New data from Ambrona: closing the hunting *versus* scavenging debate

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Available online 20 August 2004

Abstract

This paper presents a taphonomic analysis of the faunal assemblages from the 1993–1999 excavations at Ambrona (Spain), directed by Santonja and Pérez-González. The purpose of the new excavations was to achieve a better understanding of the stratigraphic sequence, general geology, sedimentary context and processes of accumulation of materials. Our objectives are to evaluate the opposing interpretations of the hominid subsistence activities at the site proposed by Freeman and Binford. The faunal and lithic remains are found in different sedimentary contexts: an alluvial fan, lacustrine muds, fluviatile clay–sands and channel deposits. Faunal remains in the lacustrine muds are often, but not always, in primary context. Remains of elephant and deer carcasses may be found in partial articulation or proximity and represent natural occurrences without any clear evidence of hominid intervention. In other contexts the faunal remains are occurrences of single anatomical elements either displaced by water or left isolated in situ. There are no carnivore marks; bones and stone artifacts show varying degrees of mechanical abrasion due to water transport. Limited evidence of human action on bones is provided by a few SEM verified cutmarks and some anthropic fractures. They document butchery of various animals, including elephants. We cannot prove hunting but we can definitely reject Binford's idea of marginal scavenging of medium-size ungulates from carnivore kills. Ambrona is a complex mix of natural and human components, the remnant of a natural landscape regularly visited by hominids, who transported some artifacts from nonlocal raw material sources and had an organized approach to meat acquisition. However, strong evidence of elephant hunting is provided only by sites younger than Ambrona.
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1. Introduction

The idea that scavenging was an important pattern of subsistence behavior in the Lower and Middle Paleolithic of Europe was first suggested by Lewis Binford based on his interpretations of a few sites, such as Torralba in Spain and two French cave sites, Combe Grenal and Vaufrey. His suggestions were part of a general model proposed for Oldowan, Middle Stone Age and Middle Paleolithic sites in Africa and Europe (Binford, 1981, 1984, 1985, 1988). Binford argued that during the Lower and Middle Paleolithic in Europe scavenging was the major method of meat procurement with a gradual increase in the importance of hunting until the appearance of fully modern humans. Later Stiner (1994) argued for a more flexible and opportunistic scavenging mode, alternating with hunting which became prevalent only in late Neanderthal times. Her model rests on the interpretation of skeletal element representations at two Italian cave sites, Grotta Guattari and Grotta dei Moscerini. Binford's and

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Stiner's arguments and some of the biases that seriously affect their arguments have been summarized in important papers by Marean and co-workers (Marean, 1998; Marean and Kim, 1998; Marean and Assefa, 1999) who concluded that there is no reliable evidence for scavenging by Neanderthals (*contra* Stiner, 2002). We discuss here evidence from an earlier site, Ambrona, for which new data are now available and which has not been considered in the most recent discussions about scavenging by early European hominids. Given that the hunting versus scavenging controversy is a major issue in human evolution and given the belief that Torralba and Ambrona play a large part in this interpretive process (Freeman, 1994, p. 636) going back to the sites was justified and necessary. Positive evidence is now available to resolve undecided issues. Analyses of the sedimentary context and of the bone and lithic assemblages refute the idea of scavenging from carnivore kills. The hunting scenario is also shown to be unwarranted. Our research underlines the importance of considering not only bone remains but also the stratigraphic and sedimentary context of bones and artifacts. We believe that taphonomy without stratigraphy is not likely to provide solid data and that large-scale behavioral reconstructions must be based on knowledge of small-scale processes.

2. Torralba and Ambrona

Following excavations at Torralba and Ambrona carried out between 1961 and 1963 by Howell and Freeman (Howell et al., 1963; Butzer, 1965; Howell, 1966) Leslie Freeman suggested that the two Acheulian sites, believed to be within the same geological formation (the Torralba Formation) and thus stratigraphically contemporaneous, were formed by a number of hunting episodes during which several animals, mainly elephants but also cervids and bovids, were killed and butchered on the spot. Elephants were driven perhaps by fire, mired in marshes then dispatched with wooden spears or stones. According to Freeman, a factor analysis of the 10 excavated levels at Torralba showed that certain kinds of tools were associated with certain kinds of bones in particular sets of butchering activities. Thus bifaces were used to batter open crania, flakes were used for fine slicing and disarticulation of joints and denticulates to remove tidbits of meat (Freeman, 1975, 1978).

In 1981 and more extensively in 1987 Binford challenged this interpretation and performed another multivariate analysis using the same counts of the 10 Torralba assemblages published by Freeman. His conclusions were the opposite of Freeman's. Artifacts were not strongly associated with elephant bones, the main activity represented at Torralba was not hunting but marginal scavenging, that is, scavenging of marginal parts (heads and feet) of various mammals, especially cervids and bovid, left by carnivores and that only occasionally humans encountered more complete carcasses. Involvement of humans with elephants was minimal and unplanned (see Villa, 1990).

At the same time as Binford, Klein (1987) published a much more cautious interpretation based on a detailed faunal analysis of both sites. Based on mortality profiles he suggested that the elephant bone accumulation was attritional, not catastrophic, that it reflected routine mortality from accidents or disease and that active driving of herds was excluded. At best only hunting of older or weak individuals could be envisaged. He also stressed that there was evidence of fluvial sorting and winnowing at both site. Evidence of sedimentary abrasion on bones from the two sites had also been provided by the work of Shipman and Rose (1983).

Extensive excavations were carried out at Ambrona between 1980 and 1983 and partly published by (Howell et al. (1995); their paper was written in 1991 but published in 1995). The spatial distribution of stone artifacts and bones was provided by main excavated areas but the materials from different layers of the so-called lower occupation complex were treated together. The elephant mortality data published by Klein (1987) were revised and MNI recalculated, suggesting a pattern both attritional and catastrophic. The scarcity or absence of certain skeletal elements was interpreted as intentional removal and the extensive fragmentation of proboscidean bones as deliberate breakage, since trampling was judged to be minimal or non-existent. Nevertheless the declared purpose of the study was to present the main features of the geology, paleontology and archeology of Ambrona without discussing in detail behavioral interpretations.

In 1994 Freeman reaffirmed his belief that artifacts and bones at Torralba and Ambrona were statistically and spatially associated and directly reflected human activities. It is important to note that neither Freeman nor Binford addressed questions of assemblage integrity and sedimentary context. Their statistical analyses were based on the a priori assumption that the assemblages were separate, self-contained units, and that patterns of association and covariation of elements reflected the original site content. Juxtaposition of bones and stones was considered enough evidence that the items were in a functional relationship.

3. New data from Ambrona

Between 1993 and 2000 geological and archeological investigations were resumed at both sites by a Spanish team under the direction of Santonja and Pérez-González. The purpose of the new excavations was to

achieve a better understanding of the sites geomorphology and stratigraphy and to analyze processes of accumulation of faunal and lithic materials. Villa was in charge of the Ambrona taphonomy together with paleontologist Enrique Soto. Our objectives were to document, refute or support the opposing interpretations of the site (Pérez-González et al., 1997 a–c, 2001; Santonja et al., 1997; Santonja and Pérez-González 2000–2001; Santonja and Pérez-González, 2001; Villa et al., 2001; Villa et al., in press).

The total area excavated by the Spanish team is about 600 m^2; Howell excavated about 2058 m^2 in the Lower Occupation (Fig. 1). The stratigraphic sequence is several meters thick; the geomorphology and lithostratigraphy of Ambrona have been described by Pérez-González (Pérez-González et al., 1997a, b, 1999, 2001). As discussed in his papers, which provide more details than this brief summary, geomorphologic analyses of the Masegar river valley, where Torralba and Ambrona are located, indicate that the two sites are in different morphostratigraphic positions, do not belong to the same formation as previously believed (Butzer, 1965; Howell et al., 1995) and are not of the same age. Ambrona is older than Torralba. Its fluviatile and lacustrine sediments with fauna and Acheulian artifacts accumulated on an erosion surface, the Ambrona surface at 1140 m a.s.l. This local erosion surface was drained by the Bordecorex, a tributary of the Duero river; the Bordecorex headwaters were then closer to Torralba than at present and the river was flowing SE to NW. Sometime in the Middle Pleistocene, due to uplifting, the Masegar river (alternative names are Mansegal or Mentirosa) captured the Bordecorex headwaters, leaving Ambrona isolated at a relative height of 39 m above the bed of the Masegar river. The Masegar is a tributary of the Jalón river, itself part of the Ebro river system, and flows NW to SE; its origins are now northwest of the Ambrona site, near the village of Ambrona (cf. maps in Pérez-González et al., 1997a, 1999).
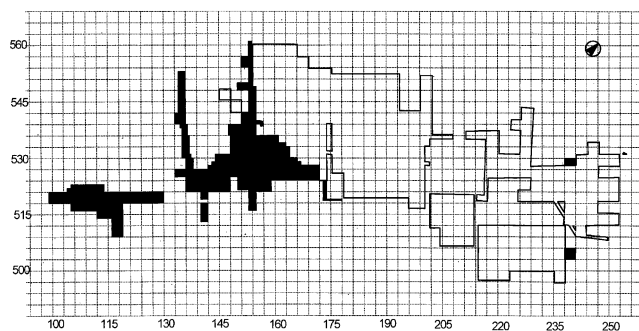

Fig. 1. Plan of the Ambrona excavations by Howell (1961–1963 and 1980–1983; in outline) and by Santonja and Pérez-González (1993–1999; in black). Distance between grid lines equals 3 m. Not included in this plan is the area of the 2000 excavation (to the NE) which was in Upper Occupation layers.

Torralba, about 2.5 km south of Ambrona, is related to the development of the Masegar river valley and lies between the +35 and +22 m terraces, at an absolute elevation of 1115–1116 m.a.s.l. (lower than Ambrona); its base is at a relative height of 28 m above the bed of the Masegar. Correlation of the Masegar terraces with the upper Henares and Jalón terraces suggests that Torralba is older than the date of the 22 m Henares terrace (240–200 ka by U 234/238). Ambrona may be correlated with the date of the 40–45 m terrace of the Henares (>350 ka by Th 230/U 234; Pérez-González et al., 1999). These estimates correspond to those suggested by Howell et al. (1995) who proposed a tentative correlation of the main occupation levels at Ambrona with oxygen isotope stage 12 (about 470–430 ka).

In the central area of the site the Ambrona lithostratigraphic column (Pérez-González et al., 1997b and 1999: Fig. 5) shows six members, AS1–AS6 corresponding to alluvial fan, channel and overbank fluviatile facies and shallow lacustrine environments. AS5 and AS6 are almost sterile. Units AS1–AS4 correspond to what had been called by Howell the Ambrona Lower Occupation Complex. Unfortunately the lack of a published stratigraphic column from the 1980–1983 Ambrona excavations allows only a generalized equivalence of our stratigraphic data, not a one to one correspondence.

We present here the results of the taphonomic analysis of the AS1–AS4 units, carried out in collaboration with all members of the team responsible for the archeology and geology. The excavators followed the natural stratigraphy and plotted in three dimensions all lithic artifacts and faunal remains that seemed identifiable or were larger than 4–5 cm. The outlines of large bones were recorded with a total station; in the lab graphic tablets and AutoCAD software were used to produce images at the desired scale. Bone fragments and lithic artifacts were recorded with single coordinates (Mora et al., 2001). Smaller pieces were collected with square provenience.

Given the sediments high clay content, fine-mesh screening at Ambrona required extensive pre-treatment consisting of spreading sediments on a canvas sheet, sun-drying them, then water-soaking in buckets. Only then fine-mesh (0.5 mm) screening of sediments was possible, using gentle water pressure on superimposed metal screens. The process was very slow. It was clearly impossible to screen the very large volume of sediments removed, so only a one-square stratigraphic column was systematically screened. In addition several thousands kilos of sediments from other areas were screened, from all layers except the AS1 gravels. Results were disappointing. No new species were added to the microfaunal list already published by Sesé (1986) and lithic debris was minimal, a fact also noted by Freeman (1994, p. 602).

The macrofaunal remains of these units consist mainly of *Elephas (Palaeoloxodon) antiquus*, *Bos primigenius*, *Equus caballus torralbae*, *Cervus elaphus* and *Dama* sp (Soto et al., 2001). Carnivores (*Canis lupus*, *Panthera* sp. and Carnivora indet.) are very scarce and represent 1–3% of the macromammal NISP in units AS3 and AS4; they are absent in other units (Tables 1–3). Other ungulates (*Capreolus* sp. and *Stephanorhinus hemitoechus*) are represented by very few remains. Neither hyena coprolites nor any hyena skeletal remains have been found. It is not clear to us if the hyena coprolites reported in previous excavations might have been in fact spherical carbonate concretions

Table 1
Total number of specimens identified to taxon in AS1

Taxon	NISP
Elephas (P.) antiquus	126
Cervids	58
Bovids	27
Equus caballus	8
Stephanorhinus hemitoechus	1
Total	220

The sample of bones with coordinates includes also 117 specimens identified to a body size category (size categories are explained in the endnote) and 118 non-identified specimens (NID).

Table 2
Total number of specimens identified to taxon in AS3

Taxon	NISP
Elephas (P.) antiquus	129
Cervids	38
Bovids	5
Equus caballus	6
Carnivores	2
Total	180

The sample of bones with coordinates includes also 41 specimens identified only to a body size category, 44 small fragments of a weathered tusk (no. 269) and 144 NID.

Table 3
Total number of bones identified to taxon in AS4

Taxon	NISP
Elephas (P.) antiquus	123
Cervids	61
Bovids	11
Equus caballus	10
Carnivores	6
Total	211

The sample of bones with coordinates also includes 143 specimens identified to a body size category and 90 NID.

which are quite common in the sediments. The Ambrona fauna is typical of the Middle Pleistocene in Europe but most species existed over a substantial block of time (Howell et al., 1995) so they cannot be used to provide a more precise age estimate.

Unit AS1 at the base of the Lower Occupation sequence is an alluvial fan merging into sandy channel deposits in the northern part of the site. The latter were excavated in 2000 and are not treated here. The total excavated area of AS1, excluding the channel facies, is $545 \, m^2$. Subrounded limestone pebbles with a mean size of 2–3 cm and a maximum size of 13 cm. are jointed forming an undulating pavement, with a maximum thickness of 20 cm. Most bones are single isolated clasts of relatively small size; both bones and stones are clearly in secondary context, as indicated by a high frequency of abraded edges (see below Figs. 17 and 18). The density is quite low, 337 NISP (identified to taxon or body size category) over $545 \, m^2$. Density of lithics is lower, 189 artifacts/$545 \, m^2$. Finds are scattered throughout the excavated squares; there are no indications of concentrations, the spatial distribution clearly reflects geological rather than human factors. The artifacts and faunal remains may very well have originated from other strata and may have been moved an unknown distance from their original point of deposition.

Units AS1/2 and Unit AS2 above are laterally discontinuous lacustrine and fluviatile deposits not very rich in either bones or stone artifacts and will not be considered in much detail here. They occur in the SE portion of the excavated area and do not seem to occur in the area excavated by F.C. Howell. They do attest however to the continuing human presence in the area (Fig. 9(e)).

AS3 is a 1 m thick unit of sandy clays with sparse small clasts between 0.5 and 2 cm in diameter; it represents a swampy or shallow lacustrine medium, with known limits to the north and west. The total excavated area is $250 \, m^2$. AS4 is a fluviatile-lacustrine deposit fining upwards, with a maximum thickness of 1.5 m. The base of the layer is formed by limestone gravels (the mean size of clasts is 1–2 cm, maximum size is 5 cm) in a sandy–silt–clay matrix; the top of the layer consists of a massive silty clay. Stone artifacts and bones are found only in the detrital facies excavated over a surface of $379 \, m^2$ (Santonja and Pérez-González, 2001). Density of bones is also quite low: there are 221 NISP/$250 \, m^2$ in AS3, and 354 NISP/$379 \, m^2$ in AS4 (Tables 1–3). Where AS3 and AS4 overlie directly AS1, some bones sank through wet sediments and came to rest on and partly in the AS1 gravel deposits whose surface must have been remobilized by water (Figs. 8(b) and 13(e)). A similar observation was made by Butzer (quoted in Freeman, 1994, p. 613).

A detailed description of the lower part of the sequence (AS1, AS1-2, AS2) falls outside the scope of

this report; we turn instead to units AS3 and AS4, both of which have provided significant new data.

3.1. The AS3 elephant skeleton

The central area of the 1993–1999 excavations contained the partial skeleton of a fully adult/old male *Elephas (P.) antiquus* (Figs. 2–4). This individual is represented by 86 bones including a cranium (AS3, 463)

Fig. 2. Layer AS3, 1995 excavations by Santonja and Pérez-González. Partial skeleton of an adult male *Elephas (P.) antiquus* from Ambrona.

with complete mandible (AS3, 492) two tusks (the right tusk 464 in its alveolus and 429 displaced) most vertebrae and ribs, the two scapulae, the pelvis (461) and various long bones. With few exceptions bones were not articulated but lay close to each other, occasionally preserving their anatomical proximity. There are two cases of articulated bones (the cranium with left tusk 464; the 7th cervical with the first thoracic vertebra) and two cases of bones in anatomical sequence (left ribs 7th and 8th; right ribs 9th and 10th).

The bones missing from the concentration or its vicinity are indicated in black in Fig. 5 and are as follows:

- All the phalanges of manus (28) and pes (28) and all the sesamoids.
- Seven of 10 metacarpals. Of the three surviving metacarpals, two (right MC4 no. 531 and right MC3 no. 452) are indicated in Fig. 3, the third one (left MC3 no. 383) is approximately 5 m to the north, in Fig. 4.
- Ten of 16 carpals. Only two of the 6 occurring carpals were found within the main concentration, three (501,534, 532) were on the NW edge and another one was about 5 m to the north (a right trapezium, no. 384; Fig. 4).
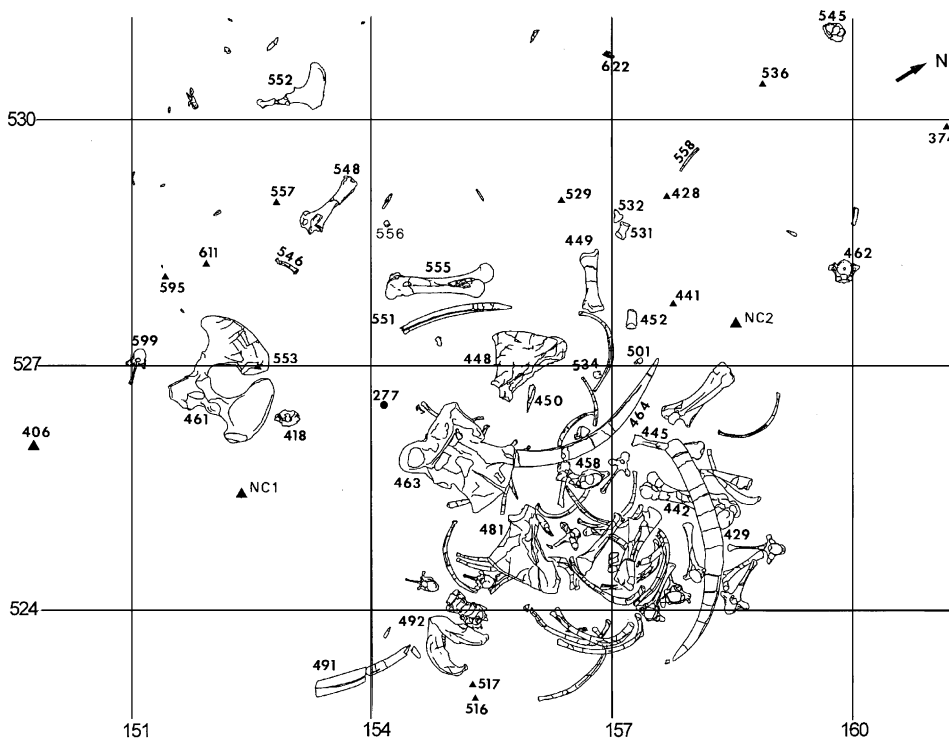

Fig. 3. Layer AS3, central area of the 1993–1999 excavations. Distance between grid lines equals 3 m. This area is approximately 80 m² and contains the partial skeleton of an adult male *Elephas (P.) antiquus* and a few isolated bones of two other elephants and other animals (*Bos* and *Dama*). Only bones discussed in the text carry their find number; the triangles indicate stone artifacts, two of which (NC1 and NC2) did not receive precise cartesian coordinates, only their one-meter square provenience. The area to the bottom left was excavated but it contained neither artifacts nor bones.
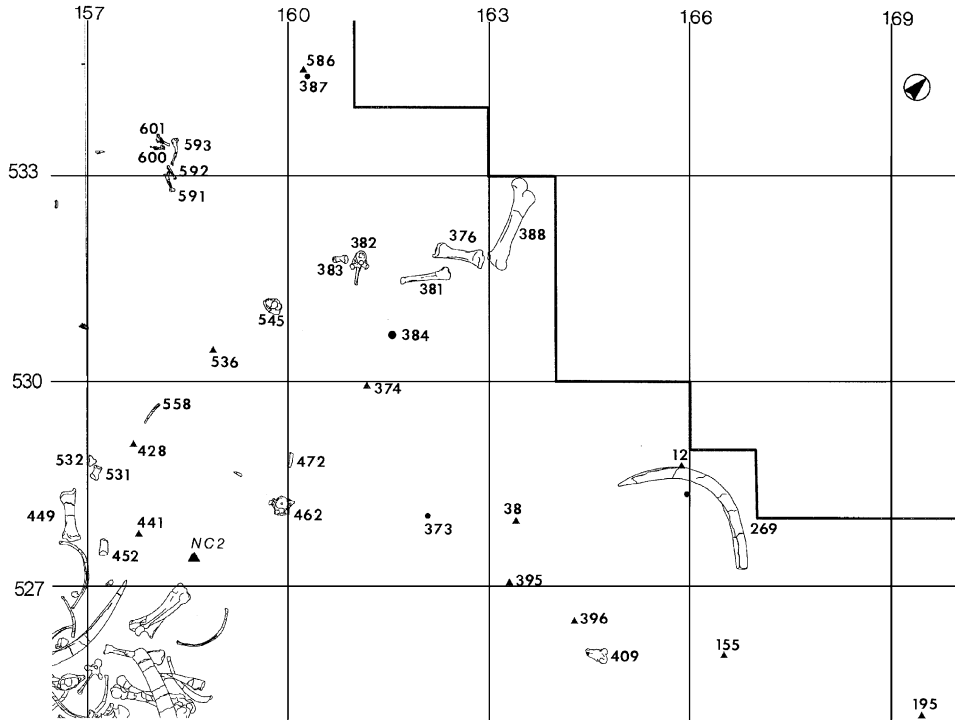
Fig. 4. Layer AS3, northern edge of the concentration represented in Figs. 2 and 3. Distance between grid lines equals 3 m. Triangles = stone artifacts, dots = small bones.

- All tarsals.
- All metatarsals.
- Four cervical vertebrae. The atlas (no. 458) and the seventh cervical (no. 438) were within the concentration but the third cervical was displaced to the north (no. 462).
- Ten of 20 thoracic vertebrae. Nine occur within the concentration, one (THO 11/12, AS3, 599) was found near the pelvis.
- All caudal vertebrae.
- Nine ribs. Of the surviving 31 ribs, most could be assigned to side and position in the rib cage except for six that were buried under the cranium, one which was under the tusk 464 and another one (558) found somewhat displaced to the north, its proximal shaft unexcavated.
- The left humerus. The right humerus 442 was under tusk 429. The only other elephant humerus from this stratigraphic unit is a left specimen found about 16 m. to the south (AS3, 715). However its total length is about 6% shorter than that of the right humerus ($L = 120$ and 127.5 cm respectively) so it is unlikely that it belonged to the same individual. Both humeri were intact (except for postdepositional compression fractures) without cutmarks.
- The right femur and the left fibula. The left femur (388), the right tibia (376) and the right fibula (381) were found about 7 m to the north (Fig. 4). At least in

the case of the right tibia its attribution to the same adult male is confirmed by its measurements (length, transverse diameter of the epiphyses, minimum diameter of the shaft) which are very similar to those of the left tibia 449.

Haynes (1988) notes that at elephant death sites near water holes the lower leg bones (phalanges, tarsals, carpals) and tail vertebrae are the first elements to be removed by scavengers.

3.2. Syndepositional processes, trampling and bone breakage

Most bones of this partial skeleton were found at the base of layer AS3, a few cm above AS2 (the maximum observed vertical distance 28 cm) or directly onto its surface; the lumbar vertebra 277 and the metacarpal 452 were surrounded by the small gravels of AS2 probably due to sinking in wet sediments. West of the concentration layer AS2 was laterally discontinuous and AS3 was directly overlying AS1 (Fig. 8(b)).

Evidence that the carcass remained unburied for a certain time is provided by a few observations:

1. The left tusk (AS3, 464) moved under its own weight to the left, most likely following decay of the gums, and lay over a rib.
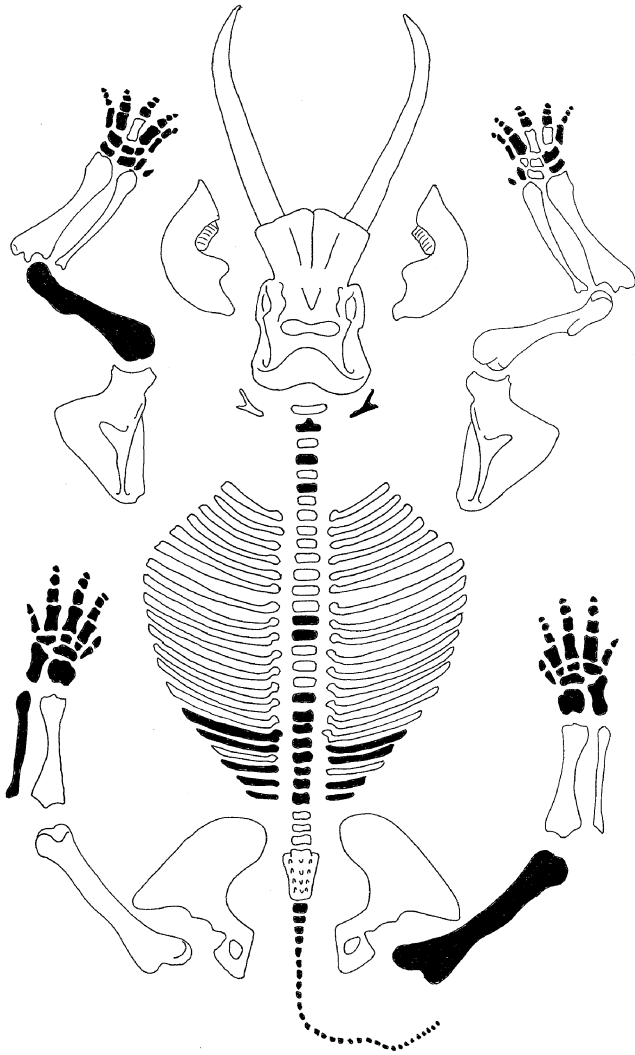
Fig. 5. Schematic elephant skeleton. Bones missing from the concentration of Figs. 2 and 3 are indicated in black; bones in outline are present.

2. The cranial border (AS3, 450) of the right scapula (AS3, 448) was broken and displaced a few cm away from the blade.
3. Likewise, near the left scapula 481 lay a fragment of its blade (526).

Apparently the carcass was lying in shallow waters or wet sediments and was exposed to trampling and displacement of bones. Six ribs and one thoracic vertebra were buried under the cranium (Fig. 6(a)). Since the combined weight of the skull and tusks of an adult male African elephant can be as much as 500 kg (Shoshani, 1996) and the Pleistocene *Elephas (P.) antiquus* was larger than most African elephants, it seems unlikely that the skull was lifted and placed where it was found purposely by human action. More likely the position of those six ribs and thoracic vertebra is the result of underwater displacement. According to Ago-
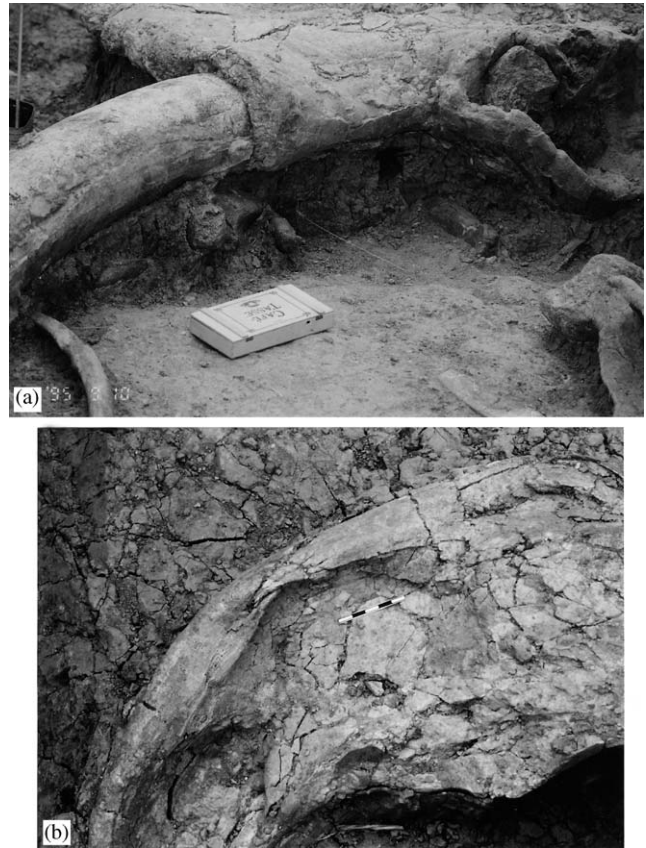

Fig. 6. (a) Bones buried under the elephant cranium AS3, 463; (b) depression fractures on elephant mandible 492.

gino and Boldurian (1987) a mammoth skull can float temporarily if the interior part, which is spongy and has many hollow pockets that can trap air, is not yet filled with sediment. The position of the skull and the distance between pelvis and skull may suggest a death posture in a prone position; note however that the pelvis has its anterior (internal) face upward so it must have tilted sidewise and got separated from the sacrum which lies near the mandible. Moreover the scapulas have been displaced several meters and their position with respect to the skull is inverted (448 is right, 481 is left). The tusk 429 overlies the right humerus 442 and the left radius 445, suggesting that it was displaced after those long bones had settled in their position. Given these complicating factors, it is not possible to reconstruct the death posture of the animal. Trampling and handling of bones by other elephants may be the cause of displacement (Haynes, 1991, pp. 156,191).

Subaerial weathering of these elephant bones is absent or extremely limited; most surfaces show no weathering cracks and can be assigned to Beherensmeyer's weathering stage 0 or 1. Diagenetic alteration is present on many bones in the form of rootmarks and abrasion striations; these latter may be due to expansion and contraction of clast-containing clays of the AS3

lacustrine muds or to trampling (Olsen and Shipman, 1988). Some manganese stains, calcareous concretions and cemented clay particles partly obscured surface details. Carnivore marks would have been visible but they were not present on any of these bones. It is worth noting that the identification threshold of carnivore marks is generally lower than that of cutmarks; with the exception of small grooves and toothpits most gnaw marks can be identified even if cortical surfaces are not well preserved.

Trampling, by other elephants or other large animals, is documented by depressed fractures on some bones, such as the cranium (on the posterior-dorsal surface of the fused premaxillae) on the mandible [on the lingual surface of both horizontal rami; Fig. 6(b)) and on the right ulna 440. These fractures cannot be the result of compression by sediments because the AS3 sandy clays here are homogeneous and do not contain large stones that may be responsible for localized damage; the maximum size of clasts is 2 cm. Thus the fractures must have occurred before interment.

Postdepositional compression fractures are very common on these elephant bones and generally on AS3 and AS4 bones. They affect the bones by overall flattening or creating a network of incomplete fractures and fissure lines (Fig. 7(a) and (b)). Voids and zones of differential pressure may occur due to flesh decay, if bones rest on convex or concave surfaces or are superimposed. Sediment pressure, acting on progressively weakened and diagenetically altered bones, will then cause fracture. None of the bones belonging to the elephant single skeleton have fractures that might be considered anthropic. Only two elephant long bones in AS3, nos. 409 and 713 (Fig. 8(c)) the distal end plus shaft of an adult left and an adult right femur, show evidence of anthropic fractures but neither belongs to the adult male of the concentration. Anthropic fractures on bones not related to the concentration in AS3 are discussed below.

3.3. Remains of other elephants and other animals

Of the two tusks that belong to the adult male, 429 is displaced but its measurements correspond to those of 464, which is in the alveolus. Two other smaller tusks, both left, are present just west and south of the main bone accumulation (Fig. 3). These are no 551, attributed to a female, and 491, also a female or a young male. In addition to atlas 458 which by its measurements and position clearly belongs to the adult male, two other smaller atlases have been found: no. 545 to the north (high in AS3, 45 cm above AS1) and 418 near the adult male pelvis 461 and in a higher position with respect to it. Thus based on tusk and atlases the elephant MNI of this area is three, although the second and third individual are represented only by isolated bones. Other

elephant bones that cannot belong to the adult male and belong instead to smaller individuals (possibly those represented by tusks 551 or 491) are a left femur 555, a right ulna 548 and a left pelvis 552 (Figs. 3 and 8 (a)). Nearby are isolated bones of other animals: 546, a right radius of *Panthera* sp., and 556, the proximal epiphysis of a *Bos primigenius* tibia. These bones are found at different elevations within AS3, sometimes in a higher position with respect to the bones of the adult male elephant, all of which lay toward or at the base of the layer. Thus the carnivore radius 546 and the elephant ulna 548 are high in AS3, about 58 and 35 cm above AS1 respectively but the *Bos* tibia was at the base of layer AS3.

In sum, the plan presented in Fig. 3 should not be considered the representation of a land surface at a moment in time but the arbitrary two-dimensional image of bones accumulated in fine-grained sediments at different times in a pond or at its edges. The major single event is represented by the elephant carcass but there is no evidence that the isolated bones found near it represent the same moment in time.

3.4. Association with stone artifacts

Fig. 3 shows 14 stone artifacts of flint and quartzite found at the periphery of the concentration. From the bottom of the plan and going clockwise, there are nos. 516, 517, NC1, 406, 553, 595, 611, 557, 529, 428, 441, NC2. Two others are 536 and 374 are more than 3 m away from the edge of the concentration to the north.

Only four of these artifacts are fresh, all others are slightly (6) to very abraded (4) thus in secondary context. The unabraded artifacts are as follows:

- 406, a small (2.3 cm) flint flake, 1.8 m south of the pelvis 461.
- NC1 and NC2, respectively a non-cortical flint flake ($L = 5.5$ cm) and a flint biface ($L = 11.2$ cm) come from the top of AS3, while the elephant bones are at its base, their vertical separation can be as much as 80 cm. The flint biface is 1 m higher than a nearby small and abraded quartzite flake 441.
- 536 is a flint flake at 3 m distance from the edge of the concentration.

Differently from the situation at Aridos 1 where 18% of the 328 artifacts could be refitted and another 44% were clearly knapped from the same few nodules (Santonja et al., 1980; Villa, 1990) none of these pieces refit. It is true that at other sites with a single elephant carcass, such as Lehringen and Gröbern, artifacts did not refit either and were made of two and five different raw materials respectively (Gamble, 1999, p. 245). It may seem unreasonable to expect refitting when a very small number of artifacts is concerned (25 at Lehringen,

Fig. 7. (a) and (b) Compression fractures on elephant scapula AS4, 685 and elephant mandible AS4, 679. (c) in situ weathering and fragmentation of tusk AS4, 1002.

Fig. 8. (a) Elephant bones (not belonging to the single male skeleton) at different elevation in AS3: tusk 551, femur 555 and ulna 548. The elephant thoracic vertebra below the femur shaft and the bone below the femur head (a bovid atlas) are in AS1/2 sediments. (b) West of the concentration three pieces of a broken deer antler, nos. 638-639-640, at the base of AS3, directly overlying unit AS1. (c) Distal end of two elephant femurs with spiral fractures, AS3 409 and 713, partly covered by concretions.

27 at Gröbern and 14 in AS3) and raw material variability may be interpreted as due to the gathering together for the hunt of people from different areas. In our case it is the vertical and horizontal positions of the four unabraded artifacts and the abraded surfaces of the other ten that do not permit an inference of association with the elephant bones. Taking into account also the absence of anthropic fractures and of verified cutmarks on the bones (cf. below) we must conclude that these artifacts are not in clear functional relation with the carcass.

3.5. Surface marks on bones

Tusk 429 and tibia 449 carried surface marks that resembled cutmarks and have been verified by SEM. The tusk has an oblique light mark on its midsection (Fig. 9a). Similar kinds of striations are observed on other tusks from the site (Villa and d'Errico, 2001, Fig. 15e). These marks were most likely produced during the elephant's life when using tusks in a variety of activities, such as digging for tubers and water or stripping bark from trees (Haynes, 1991). Tibia 449 had two marks, one on midshaft, the other on distal shaft, both transverse to the shaft long axis. These grooves have a flat bottom, unusual in stone tool marks. Their general morphology and section do not support a human origin for the marks The bone surface is affected by rootmarks and very light striations probably due to natural sedimentary abrasion (Olsen and Shipman, 1988). The deeper grooves may be due to trampling by other animals; this is supported by the fact that both marks are transverse to the long axis of the shaft.

3.6. Area north of the concentration

As mentioned before, some elephant long bones (388 left femur, 376 right tibia and 381 right fibula), various carpal and metacarpal bones (452, 531, 532, 383,384), a thoracic vertebra (382), a 3rd cervical vertebra (462) and a rib (558) found at some distance from the concentration may be from the same adult male individual. Other bones shown in the map of Fig. 4 do not belong to the single carcass. No. 409 is the distal end plus shaft of an adult left femur (hence an individual different from the one represented by 388, also left). Tusk 269 for its size and shape (quite curved) cannot be paired with any of the other tusks and belongs to a fourth individual; 373 is a tusk tip of a juvenile elephant.

Bones of animals other than elephants are represented by a right radius of *Dama* sp. *dama*, no. 472, and by nos. 591–593 and 600–601 which are the pelvis and left hind leg (femur, tibia, metatarsal) of a *Cervus elaphus*. The deer bones are not articulated but in close proximity; they carry no cutmarks and are not broken for marrow.

In addition to the five artifacts (NC2, 441, 428,536, 374) also indicated in Fig. 3, there are 7 more artifacts in this area (38, 395, 396, 155, 195, 12 to the east and 586 to the west); two are slightly abraded, the rest is fresh. The total is only 12 stone artifacts in an area of 55 m^2; their vertical separation varies from 3 cm (38 and 395) to 66 cm (12 and 155). Likewise, not all bones are on the same plane; e.g. the atlas 545 and the rib 558 (both elephant bones) have a vertical separation of 90 cm, their horizontal spread is 2.6 m. In sum, this area contains sparse bones from different episodes of accumulations, none showing clear evidence of anthropic action nor a clear association with the few stone artifacts.

In conclusion, the evidence suggests that the elephant skeleton is the result of natural death near a body of water. The absence of verified cutmarks appears to exclude the possibility of anthropic intervention (see section on butchery at the end). The stone artifacts, embedded in the sediments that contained the bones, were not located within the bone scatter but at its periphery. They do not refit. Their vertical distribution only proves that they were broadly contemporaneous with the deposition of the AS3 sediments; some, like the flint biface, were abandoned a long time after the deposition of the carcass. The abraded edges of half of them (12/22, including the 8 artifacts found north of the concentration) also show that they have been transported by water over a certain distance.

The absence of many relatively smaller elements that have a high transport potential (carpals, tarsals, patella, caudal vertebrae, phalanges, sesamoids; Frison and Todd, 1986) and the scarcity of others with intermediate transport potential (such as metapodials, cervical and thoracic vertebrae) may be an indication that some of the channels that were feeding the bodies of water present at the site (documented by localized lenses of gravels in AS3) have carried them away. There is increase in small gravels at the base of the layer which suggests a higher energy environment but it occurs some meters away from the concentration to the east, in squares 153–155/515–522 (Pérez-González et al., 1999.) The abraded artifacts are another indication in favor of water displacement. Alternatively these bones were removed by scavengers (as suggested previously) or they remain unexcavated under the larger bones. At present we have no sure way of choosing between these hypotheses.

The cause of the dispersal of long bones such as the left femur, the right tibia and the right fibula found north of the concentration is also uncertain. The bones were not broken (except for postdepositional compression fractures) and had no cutmarks. The scatter may be due to some light scavenging by local carnivores (a lion radius and a wolf maxillary fragment occur in the AS3 faunal assemblage) but if so, they have left no trace on
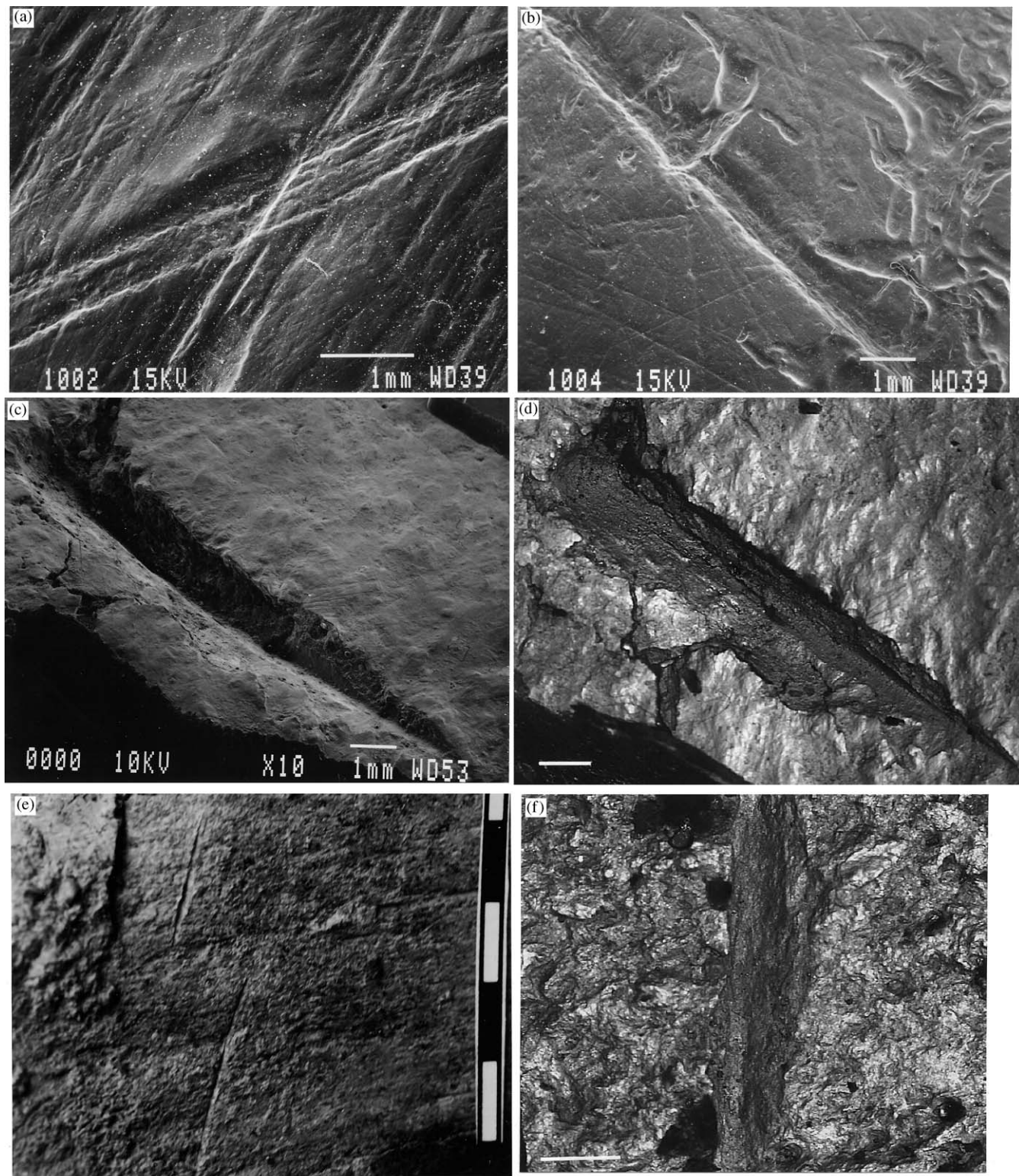
Fig. 9. (a) Mark on right tusk AS3, 429; the oblique (top to bottom) parallel lines are the natural surface. (b) Mark on midshaft shaft of tibia AS3, 449. The bone surface is affected by rootmark and light abrasion striations; (c) and (d) deep cutmark (or chopmark) on elephant premaxilla AS3, 567. Two other less deep marks parallel to this one and in the same position were not well preserved and could not be diagnosed. (d) Clearly shows the internal details of the groove, its sharp edges and V-shape, supporting its diagnosis as tool-made. (e) Cutmarks on elephant ulna AS1/2, 137. (f) Detail of right cutmark on ulna. Although not as well preserved as (d) the V-shaped groove can be confidently interpreted as a cutmark. (a)–(c) are SEM micrographs; (d) and (f) are macrophotos of resin replicas seen in transmitted light. Scale of (d) and (f) = 1 mm.

the bones themselves. It is interesting that, in contrast to the majority of bones in the concentration which show no evidence of subaerial weathering, tusk 269 to the north was heavily weathered and exfoliated; 44 small fragments were lying close to it. For a similar example, cf. Fig. 7(c). Fissure cracks indicating expansion through alternate wetting and drying and filled with carbonate concretions were present in the clayey sediments near this tusk. Thus it seems that this area was periodically dry and may have represented, at times, an exposed ground surface near a more permanent body of water.

3.7. Other elephant bones in AS3

The total excavated area of AS3 is about 250 m². Aside from the single carcass accumulation the density of bone remains and stone artifacts is extremely low. In the 250 m² including the area with a single skeleton there is a total of 67 artifacts and a total of 409 macrofaunal bones with coordinates of which 129 are of elephants. These counts do not include small unidentifiable pieces with only square provenience (Table 2).

The elephant bones, other than those assigned to the single carcass, are very sparse, NISP = 43 (excluding the numerous small fragments of the weathered and heavily fragmented tusk 269). The total MNE is 23 (Table 4). Four tusk tips with stems and two medial tusk segments (Villa and d'Errico, 2001) very probably came from live animals; tusk breakage results from intraspecific fights or when tusks are used for pushing and lifting heavy objects (Haynes, 1991). These tusk tips, tusk shaft segments and two deciduous molars are not considered for the MNE counts.

Table 4 and the diagram in Fig. 10 show that this is a depleted assemblage missing all the small elements (vertebrae, carpals, tarsals, phalanges) and other elements that have a high or intermediate transport potential (sacrum and ribs). The best-preserved elements, in addition to tusks (four, corresponding to a MNI of 3) are other large bones such as a complete cranium, portions of four scapulae and pelvises and six long bones. We should note that the absence of small elements is in no way related to excavation procedures since caudal vertebrae, sesamoids and phalanges of smaller mammals are present in all assemblages.

In contrast to the lack of evidence of anthropic intervention from the elephant concentration the cranium AS3, 567 carries an undisputable cutmark (Figs. 9(c) and (d)) and of the three femoral specimens, two distal shafts are broken by spiral, V-shaped fractures that can be diagnosed as man-made. We conclude that the AS3 elephant bone assemblage is the result of variable, both natural and anthropic, processes and cannot be subsumed under a single explanation.

Table 4
Elephant bones from AS3, excluding the single carcass

Element	NISP	MNE	MAU	% MAU	Exp. MNE (MNI = 3)	% Survival
Cra (1)	3	1	1.0	50	3	33.3
Man (2)	0	0	0.0	0	6	0.0
Tusk (2)	15[a]	4	2.0	100	6	66.7
Vert (30)	5	4	0.13	6.5	90	4.4
Sac (1)	0	0	0	0	3	0.0
Rib (40)	9	4	0.1	5.0	120	3.3
Scp + Pel (4)	5	4	1.0	50	12	33.3
Hum (2)	1	1	0.5	25	6	16.7
Rad + Uln (4)	1	1	0.25	12.5	12	8.3
Fem (2)	3	3	1.5	75	6	50.0
Tib + Fib (4)	1	1	0.25	12.5	12	8.3
Met (20)	0	0	0	0	60	0.0
Podial (28)	0	0	0	0	84	0.0
Pha (56)	0	0	0	0	168	0.0

The minimum number of individuals (MNI) is 3 and is based on tusks, taking into consideration their size and side.

Abbreviations: MNE = minimal number of elements; MAU = minimal animal unit. MAU is the statistic used by Binford (1984); percentage survival is the index used by Brain (1981). These indexes express the differential survival of anatomical parts and produce very similar diagrams. The % MAU or standardized MAU statistic is commonly used in faunal studies. However, we consider the percentage survival of Brain a more faithful representation in this case since in the % MAU statistic the most common element (tusk) is assigned a value of 100%, yet it is only represented by four tusks, not the six expected on the basis of the MNI. The MNI of three individuals is used in the percentage survival statistic to calculate the total expected MNE for each element and provides a value of 66.7% which is more precise. MAU value are provided for analysts who prefer that index.

Abbreviations: Cra = cranium; Man = mandible; Vert = vertebrae, including cervical, thoracic and lumbar; caudal vertebrae are not counted and they are not present at any rate; Sac = sacrum; Scp + Pel = scapula and pelvis; Hum = humerus; Rad + Uln = radius and ulna; Fem = femur; Tib + Fib = tibia and fibula; Met = metacarpals and metatarsals; Podial = carpals and tarsals (there are no sesamoids nor patellas); Pha = phalanges. The number of elements in a single skeleton is provided in parenthesis in the first column.

[a] 44 small fragments of the weathered and heavily fragmented tusk 269 are not included.

3.8. Remains of other animals in AS3

Remains of other animals in the 250 excavated square meters of AS3 are sparse. In addition to the 51 non-elephant specimens of Table 2, there are 41 are elements that can only be assigned to a body size category. Bovids (when fully identified, it is only *Bos primigenius*) are represented by 5 NISP and a MNI of 2. *Cervus elaphus* and *Dama* sp are represented by 8 and 9 NISP each with a MNI of 2 for *Cervus* and 1 for *Dama*. If all the bones assigned to Cervidae are considered the total NISP is 38 and the total MNI is 6, including four adults, one old and one juvenile individual. *Equus caballus* is present with 6 NISP; five of them are teeth (MNI = 1).

Among these bones few are those that present a fracture morphology indicating fresh bone breakage

(spiral or V-shaped breaks; Villa and Mahieu, 1991) and may have been broken for marrow (i.e. long bones or shaft fragments or NID): 12 of 31 broken bones. All other breaks suggest a postdepositional or indeterminate origin (transverse, irregular or stepped morphologies). None carries cutmarks (Table 7). Note however that 85% of the appropriate bone surfaces are obscured by concretions, rootmarks or diagenetic alteration and are not observable. There are no visible carnivore marks. One shed deer antler and one complete pelvis with intact left hind leg of the same animal (Fig. 4) again indicate that various elements accumulated naturally.

3.9. Horizontal distribution of bones and stone artifacts in AS4

As mentioned in the first part of this report, stone artifacts and bones are found only in the detrital facies excavated over a surface of 379 m². Fig. 11 shows a portion of the excavated surface about 30 m south-west of the central area with the elephant skeleton. This plan (squares 107–117 and 515–522) allows to visually assess differences in spatial distributions between AS3 and AS4. In these 81 square meters there are 109 bones with coordinates and 51 stone artifacts at or near the base of the AS4 layer which here overlies directly AS1. Vertical separation of stone artifacts in the same square can be up to 30 cm. The stone artifacts and the bones show variable degrees of abrasion (Fig. 12). Slight differences in the fresh category between bones (12.5%) and stones (0%) may be due to the fact that smaller elements (lithics) are displaced and rolled more easily by water. Postdepositional displacement is indicated by two conjoining teeth fragments (upper first molar of a fallow
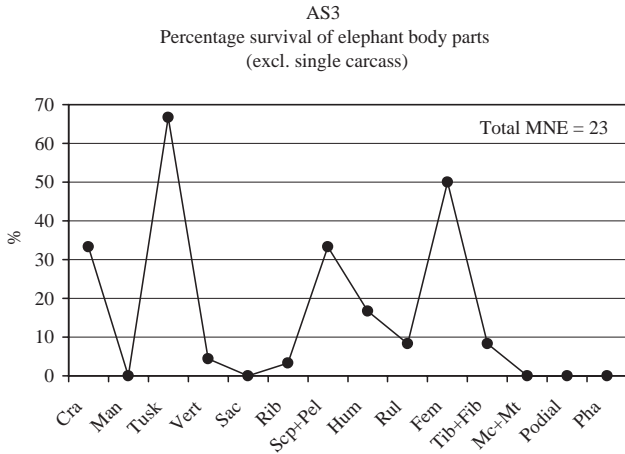

Fig. 10. The percentage survival of elephant bones in AS3, excluding the remains of the single carcass. Calculations are based on a MNI of 3.
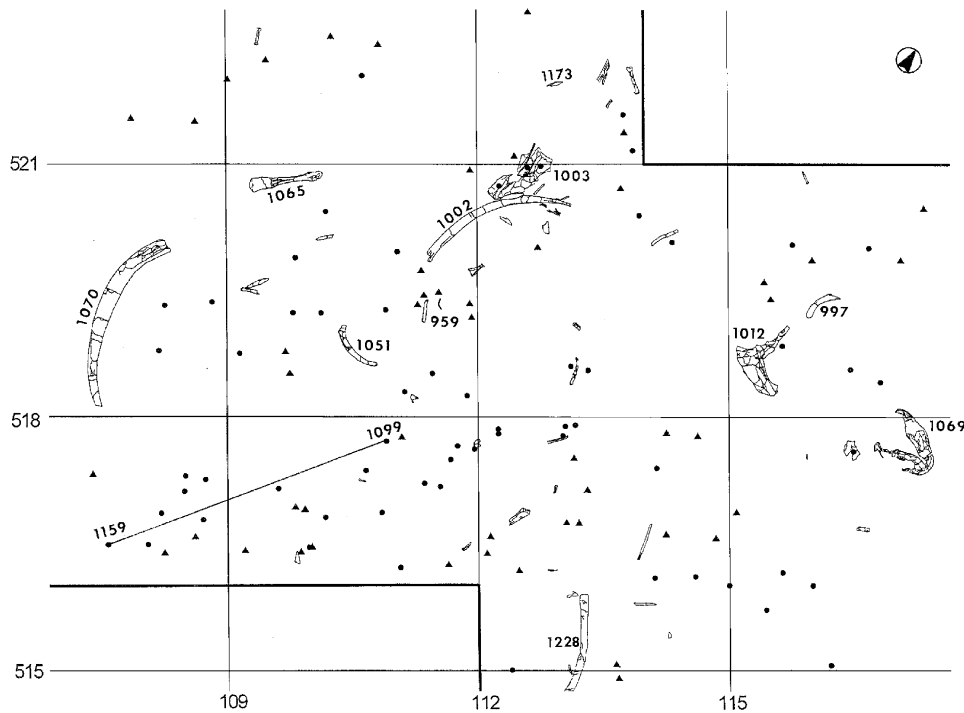

Fig. 11. Plan of a portion of the AS4 layer. Distance between grid lines equals 3 m. Dots are bones too small to be drawn at scale; triangles are stone artifacts. The larger, mostly elephant, bones are: three tusks (1070, 1002 weathered and fragmented in situ, and 1228) one humerus of a young adult (1065), one right scapula (1003, broken in situ), one juvenile right innominate (1012) and one almost complete mandible (1069). The straight line joins two fragments of the same first upper molar of *Dama* sp. 997 is a *Bos primigenius* horncore, 959 is the rib of a large-size mammal, very probably a bovid, with cutmarks verified by SEM.

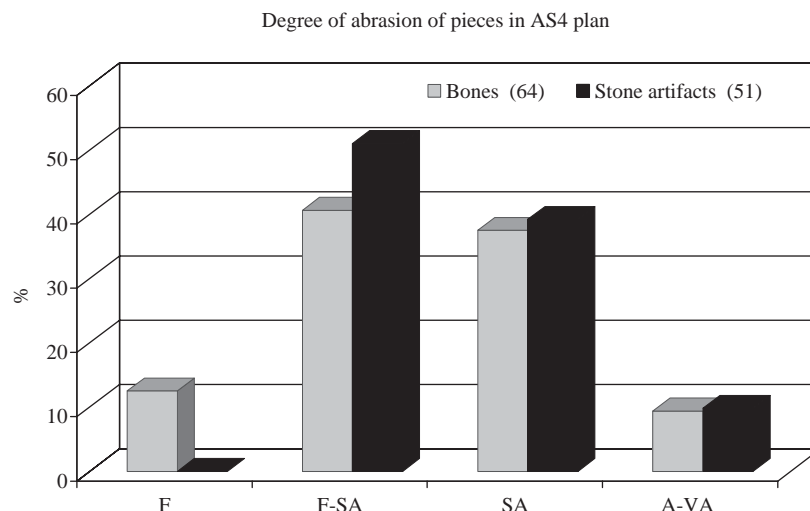Degree of abrasion of pieces in AS4 plan

Fig. 12. Degree of abrasion of bones and stone artifacts in plan of AS4 (squares 107–117 and 515–522). Abbreviations: F = fresh; F-SA = fresh to slightly abraded; SA = slightly abraded; A-VA = abraded to very abraded.

deer nos. 1099 and 1159) which are separated by 3 m. Also two fragments of the same deciduous elephant molar were found at 9 m. distance from each other; they are no. 1034 in square 112/520 indicated in the plan just over the elephant scapula 1003 and no. 1046 in square 120/519 out of this plan.

There are 21 elephant bones in this plan. Three tusks of different sizes (1070, 1002 and 1228) correspond to 3 MNI: one old individual, one young adult and one adult. Two deciduous molars with resorbed roots and one juvenile tusk tips with a dihedral fracture (for an example see Villa and d'Errico, 2001; Fig. 7(i)) very probably represent elements shed or lost by live animals. The other bones are too few and dispersed to be attributed to a specific individual. Other taxa are also represented by isolated bones (Table 5). More than half of the specimens in this plan are non-identifiable bones or bones that can only be assigned to a body size category. One bovid-size rib (No. 959; Fig. 13(a)) is the only element with true cutmarks in this area.

Perhaps the most telling pattern that emerges from this plan is the absence of dense bone clusters. This same pattern is found all over in AS4 and even more so in AS1. Materials are widely dispersed; their present spatial distribution is a reflection of geological factors.

3.10. Elephant bones in AS4

The total number of stone artifacts in the AS4 detrital facies (379 m²) is 335; there are 462 bones with coordinates. Of these only 211 can be identified to taxon (Table 3), and 143 are identifiable only to a body size category. Elephant body parts are the most abundant (Table 6 and Fig. 14). The percentage survival diagram resembles in part the AS3 diagram for the very

Table 5
Taxa in AS4 plan (squares 107–117 and 515–522)

Taxon	NISP
Elephas (P.) antiquus	21
Cervids (mainly *Dama* sp)	15
Equus caballus	4
Carnivores	3
Bovids	2
Total	45

low proportions or outright absence of elements such as vertebrae, metapodials and all foot elements (carpals, tarsals and phalanges), higher frequencies of large bones such as crania and tusks and intermediate frequencies of large bones of the girdle. In AS3 mandibles are absent and femurs are well represented, the opposite is true in AS4. One other element of difference concerns the absence of verified cutmarks (Table 7) and anthropically broken elephant bones in AS4.

As in AS3 we find elements that have been shed or lost by live animals, i.e. two deciduous molars with resorbed roots, 15 juvenile tusk tips (12 are stemmed, one has a dihedral fracture and the other two have transverse fractures at their base) and two ivory flakes (Fig. 15). These pieces were once considered evidence that Middle Pleistocene hominids made and used ivory points (Howell and Freeman, 1983) but have now been shown to be natural (Villa and d'Errico, 2001). These pieces are a clear indication of the importance of natural processes in the accumulation of materials at the site. It is clear that Ambrona was a location frequented by live elephants that must have been attracted by a water source.
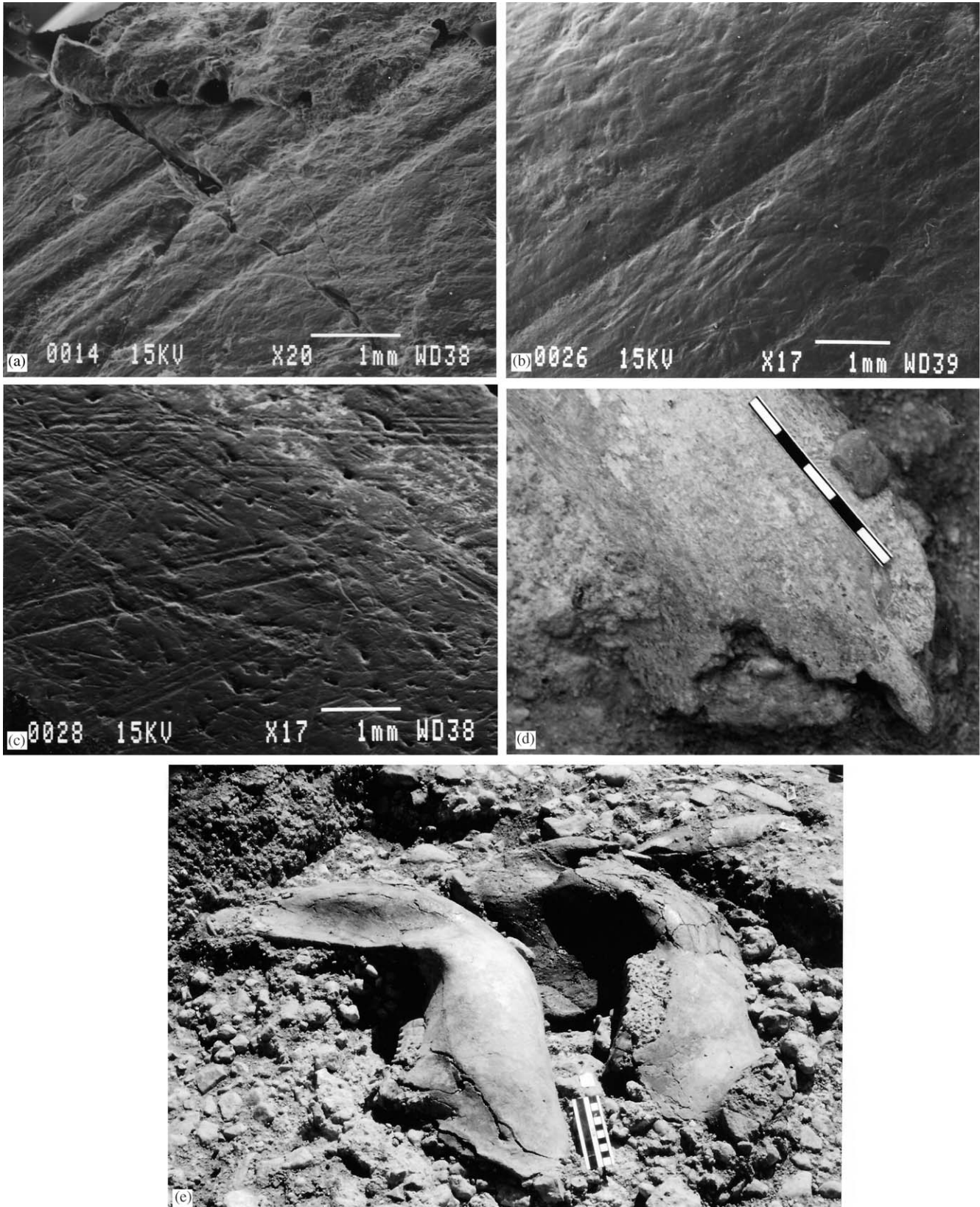
Fig. 13. (a) Cutmarks on bovid rib AS4, 959 b, partly covered by calcareous concretions, attesting to their antiquity; their depth and orientation relative to each other prove that they are man-made. (b) Non-diagnostic mark on elephant mandible AS4, 1014. (c) Abrasion striations on bone fragment AS4, 731. (d) Hypothetical gnaw marks on a fragment of an elephant flat bone (either a scapula or a pelvis fragment) AS2, 293. (e) AS4, 1014 elephant mandible. Note the small scale fault in the background. The mandible has sunk into the AS1 gravels but there was AS4 sediment around and partly under it.

Table 6
Elephant bones in AS4

Element	NISP	MNE	MAU	% MAU	Exp. MNE (MNI = 5)	% Survival
Cra with Max	6	3	3.0	100	5	60.0
Man	3	3	3.0	100	5	60.0
Tusk	40	4	2.0	66.7	10	40.0
Vert	7	7	0.23	7.7	150	4.7
Sac	0	0	0	0	5	0
Rib	29	14	0.35	11.7	200	7.0
Scp + Pel	6	6	1.5	50.0	20	30.0
Hum	1	1	0.5	16.7	10	10.0
Rad + Uln	0	0	0	0	20	0
Fem	0	0	0	0	10	0
Tib + Fib	0	0	0	0	20	0
Met	1	1	0.05	1.7	100	1.0
Podial	2	2	0.07	2.3	140	1.4
Pha	0	0	0	0	280	0

The total MNI based on tusks, 12 isolated teeth and maxillary teeth in crania and taking into consideration the age (when assigned) is 6:1 adult male, 1 adult female, 1 subadult (10–15 years old) and three juveniles (one aged 1–2 months, one 5 months to 1.5 years old, and one of unspecified age represented by deciduous premolars 3 and 4). Two deciduous premolars with resorbed roots, 15 juvenile tusk tips, two ivory flakes and various laminar fragments are not considered for MNI purposes; all, except the laminar fragments, are lost or shed by live animals. Laminar fragments are too small (compared to the size of a tusk) to enter calculations. Tusk MNE is based on 3 complete tusks; the summed length of tusk sectional fragments, divided by the average length of complete tusks (approximately 280 cm) yields an additional MNE of 1. For rib shafts we divided the sum of their length by the average length of complete ribs (94 cm); this yields 7 MNE and added to 7 complete or almost complete ribs it gives a MNE of 14. For calculating the expected MNE we used a MNI of 5, not 6, as it would not be reasonable to expect preservation of bones of one 1 to 2 months old baby elephant in the AS4 context. Abbreviations as in Table 1.

3.11. Remains of non-elephant species in AS4: scavenging from carnivore kills?

Binford (1987) published a multivariate analysis of the Torralba bones and artifacts based on counts by Freeman (1975, 1978). Binford argued that at Torralba stone tools were associated predominantly with equids, bovids and cervids, only rarely with elephants, and that denticulates and notches go together with heads and limbs/feet of non-elephant species, with rare axial parts. Since heads and feet have very limited food utility, he suggested that the major activity recorded at Torralba was scavenging of marginal food parts from carnivore kills of non-elephant species. Based on his multivariate analysis denticulates and notches are functionally related to marginal scavenging. Binford's claims merit to be considered for Ambrona, once considered Torralba's sister site.

The AS4 assemblage of non-elephant species is larger than the AS3 thus frequencies of skeletal elements may be more meaningful. We have used here a diagram designed by Stiner (1994). Stiner argued for scavenging during the Middle Paleolithic based on head-dominated patterns of faunal assemblages at two Italian caves, Grotta Guattari and Moscerini (Stiner, 1994; Marean, 1998; Marean and Assefa, 1999). She used a diagram of anatomical representation that classifies skeletal elements into nine regions; region values are MNE counts standardized relative to expected values. In other words, these values are calculated by dividing the MNE of each region by the total number of elements in each region in a living animal. Values for each region thus represent the minimum number of individuals represented by each region and the largest value provides an estimate of the largest minimum number of individuals in the assemblage. Values calculated this way were called MAU (minimal animal units) by Binford (1984) although his indices are by skeletal elements and are not grouped by region.

Frequencies of skeletal elements for bovids, cervids and equids are provided in Table 8 and in the diagram of Fig. 16. Teeth (n = 32) are not included in Stiner's regions; also not included are 2 metapodials and 27 long bone shafts that were not refittable and could not be assigned to a specific long bone type. Calculations for rib MNE in the axial region are based on dividing the summed length of rib fragments by the mean length of ribs according to animal size categories. They are fully described in a note at the end of the paper.

Clearly these calculations cannot be but approximate and there is a possibility that lion ribs may be counted in the medium-size mammals (there is one lion radius in AS4). The number of skeletal elements is also quite small so our diagram must be taken with a grain of salt. Nevertheless the pattern it provides with a genuine scarcity of foot bones does not correspond to Binford's expectations. On the other hand, the diagrams Stiner provided for Grotta dei Moscerini and Grotta Guattari (levels G4 and G5) are almost exclusively dominated by head parts (Stiner, 1994: Figs. 9.8–9.9) The AS 4 diagram has a more balanced representation and can be compared with some of the diagrams produced for Grotta Breuil where the assemblage was interpreted as the result of hunting. The occurrence of 27 long bone shafts that could not be included in the diagram should also be considered because it implies that the proportion of limb bones was actually higher than in the diagram. We should also note that carnivore marks are not present on any of these bones. In fact, the only hypothetical carnivore marks we have been able to identify on any of the faunal remains at Ambrona are on an elephant flat bone fragment in layer AS2 (Fig. 13(d)). A comparison of Fig. 13 with the breakage morphology of an elephant mandible in Fig. 7(b) suggests that similar indented edges can be found on bones broken when dry by trampling or sediment pressure. In sum, carnivore action at the site is minimal, frequencies of
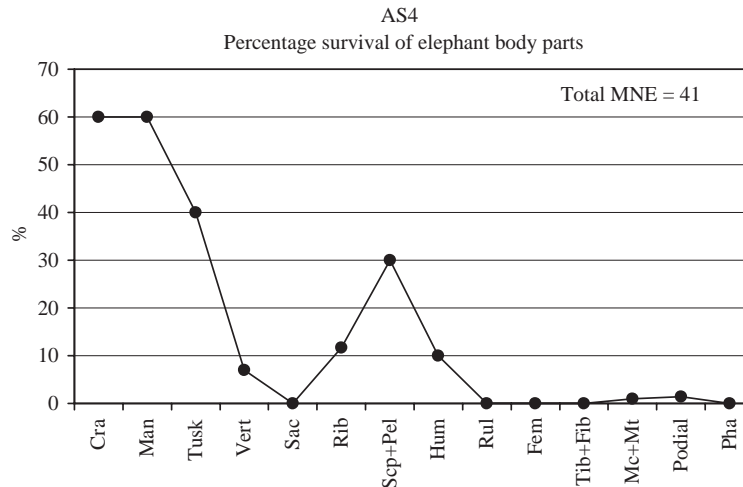
AS4
Percentage survival of elephant body parts

Fig. 14. Percentage survival of elephant body parts in AS4.

Table 7
Frequencies of cutmarks and observable bone surfaces in AS3 and AS4

	AS3 elephant (excl. single carcass)	AS3 non-elephant	AS4 elephant	AS4 non-elephant
Bones with cutmarks	1	0	2 ?	2
Bones without cutmarks, some have light abrasion striations	11	10	12	29
Bones with non-observable surfaces. In parenthesis % of column total	14 (53.8)	57 (85.1)	23 (62.2)	143 (82.2)
Total	26	67	37	174

Bones were observed with a 10× hand lense and possible marks were replicated for SEM analysis. Surfaces covered by concretions, root marks, affected by diagenetic alterations or heavily abraded are defined as non-observable. Many bones did not have cutmarks but had light and chaotic abrasion striations visible to the naked eye or with the hand lense. These surfaces are at the limit of non-observable, some were replicated (Fig. 13c). Teeth, antlers and horncores are excluded. Tusks were examined but are not included in these counts; none showed cuts that could be compared to those identified at La Cotte as related to tusk removal (Jones and Vincent 1986).
Two elephant bones in AS4 carry doubtful marks (cf. Fig. 13b) whose diagnostic features may have been obliterated by abrasion and diagenetic alteration.

gnaw marks on all bones is less than 1%. The hypothesis of scavenging from carnivore kills can definitely be rejected.

3.12. Recognizing the nature of bone and stone associations

Natural processes of displacement, loss and post-depositional deterioration stand in the way of a straightforward interpretation of the AS4 diagram as directly reflecting human hunting and butchering. These are:

1. The low density of bones and the lack of any clear concentration of materials, suggesting episodical deposition.
2. Although many items were are at or near the base of the layer, others were vertically spread within it;

measured separation in the same square can be up to 30 cm for stone artifacts.
3. The fairly high degree of abrasion of bones and stones (Figs. 17 and 18), indicating transport, displacement and loss of assemblage integrity. Variable degrees of abrasion are a significant feature of the Ambrona assemblages in the three stratigraphic units considered here suggesting that different pieces have different transport histories.
4. The low frequencies of bones with possible anthropic fractures. 75% of the non-elephant long bones in AS4 have transverse or irregular morphologies. Only 14% (5 of 36 observed cases) have curved or V-shaped morphologies suggesting green-bone breakage (Villa and Mahieu, 1991). Perhaps these bones have undergone two cycles of breakage, the second one obliterating the first. Postdepositional fragmentation is certainly indicated by the great fragmentation of
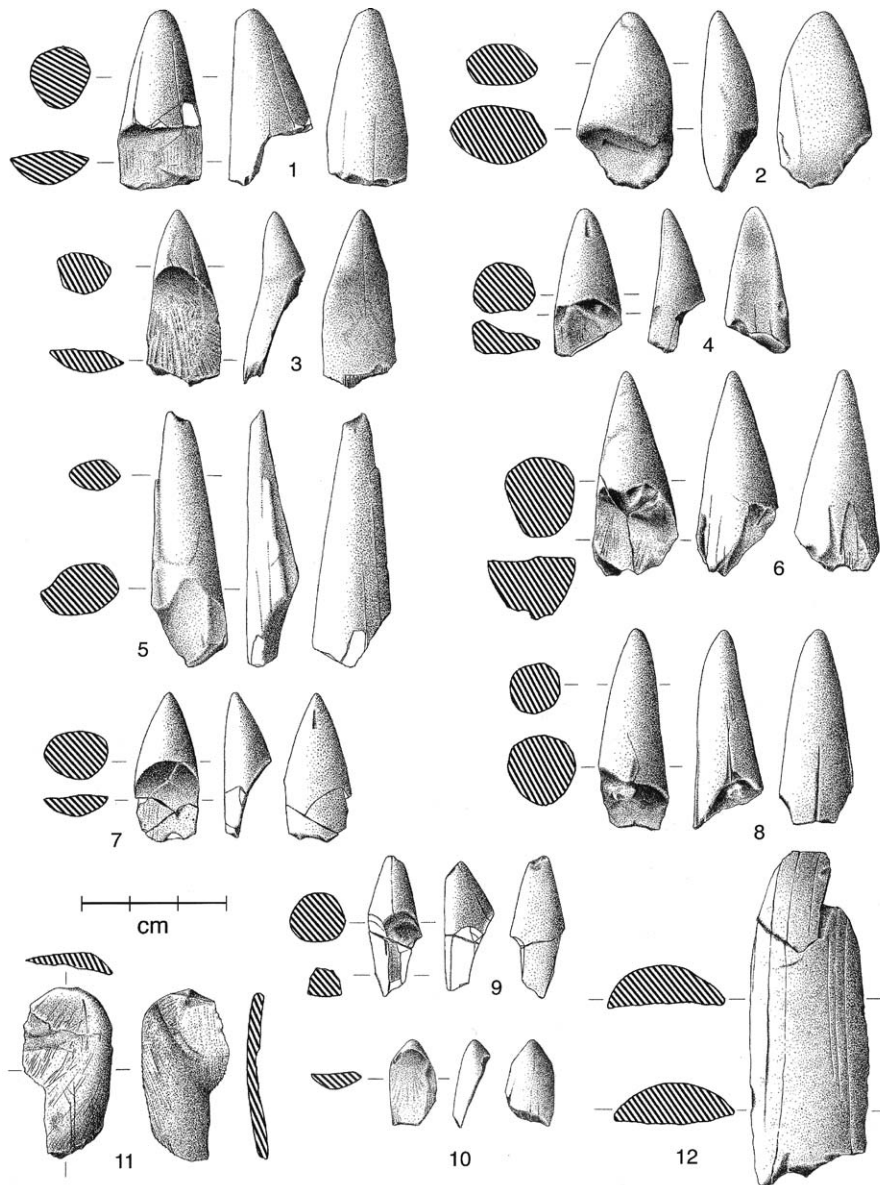
Fig. 15. Ivory points (1–10) and ivory flakes (11–12) from the new Ambrona excavations, layers AS3 (4,8) and AS4 (all others). Eight of the ivory points are abraded or very abraded, one is fresh (3) and the other is fresh to slightly abraded (7). The two ivory flakes are unabraded.

ribs and other axial parts. Only 9% of all bones of non-elephant species, not counting teeth, are complete. Elephant bones are more resistant to breakage and have a slightly higher proportion of complete bones (19.5%) much lower, however, than frequencies in AS3 where 60% of all elephant bones (excluding teeth and tusks) are unbroken.

5. The strong evidence that some bones (e.g. elephant tusk tips) accumulated naturally, hence that natural components are an important aspect of depositional processes at the site.

Contrary to suggestions by Binford and Freeman, we find that interpretations of particular associations of stone tool types and faunal remains are unwarranted.

According to Freeman (1994, p. 606) 13% of the stone artifacts from the Lower Occupation at Ambrona (199/ 1321) exhibit some "geological crushing" by which he means abrupt retouch due to cryoturbation. In fact, the most evident feature of several of the artifacts is the smoothing and rounding of their edges and dorsal ridges. The AS1 and AS4 artifacts are contained in fluvial sediments and they have the higher degree of abrasion, resulting from long incorporation in sandy stream gravels. The edge abrasion on the Ambrona bones was also noted by Klein (1987) and Shipman and Rose (1983). Abrasion striations are evident on SEM images of bone surfaces (Fig. 13(c)). For sure, artifacts clearly reflect human activities; cutmarks and anthropic fractures also provide evidence of butchery. But the

Table 8

AS4. Skeletal element abundance of bovids, cervids and equids according to the nine anatomical regions defined by Stiner (1994)

	NISP	MNE	standardized MNE
1. Horn-Antler (2)	14	5	2.5
2. Head (3)	12	5	2.5
3. Neck (7)	2	2	0.29
4. Axial (49)	60	30	0.61
5. Upper front (4)	6	5	1.25
6. Lower front (6)	7	7	1.17
7. Upper hind (2)	0	0	0
8. Lower hind (8)	8	8	1.0
9. Feet (24)	5	5	0.21
Total	114	67	

The total number of elements in any given region in a living animal are in parenthesis. Details of calculations are provided in the text. The "standardized MNE" values of Stiner are calculated the same way as the MAU of Binford but grouped by region. The nine regions are as follows:

1. horncore and antler;
2. head = two half-mandibles and one cranium;
3. neck = atlas, axis, cervical vertebrae;
4. axial = thoracic, lumbar, sacral vertebrae, two innominates and ribs;
5. upper front = scapula and humerus;
6. lower front = radius, ulna, metacarpal;
7. upper hind = femur;
8. lower hind = tibia, calcaneum, astragalus, metatarsal;
9. feet = 1st, 2nd and 3rd phalanx. Teeth, carpals and patellas are not included in Stiner's regions.
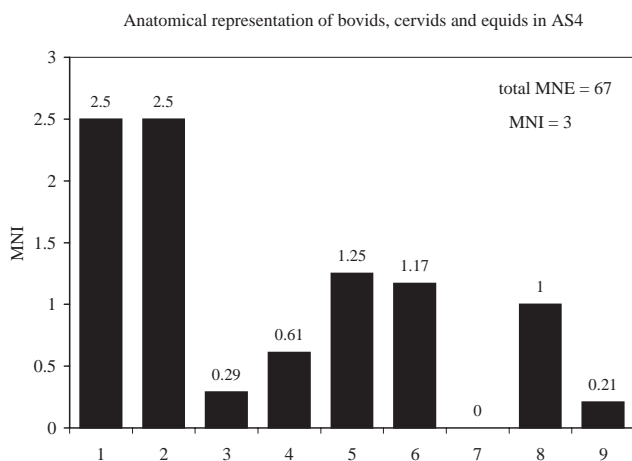
Fig. 16. Anatomical representation of bovids, cervids and equids in AS4.

sedimentary context of these materials also shows that natural processes had a significant impact, modifying and shaping the site structure. Physical proximity cannot be translated into precise functional relationships. According to Freeman (1994, pp. 624–630) his multivariate analyses prove that there are meaningful relationships between particular stone tools and particular species or skeletal elements. We believe that statistical analyses of aggregates of materials partly
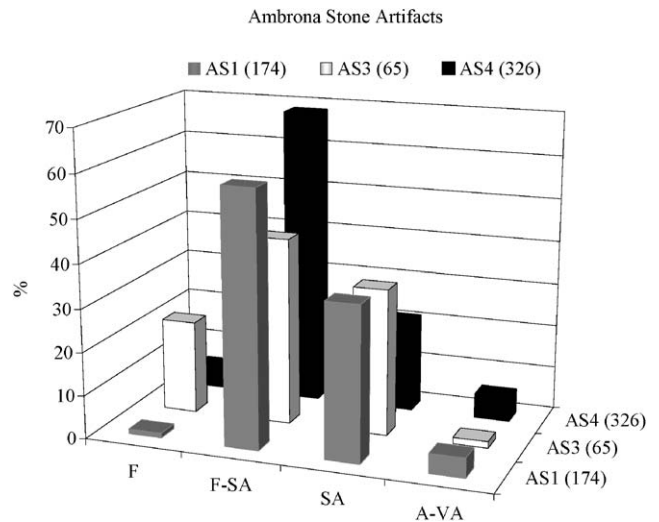
Fig. 17. Degree of abrasion of stone artifacts in AS1, AS3 and AS4. Abbreviations: F = fresh; F-SA = fresh to slightly abraded; SA = slightly abraded; A-VA = abraded to very abraded.
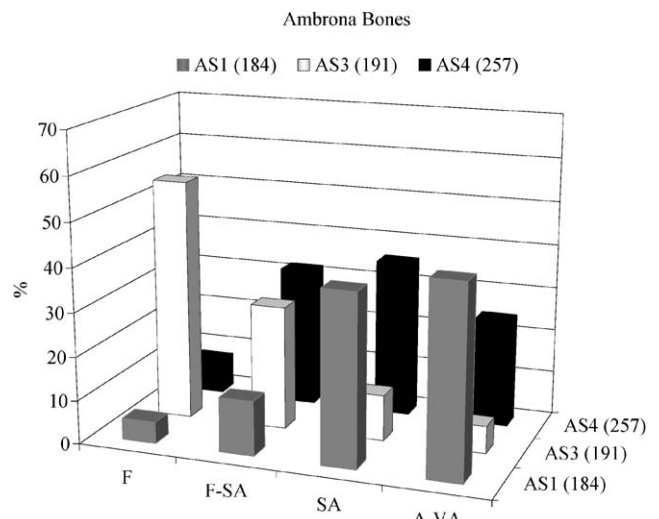
Fig. 18. Degree of abrasion of bones in AS1, AS3 and AS4. Abbreviations: F = fresh; F-SA = fresh to slightly abraded; SA = slightly abraded; A-VA = abraded to very abraded.

derived from the erosion of former deposits and only partly from in situ deposition inform us more on the potential of the transporting medium than on the specific nature of human activities taking place in another part of the site.

We agree with Binford's skepticism concerning the integrity of the Torralba's (and Ambrona's) deposits but we find his interpretation of marginal scavenging a not less imaginative scenario than Freeman's reconstructions of big-game hunting. It is true that Binford's interpretations were mainly based on data from Torralba, not from Ambrona. However it is clear from the published accounts of Torralba that there too, as at Ambrona, we deal with small and sparse artifact

aggregates in unclear relations to faunal remains and to each other (Villa, 1990).

4. Discussion

The following points summarize the results of this analysis:

- The Ambrona site is a complex mix of natural and human components.
- Natural processes of displacement, loss and post-depositional modification render the bone assemblage less informative of human activities than it has been suggested in the past.
- Mortality profiles should not be constructed by lumping materials coming from very different sedimentary environments and the various stratigraphic units should not be treated together as a complex (as it was done in the past).
- Interpretations of particular association of stone tool types and faunal remains have not taken into account displacement and transport by water, they should be discarded.
- While the occurrence of human activities at the site is clearly indicated by a few facts (the occurrence of stone artifacts and of a few cutmarks on bones) the extent and specific nature of the hominid–animal interaction, beyond a simple statement that some butchery occurred at the site, cannot be fully elucidated.
- Contrary to Binford's ideas carnivore action at the site is minimal, there is only one possible carnivore mark on an elephant pelvis or scapula fragment, and nothing else. Frequencies of hypothetical gnaw marks are less than 1%. The hypothesis of scavenging from carnivore kills can be rejected.

In our view the fundamental weakness of the opposing behavioral hypotheses put forward for the Spanish sites is that none considered the sedimentary processes and stratigraphic context of these small assemblages. Before suggesting a new interpretation of Ambrona and the nature of human activities at the site we must consider some objections raised by Freeman and the general evidence for scavenging from other European sites.

4.1. The meaning of small assemblages

According to Freeman the 10 excavated levels at Torralba yielded assemblages that, although small, were sufficient for reliable statistical analyses. To give an example, the largest series was from Occupation 10 with 124 artifacts; five other occupation levels had less than 50 artifacts each. The total excavated area was about 600 m^2, although the areas covered by items were smaller (Villa, 1990, p. 306). General densities of artifacts were in the order of 0.3–0.4/m^2 for an average area of 190 m^2. At Ambrona densities at Howell's excavation in the 2058 m^2 of the Lower Occupation were also low, about 0.65/m^2 and density of bones was slightly higher (not calculated in Howell et al., 1995). According to Freeman, other assemblages as small as those of Torralba have been considered significant (i.e. the Aridos 1 elephant site) thus he argues that the size of the sample does not affect his multivariate analyses and that Villa was wrong in questioning the Torralba evidence. At issue here is the logic of treating aggregates as if they were coherent assemblages with some measure of temporal and technological integrity.

When the evidence from Ambrona is considered, in fact when all assemblages, large or small, are considered, their size and composition are to be seen in the light of accumulation processes. The small assemblage from Aridos reflects a single event. The materials (331 stone artifacts and remains of a single elephant) were found concentrated in an area of 40–50 m^2 and occurred within a thin archeological horizon. The assemblage has a high refitting rate (18.3%), it is technologically coherent, and it was formed by in situ tool making from imported nodules and transport of some finished pieces. Refitting links overlapping the bone distribution and the fresh edges of all artifacts prove that the site is in primary context and that it represents an episode of butchering by a small group of hominids (Santonja et al., 1980). The assemblage is small because the site was occupied for a short time for a limited purpose.

The Ambrona bone and stone assemblages are small because they are depleted. Technological analysis of the lithics using chaînes opératoires categories is only at a preliminary stage but their abraded edges and their mean size (very small in AS4; with the same mean size as the gravels in AS1) indicate selective transport and redeposition (Santonja and Pérez-González, 2001) thus functional interpretations based on association with certain kinds of bones are problematic, to say the least. Klein (1987) and Shipman and Rose (1983) who gave serious considerations to the implications of the sedimentary context and the surface conditions of the bones were much more cautious in their behavioral interpretations.

4.2. The scavenging hypothesis: a postmortem

Small assemblages have also played a definite role in the interpretation of scavenging at some cave sites (Villa and Soressi, 2000). In light of the new understanding of the Spanish sites, we may briefly comment on the hypothetical evidence of scavenging from two Italian caves, Grotta Guattari and Grotta dei Moscerini. As mentioned above, Stiner (1994) extended Binford's ideas

on scavenging to interpretations of those two Neandertal sites in Italy. According to her, Neandertals were capable of hunting but scavenging was practiced on a regular basis prior to 55 ka. Grotta Guattari and Grotta dei Moscerini are older than 50 ka; each site contain several layers, some with assemblages accumulated by hyenas and others with assemblages primarily accumulated by hominids. According to Stiner the ungulate faunas in the layers accumulated by hominids are dominated by head elements. These are elements of low utility because they provide little nutrition but they are those available to scavengers.

Whether we work under the paradigm that the foraging mode of early hominids and Neanderthals was different from modern behavior (e.g. Klein, 1994, 2001) or we believe that hunting of medium to large size mammal was common practice at Lower and Middle Paleolithic sites in Europe (e.g. Roebroeks, 2001) the weight of the arguments proposed by Marean (Marean, 1998; Marean and Kim, 1998; Marean and Assefa, 1999) now seems inescapable. His papers have shown that interpretations of scavenging in the Middle Paleolithic are based on faulty data. Assemblages dominated by head parts are the result of systematic bias in the recovery or in the analysis, that is they are due to discard of long bone shaft after the excavation (at Guattari, Moscerini and Combe Grenal) or the fact that these bones, less easily identified, were not considered by the faunal analysts (at Vaufrey). According to Marean, this omission causes an underestimation of the abundance of meat-rich long bones and artificially creates a head-dominated pattern leading to interpretations of scavenging.

Klein (1995), Gaudzinski (1996a, b) and Mussi (1999, 2001) have pointed out that the Guattari and Moscerini are very small assemblages, in addition to being heavily sorted. The size of the assemblages is an interesting point that should be considered in relation to their stratigraphic context. Table 9 shows the size of the excavated area for the Italian caves, the thickness of the stratigraphic unit used in the analysis, the total number of ungulate and carnivore bones and teeth in each unit, their density and the number of stone artifacts. At Moscerini the excavated area is very small, only $3\,m^2$ representing 5% of the total preserved site area ($56\,m^2$). The sequence is 8 m thick and the excavators described 44 layers but to bolster sample size Stiner lumped the layers in six stratigraphic units. M2, 3 and 4 group layers at the cave entrance, M6 represents a test pit in the back of the cave, its size is unknown but it is known to be smaller than the area excavated at the entrance. The stratigraphic units used in the analysis by Stiner are extremely thick, between 90 and 290 cm, so we are looking at materials that cannot in any way be considered as even remotely contemporaneous or deposited in a rather short period of time.

The excavated area at Guattari is larger but the assemblages are extremely small. The cave has a total surface area of about $100\,m^2$. The area excavated between 1939 and 1955 represents about 25% of the total surface (Piperno and Giacobini, 1990–1991). Layers G4 and G5 occur at the cave mouth but they thin out and disappear deep inside; their thickness and excavated surface are not provided in publications. However, for some layers at Moscerini it is possible to calculate the density of identified specimens per liter of excavated sediment. The average is 32 l of sediment for 1 bone. If we compare bone densities at other Middle Paleolithic sites for which precise data are available e.g. Jonzac, a Quina Mousterian site in the Charente region, we can see that in level 22 the density of bone is 30 time higher, 1 bone per 1 l of sediment (2204 ungulate and carnivore NISP per 2000 l of sediment; Villa et al., in press, data by Cedric Beauval). At La Quina layer 8 the density of numbered bone specimens, not counting the screen refuse, is 2 bones/1 l of sediments (2098 bones/1000 l; sampled by Chase, 1999).

It is often believed that Neanderthal sites are poorer in materials than Upper Paleolithic sites, reflecting a lower population density (Klein, 2003). We are not so sure that this is a correct perception. There are many Mousterian cave and rock shelter sites with impressive

Table 9
Grotta dei Moscerini and Grotta Guattari. Assemblages accumulated by hominids. Data from Stiner 1994

Site	Unit used by Stiner	Excavated area (in m^2)	Thickness of the stratigraphic unit (in cm)	Volume of excavated sediment (in l)	Total NISP (bone and teeth)	Density (liters of sediment per 1 NISP)	Stone artifacts
Moscerini	M2 (levels 11-20)	3	90	2700	39	69.2	382
Moscerini	M3 (levels 21-36)	3	223	6690	361	18.5	324
Moscerini	M4 (levels 37-43)	3	290	8700	159	54.7	187
Moscerini	M6	<3	Unknown	Unknown	187	Unknown	196
Guattari	G4	<25	Unknown	Unknown	53	Unknown	876
Guattari	G5	<25	Unknown	Unknown	49	Unknown	482

Thickness of units measured from published section. NISP counts are for carnivore and ungulates.

densities of materials but this phenomenon is not appreciated because data are generally not quantified or published. The cave site of Pech de l'Azé IV for instance, excavated by F. Bordes on about 45 m² and for a depth of 3 m has yielded about 100, 000 stone artifacts (McPherron and Dibble, 1998). The site of Pech Ib excavated by Bordes in 1970 and 1971 on 25 m² for a depth of 2.5 m approximately (levels 4–7) has yielded 14,500 objects with coordinates, not counting the lithic debris from screens (Soressi, 1999).

The small lithic and bones assemblages from Guattari and Moscerini cannot in any way represent single events or even a relatively short period of accumulation. This is especially evident for Moscerini for which stratigraphic information is available. The bone assemblages are small for other reasons: the excavated area is small compared to the preserved site surface, a major portion of the deposits at the front part of the cave was eroded by the Holocene rise in sea level (Stiner, 1994, Fig. 3.18), the excavated area was occupied only sporadically and this is indicated by the fact that also the lithic assemblages are very small. Since biases in selecting and keeping excavated items did not affect the stone artifacts, it is clear that the scarcity of lithics and thus of all materials in general is not due solely to excavation biases. These Italian assemblages appear to be heterogeneous aggregates of materials accumulated over a long interval of time; they are too small and residual for making generalized behavioral inferences.

There is at present no evidence at all to support a hypothesis of regular scavenging activities by Neandertals and earlier European hominids. They may have practiced an occasional, opportunistic scavenging, such as documented ethnographically (O'Connell et al., 1988; Bunn et al., 1988). On the other hand, there is a growing body of evidence from the Middle Pleistocene that Neandertal and earlier hominid subsistence strategies were based on hunting, including hunting of large mammals and often concentrated on a single species. This is research carried out by various faunal analysts at French sites such as Mauran, La Borde, Coudoulous I, Biache St Vaast, La Quina (e.g. Jaubert et al., 1990; Farizy et al., 1994; Auguste, 1995; Gaudzinski, 1996b; Chase, 1999). Supporting evidence also comes from the site of Schöningen in Germany and from Russian sites (Hoffecker and Cleghorn, 2000; Roebroeks, 2001). The accumulated evidence from these European sites strongly suggests that hunting, not scavenging, was the main method of meat procurement in the Lower and Middle Paleolithic and that in this respect Neandertals and earlier European humans did not differ from later, Upper Paleolithic people. The non-elephant faunal remains from Ambrona provide no support for the scavenging hypothesis.

4.3. Ambrona and other Lower and Middle Paleolithic sites with elephants: bone tools, butchery and raw materials

The interaction of humans and elephant carcasses is documented by a few cutmarked pieces. But what was the nature of this interaction and how important was it in the formation of the elephant bone assemblage? We should consider the following questions:

1. Was the intervention on elephant carcasses to obtain raw material for tool making?
2. Was the role of butchery really a negligible factor in the accumulation of elephant bones at the site?
3. Have geological processes so modified and structured the site that no behavioral interpretation is possible?

4.3.1. Bone tools

There is now solid evidence that early men flaked elephant bone by direct percussion and made bone tools comparable to bifaces and other artifacts made of stone. Previous doubts and controversies (Binford, 1981; Haynes, 1991) were due to the low level of modification of putative bone tools. Doubts were caused by a combination of factors: a) analyses of early bone tools were based on a few selected pieces without consideration of fracture patterns of other faunal remains for marrow; b) the absence of actualistic data on deliberate breakage of elephant long bones; c) the lack of comparative data from archeological assemblages with a clear taphonomic history; d) the consequent lack of clear procedures to sort minimally modified bone artifacts from the byproducts of marrow extraction; and, e) the mixing of good observations with fanciful speculations. All these were the cause of skepticism and disbelief.

These doubts have now been laid to rest by the discovery of highly modified artifacts, i.e. Acheulian bifaces made on elephant bone at some Middle Pleistocene sites in the Latium region near Rome (Castel di Guido and Fontana Ranuccio). Less elaborate pieces but still clearly identifiable as man-made and deliberate tools on elephant bone are found at other sites, such as La Polledrara, Casal de'Pazzi, Malagrotta and other sites in Latium (Villa et al., 1999; Anzidei et al., 1999; Radmilli and Boschian, 1996; Villa, 1991; Villa and d'Errico, 2001). Utilization of elephant ribs and fibulae is also reported from the Middle Paleolithic site of Salzgitter-Lebenstedt (Gaudzinski, 1999; Gaudzinski and Turner, this volume).

It is important to note that there are no pieces at Ambrona that could be interpreted as bone tools. It is likely that such pieces were produced at Torralba. Direct examination of the collection of putative bone tools from Torralba studied by Aguirre (1986; cf. also Biberson, 1964) and kept at the Museo Arqueologico

Nacional in Madrid has suggested to us that at least two pieces on elephant long bone can be identified as artifacts (Q 1224 and Q 1868); these pieces have a point shaped by a few bifacial scars. Unfortunately most bones in this heavily selected collection are slightly to quite abraded and several are coated with preservative making difficult any form of surface analysis. Be as it may, the use of elephant bone as raw material for flaked tools was not practiced at Ambrona.

4.3.2. Butchery

The scarcity of cutmarks at Ambrona may be due in large part to the weathering and postdepositional alteration of most bones which may have removed the evidence of butchery. Also cutmarks on butchered elephant bones may not be as common as on other smaller animals because the periosteum and articular cartilage are very thick and after decay no knife-marks will be preserved. Stripping of meat can be accomplished without leaving tool marks because of the sheer thickness of the tissues (Haynes, 1991). Crader (1983) studied seven recent single-carcass elephant bone scatters killed and butchered with metal knives and axes by the Bisa in Zambia. The frequency of butchery marks (cut marks, chop marks and shear faces created by a heavy chopping blow) is not very high: 15.3% (72 of 469 NISP). Thus it could be argued that the absence of butchery marks does not necessarily mean that butchery has not taken place.

At some Paleoindian sites mammoth hunting and butchering has been demonstrated not by butchery marks but by the fact that the bones of several individuals were found together in piles that could not be explained by fluvial transport and that projectile points were found in proximity or under the bones. This is the case of Colby (dated to 11,000 BP) where 463 mammoth bones were found along a dry river channel over a distance of 58 m. together with four Clovis points made on chert imported from a 70–80 km distance, two rudimentary hammerstones or choppers, more than 32 flakes of which at least 20 were small resharpening flakes or impact flakes of the same raw materials, and two possible tools on ungulate bone. Several bones had been displaced by fluvial action yet two concentrations were found containing the bones of 4 and 3 mammoths each. The configuration and element composition of the concentrations cannot be explained by natural processes, there is no correlation between the element preservation and their weight, size and fluvial transport index, as it would be expected in an assemblage affected by water transport. It is interesting to note that the seven mammoths identified at Colby were juveniles or young adults (Frison and Todd, 1986).

At Ambrona such pattern does not exist. The only cluster is provided by the AS3 concentration which contains the remain of one fully adult/old elephant; the isolated remains of other individuals form a background scatter and are not clearly associated with the single carcass.

4.3.3. Marrow breakage

At most Paleolithic sites, whether residential or special activity locales, butchery is generally indicated not only by cutmarks but also by breakage of bones for marrow. Unfortunately the cumulative evidence of sites with elephant remains does not support the idea that deliberate breakage for marrow of elephant long bones was commonly practiced by Lower and Middle Paleolithic people. FLK North level 6 in the upper Bed 1 at Olduvai has been interpreted as the oldest example of elephant butchery by hominids. Bunn (1982) reported 211 fragments of elephant bones but his account makes it clear that fragmentation concerned mostly ribs, vertebrae and unfused epiphyses. The nature of limb bone breakage (limb shafts were present) is not described. Deliberate bone breakage was also not described from other probable or hypothetical elephant butchery sites in Africa, such as the *Deinotherium* site from FLK North (Olduvai Bed II; Isaac and Crader, 1981) Mwanganda's Village (in Malawi; Clark and Haynes, 1970) and Barogali (in Djibouti; Berthelet and Chavaillon, 2001). At these sites many bones were affected by strong postdepositional alteration and fragmentation.

At several Lower and Middle Paleolithic sites in Eurasia with stone artifacts and elephant remains major limb bones were either not present (Aridos I and II, Orcasitas and Arriaga II in Spain; Venosa Notarchirico in Italy; Gesher Benot Yaakov in Israel) or their breakage went unreported (Transfesa in Spain) or the bones were in bad state of preservation (Ariendorf 2 in Germany) or most bones were destroyed by machinery prior to scientific excavation (Lehringen in Germany); Cf. Santonja et al., 2001; Piperno, 1999; Piperno and Tagliacozzo, 2001; Goren-Inbar et al., 1994; Turner, 1997; Veil and Plisson, 1990. At Gröbern (a Last Interglacial site in Germany) limb bones were complete (cf. plan in Gamble, 1999, Fig. 5.25). It is not clear if deliberate breakage of limb bones occurred at La Cotte de St. Brelade layers 3 and 6 (dated to OIS 6) where the bones of 20 *Mammuthus primigenius* were found because postdepositional breakage and deterioration obscured the evidence (Scott, 1986). At the site of Castel di Guido several elephant limb bones were found (total NISP of humerus, radius, ulna, femur and tibia is 71) and there were 274 shaft fragments (Radmilli and Boschian, 1996). However the monograph does not provide a general taphonomic analysis or a specific analysis of breakage patterns except for the description and drawings of bone bifaces and other retouched bone tools. Although the reported number of bone bifaces ($n = 99$) seems excessive, it is clear that deliberate fragmentation of limb

bones was common at the site. The purpose was apparently not for marrow extraction but for the making of flaked tools using bone that was not freshly butchered but still green. Analyses of elephant bone breakage patterns at the site of La Polledrara is ongoing; eight bone tools (though not bifaces) are present at this site and there too deliberate flaking for tool-making purposes is well documented (Anzidei et al., 1999; Villa et al., 1999; Anzidei and Cerilli, 2001).

Actualistic data suggest that marrow breakage of elephant long bones is not a common practice. According to Crader (1983) the Bisa (modern agriculturalists in Zambia) hunt wild game as their major source of meat and break bones for marrow but do not break elephant bones. Clark (1977) also states that in recent African contexts elephant limb bones (which lack a medullary canal) are generally not broken and the procedure he describes to get the marrow filling the cancellous bone in liquid form is relatively elaborate. Deliberate breakage of mammoth bones also did not occur at the Colby site. However the two distal femurs in AS3 that have probable anthropic fractures suggest that marrow breakage cannot be completely excluded.

Breakage of mammoth skulls in the parietal region presumably to extract the brain is reported from La Cotte and equivalent damage just below the nasal cavity occurred on the Gesher Benot Ya'akov elephant skull (Scott, 1989; Goren-Inbar et al., 1994). In contrast, the elephant skull in AS3 did not show evidence of this kind, only damage by depression and compression fractures.

4.3.4. Planning, raw material use

It is clear from the previous discussion that we cannot prove hunting of elephants at Ambrona; we can only say that Ambrona contains the butchered remains of some elephants, together with remains from natural deaths apparently untouched by humans. Yet meat provisioning is documented by the few preserved cutmarks and there is evidence of planned actions in the form of systematic importation into the site of raw material blanks and artifacts. The raw materials used for stone artifacts at Ambrona are chalcedonous flints and silicified limestone (both called flint here), quartzite, quartz and limestone. With the exception of limestone, which outcrops locally, all other raw materials are allochthonous and transported by humans, as noted by Freeman (1994). Conglomerates containing quartzite cobbles occur at Miño, 4.5 km to the north. These cobbles were never water transported to the site because the channels in the valley bottom (i.e. the Bordecorex river) were always flowing toward the Duero i.e. SW to NE, thus in a direction away from, not toward, Ambrona. Quartz is relatively abundant in the Cretaceous beds of Ventosa del Ducado about 5 km to the west. Flint and silicified limestone come from more distant sources, not yet fully identified (Santonja and Pérez-González, 2000–2001).

Frequencies of raw material types remain fairly constant throughout: limestone varies between 0% and 6% with quartz only slightly more abundant; flint and quartzite are the two most common raw materials and their frequencies can be as high as 40% or more for each. Stone hammers, cores, cortical flakes and small retouch flakes are evidence that knapping was taking place at the site, although the assemblages are incomplete and redeposited especially in AS1 and AS4; thus reduction sequences are discontinuous and artifacts were size-selected by the transporting medium (Santonja and Pérez-González, 2000–2001, Tables 3–5).

5. Conclusion

The Ambrona site is actually a remnant of a Middle Pleistocene landscape now largely destroyed by erosion, especially to the west and south of the site (Pérez-González et al. 1999: Fig. 4). Raw material sourcing clearly indicates that humans were traversing this landscape although findspots in this area, Torralba and Ambrona excepted, are sparse (Rodriguez de Tembleque, 1998). The low density of findspots and the low density of artifacts at the two sites may reflect a non-intensive occupation of this area, which is 200–500 m higher and has a more rigorous climate than most of the Meseta (Santonja and Villa, 1990). A definitive interpretation of the site nature is limited by postdepositional disturbance processes, the loss of observable cortical surfaces on bone and the fact that some materials probably derive from nearby locations now destroyed by erosion. In spite of these limitations, the evidence allows us to say that the site was regularly visited by humans who were aware of the opportunities for meat provisioning offered by this particular locale, which was also favored by herds of elephants as a watering point within their home range. The hominids were bringing with them both blanks and finished artifacts from sources of raw materials used again and again. Their repeated visits throughout a span of time, impossible to define yet long enough for the deposition of a rather thick series of deposits and possibly in the order of millennia, suggest that knowledge of the opportunities offered by the site was passed down through generations. Whether meat was acquired through hunting or by taking advantage of natural deaths, we cannot say. But our data allow us to reject interpretations of marginal scavenging and the ad hoc exploitation of carcass remnants hypothesized by Binford. It is only at late Middle Pleistocene sites like La Cotte de Saint-Brelade (Scott 1986) or at the Last Interglacial site of Lehringen (Veil and Plisson, 1990)

that hunting of elephants (and rhinos) can be put forward as a valid hypothesis.

Author contributions

Taphonomic and faunal analysis have been carried out by P.V., E.S. and C.S, with much help by Jorge Martínez Moreno; M.S and A.P.G. directed the excavations and carried out the lithic and geological analyses; R.M. and J. P. have been in charge of site mapping, computer recording and drawings using a total station and a combination of Autocad, Arcview and D Base.

Note

In the AS4 database 51 rib fragments are assigned to body size categories as follows: large-size mammals, at Ambrona this means *Bos*/*Bison*, *E. caballus*; medium size mammals = *Cervus elaphus* and *Dama* sp; small size mammals = *Capreolus*. The very large category (elephant) is not considered in this case. We have calculated the mean length of ribs of the large animal category using measurements of 35 ribs from two single skeletons in the modern comparative collection at the University of Colorado Museum (*Bison bison* has a mean 45.3 cm;

Equus caballus has a mean 44.0 cm). The summed length of rib fragments of large-size animals from AS4 was then divided by the mean length of *Bison bison* and *Equus caballus* ribs to obtain a MNE of 12.

We have done the same for medium-size mammals using 51 ribs from three single skeletons of *Cervus elaphus* (mean 31.3) and of *Odocoileus hemionus* (mean 21.8). The latter one was used as an estimate of *Dama*-size ribs. *Odocoileus hemionus,* although smaller than the red deer, is bigger than the modern fallow deer; however the Middle Pleistocene fallow deer was about 20% larger than the modern form (Howell et al., 1995) so *Odocoileus hemionus* may be considered an acceptable approximation. The MNE obtained is 8. For small size mammals the 3 NISP yield a MNE of 1. The total for ribs is then 21 which is added to 6 vertebrae and 3 innominates to make a total MNE of 30 for the axial region.

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