distribution on the site is random, and no significant cluster can be identified (Fig. 10A).

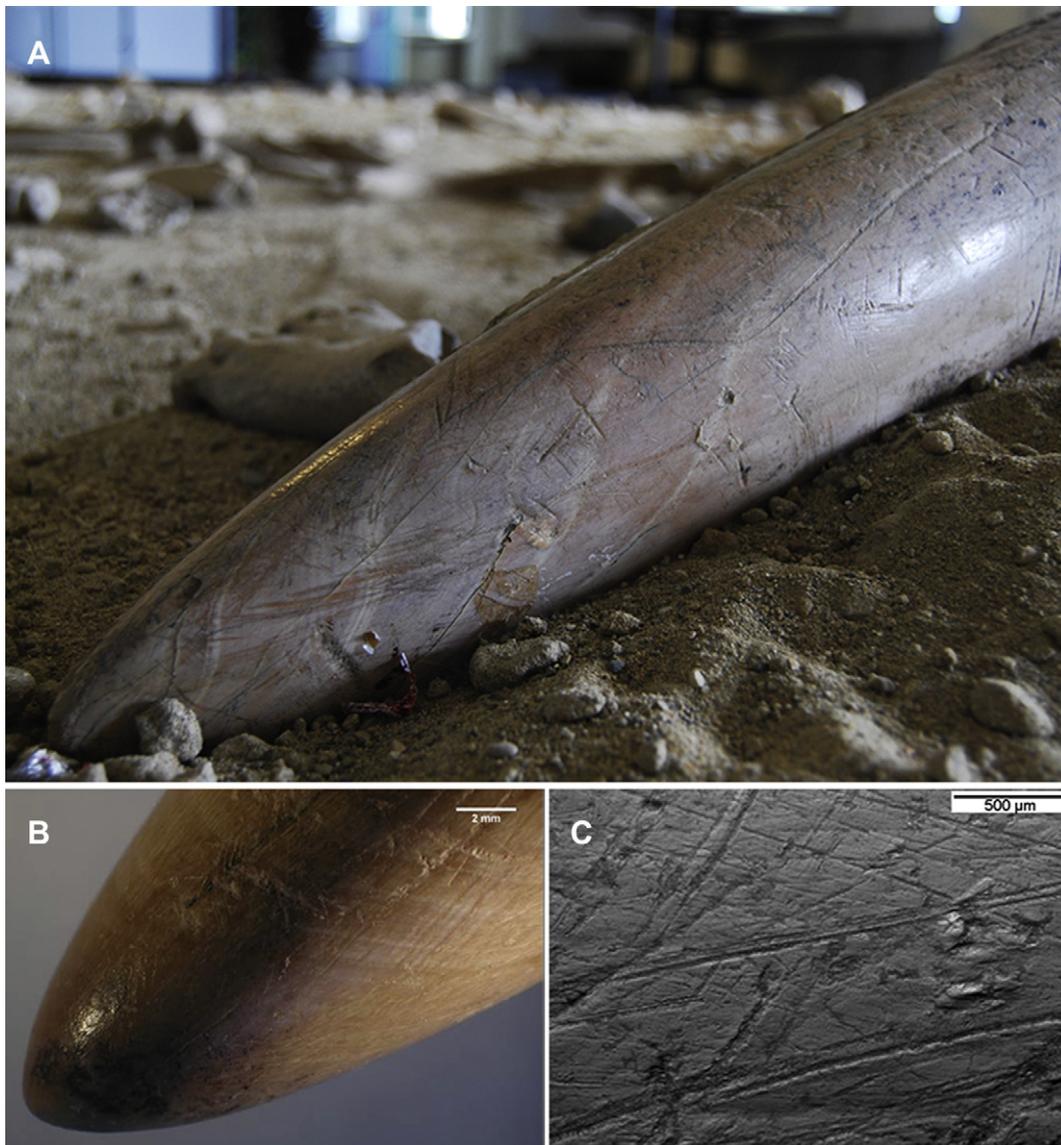


Fig. 7. Tusks with multiples striations mostly produced during the life of the elephant. A. The tip of a tusk shown on display in a reconstruction of an area of the site at the Prehistoric National Museum "L. Pigorini", Rome. B. Stereomicroscopic image of the tip of another tusk. C. SEM image of the surface near the apex showing intersecting and randomly oriented striations.

Iron and manganese mineral impregnation are relatively frequent. Manganese occurs as dendritic concretions on most of the specimens and as continuous black coating mainly on the bottom side of remains situated near some small faults that cross the area. Bones modified by mineral impregnations are scattered over the entire excavated surface (Fig. 10B).

Carnivores are underrepresented in the faunal assemblage and their role seems to be secondary in most carcass histories at the site. Gnawing marks (Haynes, 1980, 1983; Binford, 1981; Blumenschine, 1988; Villa and Bartram, 1996) are very scarce and consist of tooth pits and scores, in particular on the metapodium (Fig. 8), whereas cylinders (*i.e.*, complete shafts or shaft segments without epiphysis; Binford, 1981) are absent. Haynes (1988) notes that at natural elephant death sites near water holes the lower leg bones and the caudal vertebrae (that lack in our sample) are the first elements to be removed by scavengers. The few remains modified by carnivores are distributed across the whole erosion surface, with a large concentration in the central zone (Fig. 10C). There is no particular relationship between body parts of single species and their position on the site; therefore, it does not seem possible to obtain data useful to establish if carnivore activity happened on carcass remains or on disarticulated bones.

Root etching (Andrews and Cook, 1985) is frequent and it modified bone surfaces at various degrees. Chemical alteration by root etching acts on the bones, creating dendritic, U-shaped grooves that can either be present on limited areas or cover larger bone surfaces. Root etching is visible both on fresh and strongly abraded remains. These modifications can act on bone areas previously affected by other types of traces (abrasion striations, fractures, etc.), suggesting that it was the last modification the remains were subjected to. Remains showing root marks are distributed all over the excavated area (Fig. 10D), with major concentrations in the eastern area where the fossiliferous layer is covered by undisturbed sediments, between 10 and 40 cm thick,

and where recent rooting activities are visible (Boschian and Saccà, 2010). Generally, their presence decreases towards the N-W, where the remains are covered by 170–190 cm of undisturbed sediments, but at the extremity of this zone the remains modified by roots become more frequent and concentrated in certain areas. According to micromorphological scale observations (Boschian and Saccà, 2010), in this area vegetal elements were present prior to it being covered by diatomaceous sediments.

4.3. Butchery marks

Cut marks are imparted to bone by a sharp-edged implement, generally in the process of cutting through or removing attached soft tissue from an animal carcass. Actualistic studies show that, when removing modern elephant flesh, bones are either not incised at all (Haynes, 1991, pp. 185–186), or only rarely (Crader, 1983) because of the thickness of the tissues. Therefore, the lack or scarcity of cut marks does not necessarily imply a marginal exploitation of carcasses of animals over 1000 kg (rhinoceros, hippopotamus, elephant) as a food resource in the Lower Palaeolithic.

Natural taphonomic factors, acting on the assemblage, might have partly erased disarticulating or defleshing marks, in particular sedimentary abrasion can remove diagnostic, microscopic features of cut marks (Shipman and Rose, 1983), hampering microscopic and SEM inspection. Only a few traces that can be interpreted as cut marks, have been documented on the straight-tusked elephants of Castel di Guido.

Those marks have been identified on two ribs and one fragment of diaphysis of a long bone. They are particularly broad, probably because of the use of larger tools compared to the ones used for smaller sized animals (aurochs and horse; *cf.* Boschian and Saccà, 2010, Fig. 10, p. 10). During experiments, the use of handaxes has

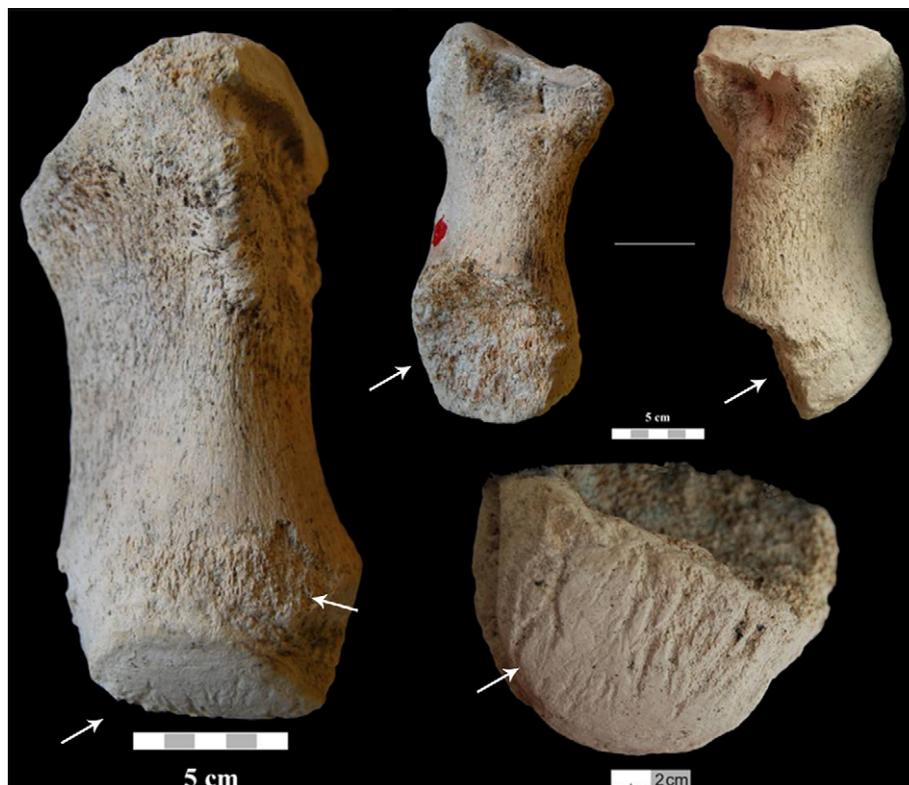


Fig. 8. Gnawing marks (arrows) on the distal end of a metacarpal II.

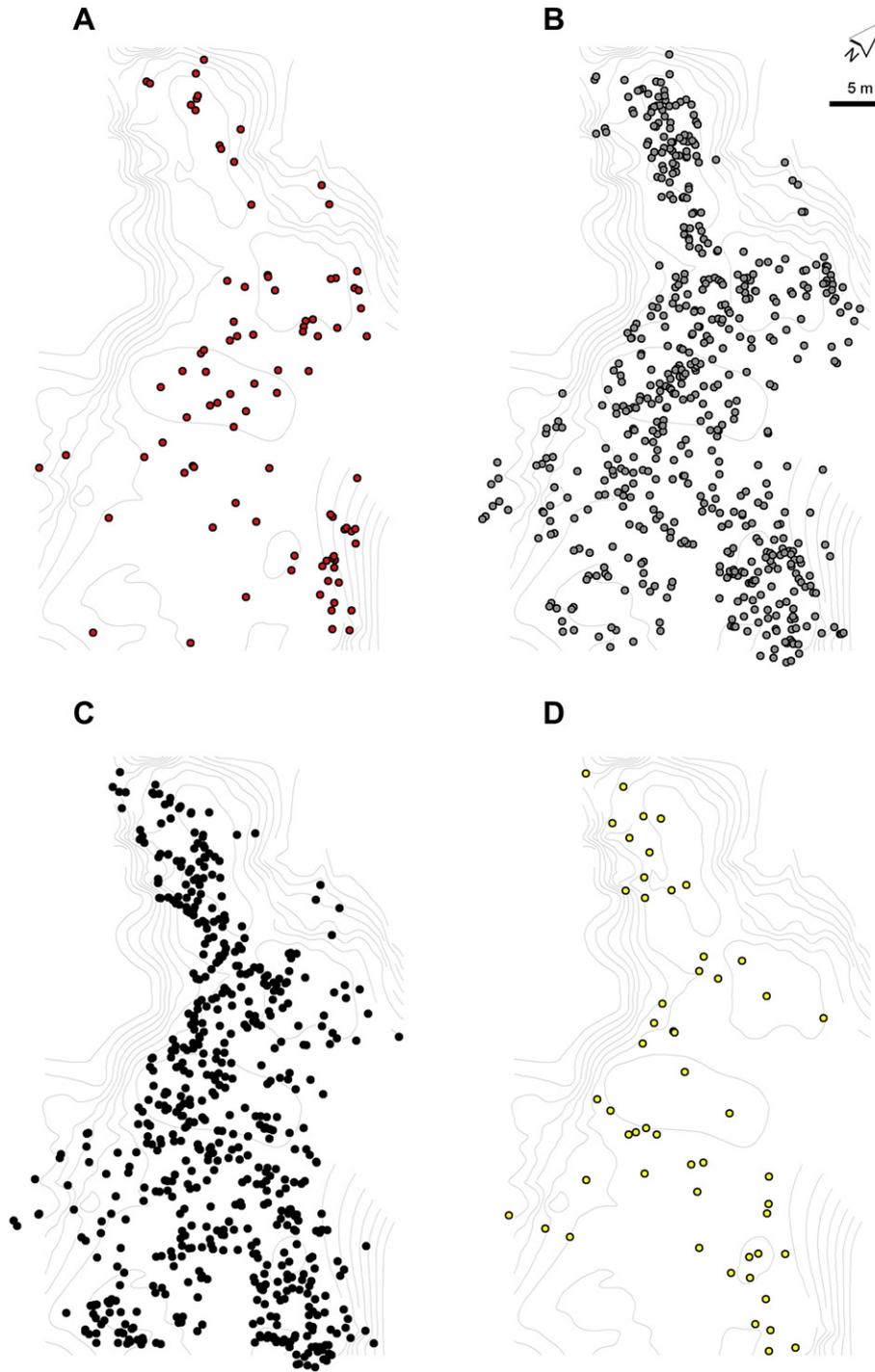


Fig. 9. GIS thematic distribution maps showing the position of bones with different degrees of abrasion. A. Fresh (unabraded); B. Slightly abraded; C. Abraded; D. Strongly abraded.

proven to be particularly efficient in the process of butchering of large preys (Jones, 1980; Bello et al., 2009; de Juana et al., 2010).

The marks were inspected using the optical microscope. Specimens are too large to fit into the chamber of the SEM. Hopefully, replicas will be made in the near future in order to examine these features by SEM and to support the interpretation of these surface modifications in terms of human activity.

The first set of marks occurs on the external side of a rib body fragment (No 5220), that shows multiple nearly parallel striations, of approximately equal width, presumably because they were made

with the same tool edge (Fig. 11A). The two marks, near the fracture, are particularly deep, characterized by a V-shaped section with flaking on the shoulders, and partially preserved internal parallel striations (Fig. 11B). In addition, some striae are visible in close proximity to the main groove. They could have been produced by contact between the tool's shoulder and the bone during cutting (shoulder effect; Shipman and Rose, 1983) (Fig. 11C).

These traces are similar to those found on the same skeletal element of straight-tusked elephants from the Lower Palaeolithic site of Aridos 2, in Spain (Yravedra et al., 2010, Fig. 9, p. 6) and of

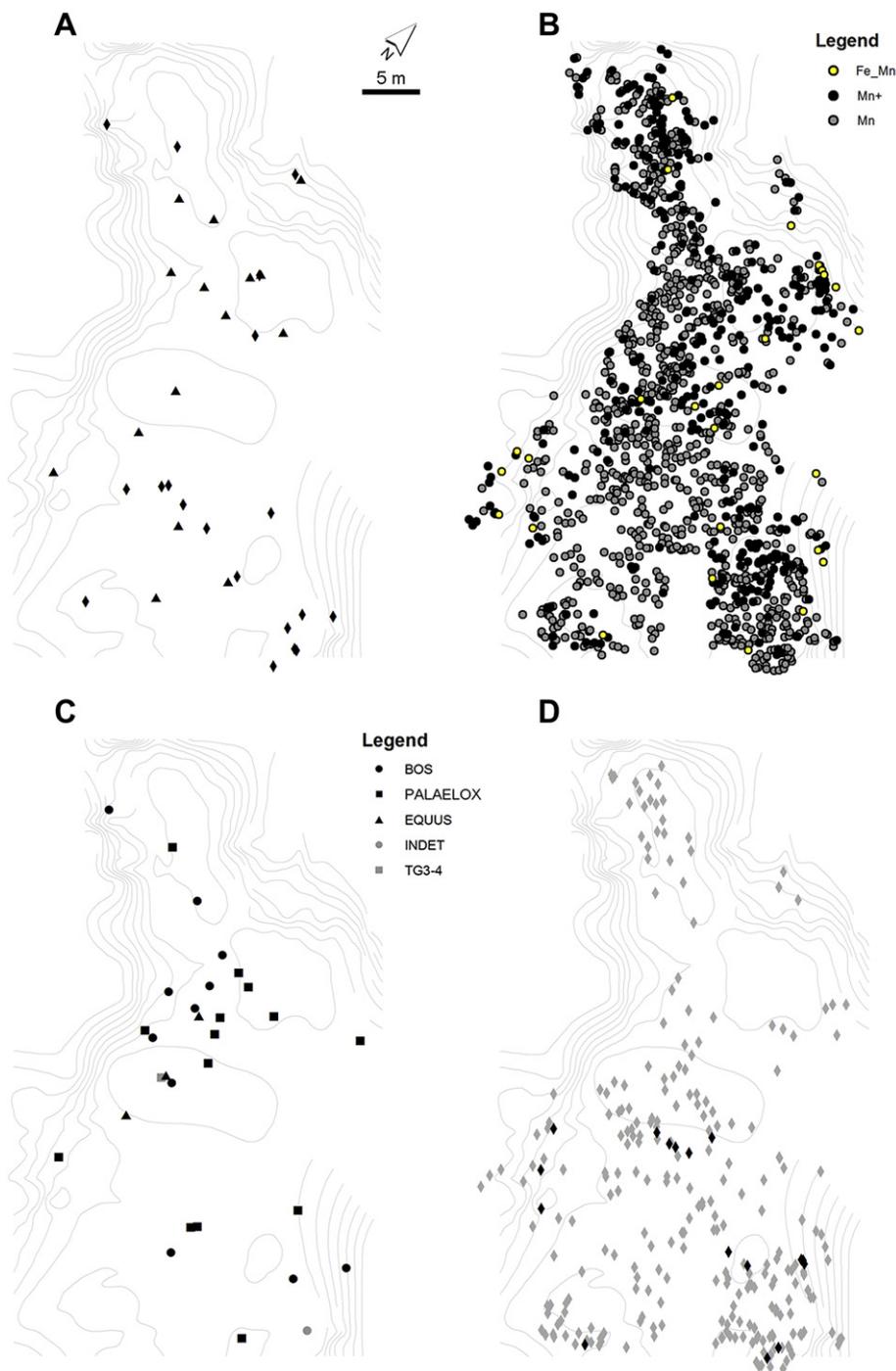


Fig. 10. GIS thematic distribution maps of various natural taphonomic modifications on the bone sample: A. Weathering: flaking (◆) and cracking (▲); B. Impregnation: iron and manganese (Fe_Mn), manganese dendritic concretions (Mn) and manganese as a continuous black coating caused by the proximity of the bones to small faults (Mn+); C. Gnawing marks present on the remains of different species. BOS = *Bos primigenius*; PALAELOX = *Palaeoloxodon antiquus*; EQUUS = *Equus ferus*; INDET = unidentified bone fragment; TG3-4 = size compatible with aurochs/horse; D. Root etching present on limited areas (gray ◆) and covering larger bone surfaces (black ◆).

mammoth from the Paleoindian Blackwater Draw Site, Clovis, in New Mexico (Saunders and Daeschler, 1994, Fig. 9, p. 20). At these two sites, chronologically far apart, these striae have been interpreted as butchery marks: evisceration at Aridos 2 and scraping in order to collect flesh at Clovis (Saunders and Daeschler, 1994; Yravedra et al., 2010).

The remaining two finds could be part of an incomplete and partially rearranged carcass of an elephant, associated with stone and bone tools, found in the N–W area of the excavation. The bones

of this cluster are mostly of elephant. They are not articulated, and some roughly resemble the anatomical position within the carcass (i.e., scapulae; proximal femur epiphysis/acetabulum of a pelvis) (Anconetani and Boschian, 1998; Boschian and Saccà, 2010, Fig. 15A, p. 13) (Fig. 12A). Therefore, this could be an animal that died either on site or in close proximity to the site and which was utilised by humans.

The fragment of a long bone diaphysis (Nr. 7169), found roughly 3 m away from the pelvis, has three deep parallel striations, with

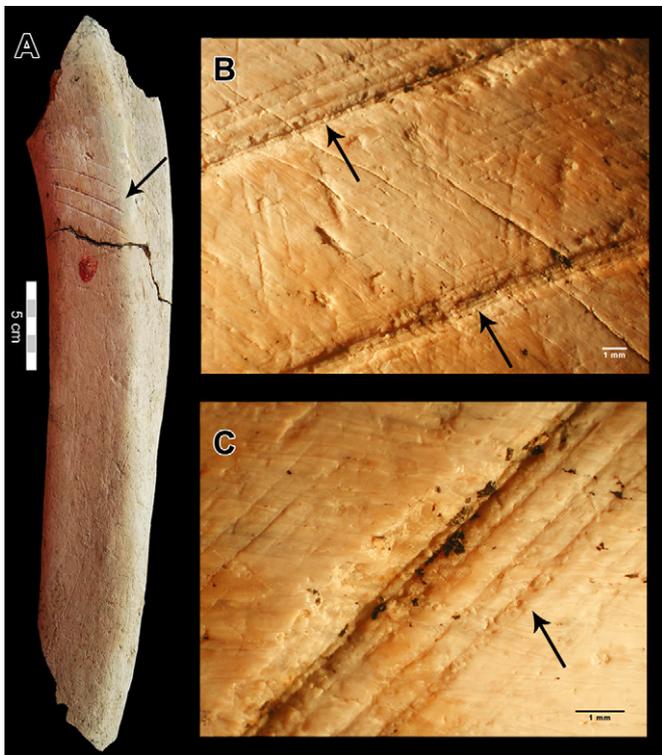


Fig. 11. Cut marks on the elephant rib. A. The arrow points to this set of marks; B. Two deeper marks near the fracture, showing V-shaped sections and partially preserved microstriations (arrows); C. A closer view of the upper mark shown in B, displaying the shoulder effect deviates from the main groove (arrow). B and C are macrophotos taken by a stereomicroscope, showing that the bone surface are also modified by post-depositional taphonomic factors: scratches (sedimentary abrasion/trampling), weathering cracks and manganese impregnations.

flaking on the shoulders, its surfaces are not well preserved and not easy to interpret. However, these marks stop at the point of an ancient fracture, and therefore they have been made prior to the bone fracture, whose characteristics suggest that it happened when the bone was still green (smooth edge, oblique fracture angle; V-shaped and curved fracture outline; Villa and Mahieu, 1991; Fig. 12B).

The other find is the fragment of a rib (Nr. 6884), that was located near a mandible. The similarities with rib Nr. 5220 include only anatomic location and arrangement of the traces. Striae are very weak, broad rather than deep, with flaking on the shoulders and could have been caused by contact between the bone surface and a material softer than flint (Fig. 12C). At the site, the lack of large-size flint raw material is dealt with by the frequent use of bone in its place, but also by the expedient use of other poor quality raw materials, as indicated by the occurrence of bifaces on siltstone, volcanic sandstone and other volcanic soft rocks (Radmilli and Boschian, 1996; Boschian and Tozzi, in press). In order to test the hypothesis of the use of softer material tools to process carcasses, experimental data, currently unavailable, would be needed. These data should be obtained by using softer stone material and bone tools (handaxes and other heavy-duty tools), alongside the use of bone flakes of larger mammals without further modification, in the butchering of the elephant.

4.4. Fracturing of bone

Intentional fracturing of bones, partially or completely devoid of flesh, represents a further level of bone exploitation. The faunal sample from Castel di Guido contains very few complete bones.

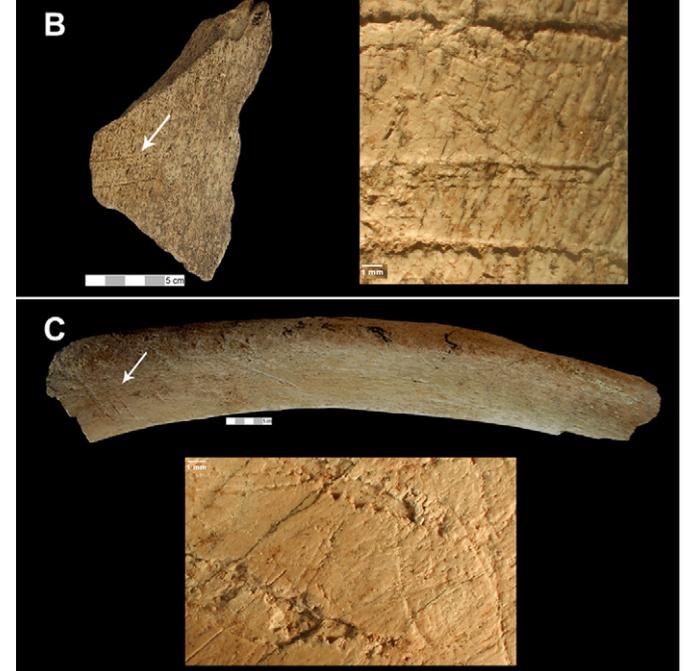
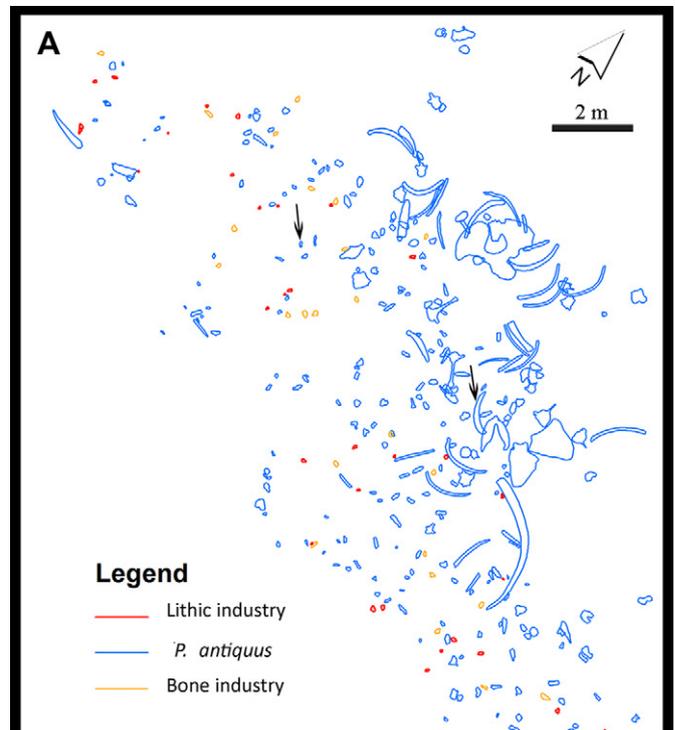


Fig. 12. Cut marks on a long bone diaphysis and on a rib of *Palaeoxodon antiquus*. A. GIS environment display of the cluster of elephant bones found in the northwestern area of the site, and associated with stone and bone industry. Black arrows indicate two bones, fragments of both a long bone shaft (B) and a rib (C) with cut marks. B and C also show stereomicroscope macrophotos of the marks, indicated with white arrows.

The sample's fragmentation intensity has been calculated using the NISP:MNE ratio, from which the exploitation of body parts richer in marrow and grease (mandible and long bones) can be inferred, whilst low food value bones were found to be intact or at most gnawed (Fig. 13).

Analysis of long bone fracture pattern was performed following the criteria developed by Villa and Mahieu (1991), that provide

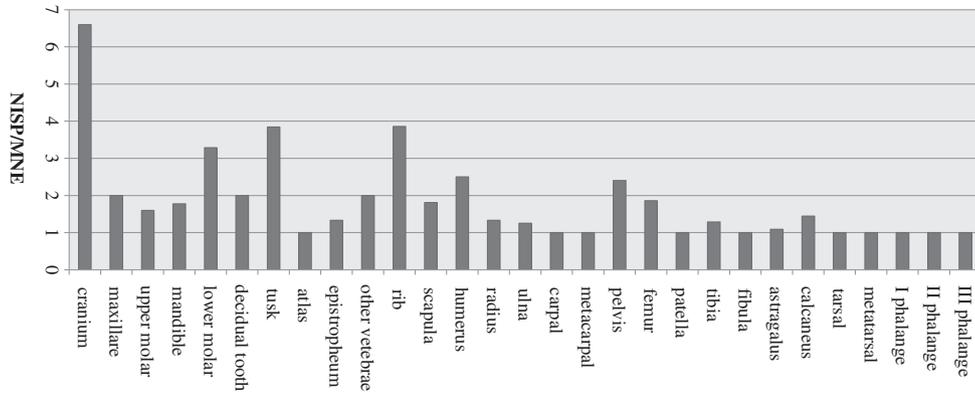


Fig. 13. NISP/MNE ratios for different body parts.

a significant line of evidence for assemblages where bones have undergone sediment attrition and do not have well-preserved cortical surfaces. Results suggest that most of the bones were fractured when they were still green. Fracture angles are mostly oblique and fracture outlines are curved or V-shaped (Fig. 14). As regards shaft fragmentation indices (Bunn, 1983; Villa and Mahieu, 1991), there are no remains where the circumference of the diaphysis exceeds the half of the total circumference: length of the preserved diaphysis is always smaller than half of the total length. The combined tabulation of these data highlights a significant fragmentation of the examined sample (Fig. 15).

Even if cylinders are absent, and in general gnaw marks are rare, the remains might have been partly altered by carnivores. After deposition, elephant behaviour such as trampling and trunk-manipulation may further damage the bone assemblage. The ability to discriminate between assemblages created by human

agency and those resulting from animal activity is particularly important in prehistoric contexts, where in carnivores and other animals, exploiting the same hunting/scavenging areas as humans, may be responsible for modifications and dispersals of bones.

According to Haynes (1983, 1988, 1991), hyena and lion are capable of breaking the diaphysis of long bones and the shapes of the fractures produced are often similar to those caused by anthropic activity. This evidence usually derives from still growing prey individuals, whose bones are structurally weaker than fully-grown and fused elements of adult elephants, and can be more easily damaged (Haynes, 1988).

The trampling hypothesis does not fit the fracture pattern at Castel di Guido where limb bones are much more fragmented than lighter elements (e.g., ribs and vertebrae). Because of the fine nature of the covering sediment, the hypothesis of sediment pressure breakage can also be excluded.

Deliberate breakage of elephant long bones for marrow does not appear a common practice during the Lower and Middle Paleolithic (see a detailed discussion in Villa et al., 2005, p. 246). This could be related to the nature of most elephant limb bones that do not possess a large medullary cavity full of marrow, but instead have the marrow contained within the hollows of the trabecular bone. Ethnographic field studies in Africa document the procedure to release the marrow and the grease: it is necessary to heat or boil the bone fragments (Fisher, 2001) or to expose bones to the sun collecting the draining liquid (Clark, 1977). Accessing this valuable resource may therefore have resulted in the great degree of fragmentation observed in the elephant remains at Castel di Guido. Particularly intense fracturing of the long bones could be basically linked to the use of blanks as raw material for making flaked tools (bifaces) and other implements bearing a low level of modification

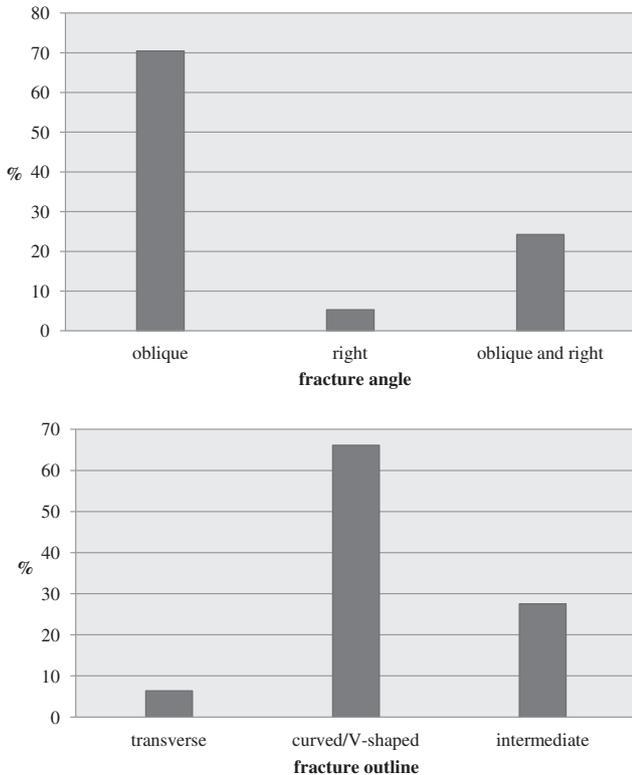


Fig. 14. Relative frequencies of fracture angles and fracture outlines.

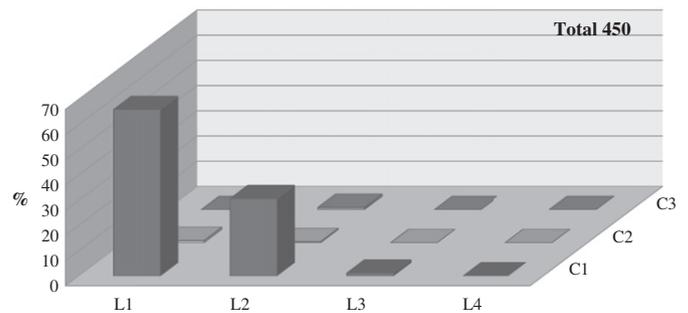


Fig. 15. Combined tabulation of relative frequencies of the shaft length (L) and of the shaft circumference (C). Shaft length: L1 = $\lt; \frac{1}{4}$; L2 = $\frac{1}{4} \leq L < \frac{1}{2}</math>; L3 = $\frac{1}{2} \leq L < \frac{3}{4}</math>; L4 = $L \geq \frac{3}{4}</math>. Shaft circumference: C1 = $< \frac{1}{2}</math>; C2 = $\frac{1}{2} \leq C < \frac{3}{4}</math>; C3 = $C \geq \frac{3}{4}</math>.$$$$$$

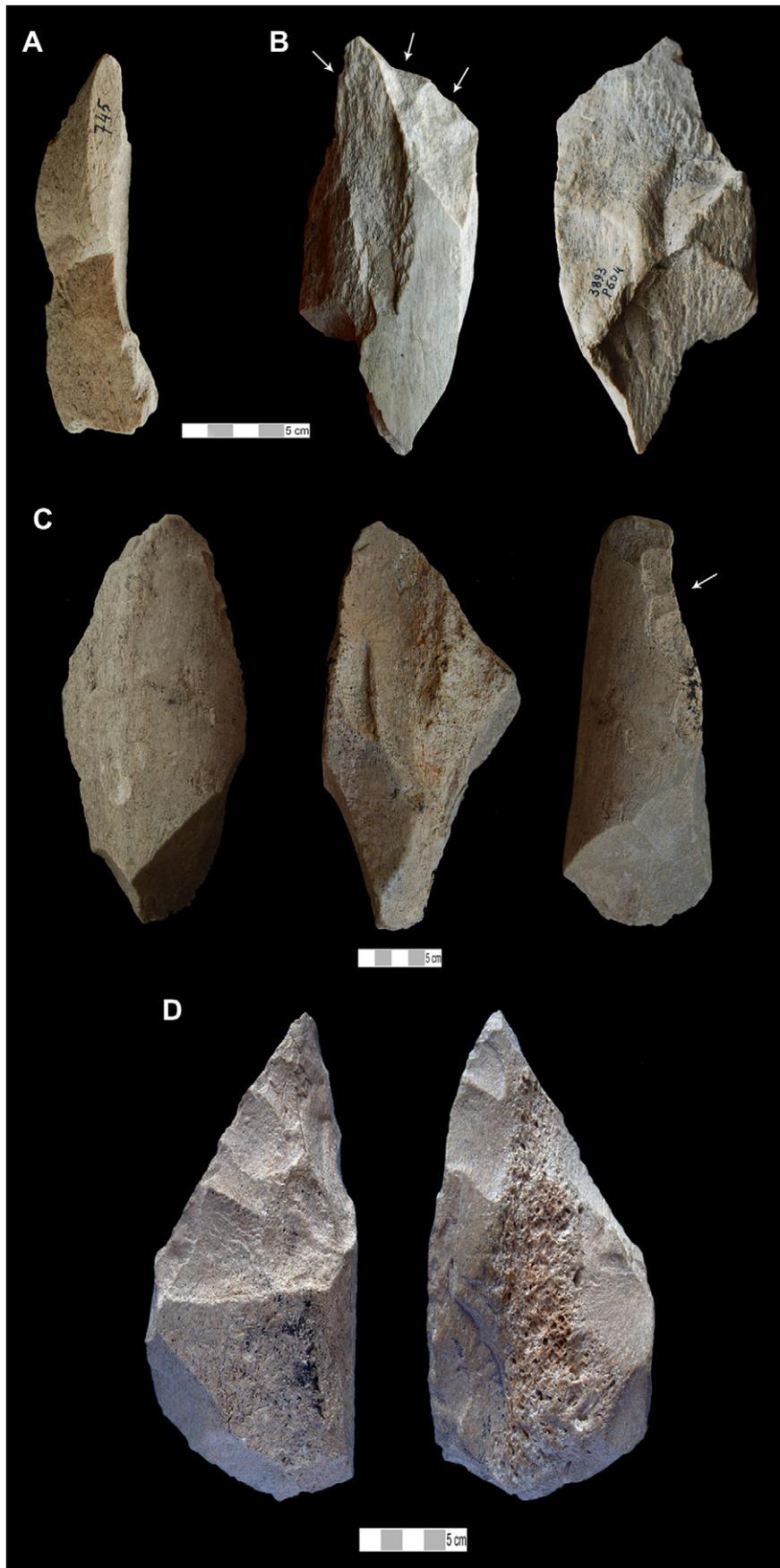


Fig. 16. Elephant bone flakes with traces of intentional percussion. A. Flake removed from a loading point; B. Cortical and medullar views of a bone flake showing negative flake scars (arrows); C. Cortical, medullar and right later side views of a very thick long bone shaft fragment displaying multiple unifacial detachments on the right margin (arrow), it may be a low accurately fashioned tool; D. Cortical (dorsal) and medullar (ventral) views of a bone biface with numerous flake scars on each face.

(Radmilli and Boschian, 1996; Boschian and Tozzi, in press; see a detailed discussion of bone flaking technology during Prehistory in Holen, 2006, pp. 39–40).

The presence of hammerstone-produced features is indicative of human action and can be used for reconstruction of carcass processing techniques. The bone assemblage of Castel di Guido has a complex taphonomic history and often the bone cortical surfaces do not allow a reliable identification of various impact traces. In well-preserved bone, especially diaphysis shards, it is possible to identify evidence resulting from dynamic loading of force against the cortical surface, mainly flake scars (Fig. 16A–B).

During experiments of elephant long bone breakage, pseudo-retouch may be produced on both cortical and medullar surfaces (Backwell and d'Errico, 2004, pp. 116–117). To sort the by-products of marrow extraction from minimally modified bone implements remains a matter of debate; only pieces having sequential flaking of fracture edges creating sinuous bifacial margins, naturally improbable, are unambiguous; their shape removes any doubts about the intentional nature of flaking (Fig. 16C–D). In the Italian Acheulean, the use of bones for biface making is recorded at several other sites in western Latium, at Fontana Ranuccio (Biddittu and

Segre, 1982; Biddittu and Bruni, 1987) and at Malagrotta (Cassoli et al., 1982). At the site of La Polledrara and at Casal de' Pazzi less elaborated, but clearly modified, artefacts are attested (Anzidei et al., 1999; Villa et al., 1999; Anzidei, 2001; Anzidei and Cerilli, 2001; Anzidei et al., 2011). The development of this type of bone artefact production is probably connected to the unavailability of high quality stone raw material in the area for the production of large-sized tools.

The distribution of remains with percussion traces is fairly homogeneous all over the surface. However, it is possible to identify some clusters, of which the one in the south-east sector of the surface, composed mostly of remains of elephant, aurochs and other fragments of a size compatible with that of this species, corresponds to an area in which the density of bone artefacts is particularly significant (Fig. 17). The taphonomic study of bone tools is ongoing and it is hoped that these preliminary observations will provide the basis for further work in the near future.

5. Concluding remarks

The issue about the univocal determination of humans–elephants interaction is a common problem in sites with elephant remains and artefacts. In most cases, this interaction is not clear because of the complex site formation processes whose results limit the informative content of the remains.

Castel di Guido is affected by the same problems. Taphonomic analyses suggest that the site is a palimpsest originated by the superimposition of several natural processes. In this framework, neither hominins nor carnivores apparently played a dominant role in forming the assemblage. The sedimentary context, as well as the state of preservation of the bone surfaces, indicates the involvement of multiple reworking and surface modification agencies that hamper, as in other similar and coeval sites, a final interpretation that clearly differentiates natural events from human behaviour.

At Castel di Guido, reworking in fluvial environment is the most evident cause for displacement and modification of the bone assemblage. The bad state of preservation of bone surfaces due to the above-mentioned processes limits the detection of anthropogenic traces of exploitation (cut marks and anthropic fractures) on *Palaeloxodon antiquus* bones. Nevertheless, the exploitation of elephant carcasses for meat procurement by hominins is demonstrated by evidence of butchery (probable cut marks and marrow extraction). Moreover, very clear and extensive use of bone for tool production is also demonstrated, while intentional bone fracturing for marrow extraction is apparently less probable.

The observed cut marks enrich the body of evidence for elephant butchering at Middle Pleistocene sites (Shipman and Rose, 1983; Scott, 1986; Mania, 1990; Mussi, 2005; Villa et al., 2005; Yravedra et al., 2010). However, the modes of procurement of these animals (hunting or scavenging) remain unclear in most sites (Gaudzinski and Turner, 1999; Gaudzinski et al., 2005; Haynes, 2005; Villa et al., 2005; Mussi and Villa, 2008), as well as at Castel di Guido. Only in two cases, at La Cotte de St. Brelade (Jersey, Channel Islands; OIS 6; Scott, 1986) and at Lehringen (Germany, OIS 5e; Thieme and Veil, 1985), is there evidence suggesting active procurement of the prey (i.e., hunting). At other sites, the bone remains could represent the result of a systematic or occasional exploitation of already dead animals (scavenging) (Mussi and Villa, 2008).

In the light of these observations, the method of prey acquisition by hominins at Castel di Guido could be described probably as a chance to scavenge from naturally dead elephants, or from the kills of carnivores. Either hunting or scavenging imply, however, a deep knowledge of the environment, and of particular areas that were utilised regularly over a period of time in order to procure

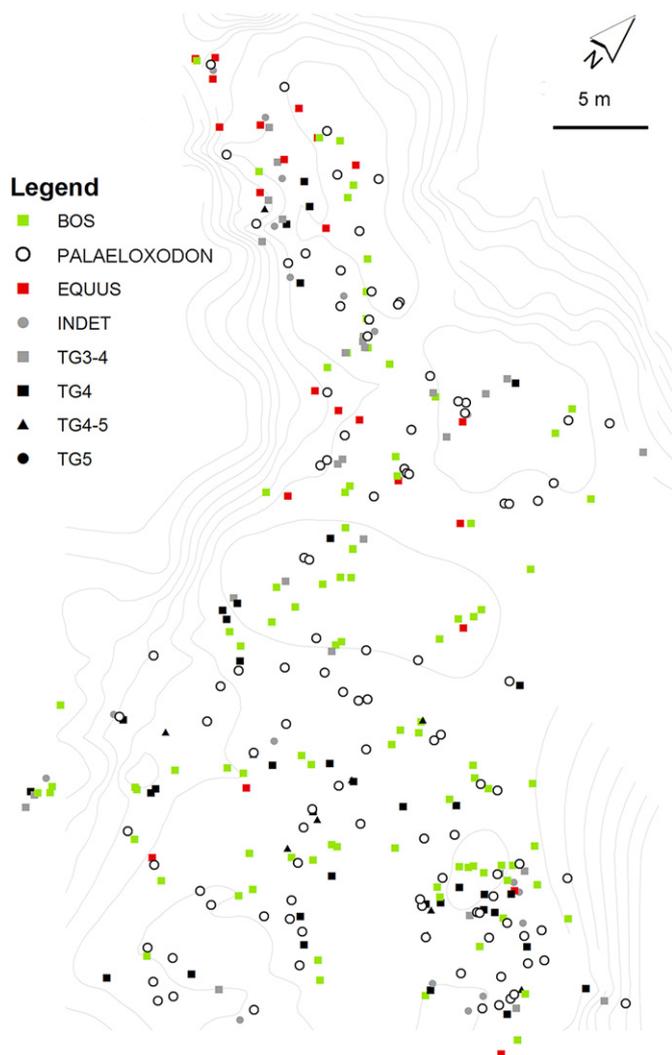


Fig. 17. GIS thematic distribution maps showing the position of bones with percussion marks. BOS = *Bos primigenius*; PALAEOLOXODON = *Palaeloxodon antiquus*; EQUUS = *Equus ferus*; INDET = unidentified bone fragment; TG3-4 = size compatible with aurochs/horse; TG4 = size compatible with aurochs; TG4-5 = size compatible with aurochs/elephant; TG5 = size compatible with elephant.

meat, marrow and bone raw material. The topographic situation of the site of Castel di Guido offered ideal conditions to satisfy the primary needs of the animals (including humans), that lived in this territory. The marshy land that characterised the site at the time the fossil bones accumulated, might have acted as a natural trap in which animals became mired after coming to drink, and therefore it attracted predators looking for food (cf. African modern water holes and lacustrine fossil assemblages; Binford, 1984; Haynes, 1991, 2006; Anzidei et al., 2011).

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