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Edaphic modifications vs anthropic activities at the Acheulean site of Guado San Nicola (Monteroduni, Isernia): a taphonomic perspective

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ABSTRACT - The Middle Pleistocene site of Guado San Nicola (Monteroduni, Isernia) is an open-air site investigated in recent years by extensive excavations. Four anthropic layers have been recognized within a thick stratigraphic sequence attributed to the end of MIS 11 based on radiometric dating ($^{40}Ar/^{39}Ar$ and ESR/U-Th combined) and the faunal assemblage composition. Numerous handaxes have been discovered in all the anthropic layers, together with bifacial shaping flakes referred to as the last stages of shaping/resharpening; the debitage component is characterized by the presence, among others, of a Levallois production. The faunal assemblage is composed by *Ursus* sp., *Palaeoloxodon* sp., *Stephanorhinus kirchbergensis, Equus ferus* ssp., *Cervus elaphus acoronatus, Dama* sp., Megacerini and *Bos primigenius*. Red-deer and horse are the most frequent species. Aurochs is always documented within the anthropic layers, while rhinoceros is scarce. Bear, fallow deer and megaceros are rare, while cervids' antlers are over-represented. The zooarchaeological analysis revealed that butchery activities were carried out on rhinoceros, horse, and aurochs. The taphonomic analysis made it possible to distinguish the anthropic alterations from the edaphic ones. Several taphonomic factors modified the faunal remains: weathering, exfoliations, manganese, and iron oxides, trampling, sediment abrasion, root-etching, and, in several cases, floating. Moreover, several notches were recognized at the base of shed antlers that could be referred to as their intentional use as hammers. In conclusion, the zooarchaeological and taphonomic analyses suggest that the assemblage represents the result of anthropic accumulations, subsequently modified by different post-depositional factors of edaphic nature.

Keywords: southern Italy; Acheulean; fauna exploitation; taphonomy; zooarchaeology.

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1. INTRODUCTION

Guado San Nicola currently represents the oldest evidence of the simultaneous presence of handaxe technology and prepared core technology in the Italian Peninsula and dates to the MIS 10/11 the emergence of the Levallois method. Therefore, the site adds new data to the debate on the Lower/Middle Paleolithic transition in Western Europe and on the origin, chronology, and evolution of prepared core technologies (Mousterian, Mode 3) and their relationship with previous technical complexes (Acheulean, Mode 2) (Muttillo et al., 2014; Peretto et al., 2016; Arnaud et al., 2017).

The faunal assemblages, recovered at the site, contribute to better defining the biochronological and paleoenvironmental context (Zanazzi et al., 2022), the taphonomic processes, the main accumulation agents, and the subsistence strategies adopted for exploiting animal carcasses (Sala et al., 2014; Peretto et al., 2016).

1.1. THE SITE

The site of Guado San Nicola (Monteroduni, Molise, Southern Italy), is located at ca. 250 m a.s.l., on the left bank of the Volturno River and ca. 30 m above the present-day floodplain of the Volturno River (Fig. 1A; Coltorti and Cremaschi, 1981; Brancaccio et al., 1997, 2000;

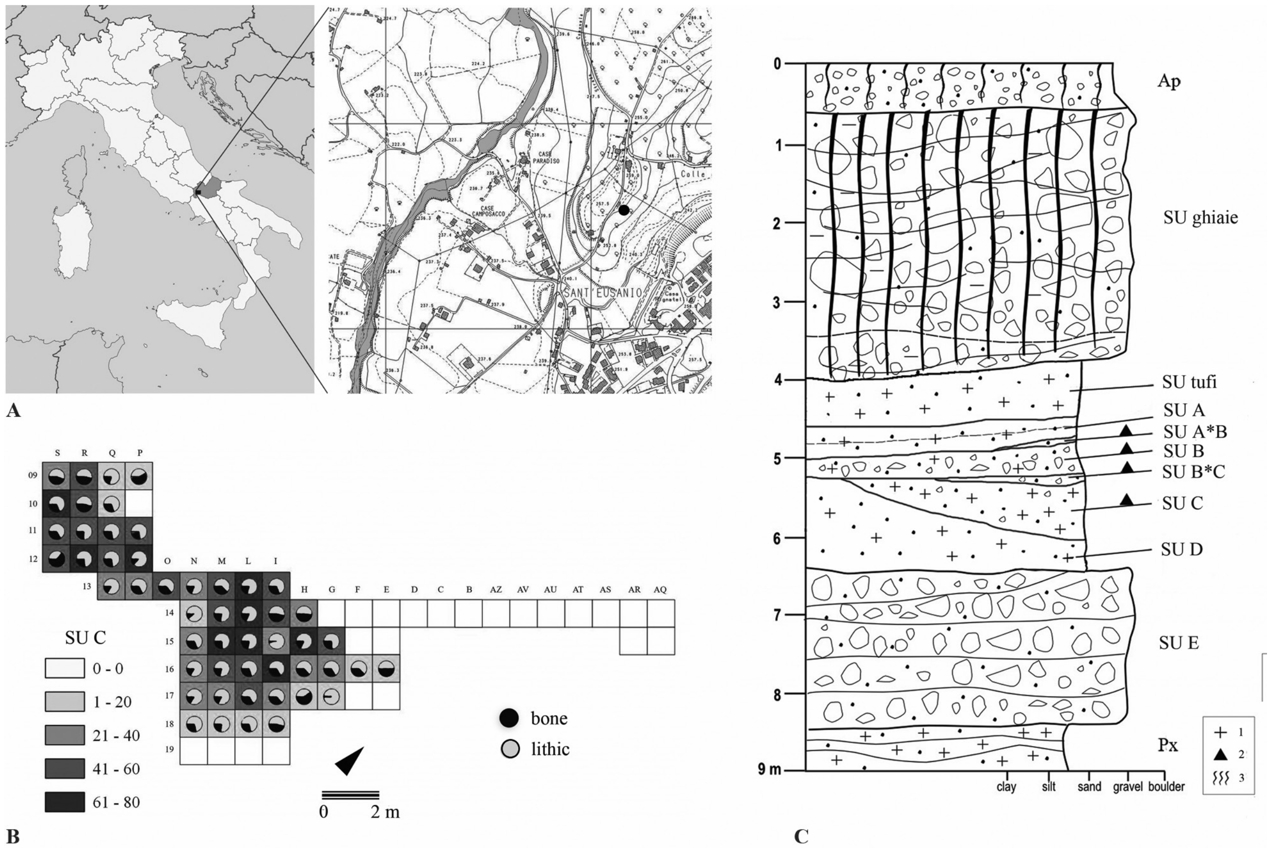

Fig. 1 - Guado San Nicola. Site location in Molise region, southern Italy, near Volturno river (top left corner); stratigraphic sequence (right): 1. Pyroclastics; 2. Archaeological remains; 3. Soils (modified from Coltorti and Pieruccini, 2014); two-dimensional frequency map of stratigraphic unit (bottom) showing the relationship between bone and lithic remains in each excavated square, with the colour of the square indicating higher (dark hues of grey) or lower (lighter hues of gray) concentrations of remains.

Coltorti and Pieruccini, 2014; Peretto et al., 2016). The site, under excavation since 2008, is dated to the MIS 11/ MIS 10 by means of biostratigraphy and radio-isotopic dating methods. The $^{40}Ar/^{39}Ar$ ages are in agreement with those made using Electron Spin Resonance and Uranium series (ESR/U-series) method applied on 6 teeth of horse and rhinoceros from the stratigraphic units C, B*C, and B that gave an average age of 364±36 ka (Bahain et al., 2014; Nomade and Pereira, 2014; Sala et al., 2014; Pereira et al., 2016; Peretto et al., 2016).

1.1.1. The stratigraphy

The systematic excavation of an area of ca. 100 m² allowed for the identification of four anthropic levels, characterized by the abundance of lithic and faunal remains (Fig. 1B; SSUU C, B*C, B, A*B) recorded in a stratigraphic sequence (Fig. 1C) mostly consisting of fluvial sandy sediments rich in pyroclastic material (Peretto et al., 2016). The stratigraphic sequence outcropping in the excavation confirms the presence of the alluvial fan. In fact, gravel, and pebbles attributable to the ancient main river were found at the bottom (SU E), overlapped by a succession of fine and middle-grained soils, ranging from silt to coarse sand, which were deposited by a tributary stream with low energy and capacity. Those deposits are characterized by sedimentary structures typical of an alluvial fan. In detail, SU C is the infilling of the main fan channel, while SU A*B and SU B*C could represent stable areas where people at that time could stay. The described environment may account for the observed different wear of archaeological finds. The higher layers of the stratigraphic sequence are characterized by the presence of volcanic materials (SU TUFI) derived from the activity of the not-far volcano of Roccamonfina and transported and then deposited by the channels of the alluvial fan. The sequence is closed by a layer of gravel and pebbles completely altered by the pedogenesis (Fig. 1C).

1.1.2. Lithic industry

The lithic industry, mostly obtained from different types of flint locally available near the site, is characterized by two components, one linked to bifacial shaping and one linked to debitage, with the use of different methods, i.e., S.S.D.A., Discoid, and Levallois (Forestier, 1993; Boëda, 1993, 1994) (Fig. 2).

Despite the prevalence of the S.S.D.A. method in all the stratigraphic units, it is recognizable a full mastery of the Discoid method and an improving mastery of the Levallois method along the stratigraphic sequence, especially in the SU B*C and B. The Levallois assemblage (20 cores and 96 flakes) is obtained on high-quality raw material, through a preferential and recurrent (centripetal and unipolar) modality (Fig. 2).

The exhaustive exploitation of raw material, recorded for all methods, testify to the high productivity of the debitage. Secondary reduction sequences on flakes are rarely attested, as well as retouched tools (sidescrapers, denticulates, notches).

The numerous handaxes (*n* 143) are obtained at the expense of slabs of flint - of high- and poor-quality raw material both - and only very rarely from flakes. Although characterized by morphological and dimensional heterogeneity, handaxes generally display common characteristics, which are: the presence of the cortex in the basal part; bifacial and bilateral asymmetry or only partial symmetry; greater accuracy in the shaping of the point and distal edges, which could represent the effective functional part; use of soft hammer for the final stages of bifacial shaping/resharpening. The use of the soft organic hammer is attested in this phase by the discovery of thin and covering bifacial flakes (*n* 138) with an extended and pronounced lip, in a very good state of preservation (Muttillo et al., 2014; Peretto et al., 2016).

The state of preservation of the lithic artifacts is good in SSUU B*C, B, and A*B, while in SU C is affected by alterations.

2. METHODS

Taxonomical and anatomical identifications were carried out using modern and Pleistocene reference collections and specialized literature (Beninde, 1937; Kahlke, 1956 a,b; Eisenmann, 1992, 2010; Rustioni, 1994; Caloi, 1997; Di Stefano and Petronio, 2002; Lister et al., 2010; Vislobokova, 2011; Kahlke et al., 2011; Alberdi and Palombo, 2013; Made van der, 2013).

Bone surfaces were macroscopically observed and microscopically analyzed by stereomicroscope Leica MZ6 and scanning electron microscope, after a long process of cleaning and restoration, which was necessary to remove part of the sediments that still enclosed the remains, especially on the large ones. For cleaning only wood tools were used with a solution of alcohol-acetone and Paraloid B72 (at 10%) for consolidating them. Edaphic and anthropic marks have been classified following the well-known literature (Behrensmeyer, 1978; Binford, 1981; Fernandez-Jalvo and Andrews, 2016; Lyman, 1994). Carnivore and rodent marks were discriminated following Fisher (1995) and Domínguez-Rodrigo and Piqueras (2003). Trampling was classified using Blasco et al. (2008) and Domínguez-Rodrigo et al. (2009). Butchery marks were recognized following Potts and Shipman, (1981), Shipman (1981), Olsen and Shipman (1988), Lyman (1994), Galán et al. (2009), Domìnguez-Rodrigo et al. (2009), and Vettese et al. (2020). In particular, Villa and Mahieu (1991) criteria were used in order to distinguish green bone from dry bone fractures.

3. RESULTS

3.1. FAUNAL COMPOSITION

The osteological remains, analyzed in this study were recovered during the excavation campaigns 2008-2012 and come from SSUU C, B*C, B, and A*B. They amount to 1260. The assemblages comprise remains of *Ursus* sp., *Palaeoloxodon* sp., *Stephanorhinus kirchbergensis*, *Equus ferus* ssp., *Cervus elaphus acoronatus*, *Dama* sp., Megacerini and *Bos primigenius* (Tab. 1; Sala et al., 2014; Peretto et al., 2016).

Tab. 1 - Guado San Nicola. Composition of the faunal assemblages per SU (NISp: Number of Identified Specimens; NR: Number of Remains).

	SU C		SU B*C		SU B		SU A*B	
Taxa	**NISp**	**%**	**NISp**	**%**	**NISp**	**%**	**NISp**	**%**
Ursus sp.			1	3				
Palaeoloxodon sp.	30	37.5	5	15.3	6	8.8		
Stephanorhinus kirchbergensis	4	5.2	3	9	7	10.3	2	50
Equus ferus ssp.	3	3.6	12	36.4	32	47.1		
Cervus elaphus acoronatus	20	25	5	15.3	7	10.3		
Dama sp.	1	1.2	1	3				
Megacerini	2	2.4	1	3				
Bos primigenius	11	13.8	3	9	10	14.7	1	25
Cervidae	9	11.3	2	6	6	8.8	1	25
TOTAL NISp	**80**	**100**	**33**	**100**	**68**	**100**	**4**	**100**
Ungulata	4		6		10			
Antler fragment	260		24		23			
TOTAL Unidentified	**475**		**82**		**175**		**16**	
TOTAL NR	**819**		**145**		**276**		**20**	

SU C. The largest quantity of faunal remains was recovered in SU C (NR 819). Identified remains amount to 43% of the assemblage. Elephant (NR 30) and red deer (NR 20) are the most represented animals followed by aurochs (NR 11) and to a lesser extent by rhino (NR 4), horse (NR 3), megaceros (NR 2), and fallow deer (NR 1). It was not possible to estimate the minimum number of individuals for the low frequency of materials. As far as the anatomical representation is concerned, all the taxa are mostly represented by cranial remains (skull - NR 7, jaw - NR 3, and isolated teeth - NR 22) and a considerable quantity of red deer shed antlers (NR 16) and antlers fragments (NR 260). These antler remains represent 95.2% of deer remains and 80.5% of the total Number of Identified Specimens. Axial skeleton (vertebrae and ribs) is only attested for elephant and cervids, while bones of the appendicular skeleton were recognized only for elephant (1 portion of the femur, tibia, and 6 diaphysis), for aurochs (2 portions of humerus, radio-ulna, and 1 tibia, metatarsal, metapodial), for a horse (1 fragment of radio-ulna), for red deer (1 fragment of the femur). Red deer shed antlers consist of at least 12 portions with a burr that can be referred to at least 7 individuals. Within the unidentified remains several long bone diaphysis (NR 51) have been recovered.

SU B*C. The faunal assemblage of SU B*C comprises 145 remains, of which 33 were taxonomically identified. The most represented species are horse (NR 12) followed by elephant and red deer (NR 5), rhinoceros, and aurochs (NR 3). Fallow deer and megaceros are present with just one specimen. The sole carnivore, attested by only one find, is the bear. It was possible to estimate the minimum number of individuals only for the horse which equals 2 individuals by the presence of two adult upper molars. As far as the anatomical representation of the carcasses concerns, isolated teeth (NR 18) are the most represented elements for all taxa and antlers for cervids (NR 28). The axial skeleton is represented only for the elephant with one vertebra and one rib, while the presence of a portion of horse pelvis is indicated. Limb bone fragments are rare (1 humerus and 1 tibia for ungulates; metatarsal for fallow deer, aurochs, and cervids), however, diaphyseal fragments (NR 32) are well represented among the unidentified remains.

SU B. The osteological assemblage from SU B consists of 276 finds, among which 101 have been identified. The horse is well represented (NR 32), followed by aurochs (NR 10), rhinoceros (NR 7), red deer (NR 7) and elephant (NR 6). The minimum number of individuals was estimated only for the horse which adds up to at least 3 individuals (1 young and two adults) by teeth. Also, in this SU, the anatomical representation of the identified taxa is characterized by dental remains (NR 46), some cranial fragments (NR 1 for elephant and aurochs), mandibular (aurochs and ungulates), and numerous antler fragments (NR 25). The bones of the appendicular skeleton are scarcely represented, only for aurochs (NR 4), horse, and rhinoceros (NR 1 for both taxa), while long bone shafts (NR 53) are well represented among the unidentified remains.

SU A*B. This faunal assemblage consists of only 20 remains, including 2 rhinoceros' teeth, 1 aurochs molar, and one antler fragment. Unidentified remains are all referred to as diaphyseal fragments. This SU was not significant for zooarchaeological analysis.

3.2. TAPHONOMY

The bone remains from SSUU C, B * C, and B appear to be relatively well preserved at a macroscopic level, although the outer layer of the surface is not preserved in 40% of specimens, due to a slight and diffuse exfoliation (Tab. 2; Sala et al., 2014; Peretto et al., 2016). The others have a discrete degree of preservation. All surfaces are diffusely impregnated by manganese and iron oxides, and only 40% by spotted iron oxides. In all the SSUU weathering has modified the surfaces to a more or less intensive and extensive degree (Stage 1-3 following Behrensmeyer, 1978), suggesting different durations to the open-air exposure. Exfoliations and erosions are mostly mild and localized in SSUU C (Ex. NR 116 - 14.2%; Er NR 226 - 27.6%) and B*C (Ex. NR 17 - 11.7%; Er NR 14 - 9.7%), while they are marked and diffuse in the SU B (NR 9 - 3.3%; 51 - 18.5%). In particular, in this SU root-etching strongly affected 28.3% of the bone's surfaces (NR 78). However, SU C is characterized by the presence of a thin reddish-yellow encrustation, made of sand, which partially coats at least 23% of the finds (NR 192), preventing the observation of the surfaces. The edge smoothing is mostly documented in the SU C (NR 378 - 46.2%). Carnivores and rodents marks are rare (Tab. 2).

The bones with preserved surfaces are 124 for SU C, 96 for SU B*C and 185 for SU C. Anthropic marks related to butchery activities such as cutmarks, have been recovered only in few remains in low rates (SU C: NR 1 - 0.8%; SU B*C: NR 3- 3.1%; SU B: 1-0.5%). Most of the linear marks, related to the flesh removal have been recovered on diaphysis fragments of the tibia and humerus, but without preserving their micromorphological characteristics (SU C: NR 5 - 4%; SU B*C: NR 7 - 7.2%; SU B: NR 8 - 4.3%). Cutmarks referable to the stripping of the pelt were found on a horse metacarpal coming from the SU B, while traces of disarticulation were found on the coxal of horse (US B*C) and rhinoceros (US B; Fig. 3C) in order to disarticulate the femur head, a large ungulate vertebra, in order to divide the spinal column into several parts.

Peculiar percussion notches have been recognized on the burr of 4 shed antlers, that could be interpreted as notches produced by their utilization as soft hammer. These notches appear as thin linear and irregular subparallel grooves and were found only on these surfaces and not on any other surfaces analyzed. These shed antlers consist of the basal portion, with part of the beam, the brow and frontal tines. In two cases, the frontal tine has been broken, but they don't seem to have been intentionally modified. As the analysis of the deer antler breakage is concerning,

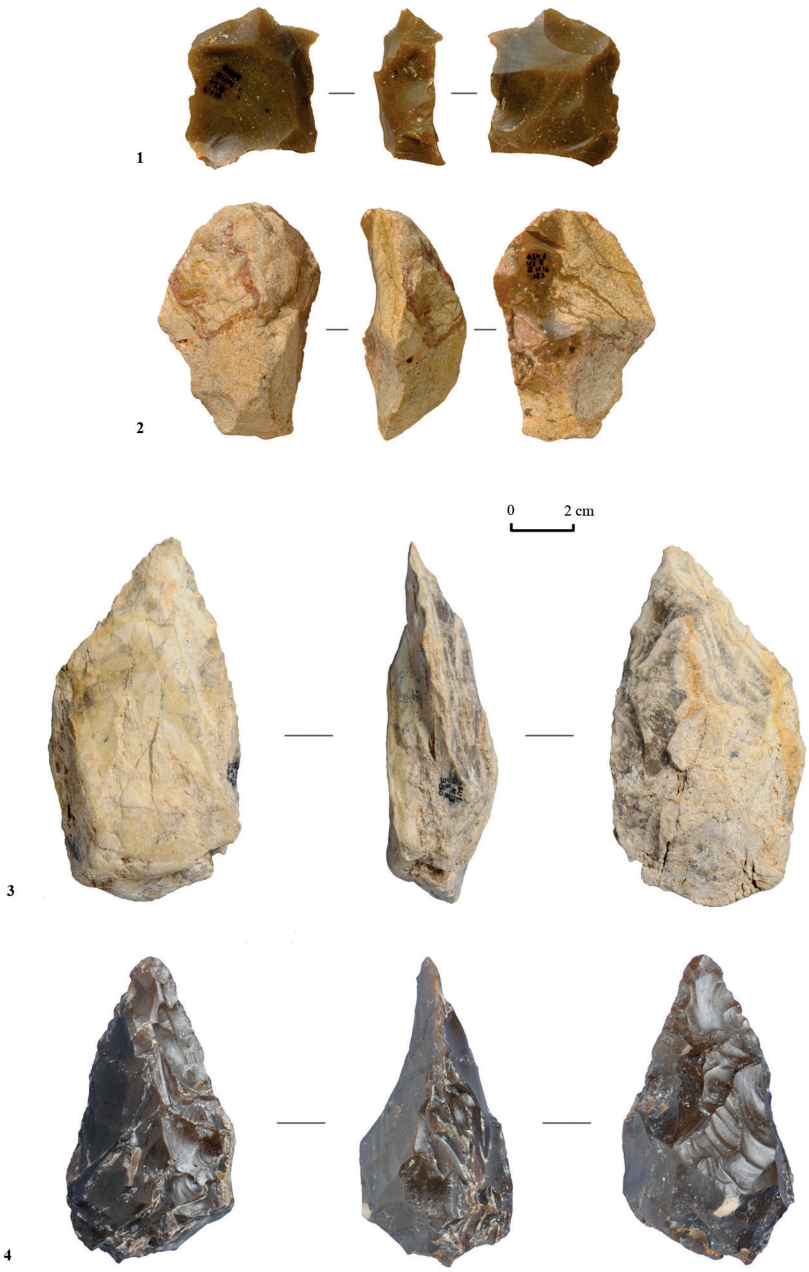

Fig. 2 - Guado San Nicola. 1-2: Levallois cores; 3-4: handaxes (photo: A. Priston).

it was possible to discriminate different types of fracture. These fractures can be sometimes attributed to natural fractures produced during the animal's life and fractures produced by post-depositional factors; for the moment it is quite difficult to demonstrate an intentional fracturing because of the scarcity of comparative data.

The faunal remains from the 3 SSUU, consist mainly of unidentified shaft fragments (Fig. 3), which can be attributed to an intentional bone breakage in order to recover the marrow. Anyway, the fresh fractures are often overlapped by post-burial fractures. Both the fractures were recognized recording the typical characteristics of the fresh outline, edge texture and angle, and long bone shaft length and circumference. Impact point, percussion cones, even if in low frequencies have been recognized too, on a couple of the diaphysis of elephant and large ungulates as aurochs (Fig. 3) and rhinoceros.

4. DISCUSSION AND CONCLUSION

The relatively high rate of determination depends on the presence of numerous fragments of cervids antlers, found mainly in the SU C, which is the most abundant in faunal remains (Tab. 1). The rates for the determination of each SU vary from 20 to about 43%. Even if the rates of identified specimens are quite high (around 40% within each assemblage), the number of identified remains in each stratigraphic unit is insufficient to clearly assess the

Tab. 2 - Guado San Nicola. Taphonomic modifications (NR and %TNR) per SSUU.

	SU C TNR 819		SU B*C TNR 145		SU B TNR 276	
Edaphic Modifications	**NR**	**% TNR**	**NR**	**%TNR**	**NR**	**%TNR**
Fe Oxydes	107	13.1	84	57.9	90	32.6
Mn Oxydes	448	54.7	121	83.4	212	76.8
Weathering	398	48.6	61	42.1	67	24.3
Exfoliation (Ex.)	116	14.2	17	11.7	9	3.3
Erosion (Er.)	226	27.6	14	9.7	51	18.5
Concretions	192	23.4	7	4.8	14	5.1
Postdepositional fractures	491	60.0	60	41.4	74	26.8
Smoothing	378	46.2	29	20.0	14	5.1
Root-etching	76	9.3	14	9.7	78	28.3
Carnivore marks	5	0.6	2	1.4	-	-
Rodent marks	1	0.1	-	-	-	-
Anthropic modifications	**80**	**9.8**	**31**	**21.4**	**50**	**18.1**
Cut marks	1	0.1	3	2.1	1	0.4
Linear marks	5	0.6	7	4.8	8	2.9
Notches	5	0.6	-	-	-	-
Anthropic fractures	37	4.5	28	19.3	43	15.6
Impact points	11	1.3	7	4.8	9	3.3
Negative Scars	21	2.6	9	6.2	-	-
Percussion cones	5	0.6	1	0.7	-	-

variation of the faunal sequence.

Therefore, it is necessary to consider the assemblage as a whole, provided that the time of deposition was relatively short. The assemblages are composed by *Ursus* sp., *Palaeoloxodon* sp., *Stephanorhinus kirchbergensis*, *Equus ferus* ssp., *Cervus elaphus acoronatus*, *Dama* sp., Megacerini and *Bos primigenius*. Based on the number of remains the most frequent species are red deer and horse. In SU C elephant is over-estimated because of teeth fragmentation.

Aurochs is always documented within the SSUU, while rhinoceros is scarce. Bear, fallow deer and megaceros are rare. Cervid antlers are over-represented, especially in SU C. The faunal composition suggests the presence of several environments in the surrounding areas: wooden areas, even bushy, occupied by cervids and open areas where elephants, aurochs, and horses lived.

Rhinoceros could graze in both environments. It is possible that, for the presence of rhinoceros of Merck and auroch and the lack of cold markers, these assemblages can be attributed to one or more temperate or warm-temperate moments. The assemblages can be attributed to the faunal unit of Fontana Ranuccio due to the presence of *Cervus elaphus acoronatus* in all the three SSUU, an exclusive subspecies typical of the Galerian mammal age (Gliozzi et al., 1997; Masini and Sala, 2011; Petronio et al., 2011), and horses with a relatively large body size even though the site is located on the southern margins of the geographical range of *Equus ferus*. This hypothesis complies with the results of the uranium-thorium (U-Th) and the Electron Spin Resonance (ESR) dating.

The taphonomic analysis was aimed at determining the degree of preservation of the bone surfaces in order to recognize the anthropogenic marks related to the processing of animal carcasses and the use of deer antlers. Nevertheless, edaphic and climate agents modified the assemblages, and despite the low frequency of identified specimens, cutmarks were found on some identified items of horse, rhinoceros, and bone breakage on several diaphysis shafts, allowing to ascribe them at different stages of butchery. The taphonomic analysis of the faunal remains of Guado San Nicola suggests that the assemblage was an anthropic accumulation and that its composition was subsequently and strongly modified by the fluvial environment. Complete bones are few and especially small ones are almost absent. The assemblages are composed of long bones shafts, often bearing traces of intentional fracturing. Unfortunately, the few finds recovered, the low anatomical representation of the carcasses, and the scarce preservation of the bone's surfaces do not allow for better reconstructing the process of prey exploitation. Some qualitative data suggest that elephant, rhinoceros, horse, and aurochs could have been slaughtered near the site. Elephant, rhinoceros, horse, and aurochs had probably been butchered near the site, whilst the interest in cervids was primarily motivated by the collection of shed antlers.

AUTHORS CONTRIBUTION - Authors contributions: C.P. directed fieldwork and studies at Guado San Nicola; G.L.

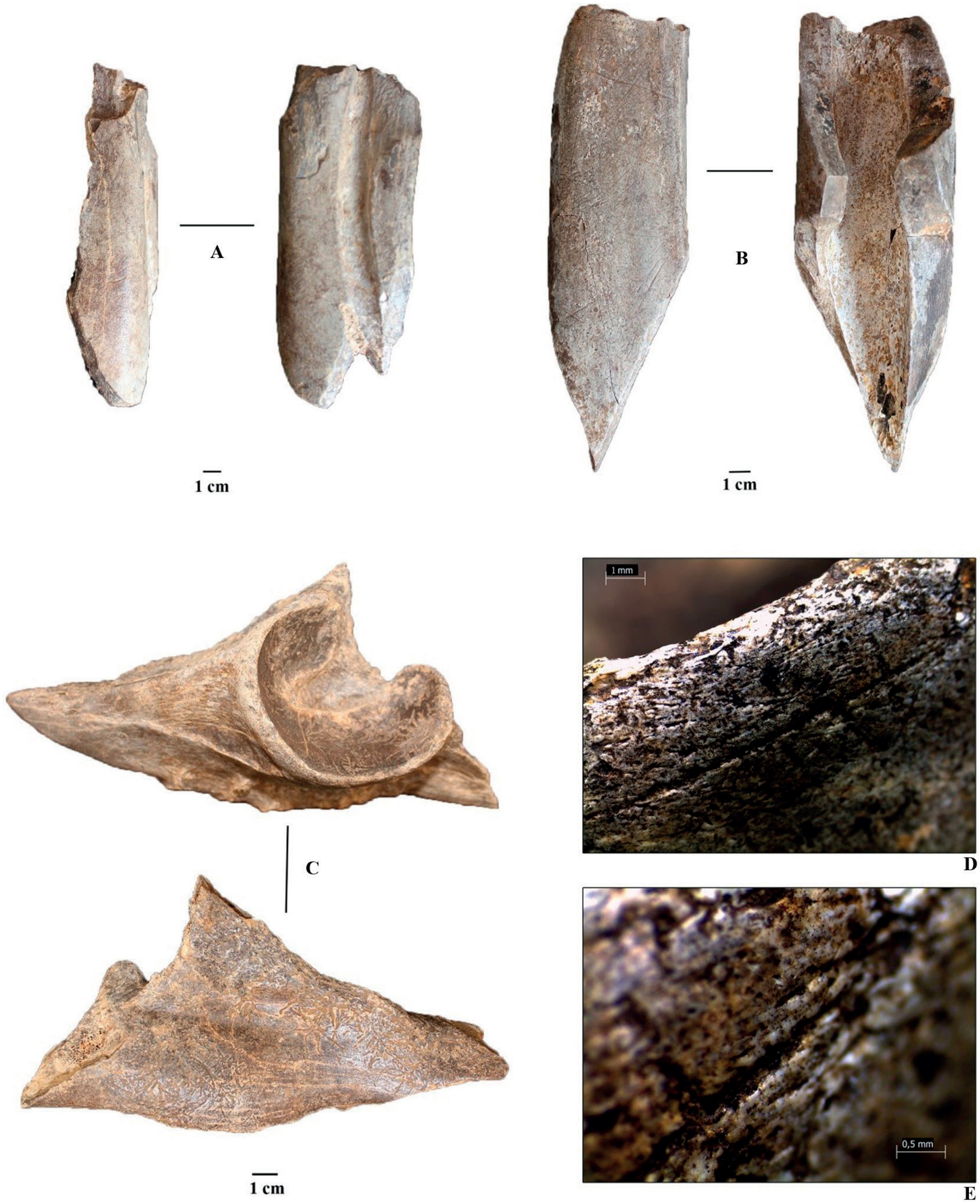

Fig. 3 - Guado San Nicola. A) *Bos primigenius* (R10B635). Left Radius shaft of aurochs with an impact point on the lateral view. B) Ungulata (Q11C032). Large ungulate tibia shaft that bears intentional fresh bone fracturing and trampling on the bone surface. C) *Stephanorhinus kirchbergensis* (R11B623). Left coxal fragment, bearing a linear mark on the *acetabulum* border (D), that could be referred to the disarticulation of the femur's head. The morphology of the entry point and the V section of the sulcus are compatible with the use of a sliding lithic tool, although some encrustrations impede to analyze the bottom of the sulcus by stereomicroscopy (E).

conducted the excavation and edited the figures; M.C.T. analyzed the geomorphological and stratigraphic context; B.S. performed the paleontological and biocronological study; U.T.H. carried out the archaezoological and taphonomic analyses; B.M., M.A. and C.P. analyzed the lithic assemblage; UTH wrote and edited the manuscript with contributions by B.M. and M.C.T.

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