INTERNATIONAL ERASMUS MUNDUS MASTER IN QUATERNARY AND PREHISTORY

Taphonomic approach to the faunal assemblage of the Lower Paleolithic site of Visogliano (MIS 13 and 10), Trieste, Italy: Presence of anthropic modification?

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“Posso ouvir o vento passar
Assistir à onda bater
Mas o estrago que faz
A vida é curta pra ver

Eu pensei
Que quando eu morrer
Vou acordar para o tempo
E para o tempo parar

Um século, um mês
Três vidas e mais
Um passo pra trás
Por que será?
Vou pensar”

O vento, Rodrigo Amarante

To the memory of my loved ones

Vó Zinha

Nonno

Tio Chico

Tia Terezinha

Tio Almir

ABSTRACT

Taphonomy is a tool widely used by zooarchaeologists to understand the strategies of prehistoric human subsistence. In assemblages where the preservation of the bone surface is poor, it is necessary to apply different types of methods and analysis to better understand and interpret data. The archaeological site of Visogliano has one of these assemblages. The site is a Middle Pleistocene shelter located in Trieste Karst, north-eastern Italy, that can be dated to the 350–500 kyr time span. Human remains, lithic industry and an extensive faunal assemblage have been excavated in the past. This is the first taphonomic approach carried out on faunal remains from this archaeological site. From an exploratory work, a selection of three layers was studied and analysis were carried out. Our results demonstrate that the bone surface is greatly altered, mostly due to concretions and the action of water. And finally, corroborates positively in the hypothesis of an involvement between hominins and faunal remains, through possible butchery marks.

KEY WORDS: Taphonomy; Anthropic Modification; Visogliano Shelter; Faunal Remains.

SINTESI

La tafonomia è uno strumento ampiamente utilizzato dagli zooarcheologi per comprendere le strategie preistoriche di sussistenza umana. Nei reperti in cui la conservazione della superficie ossea è scarsa, è necessario disporre di diversi tipi di metodi e analisi per comprendere e interpretare meglio i dati. Il sito archeologico di Visogliano possiede uno di questi assemblaggi. Il sito è un riparo del Pleistocene medio situato nel Carso triestino, nell'Italia nord-orientale, databile nell'arco temporale di 350–500 kyr. Resti umani, industria litica e un vasto assemblaggio faunistico sono stati scavati in passato. Si tratta del primo approccio tafonomico effettuato su resti faunistici di questo sito archeologico. Da un lavoro esplorativo, è stata studiata una selezione di tre strati e **vi** sono state effettuate analisi. I nostri risultati dimostrano che la superficie ossea è molto alterata, principalmente a causa delle concrezioni e dell'azione dell'acqua. E infine, avvalora positivamente l'ipotesi di un coinvolgimento tra ominidi e resti faunistici, attraverso possibili segni di macellazione.

PAROLE CHIAVE: Tafonomia; Modificazione Antropica; Riparo di Visogliano; Resti faunistici.

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How the COVID-19 pandemic affected the present work - Due to the pandemic and all the restrictions that accompanied it, such as the limitation of the use of laboratories at the University of Ferrara by decree-law, the analyzes planned for the development of this thesis underwent changes, which caused a diminution in the number of remains analyzed. However, it is believed that even with the reduction of the study expansion, results could be obtained in a positive way. And future research will need to be developed, always seeking a more complete approach. This, in fact, was expected to happen with or without a pandemic.

CHAPTER 1. INTRODUCTION

Throughout the trajectory of studies aimed at recognizing and understanding the subsistence strategies practiced during the Middle Pleistocene by hominins in Europe, aspects related to hunting activities were underestimated, giving the main role to the method of meat procurement based on scavenging (Binford, 1981; Binford, 1984). This scenario has changed in the last two decades of research, where important zooarchaeological and taphonomic investigations, through more expressive evidence, suggest that hunting played an important role, thus indicating a possible primary access to carcasses (Bellai, 1998; Marean, 1998; Roberts & Parfitt, 1998; Villa *et al.*, 2005; Thun-Hohenstein *et al.*, 2009; Domínguez-Rodrigo *et al*., 2015; Pineda *et al*., 2020).

Studies demonstrate that more than half a million years ago in Europe there was a substantial settlement with the continued presence of small groups of hominids that hunted large animals. According to Roebroeks (2001), during this period the increase in forms of social cooperation in wider areas, the exchange of information between individuals became "a standard ingredient of the behavioral repertoire of these first Europeans". Evidence tends to show different stages of food exploitation of animals involving slaughter activities, bone disarticulation and acquisition of meat and bone marrow (butchering process), a specialized hunting with selection of parts of certain animals, activities that require a certain degree of knowledge and organization of practitioners (Bellai, 1998; Thun-Hohenstein *et al.*, 2009; Pineda *et al.*, 2020).

Regarding these studies, some setbacks hinder the analysis and interpretation of faunal assemblages, such as the taphonomic history of the deposits, the equifinality of the agents and the conservation condition of the cortical surface of bones in most archaeological sites dated to this period (Domínguez-Rodrigo *et al.*, 2015).

Taphonomic history - which encompasses its important agents - is studied by taphonomy. Taphonomy is a tool widely used by zooarchaeologists to understand the strategies of prehistoric human subsistence. Has its origins back to the 40's, when paleontologist A.I. Efremov defined the terms: the study of the transition of animal remains, plant remains added later, from the biosphere into the lithosphere (Efremov, 1940; Lyman, 1994; Lyman, 2010).

Throughout the development of archaeological research, bone surface modifications (BSM's) have been gaining more and more attention and consequently greater analytical standardization, in order to facilitate their recognition and their origins, especially due to their high subjectivity regarding its perception and interpretation by researchers (Fisher, 1995; Domínguez-Rodrigo *et al.*, 2017). The BSM's are extremely important evidence, considering that they can contribute to knowledge in different areas of archaeological research, more precisely when dealing with this thesis, for zooarchaeological research.

When dealing with anthropogenic modifications, this study can also contribute to the search to elucidate questions about hominins behavior, such as subsistence patterns and its adaptations, economic and social patterns; and the relationship in the formation of the archaeological record itself together with non-human taphonomic processes (Fisher, 1995).

According to Fisher (1995), analyzes carried out in an "isolated" way are important tools, but they may be insufficient when trying to reconstruct and understand processes of accumulation and formation of bone assemblages, such as analyzes of skeletal parts frequencies and age profiles, and is exactly here where the BSM's help to differentiate and assess the role, whether of carnivores or hominids, or even the interaction between the two. These marks become the most concrete evidence that there really was an involvement between hominins and faunal remains. In assemblages where the preservation of the bone surface is poor, it is more than necessary to have different types of methods and analyzes as a basis that can jointly provide a greater and more accurate level of information.

Nevertheless, as researchers in the area are aware, the conditions in which archaeological sites are found, depending on their context, are not the most favorable, especially the degree of preservation of cortical surfaces, which unfortunately makes it even more complicated the analysis process, as is the case of the Lower Paleolithic site of Visogliano addressed in this thesis.

The Visogliano shelter is a Middle Pleistocene site located in Trieste Karst, north-eastern Italy that can be dated to the 350–500 kyr time span (MIS 13 and 10) (Falguères *et al.*, 2008). Human remains, lithic industry and an extensive fauna assemblage have been excavated in a 12 meters sequence at the site. These remains were found in two areas of a karstic doline denominated Shelter A and Breccia B (Cattani *et al.*, 1991; Tozzi, 1994; Falguères *et al.*, 2008).

Recognizing the aforementioned modifications is not a simple task and requires great caution and a series of parameters to be followed, especially when dealing with anthropogenic alterations. The Visogliano archaeological site has a taphonomic history rather complicated to investigate. In the present work, two layers containing fauna bones associated with lithic tools belonging to Loci Shelter A are the focus of the study. What influenced the choice of these two layers will be discussed later in **Chapter 3.** Materials and Methods. A taphonomic and zooarchaeological study was carried out on the faunal bones, with the aim of contributing data to the understanding of the past human behavior of the region.

1.1 The use of taphonomy as a tool for zooarchaeological interpretations

Archaeological deposits can undergo numerous changes over time, the study that investigates the forces that affected these deposits is called Taphonomy. As stated earlier, was defined in paleontology by Efremov (1940) to describe studying animal remains to elucidate their circumstances of deposition and to better define the agencies that modified them before deposition. The term comes from the greek words *taphos* for burial and *nomos* for laws. It can be divided into two distinct stages which involve pre-burial and biological processes and postburial geological and chemical processes (biostratinomic and diagenetic, respectively) (Reitz & Wing, 2018; Lyman, 2010; Efremov, 1940; Lawrence, 1979).

In a paleontological perspective, human modifications in animal remains, and the human actions that influence their burial, are just one more set of forces that affect biotic materials. From the archaeological point of view, taphonomic analyzes are essential in the task of distinguishing the traits of human action from those of other animals or natural processes that can affect animal remains (Lyman, 1987; Gifford-Gonzalez, 2018).

Taphonomy had its beginnings in archeology through researchers who sought to discern the effects of hominin in Plio-Pleistocene fossil bones through the literature on vertebrate taphonomy (Behrensmeyer & Kidwell, 1984). The concept of Taphonomy was adopted by zooarchaeologists and became fundamental for the development of zooarchaeological research, as it is used to detect and analyze human behavior traces in excavated faunal remains, obtain information about human decision-making processes, the development of deposit itself, together with past environmental conditions (Lyman, 2010; Reitz & Wing, 2018). However, its scope is relative and limited to the level of preservation that a given archaeological sample presents.

Frequently, problems related to a poor preservation of archaeological remains make interpretations impossible to perform. The integration of different methodological approaches inside and outside the scope of zooarchaeology can provide a more viable and accurate study of this evidence, together with studies of other excavated components, vegetation, and stratigraphy (Reitz & Wing, 2018). Nevertheless, it is important to emphasize that the preservation status of the material is not the only favorable factor for the occurrence of these problems, but also the choices and approaches made by researchers.

1.2 Contemporaneous sites

In Western Europe, some sites provide important data about hominins, their behaviors, and the environment in which they lived during the Middle Pleistocene. Although the archaeological remains are sometimes scarce or poorly preserved, through a range of studies and interdisciplinary analysis it is possible to slowly compose with small pieces, what can be considered a big puzzle.

In a Western European panorama, Visogliano it is contemporaneous with sites such as Fontana Ranuccio (Naldini *et al*., 2009) also located in Italy, and Arago cave (Moigne *et al*., 2006), located in France.

Visogliano shares some similarities with Isernia La Pineta, one of the oldest archaeological sites in Western Europe, represented by part of the lithic industry (limestone specimens) (Peretto, 1994); As far as its fauna is concerned, chronological calibrations include Visogliano sequence between Isernia and Erhingsdorf. However, Isernia microfauna demonstrate to be older than that of Visogliano (Peretto, 1996; Abbazzi *et al.*, 1998).

The early Middle Pleistocene open-air site (MIS 15) is located in the southern Italian Peninsula. Dating 40Ar/39Ar measurements from the layer in which an isolated human deciduous incisor was recovered suggest a chronology around 583–561 ka (Peretto *et al*., 2015). Analyzes performed indicate a primary access to the processing of the carcasses of hominins (verified through anthropic breakage and some cut-marks, mainly in bison bones) and carnivores, however evidence of anthropic activities is difficult to access and interpret due to possible processes of alteration of the bone surface (Peretto *et al.*, 2015; Pineda *et al*., 2020).

Caune de l'Arago and Visogliano have similar radiometric data, and both have the presence of human remains. The deeper and older layers of Visogliano are contemporaneous with the mean stratigraphic complex of Arago according to the faunal assemblage (Moigne *et al*., 2006; Falguères *et al.*, 2008). The Middle Pleistocene site of the Caune de l’Arago is a large karstic cave located in Tautavel, southern France. Its deposit is about 15m thick and cover a period from 690,000 to 100,000 ka (de Lumley *et al.*, 1984). Studying both in the scope of zooarchaeology and taphonomy, evidence points to the involvement of both humans and carnivores in the accumulation of carcasses in the cave. In some assemblage, the action of carnivores is more evident, such as gnawing marks and the presence of some types of bones in articulation, and in others a greater human action, with butchering marks and the relation of bones from fractured limbs to their marrow and mineral density. Some levels are constituted by a greater presence of the action of carnivores and others have a greater anthropic presence (Rivals *et al.*, 2006).

The Middle Pleistocene site of Fontana Ranuccio, located in Anagni, Central Italy, provides an extensive fauna assemblage, human remains, lithic tools, bone tools (biface made from a long bone of *Elephas*) and wooden remains. The fossiliferous layer has been dated to about 407 ka through 40Ar/39Ar corresponding to the temperate MIS 11. (Segre & Ascenzi, 1984; Pereira *et al.*, 2018;

Grimaldi *et al.*, 2020; Conti *et al.*, 2021). From the analysis made of the entire lithic sassemblage belonging to the site, researchers discard the hypothesis that retouched tools were a result of post-depositional mechanical damage and being associated with large mammal bones and bone tools, support an interaction between humans and animals (Grimaldi *et al.*, 2020).

In Northern Europe Visogliano is contemporaneous to the Acheulean Boxgrove site (UK). The quarry site at Boxgrove is located in the county of West Sussex in southern England (date range of between 524 and 420 ka). The site has a faunal assemblage with an important sample of human-modified bones. Its unusual sedimentary condition enabled the preservation of episodes of activity representing the processing of carcasses (cut-marks, marrow bone breakage and bone flakes) that can be associated with lithic tools. The possibility of refitting of this material points out that minimal disturbance occurred before the burial. Evidence of gnawing overlying cut-marks suggests that hominins had very early access to the carcasses. Nevertheless, a definitive recognition between hunting or confrontational scavenging is not yet possible (Roberts & Parfitt, 1998).

1.3 Problematic and hypotheses

Understanding how an archaeological deposit originated, and its accumulator - or accumulators - is a complex task that, within a general panorama, has its difficulty increased in proportion to its antiquity. According to Lyman (1987, p. 106), “A taphonomic history results in a fossil assemblage which may poorly reflect the quantitative properties of the biotic community from which the fossils derived. Taphonomic processes sometimes mimic and other times obfuscate their respective effects, thereby rendering the writing of taphonomic histories difficult”

Inferring subsistence strategies that date back to such ancient times as the Lower Paleolithic is by far an easy assignment; Identifying, analyzing, and interpreting the anthropogenic modifications present in bone surfaces is a major challenge, as these processes mentioned above modify or even obliterate fundamental traces that can provide a certain understanding of hominins way of life.

In the case of the Visogliano deposits, an archaic lithic industry, human remains, and fauna assemblage were found within the same layer. This event could generate good expectations in finding traces of the interaction between hominids with fauna.

The sample that will be discussed here is included in a thick part of the stratigraphy that is characterized by nonconformities arising from erosive events and changes in the depositional style (Falguères *et al*., 2008). Based on analyzes carried out on the selected layers, the following questions will be addressed:

- What is the origin of the accumulation of the faunal assemblage?

- Did humans participate in the accumulation of the deposit? If this is the case, what is their impact?
- What is the impact of taphonomic alterations on the identification of anthropogenic marks?

CHAPTER 2. THE VISOGLIANO ARCHAEOLOGICAL SITE

The Visogliano archaeological site was discovered in 1974 by a former collaborator of the Department of Sciences of the University of Ferrara and Department of Archaeological Science of the University of Pisa, Mr. Alvaro Marcucci. Bone fragments were discovered during agricultural excavations. From 1975 onwards, Professors Giorgio Bartolomei, Carlo Peretto and Benedetto Sala began surveys that lasted until 1976, where the site's antiquity was confirmed through lithic and faunal remains. Then, studies were carried out on palynology, micromammals, lithics and paleopedology, all under the coordination of the University of Ferrara and University of Pisa (Bartolomei *et al*., 1977; Bartolomei & Tozzi, 1978; Patrizi, 2011).

The Department of Earth Sciences of the University of Ferrara performed the first interventions in Visogliano during 1975. From 1983 onwards, excavations became the responsibility of the University of Pisa and in 1984 the excavations of Loci Breccia B started. The last excavation carried out on the site took place in 2004, until then, the bedrock has not been reached yet (Patrizi, 2011).

2.1 Geographical setting

The Visogliano shelter is located in the Trieste Karst, in the municipality of Duino-Aurisina, Trieste, northern Italy (Fig. 2.1). It is situated about 100 m above sea level on the side of a small doline. The karst is a limestone rocky plateau that extends in the north-east of Italy, from the foothills of the Julian Alps to the Adriatic Sea, it crosses western Slovenia, up to the Dinaric Alps massif, in the extreme northwest of Croatia. It is a relatively old karst, which has been evolving for about 10 million years. Cavities maintain rare primary morphologies due to changes in the baseline level and adaptations to tectonic movements (Cattani *et al*., 1991; Cucchi *et al*., 2001; Patrizi, 2011).

Visogliano is located in a very interesting territory considering that, as it is a point that connects eastern Europe and the Italian peninsula, it allows for an exchange of various species, generating a great biodiversity in the territory. The formation of fossil deposits in the area can be related to the local karst phenomenon that allows the accumulation of sediments since remote times, including the Middle and Upper Pleistocene (Falguères *et al*., 2008; Patrizi, 2011).

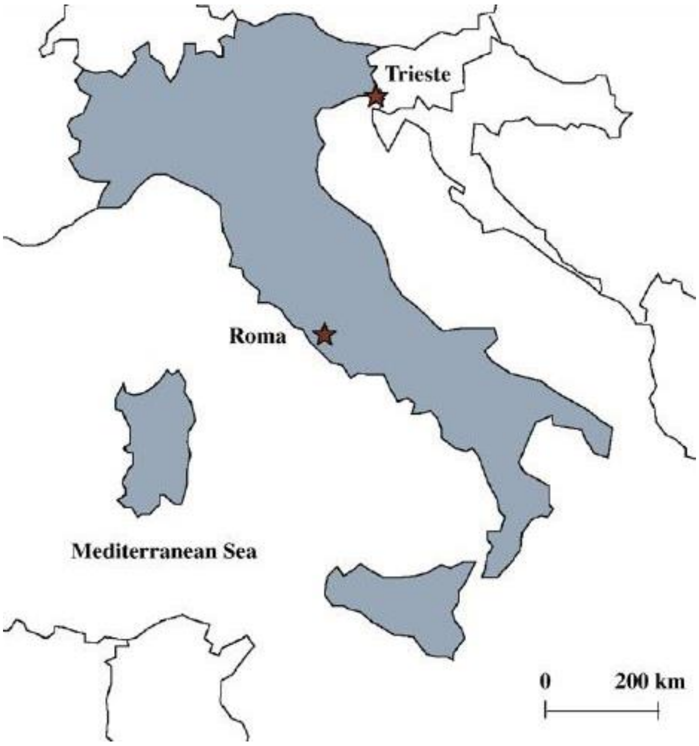

Figure 1.2. Location of the Visogliano site. Map in: Falguères *et al.*, 2008.

2.2 Site stratigraphy

Three stratigraphic units can be recognized (Fig. 2.2), from the oldest to the most recent: thick stalagmitic concretion, indicated as "Onyx"; A strongly cemented Breccia (Locus B) and finally the shelter (Locus A), separated from Locus B by a deep erosion, filled with red soil and collapsed rocks.

In Locus A and B were found human remains, lithic, large mammals and small mammals.

2.2.1 "Onyx" and Locus B: Breccia

The deposit named "Onyx" was discovered on the southern edge of the doline during past mining activities. It is a stalagmitic deposit about one meter thick, with calcite crystals and with large presence of iron and manganese hydroxyls. This thick speleothem corresponds to the first known karstic processes of Pleistocene age within the area (Cattani *et al.*, 1991; Boschian *et al.*, 2002; Falguères *et al.*, 2008).

Locus B is located near the "onyx", and it lies unevenly over it. It is about 3 meters thick, characterized by a discontinuous, heavily cemented layering, sloping towards the interior of the cavity. It consists of layers of breccia with smaller elements contained in an abundant fine matrix. It is characterized by a reddish color (Munsell - HUE 5 YR). The hyaline calcite coating can be observed in the voids and fissures present in this layer. Based on geological, fauna and pollen data, a deposition in humid, non-glacial conditions is suggested (Cattani *et al.*, 1991; Falguères *et al*., 2008).

According to Falguères *et al.* (2008), a direct stratigraphic correlation between Locus A and Locus B is not possible due to an erosion surface that is filled by Upper Pleistocene red soils and calcareous blocks. However, a provisional correlation has been established: the material found in Locus B (faunal, pollen, lithics and sediments) are similar to those found in the deepest levels of the shelter (layers 41-44), in addition, the layers from the Breccia slope towards the shelter, at an angle compatible with its deeper layers. These sequences mentioned above may be ascribed to a mild climate phase with forest cover (Falguères *et al*., 2008).

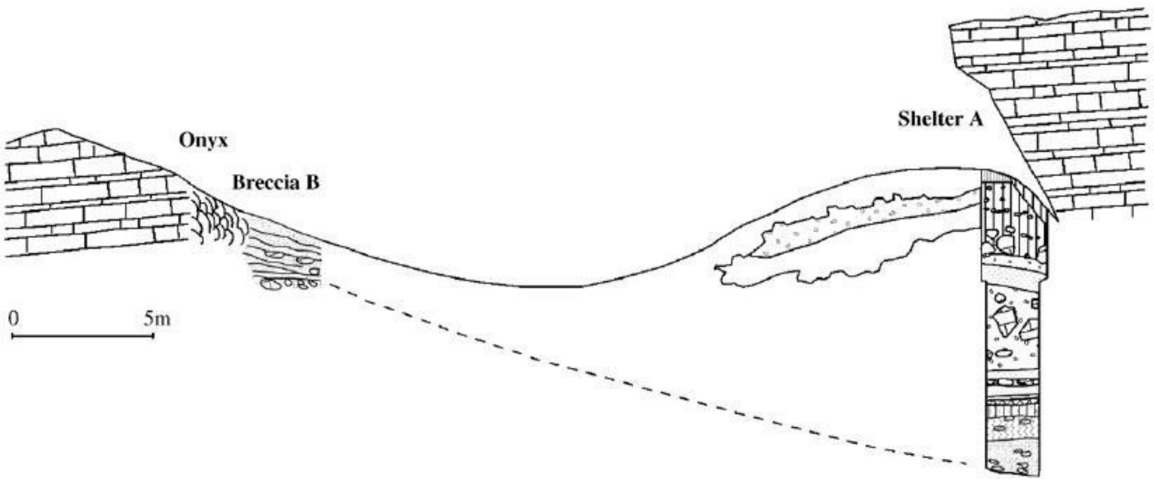

Fig. 2.2. Schematic section of Riparo di Visogliano deposits ("Onyx", Breccia B and Shelter A). In: Abbazzi *et al*., 2000).

2.2.2 Locus A: Rock Shelter

The stratigraphic sequence of the shelter is about 10 meters thick (Fig. 2.3), and the bedrock has not yet been reached. The deeper layers (40 - 46) are characterized by the presence of pollens, sediments, and faunal assemblages, which can be interpreted as a mild climate phase. Among the species found in this sequence are *Dama clactoniana*, *Felis sylvestris*, *Macaca sylvanus*., *Microtus* sp., *Crocidura* sp. Clay loam colluvium is mixed and sometimes alternated with limestone and speleothem rubble, a result of the cave's collapse. Flaked limestone tools and debris make up a large part of the gravel-size fraction of the deposit (Cattani *et al*., 1991; Falguères *et al.*, 2008).

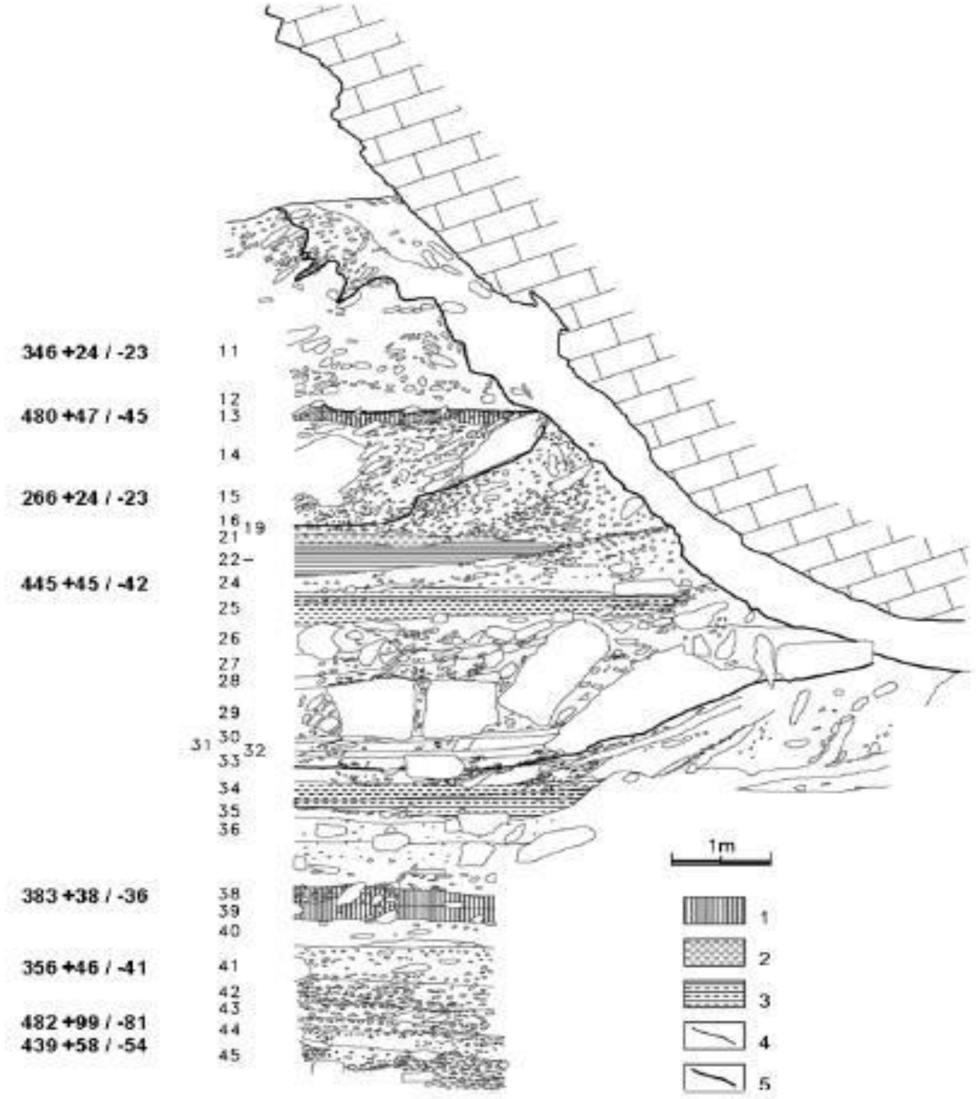

Figure 2.3. Excavation profile of Riparo A: (1) living floors; (2) loess layers; (3) altered loess layers; (4) limits of lithological units and (5) major unconformities/paraconformities. Numbers on the left correspond to the archaeological layers. The ages are presented in kyr. In: Falguères *et al.*, 2008.

The deposits belonging to layers 11 - 39, with seven meters thick, are grouped into three *facies* named: breakdown deposits, consisting of large blocks and/or frost slabs, loessic sediments and colluvia of red soils that were developed outside the cave. The upper part of these deposits is characterized by alternating phases of cold and dry-cold, with events of roof collapse and loess deposition. Discontinuity can be observed in this sequence, arising both from erosive events, as from changes in depositional style and also from a possible human activity (Falguères *et al*., 2008; Patrizi, 2011).

Within the sequence described above, between layers 29 - 30 and 17 - 18 two major breakdown phases can be seen. According to Falguères *et al.* (2008), they are found in non-erosional unconformities/paraconformities and are followed by deposition of frost slabs in layers 26 - 28 and 14 - 16, followed by loess in layers 25 and 11 - 12. Layer 13 of this sequence consists of a pebble pavement lying on a horizontal surface, which can be characterized as a living floor. The nature of this surface is uncertain, whether it was formed exclusively by a natural erosion process or whether it may have been remodeled by humans requiring a flat living surface (Peretto *et al*., 2004; Falguerès *et al.*, 2008). This surface can be characterized by a nonconformity that crosses several layers that dip in the opposite direction of the shelter, starting a horizontal sequence. The pebbles and cobbles of the pavement are rounded due to dissolution processes. Flint, volcanic rock (rhyolite) tools and bone remains are also common in this level (Peretto *et al.*, 2004). Different lithological units show that, at various stages, the sediment was eroded and transported into the rock shelter. One main colluvium can be seen in levels 23-21 and 10 (reddish color) (Falguères *et al.*, 2008; Patrizi, 2011).

2.3 Paleoenvironment

2.3.1 Vegetal Coverage

All deposits from the archaeological site were objects of palynological analysis (Cattani *et al.*, 1991; Abbazzi *et al.*, 2000).

In Locus A, layers 38 - 45 provided a well conserved pollen content, mainly in layer 38, whose presence of concretion could preserve the pollen from oxidative processes. The pollen were attributed to typical environments of woody and very temperate environments, dominated by oak-hornbeam, with pines of mountain and maritime variety, and enriched by thermophile trees of Mediterranean type (*Quercus* of *ilex-coccifera* variety, *Phillirea*, *Pistacia*). To a lesser extent, "surviving species" are also present such as *Cedrus* and *Pterocarya*. The pollen of arboreal species represents about 85% of the total content with temperate-warm species representing about 75% of the total (Cattani *et al*., 1991; Abbazzi *et al.*, 2000).

Locus B presents a palaeobotanical data similar to the deeper levels of Locus A, consisting predominantly of woods, as is the oak-hornbeam association. The percentage of arboreal rate is between 62%–75% with a maximum of 78·7% at the top of the sequence. Coniferae, such as mountain pine trees and firs are abundant in the medium-lower breccia sequence. The results of palynological study highlight a steppe environment in the upper part of the deposit through the increase of temperate broadleaves, especially eastern-type hornbeam, hazel tree, lime tree and grasses. The breccia's roofs are characterized by floristic content similar to that present in layer 38 of the rock shelter (Cattani *et al*., 1991; Abbazzi *et al.*, 2000).

Only 9 pollen spectra were obtained in this sequence, which is insufficient to effectively reconstruct the climatic and environmental changes. However, a change from temperate and damp conditions to a typically Mediterranean environment can be observed (Cattani *et al.*, 1994; Abbazzi *et al.*, 2000).

2.3.2 Small mammals

Studies carried out on micromammals provide a panorama of a continental and steppe environment, marked by the presence of *Dolomys bogdanovi* and by *Microtus* gruppo *arvalis* - *agrestis* and by the low frequency of tree species. More temperate and Mediterranean conditions of Breccia arise due to the presence of *Pitymys*, *Crocidura*, *Arvicola*, *Apodemus* and the absence of *Ochotona* and *Microtus gregalis*. This panorama can correspond to an interstadial phase, with continental climatic conditions. The climatic conditions attributed to the shelter indicate the transition from degraded rocky environments to deep loessic soils (Tozzi, 1994; Cattani *et al*., 1994).

The presence of *Ochotona* and *Microtus gregalis* marks a climatic worsening, in a continental and cold sense, whose maximums correspond to the gelifraction phases of the deposit. It is separated by moments of improvement corresponding to the maximums of *Apodemus* and *Allocricetus*. The antiquity of the deposit, in chronological and stratigraphical terms, can be confirmed by the accentuated diagenesis of the sediments, by the association of *Pliomys episcopalis*, an archaic *Arvicola* (*Arvicola* cfr. *cantiana*), *microtini arcaici* (*Microtus* cfr. *arvalinus* - *agrestoides*), *Dolomys* arcaico, *Allocricetus bursae* and *Sorex runtonensis* (Tozzi, 1994).

2.3.3 Large mammals

The macrofauna is represented by fragmented remains, which made it difficult to carry out a complete and systematic identification (Cattani *et al.*, 1991). Taxa is demonstrated by numeric importance on the faunal spectrum: *Cervus elaphus, Cervus* sp., *Dama clactoniana,* Cervide, *Bos* vel *Bison, Ursus deningeri, Bos primigenius, Stephanorhinus* sp., *Capreolus* sp, *Megaceringe, Equus* sp., *Capreolus capreolus, Stephanorhinus* cf. *hemitoechus, Ungulata, Canis mosbochensis, Vulpes*

vulpes, Sus scrofa, Felis silvestris, Martes sp.*, Ovis antiqua, Meles meles, Mecagerinae, Crocuta crocuta spalaea, Ursus* sp.*, Vulpes* sp.*, Mustela nivalis, Stephanorhinus* cf. *hundsheimensis, Bison* cf. *schoetensacki, Bison* sp.*, Panthera pardus, Lutra lutra,* cf. *Gulo gulo, Stephanorhinus hundsheimensis, Macaca sylvanus, Lynx* sp.*, Lynx cf. spalaea, cf. Panthera leo, Canis* sp.*, Stephanorhinus hemitoechus, Cervus* vel *Megaceroides, Ovis ammon.* (Patrizi, 2011; Rubinato, 2011).

2.4 Human remains

A fragment of a robust human mandible, five teeth and a root and two crown fragments (Cattani *et al.*, 1991; Abbazzi *et al.*, 2000) were found at the Visogliano site, from excavations carried out in different years.

- In breccia B, one tooth (Vis.1), a fragment of a mandible (Vis.2) and two tooth fragments (a fragment of a molar crown and the root of an incisor) were found.
- In the shelter A, four teeth were found between 1992 and 1996, (Vis.6) a first right molar (M1 right) from level 45; (Vis.4) a left first premolar (P1 left) and (Vis.5) left second premolar (P2 left) found in layer 44; (Vis.3) second molar (M2 right) found in layer 42 and another fragment of molar crown was found in layer 12d. The specimens belong to two individuals (Abbazzi *et al*., 2000; Falguères *et al.*, 2008).

Studies carried out on the first remains found (Vis. 1 and Vis. 2) show that the morphological characteristics of the superior premolar (Vis. 1) - which retains its crown and the proximal quarter of the roots - are archaic due to the presence of three roots, cingulate and molar tubercle, characteristics found on *Sinanthropus* 19 and *Pithecanthropus* IV (Cattani *et al.*, 1991). Its dimensions are exceptionally large (distal mesial diameter 10.7 mm and buccolingual diameter 12.3 mm). The mandible fragment (Fig. 2.4), which has old fractures, can be attributed to a different individual, due to the difference in size of the second premolar. It has archaic characters and can be inserted in the range of variability of *Homo erectus*, in an intermediate position between the European Anteneanderthals and the Afro-Asiatic forms (Cattani *et al.*, 1991; Tozzi, 1994).

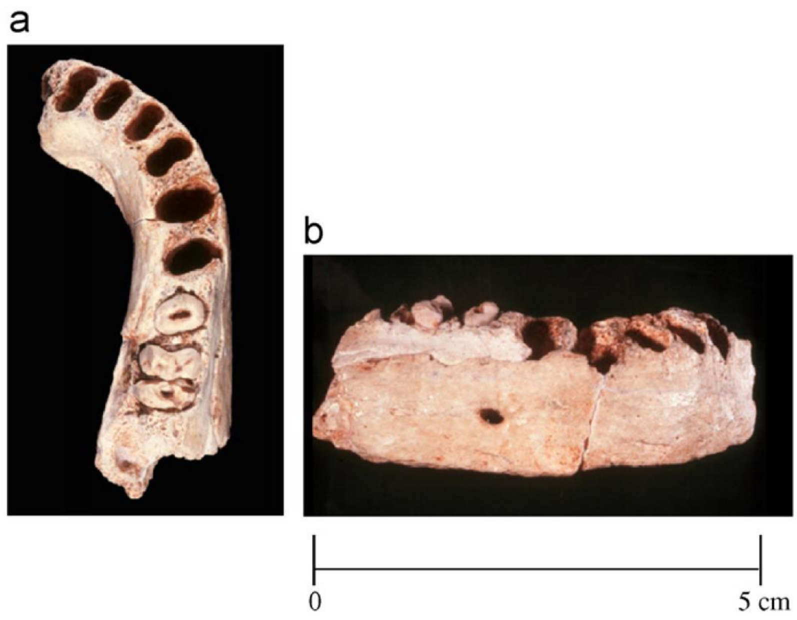

Figure 2.4 View of the Visogliano robust human mandible fragment (Vis.2): (a) occlusal view and (b) right lateral view. In: Falguères *et al*., 2008.

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The 4 teeth recovered from the shelter have been compared from metric and comparative analyzes with the values published in the palaeodontological literature (Abbazzi *et al.*, 2000). The premolars have metrical values that are in the highest range for *Homo erectus* and archaic *H. sapiens* or are in the mean part of the distribution span. Differences can be found between Visogliano teeth and neanderthalians taxon. neanderthalians teeth are almost always smaller, especially in the Eastern type. The four specimens show very archaic shapes and root structures. They can match those of *Homo erectus* remains of Zhou-kou-DianThey, to Carrieres Thomas III and Rabat. As for their volumes, they are among the biggest of the reference sample, very close to those of the most archaic Western and Eastern human groups (Abbazzi *et al*., 2000).

Molars can show more modest values, which according to Abbazzi *et al*., (2000), could be related to the fact that the individual to which they belonged was more gracile or female. In a general way, from an anthropological perspective, the four teeth analyzed can resemble both in their shapes and dimensions the specimens of the oldest eastern and western humans (*Homo erectus* and archaic *Homo sapiens*) of the Middle Pleistocene. A more determinant assignment of the studied specimens to a taxon cannot be made because they are not characterized by peculiar apomorphic features to a well-defined species.

2.4 Lithic Industry

Lithic artifacts were collected in shelter's layers 40 – 46, 37 – 39, 22 – 25, 13, 12d - and in almost all layers of the Breccia - concentrated where large mammal fossils were found (Bartolomei & Tozzi, 1978; Cattani *et al*., 1991; Abbazzi *et al*., 2000).

Layers **13** and **22 - 25** – contains similar lithic industries are made exclusively of flint and rhyolite. They are characterized by absence of points and an abundance of simple straight, convex and transversal side scrapers made with scalar and Quina retouch. The industries of these layers belong to the archaic Tayacian (Tozzi, 1994; Abbazzi *et al.*, 2000). Layers **37 - 39** – this industry differs in the fewer number of carinated pieces, in the increase in denticulates and an accentuated microlithism; Limestone artifacts have rarely been found (Tozzi, 1994; Abbazzi *et al.*, 2000). Layers **40 - 46** – is composed of more than 2000 pieces, with its highest concentration in layer 44. Limestone is the main raw material (87%) followed by flint (12%) and volcanic rock (less than 1%) (Fig. 2.4). Limestone with flaking capability in the form of big dissolution nodules was found near the archaeological site. In layers **43** and **44** there is an increase in the use of limestone. Other raw materials include small riverine pebbles and black flint. The complete unretouched artefacts, measured on a sample from layer 44, show a high number of flat, often wide flakes, and rare flake-like blades or blades. Its dimensions are between 10 and 70 mm. Complete, unretouched flint artefacts are prevalently very small, with a dimensional range between 2–3 cm. Small pieces with bidirectional blows show the use of the bipolar technique on an anvil. 23 retouched flint artefacts from 2–7 cm were collected in these layers, including denticulates and scrapers, thick or very small, with simple or semiabrupt retouch (Cattani *et al*., 1991; Tozzi, 1994; Abbazzi *et al.*, 2000).

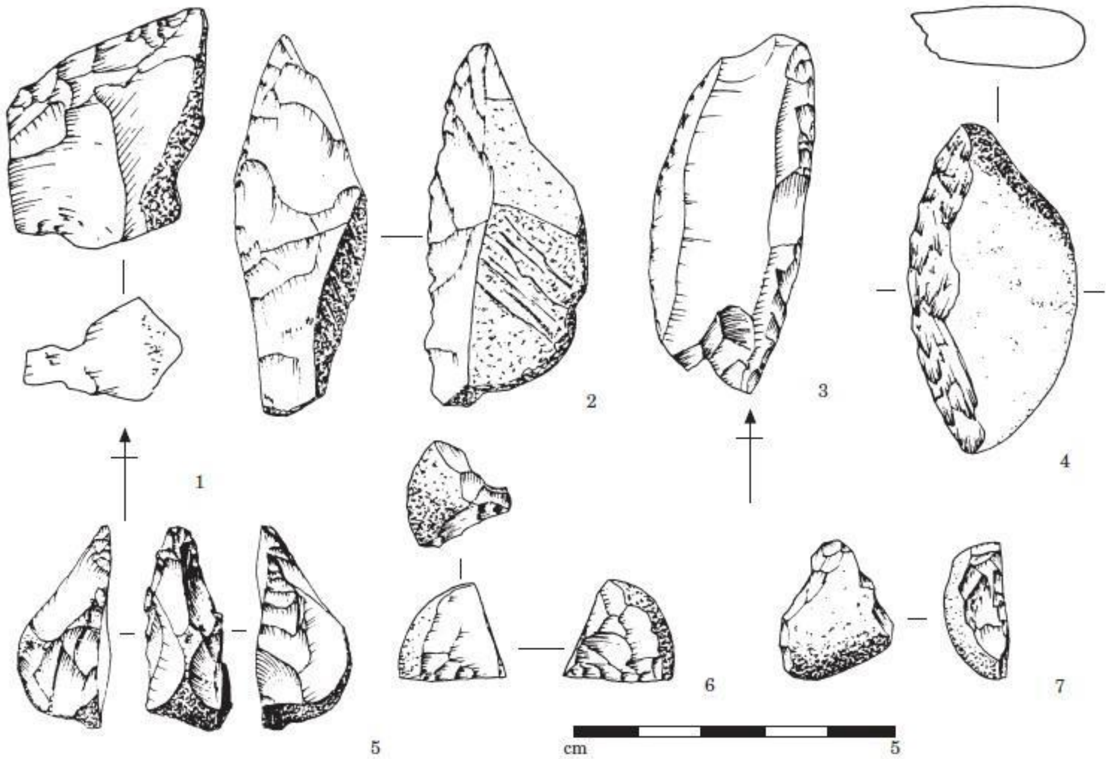


Figure 2.5 Flint artefacts from layers 40-44: (1–3) side scrapers; (5) carinated point; (6) hiper-carinated artefact (bec); (7) nosed scraper. Artefact on volcanic rock (rhyolite): (4) side scraper (micro-chopper). In: Abbazzi *et a*l., 2000.

Rhyolite is only present in layer 43. Only two pieces in volcanic rock are formed by a double-sided scraper and a side scraper on pebble (micro-chopper). Some choppers represent the first stage in the exploitation of the limestone nodules. According to Abbazzi *et al*., (2000), the high percentage of nodules left at the stage of choppers is due to the high availability of limestone. Flint, in turn, due to the low frequency, was heavily chipped. The lower layers belonging to Locus A have a lithic industry that seems to belong to an advanced aspect of the Pebble Culture, characterized by rare handaxes and numerous choppers, discoids and complex tools. These industries, based on cultural and paleoenvironmental records, can be attributed to an ancient period in the Middle Pleistocene.

The lithic industry found at Locus B Breccia includes choppers and tools made from limestone. The techno-typological characteristics of this industry are similar to those from levels 40–46 of the rock shelter, however, a major use of flint can be testified in the Breccia. The counting of lithic artifacts belonging to Breccia were made by adding materials from all levels, due to the small amount found and without very considerable technical-typological differences. The different aspects recognized between the two industries can be explained by a different use of the areas for different activities, or even because they were not directly contemporaneous (Abbazzi *et al.*, 2000). The raw materials used are limestone, flint and volcanic rocks. Limestone is used in Breccia B and in layers 40-41 of the shelter, with the exception of flint. Limestone chips were rarely retouched (28.4% against 68.6% for flint tools). Artifacts made from volcanic rock are very scarce (Tozzi, 1994; Abbazzi *et al*., 2000).

2.5 Datings

The human mandible (Vis.2) collected in the Breccia was dated by non-destructive gamma-ray spectrometry. It was placed on a low background and high-purity germanium detector and measured for 17 days. The method is based on the uranium-series principle. The age is determined from the measurement of $^{230}Th/^{234}U$ and $^{231}Pa/^{235}U$ ratios. An age of 390 kyr was obtained for the mandible fragment using the $^{230}Th/^{234}U$ ratio. However, dating has a large error range (Cattani *et al.*, 1991; Falguères *et a*l., 2008).

Combined U-series and ESR methods were used to date the samples. Teeth collected from layers 11, 13, 15, 24, 38, 41 and 44 were analyzed. The sample includes bison, rhinoceros, horse, deer teeth. The analyzed enamel was taken on the external part of each crown, which were not worn out (Falguères *et al*., 2008).

The US-ESR ages of the layers 41 and 44 range between 482 and 356 kyr (error range 15-20%). The combined age values of the intermediate levels (24 - 39) range between 445 and 383 kyr, suggesting that these layers were deposited contemporarily or right after the lowest layers. Layer 15, through the tooth (Vi9806), indicates a more recent deposition of 266 +24/23 kyr. However, the level 11 and 13 samples give much older ages. Accurate in situ dosimetry of these levels has not yet been performed (Falguères *et al*., 2008). The ages of levels 41 - 44 can be compared to the direct U-series age obtained on the Vis.2 mandible fragment. This correlation suggests that the lowest levels were deposited during the Marine Isotope Stage MIS 11 or, more likely, MIS 13. Human occupation of the Visogliano site can be located within MIS 13 and 10 with sequence deposition occurring within 500 kyr and 350 kyr (Falguères *et al.*, 2008).

CHAPTER 3. MATERIALS AND METHODS

3.1 Materials

The faunal sample analyzed in this work come from the excavations carried out at the Visogliano site between 1976 – 1999. The initial objective of the performed analyzes was to encompass all layers from the site to identify anthropogenic modifications. However, due to the pandemic and the limited access to the laboratories, it was decided to carry out exploratory work in different layers to get a general notion of the state of preservation.

A total of 563 bones and tooth fragments were analyzed from 12 layers (10/210, 212, 13/213, 214, 18, 19/219, 20, 21/221, 22, 23/223, 24/224, 25/225) (Tab. 3.1). A total of **75** fragments were analyzed from layer 10/210, in layer 212 **16**, in layer 13 **24**, in layer 214 **42**, in layer 18 **2**, in layer 19/210 **123**, in layer 20 **16**, in layer 21/221 **38**, in layer 22 **13**, in layer 23/223 **46**, in layer 24/224 **142** and in layer 25/225 **26**. (Fig. 3.1).

Layer	Sublayer	NR	NRt analysed	% NR analysed
10		1	**75**	**13,32**
210		73		
10-15		1		
212		16	**16**	**2,84**
13		2	**24**	**4,26**
213		20		
13a-b		2		
214		42	**42**	**7,46**
18		2	**2**	**0,36**
19		11	**123**	**21,85**
219	219	111		
19+10		1		
20		16	**16**	**2,84**
21		31	**38**	**6,75**
221	221	7		
22		13	**13**	**2,31**
21-23		5	**46**	**8,17**
23		31		
23	223	10		
24		124	**142**	**25,22**
24	224	4		
24	24a	2		
24-25		12		
25		5	**26**	**4,62**
25	225	1		
25	225a	20		
Total			**563**	**100**

Table 3.1 Number of remains per layer.

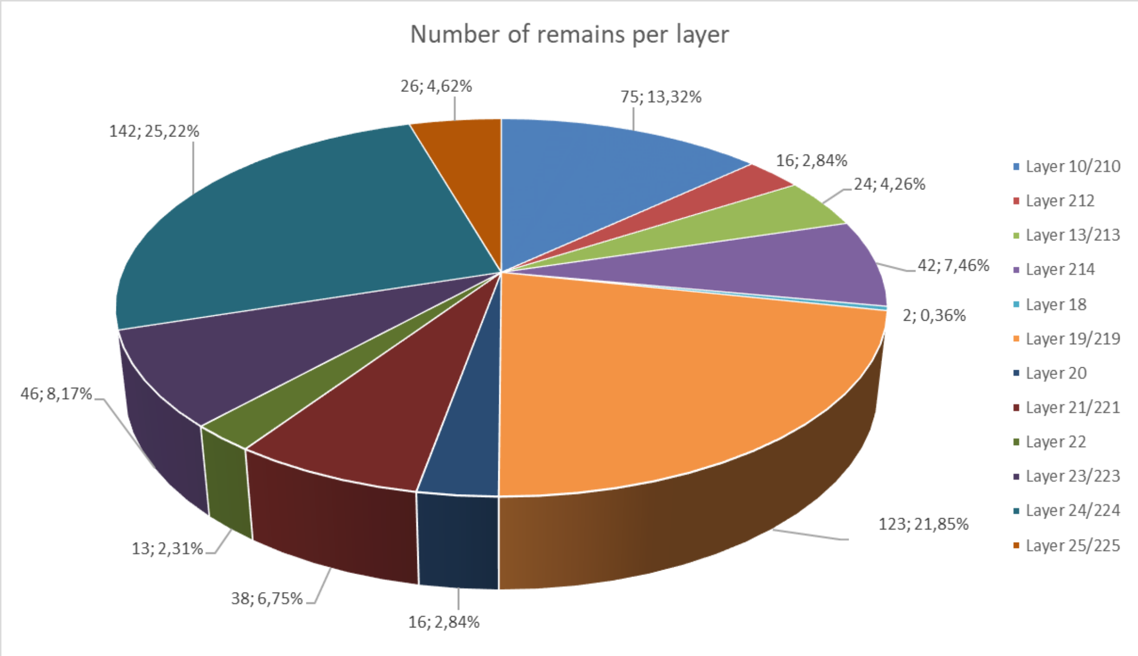


Figure 3.1 Number of remains per layer.

Layers belonging to the middle part of the stratigraphic deposit were the focus of the analyses. In these layers were found lithic and small mammals in addition of the large mammals remains. From the preliminary work, layers 19 and 24 proved to be more promising.

Methods of excavating and the cleaning of fragments damaged the bone surface and caused fractures. For these reasons, a large part of the sample present marks of excavation tools. Glue UHU were used on fragments.

Our sample is composed of identified bones at least at the anatomical level. The faunal assemblage of Visogliano was first studied by paleontologists (Bartolomei *et al*., 1977; Catanni *et al.*, 1989; Bartolomei & Tozzi, 1978; Patrizi, 2011; Rubinato, 2011). The conservation status of the undetermined fragments did not allow, during the elaboration of this thesis, the identification of anthropogenic marks. However, more comprehensive analyzes are expected to be done in the future.

3.2 Methods

3.2.1 Determination

The anatomical and taxonomic determination analyses, including sex determination and age profile of the faunal remains was carried out by paleontologists from the material excavated during 1975–2004 (Patrizi, 2011).

A review of the anatomical and taxonomic determination performed with the comparative anatomy collection of the Laboratory of the University of Ferrara was carried out. As support material, the manuals Pales & Garcia (1981) and Barone (1976) were used. We completed this first identification of the element, when it was possible, recording**:**

Proximal and distal epiphysis portions; proximal, medial and distal diaphysis and an assignment of the presence of foramens was made.

To record the data, was established a detailed database for each specimen, taking in to account**:** element, taxon, skeletal element, lateralization (right/left), bone details, element percentage conserved, size, face, portion, age estimation, sex, circumference and diaphysis length (Villa & Mahieu, 1991) and bone refit.

A review of the profile age of death assignment of the bone remains of taxa *Cervus elaphus* was completed taking into account the degree of fusion of the epiphyses and the degree of wear of teeth in the mandible, root development and considering the time of eruption. Isolated teeth have been analyzed together with the dental series (Brown & Chapman, 1991).

3.2.2 Quantification

The quantitative zooarchaeological units used in this work are (Binford 1984; Grayson 1984).**:**

Number of Identified Specimens anatomically (NISPa)

Number of Identified Specimens taxonomically (NISPt)

Number of Identified Specimens (NISP)

Minimum Number of Elements (MNE)

Minimum Number of Animal Units (MAU)

Minimum Number of Individuals (MNI)

NISP is the total count of specimens that are anatomically or taxonomically identifiable. NISP is an observational unit, which quantifies directly observable objects (Lyman, 1994).

MNI by combination is an estimate of the lowest number of individual animals. In counting specimens, laterality, maturity (adult, sub-adult, senil), size and different portions of the element are taken into account (Binford, 1981; Lyman, 1994;2008).

Minimum Number of Elements (MNE) is an estimate of the lowest number of individual skeletal elements of a taxon (Lyman, 1994).

Minimum Animal Units (MAU) MAU statistic depends upon MNE, is derived from number of each skeletal element. This parameter serves to standardize the observed frequencies of each anatomical unit as a function of its frequency in an animal (Binford, 1977).

3.2.3 Taphonomic analysis

As stated at the beginning of this work, taphonomy as an archaeological tool is used to understand the strategies of prehistoric human subsistence. The term, which over the decades has several adaptations, has been the focus of various debates about its real meaning for the different fields of research (paleontology, archeology and its sub-disciplines) (Lyman, 2010).

Taphonomy, in general, focuses on the postmortem, pre- and post-burial histories of faunal remains (Fig. 3.1). Burial is an intermediate stage to pre- and post-burial stories due to its destructive nature. It is important to keep in mind that taphonomic stories start with the death of a given animal, then its soft tissues can be removed, bones are disarticulated, scattered, buried, exposed, reburied, exposed again, transported (several times in different orders) and reburied again until recovery. Taphonomic processes can affect distribution contexts by causing unrelated elements to become associated and vice versa (Lyman, 1987). However, some major processes may not occur simultaneously, affecting only certain types of bones. According to Lyman (1987), four categories summarize the potential effects of taphonomic processes: disarticulation, scattering or dispersal, fossilization, and mechanical modification.

Postdepositional bone resistance can be determined by certain factors, such as: bone density, shape and size, mediated by the postdepositional chemical and mechanical processes involved (Marean, 1991). Differential conservation ends to favor small bones and teeth. Small bones may be completely destroyed, swallowed and digested by carnivores (Behrensmeyer *et al.*, 1979; Marean, 1991). The most mineralized bones are very vulnerable to acids. Bones with lower density are better able to withstand large and successive variations in temperature (Marean, 1991).

Problems related to a poor preservation can make interpretations impossible to perform. In addition to facing the problems mentioned above, zooarchaeologists still need to deal with dilemmas that involve the recognition of taphonomic agents, which is the basis for the development of interpretations. Different causes can generate very similar, or even identical, effects that need to be deeply analyzed (Gifford-Gonzalez, 2018). Equifinality problems are almost always present, and a good example of this are the "pseudo-cut marks" or trampling marks produced, for example, by the trampling of animals, and which can have characteristics very similar to the cut-marks produced by hominids during the butchery process. In this case, the causal process and the effector that produced such marks are the same, but different authors. Like cutmarks and trample marks, abrasion presents a case of equifinality with the same causal processes and effectors producing similar outcomes regardless of the actor involved (Lyman, 1987; Domínguez-Rodrigo *et al.*, 2017; Gifford-Gonzalez, 2018; Courtenay *et al*., 2018).

Making contemporary observations to elucidate the patterning in evidence from the past is a task that aids in the recognition and interpretation of certain alterations found in archaeological remains. Actualism is the term used to describe this strand of study (Rudwick, 1976; Binford, 1981; Lyman, 1987; Gifford-Gonzalez 2018). It is a methodology of inferring the nature of past events by analogy with observable processes and in action at the present.

All these issues should always be seen as an invitation - or even a summons - for the development and application of more objective approaches, with greater methodological standardization by researchers, considering the great weight of subjectivity that can involve this study (Domínguez-Rodrigo *et al.*, 2017).

The effects caused by taphonomic agents are highly complex and despite being studied over the years, they still need to be better understood and interpreted. There are different ways to classify such agents. In the case of this work, it was decided to approach them as follows: Non biological alteration (climate-edaphic alterations), biological non-human alterations, biological non-human and human alterations, anthropogenic modifications.

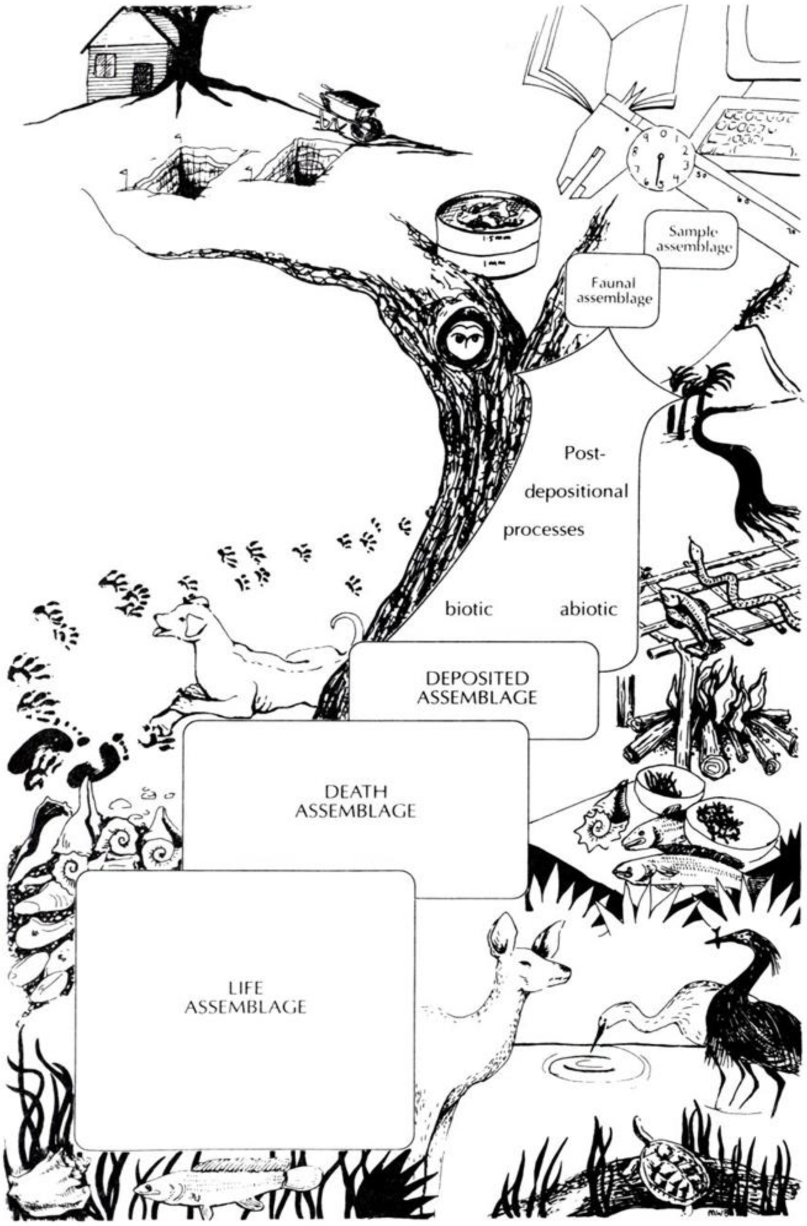


Figure 3.2 Possible pathway from a life assemblage to the archaeological one. In: Reitz & Wing, 2008. Drawn by Molly Wing-Berman.

Legibility - The degree of legibility of each analyzed specimen was recorded. For completely altered surfaces, without visibility of the cortical surface (0), slightly or medially altered surfaces where at least 1 cm² of the cortical surface were visible (1) and surfaces practically unaltered (2).

All bone surfaces were observed with naked eye or with the aid of a 60x portable lens and stereomicroscope (Leica EC3) whenever necessary. The photographs of the skeletal elements were taken with the digital camera Cannon EOS 600 D. Specimens that showed potential cutmarks were analyzed with the aid of scanning electron microscope (SEM).

3.2.3.1 Non biological alteration (climate-edaphic alterations)

Weathering

Bone elements exposed on terrestrial surfaces gradually alterated/modified (cortical surface), creating crackings and desquamation. Crackings start to penetrate bone structures, which makes the element vulnerable to mechanical damage, reducing its integrity. Behrensmeyer (1978) describes this process from a longitudinal actualistic study in Amboseli National Park (Kenya) in order to describe the different stages of bone wear according to their exposure to weathering.

It was concluded that weathering rates are influenced by fluctuations in bone temperature, environmental humidity, and soil acidity and that the presence of a vegetation cover can attenuate temperature and humidity fluctuations.

Six qualitative stages through which bones pass were described and methods for recoding it were created (Behrensmeyer, 1978):

0 Fresh bone, no weathering cracks.
1 Bone shows cracking parallel to the fiber orientation. Articular surfaces can display mosaic cracking.
2 Presence of flaking, usually beginning from cracks. Long, thin flakes are normal on long bones. Flaking continues, becoming extensive and gradually removing all outer bone.
3 Bone surface displays patches of rough, evenly weathered compact bone, showing the underlying fibrous texture of the bone. Weathering does not penetrate more than 1.0–1.5 mm. Break surfaces can be rounded.
4 Bone surface is coarsely fibrous, with a rough texture. Large and small splinters of bone may fall. In this stage weathering penetrates bone cavities. Cracks in bone are open, with rounded/splintered edges.
5 Bone is falling apart in place. Large splinters lie around the bone.

Weathering rates vary according to local conditions, with the weather being a predominant influence. It is possible to identify different stages of weathering in remains belonging to a single animal or assemblage. Weathering rates are slower in conditions of equal humidity and temperature, as is the condition of the case explained here, in cave condition.

To record the degrees of weathering in the present work we excluded stage 0, as the entire faunal sample is archaeological. Criteria such as: the most advanced stage covering an area of more than one cm² was noted; heavily damaged areas were avoided, when possible, more than one observer rated the same bone in order to be more precise.

Wind action

Archaeological materials may be subject to eolian deposition, that is, burial in wind-borne sediments. While eolian sedimentation does not move elements of larger animals, blowing sand can abrade bones to complete destruction (Reitz & Wing, 2008; Gifford-Gonzalez, 2018). Abrasion by windborne particles is known to occur in bones left on the land surface in areas of high and persistent winds. The wind blowing over the organic material will dry and break it, by scouring the surface with windblown sediments, causing the internal structure to be exposed (Shipman, 1981; Reitz & Wings, 2008).

Sediment action

Bone traces can be altered by the surrounding sediments. Acid sediments can cause loss of bone mineral by reducing or even completely dissolving bone elements (Chaplin, 1971). Bones deposited in caves can be broken and scratched by rockfall and can be fractured by earth movement. Impact marks may resemble anthropogenic marks caused by percussion, generating impact bridges. The density of the soil in which a bone is depositing can cause its compaction and fracture. In the analyzes carried out in this study, the presence of this alteration was taken into account, based on a pattern in fractures present in the bones. Unlike fractures of a weathering nature, fractures arising from soil compaction do not follow parallel to the fiber orientation of the bone, and tend to be irregular on the bone surface, the same fracture may follow a longitudinal and transverse direction. Fractures can be conditioned by three factors related to bone deposition: horizontal disposition, fixation at the extremities and the uniform load of sediments (Alcalá & Escorza,1998; Villa & Mahieu, 1991; Gifford-Gonzalez, 2018).

Ice action

In colder climates, the freeze-thaw cycle can result in damage to bones. The alterations caused by this physical agent can include striations, fissures, breakage, and disintegration (White & Folkens, 2005).

The effects of freezing can be independent of the water content of the samples, which can be modern or fossil. Porosity and its nature will control the freeze/thaw effects. The open porosity results in almost no damage, because when the ice front enters, the water is pumped out, the fragment dries and then cools.

Elements of the same nature freeze in the same way, only the speed changes. A long bone can acquire longitudinal or slightly oblique cracks that moisten in the tubercles or in the proximal and distal ends (Guadelli, 2008; Gifford-Gonzalez, 2018).

Water action

Waterborne sediment particles can produce marks similar to airborne particles, but at lower intensities for the same duration of exposure and distance from the propellant source. Sliding abrasion of particles moving in continuous contact with the bone surface produces grooves in the bone. Finer-grained particles remove a minimal amount of bone and leave shallower grooves, while coarser-grained ones leave wider and deeper. Impact and sliding abrasion in water can cause sawed surface and removal of subchrondral bone (Gifford-Gonzalez, 2018).

Water without sedimentary particles flowing over bone at high pressures can remove most bone surface lamellae. As a result of contact with water, mechanical alterations can be observed, such as the rounding of edges (blunt), cracks, exfoliation, and the presence of striations and chemical alterations such as dissolution (Gifford-Gonzalez, 2018).

Flowing water can either transport bones away from their original locales or bury them in place, depending on the physical composition of each bone. Water transport can affect skeletal elements of many sizes and shapes (Voorhies, 1969).

For the alteration attributed to the process of dissolution by water, its presence was registered, and the percentage of the area affected by this alteration in the bone surface was considered: 1 (< 25%), 2 (between 25% and 75%) and 3 (between 75% and 100%).

Concretions

The presence of concretions indicates a circulation of water loaded with calcium carbonate ($CaCO_3$), followed by drying by evaporation or deep infiltration. The presence of this alteration was classified as follows: Stage (0) absent, Stage (1) < 50%, Stage (2) < 90%, and Stage (3) 90% to 100%.

Bone surface coloration

Different colorations were observed on the surfaces and inside the bones of our sample. Concentrations of oxides of manganese are product of the terrestrial erosive processes and it can occur in different environments, including caves. Manganese oxides are the most common coloring agents in caves and can affect bones to varying degrees. Usually, the mineral of which these black-colored coverings in caves are made is birnessite [(Na, Ca, K) Mn7O14$3H2O]. The origin of these coatings is a result of the action of different species of manganese-oxidizing bacteria (Potter & Rossman, 1979; López-Gonzalez *et al.*, 2006). The categories used to classify the area covered by the manganese coatings are: 0 No coating; 1 little affected (<10%); 2 Between 10% and 25%; 3 Between 25% and 50%; 4 Between 50% and 75%; 5 Between 75% and 90% and 6 Between 90% and 100%.

3.2.3.2 Biological non-human alterations

Dendritic Erosion (Root Etching)

Plant roots secrete acids that can dissolve hydroxyapatite from bones, generating irregular networks of shallow grooves with a typical U-shaped section. Root marks may appear lighter than the main bone surface, having the shape of meanders (White & Folkens, 2005; Gifford-Gonzalez, 2018).

Extreme dendritic etching can cover so much of an element in superimposed layers resembling surface corrosion by an extremely acidic matrix. However, even in these cases it is possible to discern some traces of superficial roots on the bone surface (Andrews, 1990).

Carnivore action

Canids and hyenid are the carnivores that most modify skeletal elements in the present (Binford, 1981). The carcass consumption can leave marks on bones. Areas that offer greater nutrient yield and less risk of injury in the oral area are preferred when consumed. The most nutritional skeletal elements are the most consumed. A carnivore may go through part or all the process before deciding to abandon the carcass, depending on prey conditions, levels of competition and the species of the consumer itself and their eating habits (scavenger/hunter) (Haynes, 1980; Blumenschine, 1986; Gifford-Gonzalez, 2018).

Marks left on bones by carnivores can be made by teeth, tongue (polish) or stomach acids (Binford 1981; Haynes 1980).

Carnivore marks can be described in diverse morphological types, overall: 1 tooth pits; are small, triangular or diamond-shaped marks often associated scores, 2 tooth scores; grooves usually present in cortical bone with U-shaped section and no striations, 3 punctures; holes perforated through cortical bone superimposed on spongy tissue, usually oval and circular, 4 flaking of cortical bone; is the result of static loading, causes flake loss from the outside of the bone into the endosteal cavity, 5 furrowing; damage to cancellous bone due to repeated scraping, which produces rows or furrows, 6 scooping out; removal of cancellous bone from the spongey bone within a diaphysis, 7 Smoothing; result of repeated licking and grinding by tongue and teeth, may be confused with another type of abrasion, 8 digested marks: lamellar and cortical bone loss, pitting, rounding, thinning of bone walls;

are a result of stomach acid, can be found in vomit or feces (Binford, 1981; Haynes, 1983; Delany-Rivera *et al.*, 2009; Gifford-Gonzalez, 2018).

Carnivores normally use static loading in the task to get yellow marrow. They gnawing off the epiphysis of the bones, while also consuming red marrow, then they squeeze the bone cylinder into a vise-like grip with their back teeth, which can cause the cylinder to break and thus give access to the interior material (Binford 1981; Binford & Bertram, 1977, Villa & Mahieu, 1991). Because they have heterodont teeth, opposing tooth marks do not have equal shapes or depths (Binford, 1981; Gifford-Gonzalez, 2018).

The traits associated with this alteration were recorded as follows: number of marks, type of marks, location, measurement, type of carnivore, digestion, and intensity of digestion when possible.

Rodent action

Rodents can modify and, in some cases, accumulate bones. Marks produced by rodents can be in different sizes, with deep parallel incisions, symmetrical and with a wide and flat (U-shaped) bottom. Bones most targeted are the mandibles, cranial epiphyses of long bones. Usually appear on bone ends or edges (Hughes, 1961; Maté-González *et al.*, 2019; Gifford-Gonzalez, 2018).

Mechanical and Chemical Effects of Insects

Some invertebrates use bones as food, shelter or even as a place to deposit their eggs, which ends up causing alterations in the bones and horns. As they feed, larvae record long grooves and channels in the bones. Some types of channels can be confused with carnivore tooth scores. Some thermite gnawing expands the lines from a central point, producing star-shaped excavations of the bone surface (Behrensmeyer, 1978; Bader *et al.*, 2009).

Microbial Bioerosion

Microbial effects can reach the bone surface and also cause deep tissue modifications. However, the most likely bioerosion to be seen are channels in the periosteal surfaces of bones rather than tunnels within bone tissue. Bioerosion channels may be similar to tooth scores in carnivores (Domínguez-Rodrigo & Barba, 2006; Blumenschine *et al.*, 2007). Microbial effects on the internal structure of bone are less visible but can affect the survival of archeofauna specimens. Wedl tunnels can be divided into different types: Type 1 most common, arise at the natural surface of a bone or from a break surface. Can be randomly branched networks of tunnels 10–15 microns in diameter.

Type 2 is rarer and smaller, with five-micron diameter (Trueman & Martill, 2002, Gifford-Gonzalez, 2018).

3.2.3.3 Biological non-human and human alterations

Trampling

Trampling marks are important to recognize because they may reflect the depositional history of the site and because they may closely resemble butchering marks and intentional fragmentation (Reitz & Wing, 2018). Trampling can be caused by human or animal passage and can scatter carcasses, leave marks, and break specimens depending on intensity. Marks are characterized by randomly oriented grooves and scratches and superficial. Trampling can also smooth and polish break surfaces bone's edges (Behrensmeyer *et al.*, 1986;1989).

Trampling produce “pseudo-cut marks” with a similar morphology of cut marks: a sharp, angular edge of a stone dragging over a bone surface (Reitz & Wing, 2018; Gifford-Gonzalez, 2018).

To identify these marks some variables are used, such as: trajectory of the groove, presence or absence of a barb, orientation of the mark, shape and symmetry of the groove, shoulder effect and associated shallower striae, presence of flaking on the shoulders of the groove, striae overlapping or running across the main groove, internal microstriations and its trajectory, length of the main groove and associated shallow striae (Blasco *et al.*, 2008; Domínguez-Rodrigo *et al.*, 2009).

3.2.3.4 Anthropogenic modifications

Bones and fire

The color resulting from exposure of bones to fire vary depending on the duration and degree of temperature to which is exposed. it can be heterogeneous or homogeneous. If the bone still has flesh, the acquired coloration is uneven, whereas in bones without soft tissue the coloration becomes more homogeneous (Shipman *et al*., 1984). The exposure of bone elements to fire, in addition to resulting in different colors, also affects their structure, leaving them subject to fragmentation due to loss of elasticity (Shipman *et al.*, 1984; Stiner *et al*., 1995).

The burnt damage register was made from three simplified stages used by Vettese *et al.*, (2017) elaborated from the different color stages defined by Stiner *et al.*, (1995). Stage 1: lightly burnt (brown), Stage 2: carbonized (black) and Stage 3: calcinated (white).

Butchery activities

Knowledge about human bone modifications has expanded from contemporary observations in ethnoarchaeological and experimental settings. SEM microscopy has clarified distinctive signatures of specific effectors made by humans (Gifford-Gonzalez, 2018). Butchery refers to human subdivision of vertebrate bodies into smaller units, so it is not limited to a single act, but to a sequence of activities. The bones of animals that humans consume may show traces of how they were dismembered, and their tissues extracted. The process is guided by some considerations that can include: the anatomy of the animal, the implements for its processing, the weather and time of day, the butchery site's distance from the final destination of the animal products and the use of animal tissue (Lyman, 1987; Gifford-Gonzalez, 2018).

When dealing with this carcass processing, two distinctions are taken into account. Primary butchery (generic term) that involves eviscerating, skinning, and dismembering the carcass and defleshing; it usually happens soon after the animal's death and the secondary butchery that involves dismemberment and defleshing and happens in a different location (Gifford-Gonzalez, 2018).

In general, stone tool edge morphology determines the cross-sectional of the cut marks: unretouched flakes usually leave V-shaped marks and retouched tools leave more U-shaped (or even _/) marks (Walker & Long, 1977; Domínguez -Rodrigo *et al.*, 2009).

According to Binford (1981) and Soulier & Costamagno (2017), carcass processing can be an expression of cultural identity and an important component of the economic and symbolic system. Carcass processing steps can include skinning, disarticulation, defleshing, and tendon-removal.

Skin removal

Circular incision of the skin, longitudinal incision, and detachment are gestures made for skin removal activity. Circular incisions cause deep, transverse, and clustered cutmarks in the medial and lateral portions of the bones. When done on the outside of the leg, longitudinal cutmarks on the lateral face of the metapodials, on pyramidal and the pisiform bones can be observed. oblique gestures with stone tools can generate oblique, isolated and shallow cutmarks.

Defleshing

Defleshing cutmarks can be mostly transverse or oblique, but less often they can be longitudinal. This activity can produce cutmarks in several joint areas.

Disarticulation

Cutmarks produced in the disarticulation activity are characterized by a transverse or oblique and short orientation. In long bones, cutmarks can be seen in both distal and proximal epiphysis.

Tendon extraction

This activity can generate short, transverse-to-oblique, and are often deep cutmarks. Short longitudinal cutmarks can also be seen at the ends of bones. Shipman & Rose (1983) describe cutmarks made by flaked stone tools as: V-shaped or oblique V-shaped cross-sections, but occasionally they can have a U-shaped, little crushing of bone into the groove of the cutmark, presence of multiple striations lies in the groove, presence of "shoulder effects", main groove showing striations diverging from the main cut.

Scrape Marks - Stone tools can produce scrape marks when their edges are dragged across the surface of the bone. This activity cleans soft tissue before cutting tendons or ligaments in joints or during marrow extraction. They can be characterized as: broad and shallow grooves usually over 1cm² or more and present parallel striations in sets (Binford, 1981; Shipman & Rose, 1983). To identify and characterize the marks found in the faunal sample, the following information was recorded according to each specimen: the number of marks, the type of mark, size, orientation, location, type of related activity, relationship between sets of cut marks, dispersal.

Percussion marks

Percussion by humans is dynamic loading via hard percussor, aimed at breaking, and this way having access to the red marrow present in bone epiphyses and yellow marrow from the diaphysis. Percussion results in a series of modifications in the bone surface with differentiated morphological characteristics (Blumenschine & Selvaggio, 1988; Lyman, 1994). Experiments have augmented descriptions of their form diversity and added greater complexity to identifying its mechanical causes. This activity may involve bone on an anvil of stone (or any other material) and striking its upper side with a percussor or striking a skeletal element against a stationary rock anvil. The influence of bone morphology on the distribution of percussion marks is of great importance (Blasco *et al.*, 2014; Vettese *et al.*, 2020).

Percussion Notches

Percussion notches are the most distinctive percussion marks, usually semilunar conchoidal scar along the broken edge of a diaphysis. Several factors can interfere with bone breakage, such as the size of the diaphysis, strength to strength of the hammerstone wielder and the experience of the processor. To break the cylinder, several strokes may be necessary, thus generating consecutive notches (Blasco *et al.*, 2014; Gifford-Gonzalez, 2018; Vettese *et al*., 2020). From experiments it can be verified that casually impacts can create notches on both hammerstone- and anvil-sides of a long bone, or opposing notches (Galán *et al*., 2009).

Percussion Flakes

Small percussion flakes detached from the medullary side of the diaphyseal edge at the impact point can be associated with impact notches. These flakes can demonstrate technical percussion attributes that occur on flakes of knapped fine-grained stone: they exhibit platform at the impact point and a bulb of percussion below it; occasionally exhibit ripple marks and/or hackle marks near bulb or platform; flakes can show stepping at distal ends and the morphology is wider-than-long (Fisher, 1995; Blasco *et al*., 2014; Gifford-Gonzalez, 2018).

Percussion scratches and pits

When a bone in one hit hits an anvil, different marks are created since hammerstones, and anvils can be stones with irregular surfaces or smooth. Anvils can scratch the diaphysis on the side of the anvil. Hammerstone notches can be associated with percussion pits and depressions with microstriations (Turner, 1983; Blumenschine, 1988). These marks can be separated in three types: pits, anvil scratches, pit without microstriations and groove with a V-shape (White, 1992; Galán *et al.*, 2009). Some percussion pits have different shaped marks of 2–30 mm in maximum dimension.

To identify and characterize the marks related to percussion activity present in the sample, the following information was recorded according to each specimen: number of percussion marks, type of percussion marks, relation between percussion marks, location of percussion marks, length, width of the mark and length of negative mark.

For the description of break morphology of the sample Villa & Mahieu (1991) is a reference to describe fracture outline, angle and edge.

CHAPTER 4. RESULTS

4.1 Zooarchaeological analysis

4.1.1 The faunal assemblage

In this chapter the results obtained from the zooarchaeological analyzes carried out on the selected faunal sample will be exposed. From the exploratory work carried out, 563 faunal remains were analyzed, of which 458 are determined and 105 unidentified (NISP = 458, NUSP = 105) (Tab. 4.1). Layers 10/210, 19/219 and 24/224, which are the focus of this work, have the highest values (respectively NISP = 69, NISP = 106 and NISP = 116).

	Layer												**Total**
	10/210	**212**	**13/213**	**214**	**18**	**19/219**	**20**	**21/221**	**22**	**23/223**	**24/224**	**25/225**	
NISP	69	12	19	32	2	106	7	30	6	37	116	22	**458**
NUSP	6	4	5	10		17	9	8	7	9	26	4	**105**
TOTAL	**75**	**16**	**24**	**42**	**2**	**113**	**16**	**38**	**13**	**46**	**142**	**26**	**563**

Table 4.1 Composition of the analyzed assemblage per layer NISP and NUSP.

Of the 12 layers addressed in our work, a total of 10 ungulates, 5 carnivores and 1 lagomorpha taxa were identified. The most numerous ungulates are *Cervus elaphus* (NISP = 399), followed by *Bos* vel *Bison* (NISP = 14) and C*apreolus capreolus* (NISP = 8). The most abundant carnivore taxon is *Ursus deningeri* (NISP = 11), followed by *Meles meles* (NISP = 2) (Tab. 4.2, Fig. 4.1).

Taxon	Layer 10/210	Layer 212	Layer 13/213	Layer 214	Layer 18	Layer 19/219	Layer 20	Layer 21/221	Layer 22	Layer 23/223	Layer 24/224	Layer 25/225	Total
Vulpes vulpes						1							**1**
Ursus deningeri			6	2		1					1	1	**11**
Meles meles			1								1		**2**
Lynx sp.	1												**1**
Carnivora											1		**1**
Total Carnivora	**1**		**7**	**2**		**2**					**3**	**1**	**16**
Lepus corsicanus	1					1							**2**
Total Lagomorpha	**1**					**1**							**2**
Sus scrofa	2												**2**
Capreolus capreolus	1					2					5		**8**
Cervus elaphus	56	12	12	24	2	94	7	28	5	35	105	19	**399**
Dama clactoniana	2							1		1		1	**5**
Megacerinae						1						1	**2**
Bos primigenius								1					**1**
Bos sp.	1			3		1							**5**
Bos vel *Bison*	2			3		5			1	1	2		**14**
Equus sp.	2												**2**
Stephanorinus cf. *hemitoecus*	1										1		**2**
Total Ungulata	**67**	**12**	**12**	**30**	**2**	**103**	**7**	**30**	**6**	**37**	**113**	**21**	**440**
Total Identified	**69**	**12**	**19**	**32**	**2**	**106**	**7**	**30**	**6**	**37**	**116**	**22**	**458**
Ungulate (size 3-4)						3		1			1	1	**6**
Ungulate (size 4-5)				1									**1**
Cervidae (size 3-4)	1	1	2	2		9	6	3	5	8	20		**57**
Cervidae (size 4-5)	1					1		2		1	3		**8**
Size 3 (caprid, small cervid, wolf)		1	1	2		1							**5**
Size 4 (red deer, pig, reindeer, bear)			1	2			1					2	**6**
Size 5 (elk, megaceros, horse, bovid)			1										**1**
Unidentified	4	2		3		3	2	2	2		2	1	**21**
Total Unidentified	**6**	**4**	**5**	**10**		**17**	**9**	**8**	**7**	**9**	**26**	**4**	**105**
TOTAL	**75**	**16**	**24**	**42**	**2**	**123**	**16**	**38**	**13**	**46**	**142**	**26**	**563**

Table 4.2 Composition of the faunal remains selected analyzed per layer.

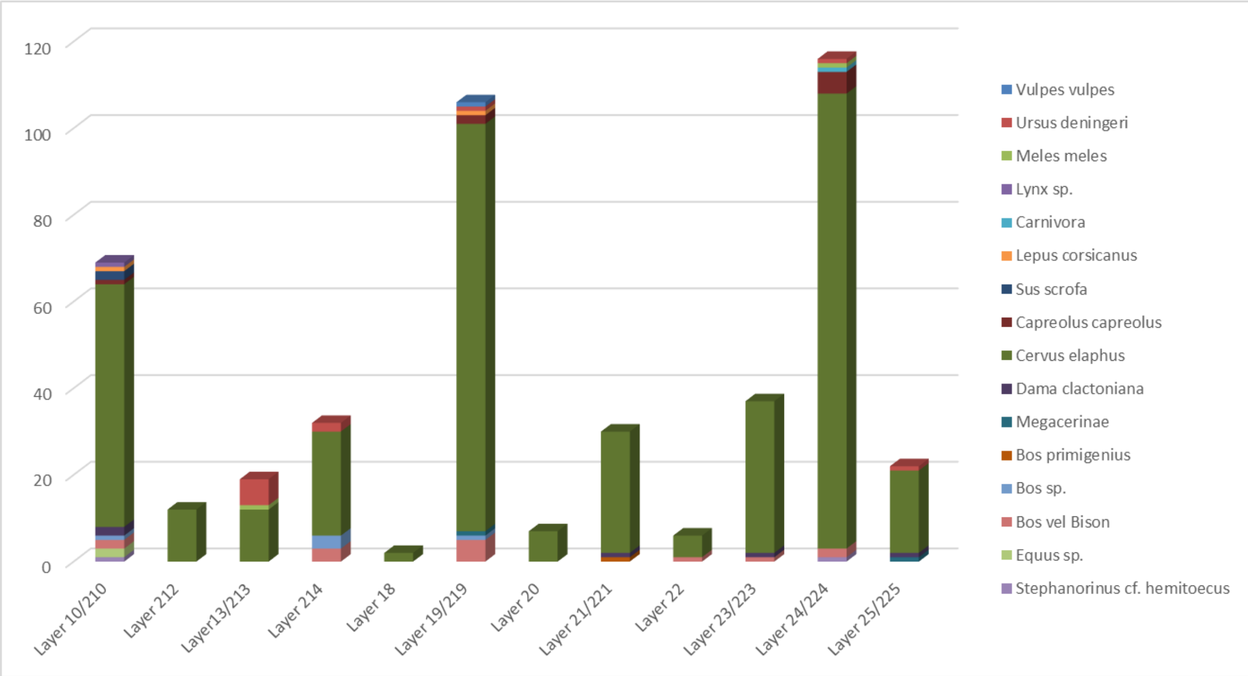


Figure 4.1 Composition of the identified remains per layer.

4.1.2 Taxonomical and anatomical distribution

4.1.1.1 Layer 10/210

From the 75 bone remains analyzed, 69 were identified and 6 unidentified. The percentage of determined fragments is 92% and unidentified is 8% (Tab. 4.3, Fig. 4.2).

Layer10/210	NR	%NR
Identified remains	69	92
Unidentified remains	6	8
TOTAL	**75**	**100**

Table 4.3 Number of identified and unidentified fragments analyzed.

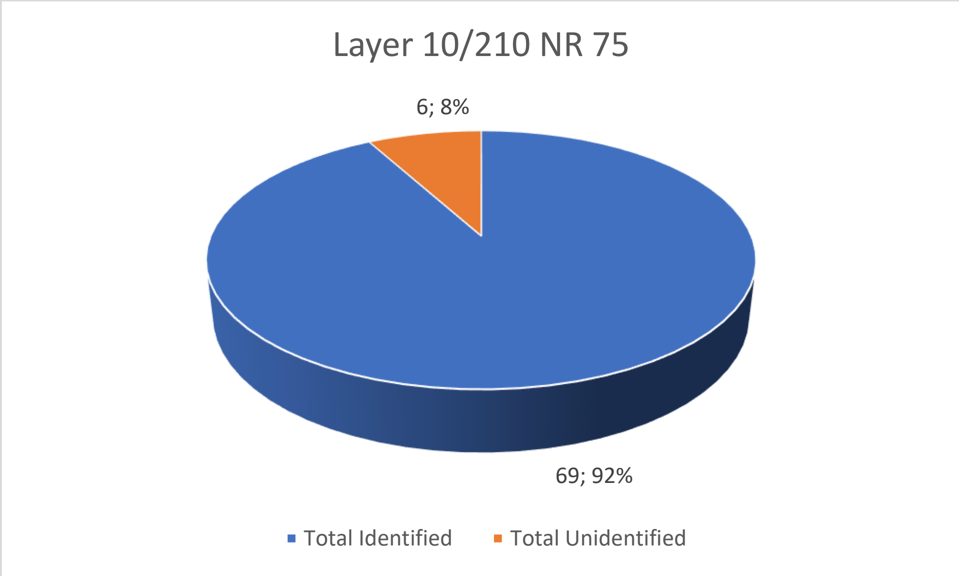


Figure 4.2 Representation of the identified and unidentified remains

In layer 10/210, the following taxa are present: *Vulpes vulpes*, *Ursus deningeri*, *Meles meles*, *Lynx* sp., *Lepus corsicanus*, *Sus scrofa*, *Capreolus capreolus*, *Cervus elaphus*, *Dama clactoniana*, *Bos* sp., *Bos* vel *Bison*, *Equus* sp. and *Stephanorinus* cf. *hemitoecus* (Tab. 4.4, Fig. 4.3). The most recurrent taxon is *Cervus elaphus* (NISP = 56, MNI = 2), followed by *Dama clactoniana* (NISP = 2, MNI = 1), *Sus scrofa* (NISP = 2, MNI = 1), *Bos* vel *Bison* (NISP = 2, MNI = 1), and *Equus* sp. (NISP = 2, MNI = 1). Other taxa rate is represented by NISP = 1 and MNI = 1 (Fig 4.4).

Layer 10/210	**NISP**	**% NISP**	**MNI**	**%MNI**
***Lynx* sp.**	1	1,45	1	9,09
Lepus corsicanus	1	1,45	1	9,09
Sus scrofa	2	2,9	1	9,09
Capreolus capreolus	1	1,45	1	9,09
Cervus elaphus	56	81,15	2	18,19
Dama clactoniana	2	2,9	1	9,09
***Bos* sp.**	1	1,45	1	9,09
Bos* vel *Bison	2	2,9	1	9,09
***Equus* sp.**	2	2,9	1	9,09
Stephanorinus* cf. *hemitoecus	1	1,45	1	9,09
TOTAL	**69**	**100**	**11**	**100**

Table 4.4 Composition of the faunal remains from layer 10/210.

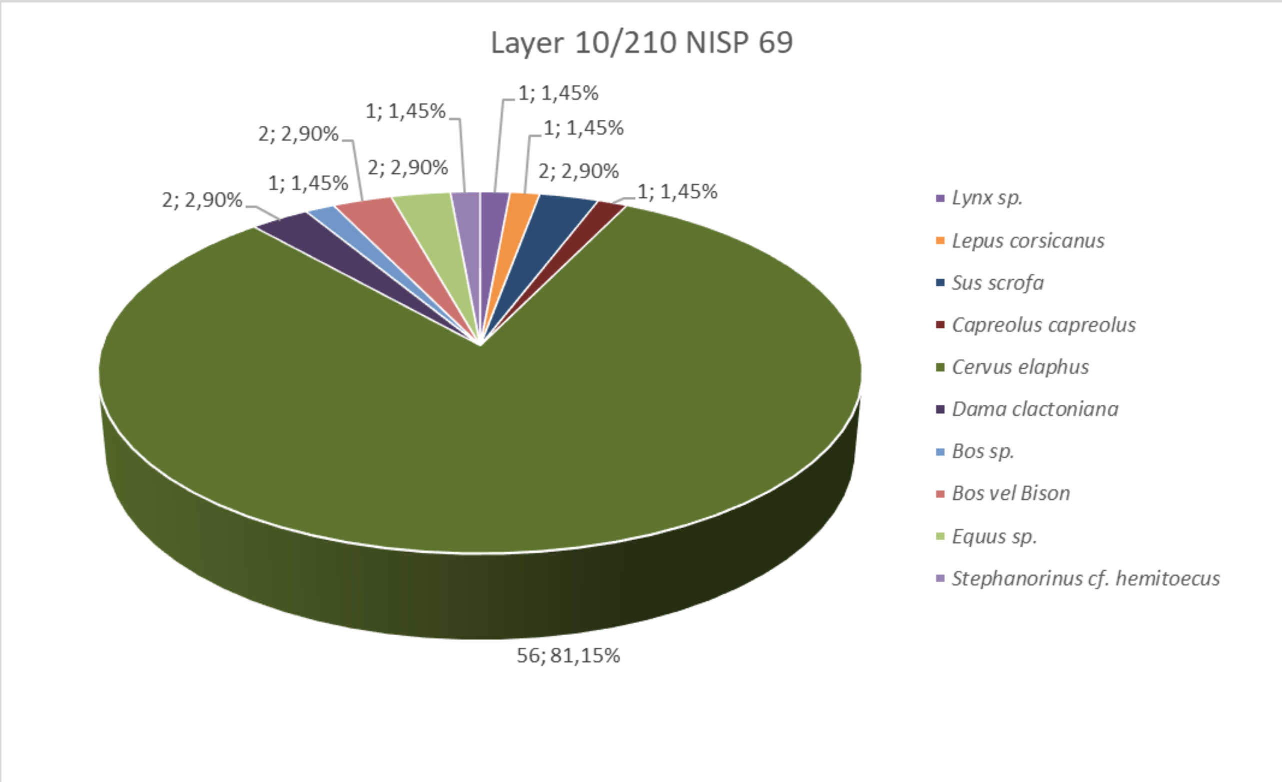


Figure 4.3 Representation of the faunal composition NISP.

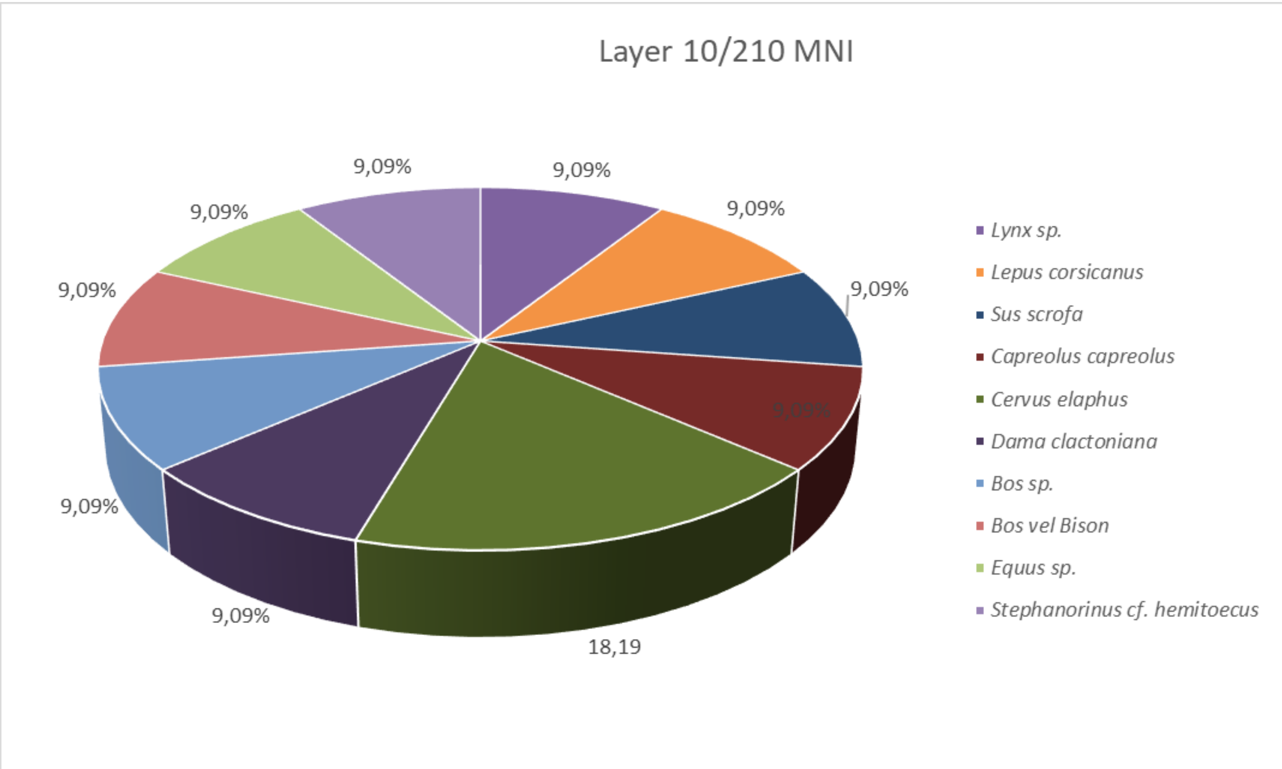


Figure 4.4 Representation of the faunal composition MNI.

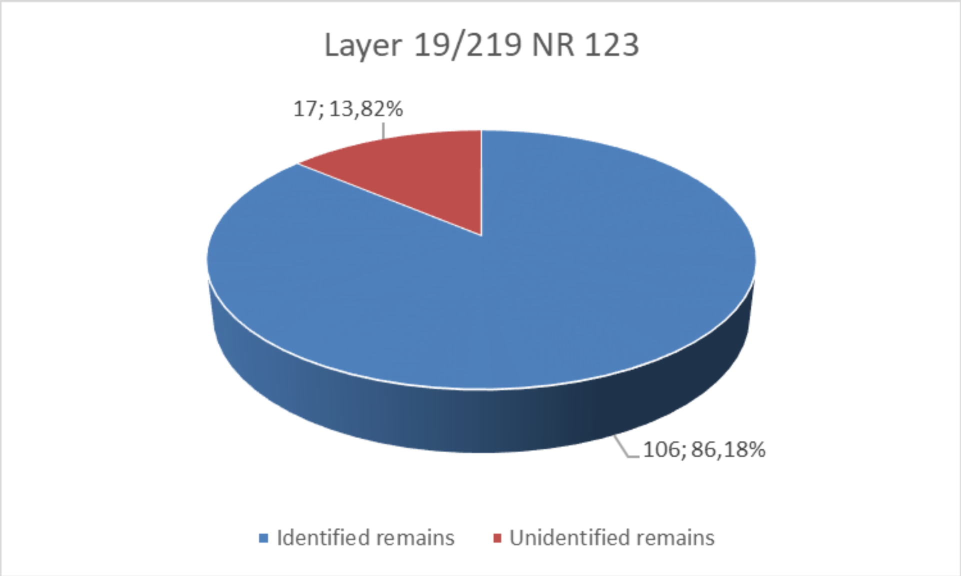


Figure 4.5 Representation of the identified and unidentified remains.

4.1.1.2 Layer 19/219

Of the 123 remain analyzed, 106 were identified and 17 unidentified. The percentage of determined fragments is 86.18% and of indeterminate is 13.82% (Tab. 4.5, Fig. 4.5).

Layer19/219	NR	%NR
Identified remains	106	86.18
Unidentified remains	17	13.82
Total	**123**	**100**

Table 4.5 Number of identified and unidentified fragments analyzed

The following taxa are present in this layer: *Vulpes vulpes*, *Ursus deningeri*, *Lepus corsicanus*, *Capreolus capreolus*, *Cervus elaphus*, Megacerinae, *Bos* sp. and *Bos* vel *Bison* (Tab. 4.6., Fig. 4.6). The most numerous taxon is *Cervus elaphus* (NISP = 94; MNI = 8), followed by *Capreolus capreolus* (NISP = 2; MNI = 1). Other taxa rate is represented by NISP = 1 and MNI = 1 (Fig. 4.7).

Layer 19/219	**NISP**	**% NISP**	**MNI**	**%MNI**
Vulpes vulpes	1	0.94	1	6.67
Ursus deningeri	1	0.94	1	6.67
Lepus corsicanus	1	0,94	1	6.67
Capreolus capreolus	2	1.89	1	6.67
Cervus elaphus	94	88.69	8	53.31
Megacerinae	1	0.94	1	6.67
Bos sp.	1	0.94	1	6.67
Bos vel *Bison*	5	4.72	1	6.67
TOTAL	**106**	**100**	**10**	**100**

Table 4.6 Composition of the faunal remains from layer 19/219.

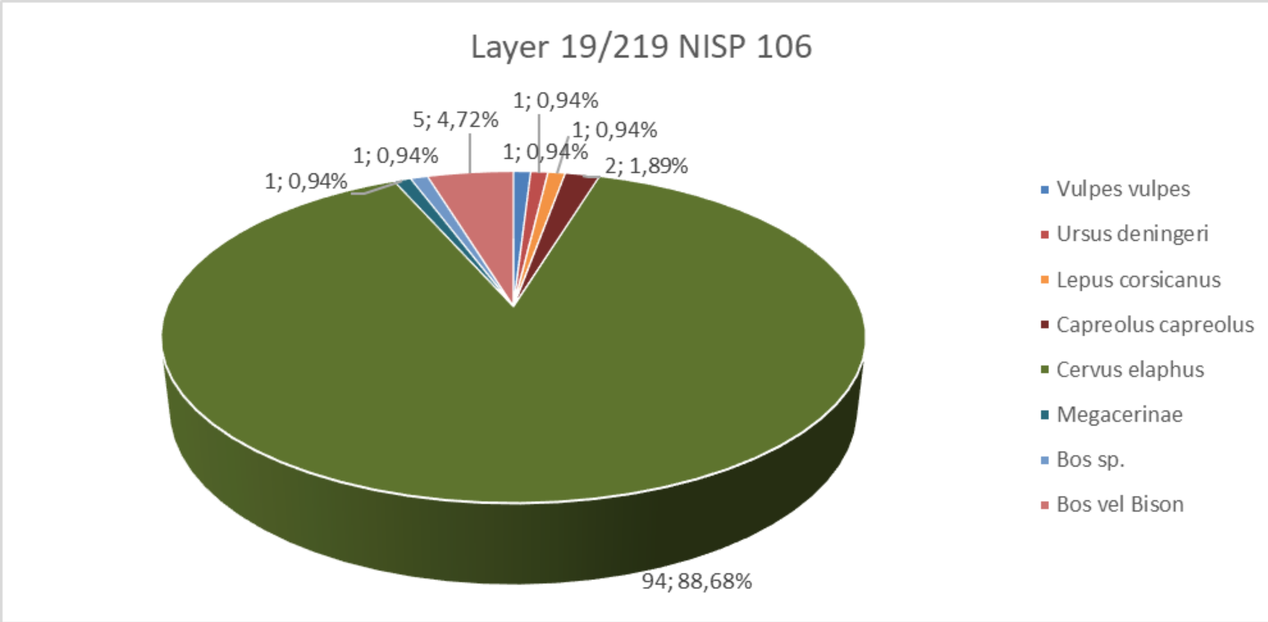


Figure 4.6 Representation of the faunal composition NISP.

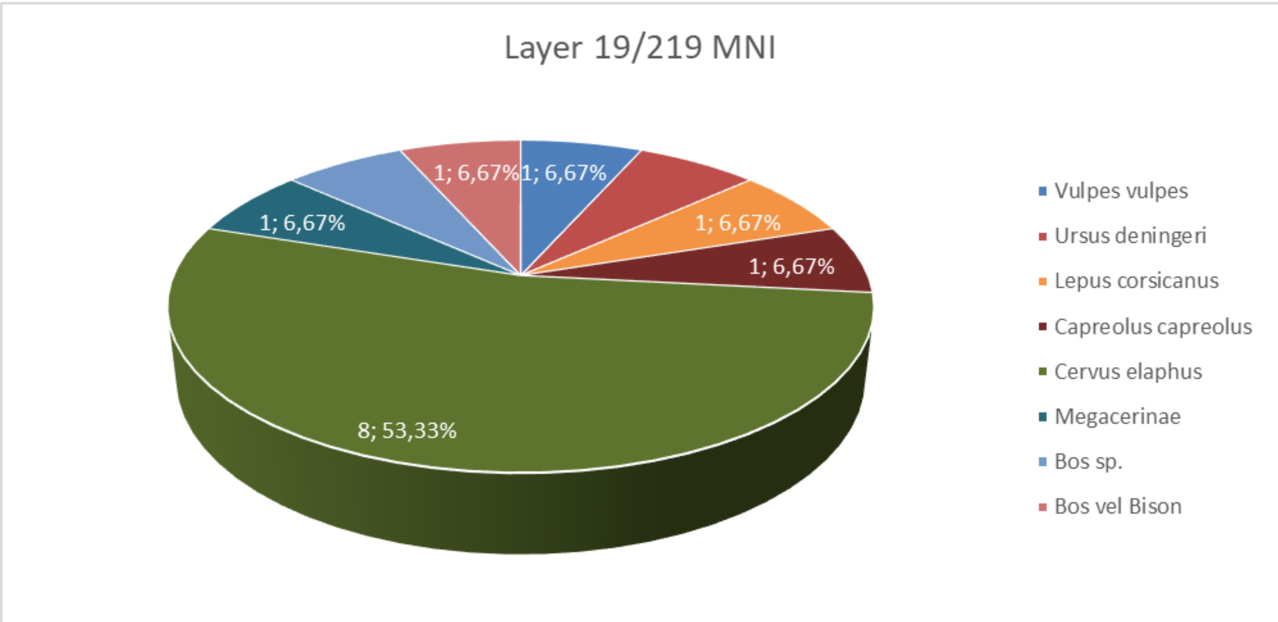


Figure 4.7 Representation of the faunal composition MNI

Cervus elaphus is represented by 94 remains in total, which are divided as follows: metacarpal (NISP = 13), mandible (NISP 12), metatarsal (NISP = 10), humerus (NISP = 8), radius (NISP = 6), I phalanx (NISP = 4), cuboid (NISP = 3), followed by scapula, tibia, scaphoid, astragalus and metapodial (each NISP = 2). Less recurrent elements were: semilunar, uncinate, cuneiform, II phalanx and sesamoids (each NISP = 1) (Table 4.7).

Layer 19/219 *Cervus elaphus*	**NISP**	**MNE**	**MNI**	**MAU**
Maxilla	6	5	4	2.5
Teeth upper	22	22	4	2.5
Teeth lower	30	30	6	4
Teeth total	78	52	6	4
Mandible	12	4	2	2
Scapula	2	2	2	1
Humerus	8	6	4	3
Radius	6	3	2	1.5
Semilunare	1	1	1	0.5
Uncinato	1	1	1	0.5
Metacarpal	13	10	8	5
Tibia	2	2	2	1
Cuneiforme	1	1	1	0.5
Cuboide	3	2	2	1
Scafoide	2	2	2	1
Astragalus	2	2	1	1
Metatarsal	10	5	3	2.5
Metapodial	2			
I Phalanx	4	3	1	
II Phalanx	1	1	1	
Sesamoids	1	1	1	
TOTAL	**94**	**103**	**8**	**5**

Table 4.7 *Cervus elaphus* remains divided by anatomical element.

A total of 78 *Cervus elaphus* teeth remains were analyzed, including 22 upper teeth and 30 lower teeth (MNE = 53, MNI = 6 and MAU = 4). A young individual could be identified through an isolated deciduous upper tooth (dP4) (Tab. 4.8).

Layer 19/219 ***Cervus elaphus***		**Laterality - NR**			**MNE**	**MNI**	**MAU**
		Right	**Left**	**Unidentified**			
Teeth	unidentified			26			
Upper Teeth	dP4\		1	juv	1	1	0.5
	P2\	2	2		4	2	2
	P3\		4		4	4	2
	P4\		2		2	2	1
	M1\	2			2	2	1
	M2\		1		1	1	0.5
	M1-2\	7	1		8	-	-
Total Upper teeth		*11*	*11*		*22*	*4*	*2.5*
Lower Teeth	I	2	1		3	1	-
	P2/	1			1	1	0.5
	P3/	4			4	4	2
	P4/	6	2		8	6	4
	M1/	2	4		6	4	3
	M2/		4		4	4	2
	M3/	2	2		4	2	2
Total Lower teeth		*17*	*13*		*30*	*6*	*4*
TOTAL		**78**			**52**	**6**	**4**

Table 4.8 MNI, MNE and MAU from Cervus elaphus teeth - Layer 19/219.

4.1.1.3 Layer 24/224

Of the 142 remains analyzed in this layer, 116 were identified and 26 are unidentified. The percentage of determined fragments is 81.69% and unidentified is 18.31%. (Tab. 4.9, Fig. 4.8).

Layer 24/224	**NR**	**%NR**
Identified	116	81,69
Unidentified	26	18, 31
TOTAL	**142**	**100**

Table 4.9 Number of identified and unidentified fragments analyzed.

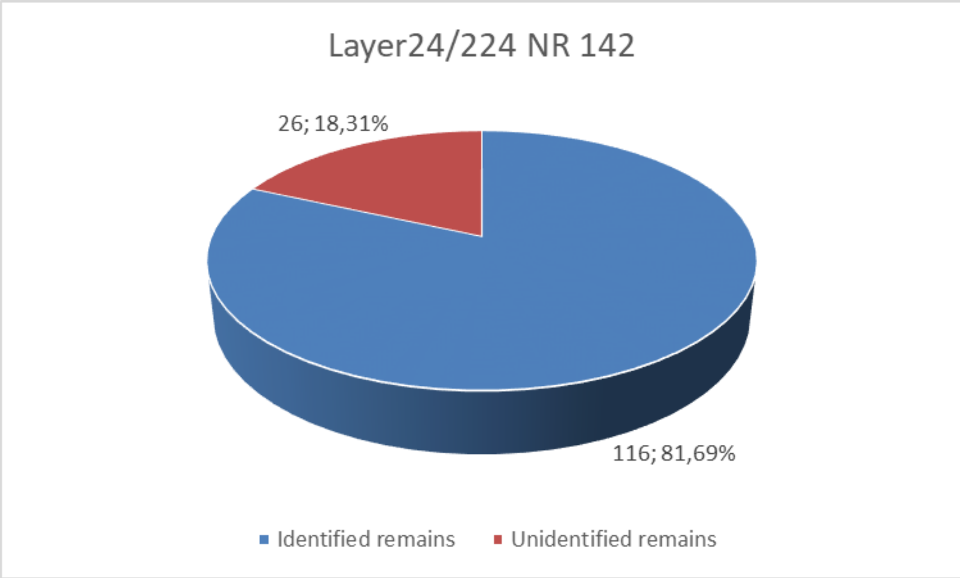


Figure 4.8 Representation of the identified and unidentified remains.

Layer 24/224 is marked by the presence of *Ursus deningeri*, *Meles meles*, carnivora, *Capreolus capreolus*, *Cervus elaphus*, *Bos* vel *Bison* and *Stephanorinus* cf. *hemitoecus* (Tab. 4.10, Fig 4.9). As in layers 19/219 and 10/210, the most recurrent taxon is *Cervus elaphus* (NISP = 105; MNI = 6), followed by *Capreolus capreolus* (NISP = 5 and MNI = 1), and *Bos* vel *Bison* (NISP = 2, MNI = 1). Other taxa rate is represented by NISP = 1 and MNI = 1 (Fig. 4.10).

Layer 24/224 - Taxa	**NISP**	**% NISP**	**MNI**	**%MNI**
Ursus deningeri	1	0,86	1	8,33
Meles meles	1	0,86	1	8,33
Carnivora	1	0,86	1	8,33
Capreolus capreolus	5	4,32	1	8,33
Cervus elaphus	105	90,52	6	50,02
Bos vel *Bison*	2	1,72	1	8,33
Stephanorinus cf. *hemitoecus*	1	0,86	1	8,33
TOTAL	**116**	**100**	**12**	**100**

Table 4.10 Composition of the faunal remains from layer 24/224.

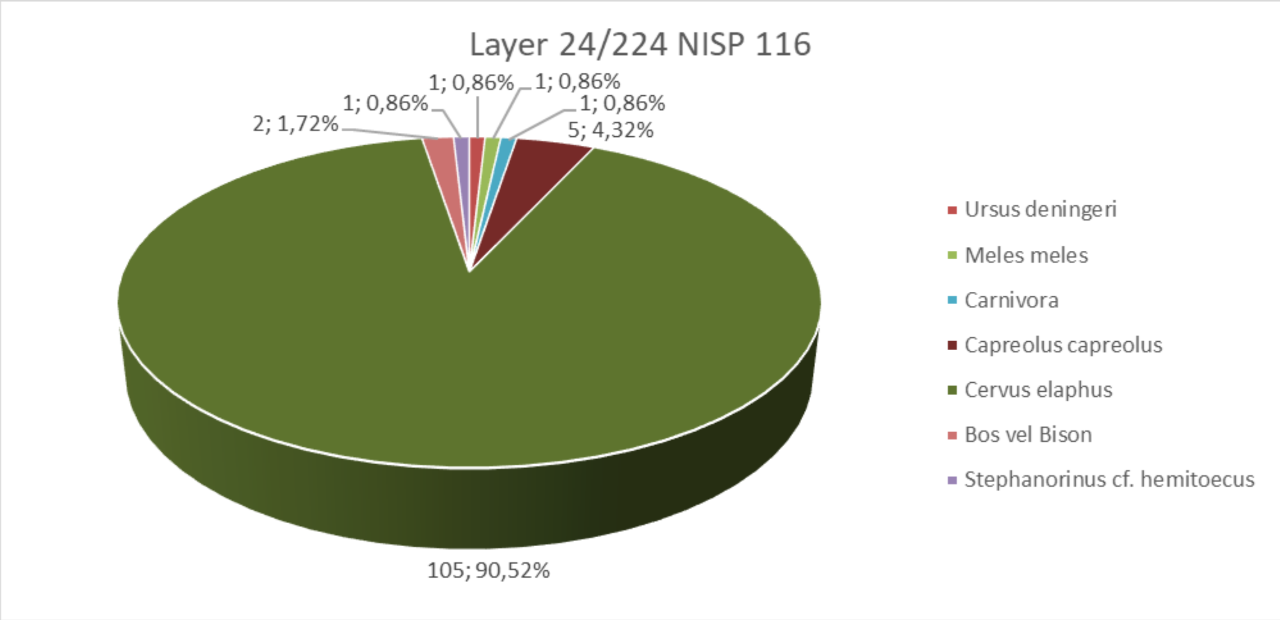


Figure 4.9 Representation of the faunal composition NISP.

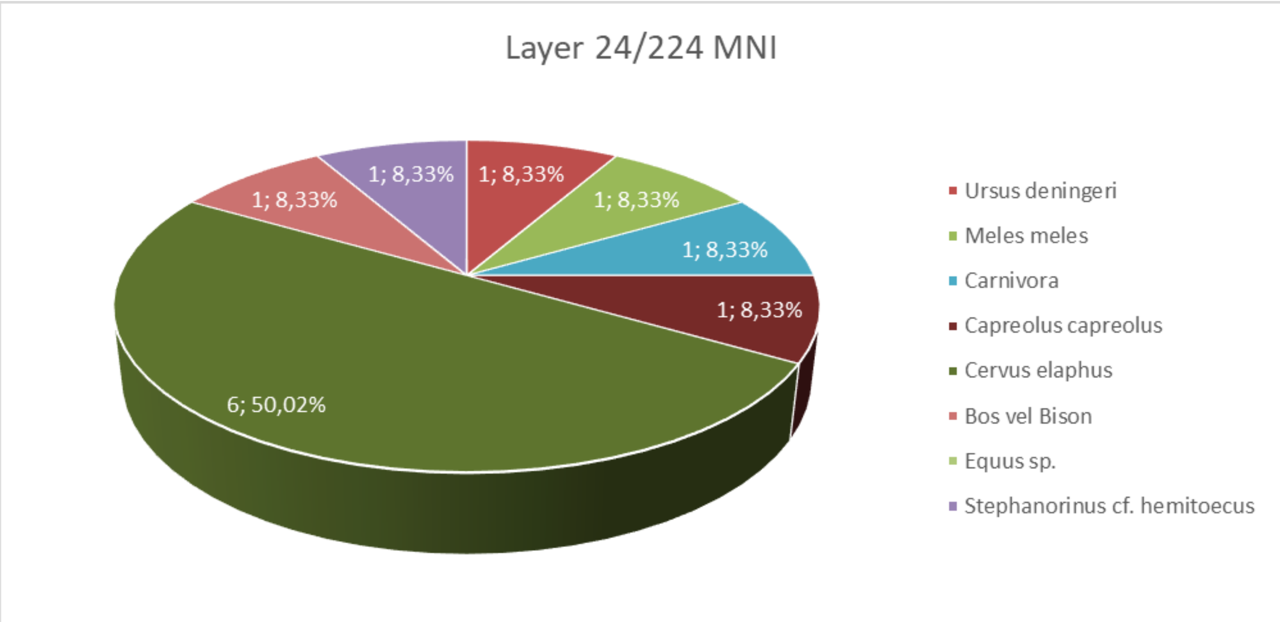


Figure 4.10 Representation of the faunal composition MNI.

In layer 24/224 the most numerous elements of *Cervus elaphus* were metacarpal (NISP = 13) and mandible (NISP 12). After these elements, the next most numerous were: metatarsal (NISP = 10), humerus (NISP = 8), radius (NISP = 6), I phalanx (NISP = 4), cuboid (NISP = 3), followed by scapula, tibia, scaphoid, astragalus and metapodial (NISP = 2). Less recurrent elements were: semilunar, uncinate, cuneiform, II phalanx and sesamoids (NISP = 1) (Tab. 4.11).

Layer 24/224 ***Cervus elaphus***	**NISP**	**MNE**	**MNI**	**MAU**
Maxilla	4	4	3	2
Teeth upper	18	15	1juv+2ad	1.5
Teeth lower	17	15	2	1.5
Teeth total	*35*	*30*	*1juv+2ad*	*1.5*
Mandible	7	5	2juv+2ad	2.5
Scapula	3	3	2	1.5
Humerus	1	1	1	0.5
Radius	8	7	1juv+4ad	3.5
Ulna	1	1	1	0.5
Capitato-trapezoide	1	1	1	0.5
Uncinato	1	1	1	0.5
Metacarpal	5	2	2	1
Pelvis	1	1	1	0.5
Tibia	2	2	1	0.5
Cuboide	2	2	2	1
Astragalus	1	1	1	0.5
Calcaneus	2	2	2	1
Metatarsal	9	5	4	2.5
Metapodial	3	1	1	0.5
I Phalanx	6	3	1	
II Phalanx	3	1	1	
TOTAL	**105**	**73**	**2juv+4ad**	**3.5**

Table 4.11 *Cervus elaphus* remains divided by anatomical element.

A total of 35 teeth remains were analyzed, including 15 upper teeth and 15 lower teeth (MNE = 35, MNI = 3 and MAU = 1,5). (Brown & Chapman, 1991) (Tab. 4. 12). At least one young individual is part of the selected sample of this layer, evidenced by the presence of two maxilla deciduous teeth (upper dP2 and dP3) (Tab. 4.12).

Layer 24/224 *Cervus elaphus*		**Laterality - NR**			**MNE**	**MNI**	**MAU**
		Right	**Left**	**Unidentified**			
Teeth	unidentified			10			
Upper Teeth	dP2\		1		1	1juv	0.5
	dP3\		1		1	1juv	0.5
	C			3	3	2	1.5
	P2\		1		1	1	0.5
	P3\	1	1		2	1	1
	M\	2	1	(3)	3(+3)		
	M2\	1			1	1	0.5
	M3\	2	1		3	2	1.5
Total Upper teeth		*6*	*6*	*3+(3)*	*15 (+3)*	*1juv+2ad*	*1.5*
Lower teeth	I	3	3	(1)	6(+1)	-	-
	P/			(1)	(1)	1-	-
	P2/			1	1	1	0.5
	P3/	1	1		2	1	0.5
	P4/	2	1		3	2	1.5
	M1\	2			2	2	1
	M2\	1			1	1	0.5
Total Lower teeth		*9*	*5*	*1(+2)*	*15(+2)*	*2*	*1.5*
		15	*11*	*19*	*35*	*1juv+2ad*	*1.5*
TOTAL		**35**			**35**	**1juv+2ad**	**1.5**

Table 4.12 MNI, MNE and MAU from Cervus elaphus teeth - Layer 24/224.

4.2 Taphonomic analysis

4.2.1 Non biological alteration (climate-edaphic alterations)

Weathering

From the selected sample, we can observe that weathering is present in 69% of the skeletal remains belonging to the 10/210 layer. In some cases (around 31%), the visibility of skeletal remains was very low, due to other alterations, and the identification of this phenomenon was not possible.

In layer 19/219 around 82% of the sample shows some stage of weathering. About 6% shows Stage 4 and around 18% is not accessible (Tab. 4.13).

In layer 24/224, 76 fragments show some modification by weathering, about 85% of the skeletal elements.

In all layers, the most present stage is Stage 1, followed by Stage 2 and Stage 3.

WEATHERING						
STAGES	**LAYER 10/210**		**LAYER 19/219**		**LAYER 24/224**	
	NR	NR%	NR	NR%	NR	NR%
Stage 1	16	55,17	36	49,32	48	53,93
Stage 2	2	6,90	16	21,92	23	25,84
Stage 3	2	6,90	4	5,48	5	5,62
Stage 4	0	0,00	4	5,48	0	0,00
Stage 5	0	0,00	0	0,00	0	0,00
N/A	9	31,03	13	17,81	13	14,61
TOTAL	**29**	**100**	**73**	**100**	**89**	**100**
T/A	**20**	**68,97**	**60**	**82,19**	**76**	**85,39**

Table 4.13 Weathering stages identified in the three layers (N/A = not accessible. T/A = Total altered).

Sediment action

Sedimentary compaction was identified in the three covered layers. The 24/224 layer has the highest value: 31.15%. Layer 19/219 has 20.55% and layer 10/210 has less than 1%.

Water action

Dissolution - As presented in the table, changes caused by water dissolution affected less than half of the sample. However, this value may be due to limited visibility of bony surfaces. Around 24% of the fragments from the layer 10/210 show some level of dissolution. In layer 19/219 the value is 30% and in layer 24/224 around 37% (Tab. 4.14).

DISSOLUTION						
STAGES	**LAYER 10/210**		**LAYER 19/219**		**LAYER 24/224**	
	NR	NR%	NR	NR%	NR	NR%
Stage 0	22	75,86	51	69,86	56	62,92
Stage 1	3	10,34	15	20,55	26	29,21
Stage 2	4	13,79	4	5,48	4	4,49
Stage 3	0	0	3	4,11	3	3,37
TOTAL	**29**	**100**	**73**	**100**	**89**	**100**
T/A	**7**	**24,14**	**22**	**30,14**	**33**	**37,08**

Table 4.14 Dissolution stages present on the three layers (T/A = Total altered).

Blunt - In layer 19/219 around 45% of the fragments have their edges smooth and blunted at different intensities, 11% being classified as Stage 3. In layer 24/224 about 30% have these characteristics and in layer 10/210 14% (Table 4.15).

BLUNT						
STAGES	**LAYER 10/210**		**LAYER 19/219**		**LAYER 24/224**	
	NR	NR%	NR	NR%	NR	NR%
Stage 0	25	86,21	40	54,79	62	69,66
Stage 1	3	10,34	8	10,96	19	21,35
Stage 2	1	3,45	17	23,29	7	7,87
Stage 3	0	0	8	10,96	1	1,12
TOTAL	**29**	**100**	**73**	**100**	**89**	**100**
T/A	**4**	**13,79**	**33**	**45,21**	**27**	**30,34**

Table 4.15 Dissolution stages present on the three layers (T/A = Total altered).

Exfoliation – This phenomenon was identified in the three layers studied. About 76% of the skeletal elements from layer 19/219 show some degree of exfoliation. In layers 24/224 and 10/210, these values are 55% and 27%, respectively. The origin of such modification is difficult to determine, as it can have its origins with the action of water and weathering. This process could also sometimes be classified as desquamation, which occurs when bones are exposed to highly alkaline environments, common in limestone cave environments (Fernandez-Jalvo & Andrews, 2016). However, its distinction is difficult to make (Tab. 4. 16).

EXFOLIATION						
STAGES	**LAYER 10/210**		**LAYER 19/219**		**LAYER 24/224**	
	NR	NR%	NR	NR%	NR	NR%
Stage 0	21	72,41	17	23,29	40	44,94
Stage 1	4	13,79	17	23,29	19	21,35
Stage 2	2	6,90	15	20,55	17	19,10
Stage 3	2	6,90	24	32,88	13	14,61
TOTAL	**29**	**100**	**73**	**100**	**89**	**100**
T/A	**8**	**27,59**	**56**	**76,71**	**49**	**55,06**

Table 4.16 Exfoliation stages present on the three layers (T/A = Total altered).

Concretion

Concretions are present in almost all remains in the sample. It appears in different intensities and in some cases covers the entire bone surface, creating blocks of sediment, and in others the concretions were visible inside the bones, usually seen in the spongy parts.

Of the three layers studied, only 1 specimen belonging to layer 24/224 had no visible concretion. Stage 1 was found to be around 19% in layer 24/224, 7% in layer 19/219 and 3% in layer 10/210. Stage 2, is the most recurrent in layers 24/224 and 19/219, being around 60% and 30%, respectively. In layer 10/210, Stage 3 was predominant in around 70% of bone fragments (Tab. 4.17).

CONCRETION						
STAGES	**LAYER 10/210**		**LAYER 19/219**		**LAYER 24/224**	
	NR	NR%	NR	NR%	NR	NR%
Stage 1	1	3,45	5	6,85	17	19,10
Stage 2	8	27,59	42	57,53	53	59,55
Stage 3	20	68,97	26	35,62	18	20,22
Absent	0	0	0	0	1	1,12
TOTAL	**29**	**100**	**73**	**100**	**89**	**100**
T/A	**29**	**0**	**73**	**100**	**88**	**98,88**

Table 4.17 Concretion stages present on the three layers (T/A = Total altered).

Bone surface coloration

The presence of black stain was observed on the remains. This coloration can be attributed to manganese and iron oxides. However, more accurate and precise analyzes need to be done to ensure the origin of this color throughout the entire sample.

In layers 19/210 and 24/224 this color is present in more than 90% of the bones and in layer 10/210 it is present in more than 50%. 81% of the fragments from layer 19/219 have their surfaces between 90% and 100% black (Tab. 4.18).

BONE SURFACE COLORATION: BLACK COLOR						
PERCENTAGE	**LAYER 10/210**		**LAYER 19/219**		**LAYER 24/224**	
	NR	NR%	NR	NR%	NR	NR%
0%	12	41,38	4	5,48	6	6,74
<10%	7	24,14	2	2,74	28	31,46
<25%	0	0,00	0	0,00	9	10,11
<50%	4	13,79	2	2,74	12	13,48
<75%	0	0,00	4	5,48	4	4,49
<90%	0	0,00	2	2,74	4	4,49
90% - 100%	6	20,69	59	80,82	26	29,21
TOTAL	**29**	**100**	**73**	**100**	**89**	**100**
T/A	**17**	**58,62**	**69**	**94,52**	**83**	**93,26**

Table 4.18 Black color representation (T/A = Total altered).

4.2.2 Biological non-human alterations

Dendritic Erosion (Root Etching)

No traces related to this modification could be identified.

Carnivore marks

During the exploratory work were identified carnivore marks in two elements. One specimen (ID 231) belonging to layer 14 and another belonging to layer 10 (ID 625). Puncture marks were evidenced in an astragalus edges of a *Cervus elaphus*. Score marks were found in a diaphysis fragment of a tibia from an unidentified species.

Layer	ID	Taxon	Skeletal element	Type of mark
10	625	*Cervus elaphus*	Astragal	puncture
14	231	Undetermined	Tibia	Scores

Table 4.19 Carnivore marks found in the sample.

Microbial Bioerosion, Rodent action, Ice action and Mechanical and Chemical Effects of Insects

No traces related to these alterations could be identified.

4.2.3 Biological non-human and human alterations

Trampling

- Specimen 554, Layer 10/210

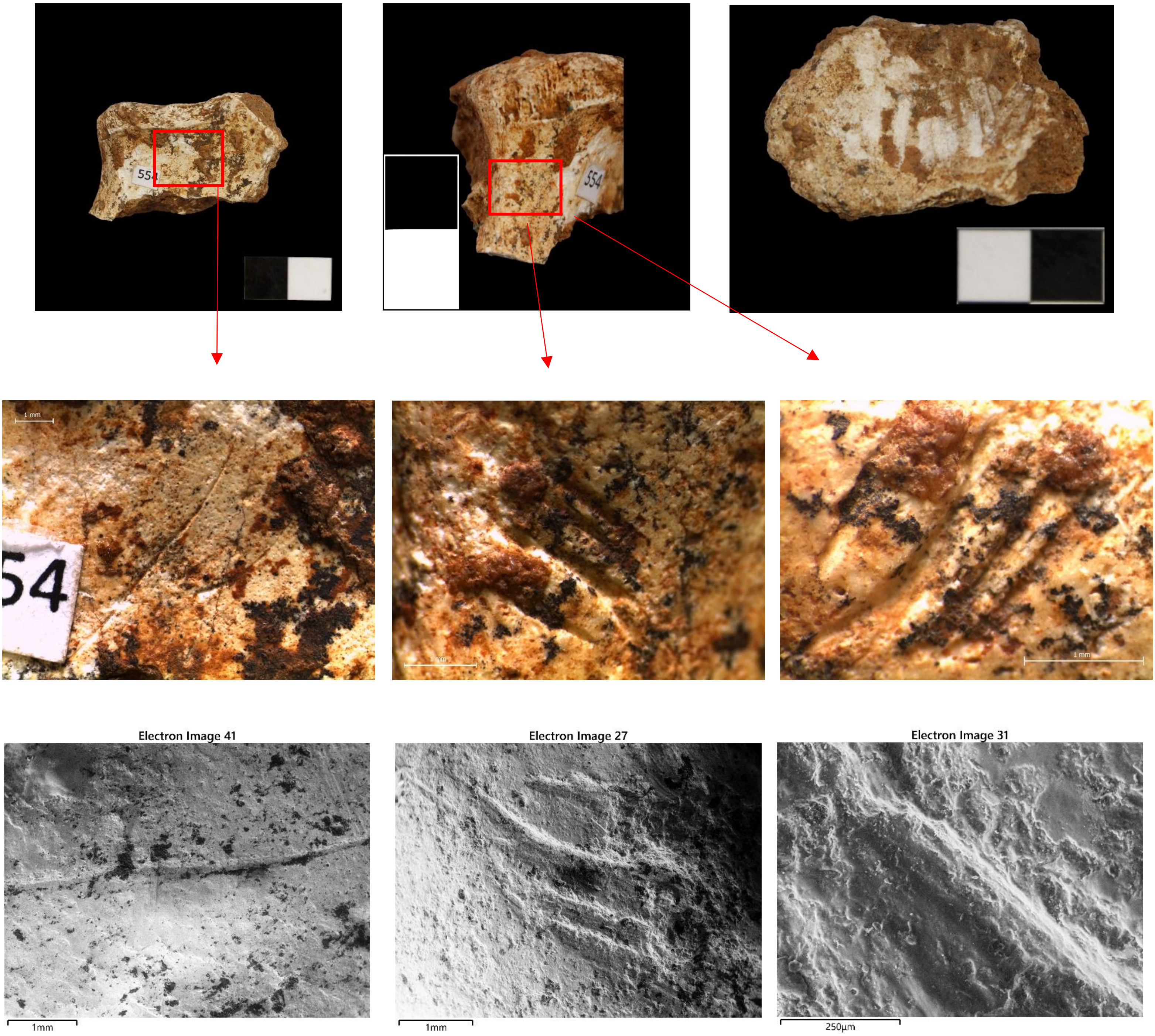


Figure 4.11 Images of a fragment of a pelvis (acetabulum) of a red deer taken with photo camera (first row), stereomicroscope (second row), and SEM microphotograph (last row). In the first row we can see 3 photos of the fragment at different angles showing the location of the linear marks. The third photo shows excavation tools marks. In the second row, the first photo shows two linear marks, possibly trampling. The last two photos show different marks in different locality but at different angles to favor the shadow. These four linear marks can also be associated with possible trampling activity. Note the U-shape cross section, without the presence of micro-striations. The last row shows in detail the cuts, which do not have mainly characteristics of cutmarks. The last photo shows the absence of microstriations and U-shape section. Presence of concretion over the mark can be observed.

Specimen 554 is a fragment of a left pelvis (acetabulum) of a *Cervus elaphus* (Fig. 4,11). The fragment has a stage 2 weathering and stage 2 concretion.

Marks were identified at two locations in the specimen. In the side and front portion (Fig. 4. 11). Four short incisions can be seen on the side of the bone fragment and are oblique. Location of the marks could be related to muscle or ligament attachment. They are characterized by a U-shape cross section and no microstriation or microsteps can be observed at the base of the groove, typical of cutmarks. Three of the cuts are shallow and one deeper. The presence of concretion and manganese and iron oxide prevents a more accurate visibility, but even so, we can observe some characteristics that help us to identify the type of mark. The trajectory of the grooves is not straight, we can see a small slope at the end of at least 3 of them, like an open hook, characteristic that resembles a barb, typical of butchery marks. However, other features are absent (Fernández-Jalvo & Andrews, 2016). Hertzian fracture, shoulder effect and flaking on the shoulders are absent, characteristics attributed to cutmarks (Bromage & Boyde, 1984).

The other two marks present in this specimen also have outstanding trampling characteristics (first photo of the three rows). These marks are located on the flat part of the bone, having an oblique orientation. are characterized by a shallow groove. The larger mark has its most open and shallow end. No microstriation can be observed. As with the other marks, concretions prevented a good view of the base of these marks. Microabrasion can be noticed near and above the larger mark. Both marks have a curvy ending. Even though there is concretion inside the groove, a U-shape cross section can be seen.

Despite having some characteristics that resemble butchery marks, these marks could be classified as trampling marks because they have more diagnostic attributes of such an alteration.

- Specimen 478, Layer 24

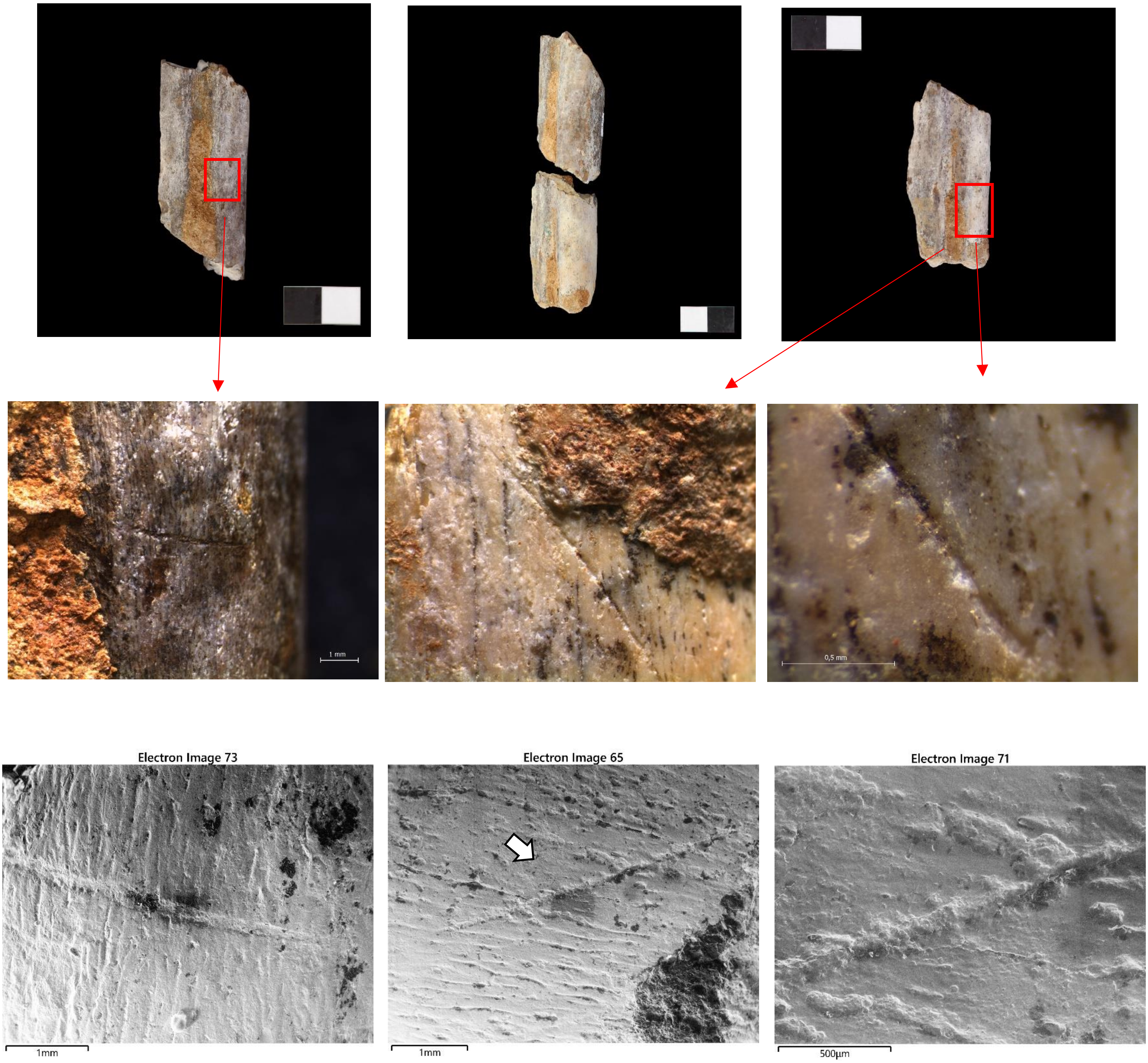


Figure 4.12 Images of specimen 478, which has a modern breakage (2 fragments). (Rows arranged as in the previous figure). On the first row, we see the anterior face of a Cervus elaphus metatarsal diaphysis. The middle photo shows an anterior/lateral view. Linear marks are highlighted in red. In the second row, the first image shows a short linear mark and below it, in the third row, SEM microphotograph shows a frame of it, where it is possible to see a U-shape cross section. The two images in the second and third row show the same linear mark, also attributed to trampling. The marks are shallow and have no microstriations. Note that the SEM microphotograph with a small white arrow is showing the end of the incision in a different orientation.

Specimen 478 is a fragment of a metatarsal diaphysis from a *Cervus elaphus*. The diaphysis has a modern break, dividing the specimen in two fragments (bone refit) (Fig. 4.12). Each of the fragments has an isolated linear mark. The fragment has a weathering stage 1 and Concretion 2.

The first image of the first row shows in evidence the location of a short, shallow, transversely oriented mark relative to the axis of the bone, on the anterior face. This mark is located in the shaft. It features a U-shape cross-section and no microstriation or microsteps can be seen at the base of the groove. The presence of concretion and manganese oxide also affect the visibility of the mark. The trajectory of the groove is sinuous. No barb, Hertzian fracture, shoulder effect or important flaking on the shoulders are present.

The second incision is located at the end of the diaphysis fragment (last photo in the first row). Its orientation is oblique relative to the axis of the bone. It is characterized by a very shallow and wide groove at certain points along the incision. No microstriations can be identified, or microsteps. However, this cut has shoulder flaking, but Hertzian fracture and shoulder effect are not present. It is possible to notice microabrasion just below the longer groove. They are shallow and parallel to the big groove. Concretions and manganese and iron oxides are present inside the cut.

According to the characteristics presented by these marks they can be associated with trampling.

- Specimen 442, Layer 24

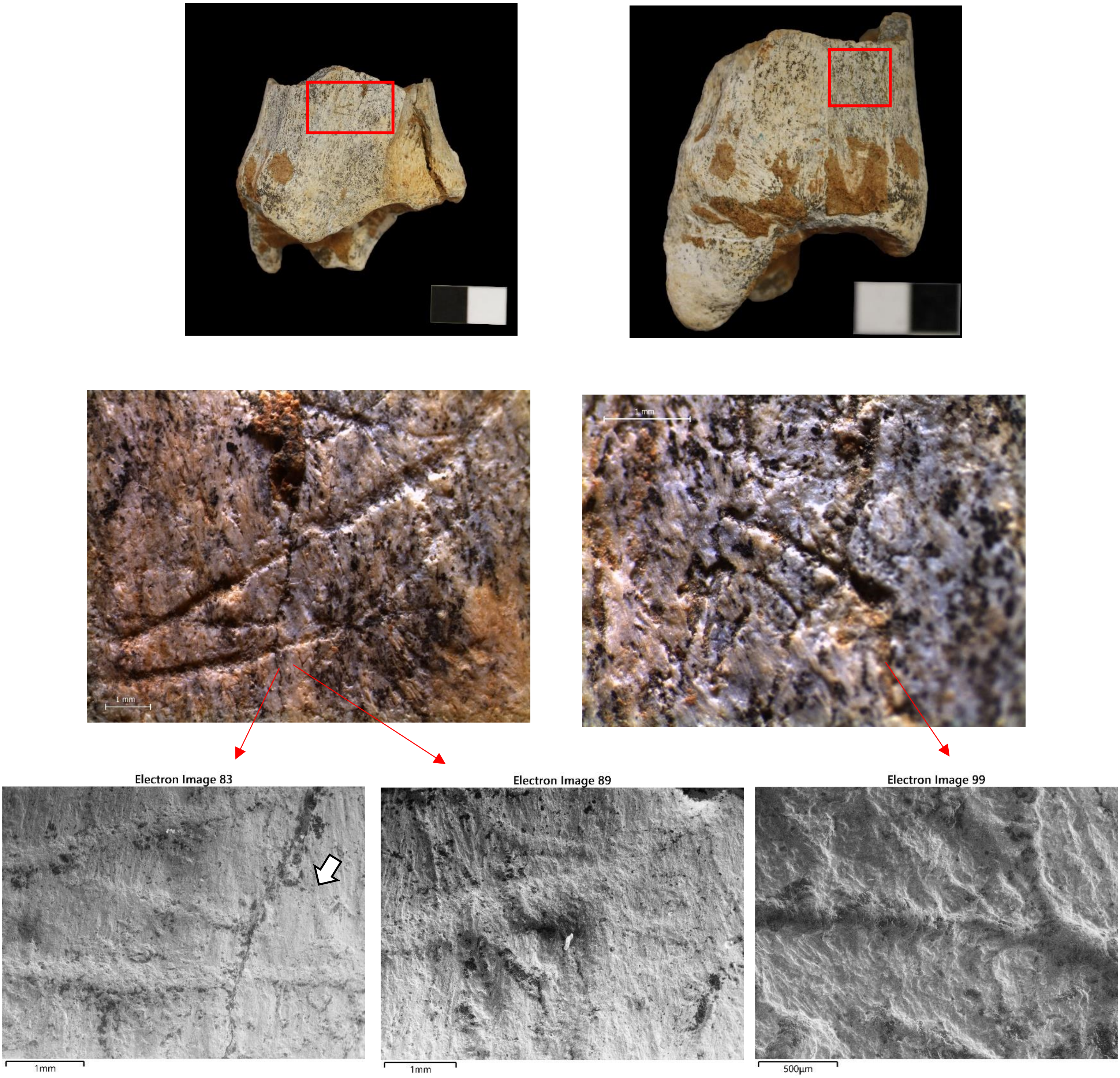


Figure 4.13 Images of a fragment of distal epiphysis of a tibia (*Cervus elaphus*). (Rows arranged like the one in the previous figure). In the first row, image showing the posterior face of the tibia with red detail in the linear marks and the second photo shows the medial face with detail in other two different marks. In the second row, the first photo shows marks with an irregular trajectory. It is possible to see an overlap of marks with part of the groove base broad. The second photo shows the occurrence of two more marks on the medial surface. Smaller, shallow marks and no microstriastions. SEM microphotograph shows in detail the base of these marks, a U-shape characteristic can be evidenced in both marks. The first photo of this last row shows the over-position of marks and a fissure caused by weathering. Note that the SEM microphotograph with a small white arrow is showing the mirrored version of that taken in the stereomicroscope.

Specimen 442 is a distal epiphysis of a *Cervus elaphus* tibia (right). This specimen has incisions in two different areas. It has modern breakage, weathering Stage 2 and Concretion Stage 2. Its surface is quite altered (Fig. 4.13).

The first images of the first and second rows show a series of linear marks on the posterior surface of the epiphysis. These cuts can be characterized by shallow grooves in a U-shape cross section. In part of the two largest incisions (3 first photos of the three rows) we can observe a greater depth, differentiating from the other extremities of the cuts, that appear shallower and wider. No microstriations or microsteps were identified at the bottom of the cuts, both the largest and the smallest. In this fragment, the presence of concretions makes it difficult to read the marks. It is important to emphasize that this bone surface presents many alterations, which may have modified the original characteristics of the marks. The two longest incisions run in parallel, have a sinuous trajectory and have an oblique orientation. Barb, Hertzian fracture or shoulder effect are not present. The first photo of the third row (SEM microphotograph) shows in detail a crossing of cuts and cracking (result of weathering). Trampling marks can produce the effect of X shape striation, typical of cutmarks. However, in this case the marks seem to have been formed in two different motions (Fernández-Jalvo & Andrews, 2016). Above this set of marks we can see another incision, with opposite oblique orientation, without any microstriation. U-shaped cross section and shallow.

The marks present in the second area of the epiphysis (last photos of the three rows) show two short and shallow incisions. These marks are randomly oriented on the medial surface of the epiphysis, present a U-shape cross section and no microstriation at the base of the groove.

- Especimen 14, Layer 24

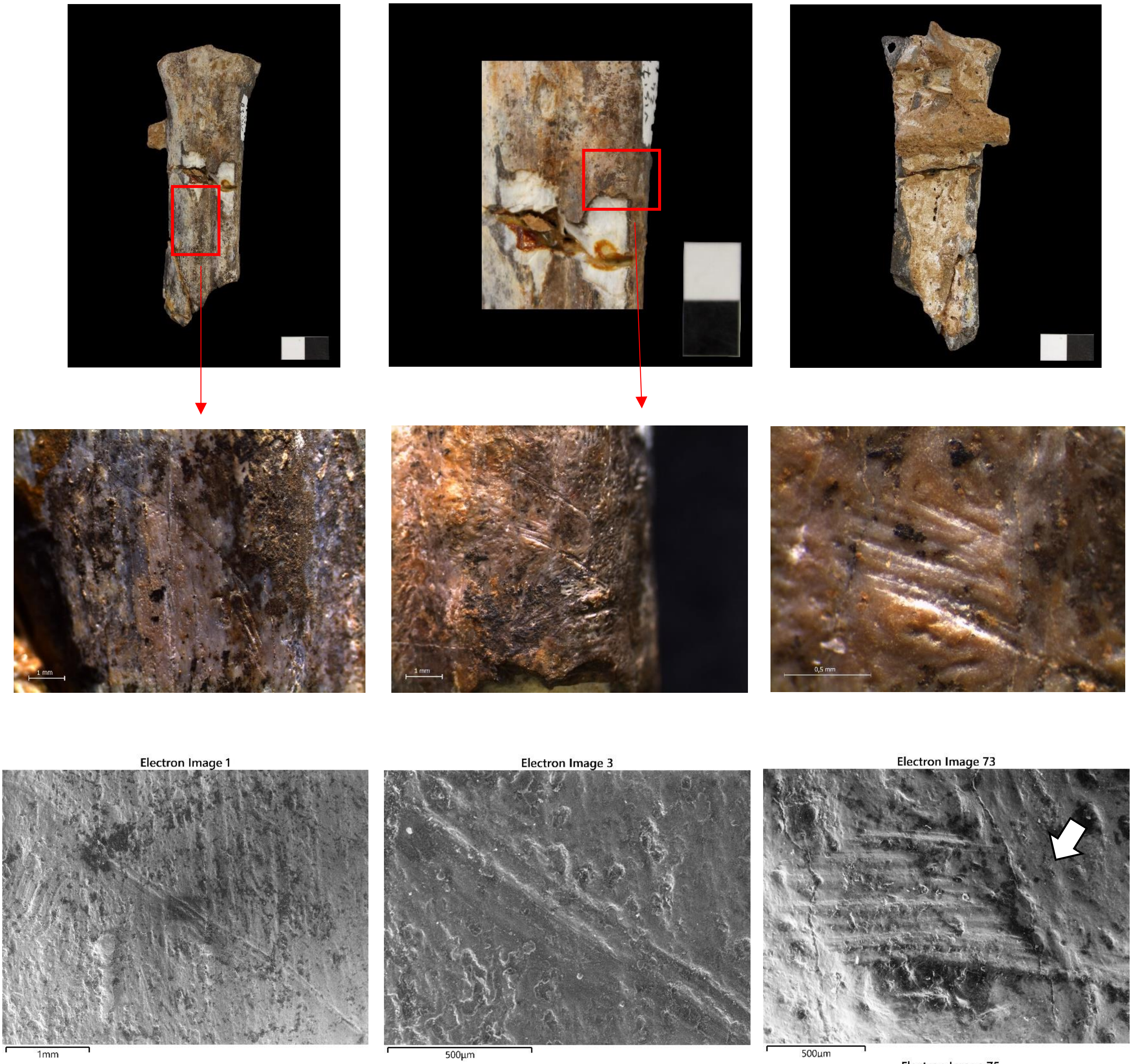
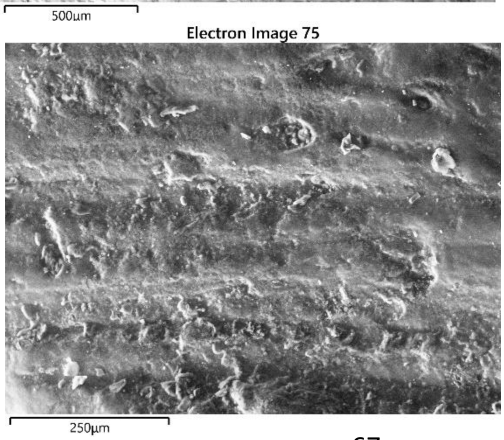


Figure 4.14 Images of a metatarsal fragment of a Cervid, anterior aspect of the epiphysis and proximal and medial diaphysis (right). (Rows arranged like the one in the previous figure). In the first row, images of the total fragment with evidence of the areas with the presence of marks (anterior face) and a posterior photo of the fragment with a large amount of concretion on the surface. In the second row, the first and the second image show the total view of the obliquely oriented incisions and a framing of its the end part. It is possible to observe parallel incisions and microabrasion. In the third photo of the second and third row, images of another set of short incisions in detail, located in a different area. The last photo in the fourth row shows the mark in detail. Note that the last photo with a white arrow shows the mark in a different orientation from the photo taken with a stereomicroscope, transversely.



Specimen 14 is an anterior portion of a metatarsal fragment of a Cervid (right). This remain has incisions at two different locations. The specimen shows modern breakage, weathering stage 2 and concretion stage 2. Its surface is very altered (Fig. 4.14).

The first row of images shows in red detail the location of the incisions in the bone fragment. In the third row, we can observe from the images of the stereomicroscope, some details of these marks. The first and second photo of the third row (SEM) allows us to observe the presence of microabrasion and microstriations at the base of the longer groove. Shorter incisions are located at the bottom of the longer incision and do not show microstriations (V-shaped cross section, shallow groove). The micro-striations follow the trajectory of the groove and the microabrasion has a random orientation, opposite the large incision and are very superficial. These incisions are oriented obliquely to the axis of the bone. The trajectory of the larger mark is sinuous, and the shorter straight. The presence of concretion makes it difficult to understand these marks, together with the degradation of the bone surface of this bone fragment. No barb, Hertzian fracture or shoulder effect was recognized. The groove is symmetrical in at least one third of its trajectory.

Images 73 and 75 show short repetitive cutmarks, the section is V-quadrangular shape and may depends by the inclination of a flint tool. This mark is obliquely oriented, has a straight trajectory and has microstriations. This mark appears superficial; however, it is possible to see concretions covering the cuts, which indicates that in addition to the non-biological alterations that affected the bone fragment, the mechanical cleaning may have removed part of the bone surface.

The marks analyzed in this specimen have characteristics that can be more common to cutmarks and others more common to trampling marks. However, due to its complicated context, the presence of diagnostic characteristics of trampling effects and the relationship of these marks distributed in the same bone, we chose to classify such marks as trampling marks.

4.2.4 Anthropogenic modifications

- Specimen 13, Layer 24

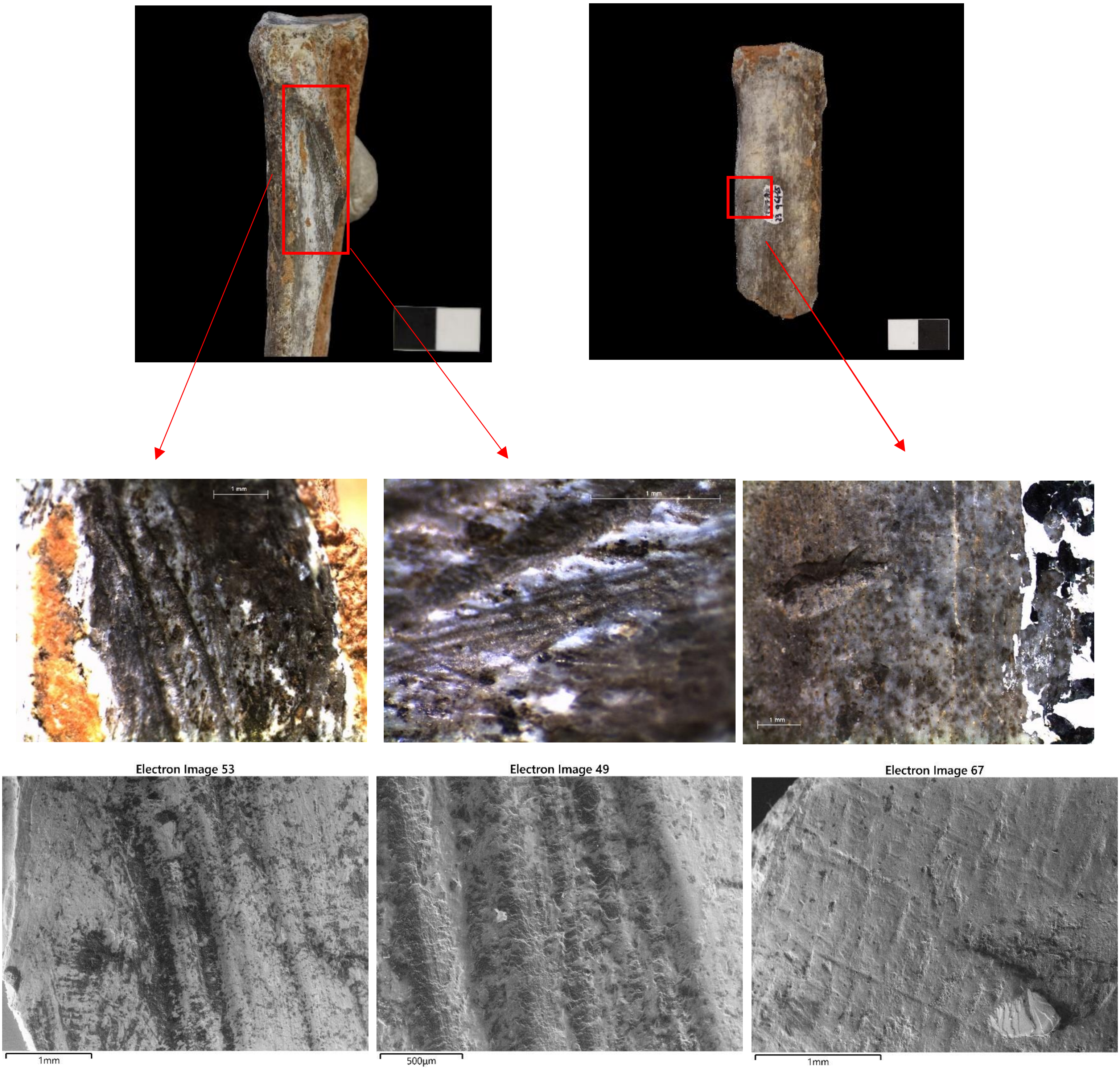


Figure 4.15 Photo camera (first row), stereomicroscope (second row), and SEM microphotograph (last row). Images show linear marks on a fragment of right metatarsal (proximal epiphysis, proximal and medial diaphysis; medial face) of a Cervid. The first two images show the two different areas where these marks are located. The first shows possible scraping marks located between the medial and posterior surfaces. In the second image, the red detail indicates the area where the other set of marks are located. In the second row is the presentation of these marks in greater focus and in the third row, details of the incisions (SEM). In the second image, it is possible to observe the presence of microstriations. In the last photo, we can see shallow incisions relative to the marks located on the medial surface of the element.

Specimen 14 is a fragment of right metatarsal (proximal epiphysis, proximal and medial diaphysis; medial face) of a Cervid (Fig. 4.14). The remain has a weathering stage 2 and concretion stage 2.

A series of linear marks were identified in the medial and posterior portion (small bone fraction). In the first image, it is possible to observe (posterior view) in red evidence the location of the marks. The trajectory of grooves can be both straight and sinuous., depending on the area. At the top, this feature is predominantly straight. At the end of at least two straight grooves, it is possible to observe a slight curvature. The orientation of the marks are oblique to the axis of the bone.

The shape of the grooves are wide V-shape. These characteristics are found only in this set of marks, the other set present in this fragment has different characteristics. Some of the cuts appear to have associated shallow striae, which occur in association with the main groove. The presence of straight microstriations at the base of some of the cuts was observed, along with possible microsteps in the longest and widest cut. The longest groove measures around 29 mm.

These incisions have features normally associated with scraping marks. According to Fernández-Jalvo & Andrews (2016), scraping marks can be the result of cleaning the edge of the stone tool when cutting, producing interrupted scraping marks. As in the case discussed here, these marks can be arranged in groups along the surface of the bone. They are usually longer than cutmarks and are oriented along the length of the bones.

Scraping marks can be similar even if produced by different agents, however, the location of these marks in the bone can provide us with an important criteria. In the case of specimen 14, these scraping marks are located between the proximal epiphysis and proximal diaphysis and are related to muscle and ligament attachment.

The other linear marks (last photos of the three rows) have microabrasion characteristics. They are very superficial, which made even their analysis with SEM difficult. They are oriented transversely and are close to a pyramid-shaped mark, which could be a result of the penetration of pointed sedimentary particles into the bone (last two photos in the last two rows).

- Specimen 477, Layer 24

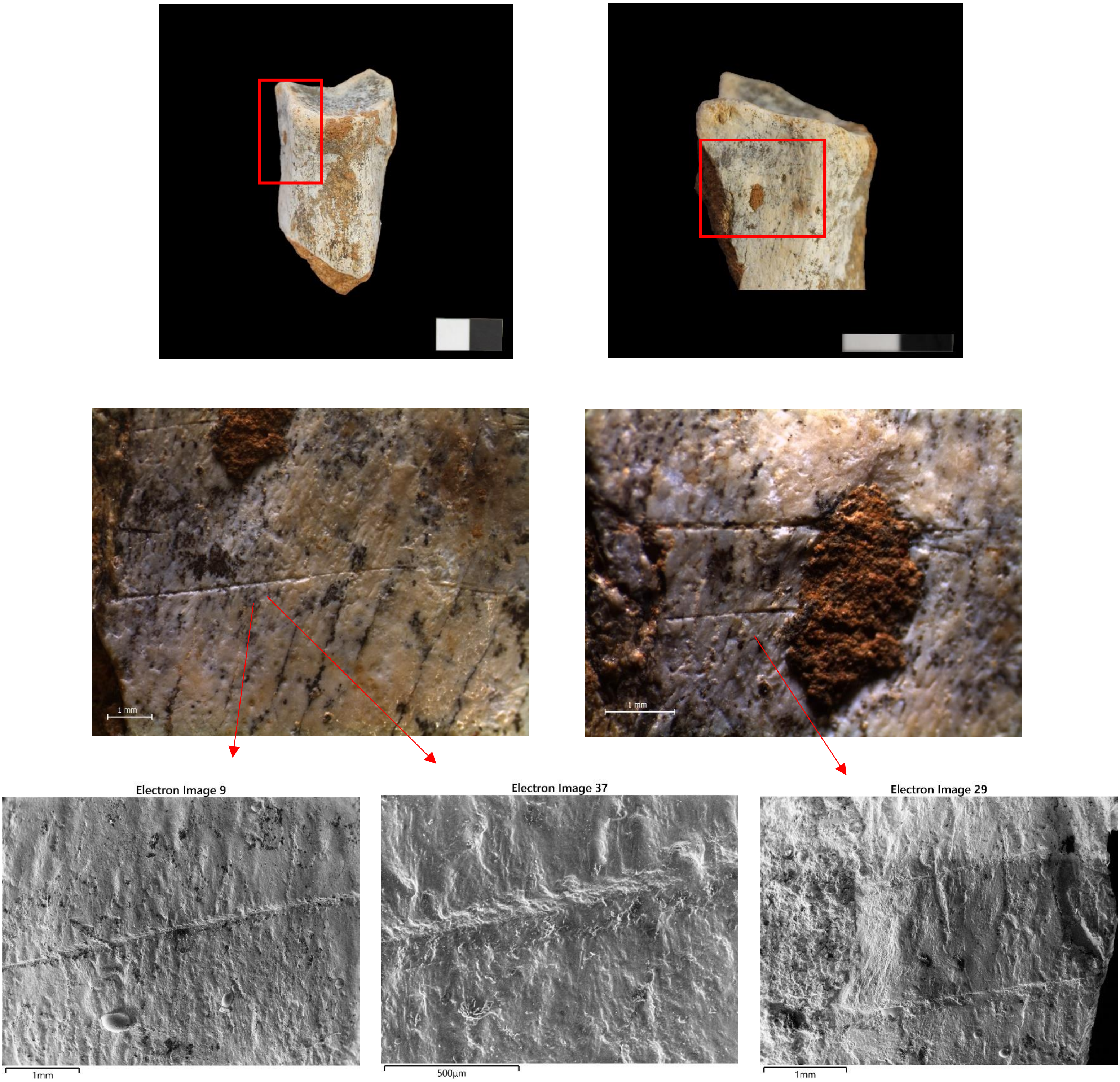


Figure 4.16 (Rows arranged as in the previous figure) Images show a fragment of epiphysis/diaphysis of a left radius of a *Cervus elaphus*. Medial portion, with a fraction of the anterior and posterior portion. The location of the incisions present in this fragment are highlighted in red in the photos in the first row. The second row shows a framing with three incisions, in the second only two smaller incisions can be seen. It is possible to observe the presence of a possible barb in the upper cut. The last images (SEM) show in detail the groove of the three marks, with the first two photos referring to the larger incision.

Specimen 477 is a proximal epiphysis with proximal diaphysis fragment of a left radius of a *Cervus elaphus* (Fig. 4.15). The remain has a weathering stage 2, concretion stage 2 and dissolution 2.

Three incisions were identified in this bone fragment located on the anterior face of the fragment. The marks are oriented transversely to the axis of the bone and are arranged one above the other. The trajectory of the grooves are straight. As can be seen in the SEM images, the shapes of the grooves are narrow V-shape cross-section. Although SEM microphotographs do not clearly show the bottom's morphology of the grooves - due to bone surface degradation and the presence of concretion inside the cuts - possible straight microstriatons could be seen at the base of the greater groove. Two of the incisions possibly present barbs. The longest incision measures around 9mm and the smallest between 3 and 4mm. Flaking on the shoulders can be observed over most of the larger incision.

The incisions do not show all the features normally associated with butchery marks, however, some features attributed to cutmarks are very well marked. These linear marks are located in proximity of proximal epiphysis and may be related to a butchery activity on desarticulation. Despite its classification being complex, due to the various alterations that affected the surface of the bone fragment, as cracking, exfoliation, dissolution, it was decided to classify it as a cutmark.

- Specimen 17, Layer 24

Figure 4.17 Fragment of a left metatarsal from a *Cervus elaphus*. The first image shows the lateral side of the skeletal element. In the second, we can see the internal part of the bone. Highlighted in red a impact notch.

Impact notches are considered the most distinctive percussion marks. These are usually semilunar concavities along the broken wall of the diaphysis. Specimen 17 shows a longitudinal fracture in a Cervus elaphus proximal diaphysis. The margin of the fracture is smooth. The presence of a simple and complete impact notch can be observed. Impact notch measuring: 11.8 mm in length and 11.14 in width. No other traces could be identified on this fragment.

- Specimen 542, Layer 21

Figure 4.18 Adhering flake and conchoidal scar in a *Cervus elaphus* metatarsal diaphysis. The white arrow indicates the conchoidal scar and the red arrow adhering flake.

Specimen 542 (weathering stage 3 and concretion stage 2 and dissolution1) shows a fracture outline oblique to the long axis of the bone. The angle between the break and the cortical surface is oblique. The margin of the fracture is smooth. These characteristics may indicate green bone breakage. Conchoidal breakage can be a result of carnivore chewing, assimilating the modifications made by humans produced through percussion. However, in this fragment no other tags can be identified. Adhering flake is also present.

- Specimen 1536, Layer 24

Figure 4.19 Highlighted in red, notch on the internal of a metatarsal diaphysis fragment of a *Cervus elaphus*. Images from the bottom row show details of the notch by a stereomicroscope

Specimen 1536 (weathering stage 1 and concretion stage 1) shows a fracture outline oblique. The margin of the fracture is smooth. The presence of a simple and complete impact notch can be observed. Impact notch measuring: 8 mm in length and 6 mm in width. No other traces could be identified on this fragment.

- Specimen 1542, Layer 24

Figure 4.20 Notch in a metacarpal diaphysis of a *Capreolus capreolus*. In the second row details of the notch by stereomicroscope.

Specimen 1542 (weathering stage 1 and concretion stage 1) shows a fracture outline oblique. The margin of the fracture is smooth. The presence of a simple and complete impact notch can be observed. Impact notch measuring: 12,18 mm in length and 6 mm in width. No other traces could be identified on this fragment.

CHAPTER 5. DISCUSSION AND CONCLUSION

The Visogliano rock shelter represents an important Middle Pleistocene site that provides lithic industry, faunal remains and human remains in association. The radiometric datation obtained from different levels of the site dates the stratigraphic sequence around 500 and 350 kyr (Falguères *et al*., 2008). This chronology places the site in a position of relevance, as it can provide information about a second wave of colonization in Western Europe that was using new lithic tools (Cattani *et al*., 1991; Falguères et al., 2008). The zooarchaeological and taphonomic analysis could help to understand the dynamics of human groups during the Middle Pleistocene. However, the conservation status of the faunal remains in this site is poor, where sometimes the bone surface is completely inaccessible. Identifying these traces becomes an even more difficult work.

The zooarchaeological and taphonomic analysis performed on a selection of faunal remains from layers 10/210, 19/219 and 24/224 provided information on the origin and processes that affected the assemblage. The results of the analysis indicate that one of the biggest post-depositional modifications were the concretions, present around 99% of the bones. An attempt was made to remove concretion from these bones with less harmful tools, however, it is noted that even with greater care with the cortical surface, when removing the concretion cape, the outermost surface was removed along with it, then we opted to analyze only the surfaces already visible in the sample. Followed by the concretions, the action of water was also an important agent, which caused erosion, dissolution and/or rounding the surface and edges of the bones. Moreover, water colored in black almost all the fragments of the lower levels, and less in the upper layers. At first, this black color is attributed to manganese and/or iron oxides, taking into account that this is the main factor that changes the color of remains in cave contexts. However, differentiating between this phenomenon and burned bones – both can result in the same coloration – can be tricky in only naked eye analysis.

Weathering is present between 70% and 85% of the sample. Weathering values on Stage 1 are preponderant on the three layers covered. Few fragments have Stage 3 or 4 (highest stages attested in the sample), a result that may be related to the context of the site, considering that weathering rates can vary according to local conditions, and in this case, we deal with equal humidity conditions and temperature in caves (Behrensmeyer, 1978).

It is very important to emphasize here that the results of the analysis were obtained from a cut in the total composition of specimens from each layer. However, generally, the values seem to follow a trend that can be most likely a reflection of the total composition of the layers. In general, the values that most differ from the others are those of the 10/210 layer. This layer along with layer 19 are made up of red soils. Layer 24 is characterized by frost slab deposition.

The fauna spectrum of the Visogliano site is dominated by the presence of *Cervus elaphus* (red deer). This species, being the most expressive of the sample, was the focus of profile age at death analysis. As a result, we observed the presence of sub-adults, adults, and senile individuals, but adult individuals predominated. Along with its high recurrence, the analyzes started with the perspective of the great presence of these animals in archaeological sites dated to this period in the region.

Of the ten specimens identified with potential marks resulting from the butchery process, seven occur in elements of this species. Two others being attributed to Cervids (the other mark occurs in *Capreolus capreolus*). This is a factor that supports human construction in the development of the deposit.

The presence of carnivore teeth marks was found in two fragments of the total sample from the exploratory work. The 10/210 layer has one of these marks (chewing marks). The presence of carnivore remains on the site occurs in several layers. However, the low occurrence of its traces can still be attributed to the selection made in the layers. This can be an indicator of the contribution of carnivores in the accumulation of bones in the deposit or can also be attributed to the filling event of red soils. Analysis to identify which type of carnivore made the marks on the bone still need to be done.

Our results demonstrate that despite poor conservation of bones, it is possible to identify the presence of linear marks associated with butchery process. Of the three layers analyzed, six fragments show potential to be the result of butchery activities. Possible percussion marks were identified in four fragments; however, other fracture factors can be discussed, considering that rockfalls in caves can fracture bones much like human breakage. Two specimens showed linear marks that can be associated with human carcass processing. One of them was classified as scraping marks, which is associated with activities of eliminating the periosteum in order to facilitate the bone fracturing. The other marks were identified as cutmarks, associated with activities of disarticulation and meat recovery. From the identification of these traces, we can attribute layer 24/224 to a human accumulation. On the other hand, the other marks, attributed to trampling, may present some characteristics that can be more associated with cutmarks, but due to the great erosion and presence of concretion on the cortical surface, it was not possible to classify them in any other way.

Nevertheless, the absence of more expressive and diagnostic traces, both of hominins and carnivores, may be a reflection not only of the taphonomic history of the site, but also the absence or little activity of these two actors. None of these hypotheses can be ruled out so far.

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ATTACHMENT

Dissolution

Fig. I. Specimen 525.2 and 525. Left metacarpal of a *Bos Primigenius*. Traces of dissolution possibly caused by the action of water are highlighted in red. Evidenced in black exfoliation marks.

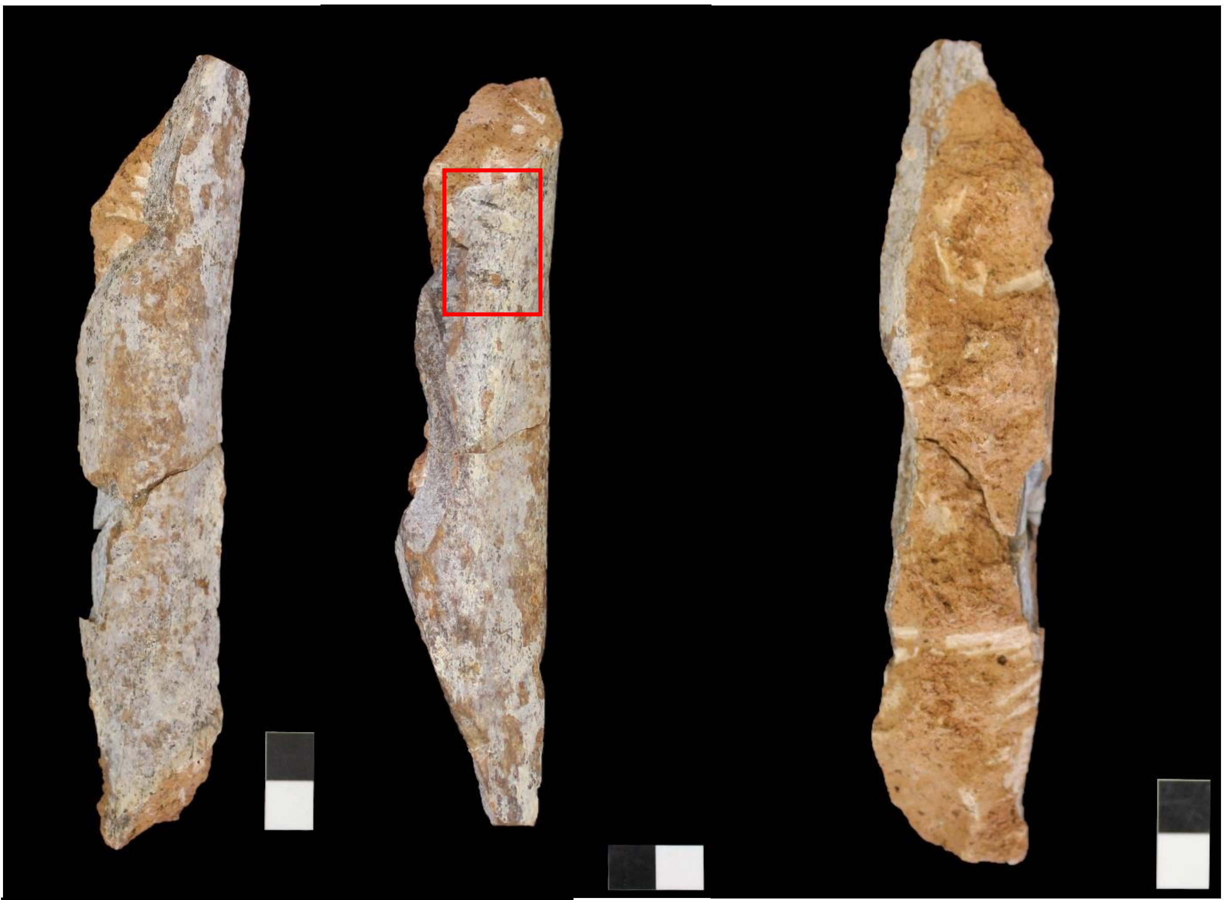
Blunt

Fig. II. Specimen 199, layer 19/219. The edge of the bone shows that underwent rounding processes. Diaphysis fragment of a Cervid metacarpal.

Exfoliation

Fig. III. Specimen 660, layer 21. Bone presents exfoliation all over the surface. External and Internal view. *Cervus elaphus metapodial.*

Carnivore marks



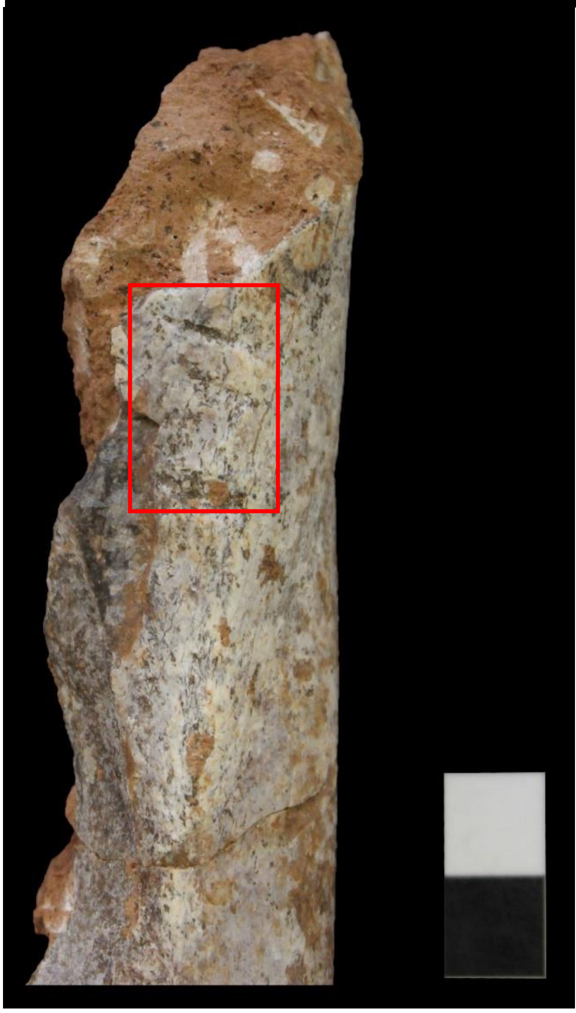
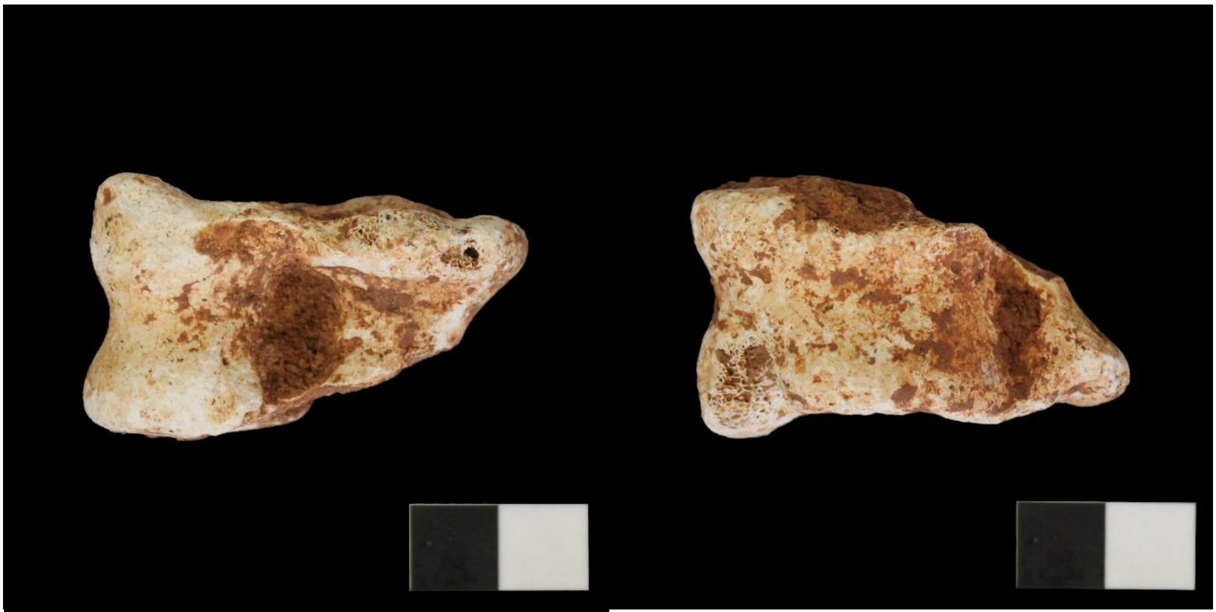


Fig. IIII Specimen 231. Diaphysis fragment of a Tibia. Evidenced in red carnivore teeth marks. The fragment presents exfoliation Stage 3. Taxon undetermined.



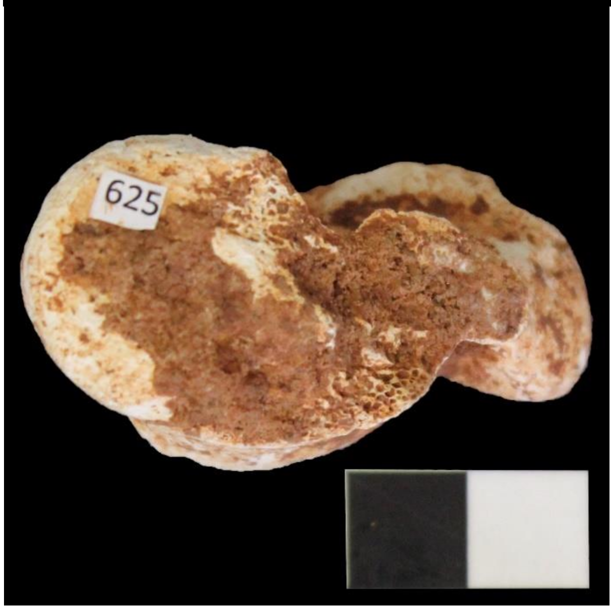


Fig. V. Specimen 652, layer 10. Carnivore chewing on the bone edges. *Cervus elaphus* astragal.

Concretion

Fig. VI. Specimen 647, layer 10. Fragment of a distal epiphysis of a femur. Taxon unterminated. Surface covered by concretion (Stage 3).

Green bone breakage

Fig. VII. Specimen 11, layer 24. Fragment of a metatarsal diaphysis of *Bos* vel *Bison*. Presents green bone fracture characteristics. It is possible to notice the smooth fracture margin.

Weathering

Fig. VIII. Specimen 768, layer 24. Fragment of a proximal epiphysis of a Megacerinae with weathering stage 4 and concretion 2.