LUNULA. Archaeologia protohistorica, XX, 2012, p. 81-88.

Burned culture: osteological research into Urnfield cremation technology and ritual in the South of the Netherlands

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Key words: cremation, urnfield, burial culture, histology, TCA, Maastricht Ambyerveld.

1. Introduction

The analysis of cremated human remains is an important research area within the discipline of archaeology. The research encompasses physical anthropological assessment, research on heat induced chemical processes, pyre technology, post depositional processes and the ideologies that motivated prehistoric people to choose cremation as a way to dispose of the dead. The fact that cremation material is often retrieved from the archaeological record due to its durable composition makes it a very interesting material with lot of potential, if well-studied. However, the act of cremation, depositional- and post-depositional processes influence the assessment possibilities. These obstructing factors create a negative bias towards the material, and consequently its value is often underestimated or misunderstood. Therefore in this article, the information that cremations can provide for archaeologists is discussed, using the Dutch site of Maastricht Ambyerveld, dated to 1050 BC to 800 BC (Urnfield Period) as a case study. The examination will consider burning degree, thermally induced deformation and the presence of other materials such as charcoal and animal bones as well as demographic assessment of the remains with the use of advanced techniques including bone histomorphology and tooth cementum annulation (TCA) methods. Although urnfields are a widely studied phenomenon, relatively little is known about the ways the deceased were cremated (Hessing & Kooi 2005, 631). This article therefore explores if the current state of cremation technology analysis is able to shed new light on the burial ritual of the Urnfield culture in the southern Netherlands, using a case study from Maastricht Ambyerveld.

2. The practice of cremation

Cremation is an important funeral rite in many cultures all over the world and has been practiced throughout history. The earliest known cremation so far was discovered in Australia at the site of Lake Mungo and believed to date to 40,000 years ago (Bowler *et al*. 2003, 837). In Europe, the earliest cremations are known from the Mesolithic period including the Netherlands where recently the oldest cremations known so far were discovered at the site of Rotterdam Beverwaard Tramremise (Zijl & Bloo 2011, 24). Cremations become more frequent or at least more visible in the Neolithic period. With the beginning of the Bronze Age, cremation can be regarded as the primary funeral practice in many parts of the European continent, their frequency peaking in the Urnfield period (Theuws & Roymans 1999). The prevalence of cremations as the main funeral practice continued for 1500 years throughout the reign of the Roman Empire (Wahl 2008). Accounts of cremation and the interment of cremated remains are found in famous accounts such as Homer's Iliad and the Odyssey, Tacitus' Germania and the account of a Viking funeral by Ibn Fadlan. After the establishment of Christian religion in Europe from the fifth century A.D., cremation was increasingly abandoned. Scandinavian people clung to their old traditions until far into the Middle Ages, but after their Christianisation, the tradition – then thought of as a pagan ritual - was abandoned here as well (Sigvallus 2005, 415). In contrast to Christianity, other religions prescribe cremation as the normative way of body disposal. This includes the Hindus and other Indian cultures influenced by religions such as Sikhism and Buddhism. In modern day Western societies, ideas on burial traditions have become less restricted. Multiculturalism makes that many different traditions exist alongside each other and old traditions may have modernised. In the Netherlands, under influence from Christianity, cremation has long been forbidden (Franke 1989, 9). However, the tradition of cremation redeveloped to a commonly accepted tradition again in only a few decades after the end of the Second World War (Franke 1989, 39).

Most people associate the term cremation with modern day crematoria and the ashes which are returned to the family. Knowledge of the fact that cremations can be quite substantial in shape and appearance is therefore relatively small (McKinley 1994, 339). Complete destruction of bones by fire actually seems to be impossible (Fairgrieve 2008, 1). The steps which are taken in modern day crematoria to turn the human remains into ashes were generally not performed on prehistoric cremations, although some scholars have suggested that prehistoric cultures may have deliberately crushed burned remains as well (Sigvallus 2005, 413). In an archaeological context, the term 'cremated' indicates that the bone material has been submitted to a series of ritual acts comprising a purposeful disposal of the dead by means of fire (McKinley & Bond 2001, 281). For certain time periods and places, cremations represent the only source of human remains for anthropological investigation due to their high degree of preservation in acidic soil which destroys inhumated, unburned human bones (Mays 2010). The study of cremation technology is therefore of vital importance to the discipline of archaeology.

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3. **The analysis of cremated remains: current issues**

3.1. Heat induced changes

Bones are composed of water, organic and inorganic parts of which only the mineral is preserved after the process of cremation. This inorganic, mineral component makes up about 70 percent of the weight of the skeleton and consists mainly of calcium phosphate such as crystalline hydroxyapatite. The remaining 30 percent consists of an organic component most of which is known as protein collagen (White 2011, 27). Fire, like that of a funeral pyre brings about a chemical reaction which rapidly breaks down the body. Exposure to extreme heat over a long duration of time destroys the organic components of the body. Between 600 °C and 700 °C the remaining carbon from the organic parts is burnt to CO_2. If the pyre construction is efficient enough and complete combustion occurs, only the inorganic mineral component of bone, roughly six percent of the body, is left (fig. 1).The analysis of cremated remains deals with this small percentage of mineral bone. Apart from a solid knowledge of physical anthropology the analysis of cremations requires more specific methods since the heat induced changes to the bone material forms a serious obstruction to examination. Due to the heat of the fire, bones will deform in many ways. Living bone is a very solid but elastic substance. This elasticity gets lost due to the process of cremation and continuous heating makes bones increasingly rigid. The heat, intensity of the fire, the rapidness in which water gets driven out as well as intrinsic variation between individuals are factors determining the extent to which bones will shrink, deform, warp, crack and fragment. In many cases, especially when dealing with cremations performed on open air pyres, single cremations can show a range of different combustion degrees (fig 1). This range may include complete calcinated bones corresponding with stage V, to merely charred bones corresponding with stage I or II. The presence of different combustion degrees can be established by looking at the colour, texture and deformation of the bones. The different appearances can be seen as reflections of the change in chemical composition due to heat exposure (Devlin 2008, 110). The burning degree gives information on how thoroughly cremations were performed. Right after the firing process when bones are still hot, they are very prone to breakage. Therefore, the way in which bones are treated right after the process of cremation plays a major role in the extent of fragmentation. Often however, post depositional processes will blur any possible inferences about post-burning treatment of the bones (Wahl 1982). Crack patterns are found to appear only when bones are burned at 750 °C or higher and can be found on most skeletal elements in a crosswise pattern or orientated parallel to the long axis of bones (Wahl 1982). Certain fissures only appear if bones are burned when they were still covered with tissue and therefore still 'fresh, visually distinct from the fissures which appear when burning dry, or excarnated bones (Ubelaker 1978, 36).

Burn stages	I		II		III	IV		V		
Temperature (°C)	100°	200°	300°	400°	500°	600°	700°	800°	900°	>1000°
Colour	Yellowish-White, ivory	Glassy	Brown/ dark-brown	Black	Grey, bluish-grey	Milky white, slightly chalky		White (surface is beige or grey when bone has been laying in the earth)		
Comments	Looks like unburned bone	~1% shrinkage due to loss of water and organic substances	No further shrinkage until ~750°C	Near complete charring of organic materials	Inner compact bone may still be black	Chalky surface, bone is light and very fragile, bone continues to shrink		Smooth surface, when cool, bone becomes very hard. Parabolic heat induced tearing and shrinkage of bone (~10-12%)		
Hardness	Decreases						Transitional phase Structure is not defined "chalky"		Increases	
Comparative materials					Glass becomes soft and malleable	Glass becomes a thick liquid			Melting point of silver	-Max temp. Achieved by burning wood -Melting point of gold -Melting point of glass -Melting point of bone

Fig. 1. Combustion degrees or burn stages: The relationship between temperature, colour, texture and hardness of cremated bone. (Redrawn from Trautmann 2006, figure 18; Wahl 2008, table 9.1 and Herrmann 1988, fig. 274).

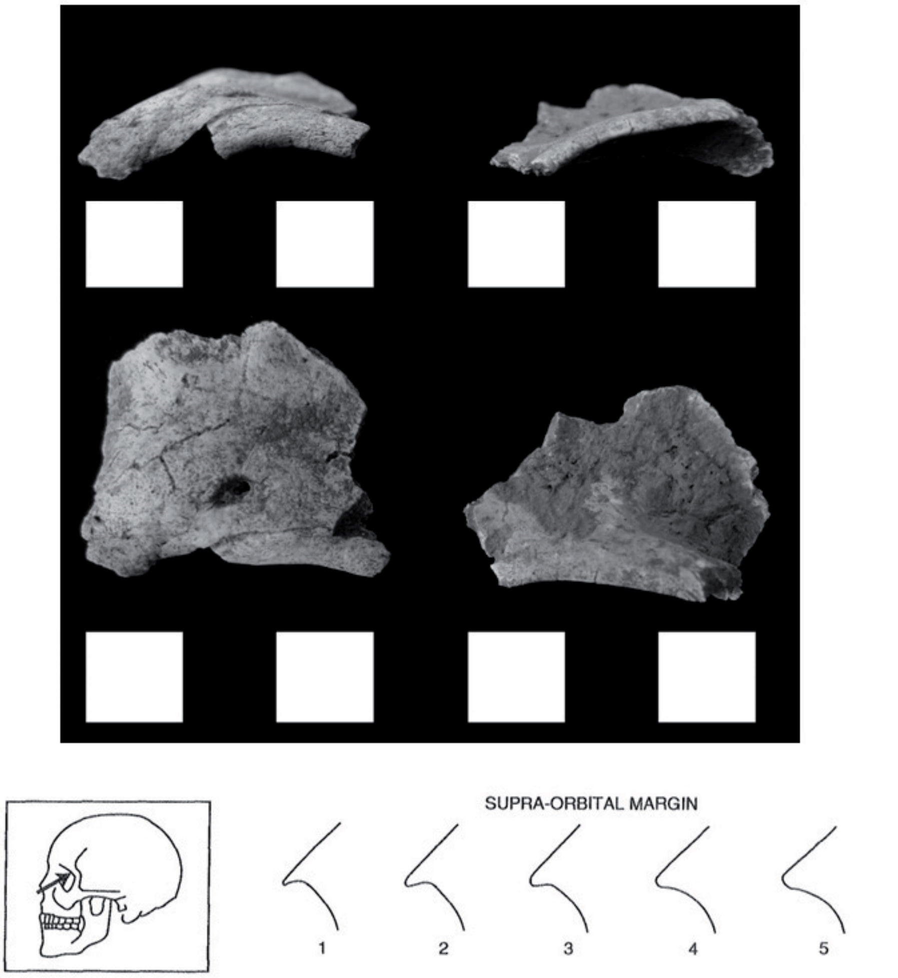

Fig. 2. Example of sexual dimorphism possible to retrieve from cremations. Left orbit belongs to a male individual, right to a female (feature 133 and 154 respectively) Lower part picture after Buikstra and Ubelaker 1994, 20. 1 and 2 are feminine, 4 and 5 male, 3 undecided.

3.2. Demographical assessment

One of the most important parts of cremation research is distinguishing between animal and human bone, determining sex and age-at-death, stature and pathological conditions. The presence of animal remains within a burial, the type of bones and their condition contributes significantly to the reconstruction of the ritual including pyre construction and technology. Animal bones differ from human bones in several ways (Cuijpers 2009). This is obviously clear on a morphological level, but on a microscopic level as well. When dealing with very fragmented material, animal remains can often be distinguished from human remains on the basis of the surface morphology of the cortex, which in animal bone commonly has a smoother touch than human bone. The internal surface of animal bone often does not display trabecular bone, since the trabecular bone is more densely structured in the epiphyseal ends of the bones (Personal communication with Prof. Wahl, February 2011). Further, animal remains often display a different burning degree. This is due to their composition, but also since they often did not form the main goal of the cremation and were situated on the side of the pyre. This has often been observed in Roman cremation burials (Wahl & Schwantes 1988).

Demographical assessments of sex, age-at-death, stature and pathological conditions in cremation research are similar to those performed on inhumated material. However, the destructive nature of cremation means that there is commonly much less material to work with. The remaining material is often heavily damaged resulting in destruction of the parts that can most reliably produce assessments such as the pelvic girdle for sex determination and epiphyses and dentition for age determination. Therefore, determination often has to rely on less reliable factors or on a very limited amount of criteria. Sexual dimorphic traits from the skull are more often used for sex determination of cremated remains than those of the pelvis because bones of the cranium are more resistant to heat than those of the pelvic girdle (fig. 2). However, methods for sex determination on small fragments have been developed such as morphological assessment of the distal humerus (Rogers 1999) and the inner ear (*pars petrosa*) (i.e. Wahl 2001, Osipov 2011). Especially the research done on the *pars petrosa*'s sexual dimorphism is of interest for assessment of cremated remains, since this element tends to stay preserved more often than other parts of the body due to its consistency (Wahl 2001). Comparable to the cranial vault, bones of the long bone diaphyses are known to survive the cremation process best and therefore, studies have tried to incorporate these elements for sex determination as well. As stated by Gejvall: "Metric sex determination relies on the fact that out of any two individuals of equal size, the walls of the bones of the female will on average be 1/3 until 1/4 thinner than those of the male" (Gejvall 1963, 454). Since this seems to be true for most populations, inferences can be made on general robustness of individuals. However, since populations can differ significantly, it is always vital to provide intra-populational comparison, setting a standard for robustness of a specific collection. Although suggested, the weight of cremations is commonly not useful for determination of sex since too many factors are of influence (Lemmers 2011).

Age determination suffers from comparable obstructions. Obliteration of the cranial sutures is commonly known not to be tightly connected to certain age categories and is therefore not considered as a reliable method for age determination (Mays 2010, 60). When dealing with cremations however, it is often one of the few features left to work with. Although not very reliable, general indications can be yielded if obliterated sutures are present, since obliteration commonly does not start until an individual is fully mature (White 2011, 391). However, the influence of heat may force sutures which are still in an early stage of fusion, to reopen and may misleadingly indicate a younger individual. The presence of fully obliterated sutures is therefore more interesting than the presence of open sutures. Dental development is widely regarded as the most accurate means of determining age-at-death in individuals who have not yet reached dental maturity and therefore, unerupted crown elements are of high importance. However, in reality these are only seldom retrieved. When assessing cremated teeth, it must be realised that when dealing with complete cremations, erupted crowns will not stay preserved since high temperatures cause the dental enamel to shatter into microscopic fragments (Schmidt 2008, 55). It is possible to retrieve crown material, but only if teeth had not erupted yet at the moment of cremation. The jaw bone offers protection in these cases. Histomorphology and tooth cementum annulation (TCA) are microscopic methods which can provide age-at-death determination. These methods are already often applied to recent material in forensic contexts and to archaeological inhumated material. Recently these methods have been delivering promising results for cremation studies as well (i.e. Cuijpers 2009).

Stature reconstruction is a topic of interest as well, and efforts are made to give calculations to reconstruct stature from epiphyseal ends instead of the complete length of long bones. The proximal epiphyses of the humerus, radius, and femur are currently used (Rösing 1977). Many factors of deformation are involved however, making the estimation less reliable. For cremations it is therefore very difficult to reliably reconstruct stature and results will always include broad standard deviations.

The identification of pathological conditions is an important part of physical anthropology and therefore cremation studies as well. Diseases, traumas and occupational markers are an important source of information. When dealing with cremated remains chances are however significantly lower of finding signs of such conditions since the material is often too fragmentary, but it may be possible using macroscopic and histological methods, as well as trace-element analysis and cremated remains can also be examined using chemical studies (Martiniaková *et al*. 2007). Finding high levels of specific elements in bone tissue which normally are only present in minor amounts can be of analytical importance (Schurr 2008). Tests have been performed to reveal how isotopic ratios can be used to reconstruct the diet and birthplace/migration history of cremated individuals. It has been indicated that the $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios in cremations are altered too much to be of use for dietary reconstruction and this leaves no possibilities for the reconstruction of diet when dealing with cremations subjected to full combustion (Deniro 1985, 1). As has been confirmed in more detail recently, stable isotope analysis of light elements in bone is only possible up to a heat exposure of 300°C. However, strontium ratios seem to remain unchanged even in bones exposed to complete combustion (Harbeck *et al*. 2011, 191). Possibilities for provenance studies exist although limitations and obstructions should not be underestimated. Apart from isotopic ratio research, research potentials of trace analyses are also present concerning ancient DNA studies. Tests have been performed to extract DNA from cremated remains, proving that in theory DNA can stay preserved up to a heat of 600 °C although the possibility of a high degree of contamination must be accounted for. This excludes the possibilities for aDNA analysis on completly combusted remains (Harbeck *et al*. 2011, 191). The most widely studied isotope in cremation remains concerns that of ^{14}C for dating, adding to the importance of the material category for archaeological assessment (Lanting *et al.* 2001).

3.3. Ritual construction

The state and condition of cremations reveals a lot on the construction of the practiced ritual. To research the care taken in the collection of the remains, the degree of completeness must be determined. For this, one does not specifically look at weight and amount of material, but how many body parts are represented in the grave. The degree of completeness can say a lot about ritual and might identify *pars pro toto* rituals in which a selection of material may be representative for a whole individual (Lemmers 2011) The presence of small skeletal elements deserves special attention as well. In many cases, teeth fall out of their sockets during cremation and small body parts such as phalanges might get lost in the pyre remains. Therefore, presence demonstrates care in collection of the skeletal remains from the remnants of the funeral pyre. If small body parts are present but no pyre remains such as charcoal, this might imply that cremations had been left to cool off for a certain amount of time before they were collected.

The archaeology of cremation encompasses more than just the calcinated fragments themselves. Theoretical approaches are inevitable when interpretations are desired involving context, artefacts, use of spaces, monuments and relationships between different stages of the cremation process. It is not easy to give reasons and establish theories about the practice of cremation, given the complexity and the diversity of the evidence for cremation rituals in past societies. The specific handling of the cremations might reveal information on the effort and rituals involved in the process. When trying to reconstruct burial ritual, cremation studies should never stand by themselves.

4. Maastricht Ambyerveld: A case study

The Late Bronze Age, which in the Netherlands encompasses the period of 1050 BC to 800 BC, is a period usually associated with the term 'Urnfield culture' in Central Europe (Gerritsen 2003, 121). This name is based on the shared burial custom of cremating the of deceased members of the society and interring their remains within a pottery container or urn. During the Late Bronze and Early Iron Age, cremation was the primary method of disposing deceased individuals throughout Central Europe. Although after cremation the remains would often be placed into an urn before being buried at a distinct burial site, much local variation is found. Urnfield Culture cemeteries uncovered throughout Europe have revealed clusters of urns buried together in substantial amounts and sometimes the number of burials at a site reaches into the thousands. Maastricht Ambyerveld is a site located in the South of the Netherlands where during the years of 2007 and 2009 the remains of a substantial urnfield were recovered, of which in total 78 graves have been made available for cremation analysis studies (Physical anthropological report with detailed information will be published in 2012 by BAAC). Ploughing activity had topped off large parts of the site and therefore the remains were to a large state disrupted (Brakman 2008). The average weight of the cremations was 258.5 grams. A relatively high percentage (23 percent) being less than 10 grams. Hardly any burials exceeded the weight of 1 kilogram. The degree of fragmentation was relatively high with 96 percent not exceeding a mean size of 25 mm. The fact that the weight of the cremations never exceeded one kilogram has probably more to do with the highly disturbed character of the site and therefore no inferences can be made on the total amount of remains which were deposited. In all cremations the prevailing colour of the bone material was old white and all cremations displayed the typical crack patterns and fissures corresponding with temperatures of 800°C or higher and are indicative for 'fresh cremation'. All material displayed the same maximal burning degree and the material can therefore be described as being very homogenous in nature. The observed minor variations in burning degrees can probably best be explained by the fact that we are dealing with the remains from open air cremations with factors such as pyre collapses and variable weather circumstances. Generally, it can be stated that the people of the community to which the Urnfield of Maastricht Ambyerveld belonged mastered the technique of cremation and pyre construction very well, leading to the complete combustion of the remains of the deceased. It was found that in 50 percent of the cremations, the whole skeleton was represented. Furthermore it turned out that 35 percent of the graves included small skeletal elements such as phalanges, tooth roots and ossicles. This is a relatively high percentage considering the amount of (recent) disturbance. When only considering the 50 percent of the graves which included all skeletal regions, 73 percent included small skeletal elements. Since in more than 50 percent of the graves most skeletal elements were present, it seems to be that no *pars pro toto* selection took place and that the skeletal elements were retrieved from the pyre with care. This inference is further strengthened by the high percentage of graves containing very small body parts such as phalanges, tooth roots and ossicles. The fact that these remains are present in the burials without large amounts of pyre remains such as charcoal point to a high amount of precision and effort put in the collection of the remains from the pyre. Sex determination proved to be highly problematic. A statement of the possible sex of the individual could only be made for 20 percent of the individuals (see table 1). All individuals to which a sex could be ascribed belonged to the complete and almost complete categories. The determination of age proved to be less problematic: For almost all burials, a certain age range could be determined (see table 2). When only the better preserved graves are considered, 80 percent of the graves could be ascribed an age range. It was found that all age categories are present within the cremation material of the urnfield including the remains of an unborn child (in combination with the remains of the mother, see fig. 3) infant, adolescent and adult.

Sex categories	Number of individuals	%
♀	1	1.25
♂	2	2.5
(♀)	1	1.25
(♂)	4	5.0
♀?	2	2.5
♂?	5	6.5
Total	**15**	**19.5**
Undetermined	59	74.5
Not relevant	5 (children)	6.5

Table 1. Results from sex determination: ♂/♀ stands for full confidence in the determination, (♂) /(♀) means remains are very likely the stated sex and ♀?/♂? means that there is no full confidence in determination, but the available evidence hints at the stated sex.

Age range	Number of individuals	%
Neonate	1	1.2
Infant	4	5.0
Adolescent	-	-
Adolescent+	28	35.5
Adult	5	6.3
Adult+	7	9.0
Mature	-	-
Total	**61**	**57**
Undetermined	9	11.5
Infant+	25	31.5

Table 2. Results from age-at-death determination. Prefix '+' indicates that the age group is a minimum age.

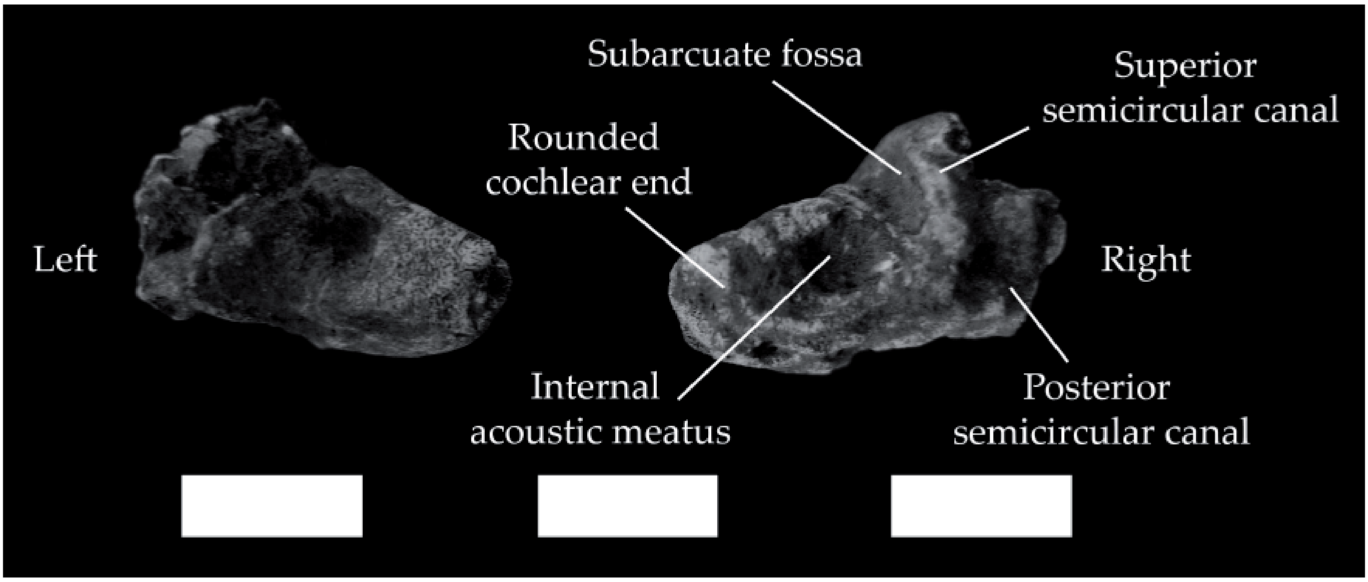

Fig. 3. The morphology of the pars petrosa, serving as an age indicator. foetus of about 4,5 months in Utero, Morphological terminology after Scheuer and Black 2004, 86.

The percentage of children was fairly low compared to the presence of adolescents and adults, but this is to be expected since the adolescents and adults encompassed a much larger percentage of a society. Pathological conditions were difficult to observe due to the fragmentary state of the remains. Only four graves of the 78 included bone material displaying pathological deformations or degenerative signs. The only observed pathological conditions were degenerations of the vertebral column. Uniformity existed in the disposal of deceased; male, female, adult and subadult graves showed an equal amount of effort in the cremation process. Striking was the abundance of animal bones present within the graves. When only the more complete graves are considered, 47.5 percent contained the remains of animals. An extra test was made, to see if there was a correlation between the presence of small body parts and animal bones. It turned out that of the complete graves which also contained small body parts (29 graves), 60 percent also contained animal material. The presence of animal bones can therefore be stated as fairly common for this Urnfield. The animal bones generally displayed slightly lower burning degrees and hardly any crack patterns, but could still be described as part of the funeral pyre, burned at 600ºC tot 800ºC degrees. Most material was described as 'small mammal', but zoological analysis will further refine these classifications.

5. Discussion

5.1. Demographic distribution

All individuals from Maastricht Ambyerveld to which a sex could be ascribed belonged to the complete and almost complete categories. Therefore, it can be said that more or less complete graves are essential for yielding reliable results for sex determination. However, it turned out that also in graves with high disturbance, sex determination was possible if the right piece was present, i.e. pelvis or cranial parts, indicating that cremation burials do not necessarily have to be complete to gain results. As mentioned before, thickness of the cranial vault and long bone shafts may serve as sex determination factors as well. Although these measurements were taken, not enough individuals from Maastricht Ambyerveld could be used to serve as a reference for robustness rates. If more material dated to the same period from surrounding sites is found and measured this might be possible. Concerning the age-at-death determination, it turned out that if a reasonable amount of bone was available, it was fairly easy to see the difference between the remains of neonates, infants and adolescents and establishing a minimum age for individuals. Especially measurement taken from the cranial vault and the femur as well as the presence of fully obliterated sutures were of value. In contrast, it proved to be highly difficult to give an upper limit for age determination. Although there were a number of graves present which contained skeletal elements displaying sings of degeneration, it was proved that this could not directly be connected with an old age since histological and TCA samples from a cremation containing several degenerative signs accounted for a maximum age of 35. It seems to be that the degenerative signs on the skeleton of this specific individual could be due to certain intense activity patterns or other diseases. Apart from this example, the application of histomorphological research and TCA yielded reliable results with relatively low extra costs and effort involved. Problems do still arise with the application of histology and TCA to cremated remains. As stated before, due to fire and heat action bones become modified in several ways. Femur fragments as well as root fragments might peel off or flake due to the cremation process, making the observations difficult. Histological analysis and TCA can therefore only be used for the estimation of minimum age, since the outer layers might be lost.

5.2. Ritual reconstruction

Although the Urnfield was disturbed to a large extent, it was still possible to make interesting inferences about the practiced burial ritual. Since in more than 50 percent of the graves most skeletal elements were present, it seems to be that no *pars pro toto* selection took place and that the skeletal elements were retrieved from the pyre with care. This inference is further strengthened by the high percentage of graves containing very small body parts such as phalanges, tooth roots and ossicles. The fact that these remains are present in the burials without large amounts of pyre remains such as charcoal point to a high amount of precision and effort put in the collection of the remains from the pyre. The high presence of animal remains is remarkable when compared to other cremation sites. The presence of animal remains can be considered as a fairly common element of the practiced ritual, indicating that the animals were placed on the pyre together with the deceased. The slightly lower burning degrees indicates that generally they were not placed on the centre of the pyre but more likely on the outer sides. In a number of graves, items were found known as 'clinkers', being sintered bone material (Hummel & Schutkowski 1987, 146). The presence of this material is known to be indicative of temperatures in a specific area of the cremation of 1000 °C. This is of interest, since it indicates an even further dimension to the construction of the pyre. This information together with the established burning degree and possible future research on charcoal remains can be of high significance for pyre technology research. Although not discussed in this article, a remarkable amount of metal objects were found in the graves. The type and condition of these objects will contribute significantly to the ritual reconstruction (BAAC *in prep*).

6. Concluding remarks and recommendations

After applying the available methods for cremation research by means of morphologic and microscopic analysis to the material of Maastricht Ambyerveld, a more grounded insight was gained into the possibilities and limitations of the analysis of cremated remains. It was proven that even if assemblages of cremations are considerably disturbed, inferences were possible almost in every case concerning the nature of the material, the way of collection, the presence of other material such as animal bones or charcoal and the 'quality' of the performed cremation ritual. The highest limitations seemed to be present for the assessment of demographic factors such as sex, age-at-death and stature estimations. Histological research as well as TCA proved to be of high value for the more detailed establishment of age-at-death of individuals and to differentiate between pathological conditions caused by an older age or activity stress. Therefore it is of interest to try and integrate the research on a more regular basis, due to relative ease of application but mainly the value of its results. The combination of applying thin section research to remains from individuals showing degenerative pathologies is of interest as well. Another recommendation concerns the determination of sex. As was demonstrated with the material of Maastricht Ambyerveld, only to a limited number of individuals sex could be ascribed with certainty. Therefore it was not possible to calibrate the metric information from the individuals of known sex to the material of un-sexed individuals. However, future possibilities still exist. If more metric information of mainly the thickness of the cranial vault and the walls of femur, radius and humerus shafts is collected from neighbouring urnfield sites, it will be possible to set a 'robustness – index' for individuals from the Late Bronze Age. Another interesting possibility for future research is that of isotopic research. Possibilities for provenance studies arise which might be interesting for the analysis of cremated remains from the Dutch Urnfield culture as well. For example, a comparison could be made between the strontium ratios of the individuals deposited in urns and the individuals of which the remains were deposited in organic containers such as linen cloths. Other possibilities would be to compare the strontium ratios of females with those of males. If differences in ratios are present, thoughts could be raised on exchange of marital partners with other areas. However, it must be kept in mind that this research is still in its test phase and lots of obstructing factors such as blurring background signals will be encountered with. The possibilities and the usefulness of this information for the Urnfield period should be further investigated.

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