INSTITUTUL DE ARHEOLOGIE „VASILE PÂRVAN”

MATERIALE ŞI CERCETĂRI ARHEOLOGICE

SERIE NOUĂ, SUPPLEMENTUM I

SCRIPTA PRAEHISTORICA. MISCELLANEA IN HONOREM MARIAE BITIRI DICATA

EDITED BY

ROXANA DOBRESCU, ADINA BORONEANȚ, ADRIAN DOBOȘ

EDITURA CETATEA DE SCAUN

2021

COVER: Dan Iulian Mărgărit

MCA SERIE NOUA
SUPPLEMENTUM I

www.mcajournal.ro

Descrierea CIP a Bibliotecii Naţionale a României
Scripta praehistorica : miscellanea in honorem Mariae Bitiri dicata /
ed. by Roxana Dobrescu, Adina Boroneanţ, Adrian Doboş. - Târgovişte :
Cetatea de scaun, 2021
Conţine bibliografie
ISBN 978-606-537-545-1

I. Dobrescu, Roxana (ed.)
II. Boroneanţ, Adina (ed.)
III. Doboş, Adrian (ed.)

902

All papers published in *Materiale şi Cercetări Arheologice* are peer-reviewed.
***Materiale şi Cercetări Arheologice* is indexed in the following data-bases:**
Persée, Copernicus, ERIH PLUS, Scopus, CEEOL, EBSCO and DOAJ.

This volume was edited with the financial support of the "Vasile Pârvan" Institute of Archaeology in Bucharest.

MARIA BITIRI

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ZOOARCHAEOLOGICAL ANALYSIS OF THE FAUNAL REMAINS FROM THE PALAEOLITHIC SITE OF LA ADAM CAVE (DOBROGEA, SE ROMANIA) – NEW DATA FROM RECENT EXCAVATIONS

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Keywords: *zooarchaeology, Palaeolithic, cave site, bone accumulation by carnivores, taphonomy*

Abstract: *Recent (2006–2009) excavations at the Palaeolithic site from La Adam Cave (central Dobrogea, south-eastern Romania) yielded numerous fossil remains, that were analysed in order to obtain more information on the Late Pleistocene faunal assemblage from the area of the cave, on the animal and anthropic contributions to bone accumulation in the cave, and on the taphonomic processes present at the site. The faunal remains analysed were highly fragmented, which prevented the precise taxonomic assessment for most of them. However, numerous specimens bear signs of chemical corrosion and carnivore bite marks, only a few showing signs of anthropic activity. The cave seems to have functioned as shelter for the carnivores, with cave bear remains dominating numerically. Other large carnivores, such as cave hyenas, most probably also contributed to bone accumulation, with large and middle-sized ruminants being their most common prey.*

Cuvinte-cheie: *arheozoologie, Paleolitic, sit cavernicol, acumulare de oase de către carnivore, tafonomie*

Rezumat: *Săpăturile arheologice efectuate recent (2006–2009) în situl paleolitic din Peștera La Adam (Dobrogea Centrală, sud-estul României) au furnizat numeroase resturi fosile, care au fost analizate în scopul obținerii mai multor informații asupra asociației faunistice din Pleistocenul târziu în zona peșterii, asupra contribuțiilor animalelor și omului la acumularea oaselor în interiorul peșterii, și asupra proceselor tafonomice prezente în sit. Resturile faunistice analizate au fost foarte fragmentare, fapt care nu a permis, în cazul celor mai multe, o determinare taxonomică mai precisă. Totuși, numeroase specimene prezintă urme de coroziune chimică și semne ale mușcăturilor unor carnivore, doar câteva prezentând semne de activitate antropică. Peștera pare să fi funcționat în special ca adăpost pentru carnivore, resturile ursului de peșteră dominând numeric. Alte carnivore mari, cum ar fi hienele de peșteră, au contribuit de asemenea, cel mai probabil, la acumularea oaselor, rumegătoarele de dimensiuni mari și medii reprezentând cel mai frecvent prada acestora.*

INTRODUCTION

The widespread occurrence of carbonated rocks, such as the Mesozoic and Cenozoic limestones (Dragastan *et alii* 1998; Mutihac, Mutihac 2010), in central and southern Dobrogea offered favourable conditions for the karst formation in this region. Several large caves have been described in the area, hosting unique ecosystems, such as the chemosynthesis-based one from Movile Cave (for a review, see Sarbu *et alii* 2019 and references therein), but also allowing the unperturbed accumulation of sediment during the Pleistocene, thus containing important fossil and archaeological assemblages, such as those from Bursucilor, La Adam, Cheia, or Liliecilor (also known as Gura Dobrogei) caves. Alongside the open-air sites from the thick Middle-to-Upper Pleistocene loess sequence that covers most of central and southern Dobrogea (Iovita *et alii* 2014; Doboș 2017; Fitzsimmons *et alii* 2020), the above-mentioned cave deposits represent a very important archive of Pleistocene vertebrate assemblages and Palaeolithic artefacts (Dumitrescu *et alii* 1963; Samson, Radulesco 1972; Radulesco, Samson, 1976, 1986; Radulesco *et alii* 1998; Terzea 2001).

La Adam Cave, located on the Vistorna Valley, between the villages of Târgușor (to the west) and Gura Dobrogei (to the east), was formed by the dissolution of Oxfordian (Late Jurassic) limestones (Dumitrescu *et alii* 1963), and partly filled with sediment during the Pleistocene. The first large-scale excavations were made in 1955–1956 by a team of researchers from the „Emil Racoviță" Institute of Speleology, who, in addition to the Neolithic ceramics and parts of an altar dedicated to Mithras, also reported the discovery of Palaeolithic and Mesolithic artefacts, and of diverse Late Pleistocene faunal assemblages (Dumitrescu *et alii* 1963). The sedimentary succession was divided into 11 layers, but, except for some general lithological features, there is not much information given on the geometry (thickness, lateral continuity) of each layer. The fossil faunal list is quite diverse, and comprises 64 taxa, including insectivores (one hedgehog – *Erinaceus rumanicus*, two shrews – *Crocidura leucodon* and *Sorex minutus*, and seven species of bats – *Myotis myotis*, *My. mystacinus*, *My. emarginatus*, *My. nattereri*, *My. bechsteini*, *Eptesicus serotinus*, and *Miniopterus schreibersii*), four types of rabbits (*Lepus timidus*, *L. europaeus*, *Ochotona pusilla*, *Ochotona* sp.), 25 species of rodents belonging to six families, carnivores (*Canis lupus*, *Vulpes vulpes*, *„Alopex" lagopus*, *Vulpes corsac*, *Vulpes* sp., *Mustela lutreola*, *„Putorius" eversmanni*, *Mustela nivalis*, *Martes* sp., *Panthera pardus*, *„Panthera* cf. *spelaea"*, *Crocuta spelaea*, *Ursus arctos*, *Ursus spelaeus*), artiodactyls (*„Megaceros" giganteus*, *Cervus elaphus*, *Rangifer tarandus*, *Saiga tatarica*, *Bos primigenius*, and *Bison priscus*), perissodactyls (*Equus „germanicus"*, *Equus przewalskii*, *Hydruntinus hydruntinus*, and *Coelodonta antiquitatis*), and one proboscidean (*Mammuthus primigenius*). Of these, large carnivores, such as the cave hyena and the cave bear, are the most abundant, suggesting they used the cave as shelter for various periods of time, which is also supported by the presence of bones from juvenile individuals. The small and large mammal assemblages were also used as proxies for palaeoenvironmental reconstructions, allowing the authors to identify colder (e.g. layers XI, X, VI, IV, and II), and warmer, i.e. temperate (layers IX, VIII, VII, V, III, and I) intervals, but the precise chronology of the succession could not be determined based on the existing information.

A brief attempt to describe the biostratigraphy of Dobrogea based on cave faunal remains (Petculescu, Ştiucă 2008) also refers to the sedimentary accumulation from La Adam Cave, but makes no reference to the layers described by previous studies (e.g. Dumitrescu *et alii* 1963). Some correlation can, however, be made, based on the occurrence of some taxa: the abundant cave hyena remains mentioned by Dumitrescu *et alii* (1963) from layer VI is assigned by Petculescu and Ştiucă (2008) to the upper part of the Marine Isotope Stage (MIS – see Lisiecki, Raymo 2005) 3, whereas the assemblage of layer VII (as defined by Dumitrescu *et alii* 1963), including woolly mammoth and woolly rhinoceros remains, is assigned by the latter to MIS 4.

New excavations were carried out between 2006 and 2009, in order to obtain new archaeological data from the site. Three sectors were investigated: one outside the cave (among a few exploration trenches only in one, S3, were found undisturbed Pleistocene deposits, which yielded a flint scraper and fossil faunal remains); one at the cave entrance (sector EG), cut through a thick sedimentary infill, and was the main focus of the research, yielding both lithic artefacts and faunal remains; and a third right in front of the cave (sector AG). The stratigraphic profile of sector EG, also continuing onto sector AG, was thoroughly described and figured by Tuffreau *et alii* (2013, Fig. 2), from top to bottom, the succession includes: plates of limestone, fallen from the cave ceiling (layer B); up to 30 cm of yellow-to-grey silt containing limestone blocks (layer C); some 15 cm of light brown silt (layer C1); up to 20 cm of dark brown silt containing many limestone grains (layer C2); centimetre-thick clayey silt (layer C3); up to 50 cm of brown silt containing several limestone black fragments and grains, but also including silty-clayey lenses up to 10 cm thick (layer D), and a lens of bioturbated clayey silt at the base; centimetre-thick yellow-brown silt and chalk grains present locally (layer D0); up to 25 cm of yellowish red to dark brown silt (layer D1); brownish yellow loess with numerous limestone blocks, up to 80 cm thick (layer E); reddish yellow loess more than 50 cm thick in sector AG (layer E1); a thick layer of limestone slabs with little dusty matrix in sector EG (layer F). The variation in thickness of the layers in this succession was thoroughly recorded and represented in a profile along the northern wall of the excavation (Tuffreau *et alii* 2013, Fig. 3).

Unfortunately, the lithic artefacts were rare and did not allow for a clear typological assignment (Tuffreau *et alii* 2013, Fig. 4). Small mammal assemblages include ten species, of which only seven were mentioned (*Microtus gregalis*, *Microtus arvalis*, *Lagurus lagurus*, *Eolagurus luteus*, *Clethrionomys glareolus*, *Arvicola terrestris*, *Spalax leucodon*). Because of their ecological preferences, depending on their relative abundance, these species allow for palaeoenvironmental reconstructions to be made. The small mammal assemblages shows that the environment was generally colder and more arid than the present one (e.g. the assemblages from layers B, C, C1, and E), temperate but still arid (e.g. layers C2 and D), but also warmer and more humid environments, even indicating the presence of forests or shrubberies (a short period during the accumulation of layer D, and layer F). Fifteen large mammal taxa were listed: *Ursus spelaeus*, *Ursus arctos*, *Capra/Ovis*, *„Megaceros"* (=*Megaloceros*) *giganteus*, *Saiga tatarica*, *Rangifer tarandus*, *Bos primigenius*, *„Alopex"* (= *Vulpes*) *lagopus*, *Vulpes corsac*, *Coelodonta antiquitatis*, *Cervus elaphus*, *Equus przewalskii*, *Hydruntinus hydruntinus*, *Martes martes*, *Mustela nivalis*. The cave hyena was considered the most probable bone accumulator, whereas anthropic traces on bones were extremely scarce (only one rib was considered to exhibit cut marks). The large number of cave bear bones, including remains of very young individuals, supports the idea that, at least for some time intervals, the cave was used as a bear den (Tuffreau *et alii* 2013). The same conclusions regarding the presence of large carnivores, and their role as bone accumulators, and the weak anthropic presence, were drawn by Wismer *et alii* (2012), who, based on a smaller sample of specimens, made a preliminary taphonomic assessment of the faunal remains. Carnivore damage on the bones is frequently observed, but traces of digestion are also mentioned by the latter authors, who also add *Lepus* sp. and *Mustela putorius/eversmanni* to the faunal assemblage.

As mentioned earlier, the chronostratigraphy of the site was very difficult to ascertain in the initial stages of the research, Dumitrescu *et alii* (1963) only tentatively linking the layers they identified to some stadials and interstadials, based on the taxonomic abundance of the taxa present in each layer. The first definitive chronological assessment was made by Balescu (2013), who obtained absolute ages of 151 ± 13 ky (during MIS 6) for the lower loess layer (L2) of sector AG, which also continues laterally into layer E of sector EG. Further investigations (Balescu *et alii* 2018) also produced an absolute date of 55 ± 5 ky (during MIS 4) for the upper loess layer (L1) of sector AG, which continues laterally into layer B of sector EG. Another date was obtained from the basal layer E, identifying an interval around 190 ± 19 ky (during MIS 6) for the beginning of its accumulation. The same work offers additional chronological data, based on biometric data obtained from water vole dentition, placing the teeth found in layer C to voles that lived during MIS 5.1 – 5.4, fitting well between the dates obtained by the absolute dating of L1 and L2, and the teeth found in layer E to voles living during MIS 5, suggesting the rodent material found in the latter layer might not all be in place.

MATERIAL AND METHODS

The material analysed in this paper, totalizing 1.599 specimens, was excavated during the 2006–2009 field seasons carried out by the joint efforts of Romanian and French researchers within the framework of „Le Paléolithique en Roumanie” archaeological mission (Tuffreau *et alii* 2013).

The specimens were grouped by the layer they were found in, according to the stratigraphy described in detail by Tuffreau *et alii* (2013), namely in layers C (993 specimens), D (433 specimens), D1 (33 specimens), and E (34 specimens), mostly from the cave entrance sector (EG), and from one exploration trench dug outside the cave (S3 – 106 specimens). The bones are mostly white and yellowish. Only a very small part are rounded, suggesting hydrodynamic transport was probably absent. A possible explanation for the presence of bone fragments with rounded edges is human or carnivore transport from outside the cave. The specimens from the exploration trench outside the cave (S3) are very fresh in appearance, showing they have a different taphonomic history.

Except for small elements, such as teeth or distal limb elements, most specimens consist of fragments of larger bones, most of which cannot be assigned taxonomically. In order to assess the degree of fragmentation, the fragmentary bones were assigned to size classes (as often done in zooarchaeological analyses, e.g. Lyman, O’Brian 1987, Lyman 1994). Given the high degree of fragmentation, we chose to divide the material into five size classes, as follows: 0–1 cm (size class 1), 1–3 cm (size class 2), 3–6 cm (size class 3), 6–10 cm (size class 4), and more than 10 cm (size class 5).

The number of bone fragments fitting each size class from all layers is given in Tab. 1, whereas Fig. 1 shows the comparison between the percentage distributions by size class.

Size class	Layer C	Layer D	Layer D1	Layer E	Trench S3
Size class 1 (0-1 cm)	586	133	4	2	19
Size class 2 (1-3 cm)	298	211	11	5	37
Size class 3 (3-6 cm)	92	52	2	11	9
Size class 4 (6-10 cm)	13	14	-	1	-
Size class 5 (>10 cm)	3	2	-	1	1

Table 1. Number of fragmented fossil bones from La Adam, assigned to size classes.

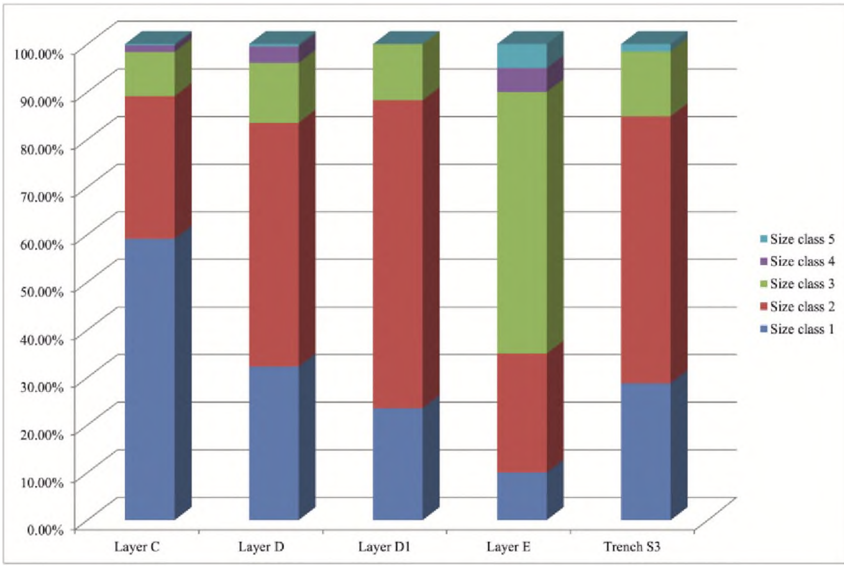

Figure 1. Fragmentation degree of fossil bones from La Adam, represented as percentage of bones belonging to each of the size classes defined in the text.

In almost all layers, the assemblage is dominated by small bone fragments belonging to the 0–3 cm interval (size classes 1 and 2) making up for more than 80% of the assemblage. Fragments in size class 3 follow, making up for around 10% of each layer, whereas larger fragments are very rare. This distribution shows the specimens in the faunal assemblage are highly fragmented, either as a result of the predators (human or carnivoran), or other taphonomic processes (e.g., large mammal trampling, the falling of boulders from the cave ceiling). Other factors, such as surface weathering, fissuring due to diurnal temperature variation, or gelifraction, are less probable, given the relatively constant temperature offered by the cave environment. The only exception is seen in layer E, where fragments in size class 3 dominate the assemblage, but the total number of specimens from that layer is very small (20), making it statistically less relevant.

Some of the taphonomic processes that can lead to bone fragmentation can be identified by the traces left on bone surfaces. Each bone was inspected in order to identify possible marks left on surfaces by various factors or processes. Following this inspection, alongside the traces of fresh bone breakage (i.e. pre-burial breakage of bone, within a few years from the animal's death), a few types of traces were identified on a fair amount of the bones in our sample.

CHEMICAL CORROSION OF BONES

Quite a few bones in the assemblage exhibit signs of exposure to chemical corrosion, which can be seen in the form of surface etching, and thinning of bone edges that become sharp and have an irregular crenelated outline (Figs. 2a–i). Often, on the same bones, tiny holes appear on both surfaces (Figs. 2c–i): larger on the inner side of the bone, where it is easier for corrosive chemicals to enlarge the already spongy structure of the bone, but smaller (1–2 mm wide) on the outer surface, which is more compact to start with. Also, the foramina present in bones, serving as access routes for blood vessels or nerves inside the bone, are much enlarged by the action of corrosive agents (Figs. 2b–c). Among the agents that are known to cause intense corrosion of bones, it is worth mentioning the highly acidic digestive fluids found in the stomach of some carnivores. Among the common members of Late Pleistocene Eurasian large mammal faunas, cave hyenas (*Crocuta crocuta spelaea*) are known as the most likely carnivore that gnaw on large bones and ingest fragments of bones, that are highly corroded when passing through their digestive tract (acid-etching, as used by Cruz-Uribe 1991). The activity of cave hyenas as bone accumulator of megafaunal remains in open-air and cave Pleistocene sites is well-documented (Villa *et alii* 2010; Diedrich 2011, 2012a, b), and it was previously suggested that they might have represented the main accumulator at La Adam as well (Wismer *et alii* 2012; Tuffreau *et alii* 2013). Other large mammals that might have contributed to bone accumulation and bone fragmentation by consumption, such as leopards (*Panthera pardus*, see, for example, Sauqué *et alii* 2014, 2018) and cave bears (*Ursus spelaeus*) are considered improbable culprits at La Adam, since leopard elements are very rare at the site so far (a few teeth presumably belonging to a single individual were described by Dumitrescu *et alii* 1963 from Layer V), and cave bears are recently proven to have a more vegetarian-oriented diet (e.g. Naito *et alii* 2020).

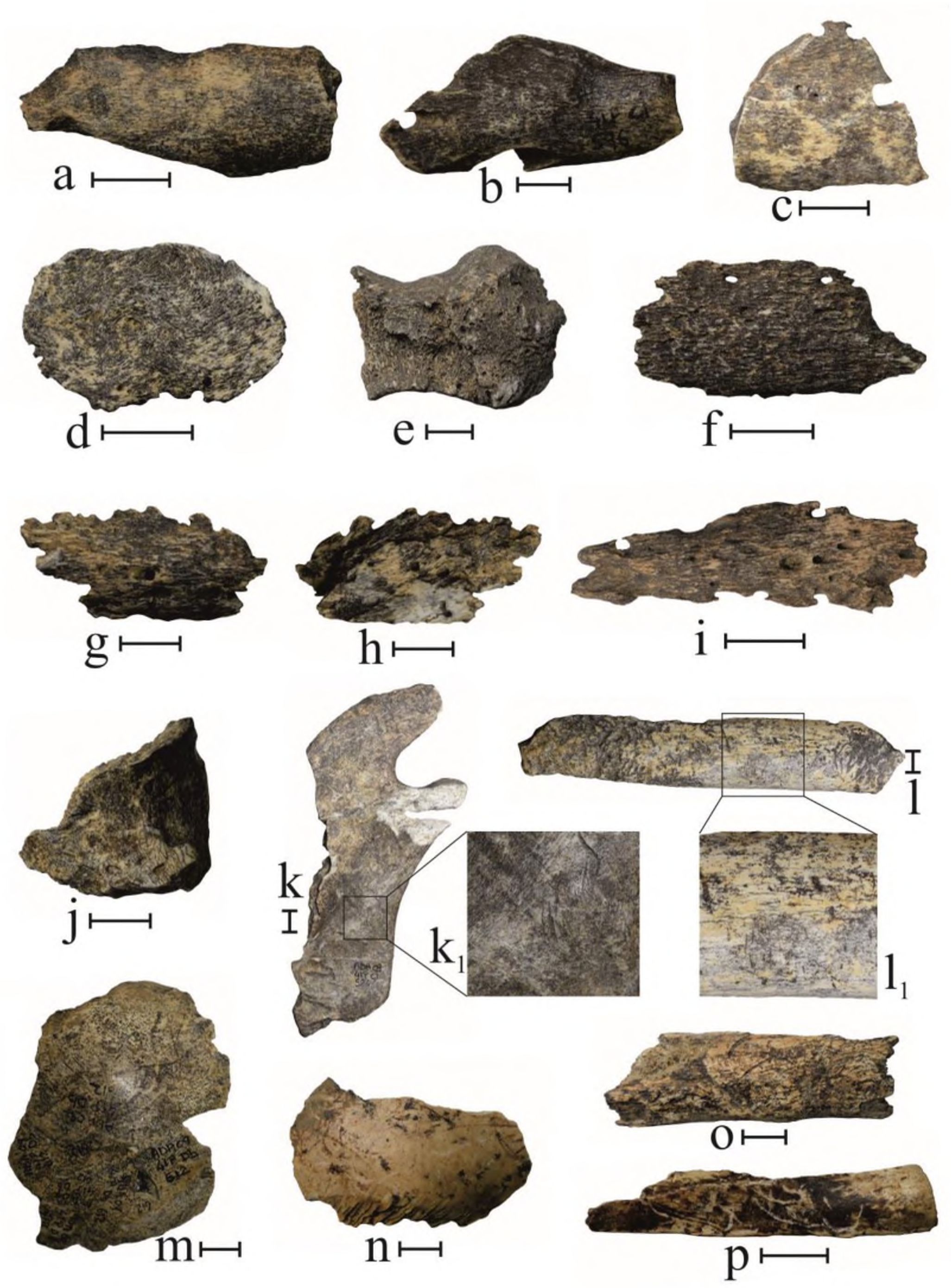

Figure 2. Examples of bone surface traces present on fossil bones from La Adam: chemical corrosion of bones in incipient (a-c), moderate (d-f), and advanced (g-i) degrees; carnivore bite marks (j-l); possible anthropic traces in the form of cut marks (k_1) and traces of percussion (l_1); non-anthropic scratches on bone surface (m-o); root/mycelia traces (p). All scale bars equal 1 cm.

There are, however, two elements that raise doubt about hyena digestion being the main factor producing the corrosion traces described above: the size of the corroded bones from the assemblage, and the scarcity of the hyena bones. The main issue regarding the possible hyaenid involvement in corrosion is the large size of the corroded bones in our sample. If it is indeed thinkable for small bone fragments to pass through the digestive tract of hyenas, it is highly improbable for larger fragments to have taken this path. Since our sample includes bone fragments larger than 5 cm (some larger than 10 cm) that exhibit the same type of features related to corrosion as the smaller fragments, we conclude that a digestive process could not account (or, at least, not entirely) for the presence of the aforementioned traces on bones. The second element of uncertainty regarding the hyena activity is the uncertain abundance of hyaenid bones at the site: no skeletal remains from the sample analysed for this study can be positively assigned to the cave hyena. However, previous works document the existence of a large (but not clearly specified) number of specimens belonging to cave hyenas of various ages, most abundant in Layer VI (Dumitrescu *et alii* 1963), suggesting that the taxon was indeed present at the site, and possibly represented one of the most important bone accumulators.

Another agent that might be responsible for the chemical corrosion of the bone is the slightly acidic water responsible for the dissolution of limestone and development of karst features. The small amounts of carbonic acid dissolved in the water percolating the sediments accumulated in the cave could, by prolonged action, across several thousand years, lead to a slow but continuous corrosion of the bone fragments, possibly in favourable conditions for high bacterial activity as well, process known as cave corrosion. Some other sources of corrosion might also be represented by the guano produced by the cave-dwelling bats (Fernandez-Jalvo, Andrews 2016: *Chapter 8. Corrosion and Digestion*).

Traces linked to chemical corrosion are by far the most frequent among all the taphonomic modifications present on bone surfaces. Except for layer D1, in which signs of acid-etching, corrosion crenels, and corrosion holes are seen on one bone each, all other layers contain a fairly large amount of corroded bones. The three types of corrosion traces appear on 56.81% of the bones from layer D, in almost equal proportions, whereas in exploration trench S3, and in layer C, they appear on 38.68%, and, respectively, 25.98% of the specimens, with acid-etching occurring twice as often as crenels and holes (Fig. 3, Tab. 2).

BITE MARKS

Given the presence of several middle- and large-sized carnivores at the site, the presence of marks left by carnivores on some of the bones is not surprising. Some are bite marks, left as isolated depressions of circular or subcircular outline by canines while puncturing the bone (Fig. 2j). Other traces appear as wide and rather deep scours, left by teeth while dragging along the bones, while gnawing on them (Fig. 2k, in the lower part of the bone fragment). In some cases, the extremity of the bone is well-chewed, leaving an irregular surface on which the cancellous inner tissue of the bone is now visible (Fig. 2l). Hyenas, leopards, and wolves are all possible candidates for leaving such traces on the bones.

Carnivore tooth marks are not that frequent, being found in as low as 1.62% of all bones from layer D, and as high as 5.88% in layer E (Fig. 3). Rodent gnawing marks are extremely rare, only two specimens in layer C showing such marks on their surface.

Bone surface traces	Layer C	Layer D	Layer D1	Layer E	Trench S3
Acid-etching	133	94	1	4	28
Corrosion holes	52	79	1	1	3
Corrosion crenels	73	73	1	-	10
Carnivore tooth marks	21	7	1	2	2
Rodent gnawing	2	-	-	-	-
Possible cut marks	3	2	-	-	-
Possible retoucher	1	-	-	-	-

Table 2. Number of fossil bones from La Adam presenting particular traces on surface.

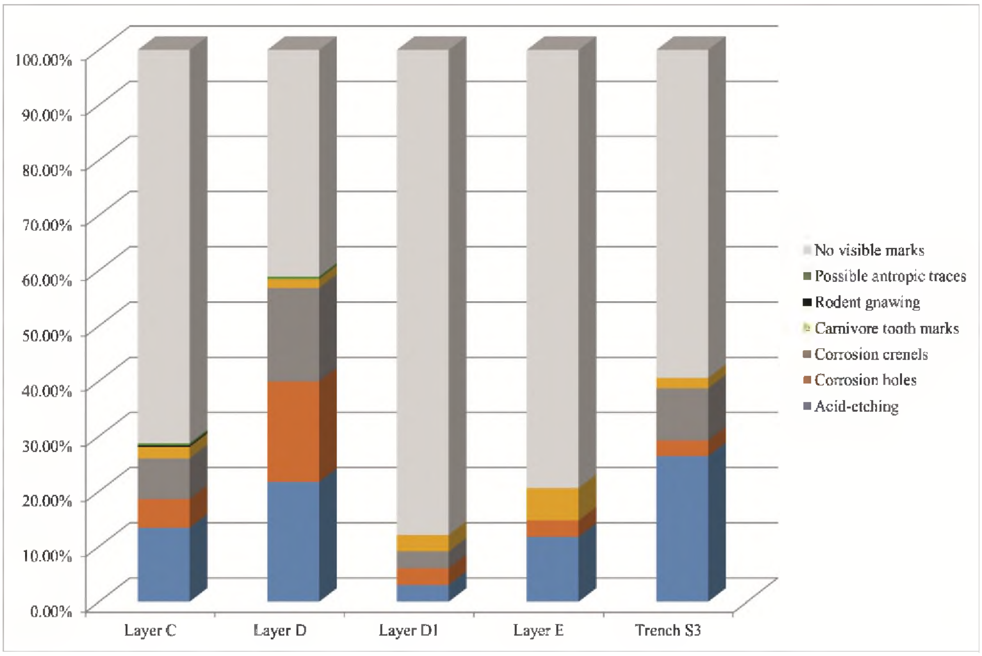

Figure 3. Percentage of traces present on surfaces of fossil bones from La Adam.

ANTHROPIC MARKS ON BONES

The presence of humans at the site is highlighted from the very title of the first papers written on the site, which was clearly labelled as „prehistoric station". Lithic elements, for which the assignment to a cultural typology is more or less clear, are described from the site (Dumitrescu *et alii* 1963, Tuffreau *et alii* 2013). The length of time the humans used the cave during the Palaeolithic, and for what purpose, is, however, unknown, as is their interaction with the local fauna. Clear anthropic traces left on bone surfaces are rare and rather unclear. Some elements interpreted as possible anthropic traces might be related to bone morphology, or produced by other taphonomic factors. Wismer *et alii* (2012) note that a single element of the assemblage, a rib fragment, bears traces of anthropic activity. However, mammal ribs sometimes show fine parallel striations triggered by the intercostal muscles attachment, and this is a reason indicating these traces were not related to human activity. One mandible fragment, from a large bovid, bears some fine parallel lines that might be of anthropic origin (Fig. 2k_1). However, the same specimen bears numerous other scratches of various size and irregular positioning, so it is possible that the fine parallel traces were made by other factors. Such fine lines, of possible anthropic origin, also occur on four other bones, two from layer C, and two from layer D. A single element from the sample analysed in this work shows signs that it can be linked to human activity with a higher degree of probability: the fragment of a horse metacarpal diaphysis from layer C, bearing numerous small linear marks on its surface, with the lines oriented perpendicular to the long axis of the bone, close to one-another (Fig. l_1). These marks are similar to the points of impact noticed on bone percutors or retouchers, used to break blades from nuclei, or for retouching stone tools (e.g. Malerba, Giacobini 2002; Schwab 2002).

SCRATCHES ON BONES

Some of the bones in the studied sample bear numerous scratches of various sizes and shapes on their surface. Unlike the anthropic traces, such as the cut marks, these scratches do not follow a distinct pattern, being rather chaotic in their distribution. Thin narrow scratches criss-cross wider ones, some are shorter and some longer (Figs. 2m-o). This irregular pattern of scratches suggests they are more likely produced by non-anthropic factors, such as animal trampling, or the falling of rock fragments from the cave ceiling. Large mammals not only break bones while trampling them, but also create friction between the bones on the cave floor and the underlying boulders. The most likely candidate for bone trampling at La Adam is the cave bear, a large animal, whose remains were identified in both the old and new excavations of the site (Dumitrescu *et alii* 1963, Wismer *et alii* 2012, Tuffreau *et alii* 2013). The occurrence of numerous skeletal elements belonging to cave bears, in various stages of ontogenetical development, documented by the presence of teeth ranging from lacteal premolars of the cubs to the well-worn molars of the old individuals, suggests the site was frequently used by cave bears for shelter.

Blocks of limestone falling from the cave ceiling could have also produced scratches on bones upon impact. The sediment infill of the cave contains such blocks, reported both during the old excavations, and linked to crioclasty during the cold stadials (Dumitrescu *et alii* 1963), and during recent ones, the detailed lithostratigraphic column of Tuffreau *et alii* (2013) showing they are present throughout the accumulation, much more frequent at the base (layers E and F) and at the top (layer B).

OTHER TRACES

Some of the bones found during the recent excavations, and available to us for study, bear thin shallow grooves, with U shaped cross-section, covering the bone in an anastomosed pattern, or, sometimes, leaving isolated lines that cross the bone surface. Such traces are commonly associated with the activity of plant roots or fungal mycelia that spread through the sediment, and feed on the minerals contained by the bones (calcium phosphates), or on whatever organic matter might still be present after burial (Fernández-Jalvo, Andrews 2016: Chapter 4. *Pits and Perforations*). Plant activity is very unlikely, due to the lack of light inside the cave, but fungal growth can take place in the absence of light, making fungi the most likely factor to have produced the traces seen on several bones (Fig. 2p).

Bone surface is frequently covered by manganese oxide, forming typical fine dendrites (e.g. on the surfaces of specimens in Figs. 2l and 2n) or covering most of the surface in some specimens (e.g. the dentine area of the woolly rhinoceros premolar in Fig. 4l).

Figure 4. Examples of taxonomically identifiable remains from La Adam: *Ursus spelaeus* upper left (a) and right (b) second molar, lower right second molar (c), left hemimandible (d); *Canis lupus* upper right first molar (e) and partial right astragalus (f); *Vulpes vulpes* canine (g) and left radius (h); *Mustela putorius/eversmanni* left mandible fragment with lower third and fourth premolars, and first molar (i); large ruminant incisor (j); *Equus* sp. upper premolar fragment (k); *Coelodonta antiquitatis* upper right second premolar (l). All scale bars equal 1 cm.

TAXONOMIC COMPOSITION OF THE FAUNAL ASSEMBLAGE

The high degree of fragmentation does not allow for a thorough relative abundance analysis of the taxa, since most fragments cannot be assigned to a more precise taxon than a general estimate placing them among large or middle-size mammals. The less fragmented specimens, bearing sufficient morphological features, as well as the complete elements (especially teeth and distal limb bones) were grouped by layer, in order to try and assess eventual variation in the faunal composition from a layer to another (Tab. 3). When the preserved features allowed it, the bone fragments were also assigned to anatomical categories for each taxon, assessment given, for layers C and D (the richest in faunal remains), in Tab. 4.

Taxon	Level C		Level D		Level D1		Level E		S 3	
	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%
Bos/Bison	11	14.10	5	8.33	-	-	-	-	11	78.57
Capra ibex	11	14.10	1	1.66	-	-	1	11.11	1	7.14
Cervus/Rangifer	8	10.25	1	1.66	-	-	-	-	-	-
Coelodonda antiquitatis	-	-	1	1.66	-	-	2	22.22	-	-
Equus sp.	2	2.56	2	3.33	-	-	-	-	-	-
Sus scrofa	1	1.28	-	-	-	-	-	-	-	-
Ursus spelaeus	26	33.33	40	66.66	14	93.33	4	44.44	-	-
Canis lupus	7	8.97	8	13.33	-	-	-	-	-	-
Vulpes vulpes	2	2.56	-	-	-	-	2	22.22	-	-
Mustelidae	2	2.56	1	1.66	-	-	-	-	1	7.14
Lepus europaeus	3	3.84	-	-	-	-	-	-	-	-
Rodentia indet.	3	3.84	-	-	-	-	-	-	-	-
Aves indet.	1	1.28	1	1.66	1	6.66	-	-	1	7.14
Pisces indet.	1	1.28	-	-	-	-	-	-	-	-
Total identified	**78**	**100**	**60**	**100**	**15**	**100**	**9**	**100**	**14**	**100**
Unidentified small vertebrates (Aves+Mammalia)	-	-	-	-	-	-	-	-	39	-
Unidentified medium sized mammals	35	-	28	-	-	-	5	-	5	-
Unidentified medium/large sized mammals	723	-	237	-	9	-	4	-	23	-
Unidentified large sized mammals	157	-	108	-	9	-	16	-	25	-
Total unidentified	**915**	**-**	**373**	**-**	**18**	**-**	**25**	**-**	**92**	**-**
TOTAL	**993**	**-**	**433**	**-**	**33**	**-**	**34**	**-**	**106**	**-**

Table 3. Taxonomical distribution of vertebrate fossil remains from La Adam.

Cave bear (*Ursus spelaeus*) remains are by far the most abundant in the assemblage, dominating in the number of identifiable remains in all of the excavated layers, except for trench S3, excavated outside the cave, where it is absent. Most remains are represented by cranial bones, teeth, and distal limb bones (Tab. 4, also exemplified in Figs. 4a–d), the size of which fits within the range of the species, with very little possibility the specimens analysed might have belonged to the brown bear (*Ursus arctos*). The teeth found came from individuals that died at various ages, from young juveniles (as shown by the presence of decidual molars and canines, also mentioned by Dumitrescu *et alii* 1963) to old bears (based on the well-worn teeth – e.g. Figs. 4b, d). Both the abundance of cave bear remains, and the presence of individuals of diverse ages, support the idea that cave bears used La Adam Cave as a den throughout most of the Late Pleistocene.

Element	*Bos/ Bison*		*Capra ibex*		*Cervus/ Rangifer*		*Equus* sp.		*Coelodonta antiquitatis*		*Sus scrofa*		*Lepus europaeus*		*Ursus spelaeus*		*Canis lupus*		*Vulpes vulpes*		Mustelidae	
	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
Cranium and upper teeth	1	-	1	-	2	-	-	2	-	1	1	-	-	-	15	24	3	3	1	-	-	-
Mandible and lower teeth	1	-	4	-	1	-	-	-	-	-	-	-	-	-	5	3	2	1		-	2	1
Isolated teeth	1	-	2	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-
Vertebrae	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Ribs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Scapula	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Humerus	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Radius	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	1	-	-	-
Ulna	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-
Carpal/Tarsal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Carpal	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metacarpal	1	-	1	-	-	-	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
Metapodial	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Femur	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-
Tibia	3	-	-	-	1	-	-	-	-	-	-	-	2	-	-	1	-	1	-	-	-	-
Astragalus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Cubonavicular	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tarsal	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metatarsal	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phalanx 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Phalanx 3	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-
Total	**11**	**5**	**11**	**1**	**8**	**1**	**2**	**2**	**-**	**1**	**1**	**-**	**3**	**-**	**26**	**40**	**7**	**7**	**2**	**-**	**2**	**1**

Table 4. Body part distribution of anatomically identifiable vertebrate fossil remains from layers C and D, the richest in faunal remains from the Upper Pleistocene deposits of La Adam Cave.

Other carnivores were also identified in the faunal material from the recent excavation, but in much lower numbers. Wolf (*Canis lupus*) remains are also present in both layers that yielded a higher number of faunal remains (C and D), being represented by dental and cranial remains, but also by limb bone fragments (Figs. 4e–f). Fox remains are rare, but the few teeth and limb bones found (e.g. Figs. 4g–h) only fit the size and morphology of the red fox (*Vulpes vulpes*). Mustelid dental remains were also recovered, but were extremely rare. The size and morphology indicate the pine marten (*Martes martes*), and either the European (*Mustela putorius*) or the steppe polecat (*Mustela eversmannii*) were also present in the area (Figs. 4i).

The largest herbivore to be found in the Upper Pleistocene deposits from La Adam Cave is the woolly rhinoceros (*Coelodonta antiquitatis*). The presence of a complete upper premolar (Fig. 4l) and a couple of phalange fragments show the large perissodactyl was present in the vicinity of the cave, and it was preyed upon or scavenged by large carnivores that used the cave for shelter. Another large odd-toed ungulate present in the faunal assemblage is the horse (*Equus* sp.), represented only by a couple of tooth fragments (e.g. Fig. 4k) and a couple of limb bone fragments, but too fragmentary to allow specific assessment. Artiodactyls are more abundant, but their remains are also fragmentary. The presence of a large bovid (either the steppe bison, *Bison priscus*, or the aurochs, *Bos primigenius*), of middle-sized bovids (such as the ibex, *Capra ibex*), deer (such as the reindeer, *Rangifer tarandus*, or red deer, *Cervus elaphus*), and, albeit in smaller numbers, even of the boar (*Sus scrofa*), is documented by the presence of dental elements and limb bone fragments. Rare European hare (*Lepus europaeus*), unidentified bird, and fish remains (a single vertebra from an unknown taxon) were also found.

Overall, the taxonomic list based on the faunal remains discovered during the recent excavations is not as rich as that from the beginning of the research in the area (Dumitrescu *et alii* 1963), but it supports the steady presence of the cave bears, and the ruminants (especially large and middle-sized bovids) as being the most common prey for the carnivores using the cave (either identified in this study, or mentioned in other works, such as the cave hyena described by Dumitrescu *et alii* 1963).

CONCLUSIONS

The large mammal faunal remains found during the latest excavations conducted at the Palaeolithic site of La Adam Cave are very fragmentary, and most of them cannot be taxonomically identified. Palaeoecological reconstructions based on such a poor sample are not relevant, but, even so, the close inspection of a large number of bone fragments offers some taphonomic information on the site. Numerous bone fragments bear signs of chemical corrosion, suggesting they crossed the acidic environment of carnivore digestive tracts (such as known for hyenas), or they were damaged by prolonged exposure to the faint acidic waters percolating the cave sediments, or maybe both processes left their mark on a fair share of bones found both inside and outside the cave. Carnivore traces, in the form of bite-marks left on bones, are a good indicator that carnivores were an important bone accumulator at the site. Cave bears that inhabited the cave for long time intervals during the Late Pleistocene also contributed with a high number of bones, left behind by individuals who could not make it through hibernation or other unfavourable times. Anthropic activity at the site was not as important – only a few bones bear marks left by human activity, which adds to an already reported low number of lithic artefacts.

ACKNOWLEDGMENTS

This work was supported by two grants of the Romanian Ministry of Education and Research, CNCS – UEFISCDI: project number PN-III-P4-ID-PCE-2020-2282, within PNCDI III (Ș.V.), and project PATCULT#RO (PN-III-P1-1.2-PCCDI-2017-0686, V.D.), and also by EEA grant 126/2018, contract no. 3/2019 - KARSTHIVES2 (Ș.V.).

The authors thank everyone involved in the 2006-2009 excavations, and most of all to Dr Roxana Dobrescu (Bucharest) for the access to the faunal material from La Adam, and for the relevant literature suggestions, as well as the additional information on the site. The editors and reviewers are also thanked for their careful reading of our manuscript and thoughtful comments – all their input helped improve the paper and it is highly appreciated.

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