Plant macroremains in funerary contexts: rituals, function and formation processes

Macrorrestos vegetais em contextos funerários: rituais, função e processos de formação

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Abstract Plants have been, and still are, an inescapable part of many different funerary practices in different cultural, chronological and geographical contexts, with functional and symbolic significance. However, due to their fragility, archaeological plant remains are only preserved in particular conditions, requiring proper methods for their detection, recovery and study. In this paper, we present an overview of the informative potential of plant macroremains preserved through carbonization and mineralization in cremation and inhumation contexts and an assessment

Resumo O uso de materiais vegetais foi, e ainda é, uma constante em contextos funerários das mais variadas cronologias, culturas e geografias, onde podem ter funções ou simbolismos variados. No entanto, sendo perecíveis, só se preservam em condições particulares e a sua identificação, recolha e estudo exigem métodos específicos. Este artigo aborda o potencial interpretativo de macrorrestos vegetais preservados através de carbonização e mineralização em contextos de cremação e inumação e fará uma avaliação dos principais desafios no seu estudo.

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of the main challenges in their interpretation. Wood is the main fuel in cremations and while fire has an indisputable symbolic meaning, the ritualistic value of firewood is disputable and likely varied in different cultural contexts. Intentional fires are rarer in inhumations, but these were used to prepare burial areas since prehistoric times. The presence of carbonized plant remains in burials, however, demands careful evaluation of formation processes to attest their actual association with funerary practices. With fire, pyre goods and grave goods are also frequently preserved, including wooden objects, fruits, seeds and foodstuffs that provide much relevant information to characterize rituals. Some of these are sometimes preserved through mineralization, particularly, but not exclusively, in association with metal objects.

Keywords: Archaeobotany; wood; fruits and seeds; cremations; burials.

A madeira é o principal combustível utilizado em cremações. Porém, ainda que o fogo assuma usualmente um valor simbólico nestas práticas, o mesmo nem sempre acontece com a lenha utilizada. Em inumações, o uso intencional do fogo é mais raro, mas ter-se-á verificado desde a Pré-história, assumindo a função de preparação da área de enterramento. Contudo, a presença de materiais vegetais carbonizados em inumações, obriga a cuidadas avaliações dos seus processos de formação, de forma a comprovar a sua associação intencional às práticas funerárias. Com o fogo também se conservam frequentemente objetos de madeira, frutas, sementes e restos de alimentos processados, fornecendo informações muito relevantes para caracterizar rituais. Algumas destes podem encontrar-se mineralizados, surgindo usualmente associados a objetos metálicos.

Palavras-chave: Arqueobotânica; madeira carpologia; cremações; inumações.

Introduction

Funerary contexts are one of the most complex and distinct in archaeology as they provide us clues into many intangible aspects of human nature that are usually very difficult to address otherwise (Ekengren, 2013). These subjects are mostly associated, directly or indirectly, with basic social concepts such as the relationship of communities and individuals with death, their core societal values, and their religious or spiritual landscapes. Consequentially, the study of funerary contexts presents an opportunity to understand much more than how a human body was disposed of but how societies were organized and their beliefs in life and in death.

Plants are a fundamental component in our everyday life as a species. In domestic sites, the study of plant remains is an invaluable source of information on a vast array of subjects, such as agricultural practices, feeding habits, landscape composition, fire use, construction, tool and object production (Hillman, 1981; Charles et al., 1997; Chabal et al., 1999;

van der Veen, 2007; Théry-Parisot et al., 2010). The urge to obtain information from these and other themes within palaeoecology and palaeoethnobotany, has led to multiple methodological and theoretical developments in several fields within archaeobotany in the last decades (e.g. Bogaard et al., 2016; Dufraisse et al., 2022). Although taking part in virtually all aspects of everyday life, plants in funerary contexts have received far less attention and research investment.

Today, different plants and plant parts are decisive elements in rituals associated with death, in several geographies and cultures. In these rituals, plants can incorporate symbolic meaning or be a simple functional element, fulfilling, for example, structural functions. Both aspects can also be connected. Archaeological and historical investigation suggests the same happened in the past. Rituals and offerings associated with the disposal of the dead have been archaeologically documented and may date back to as much as 120-90 K years ago (Vandermeersch and Bar-Yosef, 2019). Still, as with any other biological material, plants are fragile and due to preservation issues, it is impossible to determine when they were first integrated into such rituals. Nonetheless, there is some pre-historic evidence of the burning of wood and other plant parts unrelated to cremation practices (e.g. Duarte, 2002; Antolín and Buxó, 2011) or even the incorporation of flowers (Nadel et al., 2013).

Investigation of microremains has provided valuable information about the use of plants in funerary rituals, mostly in inhumations. Studies focusing on phytoliths, pollens or starch grains sometimes allow us to obtain relevant information of plants placed as offerings or used in pillows, bedding or other elements (Nadel et al., 2013; Tranberg, 2015). Samples from sediments associated with abdominal areas can eventually provide information on plant consumption if their content differs from other areas of the grave (e.g. Sianto et al., 2018). In well-preserved bodies, such as those found in central-northern European bogs (Nielsen et al., 2021), or even the Ice man Ötzi (Maixner et al., 2018), stomach and intestinal contents have also provided direct evidence of plant consumption. These are, however, revealing but rare circumstances.

In cases of preservation by desiccation or waterlogging, plant macroremains have been found in different contexts. These range from offerings such as flowers, wreaths, and wooden objects (Ives, 2021; Vidal-Matutano et al., 2021) to the funerary gardens in Ancient Egypt. Again, such a kind of preservation is only possible in limited contexts.

In temperate regions, desiccation usually does not occur, waterlogging is restricted to exceptional situations and carbonization is the main form of plant preservation. Thus, in this type of environment, the preservation of plant elements is conditioned to their contact, intentional or not, with fire and their survival to combustion. As such, the interpretation of charred plant remains in funerary

contexts presents some challenges. Mineralized plant remains have also been recorded in funerary contexts, but rather infrequently. Lack of knowledge regarding this type of remains may be sentencing them to oblivion. It is then crucial to alert field teams and conservators about under what conditions they are most likely to be found (Haneca and Deforce, 2020).

In this paper, we will explore the potential of archaeobotanical investigation in funerary contexts, namely plant macroremains from dry sites in temperate regions. Cremations and inhumations will be addressed, with special attention to the formation processes of plant assemblages and their potential to provide information regarding rituals and structural elements. This will be accomplished by exploring fundamental issues regarding plant preservation and human agency and by concisely presenting illustrative examples from distinct chronologies and different parts of the world.

A question of preservation

Plants are fragile and only prone to long-term preservation in specific circumstances, either because environmental factors delay their decomposition (e.g. extreme dryness, anaerobic conditions) or because they go through a process of chemical transformation (e.g. mineralization, carbonization) (Théry-Parisot et al., 2010; Gallagher, 2014; Murphy, 2014; Haneca and Deforce, 2020). In either case, only a small part of the organic material survives, and preservation biases may favour some type of remains, depending on their physical or chemical characteristics.

Human agency, on the other hand, may also play a determining factor, either in the past, related to different forms of plant manipulation, or during the investigation process (e.g. Chrzazvez et al., 2014; Arranz-Otaegui, 2017). Besides preservation, the detection of plant remains is highly dependent on the investigation techniques applied, which relate to the theoretical framework of the researchers (the questions they pose), their working contexts, or simply the funds and equipment available. Thus, due to numerous factors, plant remains analysed in archaeobotanical investigations are always a small and biased part of what was in fact used by the human communities under study. Understanding the magnitude of this loss is a crucial but difficult task.

In regions and contexts where plant remains are primarily preserved through carbonization, the first factor determining the preservation of plant remains is, naturally, its contact with fire. Only those plant parts that get in contact with fire may get carbonized, but only those sufficiently resistant will survive the fire. This entails a combination of cultural, technical, and biological factors. While the physical and chemical characteristics of plant parts play a determinant role, the decisions of what is subjected to fire, as well as the duration and intensity of the fire, are also determinants and they are matters of human choice. As such, more than a mere

technicality, they are among the subjects of the archaeological investigation itself.

In the case of funerary contexts, the preservation of plant remains is more likely to occur if any phase of the ritual or process of disposal of the body involves fire. Thus, it is more common to find charred plants in cremation contexts than in inhumations. Although the investigation of the formation processes of archaeobotanical assemblages is always a crucial step, regardless of the type of context, in the case of burials it is of the utmost importance. When charred plant elements are detected in inhumations, it is necessary to ascertain whether their presence is due to a deliberate and conscious action or pure chance (vide infra).

On the other hand, considering that there is a preservation bias that favours the more resistant elements, the more fragile parts of the plants, even if they have been subjected to fire, are less likely to be preserved. This includes elements such as flowers, that we now associate with funerary rituals and that have even been archaeologically identified in different cultural contexts through studies of plant microremains or even plant impressions (Nadel et al., 2013). We could also add grass stems (straw), leaves and various plant foods. While the characteristics inherent to each species' wood may have an influence in its survival to combustion, factors such as the state of preservation of wood and the conditions under which heat exposure took place may be more determinant (Théry-Parisot et al., 2010). In terms of fruits and seeds, the great differences in the dimension and composition of the diaspores of different species, leads to very different preservation potentials.

Mineralization occurs when organic material is gradually replaced by minerals precipitated from the surrounding substrate, usually in phosphate-rich contexts such as latrines or in direct contact with oxidizing metals, in which organic elements are coated or replaced (Gallagher, 2014; Murphy, 2014; Haneca and Deforce, 2020). Since not all plants come into contact with metals and even fewer are prone to mineralization, this is also a selective process, although less studied, thus less understood than charring.

For all these reasons, the interpretation of archaeobotanical assemblages must be carried out with particular care and, whenever possible, combining different techniques. From now on, we will focus on charred and mineralized macroremains in cremation and inhumation contexts.

Plant macroremains in human cremations

While the oldest proven example of cremation dates back to 30,000 to 40,000 BP in Australia, this funerary practice has been recorded throughout most of humanity's recent history and in a wide range of geographies and cultures (Quinn et al., 2014). The allure of fire and the highly sensory experience caused by the physical transformation of the human body have always created a strong impact on individual and communities (Sørensen

and Bille, 2008). Cremation was especially prevalent in European communities from the Late Bronze Age onwards, becoming almost exclusive in Mediterranean Antiquity, until gradually fading into obscurity with the advent of inhumation, as prescribed by Christian tradition, among other factors (Nock, 1932; Toynbee, 1971). Since then, cremations have been often overlooked and disdained by Western culture, although still being today the preferred funerary tradition of more than 1 billion people of Hindu and Buddhist background, and particularly established in the Indian subcontinent and Southeast Asia (Arnold, 2017).

Plants, and specially wood, play a fundamental part in all traditional cremation processes, as they are usually not only the main fuel use for the cleansing, ritualistic (but also practical) agency of fire, but also the structural raw material in which the pyre is made of. These carbonized plant macroremains are typically the most abundant archaeological remains present in cremation contexts (Deforce and Haneca, 2012), usually far exceeding the volume of bone and ceramic wares, particularly in primary contexts (i.e. in situ cremation pyres).

In this section, we will discuss many aspects associated with the importance of plants and their particularities in this type of funerary context. Unsurprisingly, much of the existing research on this topic is based on Ancient Rome and Contemporaneity, where cremation was/still is a central religious practice. However, case studies from other chronologies and backgrounds will also be appropriately mentioned.

Wood as fuel and structure: procurement, selection, and transport

As described above, the presence of wood in cremation contexts can be attributed to its dual purpose as both the main structural component of funerary pyres but also as fuel for the physical action of fire that would dispose of the body (Sørensen and Bille, 2008; Quinn et al., 2014). Given the intrinsic symbolic and ritual importance of this ubiquitous funerary method, other possible meanings – although much harder to identify – could also justify and explain the evidence of certain types of wood in these contexts, as will be discussed below.

The main criteria for the selection of the wood used in cremations contexts would have been its availability in the surrounding area where the funerary event would take place, as to minimize transportation and to make use of existing supply chains. Depending on the local and regional anthropic and environmental pre-existing conditions – such as the characteristics and size of the local human population as well as the existing vegetation – wider catchment areas could be necessary. For instance, in the case of the Roman cremation necropolis of Via XVII in Bracara Augusta (Braga, Portugal), located in a region with considerable population density and consequential environmen-

tal pressure since at least the Late Bronze Age (Ramil-Rego et al., 1998), wood for the pyres was being gathered as far as the Gêres Mountain Range, c. 30 to 40 km to the NNE of the roman city (Vaz et al. 2021a). For today's city of Varanasi, in northern India, wood for cremations is sourced in the Himalayan mountains, c. 400 to 500 km due to the depletion of suitable wood in the immediate region (Kaushik, 2018).

We must also keep in mind that pre-industrial societies required vast supplies of wood, as well as other plant resources, for virtually every daily activity, such as cooking, illumination, heating, construction and tool making. In this regard, the amount of wood necessary for cremations would only account for a relatively small fraction of the widespread use and need of this fundamental raw material. However, situations of considerable strain in the wood supply, caused by scarcity (deforestation), rising prices or rapid increase of demand (famine, epidemics or war), could also result in the adaptation of funerary methods (Arnold, 2017) or in the severe decrease in the quantity and change in the type of wood used in each cremation (Cenzon-Salvayre, 2014). In fact, it has also been suggested that the persistence of cremation practices in Roman Gaul and Hispania until the 4th and 5th centuries, far beyond what was taking place in Rome, could be partly due to the abundance of woodlands in these regions (Nock, 1932), although many other causes could have also contributed to this tendency.

Contrary to other types of combustion contexts, such as domestic fireplaces, where indiscriminate fuelwood could have been used, the material meant for cremation pyres would have required the selection of wood with specific criteria in mind, to fulfil its dual function as fuel and construction material. Long, straight, and thick logs were ideal to create the pyre platform. On the other hand, these larger pieces of wood would provide the heating potential necessary to accomplish a long-lasting combustion and thus a full cremation (Noy, 2000a).

Considering these requirements, it is of no surprise that many cremation contexts with archaeobotanical studies across Europe, in many different cultural context and chronologies (e.g. Kreuz, 2000; Deforce and Haneca, 2012; Moskal-del Hoyo, 2012; Cenzon-Salvayre, 2014; O'Donnell, 2016; Caracuta and Fiorentino, 2017; Martín-Seijo and Vila, 2018; Vaz et al. 2021a; 2021b) extensively report the use of wood from different oaks (*Quercus*). Not only this tree is abundantly available in many ecological units in temperate regions, but their typical size and physical characteristics make them particularly suitable for this purpose. Oaks provide a dense, slow-burning wood that match the physical characteristics necessary for the kind of long-lasting combustions required to fully cremate a human body (Fabre et al. 2003). Individuals could reach up to 30 m high and, as they grow older, develop wide trunks and vast quantities of biomass (O'Donnell, 2016).

Despite the overwhelming predominance of oak in cremation contexts, wood originated from other large species are also common in European archaeological cremation contexts, such as *Fagus sylvatica*, *Fraxinus* sp, *Alnus* sp., *Salix* sp. and *Pinus* sp., depending on the regional availability.

On the other hand, symbolic associations with certain species are also documented, or at least can be inferred. In Germania, Tacitus (Germania 27) refers that important men among the indigenous communities were cremated with certain types of wood, although archaeobotanical studies in contemporary cremation contexts overwhelmingly find oak to be the most frequent wood used (Kreuz, 2000). Nivkh tribes, in the Siberian Far East, used *Juniperus* sp. wood (juniper) for the pyres of children because *Larix* sp. (larch) commonly used in adult pyres created a crackling sound that could scare the younglings' souls (Black, 1973). In India, sandalwood (*Santalum album*) has been traditionally used for centuries in most religious events, and objects and as the preferred type of wood for cremations due to its sacred status (Sandeep and Manohara, 2019). However, a history of widespread demand led to its scarcity and high price – it is, in fact, one of the most expensive woods in the world – which forces lower-income classes to use cheaper alternatives, such as wood from mango tree (*Mangifera indica*) and *Eucalyptus* sp. (Kaushik, 2018).

In what appears to be circumstantial occurrences, multiple classical accounts also mention the use of wooden material from other sources in cremations, particularly in the Roman period. The large funeral pyre made for Julius Caesar included wooden benches, tables, and other furniture from the Roman Senate (Plutarch Ant. 14.8; Brut. 20.5). Similarly, the cremation pyre of Pompey Magnus was hastily constructed using the remains of a derelict boat (Valerius Maximus 1.8.9). These accounts suggest that, at least for the Roman world, availability, more than other symbolic factors, would have been the major criteria when choosing wood for cremation pyres (Noy, 2000b; Vaz et al., 2021a,b). On the other hand, these examples can also put into perspective the presence of wood from uncommon species among several archaeological cremation contexts (Figueiral et al., 2010), as these could be associated with the practice of burning furniture and other random wooden objects (Fabre et al., 2003).

Historical written sources do not provide many clues and details regarding how, where and by whom was the wood for cremations supplied, recovered and transported, at least for the Roman period. However, we can infer that in areas where woodlands and forests were abundant, wood would have been sourced by local woodcutters or intermediaries who would then carry it and sell it in the city markets (Veal, 2017). This scenario strongly resembles India's sacred cities, where the need for massive amounts of wood for cremations led to the creation of a complex indus-

try of cremation (Arnold, 2017; Kaushik, 2018). In the case of Varanasi, the wood is often transported in waterways, such as the Ganges (Cenzon-Salvayre, 2014), as also could have happened in the Roman Empire (Theophrastus - Hist. Plant. 5.8.2). In the specific case of Rome, it has also been suggested that the wood destined for cremations could have been obtained from the same people in charge of providing the fuelwood for the numerous baths in the city (Noy, 2000a).

After being acquired and transported, fresh wood required a period of drying. Although the use of wet wood is possible, it comes at the expense of its effectiveness as it could jeopardize a complete cremation, leaving "half-burned" bodies (semiustum) – something that was extremely detrimental to the soul (manes) and memory of the deceased, according to the roman religious prescription (Noy, 2000b). In this regard, archaeobotanical records do not provide conclusive evidence concerning long-term wood storage or drying, but current methodologies, through the identification of fungi and xylophagous insects (evidence of wood deterioration) or radial cracks (evidence of green firewood) may shed some light of the subject (Théry-Parisot and Henry, 2012; Toriti et al., 2021).

The pyre: construction and management

The few descriptions of cremations found in classical and historical sources are often related to the cremation of social elites and usually depict large pyres, sometimes several stories high and lavishly adorned (Toynbee, 1971; Noy, 2000b; Hope, 2007). Experimental archaeological and extensive ethnographical evidence, however, reports that the amount of wood commonly used for a standard cremation ranged between 200 kg and 500 kg, while some even propose 1000 kg (e.g. McKinley, 1994a; 1997; Noy, 2000b; Cenzon-Salvayre, 2014; O'Donnell, 2016). However, many variables could substantially affect these values, such as state and type of the wood (dried or wet, soft or hardwoods), weather conditions (air temperature, humidity and wind), and even the size, sex, and age of the deceased, as adult males usually required more wood than females and children due to their body weight and different fat contents (Noy, 2000a; 2000b; Williams, 2004; Weekes, 2005; McKinley, 2015).

However, the most fundamental factor influencing the amount of wood used in cremations should be the human intervention. The tending of the pyre consists in stirring up the fire, providing additional fuelwood, making sure that oxygen circulates between the burning logs and clearing ash deposits from the base of the pyre, allowing for a quick and efficient cremation process. Roman sources mention that the role of the ustor, in charge of building the pyre and tending to the fire (Toynbee, 1971; Weekes 2005; Hope, 2007; Thompson et al. 2016). Professionals are also employed at Manikarnika Ghat, the most sacred

cremation site in Varanasi, where more than 100 cremations are made every day (Arnold, 2017). However, the tending of the pyre does not seem to have been the rule in other periods and cultures (McKinley, 1994a; Cenzon-Salvayre, 2014).

Despite the existence of many differences, given the ubiquity of cremation across human societies and thought time, based on all available examples (written sources, iconographical depictions, and ethnographical reports), the format and construction of pyres for cremation have roughly followed the same core principles over the time. Pyres would have been built specifically for each deceased, in a pattern of superimposed, alternating logs, of larger and smaller sizes, allowing oxygen to circulate and feed the flames (Noy, 2000a; McKinley, 1994a; 2015; Cenzon-Salvayre, 2014) (Figure 1). Pyre size would have been related to the status of the deceased and its wealth – as it is clear nowadays with cremations in India (Kaushik, 2018) – but usually would not go beyond 2m in length, 1m to 1,5m high and 1m wide (McKinley, 1997). The pyres could also be constructed under a shallow pit to increase airflow and to where the bone remains would gradually fall. The use of whole logs was preferable, although halves or quarters could have also been used together with smaller twigs, branches, and other easily combustible plant materials, that would serve as kindling, as it is referred to for Aboriginal cremations (e.g. McKinley, 1994a). The pyre was held in place using nails or stakes in order to avoid a disorganized crumbling of the structure (Vitruvius 2.9.15; Noy, 2000b; Cenzon-Salvayre, 2014). The body is usually placed upon the top of the structure along with other pyre-goods.

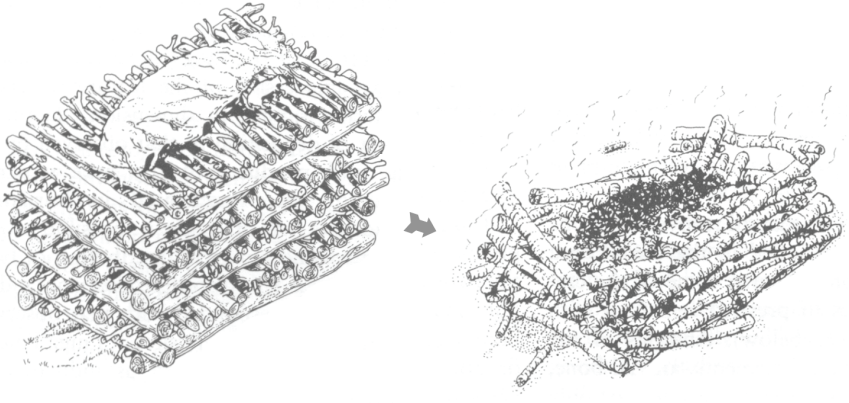

Figure 1. Illustration of a pyre and its collapse. Adapted from McKinley, 1997.

Plant pyre-goods

The custom of placing objects in the pyres, along with the body is as common as cremation itself, as extensively testified in classical and ethnographical sources (e.g. Toynbee, 1971; McKinley, 1997; Noy, 2000b; Williams, 2004; Cerezo-Román and Williams, 2014). These materials provide an invaluable way to assess the life of the deceased, the ritual of death, and the communal beliefs in the afterworld. Pyre goods are usually meant to be burned with the body and are thus frequently made of perishable, plant-based materials, contrary to other grave goods, which are added to the funerary contexts (McKinley, 1994b). Both can be aggregated in two main categories: intrinsic – personal objects worn or used by the deceased, or extrinsic – offerings of food and of other nature made by the family or the community (Gräslund, 1994).

Even if most pieces of evidence of these plant pyre goods are uncommon in the archaeological records – since they only rarely survive cremation – remains belonging to intrinsic objects are even rarer due to the difficulty in differencing carbonized fragments of wooden objects from those originated from logs used in the pyre and other extrinsic offerings made in wood. However, a proper sampling method can increase the probability of discovering these extraordinary finds. One such case was identified in the Roman necropolis of *Bracara Augusta*, where four fragments of a carbonized comb were identified among the in situ remains of a pyre (Vaz et al., 2021a; 2021b). Other possible cases are known in other regions of the Roman Empire (e.g. Kreuz, 2000; Fabre et al., 2003; Figueiral et al, 2010; Hristova, 2015).

On the other hand, extrinsic evidence of pyre and grave goods are far more frequent, particularly in Roman cremation contexts (Toynbee, 1971), and refer to foodstuffs commonly deposited as offerings in the pyre, among the body of the deceased, or with discarded leftovers from possible funerary banquets (Marinval, 1993; Kreuz, 2000). These findings, which can include several types of cereals, legumes, and fruits from wild and cultivated plants have been the focus of many archaeobotanical studies in the last couple of decades (e.g. Marinval, 1993; Kreuz, 2000; Bouby and Marinval, 2004; Heiss et al, 2015; Lodwick et al., 2015; Reed et al., 2018, etc).

Rarer evidence of foodstuffs, such as boiled legumes (Vaz et al., 2021a; 2021b) and bread-like material (Hansson, 1996; Preiss et al, 2005; Popova, 2016; Vaz et al., 2021a; 2021b) have also been found to be offered in cremation pyres in from Roman and Early Medieval periods.

Plant macroremains in human inhumations

There is ample archaeological evidence to suggest that different species and different plant parts have incorporated funerary rituals related to inhumations throughout human history and in diverse

geographies and cultural contexts, some of which will be addressed here (vide infra). Historical, literary, and ethnographic examples point in the same direction (e.g. Goody and Poppi, 1994).

This aspect of the burial ritual is, however, almost invisible in many archaeological contexts, namely those with dry and oxygenated sediments where plants rapidly degrade and disappear as a consequence of physical and biological processes. Studies focusing on plant microremains such as phytoliths, pollens or starch grains have contributed to detect the use of plants archaeologically, which includes plant parts placed as offerings or used in pillows and bedding, but also remains of the deceased's last meals (Tranberg, 2015; Sianto et al., 2018). Still, in such sedimentary contexts, plant macroremains are mostly preserved through mineralization and carbonization, the latter being, by far, the most common form of preservation. This means that only plant parts that get in contact with fire get the chance to be identified if some of their anatomical or morphological characteristics remain identifiable. This excludes many grave goods that are too fragile. Moreover, from the beginning, a fire must occur, which is the rule in case of cremations, but not in inhumations. As such, although charred wood and carpological remains are frequently collected in burials, they present severe interpretive challenges.

Burnt plants in burials: differentiating rituals from pure chance

Understanding the formation processes of the archaeobotanical record is the first interpretative step of every study and one of the most decisive. In this matter, the peculiar character of negative structures has been highlighted by some authors, including the specific case of funerary contexts (e.g. Miksicek, 1987).

The opening of a pit always implies the remobilization of sediments and these can, from the start, contain charred plant remains from previous occupations. If the same sediment is placed in the grave afterward, these macroremains can end up associated with the dead unintentionally and without any ritual or functional significance (Figure 2). In an archaeological excavation, it is therefore necessary to be able to distinguish the depositions that result from purposeful gestures from random associations without cultural meaning. This can only be achieved with well-directed sampling strategies, covering most stratigraphic units and all context types, i.e. blanket sampling (sensu Pearsall, 2016). Only such sampling allows proper comparisons between distinct contexts through which the singular ones may be detected. In the case of inhumations, it is necessary to sample the sediments where structures were dug, as well as the structures themselves. If their archaeobotanical contexts are alike, the plant remains in the inhumation are not likely the result of any conscious human action.

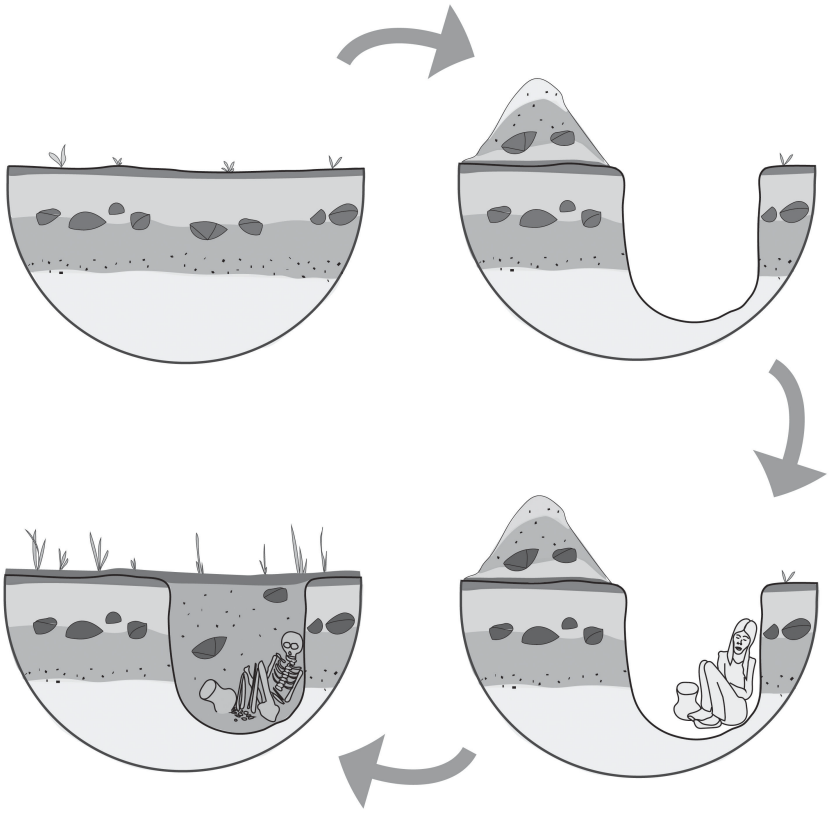

Figure 2. Depiction of the use of a burial pit and the respective sediment repositioning. Drawing by Rita Gaspar.

The archaeobotanical investigation carried out at Pancán (Jauja, Peru) (Lennstrom and Hastorf, 1995) is a good example of the virtue of such sampling and, at the same time, provides a good insight into the potential of these studies.

Pancán is a 7th-10th century AD site in central Peru where pits with human burials and pits with animal offerings were excavated in 1986. Thirty nine animals were recovered, mostly camelids and guinea pigs. Skeletons were articulated and had no cut marks, denoting these were intentionally buried and were not consumed. They were accompanied by several offerings, such as beads. Sixteen human burials were excavated, including five in a burned storage area with abundant charred plant remains. Grave goods were rare. Charred plant remains were found in pits with human and animal burials.

Archaeobotanical sampling in Pancán occurred on both the negative features and the surrounding deposits,

i.e., those where these structures were dug as well as those that covered them, with remnants of activities occurring in the area at the time of the burials. Results demonstrate that the archaeobotanical assemblages found in most pits resemble those of the surrounding sediments, both regarding the type and the proportion of taxa. It is licit to conclude, thus, that in these cases, charred plant remains were not intentionally incorporated in the pits and their association with the burials is unpremeditated. However, that was not always the case. In fact, one animal offering, a camelid, showed a completely different assemblage, integrating a great amount of *Scirpus* seeds which are not recurrently found elsewhere in the site. The authors assume, in this case, that such seeds were intentionally and ceremonially carbonized and theorize on this species' eventual significance, referring that 20th century Andean people sometimes feed Scirpus to llamas and alpacas.

Similarly, a single human burial excavated in the burnt storage area provided a unique plant assemblage, with no parallel in the site, leading the authors to suggest that it was included as offerings, having been burnt intentionally or as a result of the fire which occurred in the area in a subsequent moment.

The interpretations presented in this seminal work are not a matter of debate here. The most relevant issue is that these were made possible by a sampling strategy that was adequate and bold. If sampling had been restricted to the features this kind of approach would have been impossible and interpretations of the association between plant remains and human or animal burials would have been more difficult.

In Portuguese archaeology, we find several cases, from multiple time spans, which are well illustrative of the importance of such sampling strategies and of how delusive unappropriated field strategies can be. These include the mesolithic shell middens of Moita do Sebastião and Cabeço da Amoreira (Salvaterra de Magos, Portugal), as well as the medieval cemeteries of Laranjal (Torre de Moncorvo, Portugal) and S. Domingos (Lousada, Portugal).

Charcoal found in three burials at Moita do Sebastião has been interpreted as part of the funerary ritual, namely as votive materials, disposed of intentionally, the same as the ornaments found there (Figueiredo, 2014). However, the author never presents results from charcoal analyses conducted elsewhere on the site. On the contrary, that was done in another shell midden in the region, Cabeço da Amoreira (Monteiro, 2018). Here two graves have been excavated and sampled for plant macrorremains but these and the surrounding layers rendered similar charcoal assemblages. As such, dismissing previous interpretations by the same author, these charcoals are now thought to have been part of the sedimentary matrix and transported to the grave by chance (Monteiro, 2018). Interpretations of Moita do Sebastião, thus, need further scrutiny.

Work conducted in medieval inhumations at Laranjal and S. Domingos is equally demonstrative, although data is more limited. Charcoal analyses were conducted at the former (Vaz, 2020) and carpological studies at the latter (unpublished work by Luís Seabra and João Tereso). Both necropolises are found in highly diachronic settlements, with occupations ranging at least from the Iron Age to the Medieval period. Domestic activities in such places are prone to produce great amounts of residues which frequently include charred wood, fruits, and seeds. These are usually remains of fuel used in domestic structures on a day-to-day basis which have been transported into dumps, reused in structures (e.g. ramparts, walls) or as fertilizer and frequently end up scattered throughout the site. Unsurprisingly, the rare wood charcoal fragments found in the medieval graves of Laranjal and the also sparse fruits/seeds of S. Domingos belong to species that are common in the domestic levels of previous chronologies as well as in other negative features such as post-holes and pits in the same sites. In the case of Laranjal, a Roman ceramic oven was found in the medieval graveyard. As such, it is unlikely that such plant remains were a conscious part of the funerary rituals.

Burnt plants in burials: what information they provide

Although many of the plant remains collected in burials do not result from deliberate actions, as we have seen above, the well-targeted sampling and the comparative studies they allow provide relevant information for the interpretation of archaeological contexts. In fact, the studies of these plant remain, by helping to understand the formation processes of the archaeological record, are useful to interpret other ecofacts and artefacts associated with them and to reconstitute the life history of the structures where they were collected. In this sense, they are a relevant part of the investigation of these funerary contexts.

Still, charred plant remains in inhumations can sometimes relate to deliberate human actions and, thus, be informative about different subjects such as rituals and structural elements. Their carbonization could occur accidentally after the deposition of the plant elements, or deliberately, when the act of charring is part of the ritual. This can happen at different scales: particular plant elements can be ritualistically burned and larger fires can affect part or the whole depositional area.

Well localized fire events may relate to the burning of specific plants and objects. These could include fragrant plants burned for ritualistic purposes or to cover smells, such as those detected in a study of four Wallonian burial sites (Belgium) from the 12th–14th century AD (Baeten et al., 2014). Wood charcoal was found in perforated pots interpreted as incense burners and identified through standard procedures. While frankincense (resin from *Boswellia* sp.), was recognised

through chemical analysis of the pots, charcoal analysis suggests no particular or fragrant wood was selected and charcoal for burning incense was likely derived from domestic fires (Baeten et al., 2014). Future studies in funerary ware may eventually shed some light on plants and other offerings in different chronologies. On the other hand, remains of a wooden coffin as well as wooden vessels – a bucket and a plate – have been recorded in a 3rd-century AD woman's grave in Skovgårde (Denmark). According to F. Ekengren (2013), these were scorched to prevent rotting, allowing their preservation until today.

Contrary to small and localized fires that may leave little traces, larger ones are easier to detect archaeologically, but their interpretation as human-made or accidental may not be straightforward. This is a crucial issue since unpremeditated fires may help detect elements which were not planned to be charred, while premeditated events tend to preserve selected items. Either way, fires are destructive events, and even when deliberate they lead to the disappearance or damage of multiple, if not most, of the plant parts involved.

Deliberate fires related to funerary activity are likely ritualistic. They can occur before the disposal of the body, as a preparation of the burial area, or after, affecting grave goods and, eventually, the body itself, without being a true cremation.

Preparation fires may lead to the preservation by carbonization of part of the fuel used for such purposes as well as other plants in the area. The ritualistic nature of these fires and the carbonized remains that are left is arguable and may combine functional as well as symbolic value.

A good example is that of the Gravettian infant buried at Lagar Velho (Leiria, Portugal), known as the Lapedo Child. The presence of wood charcoal fragments beneath the feet has been interpreted as evidence for the preparation of the grave (Duarte, 2002). On a larger scale, during Late Prehistoric times, fire may have been used to clear the construction area of funerary megalithic monuments in Iberia (Zapata and Figueiral, 2003).

On the other hand, in layer 18 of the cave site of Can Sadurni (Barcelona, Spain), dating to the Early Neolithic (ca. 5400 cal BC) a fire occurred after the disposal of the bodies (Antolín and Buxó, 2011). Here 11 individuals were found together with several offerings, which included vessels with thousands of charred grains of different cereals, burnt in the consequence of a fire the authors hypothesize, with reservations, to have been part of a ritual (Antolín and Buxó, 2011). Besides the information it provided regarding the ritual practices associated with these communities, the amount of grain found, the labour involved in its production, and the food loss (or investment) it represents may allow some discussion on its meaning and the status of those to whom the offering was made. This finding has another implication in the interpretation of funerary practices at the regional level. Assuming the fire was deliberated im-

plies it was a rare event since such kinds of contexts are seldom found. If it was an occasional accident, then vessels in other funerary contexts where such accidents did not occur may have been filled with grain too, and other techniques are necessary to detect them.

Mineralized wood in burials: offerings and furniture

Mineralized plant macroremains are infrequent in funerary contexts, but that should not always be the case. As mentioned before, mineralization occurs when plant parts get in contact with corroding metallic elements or when incorporated in phosphate-rich or other chemically altered environments. The latter is more common in latrines and drains but can occur in burials. That was the case of a 16th-century grave in Kappelinmäki (Lappeenranta, Finland). Sediment from this structure was particularly rich in calcium which dissolved from the skeleton, leading to the preservation of 5719 *Rubus idaeus* (raspberry) seeds, found in the stomach area together with the bones of a small fish, suggesting it was part of the deceased's last meal (Lempiäinen-Avci et al., 2017). It provides also a piece of information on the season of death since raspberries are ripe in the late summer. Nonetheless, mineralized plant remains were found in only one out of 158 graves from nine sites. Most of the other graves provided uncharred material – contaminants from local vegetation – or charred seeds from weeds that were incorporated in the burial unintentionally (Lempiäinen-Avci et al., 2017). Still, however rare, considering the potential of some of these remains, it is worth adapting field strategies to try to find them.

On the other hand, preservation through contact with metallic elements is expected to happen in several funerary contexts, considering that metal objects, for instance, weapons, tools, and adornments, were frequently included as offerings in different cultures, periods, and geographies. Many of these objects combined both metal and plant elements, such as wood or textiles, or were in direct contact with them, but usually only the metallic parts are recorded archaeologically. That is the case of some Late Prehistoric burials in Iberia that included spear points, daggers, and other objects (e.g. Aranda-Jiménez et al., 2009; Blasco Bosqued et al., 2016; Senna-Martinez et al., 2017). Their respective shafts or handles are sometimes recorded, when they were made in ivory or bone, and only rarely when wood was used, although the latter was likely the most common raw material. Nonetheless, mineralized remains of wood handles were found attached to copper-based artifacts deposited in Bronze Age burials, namely an àlene from Monte das Aldeias (Vidigueira, Portugal) and a dagger from Monte da Cabida 3 (Évora, Portugal), in both cases together with remains of textiles, preserved in the same way (Soares et al., 2018).

Likewise, a recent recompilation of wood elements associated with early me-

dieval weapons in central and northern Europe clearly demonstrates their preservation through mineralization is much more frequent than suspected, having listed more than 800 specimens. This has allowed the identification of patterns in the use of wood for specific objects (e.g. *Alnus* for scabbards, *Fraxinus* for spear and arrow shafts) which are important to understanding weapon manufacturing in that period (Haneca and Deforce, 2020).

Additionally, metal objects could have been used as functional or ornamental parts of funerary furniture related to inhumation practices. Nevertheless, while, for instance, nails and other elements belonging to coffins are recurrently found in excavations (e.g. Moreda Blanco et al., 2010-2011; Soeiro, 2015), traces of the wood are seldom recorded (Bernardes et al., 2019).

A good example of wood preserved in such kind of contexts is that of two 5th-7th centuries AD graves of the Via XVII necropolis at *Bracara Augusta*, Portugal (Vaz et al., 2021a,b). Sixty small fragments of wood preserved through the oxidization of nails were detected during the excavation and sent for laboratory analysis. This allowed the identification of oak (*Quercus* sp. deciduous) and pine (*Pinus* sp.) wood that was used to build a coffin and a litter.

Being the deposition of metallic objects a common practice as well as the use of wood furniture associated to nails, hinges, and other elements, mineralized plant remains should be more common in funerary contexts. It is possible, thus, that its rarity in Portuguese contexts, as in other parts of the world, is due to the fact that field teams and conservators dealing with metallic objects are not sensible for the recovery of wood and other plant elements which are frequently difficult to detect.

Conclusion

Plants were relevant elements in funerary rituals and structures, being used for symbolic and functional reasons, in cremations and inhumations, in distinct areas of the world, in several periods and cultural contexts. However, due to their physical characteristics, most do not survive the passing of time and when they do, particular methodologies are necessary to identify and/or study them in archaeological contexts.

In most temperate areas, plant parts are usually preserved through partial combustion but mineralized remains are also found. Carbonized plant macroremains are particularly abundant in cremation contexts, where wood was the primary source of fuel, and their presence in inhumations must be carefully evaluated in order to distinguish wilful and accidental depositions. Still, through the examples that were given, it is clear that such remains provide data of the utmost relevant to interpret funerary contexts, not only regarding their formation processes, but also concerning some of the ceremonial and structural elements involved.

In different contexts, fire may have acted as both a functional and symbolic

element, being used to dispose the body, cleansing and/or as a mean to transform elements and make them shift between two different states (Sørensen and Bille, 2008). Nonetheless, fire and fuel are two different matters, and even in cremations, where the symbolism of fire is clear, the ritualistic value of fuel is disputable as there are contradictory archaeological and modern examples (see above). The same happens in the case of preparation fires eventually associated with burials and funerary monuments. Here the function of cleansing – whether merely physical or not – could have involved the burning of whatever was in the area and/or eventually the incorporation of external elements. Well-preserved pyres, however, may also reveal aspects of their own construction technique which may be of value to interpret fuel selection.

Besides the firewood, other plant elements may get burned, intentionally or not. In the case of cremations, intentionality is almost unquestionable and objects as well as fruits, seeds and food stuff are usually interpreted as pyre goods or grave goods (sensu McKinley, 1994). As for inhumations and cave depositions, previously referred, intentionality may be more difficult to demonstrate, but offerings, although rare, have been detected in distinct sites, such as grain and wood vessels. In contexts where metal objects are present, it is crucial to apply proper recovery and conservation strategies to detect eventual grave goods with plant elements, preserved through mineralization. These have been found in prehistoric and historic contexts, and consist mostly of wood used as handles and shafts and remains of the coffins and other funerary furniture. Their study will greatly improve our understanding of funerary practices as well as technical aspects of object manufacture and wood use.

The incorporation of archaeobotanical studies in funerary archaeology is, thus, crucial to understand relevant elements involved in rituals, as well as structural and technical features related to cremations and inhumations. The interpretation of plant macroremains, charred and mineralized, may sometimes be problematic but this only highlights the need for growing bodies of evidence and well-suited field sampling and post-excavation strategies to improve assessments.

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