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Editorial

The new Journal of Bioarchaeology, a fundamental tool for the dissemination of research

We have reached a point where it resulted necessary to disseminate Bioarchaeological Research also with a Journal that reflects today's success in this academic and professional field. In the last few decades, we have seen an important development of research in Bioarchaeology in all competence areas: anthropological, paleopathological, zooarchaeological, archaeobotanical, etc.

Today we have seen how bioarchaeology manages to obtain appreciation and credibility even outside the academic sphere. In recent years, external investments, in particular received by banking foundations, have financed a large part of our initiatives, among which the creation of a new journal in the field of bioarchaeology.

It is evident for all of us that our investigative models have the ability to give back a lot to the territory, as our research is closely linked to the contexts of discovery. Bioarchaeology has the power - and the duty- to return the results to the community precisely through the valorization of finds -the bioarchaeological ones -, which by their nature are destined for museum display.

Bioarchaeology transforms the territory, enhances our natural historical heritage, and implements knowledge in the field of landscape archaeology. This is the reason why bioarchaeological initiatives have strong repercussions in the *Third Sector,* since they are not perceived only as research products shared exclusively in the academic field, but are conceived as strategic projects capable of enhancing the landscape through recovery activities and the study of bioarchaeological contexts. Bioarchaeological research, as demonstrated by the funding obtained from the Fondazione Comunitaria del Varesotto and Fondazione Cariplo, which allowed the creation of this new editorial product, manages to be appreciated by the community thanks to its interventions that insist on the territory through the exploration of archaeological sites.

In fact, our Journal was born from the newborn project concerning the *Bioarchaeology of Valcuvia* through the study of three cemetery areas -San Biagio in Cittiglio, Sant'Agostino in Caravate, and the Crypt of the church of the Convent of Azzio- for the creation of a bioarchaeological itinerary. Therefore, in this issue, most of the contributions concern the bioarchaeological studies conducted at the sites of Valcuvia. The bioarchaeological path that is already developing on the sites of Cittiglio, Azzio, and Caravate is fully focused on making the Varese area known through the exhibition of bioarchaeological contexts. The aforementioned sites are being transformed into museums, which by the very near future will have enhanced their bioarchaeological peculiarity and, once completed, will be attracting local communities and national and international tourism.

This first number of the Journal of Bioarchaeological Research also includes other contributions of particular interest for anthropological and paleopathological research. In the paper regarding the 18th-century anatomical collections of the University of Pavia Museums System, the authors highlight the importance of studying and transferring knowledge of this type of collections also in the university context. The contribution on the mummy of Beato Antonio da Fano deals with a peculiarity of great interest for the study of human remains, which is not widely covered in the anthropological literature, namely how the nesting of rodents affects the state of conservation of mummified remains. Finally, the review on archaeoentomology shows how entomological investigations could obtain specific information about rituals, bodies' transfer and sanitary conditions.

This first issue welcomes above all articles concerning the anthropological study of human remains; nonetheless, our journal intends, as shown by the structure of the Editorial Board, to open up to other fundamental fields in bioarchaeological research, i.e., zooarchaeology, palynology, taphonomy, etc…

This is just the starting point. We trust in the success of the initiative, ready to welcome all the suggestions of our readers who will certainly be able to increase the editorial scientific value of this young product.

Marta Licata
Editorial in Chief
Journal of Bioarchaeological Research

Original Article: Physical Anthropology

Peasants, nobles and religious. Mortuary archaeology in the church of SS. Eusebio and Antonio of Azzio, Varese (Northwest Italy)

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Abstract

Aim. In this paper, we present a summary of the bioarchaeological analyses carried out in the church of SS. Eusebio and Antonio of Azzio, Varese, between 2012 and 2022.

Material and Methods. Ten years of studies have qualified this church as a context of primary importance as regards some aspects related to the mortuary archaeology of a human sample composed by peasants, nobles and religious. Several analyses have been proposed and many methods adopted, from time to time to respond to different needs.

Results. The context allows us to acquire data about e.g., the treatment of the body, the tomb types, the funerary ritual and the entomofauna of the context.

Discussion and Conclusion. This paper wants to present an overview of the analyses that have been carried out in the context also thanks to the collaboration of various scholars who have made it possible to form a multidisciplinary team.

Key words: Bioarchaeology, anthropology, body treatment, Modern Age, burial analyses

Introduction

Between 2012 and 2022, the anthropologists of University of Insubria carried out the bioarchaeological analysis in the St. Eusebio and Antonio church of Azzio (Larentis & Gorini, 2019; Licata et al., 2021), a town in the Varese municipality, lying in the north-western part of Lombardy, Italy (Fig. 1). The skeletal remains were stored and analysed in our Laboratory, in the University Department of Biotechnology and Life Sciences. The church of Azzio is an important archaeological site for Italian Modern era for its vast osteological archive (Larentis et al., 2020). Moreover, the rituality reserved for some of the bodies refers to the underground exhibition rooms sporadically analysed in Northern Italy and often called incorrectly *putridarium*. Therefore, this context is emblematic from the point of view of Mortuary Archaeology.

Bioarchaeological background

The first archaeological investigations took place in 2012, due to the need to excavate the church for a floor heating system. In this occasion, we investigated the main phases of the context (Fig. 2). We found several burials and filling levels characterised by a conspicuous presence of bones, not analysed from the anthropological point of view before the 2022.

The discovery of a hypogeum vaulted area adjacent to the high altar led in 2013 to further archaeological investigations to document this environment. The research allows us to verify the funerary function of the hypogeum, reserved for the Franciscan friars. The bone remains found inside the niches of vaulted space was recovered and preliminarily analysed by Dr Marta Licata. During the archaeological campaign was found a second trap door at the floor level, that leads to an ossuary below the room. Inside, on top of a pile of bones,

Figure 1. Above the physical map of Europe, Italy is highlighted by the white rectangle; in the lower left, the Lombardy region is highlighted in red within Italy; below right, the Azzio site is located within the Valcuvia, a pre-alpine valley in north-western Lombardy that connects Lake Maggiore and the transalpine.

a skeleton was found in perfect anatomical connection, subsequently analysed (Larentis et al., 2020).

The archaeological investigations carried out between 2012 and 2015 allow us to discover some underground rooms in the church: the ossuary chamber below the Franciscans *"putridarium"*, the Dalla Porta family tomb, and five funerary chambers. We explore these environments to draw up a work plan for subsequent anthropological research activities on the context in 2021 thanks to a research project which involves other churches in Valcuvia (Tesi et al., 2019; Licata et al., 2020). In addition, the osteoarchaeological materials found during the previous campaigns were analysed and reviewed. For the anthropological analyses, a temporary physical anthropology laboratory has been set up in the sacristy of the church.

Materials and methods

We analysed the osteological materials found between 2012 and 2015, and those recovered in 2021 in the nave and in the tomb of the Della Porta, following the ethic statement proposed by Squires, Roberts & Marquez-Grant (2022).

The skeletal remains were in a good state of preservation and representation, although in the hypogeal chambers the osteological material is really compromised. The bones were inspected macroscopically with the naked eye and by use of a magnifying glass. As for the anthropological methods, we used metric variables of the femoral head (Purkait, 2003) and pelvis for sex determination (Bruzek et al., 2017). Skeletal age was estimated from the phase of the fourth rib (Iscan, Loth & Wright, 1984; Iscan, Loth & Wright, 1985), the level of degeneration of the auricular surface (Lovejoy et al., 1985) and the pubic symphysis (Brooks & Suchey, 1990). Individuals were attributed to the following age groups: adult (20–40 years); mature (40–60 years); senile (> 60 years); adult not determinable (> 20 years). We performed trauma analysis and paleopathological evaluation following the specific literature (Buikstra, 2019; Lovell, 1997). Furthermore, we assessed the degree of osteophytosis of the insertions and origins of muscles and ligaments to verify and quantify the use of the main joints (Hendreson et al., 2016) and to hypothesize the activities carried out by the subjects (Larentis, 2017). Finally, the measurements of long bones allowed us to determine the individual's height (Trotter, 1970). Moreover, due to the importance of RX and TC acquisition (Fusco et al., 2020; Tonina et al., 2018; Fusco et al., 2018). the bones were analysed histologically and radiologically with conventional digital radiography and clinical computed tomography (direct digital Fujifilm machine, exposure [100 ms] 55 kV, 100 mA) performed at the Gaetano and Piera Borghi Foundation, Brebbia, Varese, Italy.

Results

The osteological materials of the 2012 excavation

The archaeological excavation carried out in 2012 allowed the recovery of some burials and some SU characterized by the presence of scattered bones. These were cleaned, analysed, documented and anatomically determined during the anthropological laboratory activities *in situ.* Below is the list of SU sorted by year of excavation and increasing list number (Table 1).

The research was useful to complete the anthropological and taphonomic analysis of these materials, to which the acquisition of radiological and histological data useful in order to evaluate possible deficiency states that cannot be investigated thanks to the morphological study. The materials have been washed, documented, and placed in containers suitable for their conservation over time. We briefly present the results of the analysis of SU 104, which is the one that has the most bones.

SU 104 hallway

We found 48 bone fragments of the cranial and post-cranial skeleton in this area (Fig. 2, I). The bones, divided anatomically, belong to: 22.9% skull, 14.6% left upper limb, 20.8% right upper limb, 8.3% pelvis, 6.3% thorax (vertebrae and ribs), 6.3% right lower limb, and 10.4% left lower limb.

SU 104 II chapel

We found 26 bone fragments of the cranial and post-cranial skeleton in this area (Fig. 2, II). The bones, divided anatomically, belong to: 11.5% skull, 7.7.% right upper limb, 15.4 left upper limb, 11.5% thorax (vertebrae and ribs), 26,9% right lower limb, 19.2% left lower limb.

SU 104 III chapel

We found 22 bone fragments of the cranial and post-cranial skeleton in this area (Fig. 2, III). The bones, divided anatomically, belongs to: 18.2% skull, 4.5 right upper limb, 18.2% left upper limb, 4,5% pelvis, 31.8% thorax (vertebrae and ribs), 4.5% right lower limb, 9.0% left lower limb.

SU 104 IV chapel

We found 44 bone fragments of the post-cranial skeleton in this area (Fig. 2, IV). The bones, divided anatomically, belongs to: 20.5% right upper limb, 6.8% left upper limb, 9.0% pelvis, 2.3% thorax (vertebrae and ribs), 34.0% right lower limb, 22.7% left lower limb.

SU 104 nave

We found 25 bone fragments of the cranial and post-cranial skeleton in this area (Fig. 2, V). The bones, divided anatomically, belongs to: 24.0% skull, 12.0% right upper limb, 12.0% left upper limb, 8.0% pelvis, 16.0% right lower limb, 28.0% left lower limb.

SU 104 presbytery

We found 167 bone fragments of the cranial and post-cranial skeleton in this area (Fig. 2, VI). The bones, divided anatomically, belongs to: 34.7% skull, 13.2% right upper limb, 6.0% left upper limb, 7.8% pelvis, 4.2% thorax (vertebrae and ribs), 13.8% right lower limb, 13.2% left lower limb.

SU 104 sacristy

We found 84 bone fragments of the cranial and post-cranial skeleton in this area (Fig. 2, VII). The bones, divided anatomically, belongs to: 26.0% skull, 12.0% right upper limb, 2.4% left upper limb, 13.0% pelvis, 6.0 % thorax (vertebrae and ribs), 19.0% right lower limb, 12.0% left lower limb.

We analysed 416 bones, and here we present a table that summarizes the estimate of the minimum number of individuals (Table 2).

To confirm the alleged morphological diagnoses of micronutrient D deficiency in the non-adult sample (Larentis et al., 2019), we analysed the bones radiologically and histologically. For this reason, we acquired CT / CB radiological images of molars to evaluate the pulp chamber morphology and thin section of incisors to verify and quantify the presence of interglobular dentin (Fig. 3 a-f).

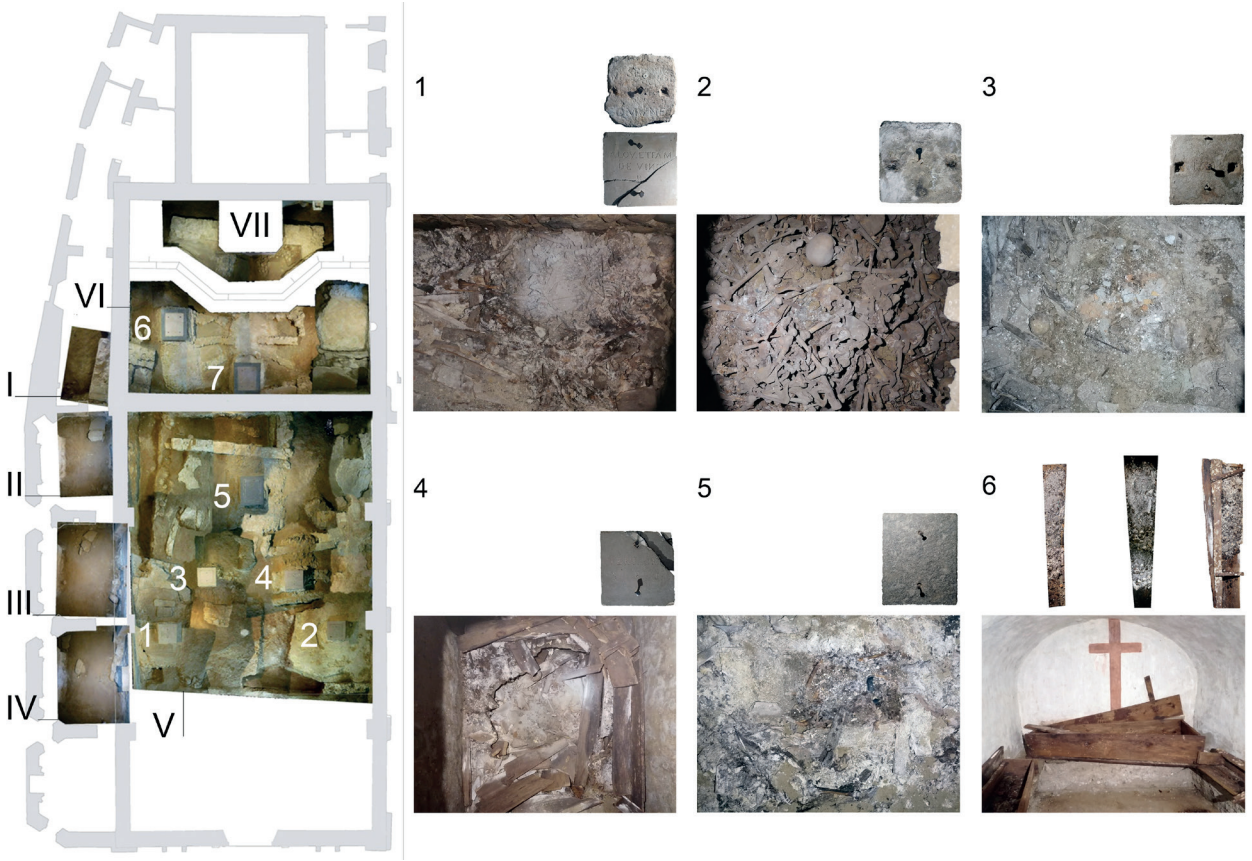

Figure 2. On the right, the orthophoto of the interior of the church of SS. Eusebio and Antonio at the end of the archaeological excavation in 2012. In Roman numerals, the excavation areas as divided by the archaeologists: I – hallway, II – II chapel, III – III chapel, IV – IV chapel, V – nave, VI – presbytery, VII – sacristy. In Arabic numerals the underground chambers under study: 1 – I hypogeum, 2 – II hypogeum, 3 – III hypogeum, 4 – VI hypogeum, 5 – V hypogeum, 6 – Tomb of the Dalla Porta family, 7 – Franciscan hypogeum and ossuary. On the right some details of the first six hypogea are shown. For the first 5 it was chosen to present the stone slabs closing the underground rooms and a zenith photograph of the materials contained in each of the rooms. For issue 6 it was chosen to show an overview of the wooden coffins of the Dalla Porta family members and a zenith photograph of each coffin.

The underground chambers of the presbytery

The crypt of the Franciscan order

The materials found in 2013 in the hypogeum (Fig. 2, 7) have been reorganised, brought back to the church, and studied to integrate the previous anthropological study. This occasion made it possible to verify the state of conservation of the remains and to put forward hypotheses on the decomposition process they encountered; this information will integrate the entomological study already carried out in this environment, with the aim of reading the ritual of treatment of the body of the confreres. Below is the list of US sorted by year of excavation and increasing list number (Table 3).

We analysed ex novo the bones of the Franciscan *"putridarium"* to verify and integrate the published data; in particular, our efforts have gone towards understanding the post-depositional and taphonomic processes that have affected the remains and context over the last few centuries (Fig. 4). The work was useful to verify the dynamics of the funeral ritual and to investigate possible anthropogenic alterations of the remains that occurred following the opening of the niches, which took place in past times and of which no historical memory remains. Finally, radiodiagnostic analyses were carried out on some finds selected for their historical, anthropological or paleopathological interest, to acquire useful data for the investigation of

Figure 3. Thin section of a second permanent lower right incisor of a subject from excavations in 2012. a) transmitted light, macro of the section in which taphonimic damage is noted on the collar and on the root and the Hunter-Schreger streaks highlighted in the rectangle are clearly visible white. b) transmitted light, 10 x, the staining allows to appreciate the dentinal tubules of the dentin, in the junction with the enamel. c) polarized light, 10 x, the Hunter-Schreger striae are evident and the junction between dentin and enamel with different colours. d) polarized light, 10x, in the portion close to the junction between dentin and enamel, in the lower left area of the white rectangle, it is possible to notice a hint of globularity of the dentin. e) polarized light, 10x, lingual occlusal surface of the tooth that allows to see the wear. f) transmitted light, 10x, near the neck some taphonomic damage to the enamel and dentin is evident.

the health quality of the group and the treatment of the body (Licata et al., 2020) (Fig. 5).

As for the ossuary below the *"putridarium"* we start with the recovery, documentation, and anthropological analysis of the skeletal remains. Prof. Stefano Vanin of the University of Genoa sampled the entomofauna linked to the deposition environment (Pradelli et al., 2019), and Prof. Susanna Bortolotto and Prof. Emanuele Zappa of the Politecnico di Milano took care of the 3D acquisition of the finds and environments.

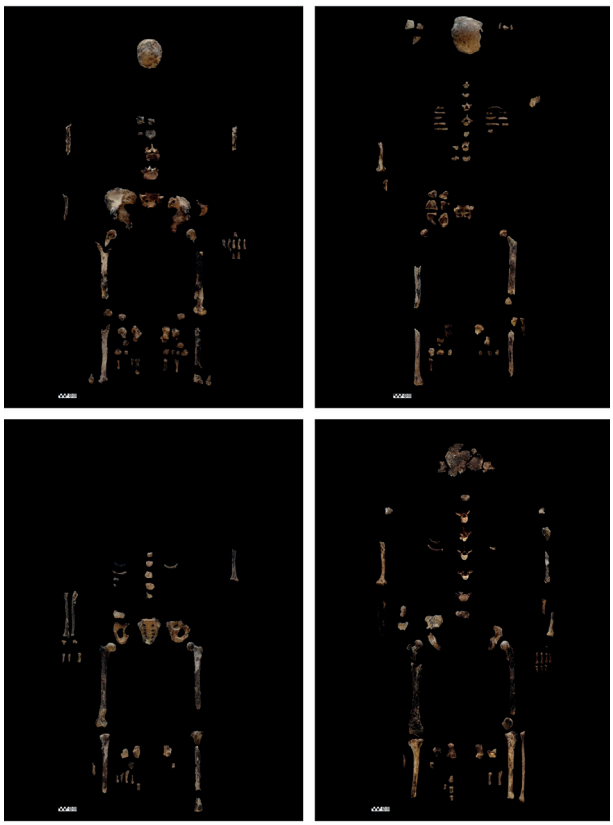

Figure 4. Anatomical arrangement of some subjects found inside the hypogeum of the Franciscans. We note the complete skeletonization of individuals and the loss of much bone tissue which implies anatomical incompleteness.

In addition, the Politecnico has acquired the photospheric images of the *"putridarium"*, useful for the subsequent phase of musealization the context.

The tomb of the Della Porta family

On 20 September 2021, we removed the covering slab of the Della Porta family tomb (Fig. 2, 6). This noble family, who lived in the nearby Villa Porta Bozzolo in Casalzuigno, looked after the economic interests of the monastery (Langè, 1968). The closing slab present today in the church replaces the original one of 1702 following the construction of the underground chamber. This last cover bore the name of Carlo Girolamo I Della Porta, who died in 1704 and was a lawyer and apostolic man of the Franciscan convent.

The single-chamber tomb is in the presbyteral area, located to the right of the main altar and the

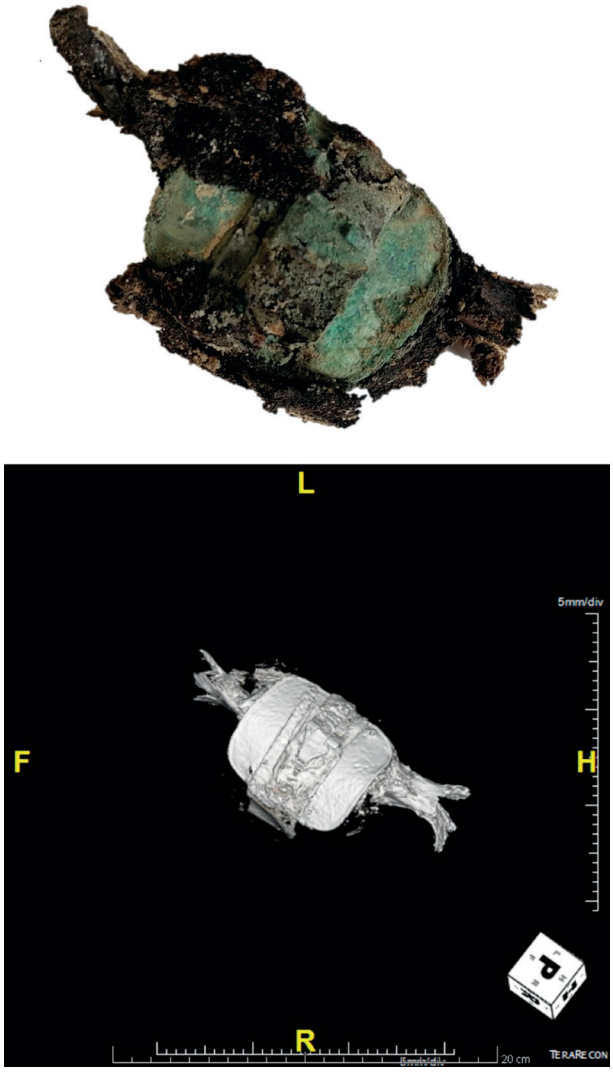

Figure 5. Above, right humerus of one of the subjects found in the hypogeum of the Franciscans; a metal alloy element containing copper was fixed to the arm by means of a leather strap. Below the CT acquisition allows to verify the shape of the metal object.

Franciscan crypt. It is a sub-rectangular room, the development of which corresponds to the longitudinal one of the church. The room is vaulted, finished with fine mortar, and roughly blanched with a layer of white paint. A fresco painted cross is in the back wall in front of the access staircase. A masonry step about 50 cm high and 40 cm wide, covered by slabs of shale, runs along the three perimeters spared by the encumbrance of the access staircase. This step was used to place three wooden coffins, each close to a different perimeter wall.

The first, entering on the right, shows some decorations painted outside the coffin. In addition, a date painted on the outside of the main head report the date 1711. The second coffin is close to the wall in front of the access stairs. The third coffin, poorly preserved in its original structure, is found as you enter on the left. This coffin, although badly preserved, allows you to appreciate some constructive elements such as the nails closing the lid and the remains of probable organic fibre straps that were to constitute the handles for lifting and transporting the coffin.

All the coffins contain poorly preserved osteological remains, condition that limits the potential of the anthropological study. However, some preliminary considerations have been made. The bones of a male are preserved in the coffin in front of the access ladder.

Considering this burial as a single deposition, it is possible to exclude, by comparing the quantity of the remains, the presence of double burials or the reuse of the same box for the diachronic deposition of several subjects. Finally, in all the coffins, the bones are not in anatomical order. This data, together with the high fragmentation of the remains and the coffins found open or damaged, can be traced back to anthropic actions of disruption of the bones aimed at the stripping of clothing or grave goods, whose presence is still indisputable today by some elements.

Also, in this case, the Politecnico took care of the acquisition of spatial data useful for the three-dimensional reconstruction of the environments, as the elements contained therein. Subsequently, entomological samples were taken, useful for acquiring data on the funeral ritual reserved for the corpses and on the dynamics of decomposition in hypogeal space. These data will integrate the available and published ones collected in the Franciscan *"putridarium"* and the unpublished ones of the context, to create a homogeneous database relating to the hypogeal environments of the 17-19th century in north-western Italy. Subsequently, the state of the crypt and its contents were also graphically documented, mostly represented by wooden crates and bone remains poorly preserved and difficult to interpret.

The underground chambers of the nave

Inside the main nave there are five underground chamber tombs, placed according to a V-shaped scheme with apex near the main altar. The tombs were opened on September 20, 2021.

I hypogeum

This room is closed by two tombstones (Fig. 2, 1). The oldest bears the epigraph "SEP COMUNE" and allows us to hypothesize that this room was used as a common ossuary of the church. However, a second plaque, placed above the first, is engraved with the words "ALOY. ET FAM.a DE VIN.is R ", which allow the use of the tomb to be traced back to the de Vincenti family. Therefore, it is possible that this environment has changed its intended use over time, passing from a common tomb of the community to a family tomb. Inside, a layer of bones in a poor state of conservation can be recognized, which totally obliterates the view of the floor. Among these at least three subjects are characterized by the anatomical connection of the skeletal elements.

This environment has proved to have a good potential from the anthropological point of view; the remains, in fact, are numerous and in a good state of conservation. However, in this step of the research, bone recovery has not yet been predicted.

II hypogeum

The burial chamber, whose tombstone bears no inscriptions, appears filled with a thick layer of bones (Fig. 2, 2). The colour and conservation of the bones allow us to hypothesize two moments of filling the hypogeum; in particular, the second seems to be a jet of bones from the entrance to the room; in fact, the elements are disposed to form a pyramidal figure with the vertex below the entrance opening. At a first visual examination, only adult bones are recognized without any anatomical connection.

Given the poor state of conservation of the remains, no anthropological interventions were planned in this step of the research to investigate the burial chamber.

III hypogeum

At the end of this hypogeum a stone on which the date of 1603 is engraved, inside which we can see the presence of a few bones and some wooden elements (Fig. 2, 3). The state of conservation of the materials appears critical, in fact the visual inspection showed that the tomb is filled, at least in its upper portion, with an incoherent layer of material resulting from the decomposition and demineralization processes of the bones.

Given the poor state of conservation of the remains, no anthropological interventions are envisaged in this step of the research to investigate the burial chamber.

IV hypogeum

This room is closed by a stone bearing the inscription "TERT. ORD. S.P.F. ", which frames it as another burial place for the members of the Franciscan order (Fig. 2, 4). Inside the chamber we recognize various wooden boards of the coffins that contained the bodies. None of the coffins appears intact, and the bones that should have been inside them do not appear in an anatomical connection but scattered throughout the environment. The chaotic situation can probably also be traced back to the subsidence of the floor, which collapsed in the central portion, partially filling a gap below the volume of the room.

In this environment there are elements of both anthropological and functional interest to complete our knowledge of the rituals reserved for members of the Franciscan order of Azzio. Therefore, the archaeological excavation of the room was carried out, followed by the recovery, documentation and anthropological and paleopathological analysis of the skeletal remains. In particular, the archaeological excavation wanted to investigate a particularity of the hypogeum and its construction history.

Inside the chamber, in fact, the schist stone slab floor collapsed in the central area, with a lowering of about 20-30 cm deeper than the original height. Over time, this area was filled with bone remains, earth and even substantial fragments of wooden boxes. This situation has led to the question of whether this compartment below the floor was an architectural stratagem to create an air cushion to make the environment healthy

for the purpose of treating the body or whether it was a structural failure. The presence of a cut made in the clayey-silty layer that is imagined to be the original substrate of the site was immediately evident. To better understand the nature of the cut, which in fact extends over almost the entire surface of the environment being clearly visible even below the floor remaining in place, a layer of crumbled bones mixed with the ground and decomposed wood, the removal of which has brought to light some slabs of the floor evidently collapsed from their original location.

The subsequent removal of the slabs revealed a layer of ocher-colored friable soil with lumps of mortar and some lithic elements, among which a limestone fragment is highlighted with the seat of a metal nail clearly visible.

V hypogeum

This room, wider than the others, is closed by a rough stone without any epigraph (Fig. 2, 5). Inside, there are few skeletal and wooden remains. The situation seems to follow that found in the III hypogeum.

Given the poor state of conservation of the remains, no anthropological interventions are envisaged in this step of the research to investigate the burial chamber.

Discussion and conclusion

The work made it possible to acquire new data on the context of Azzio, his human sample and the funeral rites practised over the centuries.

The study also led to several degree theses, of which two in particular dealt with important aspects for understanding the context.

Thanks to one of these works, we can verify the presence of micronutrient deficiencies within the medieval sample found during the first archaeological campaigns. These data are useful for understanding the quality of life and health of the population that gravitated around the religious complex more than a thousand years ago. Moreover, experimental radiological and histological methods were used for the verification of the presence of interglobular dentin and the shape of the pulp chamber to advance a diagnosis otherwise not feasible thanks to the macroscopic morphological approach alone (Zambrano et al., 2003; Souza et al., 2010; D'Ortenzio et al., 2017; D'Ortenzio et al., 2018). Another degree thesis was of fundamental importance for acquiring new data on body treatment practices reserved for Franciscans buried inside the *"putridarium"*. Until now, the "double burial" of the abbots was taken for granted; that is a very complex ritual that was divided into two parts. First, after the funeral, the body of the confrere was placed inside a niche of the *putridarium*, seated and held in position with a wooden stop at chest level; from this moment the body could undergo mummification or corruption of the flesh that led to skeletonization, all under the gaze of the brothers (Fornaciari, 2013; Fornaciari, Giuffra & Pezzini, 2008). If mummification was achieved, the friar was considered a holy body, incorruptible and therefore worthy of devotion; on the contrary, the remains were placed in a common ossuary (Imbesi, 2020). Our work has allowed us to qualify the putridarium of Azzio as a room in which decomposition took place but for exhibition and memento purposes.

In fact, it was possible to better define the ritual reserved for the abbots of the context, managing to clarify, also thanks to the entomological analyses, regarding the treatment of the corpses, which were actually exposed to the devotional practices of the confreres until the niches were closed during the period of the Austro-Hungarian domination, but which were not then placed in the ossuary below, which should have been used to complete the second part of the double burial ritual. Furthermore, by verifying the decomposition patterns, it was possible to advance new hypotheses on the taphonomic aspects that led to the corruption of the mortal remains of the Franciscans. This has also made it possible to parameterize a decomposition model that will also be usable in other contexts to verify the presence and role of anthropogenic actions on decomposition.

The anthropological work in Azzio, although it has reached new goals, is far from being considered finished. Among the future operations is an extensive study of the entomofauna of the site, an in-depth study of the taphonomic variables that characterize the burial chamber of the Dalla Porta family, and the 3D acquisition of all the environments to build multimedia

contents that will become part of the tourist offer, which will be made available at the end of the Valcuvia project in which the analyzes carried out are inserted and which will end next year.

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Original Article: Physical Anthropology

Interpreting diachronic changes and infra-contextual comparisons. The bioarchaeological archive of San Biagio in Cittiglio (Varese, Northern Italy)

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Abstract

Aim. The medieval and post-medieval cemetery of San Biagio in Cittiglio constitutes a context of archaeological and bioarchaeological interest that is significant for the knowledge of the population that once lived in the ancient region of Valcuvia (Lombardy, Varese province). The Romanesque church, originally built during the early Middle Ages and subsequently modified, is characterized by the presence of a well-structured cemetery context. The investigations conducted so far allowed us to examine the archaeological stratigraphy and bring to light the different phases of use of the cemetery areas.

Material and Methods. During the study, an almost well-preserved sample emerged, albeit affected by different sources of selection today difficult to reconstruct, which make this osteoarchaeological sample a fraction of the original subset of the population. The sample analyzed was well represented by all categories of individuals, with a disproportion between adults and subadults, who died particularly in infancy between 0 and 3 years of age. This characteristic led us to think that the sample had been the subject of several processes of selection which resulted in the over-representation of subadults and the under-representation of adults.

Results. The diachronic aspect of the cemetery, whose use extends from the 10th to the 17th century, allowed us to carry out comparative analyzes between two chronological subgroups divided according to the local and regional history of the site.

Discussion and Conclusion. The diachronic perspective has revealed the possible existence of differences in health status and dietary practices between the High Middle Ages and the Late and Post-Medieval Ages, highlighting how the social and political differences we are aware of thanks to historical documents can also be reflected from biological characteristics extracted from the anthropological record.

Key words: Bioarchaeology, chronological comparison, human remains, health status, diachronic osteological variations

Introduction

According to the available historical documentation, we know that at least until the 13th century Cittiglio was a *castrum*, a term which in the Late Middle Ages generically denoted a legal and territorial center endowed with its own physiognomy, which distinguished it from the wider organization of the *civitas* and the minor settlements in the area. The castles in this area were born as garrisons between the 10th and 12th centuries to protect limited territorial areas and played a significant role during the war between Como and Milan, the so-called ten-years' war (1118-1127). During this conflict, the territory of Valcuvia was attacked several times by the Milanese and was the scene of raids by Crema's allies. These castles were the center of territorial lordships, originating from royal concessions or from the extension of rights by the large owners, which responded to the need for protection, ensured the administration of justice and the protection of trade ("Verbanus", 2009).

During the 1400s the enfeoffment of Valcuvia, and therefore also of Cittiglio, by the Cotta family began, an action that took hold thanks to the Sforza lordship of the Duchy of Milan. Thus, with a notarial instrument, Francesco Sforza granted Pietro Cotta the feudal investiture of the parish church and valley of Cuvio, thus giving rise to the feud of Valcuvia ("Comune di Cuvio sec. XIV – 1757").

The church of San Biagio in Cittiglio, is a typical example of Romanesque architecture, attested from the 9th century and come down to the present day through multiple phases of structural modification. Initially built as a very small private chapel serving the needs of the fortified town, the Romanesque building was later erected on the first foundation. Initially dedicated to Sant'Andrea and San Biagio at least until 1421, as a document attesting to its dedication to both saints, the heading to Sant'Andrea was then eliminated in an unknown period. In the 14th century the church was extended to the west to incorporate the body of the funerary atrium, a covered space for cemetery uses initially placed outside the Romanesque facade. In the 17th century the orientation of the church was reversed with the demolition of the apse and the construction of the new entrance to the east, on the opposite side from the ancient one (Licata et al., 2019).

The excavations inside the church, that started in 2006 and aimed at the knowledge of the architectural and cemetery phases, have made it possible to investigate the structure of the funerary atrium which revealed phases of cemetery use between the 11th and 16th centuries. Inside the atrium for funerary use, 22 burials and a common ossuary (SU 157) were unearthed (Licata et al., 2019; Tesi, 2022).

The churchyard pertaining to the church, located to the east of the current entrance, was investigated by archaeological investigations in the years 2016-2020, allowing us to distinguish different phases of use of the area as a cemetery space dating from the 10th to the 17th centuries. The investigations have made it possible to bring to light 61 tombs and a large common ossuary (SU 423) (Licata et al., 2019; Tesi, 2022).

The general aim of this research is the bioarchaeological analysis of the cemetery sample of San Biagio in Cittiglio, in order to obtain anthropological data and provide information on the population that occupied the territory of Valcuvia in the medieval and post-medieval period. An important aspect of the sample is constituted by the diachrony of a sepulchral use which lasted for hundreds of years from the 10th to the 17th centuries, which defines this site as a small biological archive of the region and allows for infra-contextual comparisons between the subgroups of individuals pertinent to different chronological phases of use of the cemetery. One of the main purposes of this contribution, in fact, was also to verify any biological variation between the medieval and post-medieval groupages, conducting a diachronic approach on a sample formed over a large chronological period.

Here we therefore present a preliminary study conducted on the anthropological record retrieved from the funerary areas of the cemetery of San Biagio in Cittiglio, which has been divided into two chronological subsections based on the local and regional history of the site. Since the dating is based almost exclusively on stratigraphic data and characterized by rather wide chronological intervals, it was decided to compare only some biological aspects of the sample, divided into two distinct macro-groups based on their relevance to the High Middle Ages or the Late Middle Ages and Post-Middle Ages. This distinction is based not only on the chronologies offered by the site, but also on the knowledge of the historical and political changes to which Cittiglio and the Valcuvia region were subjected. These changes constitute a political-social watershed in the history of the territory which could be confirmed in the palaeobiological data offered by the human remains buried in the cemetery sites. It was therefore decided to compare the data derived from the anthropological analysis to verify whether these two moments of strong governmental and territorial changes of the site identify differences reflected in the biological characteristics of the individuals of the time.

Materials and methods

The archaeological investigations of the funerary areas have identified a total of 83 tombs. However, some of these burials have been exclusively documented and not recovered for stratigraphic reasons or geographic

localization in the area, while others have not returned bone remains due to translations that occurred in antiquity. The number of tombs was therefore reduced to the investigated burials that contained human remains that could be subjected to anthropological study. In particular, the individuals buried in 18 tombs retrieved in the funerary atrium and those deposed in 54 burials recovered in the eastern churchyard were analyzed.

Sex was estimated through morphological methods based on the observation of some dimorphic characteristics of the pelvic girdle and coxal bone (Acsádi-Nemeskéri, 1970; Ferembach et al. 1979; Bruzek, 2002), features of the pubic bone (Phenice, 1969), and of the auricular surface of the ileum (Bruzek et al., 1996). The dimorphism of some cranial features was also evaluated (Acsádi-Nemeskéri, 1970; Buikstra-Ubelaker, 1994). In the absence of the skull and pelvis districts, especially in cases of partial or minimal conservation of the individuals, it was necessary to refer to metric techniques and multivariate discriminant analyzes (Spradley-Jantz, 2011; Moore et al., 2016). In some cases, it was possible to integrate the skeletal data with the molecular determination of sex thanks to paleogenetic analyzes.

As regards the age-at-death, the sample was divided into age groups based on the classification of Buikstra-Ubelaker (1994). In cases where skeletal conservation did not allow reliable estimates, individuals were classified as generically adults (Ad).

The estimation of the age-at-death in adult individuals was carried out by evaluating mainly the degree of articular degeneration of the auricular surface of the ileum (Lovejoy et al., 1985; Buckberry-Chamberlain, 2002; Osborne et al., 2004), the surface of the pubic symphysis (Brooks-Suchey, 1990; Hartnett, 2010a), and changes in the surface and margins of the sternal extremity of the ribs (Iscan et al., 1985; Hartnett, 2010b).

In fetal and infantile subjects, metric methods have mostly been applied, based on the measurement of the length of the diaphyses of the long bones and the size of some primary non-obliterated bone elements, such as the pars basilaris of the occipital, the body of the sphenoid, or the pelvic bones (Maresh, 1970; Fazekas-Kòsa, 1978; Scheuer et al., 1980; Molleson-Cox, 1993; Scheuer-Black, 2000; Carneiro et al., 2016). For the measurements of the bone elements of juvenile subjects, reference was made to the standard of Fazekas-Kòsa (1978) and the modified one of Buikstra-Ubelaker (1994). For these subjects it was also necessary to proceed with the observation of the degree of fusion of the primary elements, thus those skeletal portions that ossify in the first months or years of life (Scheuer-Black, 2000).

In subadult children and adolescents, methods that consider the degree of obliteration between epiphysis and metaphysis (Scheuer-Black, 2000) and metric methods based on the measurements of the shaft of long bones (Maresh, 1970; Stloukal-Hanakova, 1978; Molleson-Cox, 1993; Scheuer-Black, 2000) have been applied.

Dental methods for estimating the age at death of subadults provide the most accurate and reliable assessment, by observing the degree of mineralization of the deciduous and/or permanent teeth (Moorrees et al., 1963; Gustafson-Koch, 1974; Smith, 1991; Beyer Olsen-Risnes, 1994; Liversidge, 1998; Hillson, 2009; AlQahtani et al., 2010). For late adolescents and young adults, the method of Mincer et al. (1993) was also applied for estimating the age-at-death through the degree of mineralization of the third molar.

Anthropometric post-cranial measurements were also collected, referring to the standard by Martin and Saller (1956-1959). The analysis of the robustness of entheses and enthesopathies at the level of the post-cranial skeleton was conducted referring to the methods of Mariotti et al., (2007). The individual entheses recorded were grouped based on the functional complex/skeletal district to which they belong, and the movements performed.

For the analysis of dental features and affections, the method by Belcastro et al. (2004), which allows the standardized recording of data with an alphanumerical code, was applied.

After a general analysis of the whole sample, comprising all the individuals pertaining to the entire period of use of the cemetery, it was divided into two chronological subsections relating to the medieval and post-medieval periods. This operation allowed us to proceed to a diachronic and infra-contextual comparison of the groups, aimed at identifying possible biological changes between the two sections.

Results

During this research, the remains found in total in 72 tombs were analyzed, of which 18 located inside the religious building and 54 in the external churchyard. In all, 102 skeletal units (SK) were identified within the burials referable to single individuals, complete or partial, and to scattered and mixed human remains related to reductions or altered burials (Tesi, 2022).

In the 72 graves and the related 102 USK investigated, 96 single individuals were identified, of which 44 adults and 52 subjects in developmental age. Among adult individuals, 10 are young adults (YAd), 14 mature adults (MAd), 5 elderly adults (OAd) and 15 adults in general (Ad); the sub-adult sample consists of 9 individuals in fetal / perinatal age (F), 27 infant subjects (I), 12 children (C) and 4 adolescents (AO), as can be seen in Table 1.

As regards the macro-class of adults, the determination of sex was possible in 40 of the 44 individuals analyzed: of these 21 are females and 19 are males, while 4 adults are of undeterminable sex due to partiality or scarce skeletal conservation (Table 1).

The sample immediately appears marked by a disproportion between the two macro-age groups, with an under-representation of adults (45.8%) compared to subadults (54.2%) (Table 1). This data is particularly significant as generally in cemetery contexts the subadult component is underrepresented due to differential burial conditions, for social and ritual reasons, but also for taphonomic influences and methodological and investigative limitations. Within the identified age groups, the most significant appears to be infants, represented by 28.1%, while the less frequent ones are that of adolescents (4.2%) and elderly adults (5.2%) (Table 1).

The fetal component is also of particular interest, generally under-represented for religious and cultural reasons, as well as for taphonomic limitations. At this site, 9 burials of individuals in fetal age were found between 28 and 40 weeks of gestation. Two cases were particularly significant, revealing the uncommon practice of burial within superimposed brick tiles (Licata et al., 2018; Tesi et al., 2021). By dividing the fetal individuals analyzed into weeks of gestational age, deaths are more frequent in the full-term phase of pregnancy (n. 7) and in particular around the 38th week (n. 4).

The diachronic approach

The entire sample thus composed was divided into two distinct groups on a chronological basis and was therefore distributed as follows: one section made up of subjects pertaining to the phases of the High Middle Ages, called IM, and a second group made up of individuals from the Late Medieval (LM) and Post-Medieval (PM) phases, called IIM.

Table 2 shows the division between the two chronological groups from which the tombs that do

Table 1. Summary of the distribution of the sample as a whole by sex and age class.

		M	F	ND	TOT	%
Subadults	**F**	0	0	9	**9**	*9,4*
	I	1	2	24	**27**	*28,1*
	C	2	0	10	**12**	*12,5*
	AO	2	2	0	**4**	*4,2*
	Tot.	5	4	43	**52**	*54,2*
Adults	**Yad**	5	5	0	**10**	*10,4*
	Mad	7	7	0	**14**	*14,6*
	Oad	2	3	0	**5**	*5,2*
	Ad	5	6	4	**15**	*15,6*
	Tot.	19	21	4	**44**	*45,8*
TOT.		**24**	**25**	**47**	**96**	
%		*25,0*	*26,0*	*49,0*	**100,0**	

Table 2. List of tombs divided by the related macro-period (IM: High Middle Ages; IIM: Late and Post-Middle Ages)

Tomb	SK	Sex	Age-at-death	Dating	Period
1	115a	ND	1,5-2,5 y	3rd q. XI c.	IM
2	147b	ND	2,5-3,5 y	3rd q. XI c.	IM
3	149	ND	~ 2 y	last q. XI c.	IM
4	151b1	ND	6-7 y	3rd q. XI c.	IM
	151b2	ND	28-34 w	3rd q. XI c.	IM
5	153	ND	1-1,5 y	3rd q. XI c.	IM
	153a	ND	1-1,5 y	3rd q. XI c.	IM
6	155b	M	1-1,5 y	last q. XI c.	IM
7 , 8	157			early XVII c.	IIM
9	159b	M	4,5-5,5 y	XIII c.	IM
	159b1	ND	7,5 m +/- 3 m	XIII c.	IM
	159b2	ND	1,5-2,5 y	XIII c.	IM
10	162	M	40-55 y	3rd q. XI c.	IM
11	164	M	43-55 y	XV- mid XVI c.	IIM
13	168b	M	19-24 y	XI-XIV c.	IM
14	170b	M	6,5 y +/-1 y	XV- mid XVI c.	IIM
15	172b	F	> 30 y	XV- mid XVI c.	IIM
16	174b1	F	25-35 y	XV- mid XVI c.	IIM
	174b2	ND	1-2 y	XV- mid XVI c.	IIM
17	176b	F	1-1,5 y	3rd q. XI c.	IM
	176b1	ND	/	3rd q. XI c.	IM
18	178b	F	4,5 m +/- 3 m	last q. XI c.	IM
19	180b	ND	11,5-12,5 y	3rd q. XI c.	IM
20	196	F	25-35 y	XI-XIV c.	IM
23	241 c1			XIV-XVI c.	IIM
	241 c2	M	30-45 y	XIV-XVI c.	IIM
	241 c3	M	40-55 y	XV-early XVII c.	IIM
25	256	NDet	ND	early XVII c.	IIM
26	258	ND	1-1,5 y	XV-early XVII c.	IIM
27	260	ND	37-40 w	XV-early XVII c.	IIM
28	263a	F	ND	XV-early XVII c.	IIM
29	265a	M	45-60 y	XV-early XVII c.	IIM
30	267	M	30-40 y	XV-early XVII c.	IIM
31	269b	F	40-55 y	XIV-XV c.	IIM
32	272	M	20-30 y	XIV-XV c.	IIM
33	275b	M	25-37 y	XIV-XV c.	IIM
	275c	ND	38 w	XIV-XV c.	IIM
	275d	M?	ND	XIV-XV c.	IIM
34	280b1	F	25-35 y	XIV-XV c.	IIM
	280b2-a	F	55-70 y	XIV-XV c.	IIM
	280b2-b	F??	11-15 y	XIV-XV c.	IIM

Table 2. List of tombs divided by the related macro-period (IM: High Middle Ages; IIM: Late and Post-Middle Ages)

	280b2-c	F??		XIV-XV c.	IIM
	280b3-a	NDet		XIV-XV c.	IIM
	280b3-b	ND	10-12 y	XIV-XV c.	IIM
35	283a,b	M+F?		XIV-XV c.	IIM
36	286	ND	36-40 w	XV-early XVII c.	IIM
37	289b	M	14-17 y	X-XI c.	IM
40	303	ND	3,5-4,5 y	XV – XVI c.	IIM
41	305 a	M	20-30 y	XV – XVI c.	IIM
	305 b	F	>45 y	XV – XVI c.	IIM
43	309 A	ND	1,5-2 ,5 y	XIV-XV c.	IIM
44	311	F?	ND	XIV-XV c.	IIM
45	315	M	35-50 y	XIII – XIV c.	IM
46	318	NDet	ND	XIV-XV c.	IIM
47	322/1	ND	4,5 m +/- 3 m	XIII – XIV c.	IM
	322/2	ND	40 w	XIII – XIV c.	IM
48	325	ND	1 y +/- 4 m	XIV-XV c.	IIM
49	329	Ndet		XIV-XV c.	IIM
50	337	ND	11,5-12,5 y	XIII – XIV c.	IM
51	349	M	25-35 y	X – XI c.	IM
52	353	M	55-75 y	XII– XIII c.	IM
53	357	F	30-35 y	XV – XVI c.	IIM
54	361	F	40-45 y	X – XI c.	IM
55	341	ND	2 y +/- 8 m	XII– XIII c.	IM
	343	F	> 30 y	X – XI c.	IM
56	372	F	30-40 y	XIV – XV c.	IIM
57	374	M??	>20 y	X – XI c.	IM
	375	F??	>20 y	X – XI c.	IM
58	377	F	50-70 y	XIII – XIV c.	IM
60	382a	2F, 2M		XIII – XIV c.	IM
	382			XIII – XIV c.	IM
61	389	ND	11-12 y	XIV – XV c.	IIM
62	392	ND	10,5 m-1,5 y	XIV – XV c.	IIM
63	397	ND	30-32 w	XIV – XV c.	IIM
65	404	2M	Ind.1: 18-24 y; Ind.2: 45-60 y	XIII – XIV c.	IM
66	408	ND	1,5-2 y	XII– XIII c.	IM
67	410a	F	30-50 y	XII– XIII c.	IM
	410b	M	ND	XII– XIII c.	IM
	418	F	35-45 y	X – XI c.	IM
68	413	F??	ND	XIII – XIV c.	IM
69	435	M	35-50 y	XIV – XV c.	IIM
71	444	ND	2-3 y	XII– XIII c.	IM

Table 2. List of tombs divided by the related macro-period (IM: High Middle Ages; IIM: Late and Post-Middle Ages)

72	449	ND	3-4 y	XIII – XIV c.	IM
	449b	ND	~ 1 y	XIII – XIV c.	IM
73	430	ND	38-40 w	XII-XIII c.	IM
74	459	ND	11,5-12,5 y	XII– XIII c.	IM
	467	ND	10,5 y +/- 1 y	XII– XIII c.	IM
76	487	ND	Full term	XIII-XIV c.	IM
77	480	M	ND	XII– XIII c.	IM
78	483	ND	1,5 y +/- 6 m	XIV-XV c.	IIM
80	496	F	17-20 y	XIV-XV c.	IIM
81	503	M??	13-15 y	XIV-XV c.	IIM
82	500	F?	ND	XIII-XIV c.	IM
	500a	M?	ND	XIII-XIV c.	IM
83	509	ND	2-3 y	XIII-XIV c.	IM

not present reliable stratigraphic and chronological data have been excluded.

As regards the composition of the samples, the IM group is represented by 18 adults and 29 sub-adults, while the IIM is made up of 25 adults and 17 sub-adults. The adult sample within the IM is made up of 9 males and 9 females, with a sex ratio of 1; within the IIM there are 10 males, 11 females and 4 undeterminable, with a sex ratio equal to 0,9. Both sexes and all age groups are represented in the two groups. IM is more represented by subadults than IIM, which on the other hand has a greater number of adults (Table 3).

Regarding the anthropometry of the post-cranium, the stature of males and females relevant to the two periods was calculated. Observing the summary table of the stature (Table 4), in both sexes the average values are slightly higher in IIM than in IM, with an average difference of 2.5 cm in males and 2.0 cm in females.

Some evaluations were also conducted on the variations of the functional muscle complexes in the two periods, as an expression of the biomechanical load to which the individuals in the two chronological groups were subjected. Observing the graphs in Figure 1, it can be observed that the average degrees of development of the various functional complexes of the upper and lower limbs are generally higher in subjects belonging to the High Middle Ages group than in those of the later period group. This is particularly evident for the upper limbs and especially for male subjects. In the lower limbs the same trend is observed in the male sex, albeit with a slighter deviation in the hip and knee complexes, while for the foot there is a greater disparity between the two periods. The differences in the degrees of development in males are particularly evident in the foot and forearm complexes, which present the greatest differences. In the female gender a similar

Table 3. Composition of IM and IIM groups by adult and subadult age classes and percentage distribution of the classes within the samples.

Age Class	IM	%IM	IIM	%IIM
F	4	8,5	4	9,5
I	18	38,3	6	14,3
C	6	12,8	4	9,5
AO	1	2,1	3	7,1
TOT. Subad.	29	61,7	17	40,5
YAd	4	8,5	6	14,3
MAd	6	12,8	8	19,0
OAd	2	4,3	3	7,1
Ad	6	12,8	8	19,0
TOT. Ad	18	38,3	25	59,5
TOT.	47		42	

Table 4. Averages of male and female stature in the two chronological groups. SD: Standard Deviation; IIM-IM: differences between the mean values in the two groups (cm).

	Mean M	SD M	Mean F	SD F
IM	**166,8**	6,1	**154,9**	3,6
IIM	**169,3**	2,8	**156,8**	3,6
IIM-IM	2,5		2,0	

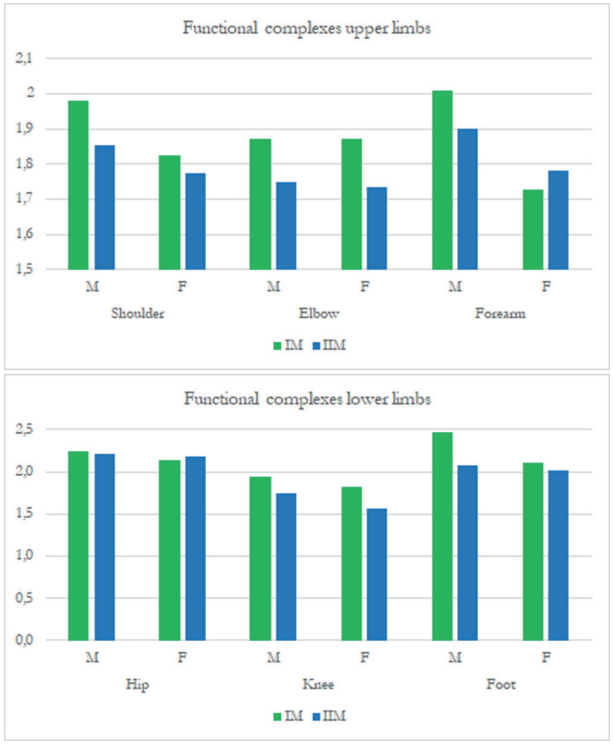

Figure 1. Variations in the mean degrees of development of the functional complexes of the upper (above) and lower (below) limbs of both sexes in the two separate chronological periods.

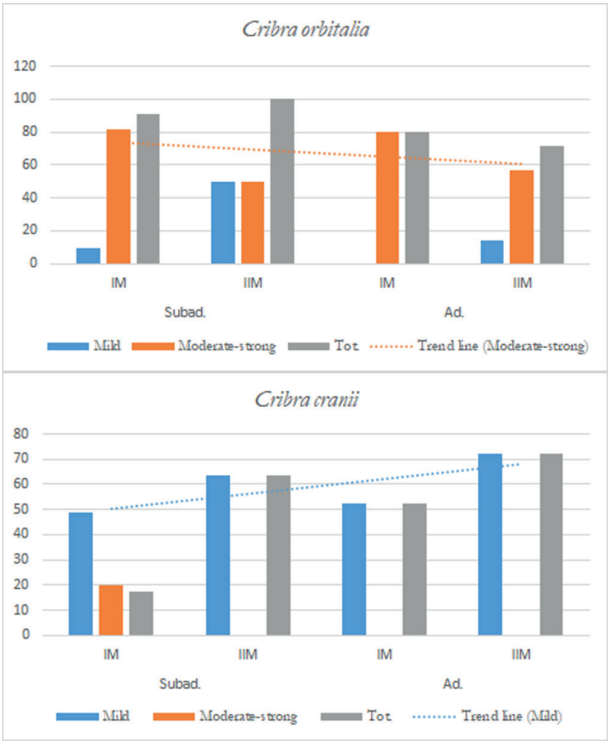

Figure 2. Cranial porosity of mild and moderate-strong degrees in the separated adult and subadult samples pertaining to the two chronological macro-groups. Dotted line: trend line indicating the increase of the mild degree of porosity (below) and the decrease in moderate-strong degrees (above).

trend is observed in some districts, including shoulder, elbow, knee, and slight differences in the complex of the foot. In the forearm, on the other hand, a slight trend reversal is observed, while in the complex of the hip the differences are minimal. For women, therefore, the hypothesis of variations in muscle stress between the two periods is less suitable, even if slight discrepancies can be observed in some districts.

The diachronic analysis of the prevalence of skeletal disorders was also conducted. In particular, the distribution of skeletal stress indicators in the two groups was examined, to highlight any changes in the physiological stress affecting the individuals in the two chronological moments.

As can be seen in Figure 2, the trend in both macro-age classes is towards a general increase in the mild degrees of cranial porosity (*cribra orbitalia* and *cribra cranii*) and a decrease in the incidence of moderate and severe cases in the transition from IM to IIM. Porosity of the cranial vault of moderate and strong degrees is found exclusively in subadults in the first period, while it is absent in the second period and in adults in general. *Cribra orbitalia* of severe and moderate degrees, on the other hand, are recorded in both chronological macro-groups and in both macro-age groups; however, a general trend towards an increase in mild degrees and a decrease in severe ones in the chronological transition between the two groups is observed. The total tends to increase in both classes and for both types of porosity as it takes into account the increase in mild cases.

Furthermore, the diachronic variation in patterns of dental disease was investigated to highlight any differences related to lifestyle and food consumption between the two periods. First, the prevalence of caries in adult subjects pertaining to the two chronological groups was investigated. Based on the analysis carried out, it can be observed that the percentages of teeth affected by caries undergo a decrease in the transition from the first to the second period (Figure 3, graph above). In fact, the rates of affected teeth are higher

in IM in almost all types of teeth (except for I1 which does not show caries in any subject, and for M2 which shows an increase in the IIM group), while they decrease by several percentage points in IIM. Caries is generally more frequent on the posterior teeth in both periods. The rates of affected individuals in the two periods are almost similar, while the number of decayed teeth per individual varies.

As regards caries in subjects in the developmental age, the opposite trend is observed: the frequency of caries in fact increases in the transition from the first to the second period in both dentitions (Figure 3, below). In particular, the greatest increase in the caries rate between the two groups was recorded in the anterior deciduous and posterior permanent teeth. Caries on the anterior permanent teeth is absent in the first period and recorded in the following period, while only in the posterior deciduous dentition there is a slight decrease in the second group compared to the first.

Finally, the presence of enamel hypoplasia was evaluated in the two groups to compare the extent of growth disturbances at different chronological moments. In adult subjects of both sexes, it is observed that the hypoplastic defects show a slight decrease in the transition from the first to the second period. The graph above in Figure 4 shows that in the first period both the number of teeth and the number of subjects affected by hypoplasia are higher. In the IIM group there is a slight decrease in the number of teeth with hypoplasia and a decrease in the number of affected individuals. No differences between the two sexes were observed, except for a slightly higher rate of hypoplasia in men than in women in the first period.

Regarding hypoplasia in the sub-adult sample, an opposite trend to adults is observed, just like in caries: in immature subjects, in fact, there is an increase in hypoplasia and enamel defects between the first and second chronological group in both dentitions (Figure 4, graph below). These results are in line with what emerged from the analysis of caries rates which, in contrast with the adult sample, seem to increase in a later medieval period.

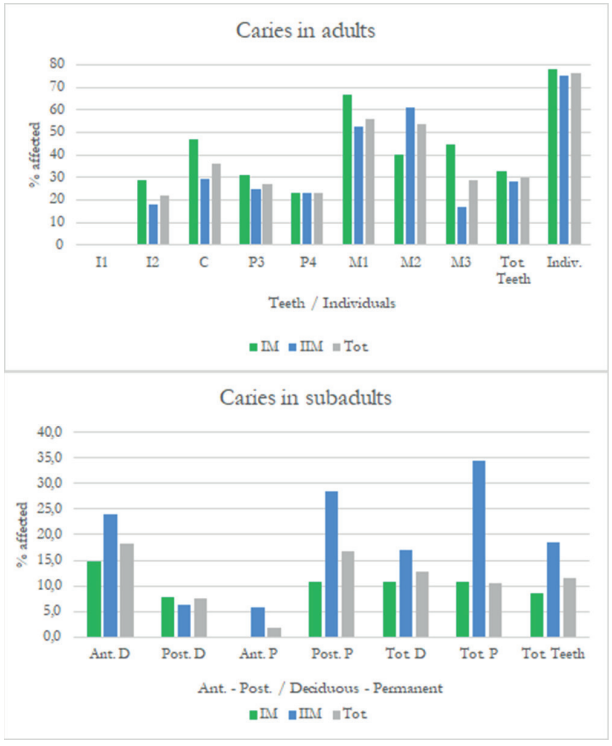

Figure 3. Frequency of dental caries in the different types of teeth in adults (graph above) pertaining to the two chronological groups, and caries rates in subadult subjects of the two chronological groups in the two dentitions (graph below).

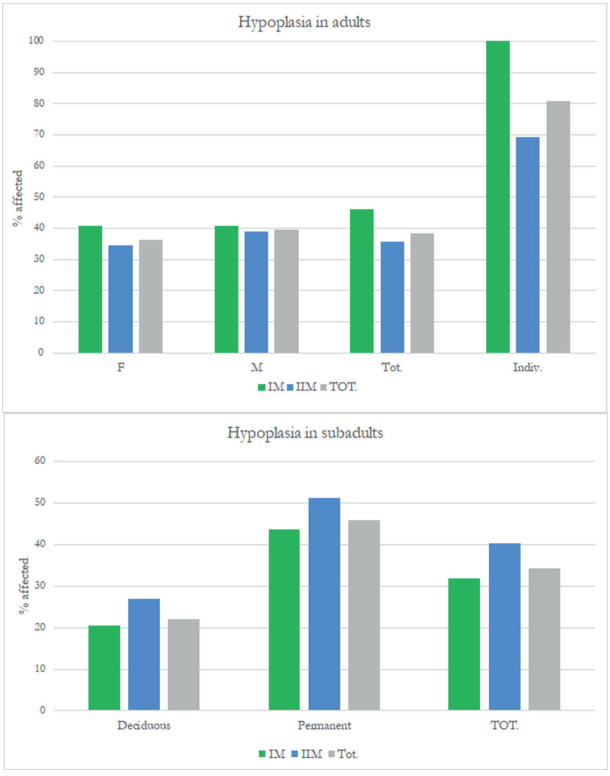

Figure 5. Percentages of teeth affected by hypoplasia in male and female adults (graph above), and in subadults of the two chronological groups (graph below).

Discussion

The investigated context shows a long and articulated phase of cemetery use characterized by an intense stratification and by multiple phases of burial, modification, and reuse of the sepulchral structures. The areas that can be archaeologically investigated today, however, certainly do not outline the entire existing archaeological record, since the number of burials pertaining to each phase of use appears rather small compared to the long period to which they refer. Furthermore, the skeletal sample shows some important bias which suggest that the population investigated, small for the long chronological period covered, is the result of multiple and successive selections that took place during time, also perhaps due to the urban transformations of the site. However, the presence of a good number of individuals in fetal age, generally underrepresented for religious and cultural reasons, as well as for taphonomic and conservative limitations, turns out to be of particular interest for this site (Tesi et al., 2021).

The diachronic approach applied to a sample extended over a wide chronological period allowed us to highlight the biological and epidemiological differences between the two temporal subgroups identified in the site. The political and socio-cultural change that occurs between the two periods during the Middle Ages finds some reflections in the biological characteristics of the individuals. In this regard, although the small sample size limits conclusive assumptions, some considerations can be made.

Between the first and second period, a general slight improvement in the living conditions of the subjects can be traced, evidenced by an increase in stature of about 2 cm in both sexes from the first to the second group (Sparacello et al., 2017). This seems to align with what is reported in the literature, according to which from the High Medieval period to the end of the Middle Ages there would be an increase in stature in both sexes (Barbiera and Dalla-Zuanna, 2009).

The variation in muscle development between the two periods seems to confirm the trend observed in the stature, suggesting that work in the High Medieval period was more onerous than for individuals in the Late Medieval and Post-Medieval group. In any case, it will be necessary to carry out further analyzes by integrating the sample with skeletal series from coeval sites in the same area.

Furthermore, at an epidemiological level, there is a decrease in the incidence of moderate and severe degrees of cranial porosity, related to nutritional and vitamin deficiencies, infections, and chronic anemias, parallel to an increase in the milder degrees. Based on this evidence, it can be hypothesized, still considering the limitation of the sample, a slight improvement in the lifestyle associated with physiological stress and problems of nutritional and vitamin deficiencies (related to the onset of chronic anemia), in the transition from High Medieval to Late Medieval and Post-Medieval periods. This hypothesis also finds support in the increase in height of about 2 cm found in the transition from the IM to IIM group in both sexes. It can therefore be hypothesized that at least a part of individuals in the Late and Post-Middle Ages had access to more or better resources than the subjects of the previous period and that this resulted in a lower incidence of serious cases of hematological problems connected to infections and nutritional deficiencies. The lower incidence of severe cases of vault porosity in adults compared to subadults may simply indicate a tendency for these individuals to heal as they progress to adulthood, due to increased resistance or better access to resources. *Cribra orbitalia*, on the other hand, seem widespread in both periods and in both age groups, indicating that presumably they present a more complex etiology or are associated with further deficiency and stress problems. If this can be interpreted as an improvement in the quality of life, it will have to be further investigated on a larger scale involving a larger cohort of subjects and a greater number of coeval bioarchaeological sites in the same area.

Furthermore, at least for the adult sample, a decrease in the rate of caries is observed in both sexes and for all types of teeth. Among various etiologies (including the association with other dental problems), caries is indicative of the carbohydrate component of the diet, suggesting that the Middle Ages (MI) diet included relatively higher proportions of carbohydrates (Hillson, 2000) than to the following period and probably a greater quantity of vegetables, since these are more cariogenic and abrasive foods than animal proteins (Jordana et al., 2010). Furthermore, the

possible association with other dental diseases must be taken into account, since the correlation between caries and wear and between caries and enamel hypoplasia has been documented (Jordana et al., 2010). A slight decrease in the later period is also recorded in the incidence of enamel hypoplasia. These findings are in line with the previous elaborations, suggesting that in a later period there was a slight change in the lifestyle of the subjects, leading to a lower incidence of stress episodes and dental affections.

On the other hand, as far as subadults are concerned, in the transition from the High Middle Ages to the Late and Post-Medieval Ages, there was an increase in the rates of caries and enamel defects. Although this picture goes against the adult trend previously discussed, the incidence of caries could relate to changes in dietary practices, suggesting a transition to a more cariogenic diet, or to a greater influence of other dental affections (Jordana et al., 2010). This hypothesis aligns with what is reported in the literature for Medieval and Post-Medieval English samples, according to which caries rates in deciduous teeth start to increase in the 15th century with the introduction of refined foods and the diffusion of sugar cane (Moore-Corbett, 1973; Giuffra et al., 2020).

The increased rates of hypoplasia in subadults from the High Middle Ages to the Late and Post-Middle Ages will need to be further investigated on more complete samples and in the light of additional pathological evidence and correlation with other skeletal indicators of stress. At present, nutritional changes, perhaps towards a less varied and more carbohydrate-based diet, and different social and cultural habits such as weaning practices may be considered as possible explanations for the increased hypoplasia found in immature individuals. Although the small sample size limits generalization, the results are consistent with those of caries rates in subadults, suggesting that an answer may be sought in the different dietary practices of the two periods. Furthermore, as known, a correlation between caries and hypoplasia has been documented in the literature (Jordana et al., 2010), therefore the increase in both rates could also be related to reciprocal influences of the dental diseases. In any case, it will be necessary to carry out an integrated analysis on a larger and more complete sample to answer all the questions and unravel the hypotheses that arose in this preliminary diachronic comparison.

From a future study perspective, it will be interesting to further conduct this type of diachronic research integrating other biological variables, such as parity features that have been recorded for the whole sample (Tesi et al., 2021), in order to identify possible differences in the female biological history between the two periods.

Moreover, paleopathological analysis of the whole sample allowed us to recognize various conditions (Licata et al., 2019; Tesi et al., 2019; Tesi et al., 2022; Tesi, 2022) that could be of interest also in a diachronic perspective aimed at the reconstruction of the health status of the individuals and its related changes between the two chronological periods.

Conclusions

The reading of the anthropological record has made it possible to hypothesize that it has been subjected to different sources of selection over time, currently difficult to reconstruct. It is evident that to date the original limits of the cemetery are not understood, which probably extended beyond the area being investigated. The hypotheses about the partiality of the archaeological record arise from a reflection on the structure of the sample itself, unbalanced towards the subadult component and insufficient from a numerical point of view with respect to the long phases of cemetery use.

The results of the diachronic comparison carried out on the individuals retrieved from the cemetery areas of the site show a slight improvement in living conditions in the later phase of the Middle Ages compared to the High Middle Ages, attested by an increase in stature of about 2 cm in both sexes and by a decrease in severe degrees of cranial porosity, caries, and dental hypoplasia. In subadult subjects, on the other hand, the increase in caries and hypoplasia is observed in contrast, evidence that can relate to a change in nutritional practices and with a diet more based on the consumption of refined and cariogenic products.

These hypotheses will have to be further investigated on a larger and more complete sample, in the

light of the completion of the archaeological investigations in the site, and through the integration with other osteoarchaeological samples from other regional contexts. Only in that case will it be possible to obtain information on the changes in the health status of the subjects between historical periods characterized by profound political and social transformations.

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Case Report: Physical Anthropology

Endocranial mice nesting in the body of the Blessed Antonio da Fano (dead 1435)

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Abstract

Aim. Rodents nesting is not frequently described in bioanthropological literature, although it represents a common finding in mummified bodies.

Material and Methods. The partially skeletonized mummy of the Blessed Antonio da Fano (dead 1435) underwent external inspection, digital radiology, and computed tomography scanning. Inner body cavities were inspected through endoscopy.

Results. Traces of rodents nesting were noted and morphologically referred to an adult and a subadult house mice (*Mus musculus*, Linnaeus 1758, subspecies *domesticus*, Schwartz & Schwartz 1943).

Discussion and Conclusion. Our present report represents the first description of rodent nesting occurring in the body of a Saint or a Blessed of the Catholic religion. A short literature review confirm that this instance is not rare and should be carefully checked and described, in order to better understand this occurrence and to plan effective countermeasures.

Key words: rodent, nest, mummy, paleopathology, paleoradiology

Introduction

The bodies of Catholic Saints and Blessed represent a special category of human remains (Fulcheri, 1996). They deserve a special care, and Canonical Recognitions are carried out to verify the authenticity of relics, to guarantee their preservation, and to promote their veneration (Amato & Bartolucci; 2018, Fulcheri, 1991). Scientific investigations on these remains are of particular interest from the bioanthropological and paleopathological viewpoint (Fulcheri, 2013). Nest construction is widespread throughout the animal kingdom. For small rodents, nesting is important for heat conservation, reproduction, and shelter from elements, predators, and competitors (Deacon, 2006; Jirkof, 2014; Bateman, 1982).

Aim of the present study is to describe a rodent's nest found during scientific investigation of the body belonged to a Franciscan friar. To the best of our knowledge, this is the first case of rodents nesting inside the mummified body of a Saint or a Blessed of the Catholic religion.

Material and Methods

In 2019, the body of the Blessed Antonio da Fano was found in the Church of Santa Maria Nuova in Fano, Marche region, central Italy (Fig. 1) (Ventura et al., 2021; Traversari, et al. 2021). During restoration works of the building, a metal coffin dating back to 1959 and holding his mortal remains was found

Figure 1. Position of the church in Fano, Italy. Maps data ©2022 Google.

set into a brick wall (Fig. 2). The coffin and the body were later moved to the Hermitage of Val di Sasso in Valleremita, Fabriano, Marche region.

Subsequently, a thorough bioanthropological and paleopathological investigation was carried out. The body underwent external inspection, digital radiology (GMM Opera Swing system) and total body multidetector computed tomography (CT) using a General Electric Optima 64-slides scanner. Inner body cavities were inspected through a endoscopy device (Bosch® inspection camera GIC 120 C Professional). An anthropometric survey with sampling of representative materials took place shortly after. In the following months, analysis of the biological profile with Age-at-death estimated thanks to degenerative indices and morphological variants of the skeleton and dental wear

Pattern , height (Trotter & Gleser, 1958)., anthropomorphic indices, ergonomic indicators (Capasso et al., 1999) and the study of occupational markers (Mariotti et al., 2004), textile examinations and paleozoological investigations were carried out with the aim of reconstructing the lifestyle, the physical characteristics and better analyzing the taphonomic aspects that occurred after the death of the Blessed, whose life, at least in the documents, is still rather obscure and unacknowledged. Furthermore, the study of the nest intends to shed light on an aspect which, although known to the scientific community, is still probably underestimated and partially misunderstood.

Results

The well-preserved mummy with partially skeletonized chest and arms belonged to a non-slender, Caucasoid, male individual, with an estimated age at death between 45-49 years (Fig. 3). Except for some decomposed regions, a natural mummification

Figure 2. The mummified remains in the metal coffin.

Figure 3. The partially skeletonized mummy of Antonio da Fano.

process occurred through rapid dehydration, in a temperate dry climate. CT scanning and endoscopic examination of the cranial cavity revealed the presence of dense, amorphous material (Fig. 4) containing textile fragments (Fig. 5) and bony remnants of rodents (Fig. 6). Fragments of the textiles taken from the endocranium were composed of animal and vegetable fibers, namely silk and linen. All the textile fragments were made with simple weave or canvas / taffetas. Considering the information obtained from the first analysis, it is difficult to establish a dating for all the fragments, due to the small size and the lack of details related to weaving such as the selvedge or the beginning/end of the piece and the absence of design. However, it is likely that the textiles belong to the subject's primary burial. Bony remnants of rodents included two hemi-mandibles, two skull fragments, and a smaller hemi-mandible, which were morphologically referred to an adult and a subadult house mice (*Mus musculus*, Linnaeus 1758 subspecies *domesticus*, Schwarz & Schwarz, 1943) (Maga et al., 2017; Reitz & Wing, 1999). It is quite possible that the textile fragments were brought into the cranial cavity by rodents.

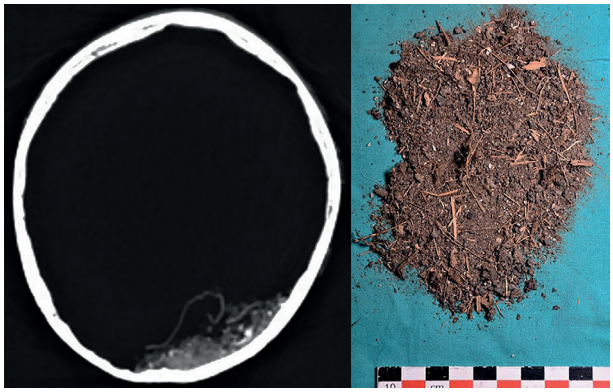

Figure 4. Left: CT scan showing granular dense material in the posterior cranial fossa. Center: endoscopic views of the posterior cranial fossa. Right: material removed from the endocranium.

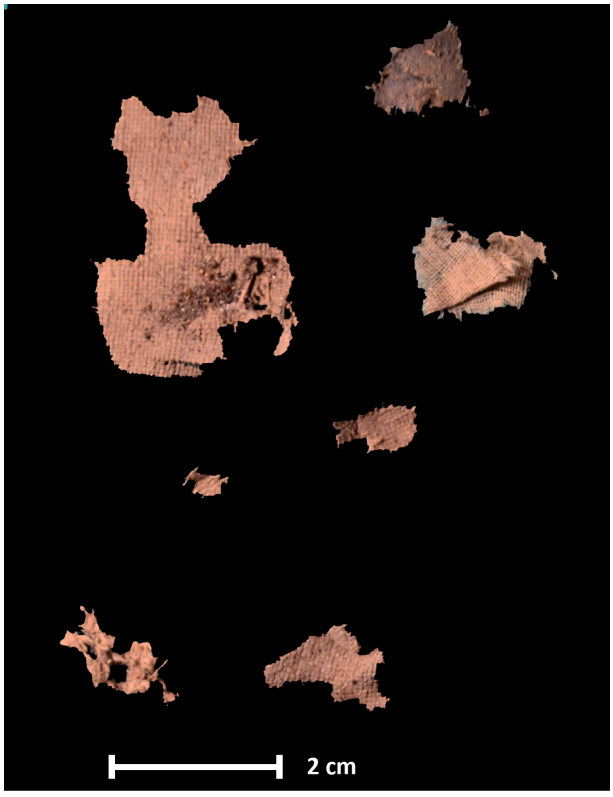

Figure 5. Textile fragments removed from the head.

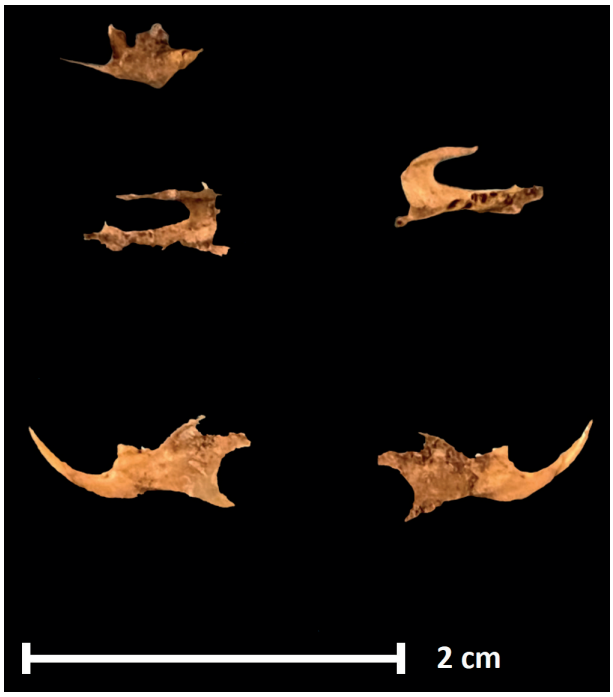

Figure 6. Two hemi-mandibles, two skull fragments and a small hemi-mandible, belonging to house mice.

Discussion

Even though rodents nesting is not frequently reported in bioanthropological literature, we believe it represents a common finding in mummified bodies. Rodent nesting inside mummies has been incidentally reported in paleopathological and forensic cases but no similar instance has been described to date in a body belonged to a Saint or a Blessed of the Catholic religion. Our present report confirms these assumptions. Rodent nests built with spun threads and fabric scraps from mummy's clothes were found inside the abdominal region of a partially skeletonized, natural mummy found in Roccapelago (Schoenholzer Nichols, 2020). A vole's nest was reported in the case study about the mummified remains of the XVII century vicar Nikolaus Rungius (c. 1560-1629). CT scanning allowed to detect some denser granular matter, mainly inside the thoracic cavity (Väre et al., 2016a). Similar structures had also been encountered inside other coffins and mummified remains (Väre et al., 2016b). Damage caused by a mouse was also noted during the conservation project of an Egyptian mummy and the related sarcophagus in the Museo Civico of Merano, Italy. The rodent damaged the mummy to build up its nest with cotton stuffing removed from a pillow and bone fragments taken from the body. The corpse of the mouse was found under the coffin (Nicola et al., 2008). A recent forensic case described red squirrels (*Sciurus vulgaris*, Linnaeus, 1758) nesting in the partially mummified body of a 35-40 years old hanged man found 13 years after death. The pelvis minor and lower part of the abdominal cavity were filled with dry yellowish-brown moss mixed with numerous small scraps of plastic film, forming the nest (Szleszkowski et al., 2018). In order to find traces of a mouse nesting within the skull of a dead man, we have to leaf through the pages of the delightful collection of anecdotes dealing with different aspects of medicine, written by Dr. Richard Francis Mould. In the "Anecdote of the Earl of Shrewsbury and a mouse" we found out that this nobleman died in 1453 and was buried at Rouen. Fifty years later his heart and his bones were moved to be buried in Whitchurch. In 1874 his tomb was restored and in the old warrior's skull the body of a mummified mouse with her three young ones was found. A truly enjoyable controversy ensued: was the mouse a French Catholic or an Anglican? The dispute ended when the Rector of St. Alkmund Church claimed to have found torn leaves of an English Prayer Book in the mouse's nest and a gnawed hole in the cloth on which the skull was wrapped. It was an Anglican mouse! (Mould, 2018)

Nesting and burrowing are spontaneous behaviors and represent daily activities. Nest building behavior is common in rodent species, as it increases lifetime reproductive success and represents an essential thermoregulatory adaption (Deacon, 2006; Jirkof, 2014). Nest material reduces heat loss and associated food consumption, as well as nests may also lower the risk of predation, by hiding or camouflaging the mouse (Deacon, 2006). Such behavior may be increased due to cold ambient temperature and complex nests could indicate cold stress (Jirkof, 2014). These pests share our need for warmth, food, and shelter, but they are unacceptable in building for many reasons such as legislation, contamination, depreciation, and reputation (Bateman, 1982). As regards dried bodies, used to form microhabitats, rodents cause physical damage because of their need to gnaw constantly to keep their front teeth worn down

and sharp, as well as chemical damage due to residue stains and surface modifications (Bateman, 1982; Cassman et al., 2007). Mice can be easily detected by their teeth marks, droppings, body hairs and smears of grease on surfaces (Bateman, 1982).

Conclusion

In conclusion, rodent activity on mummies should be carefully checked and described, in order to better understand this occurrence and to plan effective countermeasures. This important goal can be achieved only by a multidisciplinary approach, with full radiological and endoscopical investigations. Finally, it is also worth noting that contact with rodents, nests, and droppings represent a common occupational exposure for archaeologists, forensic anthropologists, and museum personnel (Cassman et al., 2007).

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Original Article: Paleopathology

Some paleopathological cases from a Medieval Necropolis of northern Italy

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Abstract

Aim. This article presents some interesting paleopathological cases from the osteological sample of the medieval church of Sant' Agostino in Caravate.

Material and Methods. The building and the adjacent cemetery area were investigated during the excavation campaigns in 1989, 2002-2003, and 2018-2019. The site, dated the 11-12th century, is characterized by a cemetery function of broad chronology. The archaeological investigations made it possible to document a total of twenty-eight structures for funerary use, both primary and secondary. This study included the skeletons of 45 individuals, which allowed us to expand our knowledge of the population of northwestern Lombardy from anthropological and paleopathological points of view.

Results. The tombs 1, 2, 9, 8, and 18 present significant pathological cases: multiple osteomas, biparietal thinning, Legg Calvè Petres, traumas, etc..

Discussion and Conclusion. These cases are important because they increase the series of even rare pathologies such as Legg Calvè Petres and biparietal thinning within the paleopathological literature.

Key words: medieval necropolis, Legg Calvè Perthes, Biparietal thinning, Osteoma, Medieval Age, north Italy

Introduction

The site of Sant'Agostino stands in the center of Caravate, a town in the Valcuvia located in the north of the province of Varese (Lombardy), in an area of intense passage and ancient connection between the Ticino and the Alpine passes.

The historical information relating to the religious building is sparse; it was mentioned for the first time in 712 in the so-called Diploma of Liutfprando, which speaks of the news of the donation of lands in the district to the monastery of Ciel d' Oro of Pavia (Frigerio et al., 1975). Later it appears in a document of 1157 in which Federico Barbarossa confirmed its belonging, together with the church of Santa Maria del Sasso, to the monastery of Pavia, San Pietro in Ciel d Oro. This documentation also appears with the toponym of Calafate or Calevade (Ghidotti & Mariotti, 1989). The whole area of Caravate then belonged to the Pavia monastery of San Pietro in Ciel d'Oro. It passed between the 12th and 13th centuries to the parish church of Cuvio under the diocese of Como. This later conceded the property to a private citizen in exchange for land in Lomellina (Mariotti, 1989). The pastoral visits in the 16th century describe the poor state of conservation and the lack of furnishings. In 1853 a new parish church was built a few hundred meters from the ancient oratory; this led to the definitive abandonment of the building that was surrounded and almost incorporated into subsequent buildings (Ghidotti & Mariotti, 1989).

The small church has been the subject of recent studies and restorations, bringing it back to its ancient medieval splendor, which isolated the building,

finally making it legible and saving it from complete deterioration.

Archaeological campaigns also investigated the church and the adjacent cemetery area from 1989, 2002-2003, and 2018-2019 (Biniaghi, 2002; Mariotti, 1989).

The first archaeological excavation was conducted in 1989 on essential restoration works; the research mainly concerned the internal area, while the area outside the church was investigated in more depth in 2002 and 2003.

New interventions, an integral part of a multi-year project launched by the Department of Biotechnology and Life Sciences of the University of Insubria, were conducted between 2018 and 2019. The previous bioarchaeological investigations have made it possible to outline the conformation of the cemetery more clearly, as it was possible to explore a more significant portion of terracing. A cemetery function of probable broad chronology characterizes the area. The excavations have made it possible to document burials inside and outside the church, which has returned a total of twenty-eight structures for funerary use, both primary and secondary, for a minimum number of 42 individuals.

This article presents some interesting paleopathological cases from the osteological sample recovered during excavations between 2002 and 2019. Paleopathology is the scientific study of the evidence of disease that affected living organisms in the past (Ortner, 2011). It is a discipline that aims to trace a disease's origin, evolution, and history over long periods through pathological changes representing diseases suffered in life and observed in human remains buried at archaeological sites (Buikstra, 2012). Human remains are the primary source of evidence for past diseases, and the paleopathological examination gives an idea of the disease's frequency, dissemination, and seriousness (Roberts & Manchester, 2005). Moreover, the data collected provide additional information about the way of living of the historical populations.

Material and Method

From 2001 to 2019, archaeological investigations conducted in the medieval site of the church of Saint Agostino in Caravate (Varese, north Italy) allowed us to discover a funeral area dated back to the High Middle Ages, exploited approximately from the 11th century.17 Several archaeological phases have been recovered and, until now, 20 structured tombs, 2 reused as a common ossuary, have been brought to light (Licata et al., 2016a, 2016b; Licata et al., 2021; Licata et al., 2020). This study will deal with some of the most interesting paleopathological cases that emerged during the excavation campaigns. We proceeded with the anthropological analysis to reconstruct the skeletons' biological profile. Sex was determined based on the morphological features of the skulls and of the pelvis (Phenice, 1969; Acsádi & Nemeskéri, 1970; Bruzek, 2002). Age-at-death was estimated using degenerative changes of the auricular surface and pubic symphysis (Lovejoy et al., 1985; Brooks & Suchey, 1990), sacrum (Passalacqua, 2009), and of the auricular surface and acetabulum (Rougé-Maillart et al., 2009); moreover, ectocranial suture closure (Meindl & Lovejoy, 1985) and dental wear were considered (Brothwell, 1981; Lovejoy, 1985). Stature was calculated using the formulae for white males by Trotter and Gleser (1958). After macroscopic observation, photographic documentation, and description of the evidence, computed tomography (CT) examinations were conducted on the whole skull. For CT scans, conventional medical radiological equipment was used (GE Healthcare Revolution- GSI 128 Layers). Imaging parameters were as follows: 100 kV, 80 mA. The slice thickness used was 2.00 mm.

Results

We present the most significant pathological cases.

Tomb 8

The skeleton under investigation was in a primary deposition in a burial location, laid inside an anthropomorphic tomb-oriented East-West. The skeleton of tomb 8 belonged to a woman with an estimated age at death of 45 to 55 years and 152 to 155 cm tall (Tonina et al. 2021). The parietal bones display 2 elliptical and symmetrical depressions: the right measured 68.8 x 53.5 mm, and the left measured 73.0 x 57.1 mm. Both lesions

show an anteroposterior direction and are located between the temporal line and the sagittal suture (Fig. 1). The right parietal presents a minimum thickness of the cranial theca of 0.75 mm, whereas the left parietal of 0.79 mm. In the section, the progressive disappearance of the diploe and the exposure of the internal surface were visible. The endocranial surface also presents non-specific multifocal lesions with a serpentine appearance on the frontal and parietals, from the frontal crest continuing along the superior sagittal sinus. The same aspect was also observed at the level of the areas of thinning. Computer tomography allowed us to understand the lesions and detect the progressive loss of the diploe and the external bone table. In contrast, the inner surface appears to be preserved (Fig. 2). Moreover, radiological investigations made it possible to detect alterations in the typical curvature of the parietals (Tonina et al., 2021).

Tomb 18

The skeleton of T. 18 was in a primary deposition in a burial located outside the church, oriented N-S, and, according to the archaeological stratigraphy, dated to the 12th and 13th centuries. The skeleton was well preserved and belonged to a man with an estimated age at death between 40 and 50 years and a stature of about 166 cm.

The individual exhibited bone changes in the right hip involving the femoral head and the acetabulum, which appear to result from a pathological condition. The left hip showed no pathological changes. The right femoral head was flattened superiorly and larger than the left one, with the edges widening into a mushroom shape (Fig. 3). The articular surface showed porosity and exostosis. It could not be stated with certainty whether the fovea capitis was dislocated or resorbed due to the incompleteness of the femoral head. There was no substantial dislocation of the center of the femoral head from the axis of the shortened and thickened femoral neck. The right acetabulum was markedly shallower in comparison to the left. Its borders were hyper-developed, with a diameter of 73 mm (differing from the 51 mm of the left coxal bone and presented important bone neoformation (Fig. 4). The inner surface was also characterized by great porosity. No traces of neo acetabulum in either the proximal or the dorsal direction (Fusco et al., 2022).

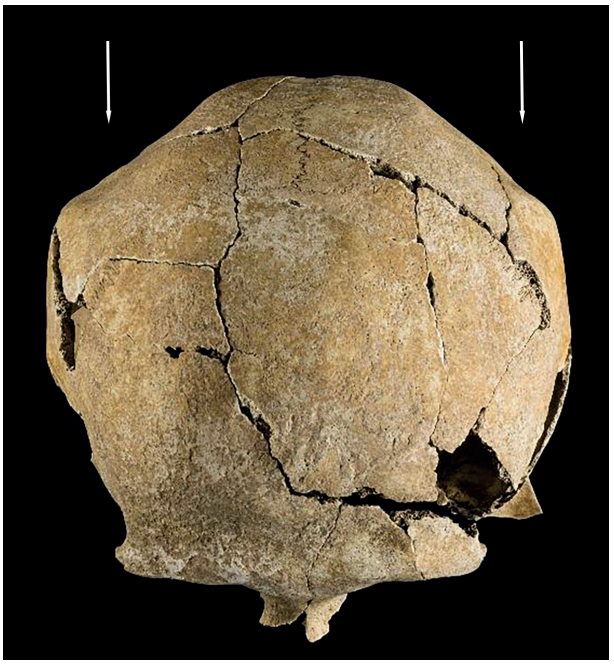

Figure 1. 4 Elliptical and symmetrical depressions located between the temporal line and the sagittal suture of the skull.

Figure 2. CT coronal vision, symmetrical depression of the parietals whit resorption of the external table and the diploe.

Tomb 1- 2 -9

Tomb 1: The skeleton of tomb 1 belongs to a woman 30-40 years of age. The frontal bone exhibits a partially healed quadrangular lesion on the right, probably due to trauma caused by a pointed weapon with a quadrangular section.

This woman shows twelve osteoblastic lesions at the level of the neurocranium. These are located mainly

Figure 3. Medial view of the flattened right femoral head.

in the sagittal suture and are characterized by well-defined margins, oval shape, with not fully smooth margins, and small dimensions.

Tomb 2: The skeleton belongs to a man of 35-45 years of age. The skull presents a com completely healed depressed trauma on the left parietal bone. The skull of the subject of tomb 2 is characterized by the presence of six osteoblastic lesions located on the frontal, on the right (one of which is near the obelion), and left parietals. They have well-defined margins and circular shapes. The individual has a well-visible oval-shaped bone formation on the dorsal surface of the 3rd proximal phalanx of the left hand (Table 1).

Tomb 9: The skeleton belongs to a male individual of 40-45 years of age. The individual has nine osteoblastic lesions at the level of the neurocranium, located mainly on the frontal and parietal bones, near the sagittal suture, and above the lambda. They are poorly

Figure 4. Right coxae showing pathological alteration of the acetabulum.

Figure 5. Skull of the subject, superior view. The left parietal bone shows many osteomas near the posterior part of the sagittal suture.

detected and are characterized by a circular or ovoid shape with irregular margins (Table 1). Except for the osteoma found at the level of the 3rd proximal phalanx of the left hand, in all cases, the osteoblastic lesions were observed on the cranial vault. The rounded lesions of different sizes present a smooth surface and defined margins (Licata et al., 2022).

Discussion

T. 8

The skeleton shows symmetrical cranial depressions involving both parietal bones in the exact location. As the appearance of this condition respects a symmetrical and bilateral disposition on the parietal bones, our reading of the case refers to a severe state of biparietal thinning. This pathological condition appears to have been present elsewhere in the past and, albeit rarely recorded, is also recognized in today's clinics. Several published palaeopathological cases are documented in Europe, America, Africa, and Australia. Biparietal thinning has been found even in India in a skull from the Bronze Age, representing one of the oldest cases (Dutta, 1969). This pathological condition has been known for a long time. Called by different names: "biparietal senile disease," "senile arthropathy," "biparietal thinning," and "parietal osteodystrophy," with unknown etiology, this pathological condition appeared to usually involve the posterior parasagittal regions (Camp & Nash, 1994). Bruyn and Bots described 2 types of biparietal thinning related to each other: flat or grooved (Bruyn, 1978). Cederlund, in the article published in 1982, reported radiological observational criteria to classify the degree of parietal thinning. In particular, based on the thickness of more affected bone, three stages were proposed: I) thinning is only superficially observed in the parietal region, and in tomographic images, a radiolucent area is highlighted; II) a considerable thinning in anterior and posterior view is recorded, in particular the loss of more than half of the bone substance, even if the diploe is preserved, is observable; III) external surface is affected, and the total loss of the diploe and the outer region is observed (Cederlund et al., 1982).

In our case, we can record the presence of bilateral parietal thinning of the third degree, stating to the classification of Cederlund,3 and referring to the classification of Bruyn and Bots,1 of the groove type.

For more than two centuries, anatomists, physicians, and anthropologists have tried to find the answer to the etiological nature of this condition. Different causes have been associated with the condition by several authors: constant pressure on the bones, developmental dysplasia, congenital dysplasia of the diploe, diabetes, growth defects, post-menopausal osteoporosis, gonadal insufficiency, hormonal changes, inflammatory arthropathy associated with trauma, primary metastatic tumors, gonadal insufficiency, Gorham disease, senile changes of the temporal artery and simple anatomical

Table 1. Osteoma locations and dimensions on the skeletal remains.

	Osteoma location				
	Occipital	**R parietal**	**L parietal**	**Frontal**	**Postcranial**
Tomb 1/2002	1.93 x 2. 32 mm	3.5 x 2.3 mm; 2.32 x 2.03 mm; 1.76 x 1.40 mm; 1.40 x 2.21 mm; 1.65 x 2.66 mm; 2.40 x 1.76 mm	2.07 x 1.76 mm; 2.74 x 3.07 mm; 3.27 x 2.35 mm; 2.82 x 1.96 mm; 1.81 x 1.80 mm	-	-
Tomb 2/2002	-	3.87mm x 3.39mm; 3.98x3.18 mm	4.24 x 3.67 mm; 2,52x3,06 mm, 3,73x3,24 mm	3.4mm x 3.25 mm	3rd proximal phalanx of the left hand 6.4 x 4.6 mm
Tomb 9/009	-	4.37 x 3.52 mm	3.39 x 2.40 mm; 3.70 x 2.99 mm; 2.63 x 2.65 mm; 2.73 x 2.47 mm; 7.06 x 2.0 mm; 7.54 x 4.63 mm	2.58 x 2.25 mm; 1.42 x 1.40 mm	-

variation, osteomyelitis, granulomatous infections, aseptic necrosis, bone aneurysm, cystic angiomatosis of bone and systemic macrocytosis prolonged steroid therapy.

Many researchers linked the biparietal thinning condition to genetic factors, others to vascular causes. Other authors consider the condition age-related (Grainger et al., 2001; Sanati-Mehrizy et al., 2020) or a consequence of postmenopausal (Mallegni, 1976) or senile osteoporosis (Virchow, 1854) and atrophy. Among the most acclaimed hypotheses, senescence is the most convincing. By the clinical cases recorded, the literature informs us that most patients have a minimum average age of 50 for men and over 60 for women (Fusco et al., 2020). It can therefore be suggested that this condition is related to the reduction or cessation of sex hormone activity (Epstein, 1953)

The skull, belonging to a mature female, could support the link to biparietal thinning, postmenopausal osteoporosis, and senile osteodystrophy (Tonina et al., 2021). It is essential to highlight that biparietal thinning is not often considered from a clinical point of view. Usually, it has no pathological significance except for the potential increased risk of fractures. (Fournier et al., 1968).

T. 18

To proceed to an accurate differential diagnosis, we considered congenital hip dislocation (CHD), slipped capital femoral epiphysis (SCFE), multiple epiphyseal dysplasias (MED), Gaucher's disease (GD), infantile hypothyroidism, sickle cell disease (SCD) and Legg Calvè Perthes (LCP). All these conditions can produce similar lesions on the femoral head, making diagnosis difficult (Kozlowski et al., 1995; Spranger et al., 2002). CHD can be ruled out since, in this case, a pseudo-acetabulum is absent from accommodating the dislocated femoral head, and the aspect of the original acetabulum suggests its functionality until the individual's death. We also excluded SCFE because, in this condition, the epiphysis is characterized by head center dislocation toward the neck axis, shortening, and thickening of the neck, with the formation of a new acetabulum at the ilium. (Herrerín & Gallarda, 2012; Rosenfeld et al., 2007). We also considered GD, MED, infantile hypothyroidism, and other types of osteonecrosis due to SCD, but they usually involve both hips and other joints, whereas in our case, only one of the hips was affected (Anderso et al., 2010; Manzon, 2017). The mushroom-shaped femoral head is one of the most striking and representative features of Legg-Calvé-Perthes. The increasing size of the femoral head can be explained by several factors, such as the necrosis of the bone, natural remodeling, and the potential adherence of small necrotic fragments that might have been detached from the bone during the pathological process (Roberts & Manchester, 1995). The deformed femoral head has led to modifications of the acetabular shape, inducing a severe degenerative disease on both articular surfaces. Sex determination is also suggestive of the diagnosis of LCPD, as it primarily involves European males (Chaudhry et al., 2014). In conclusion, morphologic examinations of the right hip of the individual buried in T.18 suggest a diagnosis of unilateral LCPD. The aetiology of the disease is still unknown. Still, the role of traumatic, genetic, metabolic, nutritional, environmental, hormonal, and hematologic factors as the potential causes of the changes at the femoral head has been discussed (Thompson & Salter, 1986). One seems the most likely of the proposed etiological theories. There is experimental evidence that the original occlusion of the precarious blood supply to the femoral head may be caused by excessive fluid pressure from an inflammatory or traumatic synovial effusion in the hip. Approximately 5% of children with transient hip synovitis show the complication of Legg-Calvé-Perthes disease. According to some authors, it is likely that multiple factors can combine in a constitutionally vulnerable child and cause the disease (Schwarz, 1986; Nevelos, 1986). When comparing our case with clinical examples, we can hypothesize that the lesions worsened over the individual's life without suitable treatment. In effect, when medical treatment is provided, the complete regeneration of Perthes disease takes 2-5 years. On the other hand, when an individual lives for too long with this disease, the natural remodeling of the bone leads to a permanent mushroom shape of the head with an indiscernible fovea capitis and corresponding ligament attachment. Based on these hypotheses, in the individual of T.18, the first symptoms probably appeared at a very early age, before age 10. The disease encompasses a wide spectrum of manifestations, from mild with no long-term sequelae to severe with permanent degenerative hip joint changes. Occurrences include a deficit in hip abduction and internal rotation nature, along with

Trendelenburg gait in advanced stages (Divi & Bielski, 2016). LCPD can be a self-limiting disease. However, in our case, the appearance of the acetabulum and femoral head suggests the functionality of the right hip until the individual's death.

Tomb 1- 2 -9

An osteoma is a benign bone lesion with no clear pathogenesis, almost exclusive to the craniofacial area. From a histological point of view, it results in a proliferation of either compact or cancellous bones, following endosteal or periosteal surfaces, with many size variations. Osteoma advances mainly in the skull; facial bones and the mandible are the most affected. Instead, the location in the occipital region is rare. Osteoma represents the most common benign tumor of the nasal tract.

Osteoma of the facial bones is a fairly asymptomatic condition. Still, in severe cases, it can alter sinus drainage and sinusitis or even deform the bones of the orbits and expand under the oral mucus (Di Girolamo et al., 2019).

The single osteoma may have no pathological significance. Instead, multiple osteomas may indicate a disease condition and is a less common condition.

According to the literature, the lesions can be produced by congenital anomalies or other chronic inflammation that can originate within the neoplastic proliferation. Another cause of osteoma growth can also be a consequence of trauma or embryogenic alterations. Osteomas because of congenital skin abnormalities are poorly documented. Their development has been suggested from embryonic cell remains as heterotopic formations for these cases. As chronic inflammation, osteomas can lead to chronic mucosal inflammation.

Multiple osteomas may also refer to hereditary adenomatous colic polyposis associated with Gardner syndrome (Dolan et al., 1973). Multiple osteomas may refer to hereditary adenomatous colic polyposis (APC) associated with Gardner syndrome (GS). Some authors consider that the diagnosis can be in the presence of more than three osteomata on the maxillo-facial complex (Chimenos-Küstner, 2005). From an archaeological perspective, GS could be indicated by numerous skeletal osteomas, above all at the cranial level.

Only some cases are attested in the palaeopathological literature. In the Czech Republic, the skull belonging to a female individual 20-25 years old, discovered in an ossuary of the eighteenth century, showed two osteoblastic overgrowths (Strouhal et al., 1996). Another case comes from the Medieval site of Pieve di Pava (Central Italy). The remains belonging to a female 40–50 years old show six osteoblastic lesions on the cranial vault and three similar lesions on post-cranial bones (Giuffra, 2019). Finally, a case comes from an Iron Age site Swiss, represented by a skeleton of a woman 30–50 years old with multiple osteosclerotic lesions to the skull (Moghaddam, 2013).

According to some authors, multiple osteomas may also be due to traumatic aetiology. Kim et al. l consider a combination of trauma and muscle traction as a possible cause, where subperiosteal bleeding from trauma combined with elevated muscle traction force can cause an osteogenic reaction. This aetiology may cause numerous smaller lesions than a single larger one (Kim et al., 2017). Some authors point out that the irregular bony overgrowth of the cranial vault due to reactive post-traumatic events is histologically characterized by rich vascular channels, a lack of laminated structure, and numerous osteocytes and the Haversian system (Eshed et al., 2007). Moreover, the distinction between the lesion and the ectocranial table needs to be better defined. Thus, these characteristics distinguish this type of lesion from "button osteoma." In our sample, all skulls present a healed trauma condition; therefore, it is possible to consider the association of multiple osteomas with traumatic injuries, as has been advanced in the literature. Since osteomas are mainly located in the parietal districts in our skulls, the hypothesis that this condition is linked to muscle stress cannot be excluded (Licata et al., 2022).

Conclusion

This study presented evidence of Legg Calvè Petres, biparietal thinning, and multiple osteoma conditions. The utility of case studies of single or small groups of individuals in paleopathology has been examined repeatedly over the past two decades, and some scholars have recently argued that they serve as essential additions to population-level analysis (Bradbury

et al., 2016; Buikstra & DeWitte, 2019; Grauer et al., 2016). Furthermore, analyzing these pathological cases helps to implement a limited list of archaeological cases, expanding our knowledge on the onset of these conditions thanks to the continuous development of bioarcheological sciences and the excavations of other necropolises. Additionally, the advanced observational methodologies applied to ancient human remains will allow the discovery of hitherto unknown pathological signs of the past and enrich the diagnostic analysis in the clinical experience.

Finally, it is essential to add that a museum project is underway on the site of S. Agostino, which also includes the sites of S. Biagio in Cittiglio and the Crypt of S. Eusebio di Azzio; the project involves the creation of a bioarcheological archive in which the skeletal remains of the three sites will converge. This archive and the studies conducted will further expand our knowledge of the population of north-western Lombardy.

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Short Report: Museum

Restoration activities for the enhancement of the anatomical collections of the Pavia University Museum System

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Abstract

Aim. The restoration activities carried out on the anatomical collections of the Pavia University Museum System are presented. These anatomical preparations dates back to 1772, with anatomist Giacomo Rezia, and was subsequently enriched by Antonio Scarpa, Bartolomeo Panizza, Giovanni Zoja, and others. In the 1930s the human anatomy collections were transferred to the new medical institutes in Via Forlanini and recently named after anatomist Luigi Cattaneo, while some anatomical specimens were chosen for the Pavia University History Museum. The collections testify to discoveries and turning points in the history of science and show how teaching anatomy to future doctors and surgeons required a huge effort in the preparation and setting of pieces, both dry and wet, that would allow the transferring of anatomical and surgical knowledge.

Material and Methods. In 2016 the restoration activities of anatomical preparations began to stop their physiological degradation. For each preparation, all the information regarding the storage conditions and past restoration operations was collected; accurate photographic documentation was carried out, to make every intervention traceable. The interventions were strictly conservative, aimed at preserving the specimens as they were originally prepared and improving their general conditions of conservation. The restoration was authorized by the Superintendence of Archeology, Fine Arts and Landscape. To date, 366 dry-preserved anatomical preparations and 58 liquid-preserved anatomical preparations have been successfully restored.

Results. The restoration made it possible to efficiently recover precious finds from the University Museum System of the University of Pavia, without altering any element that could provide historical information on the pieces in question, avoiding the replacement or alteration of each component of the find that could provide indirect information regarding the preparation technique, the preparer, and the date of realization. Furthermore, in order not to invalidate future paleopathological studies, particular attention was paid not to alter signs of pathologies or trauma and not to use aggressive solvents, in order to protect the integrity of the DNA for genetic or molecular analysis.

Discussion and Conclusion. The conservative restoration conducted allowed to renew the scientific usability of such valuable biological preparations, making them, still nowadays, a useful tool for educational purposes in university anatomy courses.

Key words: anatomical collections, conservative restoration, medical collections, dry collections, wet collections

Introduction

The anatomical collection of the Pavia University Museum System dates back to 1772, with anatomist Giacomo Rezia (1745-1825), and was subsequently enriched by Antonio Scarpa (1752-1832), Bartolomeo Panizza (1785-1867) and Giovanni Zoja (1832-1899) (Dubini, 1837; Monza, 2006; Garbarino, 2014; Garbarino, 2020). Towards the end of the 19th century, the Normal Human Anatomy Collection was transferred to a new location, in Palazzo Botta, an ancient noble residence acquired by the University of Pavia for its scientific institutes. The collection was moved again in the '30s of the past century in the new buildings of the Medicine Faculty, in Via Forlanini. Scarpa's Museum also preserved a Pathological Human Anatomy Collection, which was enormously increased from 1855 by Giacomo Sangalli (1821-1897) with exemplary pieces and autopsy examination protocols, so much so that the assignment of new premises was soon necessary.

Some anatomical preparations can be linked to clinical records or autopsy reports. It is therefore possible to examine biographical and clinical information of great interest, which however, opens up some ethical problems relating to exhibiting such pieces. This collection was eventually moved to the building in Via Forlanini in the '30s, leaving the rooms that had once housed Scarpa's Collection.

In the same years, the Pavia University History Museum was founded; anatomical pieces of particular interest were selected for its displays, from the two collections that had found in Via Forlanini their new home (Monza & Poggi, 2003; Falomo et al., 2020).

The collection in Via Forlanini, named after anatomist Luigi Cattaneo, consists nowadays of more than 2000 finds, including anatomical preparations, models, and wax sculptures, dating back to the late 18th and late 19th centuries. The collection is divided into different sections: Osteology, with various types of preparations, from infants to adults, and a rich collection of skulls, including the one belonging to scientist Valentino Brugnatelli (1761-1818); the Angiology section with dry prepared whole cadavers, as well as a series of preparations relating to the heart and venous, arterial and lymphatic systems; the section of Embryology with embryos, human fetuses, and gestating uteri; the section of General Anatomy with fine preparations relating to connective, cartilage, and bone tissue, preparations of muscle, nervous tissue, and blood vessels; and the sections of Splanchnology, Estesiology, Neurology and Topographical Anatomy.

The Medicine section of the Pavia University History Museum includes instruments, memorabilia and anatomical preparations relating to the second half of the 1700s, to the 1800s and to the 1900s. Among these is also the anatomical and pathological collection of a museum founded inside the S. Matteo Hospital by surgeon Luigi Porta (1800-1875), pupil of Scarpa (Garbarino, 2016).

To stop their physiological degradation, restoration activities of anatomical preparations began in 2016 (Restivo et al., 2019). All the information regarding storage conditions and past restoration operations was collected for each preparation; accurate photographic documentation was carried out, to make every intervention traceable.

Materials and e Methods

The restoration of the 'Luigi Cattaneo' Collection (Institute of Human Anatomy)

The restoration, authorized by the Superintendence of Archeology, Fine Arts and Landscape, involved four full-length myological statues, significant and very complex anatomical preparations that presented a fairly critical conservation situation. By comparing the identification tags, in some cases incomplete, with the historical inventories of the Anatomical Museum, a good number of information relating to these precious preparations was collected. They are described in the angiology section of the catalog published by Giovanni Zoja (1889): they are myo-arterial preparations of the corpses of a 7-year-old boy (E4) and a 13-year-old boy (E3), attributed to Panizza. The third statue is also ascribable to him and is identifiable with the number E2 based on the description provided by Zoja: "Dry preparation of the whole arterial and muscular system of an adult, for which care was taken to leave, on the right side, the arteries in their relations with the superficial parts, whereas on the left side the deeper arterial ramification

where left exposed" (Zoja, 1899). The fourth statue is accompanied by a tag with the number 136 and seems to have been prepared by Scarpa, instead: an adult man, with emphasis placed on major arteries and veins with their ramifications. The muscles are accurately highlighted, and in some cases artificially enlarged. The biological preparations have undergone thorough cleaning and repair, with a preference for the less invasive restoration techniques - agreed upon with the staff in charge of the collections - and with the highest regard for the historical value of the pieces.

The considerable dimensions of the preparations, together with their complexity and fragility, made the operations for both transport and restoration quite elaborate. The four preparations were taken from the displays and moved to a laboratory especially set up for the occasion inside of the same building. Any damages detected on the samples were marked on a dedicated restoration record card, together with notes on the state of conservation. Tags and labels were photographed, and the contents were transcribed, when readable; ultraviolet light was also employed to verify the presence of characters and numbers that might have lost pigment and might therefore have become invisible to the naked eye. A general cleaning and disinfection of the pieces followed. During a first stage, dust and dirt deposits were removed, using a controlled flow of low pressure compressed air and soft-bristle brushes. Afterwards, a deep clean of the preparation and of its base was carried out, manually removing any dirt adhering to the surface by wetting and dabbing with a solution of H_2O and benzalkonium chloride 10 %, which also performs a disinfecting action (Fig. 1). The tissues presenting with mold were treated with denatured hexane or with a solution of H_2O and benzalkonium chloride 10 %, according to their frailty. Wherever the shellac was irreversibly deteriorated or altered, it was necessary to remove it by delicately dabbing it with 95° alcohol. After cleaning, a thin layer of shellac was applied to protect the tissues and to restore their original lacquered appearance. Repairs relating to the breakage of tendons, nerves and blood vessels were carried out with mechanical techniques (binding etc.) or with chemical ones (gluing). Gluing was achieved with an acetovinyl homopolymer dispersed in water at different solutions, to ensure that the process be reversible. Finally, a detailed photographic documentation of every piece that underwent restoration was produced both before, during and after the process (Fig. 2, 3 and 4).

Figure 1. Deep clean of the preparation is carried out, manually removing any dirt adhering to the surface by wetting and dabbing.

The restoration of the collection of the Pavia University History Museum

The restoration of the dry biological preparations followed the same intervention protocol used for operations on the "Luigi Cattaneo" collection, accounting of course for necessary differences. For the restoration of preparations preserved in liquid, the protocol required the preliminary analysis of the state of conservation of each piece in its entirety, meaning: the biological sample, the preserving solutions -which develops a chemical balance with the biological sample- and the original glass vase with its tag, both rich in useful historical and scientific information. According to any critical issues emerging on any of the three elements (biological sample, solution, and vase), a series of specific operations apt to recover each of them is put into action.

Figure 2. Myological statue E2 before (a) and after (b) the restoration.

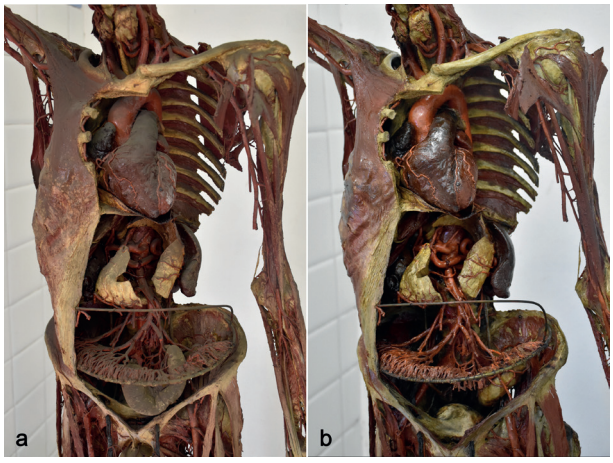

Figure 3. Detail of the myological statue E2 before (a) and after (b) the restoration.

As for the procedure reserved for the glass vases, the closure of the lid of each container is verified before the cleaning phase, as well as the integrity of all the components: vase, lid, lid-ring (pig bladder or parchment of animal origin) and the state of the external sealant (black sealing wax or shellac), when present. After the analysis, the external surface of the container is thoroughly cleaned, with products specifically

Figure 4. Details of the myological statue E3 before (a, c) and after (b, d) the restoration.

intended for glass cleaning and solvents suitable for the other parts. In a few cases, the lid had to be replaced (being broken or not fitting) with a new glass disk bearing a sandpapered lower side.

For the operations concerning the solutions, its quantity present in the vase and its state of alteration was evaluated by visual examination; the type of solution was then verified and proven to be formalin in all cases except one. The pH was determined with indicator papers with different sensitivities. Where necessary, the liquid was topped up with 4% buffered formalin. Only when the quantity of liquid in the vase was extremely low, it was substituted, particularly if it was visibly altered. Lastly, when the liquid was not present at all, but the biological sample was not entirely dried out, the solution was restored with 4% buffered formalin. To further increase the data available on the collection, where possible, a sample of the liquid was drawn to allow future analysis. The biological samples have been carefully examined to determine the presence of mould or any breakage of the tissues. Where necessary, the preparations were removed from the vase, cleaned from any residue of altered liquid or salts, and placed back inside the cleaned vase. In some

cases, it was necessary to tie the biological sample back to its supports to restore the original setting. The containers were then newly sealed with different methods, considering the type of lid and the content of the vase. The lid and the mouth of the container were covered with a sheet made of pig bladder, tied by hand with waxed twine, on which a layer of black sealing wax dissolved in ethyl alcohol was applied (Fig. 5) (Gestro, 1925; Zangheri, 1969; Naj et al., 2019; Restivo et al., 2019). Besides securing the airtight closure of the vase and bettering its state of preservation long term, this last operation intensifies the ostensive value of the preparation.

Where necessary, a delicate superficial cleaning of the original tags was carried out, whereas any partially detached one were attached again to the vase.

Figure 5. Application of black sealing wax dissolved in alcohol.

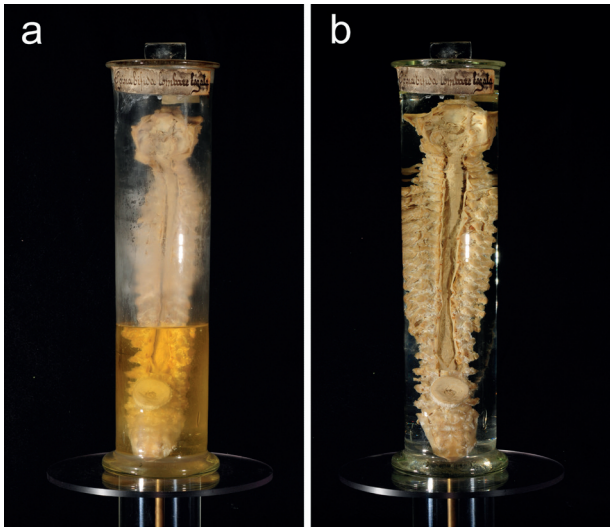

Figure 6. Specimen no. 824, example of an anatomical preparation preserved in liquid before (a) and after (b) the restoration.

Results

The restoration made it possible to efficiently recover precious finds from the University Museum System of the University of Pavia, without altering any element that could provide historical information on the pieces in question, for example avoiding, the replacement or alteration of nails, bindings, original supports or labels and, more generally, of each component of the find that could provide indirect information regarding the preparation technique, the preparer and the date of realization. Furthermore, in order not to invalidate future paleopathological studies, particular attention was paid not to alter signs of pathologies or trauma and not to use aggressive solvents, in order to protect the integrity of the DNA for genetic or molecular analysis.

The interventions were strictly conservative, aimed at preserving the specimens as they were originally prepared and improving their general conditions of conservation. To date, 366 dry-preserved anatomical preparations and 58 liquid-preserved anatomical preparations have been successfully restored (Fig. 6). Particularly worth mentioning among the restored preparations, aside the four myological statues, is the common torpedo or electric ray fish preserved in formaline in the room dedicated to Alessandro Volta (1754-1827) (Bellodi et al., 2002), Antonio Scarpa's head, preserved in alcohol (Cani & Garbarino, 2017; Garbarino & Cani, 2018), and the skeleton of a man called Luigi Cella, who was known as the "dwarf of the bridge", one of the preparations with the most dramatic story. Affected with dwarfism, Cella was a beggar who lived most of his live asking for alms near the covered bridge on the Ticino river, singing and playing a mandolin to entice by-passers to donate. He was extremely well known in Pavia in the mid-18th century and he was portrayed, among others, by painter Ezechiele Acerbi in the wooden frame of a view of Pavia (preserved at the Pavia Civic Museums). In 1843, newspaper Gazzetta della Provincia di Pavia reported

the news of the lithography, found "in the display of some shop", which represented "a most renown man to anyone who visits the streets or the cafes of Pavia: who in others times would have been sitting at the most sumptuous banquets of Kings, but nowadays lives on charity by touching, the best he can, the strings of a guitar" (Bernardi et al., soon to be published). Cella died in 1872 at San Matteo Hospital in Pavia, at the age of sixty-six. Giacomo Sangalli conducted a thorough autopsy on the body and the skeleton was prepared for the Pathological Anatomy Museum, of which Sangalli was the director.

Conclusion

The anatomical collections are extremely valuable to gain an understanding of the complexity of the human body but also of the meticulous and difficult work of the scholars who, through the centuries, were able to describe increasingly accurately the human structure, both in normal and pathological conditions. The collections testify to discoveries and turning points in the history of science, but also to errors and sufferings due, on the one hand, to the impact that illness has always had on the human condition, and on the other, to social circumstances that affected particularly the most fragile (Mazzarello, 2015).

The Pavia collections furthermore show how teaching anatomy to future doctors and surgeons required a huge effort in the preparation and setting of pieces, both dry and in liquid, that would allow the transferring of anatomical and surgical knowledge.

The conservative restoration conducted allowed to stop the deterioration that was developing and to renew the scientific usability of such valuable biological preparations, making them, still nowadays, a useful tool for educational purposes in university anatomy courses (Garbarino et al. 2020; Falomo Bernarduzzi et al., 2021).

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Review Article: Archaeoentomology

When Entomological studies meet Archaeology: archaeoentomology an old, new discipline for investigation of the Past

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Abstract

Due to their widespread distribution and their ability of colonizing all the terrestrial and freshwater ecological niches, insects represent a good candidate in archaeological investigation to derive further levels of knowledge. Archaeoentomology is the discipline devoted to this aim. In addition, a more specific discipline, funerary archaeoentomology focus its attention to the funerary context in order to reconstruct the funerary practices and obtaining specific information about rituals, bodies' transfer and sanitary conditions. In this review the potentialities and the limits of this disciplines are described.

Key words: Insects, Diptera, mummies, burial, decomposition

Insects, with more than 1,300,000 described species, represent about the 75% of the known animals and are present in all the terrestrial and freshwater environments of our planet. Only the deepness of the oceans is not inhabited by insects, however crabs and shrimps belonging, as the insects, to the phylum Arthropoda are the "citizens" of that obscure, dark environment. Due to their high number, worldwide distribution, high rate of reproduction and elevate adaptability insects are quite common in all the anthropic environments where they can found microhabitats similar to their natural environments and benefit from their facultative or obligate association with humans (King, 2014). Our species, *Homo sapiens*, has been and is strongly affected by insects at different level: i) public health, insect are vectors of several pathogens and among them malaria, counting 627,000 deaths in 2020 (WHO, 2021); ii) economy, pollination of a high variety of edible plants is done by insects such as the small biting midges in the genus *Forcipomyia* (Diptera, Ceratopogonidae) pollinating the cacao tree. Insects also have an important economic impact destroying or affecting the quality of edible plants, seeds, cheeses, dry fishes, etc., with an economical lost evaluated in more than 700 billion dollars per year; iii) waste recycling, the necro-mass of animals and plants and the excrements of animals are transformed and recycled by insects and other arthropods - the problem created introducing livestock in Australia where scatophagous insects were not present is one of the most illuminating example of the importance of insect in "organic waste" cycling; iv) culture and symbolism, insects played an important roles representing obscure forces (Beelzebub is the king of flies) or richness and power (honey bees are represented in a lot of family stemmas such as the Napoleon one). This has happened not only in the past but also nowadays where several companies are using images and names of insects and other arthropods in their brands and models (for example among the motorbike the Piaggio's Vespa and the Honda's Hornet).

The relationship between human environments, human goods and insects if correctly investigated may provide a further level of information to better reconstruct past environmental and climatic conditions, landscape usage and cultural practices (Kenward, 1978). The discipline devoted to this aim is

called Archaeoentomology. This discipline deals with the study of synanthropic insects and other arthropods recovered during archaeological excavations, whereas another discipline paleoentomology focus on the study of insect remains collected from natural environments free from any kind of anthropic activity (Ashworth et al., 1997).

More in general, as suggested by Kenward (2009) archaeoentomology can be considered a branch of the environmental archaeology which is a large interdisciplinary subject involving other disciplines as geology, geography, climatology, biology, history, and anthropology, all collaborating and providing information field-specific in order to draw a scenario as much accurate and complete as possible about the human past (Kenward, 2009).

The first usage of insects in for the interpretation of past environments had its beginnings in Egypt in 1842 when Reverend Hope described the diet of mummified ibis from the insects found in their gut (Panagiotakopulu, 2001). Since that the discipline has developed in different ways across the world, with entomologists and archaeologists of some countries more sensitive to the discipline and others, from other countries, more indifferent. Anyway, it is worth of mentioning that the attention to insects from archaeological contexts has shown a significant increase in the last decades.

The utility of the entomological approach in the archaeological context is related to the fact that: i) insects are the most ecologically diverse group of animals, capable to survive in a large variety of habitats with the most diverse environmental/climatic conditions (Buckland et al., 2014). Some species are cosmopolite and adapted to different habitat in contrast other species are quite specific in term of habitat and distribution; ii) insects did not evolve in the last 2 million years (Forbes et al., 2013; Buckland et al., 2014). The information about the ecology of populations of insects living today can be used for reconstructing the past specially to derive: past climate and environments, both terrestrial and marine (Ashworth et al., 1997; Buckland et al., 2016); human diet (Panagiotakopulu, 2001); agricultural practices, food storage even through the study of stable isotopes accumulated in the exoskeleton (King, 2012); commercial trades (Panagiotakopulu, 2003); human living conditions and attitudes to hygiene (McCobb et al., 2004; Panagiotakopulu, 2004); permanence of settlements (Panagiotakopulu et al., 2007; Panagiotakopulu & Buchan, 2015) and funerary practices (Huchet, 1996; Giordani et al., 2020).

A very peculiar branch of archaeoentomology has been developed in 1996 by Jean-Bernard Huchet transferring the methodology and the knowledge about human colonization typical of forensic entomology to funerary contexts of archaeological interest. Records of insects from Egyptian mummies date back in the 17th century when Vallisneri described and sketched puparia of flies, potentially in the family Fanniidae from a mummy (Benecke, 2001).

Different groups of insects can be collected from a funerary context, each of them, if correctly identified and correctly interpreted may provide a specific kind of information:

- Insects associated to the corpse remains - and strictly associated to the decomposition process as members of one of the "successional waves"- (Fig. 1). Among these insects Huchet (2014) recognizes also two additional categories: i) pre-depositional phase insects, necrophagous insects colonizing corpses shortly after death in a time period prior to burial

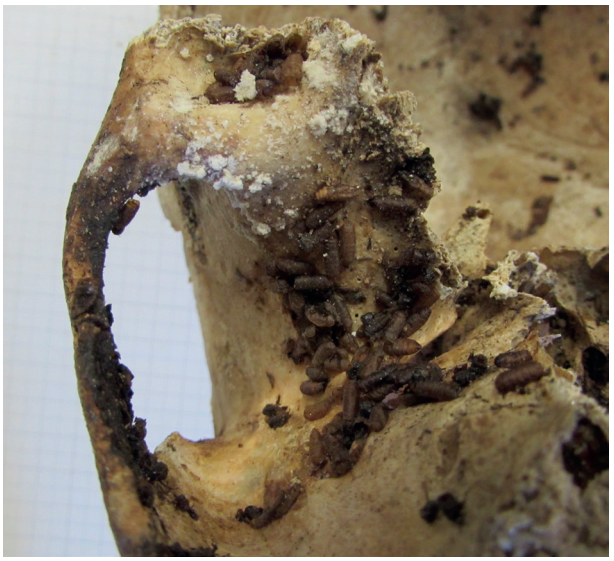

Figure 1. Puparia of *Hydrotea* (Diptera, Muscidae) on a skeletonized skull from the putridarium of Azzio (Northern Italy) (for further information see Pradelli et al., 2019).

– mainly Diptera in the family Calliphoridae and ii) post-depositional phase insects, specialized in colonizing underground corpses such as Diptera in the family Phoridae or among the Muscidae the genus *Hydrotaea* (Giordani et al., 2018). This distinction is essential to reconstruct the taphocenosis (i.e. the assemblage of cadaveric organisms) post facto, as the biodiversity of the entomofauna of buried corpses is different and reduced when compared to the community colonizing an exposed body (Pradelli et al., 2019);

- Taxa associated with offerings such as clothes, ornaments, personal artefacts, or vegetal matter;
- Taxa resulting from subsequent contaminations. In archaeological material stored in collections and museums also the so-called museophagous insects can be found (Vanin et al., 2021);
- Human and other animals – often used as offerings - ectoparasites such as lice, fleas, etc. that can be vector of pathogens (Amanzougaghene et al., 2016);
- Environmental indicators, taxa associated with the primary deposition site/s. These insects can be associated to specific habitat, or to specific locations. Their presence on the body can be occasional or due to a passive transport.

The first step for any interpretation and deduction based on insects is the correct species identification done by a specialist. The identification of archaeological material is mainly done using a morphological approach being the DNA analysis of ancient insect still difficult and in most of the cases useless. However, the very first step in an archaeoentomological investigation is the correct collection of the insects, whole specimens, or fragments of them. Due to their small size the collection is not always simple and easy to perform, and it has to be scheduled before the starting of the digging process where also the size of the tools used for sieving the soil is defined. In this way the majority of the specimens will be properly collected, identified and interpreted.

Entomologists working at the Natural History museums or in other scientific organization (eg.: University) may be helpful to carry this kind of analysis, till now underestimated and not fully explored in its potentiality.

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