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Rhinoceros exploitation at Érd (Hungary). What a place for the megaherbivores in the Neanderthal diet in Hungary?

ABSTRACT

The Hungarian Transdanubian site of Érd, where a Mousterian industry and abundant osteological material were discovered in the early 1960s is well known to prehistorians. The remains of megaherbivores *(Mammuthus primigenius, Coelodonta antiquitatis)* are re-examined here under the taphonomic and archaeozoological components in order to complete the Hungarian and European *s.l.* data and reassess the potential exploitation of these two pachyderms in the Neanderthal diet and economy. The cut marks, the intense activity of carnivores/hyenas and the skeletal profiles indicate a mixed origin of the carcasses. Mortality patterns of rhinoceros are characterized by the presence of young, subadult and adults, and suggest multiple acquisition by active scavenging and/or hunting with quick access. Skeletal profiles suggest a selective transport of rich/nutritive elements by humans to the site. The cut marks and fracturing of some elements (*in situ* butchery treatment) confirm that Neanderthals consumed these species on site and that they had at least partial primary access. The mode of acquisition seems active with rapid access for a young mammoth. Érd confirms the Neanderthal exploitation of rhinos and mammoths in their steppic environment during the Middle Palaeolithic. Érd is currently the only Hungarian Middle Palaeolithic site with a proven exploitation and consumption of these megaherbivores.

KEYWORDS

Middle Palaeolithic, Rhinocerotidae, Proboscidea, rhinoceros exploitation, mammoth exploitation, Carpathian Basin

I. INTRODUCTION

The site of Érd is particularly important because of its abundant Weichselian archaeofauna, whose depositions (mainly limestone and lœss, cf. Kriván, 1968) also buried and protected a significant quantity of lithic tools attributed to the Middle Palaeolithic Mousterian (known as "Charentian").

This article focuses on the archaeozoological study of the remains of *Érd's* megaherbivores, the woolly rhinoceros *(Coelodonta antiquitatis)* and the woolly mammoth *(Mammuthus primigenius),* including the remains attributed to *Proboscidea* and *Rhinocerotidae* from the archaeological complexes of this site.

In Hungary, it is in the site of *Érd* that the remains of rhinos have been discovered in the greatest abundance. More generally, the questioning of the place/importance of these two species in human diet is all the more important as their remains are sometimes rare, sometimes in significant quantities (regionally and/or chronologically), in archaeological or mixed context.

At *Érd*, the presence of the rhinoceros as well as that of the mammoth may have a mixed and not exclusively human origin due to the presence of the cave hyena and the frequent traces of gnawing observed on their bone remains. Rhinoceros can represent up to 20% of the hyena's prey choice in the context of a typical den (Camiac site, France, MIS 3, Discamps 2011).

Hominids and carnivores used the same spaces and consumed/hunted the same species during the Pleistocene (Brugal, Fosse 2004), as evidenced by the numerous remains and marks left on the bones, particularly those of the megafauna at this site. Thus, their co-occurrences in terms of hominid-carnivore relationship asks for clarification about their competition of resources and potential interactions (e.g. Rosell, Blasco 2009). Our objective was, based on an initial study (Daschek 2014), to find out whether Neanderthals at the *Érd* site exploited the rhinoceros and to understand the place of megaherbivores in the Neanderthal diet and subsistence economy in Hungary. The archaeozoological study of this osteo-material has made it possible to understand the origin and history of the accumulation of pachyderms within the *Érd* site and to interpret their role in the economy of the Palaeolithic groups in comparison with other sites (Biache-Saint-Vaast (BSV) IIa, Auguste 1992; 1993; 1995; 2012; Louguet-Lefebvre 2005; Arago F, Chen, Moigne 2018; Vogelherd VII, Niven 2006; Hofstade I, Germonpré 1993; Taubach, Bratlund 1999; Tata, Pathou-Mathis 2004; Suba-lyuk, Mester, Patou-Mathis 2016).

II. THE TRANSDANUBIAN SITE OF ÉRD – SITE SETTING AND RESEARCH HISTORY

The city of Érd is located in the Parkváros region of the Budapest metropolitan area, 25 km south-west of the capital. This region is formed by a succession of plateaus and is part of Transdanubia (Western Hungary, lowlands). The Tétény Plateau is cut by several valleys, including the north-west/south-east trending Fundoklia Valley, between the Danube plain and a mountain of medium altitude. The Danube flows to the east, some 5 kilometres away, can be reached directly through this valley. The site of Érd opens on this same valley, on the northeastern border of it (Fig. 1). The site, a depression

FIG. 1. Location of the site in the map section: Érd site (+)

120 m a.s.l. and 8 m above the valley bottom with a maximum depth of 15 m, is closed on three sides (Gábori-Csánk, 1991, 47). It consists of two parts or "vallons" (V.I and V.II), sub-parallel and irregular, with a maximum length of 22 m, forming a "complete unit", a "dwelling area", due to the junction between the two vallons from the base of the filling in a kind of "hemicycle" (Gábori-Csánk 1968, 10).

The site was discovered in 1961 (Hunyadi 1962). V. Gábori-Csánk (1968) took over the direction of the excavations which the archaeologist carried out in full in 1963 and 1964 over the entire surface area of the site, i.e. 214 m^2 (Fig. 2). The "nature" of the site is said to be open-air (depression) (Gábori-Csánk 1964, unpublished excavation report; Gábori-Csánk 1968 in particular), even if the first publication mentioned it as a collapsed cave (Hunyadi 1962). It is not be a cave *stricto sensu* according to the definition of Straus (1990). However, the nature of certain occupations (of bears, hyenas) and the taphonomy of the bones indicate a more complex geomorphology and site function (Daschek 2014; Daschek, Mester 2020; Gamble 1986, 318–319, legend of the Table 7.10) than an (almost) exclusively anthropogenic site (Gábori-Csánk 1968 and all of this author's publications on Érd) and call into question the (entirely) open-air nature of this site (Daschek *et al.* in preparation; Daschek 2014; Daschek, Mester 2020; Fosse *et al.* 2002, 93).

The Érd site is a limestone bimodal structure. The 3–4 m filling is subdivided into seven complexes (Kriván 1968, Figs. 9–10 in Plate II.; Gábori-Csánk 1971, 12). The complete stratigraphy of the filling was reconstructed from several stratigraphic sections, including the main section (Fig. 3; Kriván 1968, Figs. 9–10 in Plate II; Gábori-Csánk 1971, 12). At its base, the first phase of deposits "A" corresponds to the whole archaeological "ensembles"[1] showed in color on this Fig. 3 (Gábori, Gábori-Csánk 1978, 184; Gábori-Csánk 1968; Kriván 1968): the lower (L) one, also indicated in the monograph 'A', which correspond to "EnsL" with 1 phase of human occupation, and the upper (U) one (i.e. "EnsU") with 5 levels/phases of human occupation (since the most recent a, b, c – upper horizon – and d, e – lower horizon). This latter (levels of EnsU) are grouped together into a single ensemble (Ens), by vallon (V.), on the basis of lithic (Mester 2006; 2012), but also bone refittings (Daschek 2014, 143, Fig. 89). These two large complexes are separated by a "sterile" deposition,

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[1] We use the term "ensemble" and not the term "layer" as used in the monograph (Gábori-Csánk 1968).

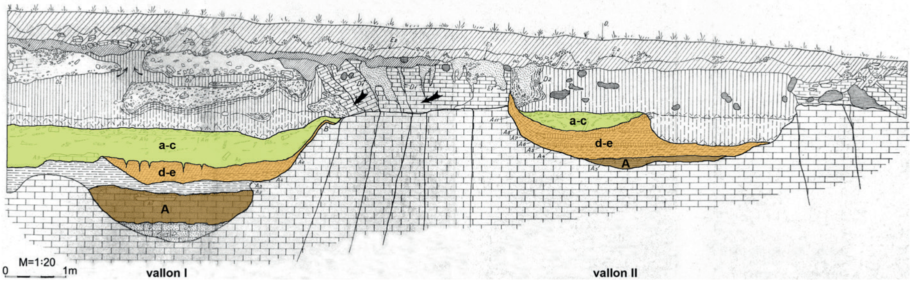

FIG. 2. Stratigraphic sequence of Érd in the main cross-section (after the original drawing, which was never published entirely (cf. Gábori-Csánk 1968, Fig. 10A, © Mester Zs., modified). A: lower archaeological layer (i.e. EnsI); a-e: upper archaeological layers (i.e. EnsS); d-e: lower horizon of the upper archaeological layer; a-c: upper horizon of the upper archaeological layer

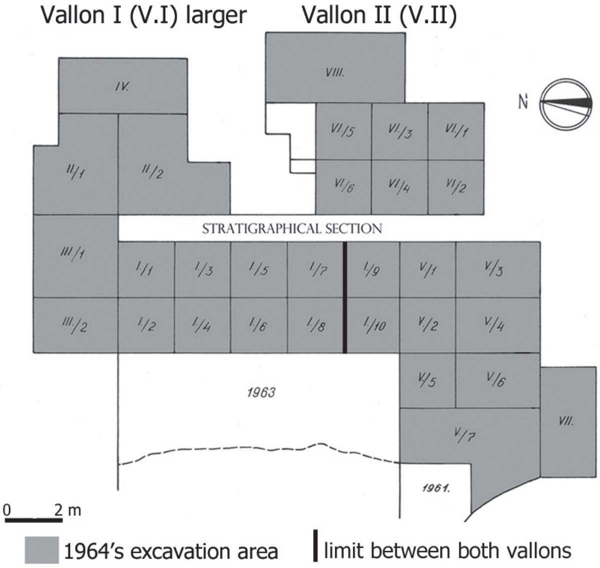

FIG. 3. Spatial distribution of the different phases of excavations on the Érd site, of 1961 (discovery), of 1963 (rescue) and 1964 (programmed, grey area) (© Daschek, modified from Gábori-Csánk 1968)

about 20 cm thick, unevenly present in the 2 vallons, as are also the lower depositions, while the upper depositions are present over the entire surface of the site. The filling consists of lœss attributed to the Upper Pleistocene

(Kriván 1968, 33–38) and detritic sediments based on limestone or mixtures thereof, of tundra character, embedded, ravine-like, in the roof of Miocene Sarmatian limestone (Kriván 1968; Jánossy 1986). The remains, recorded by depth sections (i.e. phases of occupation=levels), do not allow an osteo- or lithostratigraphic reconstruction, nor a detailed spatial analysis.

The sedimentary sequence would be common to the two vallons (V. I and II) (Gábori-Csánk 1968, 12, 32; 1971, 29), 1.5 m thick on average. It is attributed to the initial phase of the last glaciation of the Lower Würm on the basis of faunal and anthracological data (Kretzoi 1968, 59–104; Stieber 1968, 39–55), but differ from the sedimentological data, according to which the deposits stagger from the end of the Riss–Würm interglacial to the end of the Brørup interstage (Kriván 1968, 33–38). The paleoclimatic and/or chronological interpretation is questioned (Musil 2010, 49; Klein 1969, 1221). R.P. Musil (2010, 25–27, 49–51) places the dated archaeological levels *d, e* in MIS 3 and EnsL-A (pre-Brørup) would correspond to MIS 5b.

Four ^{14}C datings were carried out on charcoal (hearths and scattered coals). Two of them indicate 35,300 ± 900 BP (GrN-4443, *d*) and 44,300 ± 1400 BP (GrN-4444, *e*) (Gábori-Csánk 1970; Gábori-Csánk 1968; Vogel, Waterbolk 1967), corresponding to 41,239–39,025 calBP (*d* level) and 49,700–45,829 calBP *(e)* (Mester, realisation[2] and pers. com.).

During excavation seasons, 3093 lithic artefacts (Gábori-Csánk 1968) were discovered. Zs. Mester studied altogether 1,844 pieces, including retouched tools, cores, blanks, stone hammers and raw material blocks (pebbles) (Daschek, Mester 2020, 2–3, 5, 15, Table 1–2, Figs. 3–5). The pebbles have been exploited as uni- and bidirectional or centripetal flake cores. Three different debitage concepts were recognized in the blank production: bifacial discoid, unifacial discoid or semi-discoid and Quina (Mester 2004b, 238–239; Mester, Moncel 2006, 225–228; Daschek, Mester 2020, Fig. 3A). Those pebbles were selected for raw material which corresponded the most to the expected debitage (Mester 2012, 11–12; Daschek, Mester 2020, Fig. 3B), such as characteristic flake types could be linked to each debitage (Daschek, Mester 2020, 5). A high ratio of retouched tools which reach 40% was observed in both Vallon I and II. Except one, all the cores are of quartzite, however 22% of the assemblage were made on non-quartzite raw materials (cherts, nummulitic chert, silicified wood, jasper, radiolarite). Neanderthals at Érd preferred the short

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[2] By CalPal online http://www.calpal-online.de/

and thick (~4 cm) or ordinary flakes for tool making, regardless the raw material (Mester, Moncel 2006, Fig. 4A, Table 2, 3). For the spatial distribution study of the artefacts, artefact frequencies show the importance of the larger section of the bigger Vallon I, closer to the Fundoklia valley, as well as the rear section of the smaller Vallon II (Daschek, Mester 2020, Fig. 5). However, cores, hammerstones and raw material pebbles have been found dispersed over almost the whole excavated surface. Gábori-Csánk mentioned three workshops recognized by the frequency of cores and debris located at the rear part of the area (trenches II/1, III/1 and VIII) (Gábori-Csánk 1968, 216).

During these excavations, a rich faunal material was also collected: 50,000 animal bones unearthed but 14,930 identified at taxonomic level after the table of fauna spectrum according to Gábori-Csánk (1968, 61, 62, 111). The author of this publication studied altogether 18,074 pieces. For the main excavation field year (1964) more than 8700 (NISP) taxonomical remains were identified sine lower determination categories such as small/medium/large herbivores/carnivores/mammals (Daschek 2014). Herbivores constitute 11% (of NISP), while carnivores (cum Ursids) are dominant (NISP=88%), with the main species, *Ursus spelaeus* (NISP=81%). However, herbivores represent 97% (NISP) if calculation do not include Ursids among carnivores, as they contribute differently to the formation and the modification of the bone assemblages. The remains of megaherbivores amount to a total of 275 remains, i.e. 28%NISP of herbivores (sine Ursids) and 3%NISP (cum Ursids).

Taxonomic identification revealed the following species of EnsU, in decreasing order, with 8381 remains (in NISP): *Ursus spelaeus* (7056, 84%), *Equus sp.* (569, 7%), *Crocuta spelaea* (228, 3%), *Coelodonta antiquitatis* and *Rhinoceros sp.* (216, and 6 uncertain, 3%), *Canis lupus*, Bos/Bison (70, 0.8%), *Mammuthus primigenius* and *Mammuthus sp.*/Proboscidian (35 and 1 uncertain, 0.5%), *Equus hydruntinus*, *Megaloceros giganteus*, *Panthera (Leo) spelaea* and with less than 10 remains (≤1%) each: *Cervus elaphus*, *Lepus timidus*, *Rangifer tarandus* and *Mustela sp.*, *Proboscidea/Rhinocerotidae* and *Alopex/Vulpes sp.*, *Felis silvestris* and *Ursus arctos*. The faunal spectrum of EnsL with 344 (NISP) taxonomic remains is less varied and much smaller than that of EnsU, although similar in terms of species. The following species can be found: *Ursus spelaeus* (NISP=316), and with less than 10 remains each: *Equus sp. Panthera (Leo) spelaea*, *Coelodonta antiquitatis*, *Proboscidea* and/or *Rhinocerotidae*, *Crocuta spelaea*, *Canis lupus* and *Bos/Bison*.

The macro- and micro-mammals testify to a generally cold and dry "lœssic steppe"/"mammoth steppe" environment, and species that thrive in a more humid climate (Daschek 2014; Kretzoi 1968, Table p. 93). The molluscs, although few in number, indicate an open steppe environment (Krolopp 1968, 57; com. pers.).

At least two sure fireplaces are preserved (level *d* in both vallons) in Érd, but several ash and charcoal areas have been observed, which at least partially limits spatially the destructive action of carnivores/bears (cf. Camarós *et al*. 2013).

The human occupations of this station are recurrent and seasonal, of short duration or even brief (Daschek, Mester 2020; Daschek 2014), indicated by the continuous, but variable proportions of faunal species and lithics and their spatial association (Gábori-Csánk 1968; Daschek, Mester 2020), with short-term bear den levels (Daschek, Mester 2020; Daschek, in preparation).

III. MATERIAL AND METHODS

The excavation methodology applied at the site had been to dug out a trench of 10 m × 4 m during the first excavation season in 1963, while during the second and last 1964's excavation of 2 months, the area was subdivided in 30 squares of 4–6 m^2 (2–3 m wide trenches) while progressing in exploratory of the site extension. Provenance data of the lithic and bone finds were recorded with the identification of the trench and the level.

The faunal material studied in this article includes only the megaherbivores (*Coelodonta antiquitatis*, *Mammuthus primigenius* and undetermined remains of mega-sized animals) from Érd from the excavations of 1964, from the two vallons (V.I, V.II) and from the two ensembles ('EnsU'/'EnsL'), collected over an area of 169 m^2. This material is preserved (not referenced, except for about twenty remains) in the Mining and Geological Survey of Hungary[3] (mainly) in Budapest, the Aquincum Museum[4] and the Budapest History Museum[5].

The material in this study includes 251 taxonomically determined remains and 24 undetermined remains (Proboscidea/Rhinocerotidae), i.e. a total of 275 remains. Neanderthals and (non-ursid) carnivores also frequented the site of *Érd*. They could consume/hunt potentially the same species, as evidenced by the numerous carnivore and ungulate remains, the lithic finds, associated

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[3] Magyar Bányászati és Földtani Szolgálat

[4] Aquincumi Múzeum

[5] Budapesti Történeti Múzeum

often (zone and level) and the marks left on this megafaunal bones. The reason of their co-occurrences (hominid-carnivore relationship) requires to be explored. There has not yet been a detailed archaeozoological study focused solely on these megaherbivores in Hungary. Our objective was to find out whether Neanderthals at the *Érd* site exploited the rhinoceros mainly (most abundant) (Daschek 2014; Kretzoi 1968) and to understand the place of megaherbivores in the Neanderthal groups' diet that occupied the site at *Érd*.

One of the reasons for Érd's fame is based on the "archaeological zoology" study of this bone material developed by M. Kretzoi[6] (Kretzoi 1968, 223–244). A very important work of identification and taxonomic description (faunal list by years of excavation and palaeontological, phylogenetic/systematic description/discussion, Kretzoi 1968, 59–104) served as the basis for a palaeoecological analysis (Kretzoi 1968, 90–94, micro- and macro-mammals), a pioneer "palaeoethnological"/"archaeological zoology" (Kretzoi 1968, 223–244) (game acquisition strategy, choice/transport, seasonality, use/role of inhabited/used space, fauna/lithic relationship, spatial/heaps, stratigraphic distribution). The latter from an ecological perspective of the available animal biomass-economy, internal and cultural evolution in terms of specialization, require precise "raw" data from quantification, anatomical and age profiles, and "inferred" data such as the amount of meat consumed recovered by Neanderthals, number of animals killed, available ungulate biomass, hunting territory (Kretzoi 1968; Gábori, Gábori-Csánk 1978; Dobosi 1988).

The bones belonging to the rhinoceros and the mammoth are part of the remains of at least 7 of 11 detailed heaps of different phases of occupation in the palaeoethnological study (Gábori-Csánk, Kretzoi 1968, Tables p. 237–239, Fig. 43).

The re-examination of the bone material of megaherbivores was undertaken in order to complete an earlier study (Daschek 2014) with new remains in the light of new works on the place of pachyderms in the spectrum of animals exploited within the Neanderthal economy (e.g. Louguet-Lefebvre 2005; Morin *et al.* 2015; Smith 2015).

The study was made with the zooarchaeological methods including palaeontology, taphonomy and palaeoethnography (Patou-Mathis 1993; 1994; 1997; Lyman 1994a, b; Reitz, Wing 1999). To identify the faunal remains, we used comparative anatomy and specialized reference sources for both species

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[6] No bone remains are individually referenced during this study.

(Coppens, 1965; Lavocat 1966; Laws 1966; Pales, Lambert 1971; Borsuk-Białynicka 1973; Olsen 1979; Guérin 1980; Pales, Garcia 1981; Haynes 1991; Fortelius *et al.* 1993; Garutt 1994; Lacombat 2005; Louguet-Lefebvre 2005; Pandolfi, Tagliacozzo 2015), and osteological collections (Collections of the Mining and Geological Survey of Hungary and the Institute of Human palaeontology of the National Museum of Natural History in Paris).

Bone remains not determinable to species/genus level were classified into broader categories such as mega/large/medium/small herbivore, carnivore and mammal, indeterminate mammal.

The taphonomic analysis is based on the identification of the stigmata of extrinsic alterations of climatic-edaphic (stages 0 to 3 and mixed, cf. Haynes *et al.* 2021, Table 1, p. 961; Haynes *et al.* 2020, Table 1, p. 3; Behrensmeyer 1978, 151), non-human biological and anthropogenic (presence/absence, type of marks) origin. 0 means no alteration visible to the naked eye (no cracking or flaking), while 3 means a very high intensity and/or extensive alteration, so (almost) total coverage of surface (unreadable surface, open/deep cracks, rounded crack edges, rough/splintering cortical surfaces, strong exfoliating, lamination). Stage 1 indicates low intensity and localized damage (fine/mosaic microcracks); stage 2 indicates relatively poor conservation with deep and/or extensive traces on half surface (macrocracks, lenghten cracks, medium sharp edges). We also use intermediate stages, noted as 0-1, 1-2, 2-3, or different mixed stages (e.g. 1, 3) on different zone on the bone. Stage(s) where soft tissue, grease or marrow could present is not taken into account as the material is fossilized; however, no or slightly visible weathering traces mean that bones transported to the site presented edible or dried tissues at that time when embedding soil (stages 0 to 2/3 of Haynes *et al.* 2021/Behrensmeyer's stages or characteristics). The following criteria were sought on the bones (bones and teeth, but the calculations here concern only the bones): exfoliation, lamination, cracking (=weathering), water action (dissolution, oxidation, concretion), abrasion, fracturing/fragmentation (types and aspects), traces of plants (coloration, root etching), marks of carnivores and rodents (gnawing), anthropic marks (cut marks, impact notches, fire traces/colors) following e.g. Behrensmeyer (1978), Binford (1981), Blumenschine (1986), Blumenschine, Selvaggio (1988), Brain (1981), Bunn (1983), Fisher (1995), Guadelli (2008), Haynes (1983), Lyman (1994a), Villa, Mahieu (1991). Burning damage categories were based on macroscopic appearance and colour after Stiner *et al.* (1995, Fig. 2, Table 3). The distinction between elements burned directly in the fire or in the periphery was made according to Smolderen, Jiménez (2016).

Age classes were established according to tooth eruption, replacement and wear based on the work of Louguet-Lefebvre (2005) for the rhinoceros (based on Goddard 1970) and the mammoth (Louguet-Lefebvre 2005; Laws 1966). The births may have taken place after the spring thaw.

For quantitative data, we used, according to Brugal *et al*. (1994), the number of identified specimen (NISP), the minimum number of elements (MNE) together of both anatomical sides (Lyman 2008) and the combined minimum number of individuals per anatomical element (${}_{c}$MNI), taking age into account and overlapping areas, which corresponds to the highest number for the same laterality of an anatomical element indicating the number of individuals of a species, regardless of other criteria. The skeletal complexity number (SC) corresponds to the number of bones making up a skeleton, which varies according to taxon, sex and age. We also use the minimum animal unit (MAU) and its percentage (%MAU). The MAU is obtained by dividing the MNE of each anatomical element by the skeletal complexity number (MAU=MNE:SC). The standardised form (in %) is calculated by dividing the MAU of all elements present by the highest MAU value (MAU$_{max}$) and multiplying this number by 100 (%MAU=(MAU:MAU$_{max}$)*100). The percentage of survivorship (%S) makes it possible to assess the difference between the bone elements counted and the theoretical number expected, according to the highest ${}_{c}$MNI, so %S=(MNE*100):(SC*${}_{c}$MNI$_{max}$) or %S=(MAU*100):(${}_{c}$MNI max) was calculated according to R.L. Lyman (1994b). The bone deficiency index, according to Frischauf *et al*. (2017, 41, Table II), shows the variation in the frequencies of preserved elements in relation to a complete skeleton in relation to the number of individuals (here of combinaison, ${}_{c}$MNI) identified. Thus, the formula is: [NR/(${}_{c}$MNI*SC)*100], assuming whole carcasses and that teeth and bones belong to the same individuals.

IV. ARCHAEOZOOLOGICAL RESULTS

Vallon I and II of EnsU

Rhinoceros skeletal and age profiles. The rhino remains of this complex are very unevenly distributed between the two vallons (Table 1; Graph. 1; Fig. 4): at Vallon I, 176 remains, 70% of remains, and at Vallon II, only 40 remains. 6 possible rhinoceros bones can be added to these remains, 4 in Vallon I and 2 in Vallon II.

TABLE 1. Anatomical elements of the rhinoceros and of the mammoths from EnsS at V.I and V.II of Érd

	EnsS V.I (=V.I-s)					**EnsS V.II (=V.II-s)**				
	RHINOCEROS									
Elements	NR	MNE	$_c$MNI	%MAU*	%S	NR	MNE	$_c$MNI	%MAU**	%S
Skull						1	1	1	100,0	16,7
Mandible	2	1	1	7,7	5,0	1	1	1	50,0	8,3
Upper teeth	47	32	6	24,6	16,0	5	4	2	20,0	3,3
Lower teeth	32	19	7	14,6	9,5	13	7	4	35,0	5,8
Isolated teeth indet.	24					8				
Coast	2	2	1	0,9	0,6	1	1	1	2,8	0,5
Cervical vertebra	2	1	1	2,2	1,4					
Other vertebrae										
Vertebra indet.	2									
Scapula	1	1	1	7,7	5,0					
Humerus	17	11	10	84,6	55,0	2	1	1	50,0	8,3
Radius	7	7	5	53,8	35,0					
Ulna	3	3	2	23,1	15,0					
Innominate	6	2	3	15,4	10,0	1	1	1	50,0	8,3
Femur	1	1	1	7,7	5,0	1	1	1	50,0	8,3
Tibia	19	13	8	100,0	65,0					
Patella						1	1	1	50,0	8,3
Fibula										
Carpal	1	1	1	1,0	0,6					
Tarsal (Talus)	3	3	2	3,3	2,1	3	3	2	21,4	3,6
Metacarpals	1	1	1	2,6	1,7					
Metatarsals										
Metapodials indet.	1					1				
Phalanges										
Sesamoïds	1	1	1	0,6	0,4					
Bone indet.	4					2				
Total	**176**	**99**	**10**	**7,4**	**4,8**	**40**	**21**	**6**	**20,8**	**3,5**
Total without teeth	**73**	**48**	**10**	**3,6**	**2,3**	**14**	**10**	**2**	**9,9**	**1,7**
Total cranial	**105**	**52**	**10**	**3,9**	**2,5**	**28**	**13**	**6**	**12,9**	**2,1**
Total post-cranial	**71**	**47**	**10**	**3,5**	**2,3**	**12**	**8**	**2**	**7,9**	**1,3**

(*MAU$_{max}$=6,5; **MAU$_{max}$=1 ; SC*=205; SC**=101)

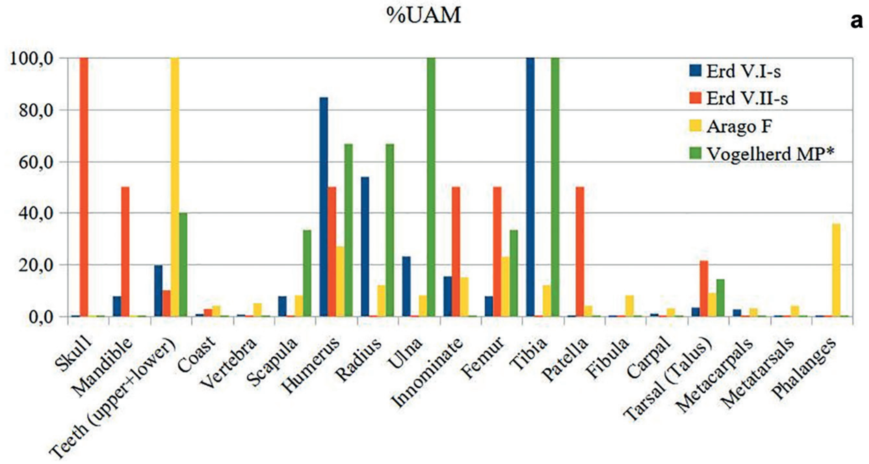
cont. Table 1

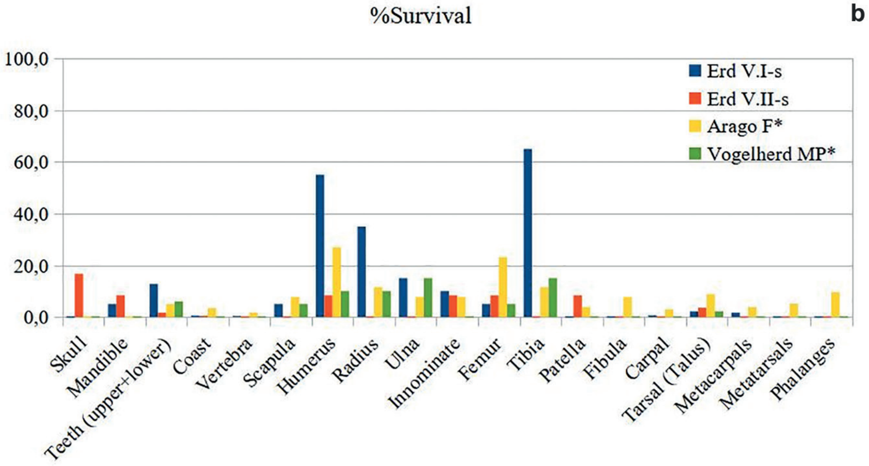
	EnsS V.I (=V.I-s)			**EnsS V.II (=V.II-s)**		
	MAMMOTH					
Elements	NR	MNE	$_{c}$MNI	NR	MNE	$_{c}$MNI
Tusk	~17	2	2			
Upper teeth	2	2	2			
Lower teeth	2	1	1	1	1	1
Isolated teeth indet.	6		1	1	1	1
Femur				1	1	1
Patella				1	1	1
Long bones indet.	2	1	1	1	1	1
Total	**~30**	**6**	**2**	**5**	**5**	**2-3**
Total without teeth	**2**	**1**	**0**	**3**	**3**	**2**

cont. Table 1

All major units are represented, mainly by long bones. Bone and dental elements are present within the assemblages. In both assemblages, there are 133 remains of the skull (including 3 fragments of mandibles). Dental material, with 129 remains (60%), is more common than post-cranial material (83 remains).

In V.I, 47 upper teeth (MNE=32), 32 lower teeth (MNE=19) and 24 fragments were found, while in V.II, respectively, only 5 (MNE=4) and 13 (MNE=7) teeth and 8 fragments were identified. With regard to the relative density of the bones in general, cranial fragments are proven but rare (occipital, mandibles with or without teeth, skull fragment of large undetermined herbivore), and explains the presence of numerous isolated teeth, but not the rarity of cranial fragments. The autopod is rare or even absent, except for the talus: only the first row of bones of the basipod (semilunar and talus) and intermediate (metacarpal) bones have been discovered. Lack of carpal bones could be result of dismembering practices or destroying bones at the site by diagenetic processes. The fleshy femora is unique in both vallons. Humerii are well represented among limb bones, but one observe a dominance of the lower section long bones, tibiae and radii. Without considering possible marks, the forelimbs of at least 10 individuals, and the hindlimbs of at least 8 individuals were transported to the site. If we take into account the presence of cut marks on these remains (cf. section on taphonomy below), thus, at least 1 forelimb and 2 hindlimbs were transported to the site by Neanderthals (Table 2).





GRAPH 1a, b. Skeletal representation of the Érd's rhinoceros (Daschek 2014 modified) from EnsS (V.I, V.II) in %UAM (a) and in %Survival (b) and comparison with Arago F (Chen, Moigne 2018, modified) and Vogelherd VII (Niven 2006 modified). Blue line: Érd V.I upper, Red line: Érd V.II upper, Yellow line: Arago F, Green line: Vogelherd Middle P. Data in %UAM of Érd and the two other sites are shown on the Graph 1a; data in %Survival are shown on the Graph 1b

The diagenetic process is limited or constant (balance of tooth and bone pairings, except for the permanent upper teeth and humerus) if, however, the skulls/carcasses had been brought/transported to the site whole. It is the result of different episodes of accumulation of elements in each of the vallons.

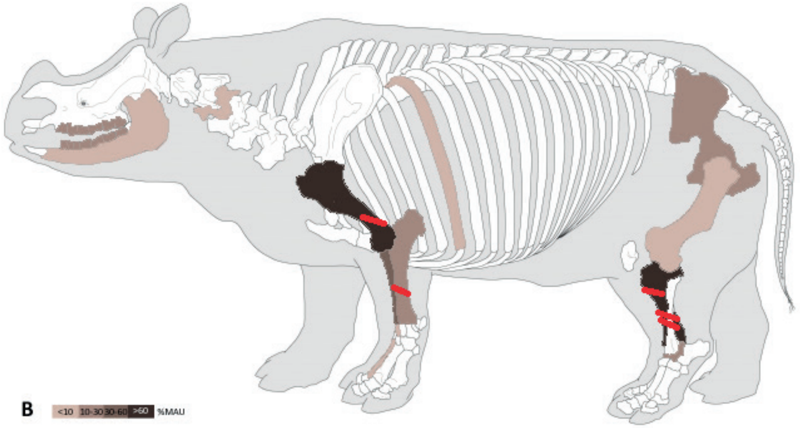


FIG. 4. Skeletal representation of the Érd's rhinoceros in %MAU, EnsS V.I, and butchering marks (red furrows)

Multiple agents and processes were therefore involved in the formation of these assemblages of Érd.

The dominance of long bones, girdle bones and skull, in contrast to the axial, is characteristic of hyena dens (e.g. Fourvel 2012, 397). At Érd, the pattern of conservation of anatomical units and the predominance of that of the cranial (teeth), is followed by the long bones and, to a much lesser extent, by the girdle bones and those of the axial. This observed difference in representation does not correspond to that found strictly in the dens, but the assemblages (can) result partly of hyena activity (cf. section on taphonomy below).

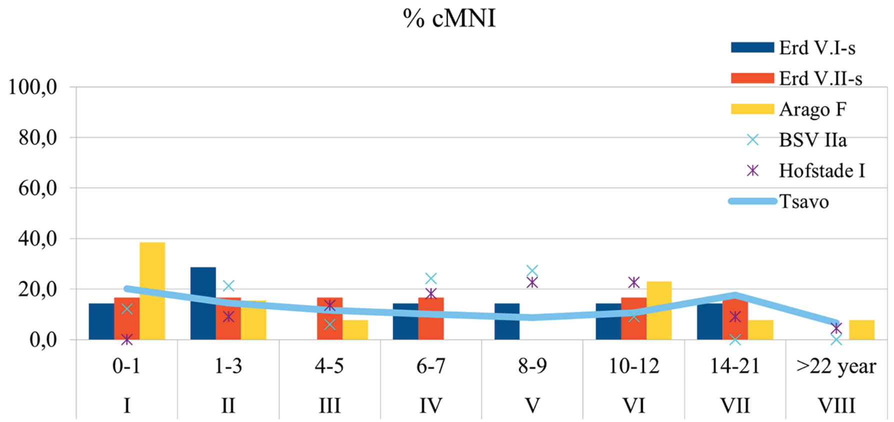
The assemblages considered together, at least 18 individuals were counted, including 7 young (<5 years), 6 sub- and young adults (6-12 years), 2 mature (14-21 years), none elderly (>22 years) and 3 adults s.l. by bone (in V.I). The youngest may died during spring/summer period.

In V.I, at least 10 individuals are represented, by 8 adults (left humerus) and 2 (perhaps 3) young (teeth or right humerus). According to the dental mortality profile (Graph 2), at least 7 individuals are represented, including 3 young (<1 and 1.5-3 years old) under the supervision of their mothers, 2 subadults (6-7 and 8-9), 1 young adult (10-12) and 1 prime adult (13-21 years old).

In V.II, at least 6 individuals are represented, by the teeth mortality profile (Graph 2), with 3 juveniles (<1, 1.5-3 and 4-5 years old), 1 subadult (6-7 ans), 1 young adult (10-12) and 1 prime adult (14-21 years) could be highlighted. Three cylinders of juvenile/immature humerus were also identified.

TABLE 2. Description of the cut marks in EnsS, V.I at Érd.

Species N° piece	Element			Cut marks		
	Description	**Diaphyse length**	**Diaphyse circumpherence**	**Description**	**Anatomical localisation**	**Butchery action**
Rhinoceros N°130122	Humerus left cylinder, base of mid-shaft diaphysis/distal diaphysis, near of the beginning of fossae, foramen presence?	1	1/4-1/2	*numerous, transversal, short, wide, shallow ; *numerous, transversal, very short, shallow-superficial	*cranio+medial/lateral side on medial diaphysis; *near the fissure and inscription on median diaphysis	filleting
Rhinoceros N°310186	Radius (?) mid-shaft fragment portion	>1/2	<1/4	*1 isolated, ~transverse, relatively long, broad, shallow; *1 isolated, oblique/transversal, long, fine, shallow; *(?) oblique/transversal, very long, double, shallow - barely visible	*narrow convex face on median diaphysis	filleting
Rhinoceros N°310210	Tibia left mid-shaft fragment portion, medial side	<1/2	<1/4	*7+3, ~oblique/ transversal, short and relatively long, wide, relatively deep	*rounded medial face: edge (transversal); *fracture edge	filleting
Rhinoceros N°400180	Tibia left cylinder, mid-shaft diaphysis portion, foramen present	1	<1/4	*1 isolated, oblique, relatively long, wide, deep	*cranial face on median diaphysis, near distal edge if frontal crest.	filleting
Rhinoceros N°400182	Tibia right cylinder, proxima and mid-shaft diaphysis portion, foramen present	1	1/4-1/2	*1 isolated, ~transversal, relatively long, wide, shallow-superficial	*"distal" cranio-lateral face on medial diaphysis	filleting
Mammoth N°800285	Tibia (?) Fragment of part of mid-shaft and distal diaphysis	1/2-3/4	>1/2	*1 isolated, oblique, superficial, barely visible, relatively long, wide	*at the middle shaft (of the fragment)	filleting
Mammoth N°800286	Femora left Cranial side of proximal to distal diaphysis and complete mid-shaft diaphysis, foramen present	1	1	*2+1, transversal, relatively long, shallow-superficial	*at the middle shaft and distal zone of cranial face	filleting



GRAPH 2. Mortality profile (%cMNI) of rhinos in EnsS (V.I and V.II) at the Érd site, in comparison with Biache-Saint-Vaast IIa (Louguet-Lefebvre 2005), Arago F (Chen, Moigne 2018), Hofstade I (Germonpré 1993) and Tsavo (present-day black rhino, Goddard 1970, Table 8). BSV: Biache-Saint-Vaast or Biache

The elements are greatly under-represented in relation to the estimated number of individuals (16 and 11 remains *per* individual).

Graph 2 shows that the age group >22 years are not represented by the material of the two vallons. The percentage of 8-9 year old is above the average for a natural population (Tsavo, in grey), as at BSV IIa and Hofstade I, but 0-1 year old are under-represented, as in BSV.

The observed profiles (in V.I) are representative of several mortality episodes with a selection/acquisition of young, subadults and adults.

Rhinoceros taphonomy. The preservation of bone surfaces of rhinoceros remains is very variable, from excellent/very good to very poor. The main types of alterations are of climato-edaphic and biological nature. It appears that all stages of alterations (0 to 3 and mixed) are represented. Rare remains with very abraded edges are also observed. 9 pieces have a trampled surface. Oxidation (with manganese, and rarely with iron) reflects the major action of water, especially of stage 1 (light) and moisture during the overlying deposit. Some remains clearly show that the concretion was removed during post-excavation handling (chipping of surfaces, unpatinated grooves, staking). Root etching appears on 29 remains (40%NISP) from colouring to deep dissolution and (almost) total surface area. Trampling scratches were observed on 11 remains, thus attesting to a pre-bear presence. Some bones (n=11) are illegible taphonomically. Surface condition, variety of weathering stages and root etching indicate that the bones are in the open air or in the (sub)surface for a long time.

Fragmentation on dry bone is rare. The fragmentation index is similar between the two vallons with 1.8. The bone deficiency index is of the order of 14% at both vallons for the rhinos. However, these fragments resulting from such a process would be more identifiable (category "Proboscidea/Rhinocerotidae"). Moreover, there is a notable presence of fragments classified as "large carnivores" (i.e. cave bear, cave lion), smaller in size; this category constitutes the bulk of the non-specific remains, even though they are much smaller in size then "Proboscidea/Rhinocerotidae". Some rhinoceros bones of Érd (10 and 2 possible out of 83 in total of which 3 in V.II and the others in V.I) show a fracture on fresh bone (mandibles, even of young, innominate, long bones and metacarpal, see for this latter. Some of the isolated teeth are fragmented, especially the upper ones (Fig. 5: B). Rare upper cheek teeth show special fresh fracturing, possibly related to skull fracturing or related to gelifraction by mechanical action. A wide variety of diaphysis length proportions (<¼ to ¾-1 in V.I, ½-¾ in V.II) are represented. The same phenomenon is observed for the circumference of the long bones (<½ to 1 in V.I, <¼ to ¾ in V.II).

At Érd, fragmentation is therefore limited; only a few teeth were refitted. 63 of the 83 bone remains of adult and young rhinos, i.e. 75%—but only half in MNE—bear traces of gnawing. The gnawing marks appear in 59 cases in the V.I, 7 in the other vallon. Cervical vertebra, innominates, femur, mandibles, metapodial, humerus, radius, tibia, ulnae and talus constitute the damaged skeletal elements. The long bones (80%) are reduced to bone cylinders with very open diaphysis by a high intensity of gnawing activity. Incomplete bones (NR=23, cylinders excluded for long bones) are present in (large) fragments, 16 of which bear traces of teeth of carnivores. For large- and megaherbivores, these fragments are less ingested than gnawed (Beauval, Morin 2010). The action of carnivores/hyenas has been observed on the remains of other species at all levels such as cave bears and horses. The bear is the main accumulator by its own remains in these assemblages, although other biogenic contribution cannot be excluded. The observed morphology of long bone gnawing (in particular) (Fig. 5) corresponds to that described in hyena dens (Fourvel 2012, Fig. 189). In Érd's assemblages, only one tooth fragment bears witness to the action of gastric juices. Carnivore ravaging is important during the formation of those bone assemblages.

FIG. 5. Remains of Érd rhinoceros. A-1a, b: Tibia with cutting marks (a, b: details) and crenulated edges, B: Probable fracturation due to frost wedging on an upper tooth, side view (pers. com. J.-L. Guadelli) © É.J.D.

All from V.I-s, 5 long bones of variable state of preservation – sometimes in poor condition – bear butchering marks attesting to human action. The characteristics of the anthropogenic marks are presented in Table 2 and Fig. 4. These are humerus, 3 tibiae and a probable radius, all adults (Fig. 5). The cut marks are located on the median diaphysis. The furrows are always wide and relatively deep (Table 2). They were made using a tool, with a thick or very abraded cutting edge. 4 remains (two teeth and two fragments of mandibles, all within sectors II and III at the top of the upper set) were heated, involuntarily, close to or below the hearths, none found inside hearths.

These carcass parts, from a primary acquisition, were abandoned after a processing at the place of slaughter/butchery by the Neanderthals. With the exception of the radius, they were all recovered by the hyenas for secondary exploitation, abandoning them, in turn, to the state of extremely gnawed diaphyseal cylinders. Their activity may have contributed to masking possible striations on the epiphyseal areas which can indicate the place of acquisition related to *in situ* disarticulation or, at the initial place of slaughter.

According to the previous study in the monograph (Gábori-Csánk 1968), the rhinoceros is in 4th place among the species (considered) hunted (10.8%). Authors find that dental elements and long bones dominate the rest of the skeleton, as we have also observed. The bones of the lower limbs are better represented than those of the upper limbs (femur, scapula, the proximal part of the upper long bones), which indicates sometimes the abandonment of the shoulder and thigh at the place of acquisition, without excluding a contribution of boneless flesh, as we have also observed. The absence of vertebrae and ribs indicates a recovery of the carcasses away from the Érd site. The heads were transported to the site and fracturing (not just those of the pachyderms). Young (and old) animals do not seem to have been sought after by hominins (Gábori-Csánk, Kretzoi 1968, 243).

According to our work, shoulder, thigh, spine and rib cage are present, but only by one or a few parts. The same is true for certain age groups. As we also believe, none of these megafaunal species is present in natural skeletal proportions[7] (Gábori-Csánk 1978; Gábori-Csánk, Kretzoi 1968). Indeed, the number of remains *per singula* is very low. The numerical inequality between the basipod (most frequent talus) and the long bones is partly the result of occasional fracturing by men in order to recover the marrow of the long bones

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[7] In the sense of a complete skeleton per individual.

of the mammoth and sometimes of the rhinoceros (cf. Figs. 5; 6) or post-depositional factors *in situ*. It is possible that fragments of long bone diaphysis of herbivores were not taken into account in order not to increase the frequencies (Gábori-Csánk, Kretzoi 1968, 235).

69 show stigmas of cleaning of concretions and/or those of impacts from excavations (recent breaks no doubt due to the use of the pickaxe), or even very wide recent cracks and re-glueing suggesting (post-)excavation actions.

Mammoth skeletal and age profiles. Specimens identified as belonging to the woolly mammoth are 35 remains (MNE=11) (Table 1). One more unsure piece can be added to mammoth remains in V.I..

Dental material makes up the bulk of the mammoth remains with a total of 5-6 individuals in the assemblages. The (very) young (<12 years) are as much represented as the adults *s.l.*.

In V.I., 1 individual of about 1.5 years old (according to Laws 1966) would be represented (permanent tusk – Fig. 6c – which seems slightly worn at its anterior/posterior occlusal surface, a complete dp3/, which wears away half of the surface area and a fragmented but almost complete dp2 which is very worn) as well as an adult (M2?/).

In V.II, 3 individuals would be represented, including 2 young (dp/3, a small larger fragment dp4?) as well as an adult (long bone). The femur of an immature could belong to one of the two juveniles.

The fragments of tusk ivory platelets were counted as an adult s.l.; they are located at the same depth in nearby squares.

Mammoth taphonomy. The preservation of bone surfaces of the mammoth remains is relatively variable, *a contrario* to most teeth, which are in excellent condition except the “adult” tusk fragments, poorly preserved and extremely fragmented, found in squares I/2, II/2, III/1. The action of water (especially oxidation) are low, not many remains have signs of influence of the water. The abrasion of the edges is intense. Rare scratch marks of trampling were observed. The scarcity of bone remains and their strong alteration as well as the absence of joints undoubtedly explain partially the quasi-absence of biogenic/anthropogenic marks, without excluding anthropogenic choices (Haynes *et al.* 2018). Only the tusk of a young shows a corroded surface due to exposure to acids and enzymes during digestion. No remains bear witness to the action of the fire.

This pachyderm is represented by only 3 very large fragments of the same long bone of an adult with the presence of breakage on fresh bone (Fig. 6: D).

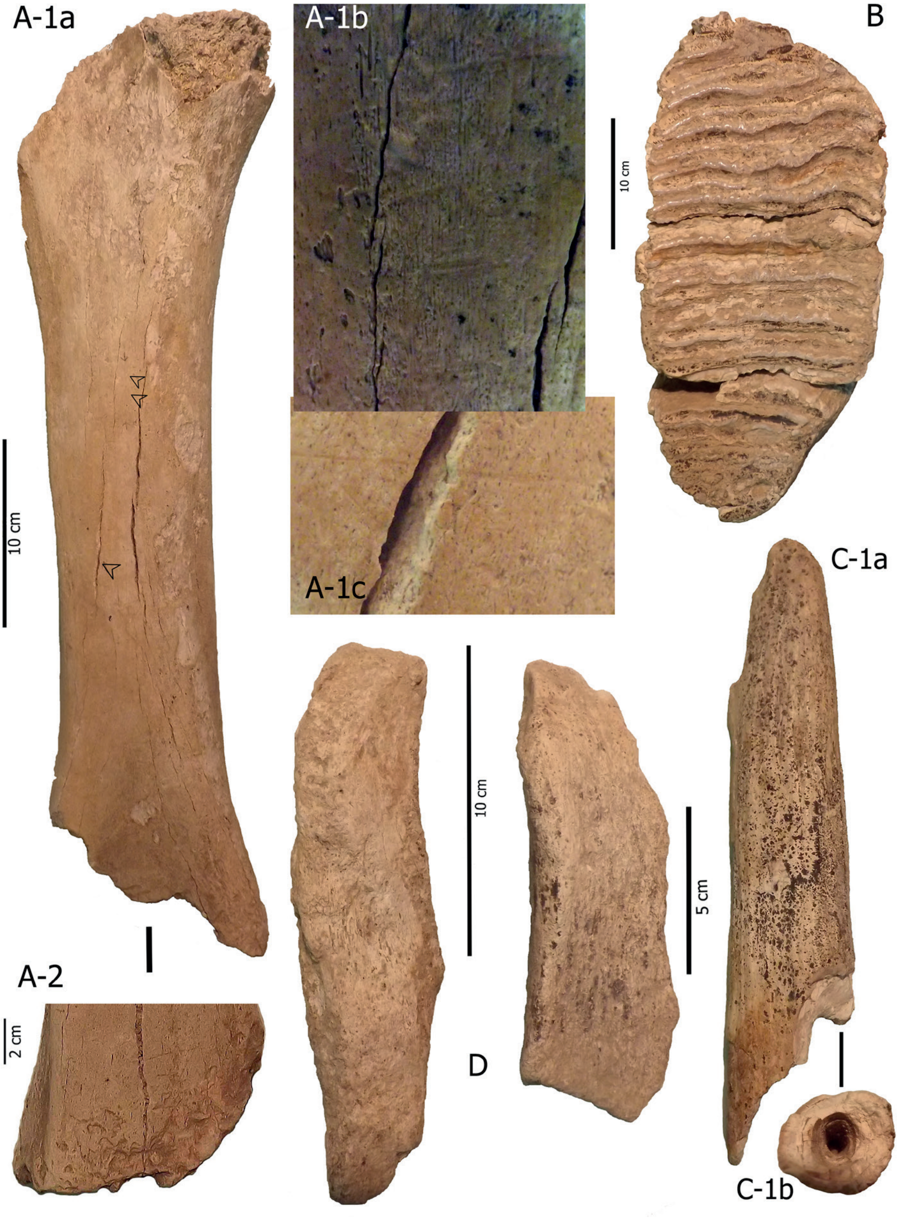

FIG. 6. Mammoth/proboscidian remains from Érd. A-1a–c: left femur of a young with cut-marked anterior surface (b, c, d: details), A-2: Same femur, caudal surface with pits or impacts of fracturation, B: Upper adult molar, occlusal surface, C1-a–b: digested tusk of a young (b: detail, section), D: Two fragments of the three same long bone with fracturing on fresh bone. © É.J.D.

1 probable cut mark was observed on the same left femur of a juvenile (Fig. 6: A). One or more transverse, relatively long and superficial marks of defleshing are situated on the cranial face of the median diaphysis. On its distal anterior surface carnivore gnawing marks are visible (Fig. 6: A-2). The distal caudal surface shows traces of teeth of carnivore.

Fragmentation on fresh bone and, to a lesser extent, on dry bone shows a diachronic history of these remains. The remains of the pachyderms in Érd are the result of palimpsests, various accumulations in variable quantities, especially towards the end of the phases of human occupation.

Among the indeterminate bone fragments, Rhinoceritidae/Probiscidea, 17 remains are present, of which 4 in V.I and 13 in V.II. Their state of preservation is varied.

Vallon I and II of EnsL

Rhinoceros skeletal and age profiles. The rhino remains of the EnsL, only 4 dental remains were unearthed from V.I, and 1 from V.II. In EnsL V.I, a fragment (flake) of upper deciduous tooth indicates a young individual. A pair of teeth belongs to the 1 same young adult individual. No bone completes the 4 present teeth. Only the head would have been transported to the site. No remains were found in V.II.

Mammoth skeletal and age profiles. A single remain has been identified in EnsL, in V.II, a post-cranial element of an adult *s.l.* individual (patella – uncertain).

Proboscidea/Rhinocerotidae skeletal and age profiles. 1 bone element was found in EnsL V.II. In EnsL V.I, no remains were found.

Comments on previous work (Gábori-Csánk, Kretzoi 1968) in the light of our data

Our observations do not entirely support the observations described above. The differences have, at least, a double methodological origin: (1) the taking into account in our study of all the bone material of each of the levels (the bones making up the heaps, which are in no way distinguished from the rest) influencing the number and the type of remains and the ages represented, (2) the grouping of levels into "sets" in our analysis (horizontal and vertical grouping), which artificially contracts the number of individuals in relation to the distinction of each level. On the other hand, the anatomical division[8] into segments – the basis for the description and interpretation of activities – does not influence our interpretations.

The study of "archaeological zoology" (Gábori-Csánk, Kretzoi 1968, Figs. 3–7, 37–41, 43) is based on the remains from 11 horizontal heaps or concentrations found during excavations within the EnsU (of which 7 in V.I) and EnsL. The remains from these concentrations therefore do not constitute all the osteological material taken into account in their study (except when calculating the quantity of meat). The rhinoceros and the mammoth are among the 7 heaps detailed in the monograph (Gábori-Csánk, Kretzoi 1968, 230–236, 236–244). These heaps are described by the number of remains (5 to 46 for the rhino and 1 to 4 for the mammoth), by species (9 to 13 species of carnivores and herbivores), and their equivalent in quantity of meat (25-30 individuals of rhino for 10–12,000 kg and 9-13 mammoths for 2–3.500 kg). The calculation of the amount of meat consumed/provided in was based on the richest heaps only (*a–d* in V.I and *d* in V.II), while that of the killed/slaughtered animals was carried out with all the material expanded to the corresponding level in each vallon, including the poorest levels *e* and *A*. Spatially, the different heaps of herbivores are located in the middle and towards the northern edge of the vallon (direction sector I towards IV or VIII), thus partially occupying more or less the same area over the course of human occupations, at different depths. However, Fig. 43 (Gábori-Csánk, Kretzoi 1968, 243) shows only the contour of the heaps like those of "horse" or "horse-rhinoceros". The remains of megaherbivores were unearthed from elsewhere as well as from the heaps described, which indicates either another accumulating agent, or a displacement of the accumulator to another area of consumption with the scavenged remains of a carcass or others brought, or a spatial disturbance.

25-30 rhinos were counted (10-15 juveniles and 15-20 adults, cf. Gábori-Csánk 1968), whereas in our study, 18 individuals would be present. The difference is also marked for the mammoth, which would be represented by 9-13 individuals compared to 5-6 in ours (Gábori-Csánk, Kretzoi 1968, Tables p. 237-239, 241). This contraction in the number of individuals is artificial, methodological, and can be explained by the grouping of higher levels. The rhinos, mostly young (<3 years old) present in our material were slaughtered presumably in the summer "when (...) [they] grazed the still fresh grass of the

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[8] The skeletal elements grouped into anatomical units differ slightly from the one established by V. Gábori-Csánk, M. Kretzoi (1968, 230).

Danube flood zone"*[9] (Gábori-Csánk, Kretzoi, 1968, 240) or gathered during the rainy seasons.

There is reportedly no particular seasonality of birth in rhinos. However, births may be more numerous at the beginning of the year or in autumn (Bratlund 1999, 141), but in the Pleistocene and temperate zone births had to be coordinated among the different herbivores/ungulates towards the end of spring so that calves could take advantage of the resources during the summer.

Breeding males would not be territorial[10], but would rather have exclusive areas ("range exclusivity"); these can vary in size and location (Bratlund 1999, 141).

The area of mobility has been estimated at 15–20 km on the basis of 15–20% possible slaughter of game in the ecosystem (maximum meat quantity based on *per capita*, Kretzoi 1968, 242). This area of mobility seems comparable to the data provided by petrography for places of acquisition, multiple, of lithic resources at the same time local, semi-local and distant (500 m, 12 km and more) (Mester 2004a; 2004b; Mester 2006; Daschek, Mester, 2020).

V. SPATIAL ANALYSIS OF THE MEGAFAUNA REMAINS

The rhino remains (NISP=216), in the EnsU, are distributed throughout the entire thickness of the Vallon I sets, whereas the mammoth (NISP=35) only appears from the upper half. In Vallon II, the rhinoceros appears in the upper half also, as does the mammoth, which is rarely present.

The two species (and the undetermined ones) are, in EnsL, 4 (V.I) and 2 (V.II).

The undetermined remains are in the same squares as those identified taxonomically. Overall, because of the thickness of the accumulations, their remains cannot represent a single accumulation, but a palimpsest/amalgam of multiple accumulation episodes. Globally, several aspects can be highlighted for EnsU and EnsL: (1) dichotomy in terms of frequency between Vallons I and II, in favour of the former; (2) distribution of the remains in all levels, including the "sterile" layer, but not in all squares; (3) presence of remains of

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[9] This quotation and others below (all marked with *) have been translated by the author of this article as well as the others below (marked *).

[10] In the case of Indian rhino in the Chitawan Valley in Nepal (Bratlund 1999, 141).

rhinoceros (NISP=17) and proboscidian (~17, mainly tusk fragments) above the last archaeological level *(a)* from which comes a remain bearing a cut mark (square III/1); (4) weak/rare presence (<5-15 remains) at different depths of the archaeological fill. The frequency (barely) and variety of elements increases a little towards the middle of the archaeological deposits and it is only during the last two phases (*a-b* artificially distinguished by the excavators because of the sedimentary thickness, but stratigraphically indistinct) that the remains reach about forty (almost 100 in total in V.I, between 130 and 180 cm of depth) with various anatomical regions. The joint intervention of carnivores and hominin on long bones, only in V.I., appears between 130 and 200-220 cm, then in the sterile layer (the only identified vestige, a femur cylinder) and outside the stratigraphy.

The proboscidean remains appear between 130-220 cm deep in the larger Vallon I, except for one remain, the other 5 remains are distributed between 180 cm and the bottom of the Vallon II.

As the archaeological levels are not correlated (or not indicated) with the geological strata and the depth indications are not always obvious, we preferred not to calculate the ages of the corresponding individuals. A taphonomical and bone-colour study is currently underway (Daschek, in preparation) in an attempt to overcome this problem and to refine/clarify the levels.

Dissimilarities can be observed by comparing the number of remains observed in our analysis in the levels (depth levels) with those counted in the heaps (Kretzoi 1968, Tables p. 237–239, 241), and with the count of the faunal spectrum (Kretzoi 1968, Table p. 62–63). In terms of individuals for these two species, the difference is noticeable (essentially in rhinos); in fact, the 7 counted heaps (Kretzoi 1968, Tables p. 237–239) with the maxima (Kretzoi 1968, 241) and the small number of remains found in the lowest depths (*e*, EnsL=A), which can hardly correspond to 8-11 adults and 3-5 juveniles for the rhinoceros and 1-3 adults and 0-2 juveniles for the mammoth, deducted from the total (Kretzoi 1968, 241). Maybe some elements are lost since.

Refittings of skeletal elements of rhinos, such as of mammoths, come both from the two vallons (Daschek 2014, 135–153, Figs. 78–88, 89, 90–99) and from different levels of occupation. None of which connects the two vallons. They indicate a maximum distance of 4 m (2 adjacent squares) and a minimum distance of <2 m (intra-square) for a maximum depth of 40 cm. The remains of rhinoceros are located over almost the entire excavated space (little mixing or limited input over time?), while those of the mammoth and the undetermined remains partially cover them (regular inputs and/or amalgam?). Excavation notes (Gábori-Csánk 1964[11]) make it possible to specify the location of the mammoth remains, in Vallon I (around 130 cm deep, west side of sector II and east side of sector III) they would form a linked and fairly close ensemble, and in the other vallon, they are found at very distant depths (sectors VI, 235 cm in EnsL and VIII at 200 cm), on a maximum surface of approximately 44 m^2. Their vertical distribution may be due to re-exposure (activities of bears?), several accumulations/acquisitions by agent(s), and/or to their difficult burial (variable surface conditions).

In spite of the imprecise excavation protocol (2 x 2 m squares, densities of remains by depth sections) and, although carnivores (especially bears, then hyenas) are capable of more or less strongly disturbing and dispersing abandoned anthropogenic remains, destroying them (Camarós *et al.* 2013), the little variable location of the layers of remains and their superimposition at different depths (Gábori-Csánk, Kretzoi 1968, Fig. 43.) seem to rule out a chance creation/relationship. As we saw previously, taphonomic analysis has revealed an unmistakable relationship between megaherbivores and lithic, at least partially, thanks to the butchering marks (Daschek 2014; Daschek, Mester 2020).

VI. DISCUSSION

Thus, analysis of data on these pachyderms in terms of skeletal and age profiles as well as taphonomy allows us to understand the role and importance of hominin behaviour in their choice of meat supply in the context of the history of the formation of the Érd site. After the synthesis of the first study and the archaeozoological interpretation relating to the megaherbivores of this site (Kretzoi 1968), we bring our complementary viewpoint in the light of our results, then we evaluate and discuss the respective roles of Neanderthal groups and large carnivores (hyena) in the constitution of these assemblages, then try to attempt to find time indications (duration and types of occupations, intra-site evolution) of and from megafaunal accumulations.

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[11] Sector II: small heap of tusk fragments and, 50 cm away, a tooth and bone fragments; sector III: several remains with (mixed) tools made of silicified wood; sector VI: on the rocky base, a juvenile tooth; sector VIII: several fragments of long juvenile bone.

Taphonomic analysis and the conditions of the surrounding sedimentary environment made it possible to exclude the major effect of a differential post-depositional conservation and fragmentation predominating in these assemblages (EnsU), although some remains are very badly preserved. The origin of these particular herbivore accumulations is due to a double accumulator: human and hyena. But more precisely, what are their respective role and share?

Through direct (surface modifications) and indirect (lithic industry) aspects we will discuss their respective impact: food resource, source of raw material, ethology and modes of acquisition, butchering marks morphology and rocks relationship.

The role of the Neanderthals at Érd

Similarities and differences appear in the profiles of skeletal representations with the comparison sites (Graph. 1). The dominance of isolated teeth is a common feature of all sites. Although many remains represent almost all the anatomical elements at Érd, the identified remains of *S. hemitoechus* at BSV IIa (NR=3151, MNI=8), of *S. kirchbergensis* at Taubach (NR=1224, MNI=76) and of *S. hemitoechus* at Arago F (NISP=423, MNI=13) are much more abundant, but differs, on the other hand, from Vogelherd VII (NISP=57, MNI=10, middle Palaeolithic level, *C. antiquitatis*), fewer, and where neither the axial nor the autopod is represented. At Érd, fleshy bones rub shoulders with bones of the lower limbs (radius, ulna, especially tibia), which are the most common. The opposite is observed in Arago F and BSV IIa. Although not all elements are represented at Érd, the skeletal profiles (Graph. 1) show a similar conservation between Érd and the other assemblages with, however, a better conservation of the humeri and tibiae at Érd, both of which were intensively gnawed on for the most part. The proportions of isolated teeth and foot bones (autopod) resemble to BSV IIa (Louguet-Lefebvre 2005, Fig. 58) and Arago F (Chen, Moigne 2018 Table 3) and Érd EnsU V.I, but where the autopod is present to a lesser extent. At Taubach (in NR), scapulae, humeri, radii, atlas, ulnae and talus are the best represented elements (Bratlund 1999, Table 9). At Camiac, the humerus and tibia are the best represented bones (%MAU), then the femur and innominate, the scapula, the radius and ulna, then the cranial/dental (weak) and a rare presence of the metapodials and the basipod (talus) (Discamps 2011, Fig. 4).

The mortality profile of rhinos at Érd is rather similar to that of BSV IIa, for which opportunistic and seasonal man-made hunting has been proposed

(Auguste 1995). At *Érd*, it is possible to propose an active human acquisition of mammoth calves, but also of some rhino calves and its older congeners. Some young pachyderms may also have been preyed upon by carnivores. In the two re-studied Transdanubian sites, Suba-lyuk cave (Mester, Patou-Mathis 2016) and the Tata open-air site (Patou-Mathis 2004), both rhinoceros and mammoth are represented in several levels, sometimes together. Juveniles and adults are present for both species, in both sites. At the former site, 7 rhinoceroses (1 very very young, 1 juvenile, 2 subadult, 3 adult) and 2 mammoths (1 newborn, 1 adult) were identified. None of their bone remains show evidence of human action and only 4 rhino remains are damaged by hyena and wolf. The authors suggest consumption following hunting or scavenging of rhinos in layer 3. At the other site, at least 2 rhinoceroses are present and possibly a third with Merck's rhinoceros, as well as 7 mammoths (6 young of which 1 very young and 1 young adult). Only 2 rhino remains bear carnivore tooth marks (wolf/hyena). Despite the absence of anthropogenic mark on these megafaunal remains, the author suggests/does not exclude their hunting, but more likely, their scavenging near water sources or seasonal swamps (autumn/winter).

Large/mega size ungulates are reported to be proportionally less common (and even boneless) in caves/shelters than smaller ungulates (Morin *et al.* 2015). At Érd, the number of rhino remains is greater than that of Bovids (NISP 55 in EnsU Vallon I and 15 in EnsU Vallon II, total NISP=70), but less than that of the horse (NISP 446 in EnsU Vallon I, NISP 123 in EnsU Vallon II, total NISP=569). The latter two are fragmented (except the metapodials), but the post-cranial elements are less frequent than the cranial (isolated teeth) ones. As a general rule, the choice of transporting a (part of a) carcass depends on several factors. The archaeological remains of the site of Bolomor, which is high up and difficult to access (Agam, Barkai 2016, 2018; Reshef, Barkai 2015), as well as the ethnological sources, indicate that humans are capable of transporting parts of heavy carcasses of proboscidians over a certain distance. However, the acquisition of fat/marrow is central to "transport strategy and decisions" in the Middle Palaeolithic (Morin *et al.* 2015). Neanderthals have a developed musculature. Indeed, "[...] upper body strength was probably important to hunting success in the context of close-range hunting with hand-delivered weapons, and greater strength probably increased the diversity of prey species the Neandertals could hunt" (Churchill, Rhodes 2006) and the ability of transport heavy parts of carcass.

Somewhat different from that of rhinos, the internal structure of proboscidian long bones seems more interesting for marrow extraction by hominins (Boschian *et al.* 2019, 92–95, Figs. 5–9), but not after Haynes *et al.* (2021, 964). At Érd, the femur (Fig. 6: A) and the mandibles of young mammoths attest to active acquisition/procurement by hunting or scavenging with quick access and their brought to the site. The tooth of an adult of this species (Fig. 6: B) has maybe been collected, although its appearance (colour, preservation) seems consistent with the other remains.

At least part of the butchering of the carcasses was carried out on the Érd site itself: defleshing (filleting) and marrow extraction from certain bones (rare, non-systematic). Beforehand, at the place of acquisition, an initial treatment of the carcass took place: disarticulation, quartering, eventual removal of boneless muscles, then, transport of pieces (in this case with bones) to this site by Neanderthals. Some of these pachyderms (at least 5 parts of rhinoceros carcasses and 1-2 mammoths) come from a presumably human activity/acquisition with primary access according to the selected highly nutritious pieces and the presence of cut marks. Nevertheless, the carcasses (of megaherbivores in the case of this study) could be available for a relatively long time in cold period – due to their size and the quantity of flesh/nutrients present – than those of smaller species, and therefore with a longer access time also compared to the latter (Dusseldorp 2009, 35). The cold prevents the carcass from rotting/ripening and causes the same stiffness as death (or intensifies), or progressive desiccation in a warm climate, which requires a great deal of effort during processing (heavy-handedness) (cf. extended, secondary butchery; Haynes, Krasinski 2021). This could explain the types of striations observed on the bones of *Érd's* pachyderms. The absence of butchery striae cannot be retained as a necessary condition for the identification of anthropic activity of the mammoth (Haynes *et al.* 2021; Péan 2001, 296).

The hunt/scavenge of megaherbivores took place in close vicinity the site on a passage of herbivores and in an advantageous crossroads situation (regional-local biotopes: swamp or alluvial plain, plateaus, valley (with Larix-Picea) with varying behaviour during the year in terms of family/specific links (grouping-separation) and/or territorial use (territoriality, routine paths, time or place of birth), since these species are highly dependent on the presence of water and (seasonally) abundant ecological resources.

An undisputable faunal/lithic relationship has been demonstrated (choice of individuals' ages, species, and carcass pieces), in addition to a spatial relationship observed during excavations.

"[Hominins] probably lived [in open environments, with higher animal biomass densities and] in larger groups and were able to more efficiently pursue and kill mature animals" (Dusseldorp 2009, 152), as at Érd, in a steppe-like environment "with few species but very abundant in individuals" (Gábori, Gábori-Csánk 1978, 182). Gábori, Gábori-Csánk (1978, 182) sees in it "the generalization and development of more intensive hunting in the Middle Palaeolithic from the Würm 1 in Europe". Érd is considered a specialised human hunting site (Patou-Mathis 1993, 25). For Musil (2010, 51), one cannot speak of specialisation, regardless of the species, but of the maximum/optimal use of the animals available according to their biomass, which is itself dependent on location/environment/topography and climate".

Food resources

At *Érd*, the presence of nutritious bone elements/carcass parts in the rhinoceros (head, limbs, feet – sole containing edible fat; after Fladerer 2003, 146; Haynes 1991; Weissengruber *et al.* 2006 – axial region: spine and rib cage, skin, tendons), as well as the ages at death and stigmata of human activities suggest primary/rapid human acquisition, through active hunting or scavenging of the carcasses. The presence of the axial region of the carcasses would indicate a short transport distance, maybe from the plateau overlooking the site.

The skulls of herbivores were transported to the site after R.P. Musil (2010, 51), such as at *Érd* (Gábori-Csánk, Kretzoi 1968, 233; Daschek 2014; Daschek, Mester 2020), where we identified cranial, dental and bone remains belonging to megafauna and almost all ungulates in EnsU and EnsL. Hemimandibulae, horn or antler fragments are attested in EnsU for rhinos (V.I, V.II), horses (V.I., V.II.), Bovids (V.I., V.II.) and megaloceros (V.I.). Only for hare (V.I.) and megaloceros (V.II.) in EnsU. No megaherbivore (V.II.) is represented by cranial/dental remain in EnsL (Daschek 2014). The consumption of nutrients from the head is proven for young megaherbivores (Fig. 4). The absence or rarity of cranial fragments indicate a possible post-depositional taphonomic or modern bias.

Archaeological – from the Acheulian, in Europe and elsewhere – and ethno-historical data positively support Agam, Barkai (2016; 2018; Ben-Dor *et al.* 2011; Reshef, Barkai 2015) concerning (1) the value of the consumption of many highly nutritious constituents of the head of Proboscidians, (2) according to archaeological documentation, the recurrent presence of cranial and mandibular elements or fragments, isolated teeth, would confirm the consumption of the head's parts (including brain, tongue, mandibular fat, cf. Fladerer 2003), (3) the ability to acquire by hunting this larger pachyderm than today, and (4) the intentional transport of even very heavy pieces to the *sensu lato* "habitat", especially in caves (cf. the Bolomor site, Agam, Barkai 2016, 221, 223).

In the rhinoceros, the fracturing of the long bones would not be attractive for hominins due to the absence of a non-sponged medullary cavity (Niven 2006, 75), such as for mammoth (Haynes *et al.* 2021), contrary to the observations of Boschian *et al.* (2019). However, various studies (Chen, Moigne 2018; Daujeard *et al.* 2018; Auguste 1995; Auguste *et al.* 1998; Demay *et al.* 2012) indicate systematic fracturing on fresh bone in rhinoceros and sometimes in mammoth, but recent study of Haynes *et al.* (2021) shows that fracturing on fresh bone is not systematically due to anthropogenic action. At *Érd*, at least one portion of limb belonging to a mammoth *s.l.* was voluntarily introduced disarticulated to the site and consumed on site by hominins, as were some of the bones of the adult rhinoceros.

Megaherbivores as source of raw materials and functional objects

Recent publications (cf. hereinafter) indicate that megafaunal remains can also be a raw material. In our material, the number of dental remains, often entire, is quite striking. The presence of isolated upper and lower teeth suggests the transport of the head to the site and its exploitation/consumption locally. In the rhinoceros, these elements are found in large numbers within the archaeological anthropogenic sites/levels (e.g. Arago F with 41%NR, cf. Chen, Moigne 2018; BSV IIa with 40%NR, cf. Auguste 1992; 1993; 1995; 2012; Louguet-Lefebvre 2005), parallelly with the absence/rarity of cranial bone remains, not related to post-depositional processes. At *Érd*, teeth constitute 60%NISP (NR). These skeletal remains had an original use as tools at sites of contemporary ages (MIS 6–8) of Panxian Dadong cave in China (scrapers on enamel splinters, cf. Miller-Antonio *et al.* 2000, Fig. 5; Schepartz, Miller-Antonio 2010) and Payre in France (retouchers related to percussive activities on hard sharp material, cf. Daujeard *et al.* 2018, Fig. 3; Daujeard *et al.* in preparation). At Érd, some rhinos teeth show detached dental (enamel) splinters and bulbs (Fig. 5: B). It could be due to frost (Guadelli com.pers.). However, the large adult mammoth tooth damaged surfaces and enough poor conservation, particularly on the enamel, raises questions (long burial?, gathering?, utilization as hammer?).

Ethology and method of acquisition of megaherbivores

In EnsU V.I, at least two emancipated rhino subadults (6-7 years old) have been identified. This age class was interpreted by P. Auguste (1995) as the result of hunting at BSV IIa. Rhino mothers having calves not necessary (Bratlund 1999, 138, 141–142), but males can be a danger to hominins and, more generally, "social interactions" may represent danger for calves (Law *et al*. 2018). It is possible that the Neanderthal groups of Érd may have used this moment of temporary separation on their way to water points to kill individuals (Daschek, Mester 2020). According to Dusseldorp (2009, 151), mammoths females and calves live in herds, making their exploitation potentially even more difficult than that of lone males. However, this does not explain the presence of older individuals, both rhinos and mammoths, in the assemblages of Érd, interpreted as Neanderthal groups game. The known or assumed behaviour of these pachyderms, present or fossil, seems to offer few possibilities of acquisition. However, there are present-day examples of their acquisition by direct hunting (not only with gun).

Was there predation pressure in the area of the Érd site? The frequency of hyenas is highest at Érd compared to other Hungarian sites during this period (Tata, Subalyuk). It is possible that they may have visited the surroundings because of the large animal biomass present in the different nearby biotopes or that they were attracted by the remains abandoned by humans. There were potentially higher conflictual situations between hyenas/carnivores, whose final outcome was their death.

According to ethnographic sources, some African and Asian peoples hunted rhinos (Guérin, Faure 1983; Auguste *et al*. 1998), mainly for their horns and skins (shield making), but also elephants for their tusks, skins and meat (e.g. Haynes *et al*. 2021; Haynes, Krasinski 2021; Bratlund 1999; Agam, Barkai 2016). In the chapter on the rhino from Taubach, Bratlund (1999, from p. 138) presents numerous examples of techniques of acquisition (trap, pitfall, thrust the spear into the jaw, approach, beaters with camouflage, coat with excrement, hock cut), tools of acquisition (spears, assegais, javelins, spears, poisoned arrows, use of dog, saddlehorses, bamboo spear armed with the horn of a swordfish, knife, gun), human behaviour during the procurement (confrontational hunting, jump on side, cut to the throat, keep calm during animal charge). The spearhunters kill both young and old, males and females alike, and the kills appear to be determined more by encounters and luck, than detailed planning. Pitfalls appears to have been a cost-effective hunting method in areas where the soil conditions supported stable or even slippery walls for the pits. Archaeological data show that one of the modes of food procurement through active hunting was wooden weapons (e.g. sites of Clacton-on-Sea,Schöninge, Lehringen, La Cotte-Saint-Brelade, Biache-Saint-Vaast, Taubach, Gröbern, Salzgitter-Lebensted, Zwoleń) as well as projectile points (Dusseldorp 2009, 157–158).

Relationship between the morphology of the cut marks and rock type

This is an exploratory question. Indeed, no study exists to date on this subject on the Érd material. Our objective is to see if the two aspects, the *in situ* activities on the one hand – related to the butchery treatment through the cut marks – and the lithic artefacts on the other hand – types of tools, their functions, types of rocks as well as the characteristics of the striae – corroborate each other or not, or imply other aspects. It is obvious that these simple observations are not sufficient to answer the question of which tools in which rock types produced which marks.

The presence of thicker cut marks on the remains of megaherbivores than on those of large herbivores is discussed here in relation to the tools left at the site by the Neanderthal groups.

Among the variety of rocks used for the manufacture of tools in Érd, the ideal candidate is quartzite, which is of local origin and has the entire *in situ* manufacturing *(chaîne opératoire)* process.

At Érd, the presence of fine (on non-pachydermic ungulates remains) and wider (on those of rhinoceros, mammoth) cut marks and the presence of rocks of fine constitution, such as flint, or coarser, such as quartzite, raw or retouched flakes (e.g. Buccheri *et al.* 2016; Greenfield 2006), could suggest a different use of the rocks depending on the size of the game and particular needs on site. But is the presence of these cut marks and their "thickness" related to the structure of the rock itself (grain), to its use/function or to the pressure of the gesture in relation to the size of the herbivores (especially megaherbivores), the thickness of the muscles and fat to be sliced, the mode/time of acquisition and thus the freshness, the quantity and interest of the remaining nutrients? In other words, is there a link between the type of cutting edge of the tools (and tool type), the butchering activity/treatment carried out and the size of the herbivores concerned in relation or not to the possibilities offered by local rocks (efficiency...)?

As the pebbles used to make the tools can be used in their entirety, the production strategy implemented is standardised, fast, sometimes not very productive (Mester, 2012), but adapted to needs that may be immediate. "Quartzite pieces have steeper edges when retouched and finer edges on fine-grained rock artefacts"* (Mester 2012; Mester, Moncel 2006). This different width between rocks (quartzite *vs*. others) would explain at least in part the variation in the thickness of the cut marks but, after Greenfield (2006, 155), the rock used cannot be deduced from the cut marks. "The presence of [retouching] in Érd would then be an indication both of a revival of the edges and of diversified functional needs"* (Mester, Moncel 2006). The raw material (quartzite) came from 500 m away from the site and was therefore not gathered on the banks of the Danube river; maybe near the site after the acquisition of the game.

The maintenance and (re-)sharpening and toolmaking (quartzite flakes) on site suggest that Érd was, during the deposition(s) of the EnsU upper levels, a site of tool use (butchering activities within or near the site, or other activities as fur processing with numerous and various scrapers).

According to Auguste *et al.* (1998, 143–145), lithic tools – obtained by various production methods or not – and not specialised (in the absence of conservation of wooden stakes[12]) – would be "suitable for activities on all kinds of animals" (...) even if "the presence of long edged pieces" is characteristic of these sites with megaherbivores. At *Érd*, "on most *débitage* products there is a long cutting edge that is unilateral, transverse, or peripheral" (Mester, Moncel 2006, 232). According to Louguet-Lefebvre (2005, 172–174), "skinning and evisceration activities" could be carried out with "sharp lithic artefacts such as unretouched splinters found at all sites". Moreover, "the tools likely to break a bone, at least those of the Rhinoceros, could correspond to the shaping pebble", but do not seem to be decisive during fracturing in north-western Europe. Indeed, "no one lithic tool rather than another seems to be associated with the treatment of megaherbivores" (Auguste *et al.* 1998, 144) and in the case of the remains of Elephantidae" for whom the method of "longitudinal fracturing" by ["wedge cracking"] would be the most convincing, as in Bilzingsleben (Louguet-Lefebvre 2005, 174, 209).

5 bony remains, all long bones, of rhinoceroses and 1 of mammoth calf bear cut marks. The muscle mass is so thick, that the tool does not reach the bone*, moreover, a 9 cm layer and of ~150 kg of fat is present under the mammoth's thick skin and is abundant all over the body (Guil-Guerrero *et al.* 2018). Indeed, at Érd, the average dimension (length) of quartzite tools is 42mm, and even the

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[12] This type from 'silicified wood' tool has been found at several sites, see below.

few longest pieces reach 108mm (Mester 2012, Table 1, Fig. 6), bearing in mind that the length of the cutting edge may differ from the total length of the tool.

Firstly, we can rule out the hypothesis of bone breakage and surface marks by rhinoceros or mammoths by trampling by their congeners, especially the mammoth (Haynes *et al.* 2020; Haynes *et al.* 2021). Indeed, according to a new hypothesis (Daschek, Mester 2020), the site may have functioned as a cave or closed cavity and then, in the course of its internal evolution, become open-air at the end of the archaeological deposits during Late Pleistocene. Furthermore, its topographical position (high on a slope opening onto the Érd plateau) and the behaviour of mammoths, which prefer to avoid hilly areas, reinforce the improbability of damage caused by these pachyderms. Two aspects can be highlighted in this respect. Bone remains of smaller species "accompanying" those of pachyderms would be more destroyed by pachyderm trampling and would bear surface marks. The megaherbivore bones are intimately mixed with lithic tools, at least in part (not at the base of the site fill, distinct human and animal occupation) and suggest an anthropogenic origin and activity on their carcasses, at least partially.

Through experimental work, Haynes *et al.* (2021, 21) have demonstrated two types of processing of elephant *(L. africana)* carcasses. The process of meat removal that clearly leaves cut marks on the bones (diaphyses) states "extended utilization", i.e. a secondary removal of meat scraps. This type of exploitation only leaves multiple butchering striae in fossil assemblages, and correspond to "full removal of bulk and scrap meat" remaining on the largest limb bones on a fresh carcass or "human scavenging of carcasses that already had been stripped of most meat by carnivores". Also, it "may involve transport of bones away from the primary butchering locality". (…) "We show that features thought exclusively diagnostic of percussive fracturing of green proboscidean long bones such as notched fracture edges, smooth fracture surfaces, and curvilinear fracture outlines also can be created on non-green bones and on bones affected by non-anthropogenic processes."

Studies[13] seek to relate, through traceology, the presence or absence of retouching on tools and the actions/activities carried out on this or that raw

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[13] Examples cited by Mester, Moncel (2006, 236–238), SW sites in France (Geneste, Jaubert 1999); La Combette cave, layer D in France (Texier *et al.* 1996, Lemorini 2000); Grotta Breuil in Italy (Bietti *et al.* 1991, Bietti, Grimaldi 1993, Grimaldi 1996, Lemorini 2000); Fumane in Italy (Peresani *et al.* 2001, Lemorini *et al.* 2003).

material (Mester, Moncel 2006, 238). However, these studies do not take into account the thickness of the striations observed from cutting edges (raw or retouched), or their wear, on the bones of megaherbivores and therefore the fineness of the mineral grains of the raw material used (e.g. quartz(-ite) *versus* flint). The retouching used in this industry is of the "scaly, ordinary, or marginal type, rarely invasive scalariform", therefore not very transforming and "often results, however, in micro-denticulation[14]" (Mester, Moncel 2006, 232–238).

The role of the cave hyena/predators in the acquisition and modification of megafaunal remains

What role should be attributed to hyenas in the accumulation of the megamammal remains and/or the modification of the bone assemblages of Érd interpreted as being of (almost) entirely human origin of macro-mammals and where the mode of acquisition of meat resources has been interpreted as resulting from hunting (Gábori-Csánk, Kretzoi 1968)?

Our complete study of Érd's bone material from the 1964's digging showed that the site functioned as a refuge and/or consumption site or even sometimes hiding place for hyenas (eg. Daschek, Mester 2020) according to: (1) the % hyena and non-ursid carnivores, (2) age classes of preys, (3) the presence of coprolites and ingested elements; (4) carnivore ravaging and characteristic consumption morphotypes of rhino long bones. These morphotypes are similar to those observed in hyena dens (cf. Fourvel 2012). The gnawed rhinoceros remains suggest the presence of hyenas before hominin occupation by their prey contribution and after the Neanderthal abandonment while hyenas scavenged abandoned remains.

Thus, the types of tooth marks and their positions on the long bones correspond both to the activities observed in a carnivore den, and to carnivore gnawing marks (pits, imprints, pitting) on remains abandoned by hominins. The proportions of the radius, ulnae, carpals and tarsals in Érd resemble those of observed in anthropogenic sites by lower proportions than in carnivore/mixed sites ones. The lesser proportion of phalanges and sesamoids can indicate carnivore-modified assemblage. Conversely, the high frequency of tibiae, up to 100% MAU (Érd, Camiac (Discamps 2011), Vogelherd VII (Niven 2006))

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[14] Meaning? Special use?

seem to testify an anthropogenic activity. However, in Érd, tibiae bear almost exclusively cut marks. The femur, rare in Érd, is much more frequent in the other types of sites. Finally, the head and the most fleshy bones (humerus and femur) appear in very variable proportions in both types carnivore and anthropogenic sites, which makes their discrimination hazardous, seems to be a constant (logical in nutritional terms) and suggests primary access to the carcasses whatever the accumulator. Epiphyses are almost absent and their absence is not always linked to the gnawing of carnivores. There is also evidence of intense consumption of bones most of which are not fractured by hominids and exploited secondarily by hyenas. Consumption is confirmed of the rhinoceros (EnsL) and perhaps that part of young mammoths, but it is more likely that the skulls and the 2 long bones (young and adult *s.l.*) are of human origin, in particular because of the probable butchering marks on the young one and the consumption of the marrow of the adult one.

At *Érd*, the remains of megaherbivores represent 22% of herbivores. In a context of mixed occupation, in the absence of most of the splinters and especially in the absence of the articular region of the long bones, although the intervention of each of them – man and hyena – could be highlighted, it is difficult to know what share each of the accumulative/modifying and post-deposition agents had, but the action of both biogenic agents has been demonstrated.

In the case of *Érd's* assemblages, for the EnsL (V.I), the rare remains do not allow us to rule on their origin, presumably resulting from non-human contributions. For the EnsU, the skulls of juveniles and their skeletal elements may have been brought to the site by carnivores (hyenas), but just as much by humans (trace on a mammoth calf bone); remains belonging to adult rhinos or at least to individuals that have reached their adult size are considered to be the result of human acquisition as well as the skulls of rhino calves (active hunting or active scavenging). The only adult mammoth tooth is also considered to have been brought to the site by Neanderthals (gathering). After Haynes, Krasinki (2021, 3), "large predators (lions, spotted hyenas) which killed elephants stripped meat from femora and humeri at the primary feeding, but consistently ignored the lower limbs (see, e.g., Haynes, Klimowicz, 2015, 21, fig. 2)" (…) and secondary scavengers deflesh sometimes the lower limbs of abandoned carcasses by primary predators.

Adult rhinoceroses indicate a more particular acquisition by humans (as in Biache, Molodova). Indeed, "when looking at the totality of hyena den (…) [h]yenas exhibit a more variable, opportunistic kind of prey selection (foraging: scavenging, hunting solitarily and hunting in groups)" (Dusseldorp 2009, 156).

At the scale of the whole site, non-ursid carnivores constitute only about 3% NISP (cum Ursids) of the assemblages, mainly hyena, then wolf and lesser, cave lion.

Érd is not a den *stricto sensu*. Nevertheless, it is possible that, temporarily, it may have functioned as such (Daschek 2014; Daschek, Mester 2020) based on the similarity of hyena gnawing morphotypes with those observed in dens.

After partial consumption on place, cave hyena females only bring a few pieces of food for themselves (<2%) to their "natal den". These nocturnal predators are quite capable of transporting over long distances pieces of carcasses, even heads (Dusseldorp 2009). Cranial and mandibular elements are found in both anthropogenic, den and mixed sites, varying in number: numerous at the anthropogenic site of Arago F (Chen, Moigne 2018), in small numbers at carnivore-accumulated sites such as Vogelherd VII (Niven 2006) and Camiac (Discamps 2011).

The megaherbivores heads were regularly transported to the site at Érd. In packs, they can successfully kill herbivores up to 600 kg or more. Among their potential prey (reindeer, horse) are also young rhinos and mammoths (Kruuk 1972; Patou-Mathis 1998, 287). The humeri of the Érd rhino calves are all trimmed by hyenas. The rhinoceroses reach their adult size at around 9 years of age and 8-12 years of age for the mammoth. According to Dusseldorp (2009, 156) "in the Rhinocerotids, the focus of exploitation seems to have been on very young animals [in hyena dens]". At the den of Camiac, the rhinoceros constitutes the bulk of the remains identified in MNI (Discamps 2011). Thus, part of the young pachyderms of Érd would represent a primary or secondary acquisition by the hyena. The species present and the age categories are characteristic of predation by hyenas or hunting in packs (wolves). However, this age class (sub and young adults) is also present and is interpreted as anthropogenic hunting.

Hearths and charcoals are not always present in the accumulation levels contemporaneous of these pachyderms at Érd. Is it an argument in favour of the acquisition of young(er) individuals by hyenas?

Multiple factors/hypotheses explain this relative "abundance" of pachyderms (woolly rhinoceros) at Érd (after Discamps 2011): (1) excavations (4 months for a surface area of 214 m^2, brecciated sediment, pickaxe, three types of excavations), harvesting and coarse sieving likely to have little impact because of their mammalian size class, including perhaps in the case of analytical choice of determined/undetermined items and their conservation (low presence of indeterminates), very large quantity of material collected[15] and estimated from taxonomic determinations (circa 50,000 bones and circa 3,100 lithic), presence of refittings[16] (cf. Daschek, Mester 2020), (2) food choice of accumulators (same prey), (3) economic choice of hominins (acquisition of variable ungulates with very different ethology including pachyderms, exploitation of the same landscapes and "habitat"), (4) taphonomy of the site (carnivore ravaging-consumption, unknown sedimentation rate).

The question of the representativeness and integrity of bone material in terms of taphonomic bias has already been addressed (Daschek, Mester 2020, 4-5) in relation to the questions raised by the difficulties of re-studying old collections (e.g. Discamps, Faivre 2017). The history of the accumulations of these pachyderms of Érd is more complex than the hypothesis put forward by M. Kretzoi (Kretzoi 1968).

The presence of these ungulates, of mixed origin, corresponds to the food choice of hyenas and hominids of predatory/scavenging activities and constitute partly their respective diets in a topographical context favourable to the implementation of variable acquisition strategies, mainly on the mammoth steppe.

VII. TIME INDICATIONS

Duration and types of occupations

It is essential to specify and attempt to characterise the chronology of Neanderthal and carnivore occupations in the context of a non-karstic region (in the sense of L.G. Straus 1990), where (in Érd) fine stratigraphic data are absent or inaccessible and not (or only partially) correlated with levels of human occupation.

Without direct dating of the faunal remains, especially those of the rhinoceros and the mammoth, which bear witness to human action, it is not

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[15] Presence of small vertebrates, millimetre-sized mollusc shells, wood charcoal in dust, lumps, fragments, in circumscribed areas.

[16] Non-exhaustive, lithic (2 groups of tools for 12 pieces, Mester 2006) and especially bones (194 groups, including 6 groups involving 8 rhino teeth and 4 groups involving 7 mammoth teeth, cheek teeth and numerous fragments of at least 1 tusk, only), rarely involving debris (splinters).

possible to know the relative dates of the occupations. The existing ^{14}C dating on coals indicates a difference of 9000 years (8461-6804 calibrated years) for the two lower levels *(d-e)* of EnsU archaeological complex, which is too wide from a palaeoethnographic point of view.

On the other hand, indirectly, the subsistence activities concerning these megaherbivores carried out on the site make it possible to deduce some information on the intermittent duration of human occupations of short duration or low intensity according to several factors: (1) at least part of the carcasses were transported by hominins to the site (secondary butchering *in situ*, consumption); (2) incomplete butchering sequence ("extended" utilization); (3) the juveniles (only the mammoth calf bears direct anthropic action) indicate maybe (probably) summer acquisition or during rainy and seasonal climate (Kriván 1968; Stieber 1968); (4) at least part of the carcasses abandoned by hominins was eaten by carnivores, i.e. (sub)contemporaneity; incompatibility of simultaneous human and carnivore occupations, but not in terms of activities; (5) the seasonal (?) (summer) acquisition of gregarious species like megafauna or due to possible climatic (flood), topographical (pasture, swamp?, plateau) or related to favourable moments of vulnerability (age, separated or solitary individual) factors; (6) the presence of retouched tools, often raw, in local rock (immediate activity(ies) *in situ* with complete *chaîne opératoire*).

The climatic cooling, indicated by different disciplines, allows us to assume a gradual reduction in the vegetation period – estimated at 3-4 months during the glacial maximum between May and September inclusive with positive temperatures (Stieber 1968, 51–52) (and therefore reduced "optimal" feeding time), the possible period of occupancy/use of the site (availability) is also reduced when other wintering occupants are present (bears and possibly hyena).

The remains from the smaller vallon could attest either to the displacement of remains from the other vallon by carnivores or trampling, or a direct introduction by an accumulator. The refittings is confirmed for rhinos remains, but not between both vallons during EnsU.

As for the first phase of Érd's occupation (i.e. EnsL: A), ephemeral, it attests to two distinct phases of occupation (spatially and temporally according to textual descriptions) by Neanderthals and at first carnivores. The rare lithic tools discovered in EnsL suggest that hominins made very brief visits/passages there (Daschek, 2014; Daschek, Mester 2020; Gábori-Csánk 1968; 1971, 12). The origin of the remains of megaherbivores is undetermined; no carnivore or anthropogenic traces could be observed. Overall, for either animal, in our opinion, a natural accumulation/slaughter/primary butchering on place/at Érd can be excluded. During the EnsU depositions, these are short meat acquisition stays and their consumption *in situ* with a local (?) exploitation of lithic tools on flakes often retouched.

Intra-site evolution?

Gábori-Csánk, Kretzoi (1968) and Gábori, Gábori-Csánk (1978) thought they had highlighted a "spontaneous" internal evolution, parallel between the fauna and the lithic. This very slow co-evolution is manifested, according to the authors, in the strategies of acquisition of actively hunted animals, based on a mono-specific specialization (bear), then secondarily multi-species (horse, rhinoceros) towards the last human settlements at the top of archaeological depositions. Moreover, this internal evolution, from bottom to top, would have had the consequence of changing the typology (composition of the tools) through the types of activities carried out and the animals concerned (dangerousness, specialization).

According to the re-examination of the lithic material (tools), it does not show any internal evolution within Érd (Mester 2004b; 2006; 2012; Mester, Moncel 2006, 232; Daschek, Mester 2020).

The grouping of the bone material (vertically, horizontally heaps *vs*. level) and the lack of data on possible carnivore gnawing or anthropic action on the remains, do not allow, to date, to reliably distinguish between the two agents (even if they are young enough to suspect acquisition partly by carnivores) and to rule on a possible internal evolution or at least on behavioural changes in the acquisition and exploitation of game by hominins. The bone remains of megamammals with anthropogenic marks and their distribution within the stratigraphy are too few for such a large amount of available deposits and surface area that no reliable internal evolution can be deduced.

R. Klein (1969, 1221) develops a critique of statistical calculations for inter-level comparison and its correlation with the climatic changes observed by the appearance or diminution of the main plant species of *Érd*. According to this author, "differences might simply reflect changes in hunting preferences rather than changes in the proportions of different species in the environment".

The palimpsests of occupations within the phases of human occupation is confirmed by the mixing of varying degrees of surface alterations (on the same remain) and bone (Daschek 2014) and lithic (Mester 2012) refittings, and underlie stratigraphic disturbances unidentified by sedimentology (Kriván 1968).

This type of short but regular/recurrent occupation during the acquisition of megaherbivores can be corroborated by the small number of their remains distributed in the archaeological filling – but nevertheless more numerous (rhinoceros) than elsewhere during the Palaeolithic in Hungary, like at the two main sites of Subalyuk (MIS5e, Mester, Patou-Mathis 2016) and Tata (MIS5/Brørup, Patou-Mathis 2004), where rhinoceros and mammoths were probably hunted/scavenged even if there is no anthropogenic mark on their remains corresponding to less than 10 (youngs and adults) individuals each.

VIII. CONCLUSION

This is the first archaeozoological publication focusing on the Upper Pleistocene megafauna in Hungary.

The study of these megaherbivores has made it possible to provide information on the interaction between human and megaherbivores and to clarify the role of hominin/carnivores/geological processes in the formation of the Érd bone accumulations relating to this group of ungulates.

Indeed, the palimpsestuous nature of the depositions, the major archaeo-stratigraphic ensembles under consideration (ensembles) and the absence of some – mainly non-taxonomic – likely to have little impact as far as pachyderms are concerned, calls for more cautious interpretations as regards the exploitation of their carcasses (Daschek, Mester 2020). The evidence of the clear and unmistakable action of the hyena on the remains of these woolly herbivores as well as the irrefutable relationship of the lithic remains directly associated, at least partially, with those of these pachyderms attest to their close interactions. The Érd site can be considered, not only as a mixed site of accumulating and/or modifying agents, but also, as a result, as an amalgam of multiple occupations. More stratigraphically precise archaeological levels would allow more refined hypotheses of subsistence activities over the history of human occupation to be formulated. Direct dating, which is planned, on rhino remains from this site bearing butchering marks would also make it possible to clarify the geochronology of the site, that of the presence of this pachyderm in Hungary as well as the phases of human occupation.

The meaty and marrow exploitation of the carcasses is corroborated by the *in situ* manufacture of lithic tools on flakes, usable raw or retouched, on essentially local supports (quartzite) with a complete *chaîne opératoire* and their processing waste, type of rock which may have been used preferentially (?) if the “wide” striations are due to their thick edges (quartzite of different qualities, geographical and numerical availability).

Megaherbivores, especially adults, especially rhinos, made up the game eaten by Neanderthals at Érd among other ungulates such as horses. Some young may also have been prey for large predators. The presence of large predators reflects the dual problem of their access to food and habitat and their relationship to humans. Indeed, their impact on the accumulations of megaherbivores in this site – the preponderance of hyenas (intensity of gnawings recognisable by their particular morphotype, rare digested elements and, indirectly, the presence of coprolites and their own remains) – suggests a notable role in the constitution or modification of these assemblages of these megaherbivores, either by contributions (primary or secondary acquisition), or by pilfering (defleshed bones not opened, abandoned by hominins). It is therefore more of a consumption and refuge site for a variety of predators using Érd repeatedly, alternating with hominids.

In particular, the anthropic stigmata allow us to trace back to the modalities of use of certain carcasses. The use of these seems complete (flesh, skull contents and/or sometimes long bones), despite the observable absence of the entire processing chain. The hypothesis of a collection of teeth can hardly be discussed as it stands (except for the tooth of the adult mammoth) compared to the transport of the heads for a consumption, it appears that these animals were nutritional resources, but apparently not of raw materials or of tools at Érd. This mega-herbivore site represents one of the places reflecting subsistence activities (dietary and indirectly dietary by the lithic) of Neanderthal human groups.

Multifunctional site, not only in terms of human activities, which are only partly reflected in the reason for the presence of megaherbivores, but also in terms of the activities of carnivores (refuge and wintering den of bears), which suited these different occupants mainly in the second half of the site’s history (topographical changes perhaps, palaeoecological, strategic, subsistence) and which indicates their suitability for a favourable location within a larger geographical area (relatively large numbers of rhinos and hyenas compared to other sites). However, if one parallels the recurrence of occupations with the duration of the deposits in millennia, the frequency of occupations and/or individuals and the bone accumulations appear limited (excluding taphonomic bias). In a deliberate way (site at a relative height, on a slope, without a regular immediate water point), the acquisition methods seem multiple, the desired exploitation (hunting/active acquisition[17], active scavenging, gathering). All the observations tend towards a use of space, or even of particular territorial management, and seasonal or climatic, short-term (EnsU), even ephemeral (EnsL) and mobile occupations or even seasonal. It testifies to the ability of Neanderthal groups to develop and use strategies for the acquisition of resources (meat and lithic) through technique (choice of the type of raw material and its quality: quartzite of various to excellent qualities, hypothesis to be tested), and the planning of activities and needs and the reasoned use of their living space. Clearly, it testifies to an obvious management of the territory at various scales, but directed more particularly towards the available local resources (game, mineral and organic material) and not a camp, while taking advantage of the geo-topographical conditions (passage, plateaus, valleys, flood plains of the Danube, increased floor space, availability of evening light) and this, in a changing climatic context of cooling/cold between MIS 5b and 3 of the Hungarian and the Carpathian Upper Pleistocene.

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[17] Auguste *et al.* 1998, 148.

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