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Integrating conservation strategies into archaeological research: insights from the Early Pleistocene site of Barranc de la Boella (Tarragona, Spain)

Estratégias de conservação na investigação arqueológica: perspetivas do sítio Barranc de la Boella (Tarragona, Espanha)

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Abstract

Stone tools and faunal remains are abundant in the archaeological record, serving as key focal points for research and important features of museum exhibitions. Nevertheless, they are under-represented in the conservation literature. This article reports on the conservation of over 2,000 finds from the Early Pleistocene site of Barranc de la Boella (Spain) recovered during field seasons 2007-2023. It focuses on osteological remains, lithic artefacts and coprolites (fossil faeces), detailing the workflow from the fieldwork to the laboratory, specifying the criteria and techniques employed for each group of materials. In the absence of clear guidelines, the archaeological study approaches adopted for each group of finds helped define the conservation strategies. Therefore, conservation treatments are naturally aligned with the research aims, making conservation an integral part of the research project. We conclude by emphasising the importance of sharing conservation practices to inspire innovation in conservation techniques.

KEYWORDS
Conservation
Archaeology
Bone
Lithics
Coprolites

Resumo

Instrumentos de pedra e remanescentes faunísticos são elementos abundantes no registo arqueológico, fundamentais para a investigação e para as exposições museológicas. No entanto, continuam pouco representados na literatura dedicada à conservação. Este artigo apresenta o trabalho de conservação de mais de 2.000 achados provenientes do sítio do Pleistoceno Inicial de Barranc de la Boella (Espanha), recolhidos entre 2007 e 2023. Centra-se nos restos osteológicos, artefactos líticos e coprólitos (fezes fósseis), descrevendo o percurso dos materiais desde a escavação até ao laboratório e especificando os critérios e técnicas utilizados para cada grupo de materiais. Na ausência de diretrizes específicas, as práticas de levantamento arqueológico adotadas para cada tipo de achado orientaram a definição das estratégias de conservação. Os tratamentos de conservação alinharam-se com os objetivos de investigação arqueológica e a conservação tornou-se parte do projeto científico. Destacamos a importância da partilha de práticas de conservação, para promover a inovação nas técnicas aplicadas.

PALAVRAS-CHAVE
Conservação-restauro
Arqueologia
Osso
Indústria lítica
Coprólitos

Introduction

Archaeological conservation poses unique challenges due to the vast range of materials that comprise the archaeological record, including human-made objects, ecofacts (biological remains), and non-portable features such as post holes and buildings [1]. Furthermore, the preservation of remains in burial environments leads to changes that are not commonly seen in other areas of conservation. The long timespans of these sites, which together cover the entirety of human existence, amplify these material transformations. In fact, only palaeontological conservation encompasses a broader timescale than archaeological conservation, which is a key consideration for conservators.

A distinctive aim of archaeological conservation compared to other fields of heritage conservation is its focus on the recovery of information [2-3]. As Caple (2021) notes, the conservation process aims to transform an unstable and unreadable object into a stable information source [4]. To accomplish this, the conservator must have a deep understanding of which information is relevant and how it is going to be analysed. This presents a significant challenge due not only to the aforementioned broad range of materials encountered, but also because of the various work scenarios, such as excavations, and the diversity of sites and time periods involved.

The Palaeolithic is the oldest and longest period of human history. Sites from this period have yielded collections consisting largely of stone artefacts, as well as faunal remains and, in less abundance, hominin remains. These types of archaeological materials are very common in the archaeological record. However, although they have been the subject of seminal multidisciplinary research into human behaviour and evolution and are central to many museum collections, they have not received equal attention in the field of archaeological conservation. In addition to macrofauna skeletal remains and lithics, prehistoric sites contain a wealth of meaningful material that may be less relevant in later chronologies. For example, small vertebrates like rodents or, as covered in this paper, coprolites (fossilised faeces) may contribute key data for unlocking aspects of the ancient past. These materials are primarily studied to infer paleoenvironmental data, which is the focus of less attention in the study of later periods.

Many of the challenges and conservation procedures are addressed in some of the literature on the conservation of archaeological bone remains, in addition to that on palaeontological sites [5-8]. There is also a growing body of work on conservation interventions on human fossils, either reported independently or in articles with a paleoanthropological focus [9-15]. However, with a few exceptions, remains such as lithic artefacts have not received much attention. The initial cleaning process, typically a simple rinsing with water using brushes or small tools, is assumed to be part of the archaeological processing of the material. Cleaning with additives to the water, such as sodium hexametaphosphate, as well as acids to remove sedimentary deposits, has also been reported [16-18]. But some artefacts may require more extensive treatment. For example, we have reported challenges in conserving lithic artefacts from several Spanish sites which required consolidation [19-20]. Lastly, to our knowledge, the conservation of coprolites has not been extensively reported (although we address it briefly in our article [21]).

This article reports the conservation work carried out in the Early Pleistocene open-air site of Barranc de la Boella, dated to approximately 1 million years BP and located in Tarragona, Spain. Conservation efforts have focused on three material groups: osteological remains, lithic artefacts and coprolites. Between 2007 and 2023, more than 2,000 finds underwent conservation. This article covers the objectives and workflow of the conservation team within the context of archaeological research, from fieldwork to preparation for study. The primary goals of this report are to share conservation practices that may guide conservators facing similar challenges. It also aims to disseminate criteria for conservation to better meet the requirements of early prehistoric archaeological research and to highlight the unique aspects of the Pleistocene archaeological record that have been underrepresented in the conservation literature.

The site, the excavation and the conservation workflow

Barranc de la Boella is located in a ravine in the area of La Canonja (Tarragona, Spain) (Figure 1). It is an open-air site with a nine-metre thick stratigraphic sequence comprising six units from the Late Early to the Late Pleistocene. Since 2007, fieldwork has been conducted in three localities: Pit 1 (P1), La Mina (LM), and El Forn (EF). This paper focuses on the most abundant and significant material record of the three localities, which comes from Unit II and which contains archaeological deposits dating to the Late Early Pleistocene (0.99-0.78 Ma). Research on this unit has shed light on the interpretation of hominin behaviours in an open-air fluvial-deltaic sedimentary environment. These behaviours include examples of cumulative palimpsests, such as those found at the site of La Mina, in which hominins played only a minimal role as modifying agents, as well as the extraordinary mammoth butchery site documented in Pit 1 (Figure 1d). Barranc de la Boella also provides insights into Early Acheulean technology in Europe, adding critical information to the debate on the Early Pleistocene hominin occupation of the continent [22-25].

Figure 1. The Barranc de la Boella site: *a)* the location of the site in La Canonja (Tarragona, Spain); *b)* the modern seasonal ravine (barranc in Catalan) with the blue shed awning covering the El Forn locality (field season 2009); *c)* Pit 1 during the 2018 field season; *d)* the assemblage of Pit 1 interpreted as evidence of a mammoth butchery site.

Figure 2. Faunal remains from La Mina recovered in 2018: *a)* restored ones; *b)* some spread out during the conservation work – each group of fragments on each piece of paper corresponds to one recorded item before restoration.

Barranc de la Boella was reported as a palaeontological deposit in the twentieth century, but it was not until 2007 that the first systematic excavations began, led by researchers from the Catalan Institute of Palaeoecology and Human Evolution (IPHES-CERCA). Since then, archaeological excavations have taken place every year in field seasons lasting about one month, usually at different sites simultaneously.

These iterative excavations, carried out year after year since 2007, are conducted using open-air and archaeological stratigraphic methods. A grid is established, and as finds are collected, their precise locations are individually recorded using a total station, which provides x, y, z coordinates for all stone artefacts, coprolites, and faunal remains. The rate at which finds are recovered varies, as does the density of the assemblages, but to give an idea, over the last ten years the number of items recorded has ranged from 250 to 550 per season, including faunal remains, lithics and coprolites. For our purposes, an item is considered any find excluding bone fragments measuring less than 2 cm that are taxonomically and anatomically unidentifiable, which are collected daily in a bag for each square and every 10 cm of depth. This has resulted in a large number of items to be processed (Figure 2).

Conservation begins on site, where conservators are part of the excavation team throughout the field season. The involvement of conservators in this process allows them to become familiar with the site, the excavation methods, and the complete material record that emerges. This hands-on experience helps in planning conservation strategies for both the ongoing fieldwork and subsequent laboratory conservation. By having a comprehensive view of the entire assemblage, conservators gain a deeper understanding of the site and the research than a selection of finds sent to the laboratory alone can fully convey.

Field conservation techniques are well-established and widely understood by the experienced excavators who work at Barranc de la Boella. The excavators themselves are responsible for consolidating, block-lifting and/or preparing packaging for their finds. The conservation team advises less experienced excavators on the application of basic conservation techniques and, usually takes on the most complex cases. Field treatments are undertaken with the understanding that the remains will be treated at the nearby IPHES-CERCA laboratory at the end of the excavation period. For this reason, very simple and effective systems can be used without the need for excessive intervention in the field (Figure 3).

Figure 3. Rhinoceros humerus from La Mina: *a) in situ*, strapped with tape (plastic film was placed between the tape and the bone to protect the surface of the bone from the glue of the tape); *b)* in the laboratory after removal of the wrapping; *c)* restored.

After each field season, the material recovered is processed at the IPHES-CERCA laboratory. First, the archaeological team reviews all the recovered material and checks the inventory, and then only the altered lithic artefacts are sent to the conservation laboratory. Due to the fragility of faunal remains and coprolites, the process is reversed for these materials: all of them are first sent to the conservation laboratory, where the conservators separate out the few pieces do not require any intervention. The conservation workflow in the laboratory begins with the treatment of unstable but quickly treatable finds, such as small faunal remains. More time-consuming items are prioritised according to research needs. A notable example of this is the large mammoth remains for which, after the initial stabilisation and treatment to allow them to be studied, conservation is addressed in stages and only prioritised if they are selected for display.

Finally, in a similarly integrated manner, conservation treatments are recorded in the same database as the excavation data. Conservation data are always linked to each record and are accessible to any researcher.

The conservation treatments

A large number of remains from the Barranc de la Boella site have undergone conservation treatments. Most of these finds were recovered from Unit II, which is the focus of this article. To date, nearly 2,000 faunal remains, approximately 200 coprolites, and 15 lithic artefacts have been treated in the conservation laboratory. This section provides an overview of the conservation work performed on each group of materials based on their condition and the specific requirements of the studies to be conducted on them.

Coprolites

Coprolites or fossilised faeces are aggregates of macroscopic and microscopic remains that have been digested by the defecator agent, including bone fragments in the case of carnivores. Coprolites provide valuable information about the presence of the producer, its diet, and, on a broader scale, the ecology of its habitat. Coprolite studies might focus on the analysis of embedded micro- and macro-remains, often requiring sampling, or they may simply examine morphology and size [26-27].

There is limited information on conservation treatments for coprolites. Thus, our approach was based on the intended use and objectives of the studies. As previously mentioned, coprolites can be analysed morphologically or through content analysis, or a combination of both, which is the process being undertaken with the hyaena coprolites from Barranc de la Boella [28]. For morphological analysis, the coprolite must be stable and restored. In contrast, for content analysis, preserving the integrity of the coprolite is less critical, and limiting the use of substances that could complicate future sampling is recommended.

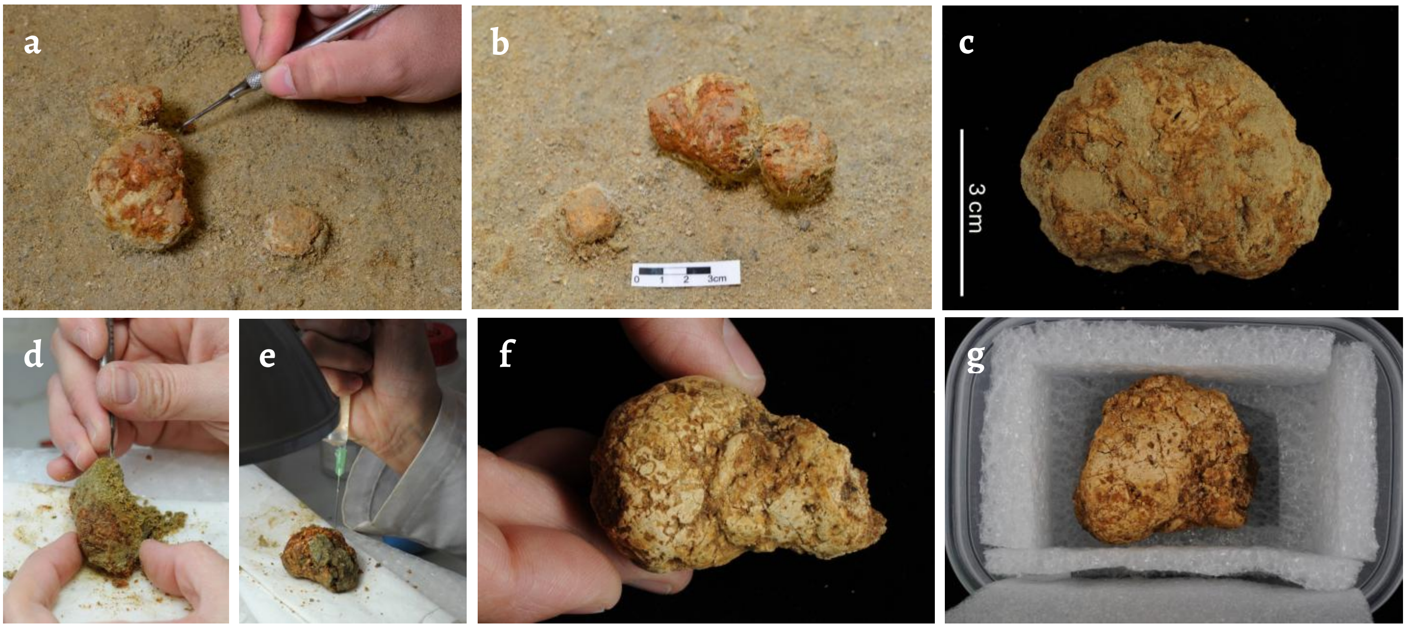

Figure 4. Treatment of a hyaena coprolite from the field to the final packaging: *a)* three coprolites at the La Mina site during excavation, and *b)* ready to lift; *c)* the larger coprolite before conservation; *d)* during cleaning; *e)* consolidation processes; *f)* the restored coprolite (opposite side); *g)* the packaging system in a polyethylene (PE) plastic box padded with PE foam.

At Barranc de la Boella, most of the hyaena coprolites were recovered from the La Mina site, and most of them were highly susceptible to disintegration during excavation. Even gentle handling with a soft brush or a mild air jet caused particles to break apart, and removing the coprolites from the sediment often led to cracking or complete fragmentation. To preserve their integrity for later measurement and morphological analysis, immediate action was required on site. To that end, they were carefully excavated using small tools and air blowers and consolidated as they were uncovered (Figure 4). To consolidate, we used Mowilith DMC2 during the early years of excavation, when the site was unsheltered and occasional rainfall wet the sediment. This product, an aqueous dispersion based on a vinyl acetate/maleic acid copolymer, strengthened the coprolites in the presence of moisture. After the site was covered, the sediment remained reasonably dry even on rainy days, allowing us to switch to the more stable acrylic copolymer Paraloid B72, which dissolved in acetone (approximately 10–15 %) before application. Once in the laboratory, the focus was on maintaining the integrity of the more complete and potentially recognisable coprolites, while those in poorer condition were left untouched.

To date, over 40 % of the recovered coprolites have been treated using a relatively standard approach because of their similarity in size, shape and condition. First, the sediment was removed with small tools and the same product used on site was used as a consolidant. Afterwards, they were packed in polyethylene boxes.

Stone artefacts

Stone, or lithic, artefacts encompass all types of stone tool materials found at prehistoric sites, ranging from unmodified objects used in percussive activities to discard pieces removed during tool production, as well as finely worked pieces in the form of retouched flakes and large tools such as bifaces [29]. Sizes are also diverse, from a few millimetres for debris to over 20 to 30 cm in length for the largest tools.

The analysis of lithic artefacts begins with a technical reading of each artefact, the identification of the raw material and the classification of specimens based on their morpho-technical features [29]. To facilitate this, the artefacts must be as complete as possible, and conservation interventions must ensure the clarity of the edges and the flake scars on artefact surfaces. Studies can also be based on the existent conjoins between different artefacts, for which the possible contact planes of each individual artefact must be sufficiently cleaned to permit refitting. Meanwhile, microscopic use-wear studies tend to concentrate on the edges of the artefacts. These studies require the edges to be clean enough to be observed, but otherwise largely untouched, as use-wear traces are quite sensitive to any contact. This rather difficult balance sometimes requires redefining the level of intervention for specific artefacts or assemblages. Other analytical approaches may be used with study-specific requirements, like the study of residues on artefacts. Ideally, the conservator is generally informed in advance which artefacts will be studied in one way or another, and which particular part of the artefact might be subjected to each type of analysis, especially for studies that are more sensitive to any direct intervention performed on the artefacts.

The lithics of Unit II are mainly made of chert (>80 % of the sample), but there are also artefacts produced from schist, quartz and other raw materials. They range in size from <2 cm to slightly over 20 cm [30]. The artefacts are generally well preserved. In fact, to date, 99 % of the samples were simply washed with water in the archaeological laboratory and did not undergo any type of conservation treatment. Only a small number of the schist artefacts were treated (fewer than 15 % of those recovered). Delamination can cause schist artefacts to split into fragments. Some have also exhibited superficial granular disintegration, which can be more extensive and even penetrated down to the core in some cases (Figure 5). Because of this, some pieces had to be consolidated *in situ* with Paraloid B72 in acetone (ca. 10 %) to prevent them from disintegrating during lifting. We used Paraloid B72 even though some data suggest that silica-based products may perform better in the long term [19, 30]. However, such products require a minimum of three days to become effective, which is not possible in an excavation scenario. In the laboratory, on the other hand, slower treatments are more feasible, so for some artefacts (n=6) we used a colloidal aqueous dispersion of silica nanoparticles (Nano Estel). As demonstrated in other lithic assemblages, such as those of the Sierra de Atapuerca and La Cansaladeta [20, 31], both types of products work to reinforce artefacts. Depending on the porosity of the stone, Paraloid B72 can give it a plastic appearance. In contrast, siliceous consolidants do not cause a plastic film to form, although they can slightly intensify the colour tone of the materials.

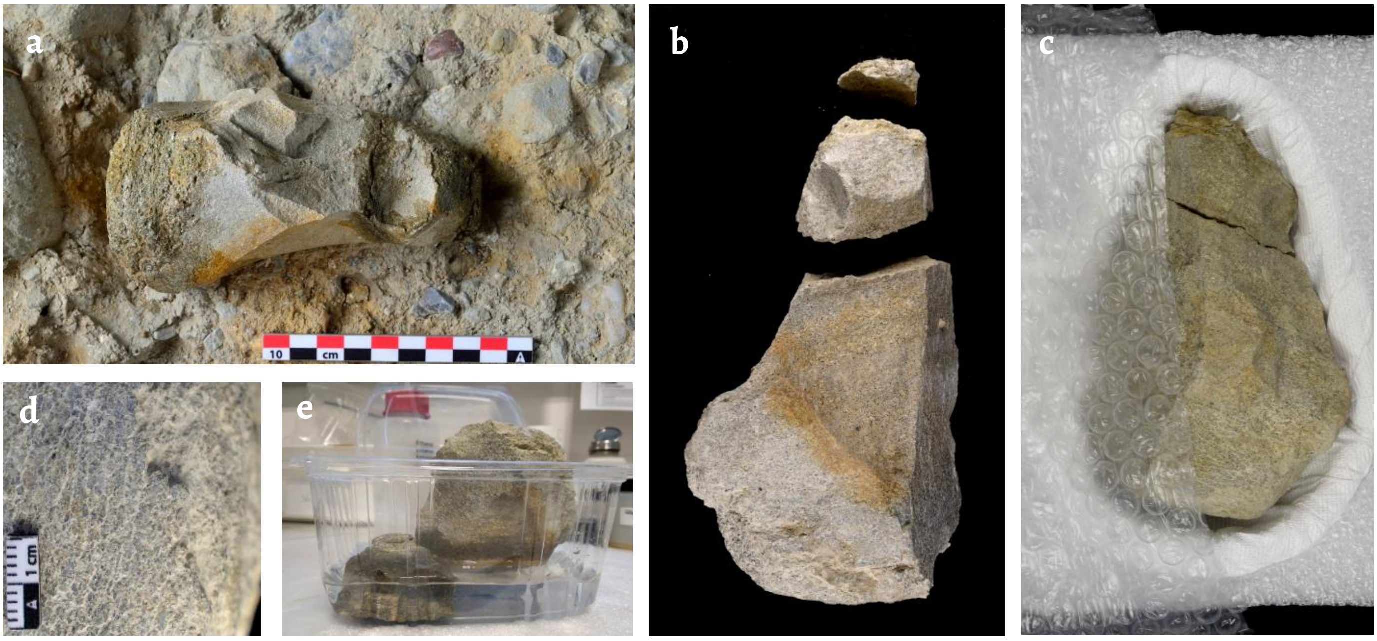

Figure 5. Schist artefact from Pit 1, from the field to final packaging: *a) in situ*; the darker areas at either end of the artefact are due to the presence of Paraloid B72; *b)* after lifting, the artefact split into three pieces along schistosity planes; *c)* the restored artefact in its final packaging; *d)* detail of the proximal part of the artefact (extreme left end in Figure 5a) – an outer layer of about 2 mm in depth was preserved without serious decay, while the core of the tool was granularly disintegrated; *e)* capillary consolidation with Nano Estel.

In addition to consolidation, laboratory conservation included cleaning, joining pieces, and filling voids. The cleaning techniques used on these artefacts were simple, as they mainly had silty or sandy sediment that was loosely adhered to the surfaces. This sediment could be easily removed with small hand tools, such as brushes or plastic and metal spatulas, either alone or combined with water, ethanol or acetone. Paraloid B72 was used to rejoin pieces, while some gaps were filled with a mixture of Paraloid and glass microspheres.

Fauna

Faunal remains from Palaeolithic sites vary greatly, ranging from small, unidentifiable fragments to complete anatomical elements. Whether identifiable or not, all remains are recovered and recorded during excavation. Better preserved and identifiable elements provide more accurate information about the species and facilitate systematic palaeontological and palaeoecological research. Zooarchaeological and taphonomic studies analyse every component of the assemblage to gain insight into the origin of the accumulation and the agents that caused it and infer the behaviour of the hominins or other species that generated the accumulation. As we have argued in previous works, each research approach may require a slightly different conservation treatment [32].

The most basic step in analysis is identifying the remains for the collection of primary data, such as the anatomical element and the taxonomic group [33]. This is based on a biometric analysis, examining the shape and size of the specimens. To do this, the specimen must be sufficiently stable and have a level of reconstruction that allows it to be identified and measured. From there, there are a number of options for studying the bones, which will influence the choice of conservation approach. Among other things, systematic palaeontological research requires precise measurements to be taken at key points or landmarks. This usually means that a more complete and accurate reconstruction is required. Additionally, taphonomic studies analyse post-mortem modifications in bones to infer the causal agents (including hominins, carnivores or geological processes). For these studies, fragmented or distorted specimens should be conserved in a state that closely resembles their condition when originally found, rather than being fully reconstructed to their original morphology. Similarly, zooarchaeological studies analyse the breakage patterns of bones, for which the fragmented specimens and their fracture edges can be significant. Therefore, the degree of reconstruction is usually a case-by-case decision based on the relevance of each analytical approach to each specimen in a particular context. Also, the level of cleanliness required might vary from just enough to see the specimen to enabling full analysis of the bone surface in detail for bone remodelling or pathology studies, or for detecting conspicuous and inconspicuous taphonomic traits. In the latter case, accurate but gentle cleaning is often required. Finally, some restrictions to conservation treatments may be imposed by the need to sample various chemical components for different types of analyses (isotope, DNA, protein analysis, etc.) [34]. Each type of study, each individual element, each assemblage and research question, could lead to slightly different conservation treatment decisions.

The faunal record of Barranc de la Boella is made up of bones, teeth, and antlers. This group of finds presents a wider range of preservation conditions than the lithic artefacts or coprolites, largely because their dimensions and shapes are more varied, which multiplies the number of potential problems. The size of these pieces ranges from small bone fragments, some of which are of indeterminate origin, to the largest finds recovered from the site, identified as mammoth remains. To give a more accurate picture, 90 % of the fauna sample measures less than 10 cm, and the remainder mostly measures between 10 and 30 cm. There are also six large specimens measuring between one and two m in length, all of them mammoth remains, which although very few in number, are extremely time-consuming in terms of conservation.

The processes and agents that have acted over the years in this open-air site have significantly contributed to the modification of the bone surfaces. Many of the osteological remains bear taphonomic alterations, including weathering, hydric abrasion and chemical changes due to leaching [35]. Recent studies corroborate our experiential knowledge, which had already led us to consolidate the bone remains recovered: the porosity of the bones from this deposit was higher than that of fresh bone, and the surface microhardness was lower [36-37]. The bones from the site were in poor condition and problems had already arisen during excavation. Some were already cracked, some broke during excavation, and others simply crumbled. However, 90 % of the bones recovered measure less than 10 cm in length, making it easier to dig them out and handle them, and field conservation techniques were generally reserved for the larger specimens.

Consolidation is the most commonly used technique in the field. Initially, Mowilith DMC2 was used to consolidate both bones and coprolites because the sites were unsheltered in the early years of fieldwork and the sediment was often damp. Following the installation of protective structures, Paraloid B72 became our preferred consolidant. Additionally, some specimens (n=43) were faced with cotton gauze applied using Paraloid B72 (Figure 6). Only the larger and heavier mammoth remains – four mammoth tusks, a rib, a tibia, a femur and a scapula – were block-lifted using polyurethane. In most cases, two-component polyurethane was used due to its ability to penetrate cavities effectively and conform to irregular surfaces. In some cases, a one-component foam was employed; although less fluid, it is easier to apply and more readily available from less specialised suppliers (Figure 7).

All the faunal remains recovered from the site, whether treated *in situ* or not, were transferred to the conservation laboratory due to their poor state of preservation and the risks involved in handling them. In the laboratory, each fragment underwent detailed examination, and the conservators determined the necessary treatments. Some fragments could be cleaned with water, while others required consolidation either before or in conjunction with cleaning. Our experience allowed us to predict which specimens would tolerate water exposure. When we were not certain, a preliminary resistance test was conducted by dabbing or pipetting a small amount of water onto the surface. If the fragment demonstrated stability, it was considered safe to proceed with progressive and controlled immersion. Water cleaning was typically paired with brushing using fine, soft brushes to avoid unnecessary abrasion. Less gentle tools, such as bristle brushes or toothbrushes, were deliberately avoided. Practical experience, supported by research, has shown that these bone surfaces are particularly vulnerable to damage from even mild pressure or soft tools, especially when dampened with water or other solvents [36, 38-39]. Alongside water-based methods, manual mechanical cleaning remained the predominant approach, employing tools such as soft brushes, scalpels, and Teflon instruments to ensure delicate handling.

In the laboratory, Paraloid B72 in acetone was predominantly used for consolidating the faunal remains. The application methods varied, though brushing or dripping were the most common approaches, and immersion was used occasionally for smaller fragments. The same product also served as an adhesive for reassembling fractured remains.

When reconstructing fragments, the origin of the fractures was a key consideration in determining whether they should be re-adhered. Fractures that occurred before excavation were generally not initially re-adhered, as the study of edges and breakage patterns is critical for certain archaeological analyses.

Figure 6. Removal of a deer metacarpal from Pit 1: *a) in situ*; *b)* during facing with cotton gauze and Paraloid B72; *c)* the underside of the metacarpal immediately after lifting it.

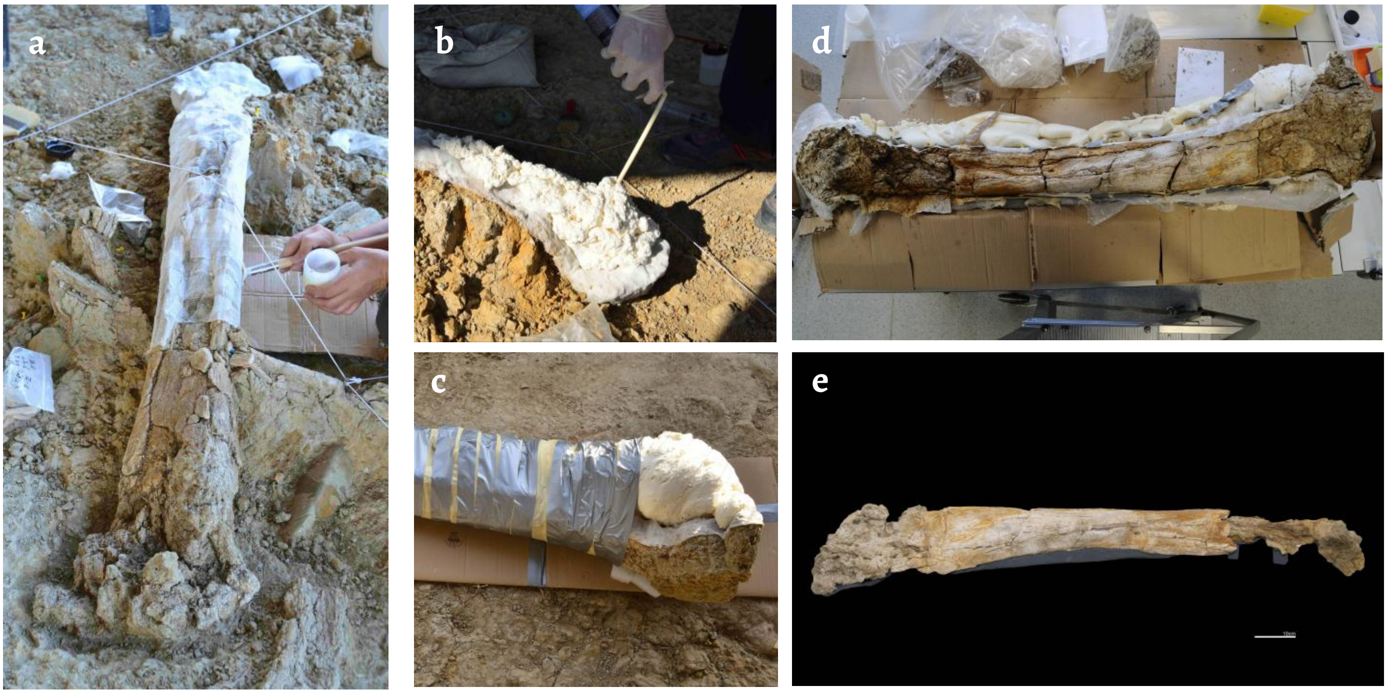

Figure 7. A mammoth femur from Pit 1 from the field to exhibition: *a)* facing with cotton gauze and Mowilith DMC2 vinyl acetate resin (following previous consolidation of the femur with Paraloid B72); *b-c)* application of one-component polyurethane to the exposed side of the femur, which was then turned over and secured with tape; *d)* in the laboratory, resting on polyurethane after removal of the sediment, the first step in a long restoration process; *e)* the restored femur, ready for exhibition.

Packaging

The packaging of finds is a continuation of the conservation process and primarily aims to protect the specimens while ensuring ease of access for study. Packaging is designed to be practical: it must be easy to open and close, and researchers must be able to handle the objects contained within it without risking damage. Most finds are stored in polyethylene plastic bags with individual identification labels, ensuring that both the artefacts and labels are easily visible. For additional protection, many of these bags are placed in an outer layer of bubble wrap. This method is typically used for small and medium-sized (roughly up to 20 cm) faunal and lithic remains in good condition.

Figure 8. Mammoth molars from Pit 1: *a) in situ*; *b)* before conservation, still wrapped in bubble wrap used in the field on site to secure the molar; *c)* final packaging of this and other molars in cavity mounts in polyethylene (PE) foam covered by Tyvek, also PE-based.

A small percentage of finds require additional protection. This is the case with coprolites, which are usually kept in individual plastic boxes. Similarly, larger and more fragile faunal and lithic finds are housed in customised polyethylene foam cavity mounts to secure them. An intermediate layer of Tyvek woven plastic is added to minimise friction between the artefact and the foam, following practices outlined, amongst others, by Schilichting (1994) [40]. This approach balances protection with usability, ensuring the artefacts remain safe as well as accessible for further research (Figure 5 and Figure 8).

Concluding remarks

At the Barranc de la Boella site, all conservation processes must meet one fundamental requirement: the finds must remain identifiable and stable enough to allow handling and analysis. To this end, as Pye (2009) noted, sometimes the extent of the remedial work (i.e., cleaning, reshaping and systematic consolidation) that would normally be considered over-interventive in other areas of conservation is the only chance of survival for unstable finds [41]. Therefore, knowing what the finds are and how they will be studied has acted as the real guide in this case, especially for the lesser-documented types of finds in conservation, such as lithics and coprolites.

The techniques and products described are not new, and most techniques are quite straightforward and versatile. In fact, field conservation techniques have barely changed for decades [2, 42-47]. Treatments like those described here have been reported for different Pleistocene skeletal remains, both for field and laboratory work [6-7, 15]. On the other hand, although reporting the treatments used for coprolites and lithics is a novelty, in the end, the techniques used for these finds were essentially the same as those used for faunal remains. Nevertheless, the repetition of techniques should not discourage conservators from reporting them. The fact that some procedures are repeated reveals which techniques are actually used in the field of conservation. This is important for both research and practice.

The problems and challenges encountered in conservation practice should guide a substantial portion of research efforts, which are very often dedicated to new techniques or products but rarely address these practical issues. For instance, there is a disconnect between the criteria conservators prioritise when choosing a consolidant and the consolidant properties most tested in research. In in our own our experience with lithics, although some laboratory tests on chert tools have shown that silicate-based products may be better in terms of durability and compatibility than the acrylic Paraloid B72 [19, 30], we mostly use the latter. The same is true for coprolites and bone material, for which Paraloid B72 has proved effective due to the practical demands of the conservation work, such as speed and efficiency – factors that are both deliberate and justified. Archaeological remains can disintegrate as they are being dug up. It is not possible to consolidate a centimetre, wait a few days, dig another centimetre more, and so on. In the laboratory, the timeframe changes, so we use different products like silica-based consolidants for lithics. However, sometimes we need to alternate cleaning with consolidation on small areas as the only safe way to progress, and again this is only possible with a product with a fast-setting time. In fact, the setting time of a consolidant plays a critical role, often overshadowing other properties such as long-term durability or chemical compatibility, which tend to be the dominant aspects examined in laboratory-based evaluations. For this reason, even though we recognise the need to test other consolidants, we have continued to evaluate acrylic resins as well [19, 30, 48-49]. A step further in consolidant research would be to find an alternative product that meets the time-sensitive demands of real-world conservation scenarios. Similarly, simple techniques for cleaning or removing sediment with small tools, which are consistently and constantly used in conservation practice, have received very little attention. Our own research, which included samples from Barranc de la Boella, is an effort to fill this gap and determine which tools – such as brushes, cotton swabs or scalpels – are most likely to damage bone surfaces and other fragile materials [39]. Ultimately, we believe the field would benefit from research into the most common – and not necessarily the newest – materials and techniques, such as consolidation with acrylic resins and cleaning with small tools.

Publicising practical cases also helps to improve conservation practice. Conservators often lack complete information about all of the materials and situations they encounter. Even specialists in archaeological conservation are faced with a vast array of materials, chronologies, and contexts – ranging from field to laboratory work, and from newly discovered finds at excavation sites to museum objects that may have undergone prior interventions. Given the sheer diversity of scenarios, it is simply not feasible for conservators to master every case. Each reported case therefore contributes to the existing catalogue of problems encountered by practitioners in the field. As discussed earlier, although there are some general criteria for each group of materials, there are also specificities that can slightly change the course of treatment for each specimen. And, in order to plan the overall conservation strategy and decide on priorities, the focus needs to be broadened from single specimens to whole assemblages. Some specimens are not as relevant to the research and may receive less attention than those that are more germane to the project's objectives [33]. It is therefore crucial that conservators know the state of the art of archaeological research as well as the research workflow at each specific site. Only the long-term integration of conservation into the archaeological project itself can truly make this kind of approach feasible.

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