BEYOND URNFIELDS

New Perspectives on Late Bronze Age – Early Iron Age Funerary Practices in Northwest Europe

Edited by
Helene Agerskov Rose, Lisbeth Christensen
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New Perspectives on Late Bronze Age – Early Iron Age Funerary Practices in Northwest Europe

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Table of Contents

Ralf Bleile, Dieter Quast and Berit Valentin Eriksen
Preface 7

Lennart S. Madsen
Preface 9

Helene Agerskov Rose, Arjan Louwen and Lisbeth Christensen
Beyond urnfields – an introduction 11

Lisbeth Christensen
The Early Pre-Roman Iron Age urn grave tradition of southern Jutland 17

Scott Robert Dollar, Martin Egelund Poulsen and Lars Grundvad
Burial and settlement during the Early Pre-Roman Iron Age in south-central Jutland 33

Lene B. Frandsen
Billumvad urnfield and some other sites with circular ditches in the western part of Jutland 49

Sarah Skytte Qvistgaard and Bente Grundvad
Pre-Roman Iron Age cremations in Korsvanggaard, southwestern Denmark –
an urnfield with urn graves, cenotaphs and exhumations revealing *pars-pro-toto*
burial rituals. 59

Helene Agerskov Rose and Anna Egelund Poulsen
Revisiting Aarupgaard urnfield in southern Jutland, Denmark 81

Angelika Abegg-Wigg
Urn cemeteries from the Pre-Roman Iron Age and the Migration Period
in Schleswig-Holstein: An overview of the research history 93

Ingo Lütjens
Burials of the Pre-Roman Iron Age in Schleswig-Holstein. A short overview 105

Ringo Klooß
Short report on the excavation of the Early Iron Age burial site of Borgstedt
in the Rendsburg-Eckernförde district. 111

Stefanie Schaefer-Di Maida and Jutta Kneisel
The urnfield phenomenon in Schleswig-Holstein:
New insights into the chronology and hypotheses 117

Jochen Brandt
Pre-Roman Iron Age burials in the lower Elbe region 133

https://doi.org/10.2369/9783869354439.21-snoeck-et-al

Wenke Domscheit
Grave groups in Late Bronze and Early Iron Age grave fields –
the grave field of Pinnow as an example of a phenomenon 147

Robert Schumann
A tale of ancient mounds …
The re-use of old monuments for Iron Age burials in northern Germany 165

Claudia Pankau
The ceremonial wagon and its relationship with the Urnfield burial rite 183

Katarzyna Ślusarska
Between the Urnfield culture and the Nordic Bronze Age.
Man and environment in the Late Bronze Age on the southwestern Baltic coast 199

Karol Dzięgielewski
Urnfields in their own way:
The Late Bronze Age on the southern Baltic coast (middle and eastern Pomerania) 217

Arjan Louwen
A tale of people, places and broken pots. A long-term perspective on the emergence
of urnfields in the Lower-Rhine-Basin 235

Stijn Arnoldussen and Karen M. de Vries
Cups that cheered no more. Funerary rites in the urnfields of the northern Netherlands 253

Christophe Snoeck, Giacomo Capuzzo, Barbara Veselka, Kevin Salesse,
Ioannis Kontopoulos, Rica Annaert, Sarah Dalle, Marta Hlad, Charlotte Sabaux,
Amanda Sengeløv, Elisavet Stamataki, Mathieu Boudin, Eugene Warmenbol,
Martine Vercauteren and Guy De Mulder
Unravelling the mysteries hidden within the cremated human remains from Belgium –
The inter-disciplinary CRUMBEL project 271

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Unravelling the mysteries hidden within the cremated human remains from Belgium – The interdisciplinary CRUMBEL project

Christophe Snoeck, Giacomo Capuzzo, Barbara Veselka, Kevin Salesse, Ioannis Kontopoulos, Rica Annaert, Sarah Dalle, Marta Hlad, Charlotte Sabaux, Amanda Sengeløv, Elisavet Stamataki, Mathieu Boudin, Eugène Warmenbol, Martine Vercauteren and Guy De Mulder

Keywords: CRUMBEL project, cremation burial, cremated remains, Belgium

*Abstract: The CRUMBEL project stands for **CR**emation, **U**rns and **M**obility – Population dynamics in **BEL**gium, and focusses on the study of cremated human remains from Belgium dating from the Neolithic to the Early Middle Ages. It combines radiocarbon dating, infrared, elemental and isotope analyses, osteology, and experimental cremations to gain new insights into diet, mobility, landscape use, funerary practices, health and demography of past Belgian populations who practiced cremation. The initial results of the CRUMBEL project highlight clear differences in diet, mobility and funerary practices for example between the Scheldt and the Meuse basins in the Metal Ages, as well as a clear increase in salt-rich foods during the Roman Period compared to the periods before and after. The unique interdisciplinary and diachronic approach of the CRUMBEL project has shown how contrasting different methodologies with archaeological and historical evidence can help uncover new information about past populations that practiced cremation.*

Introduction

Cremated human remains are often encountered in archaeological excavations in Belgium, especially from the Metal Ages and the Roman Period where they represent the majority of the human remains found in funerary contexts (Capuzzo et al. 2020; 2023). Unfortunately, they have received too little attention leaving many blank pages in our understanding of the Belgian past, especially concerning periods where cremation was the dominant funerary practice. The last two decades, however, have seen a drastic increase in the number of studies focussing on cremation rituals and cremated human remains. New methodological developments have among other things focussed on radiocarbon dating (Lanting/Brindley 1998; Lanting et al. 2001), isotope and infrared analyses (e.g. Snoeck et al. 2014; 2016; Thompson et al. 2009), age and sex assessments (Gonçalves et al. 2011; 2013; Cavazzuti et al. 2019). Although some recently excavated cremation sites had been radiocarbon dated, this had, however, not been applied to the older extensive collections of cremated human remains from Belgium (De Mulder et al. 2007; 2017; De Reu et al. 2012; De Mulder/Bourgeois 2014).

The CRUMBEL project, which stands for **CR**emation, **U**rns and **M**obility – Population dynamics in **BEL**gium, aims to remedy this situation by focussing on applying these tools (osteology, isotope and infrared analyses, radiocarbon dating, etc.) to Belgian cremated human remains dating from the

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Neolithic to the Early Middle Ages when the practice of cremation almost completely disappears (Capuzzo et al. 2020). This diachronic approach offers a unique opportunity to not only investigate geographical trends (e.g. differences between the two major river basins crossing Belgium: the Meuse and the Scheldt) but also key transitions such as the transition from the Iron Age to the Roman Period and its impacts on the life and death of those living in Belgium during this period (e.g. Dalle et al. 2022; 2023a). In parallel, new tools are being developed and experimental cremations are carried out to increase the amount of information that can be extracted from cremated human remains. This approach and the new developments carried out in the CRUMBEL project open the possibility to gather more information about any archaeological sites where cremations are found.

Cremations in Belgium

The first cremation burial found in Belgium dates to the Mesolithic period and comes from the Early Mesolithic rock shelter of Abri des Autours (OxA-5838, 9090 ± 140 BP; Polet/Cauwe 2007). Cremation occurs only sporadically in the Mesolithic period as inhumation remains the major funerary practice. A similar situation is observed in the Neolithic where only few cremation burials have been recovered, such as in Kruishoutem-Wijkhuis, Oud-Turnhout Hueve Akkers, and Ranst-Zevenbergen (De Laet/Rogge 1972; Van Liefferinge 2009; Sergant et al. 2009; Delaruelle et al. 2012). The dating campaign of the CRUMBEL project with more than 500 new radiocarbon dates obtained directly on calcined human remains (De Mulder et al. 2020; 2021a; Draily et al. 2021; Sabaux et al. 2021; Meylemans et al. 2022; Capuzzo et al. 2023; Dalle et al. 2023a) highlighted a new Middle Neolithic cremation burial from the site of Meerdaalwoud at Hamme-Mille (Beauvechain), successfully demonstrating it to be the oldest Neolithic cremation grave found in Belgium (Capuzzo et al. 2023). Still, the number of cremations dated to the Neolithic period remains very low. Following a period of decrease in both inhumation and settlement evidence around the 4.2k BP event (Fig. 1A), cremation appears and becomes the main burial type in Belgium from the Middle Bronze Age onwards (Capuzzo et al. 2020; 2023). Several different types of cremation deposits are found ranging from classical urn graves to bones scattered in a pit in association with pyre remains (De Mulder 2014). Another decrease is visible around 3.2k BP after which burials with cremated bones scattered in a pit become less common while other types of cremation burials, especially urns, dominate (Fig. 1B). This change corresponds to the abandonment of barrows as funerary monuments in favour of cremation deposits in flat graves from 1200 BC onwards, following the urnfield tradition (De Mulder 2020; Capuzzo et al. 2023). Whether these two decreases in burials around the 4.2k and 3.2k events are linked to changes in the environmental and climatic conditions requires further investigation. After 500 BC the urnfields decline and smaller cremation cemeteries appear. In the Roman period, cremation continues to dominate in Belgium as well as in the Early Middle Ages when, around the 7th century, it seems to completely disappear, and inhumation becomes the sole funerary ritual from the 8th century onwards (Capuzzo et al. 2020).

Palaeodemography

Due to the high fragmentation of cremated human remains it is often difficult to assess their age and biological sex, as well as identify potential pathologies. Furthermore, the presence of the remains of more than one individual with a single cremation deposit is difficult to detect. It is often the case that only 20 % or even less of the cremated individuals can actually be sexed (e.g. Holck 1986; Veselka/Lemmers 2014), while for ageing, individuals can often only be placed in broad categories such as adult

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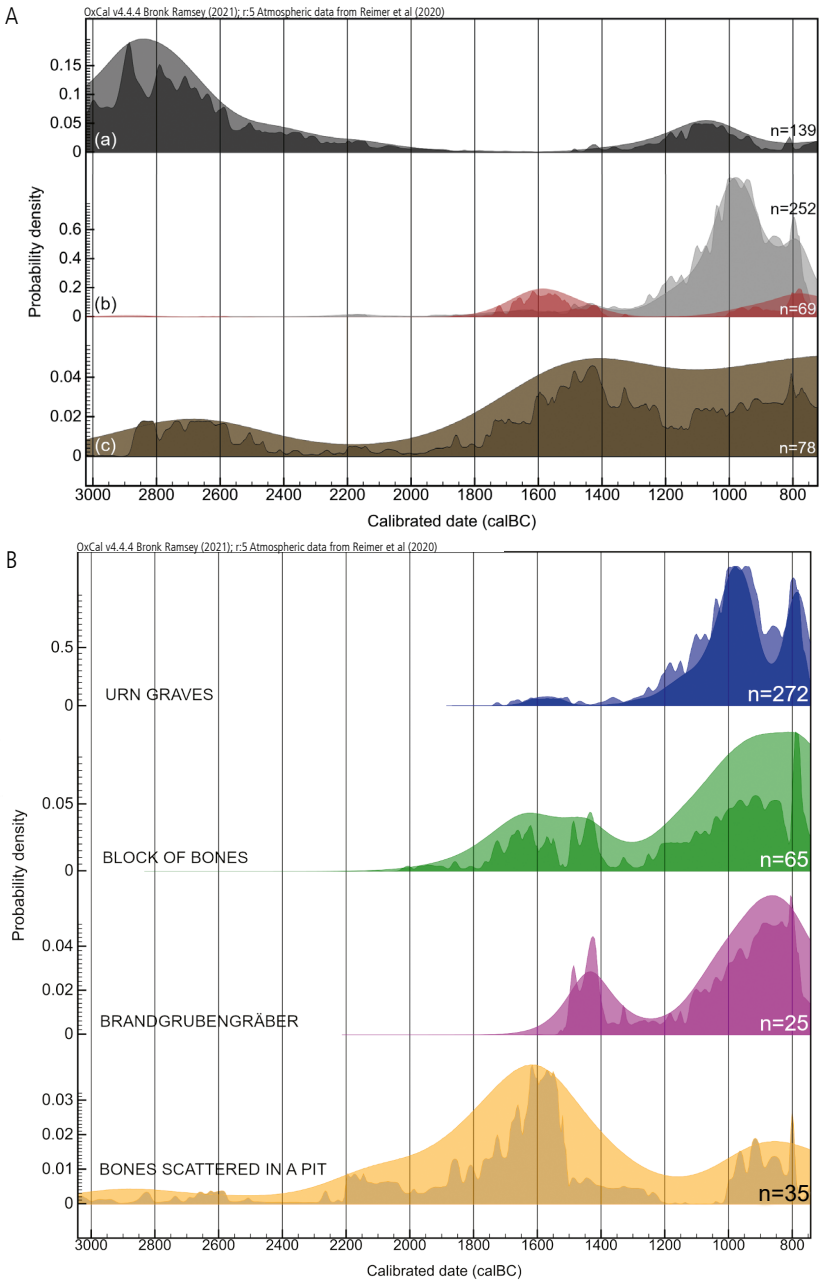


*Fig. 1. A: Summed Calibrated Probability Distributions (SCPDs, dark colours) and posterior Kernel Density Estimates (KDE) models (light colours) describing the temporal diffusion of (a) inhumation and (b) cremation burials in Belgium as well as (c) settlements in Flanders; B: SCPDs and posterior KDE models which describe the temporal diffusion of the following cremation grave types: urn graves, block of bones (*Knochenlager*), deposits with cremated bone and remains of the pyre (*Brandgrubengräber*), and bones scattered in a pit, in Belgium between the Final Neolithic and the Iron Age transition (modified after* Capuzzo *et al. 2023).*

and non-adult, based on the major differences in size and robusticity between adult and non-adult bones. These broad categories and the limited number of individuals for which a biological sex could be obtained as well as the complexity to identify pathologies such as vitamin D deficiency, limit the type of information that can be obtained from cremated human remains. To this end, the CRUMBEL project developed new methods to 1) increase the number of individuals that can be sexed, 2) refine the broad

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age categories usually used for cremated human remains, 3) help detect vitamin D deficiency in cremated individuals, and 4) identify with more precision the number of individuals present in a cremation deposit.

Over the last decades, different methods were developed to improve the identification of the biological sex of cremated individuals, such as the assessment of the lateral angle of the internal acoustic meatus (Gonçalves et al. 2011; Masotti et al. 2013), metric analyses of teeth (Gouveia et al. 2017; Godinho et al. 2019) and bones (Wahl 1996; Gonçalves et al. 2013; Cavazzuti et al. 2019). In order to increase the number of correctly sexed cremated individuals from archaeological and forensic contexts, the sexual dimorphism of 22 commonly used and new skeletal elements was evaluated in 86 individuals from the William M. Bass donated cremated collection of know sex and age-at-death (Forensic Anthropology Center of Tennessee University in Knoxville, United States). The results were analysed using different predictive models to assess the classification accuracy (CA) of the different skeletal elements and combinations thereof (Hlad et al. 2021). From the 22 skeletal elements investigated for sexual dimorphism, 12 presented an overall CA ≥80 %, e.g. humerus trochlea maximum diameter (Fig. 2a), lunate length, humerus head vertical diameter, humerus head transverse diameter, radius head maximum diameter (Fig. 2b), femur head vertical diameter, patella width, patella thickness, and talus trochlea length. An even better CA (≥95 %) was obtained using multivariate analyses of a combination of elements (e.g. humerus trochlea max. and patella thickness). While future research is still needed, the results obtained using machine learning approaches show how sexual dimorphism is well preserved in several skeletal elements even after calcination and can help increase the biological sexing rates of burnt individuals (Hlad et al. 2021).

The same William M. Bass donated cremated collection was also used to refine the age categories usually used for ageing adult burnt individuals (Veselka et al. 2021a). In non-adult cremated remains, age is usually based on dental development and eruption (Moorrees et al. 1963; Demirjian et al. 1973; Liversidge et al. 1998) and stages of epiphyseal fusion (Black/Scheuer 1996). For adults, age determinations are usually based on different macroscopic observation such as modifications of the pubic symphysis (Brooks/Suchey 1990), sternal rib ends (Işcan et al. 1984; 1985), or the auricular surface (Buckberry/Chamberlain 2002). These assessments do, however, lead to rather broad categories, especially for older individuals (46+ years; Falys/Lewis 2011), which are even broader in cremated individuals (Silva 2015; Ulguim 2015; Veselka/Lemmers 2014). Fortunately, Falys/Prangle (2015) designed a method to assess the age of older individuals and classify them in narrower categories based on changes to the sternal clavicle end. The Falys–Prangle method has been applied to the 86 individuals from the William M. Bass collection and this showed that the method can be applied to cremated individuals also (Fig. 3), allowing to better assess the age of cremated individuals with a preserved sternal clavicle end (Veselka et al. 2021a).

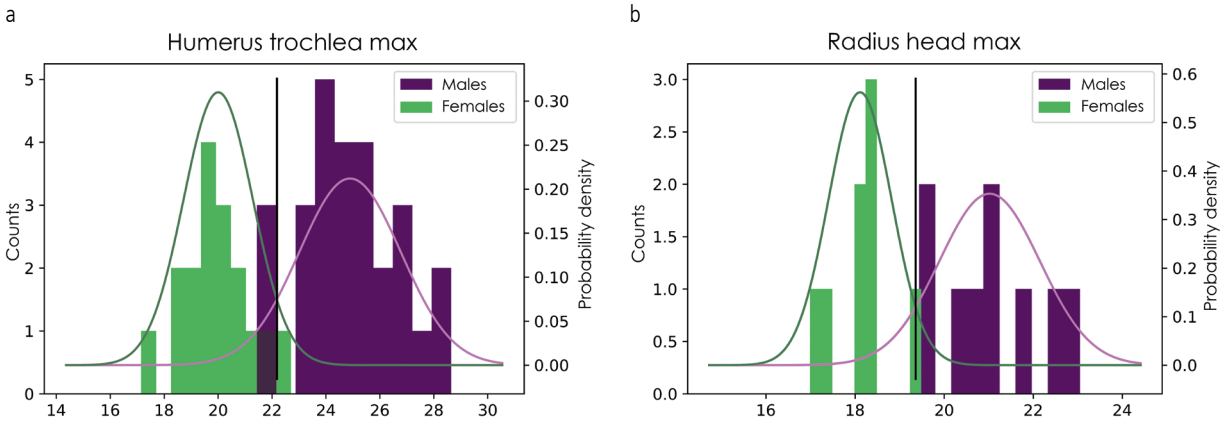


Fig. 2. Female and male data for two traits (a: humerus trochlea maximum diameter; b: radius head maximum diameter) with the calculated cut-off point represented by the black line parallel to the y-axis. The x-axis represents the measurements in mm (after Hlad et al. 2021).

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Within the CRUMBEL project, several cremation experiments were undertaken, including the assessment of vitamin D deficiency in burnt teeth (Veselka/Snoeck 2021). Traditionally, vitamin D deficiency was considered to be one of the consequences of the Industrial Revolution, resulting from air pollution, tall narrow buildings blocking the sun, and working long hours inside (Veselka et al. 2015; 2018; 2019; 2021c). However, several researchers demonstrated the cause for vitamin D deficiency to be more complex and to have been prevalent throughout the ages (e.g. Mays/Brickley 2018; Lockau et al. 2019; Veselka et al. 2021b). Unfortunately, until the study by Veselka/Snoeck (2021), it was not possible to identify vitamin D deficiency in cremated human remains, leaving out a significant portion of human remains contexts. For this experimental study 17 paired teeth were used (Veselka/Snoeck 2021). One of each set was analysed microscopically for the presence of interglobular dentine (IGD), a dental mineralisation defect attributed to vitamin D deficiency (D'Ortenzio et al. 2016). The antimeres were burned at different temperatures, ranging from 400 °C to 900 °C, in a muffle furnace. This way, the visibility of IGD in burnt teeth could be assessed (Fig. 4). Observations of unburned and burned teeth were compared and the remarkable finding

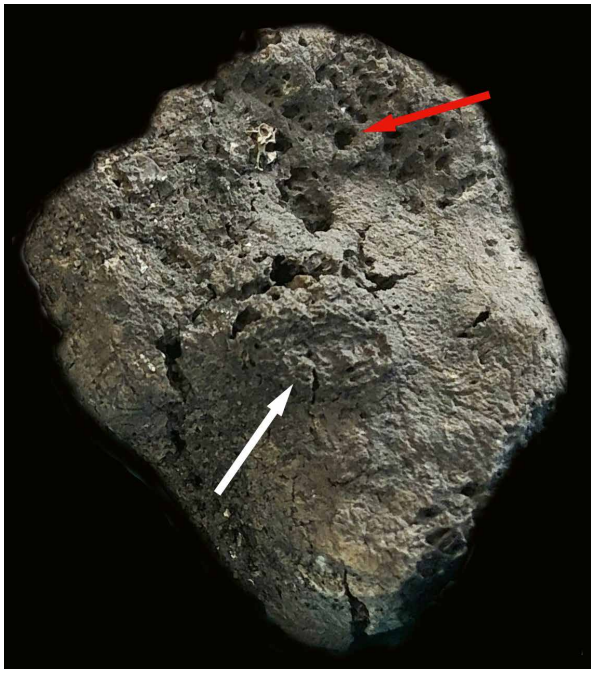


Fig. 3. New age-estimation method using sternal clavicle end morphology as developed by Falys/Prangle (2015). Note the undulation (white arrow) and the microporosity (red arrow) which would result in an age range of 62 to 83 years (after Veselka et al. 2021a).

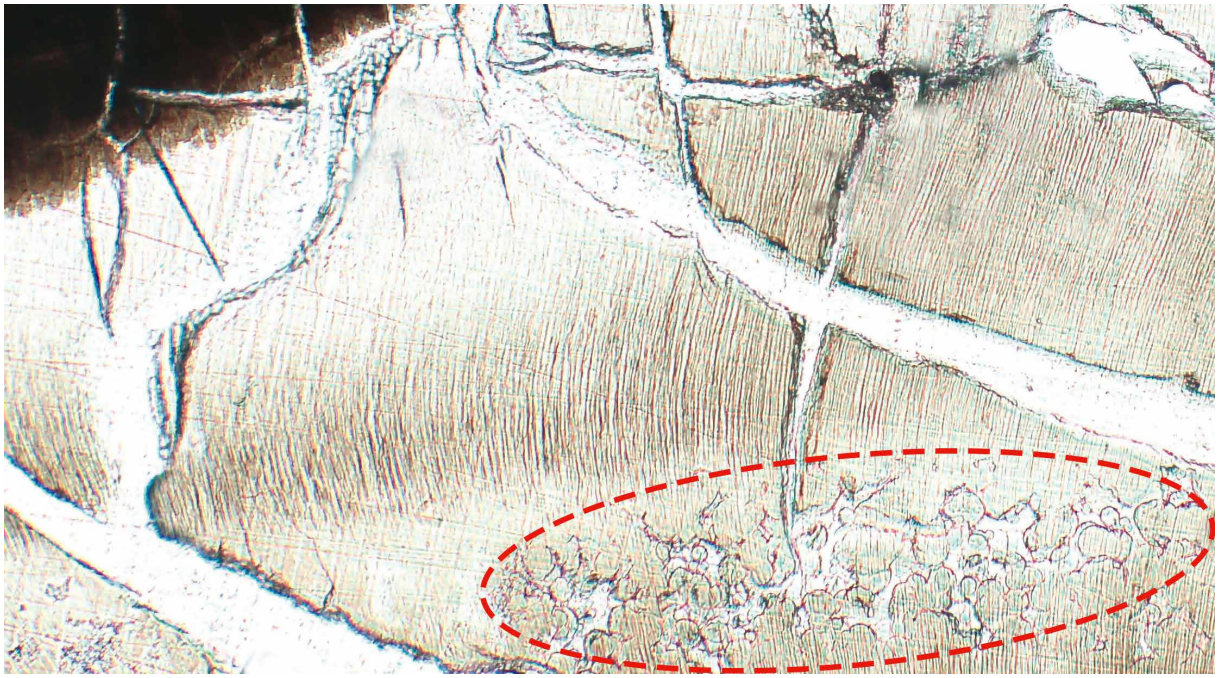


Fig. 4. Interglobular dentine in a permanent right mandibular molar after burning at 600°C for 2 hours (red oval). Dentine is light brown and striped, enamel is dark brown (upper left corner). Note the heath induced cracks. Magnification 40x (photo B. Veselka).

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was that IGD was indeed still visible in teeth that were burned at temperatures as high as 900 °C. It is the first time vitamin D deficiency has been observed in cremated remains; this represents a huge step forward in the field of palaeopathology. Usually, it is very difficult to observe pathological anomalies in cremated remains, let alone vitamin D deficiency which is generally identified macroscopically based on bending deformities of the long bones, which is impossible to do in cremated remains. By demonstrating IGD to still be visible in calcined teeth, vitamin D deficiency finally can also be identified in cremated human remains.

Osteological analyses provide crucial information about age and biological sex of cremated individuals as well as information about pathologies. They can also help assess the minimum number of individuals (MNI) present in a cremation deposit. However, due to the high level of fragmentation and absence of identical skeletal elements, this assessment often underestimates the number of individuals present in a cremation deposit. The combination of osteological analyses with radiocarbon dating and strontium isotope analyses provides a new tool for improving the MNI assessment. A pilot study on the cremation deposits of the Bronze and Iron Ages cremation cemetery of Herstal, Belgium, demonstrated two cases of a cremation grave containing one additional individual that had not been identified osteologically (Sabaux et al. 2021). Some of these individuals had radiocarbon dates up to one century apart (Fig. 5). This has important consequences as it implies that cremation rituals might be more complex than initially thought. Furthermore, it highlights the importance of carrying out all analytical measurements (radiocarbon dating, isotope, and infrared analyses, etc.) on the same bone fragments (Sabaux et al. submitted).

Diet and mobility

During the cremation process, the temperature can reach 1000 °C and more. This leads to the destruction of all the organic matter, including collagen (Snoeck et al. 2014), which is usually used to reconstruct the diet of past population through carbon and nitrogen isotope ratios. Furthermore, the inorganic fraction, commonly called bioapatite, is heavily altered and its carbon and oxygen isotope ratios are modified and cannot be used for palaeodietary or palaeomobility analyses. Instead, they can inform on funerary practices such as pyre size or temperature (Snoeck et al. 2016; Salesse et al. 2021; Stamataki et al. 2021). Fortunately, strontium concentrations ([Sr]) and isotope ratios ($^{87}Sr/^{86}Sr$) remain unaltered during and after cremation (Harbeck et al. 2011; Snoeck et al. 2015; Dalle et al. 2022), opening the possibility to investigate mobility and landscape use of past populations that practiced cremation (Snoeck et al. 2022).

The CRUMBEL project took advantage of this new methodological development and applied it on cremated human remains from Belgium and surrounding areas using a diachronic approach from the Neolithic to the Early Middle Ages. Site-specific studies highlighted the importance of contrasting the strontium isotope ratios with a well characterised baseline of the biologically available strontium (BASr). For example, the early medieval cemetery of Echt in the Netherlands showed a wide range in $^{87}Sr/^{86}Sr$ going from 0.7096 to 0.7139 (Veselka et al. 2021c). A similar wide range was observed in the Metal Ages site of Herstal, Belgium, located only 50 km south of Echt (0.7109–0.7138; Sabaux et al. 2021). The initial results thus suggested a high degree of mobility, but when comparing these ranges to the ranges of values seen in the environment (BASr), it becomes clear that all these $^{87}Sr/^{86}Sr$ can be found within a few kilometers from each site. Indeed, modern plants samples collected in the vicinity of the sites returned values going from 0.7088 to 0.7141 (Fig. 6; Veselka et al. 2021c), demonstrating that rather than mobility, $^{87}Sr/^{86}Sr$ show that those buried in these cemeteries were using different parts of the landscape around the sites.

At both urnfields of Velzeke, Belgium, the cremated remains show a local population was buried there. It is only during the final phase of the Late Bronze Age (9th century BC) and the Early Iron Age

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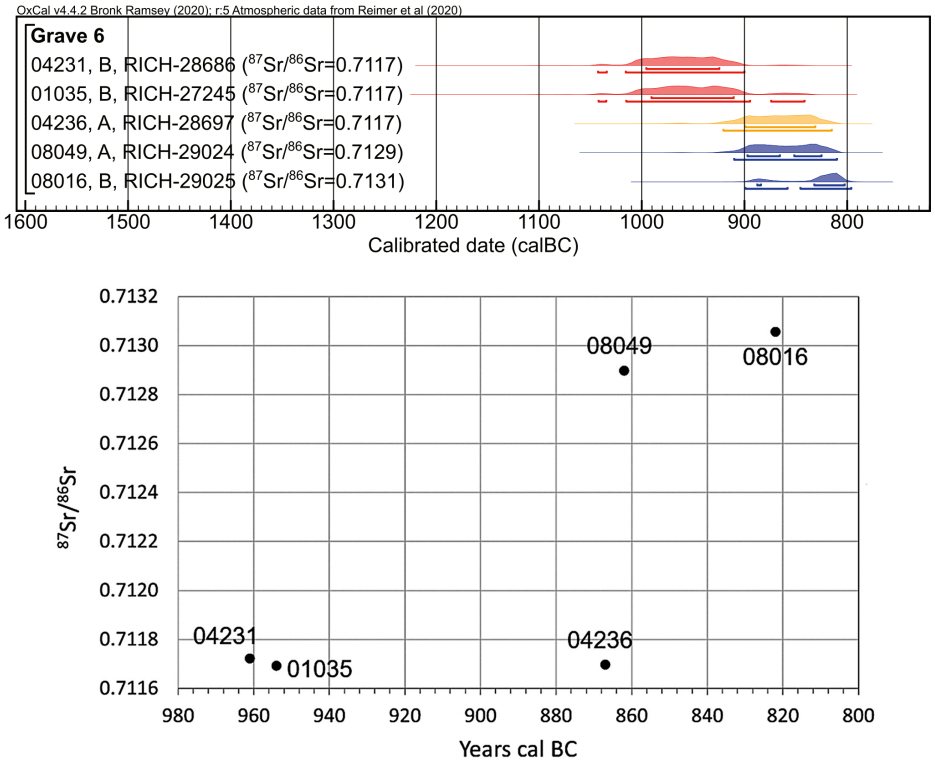


Fig. 5. Radiocarbon dates and strontium isotope ratios of five diaphysis fragments from Grave 6 of the Metal Age cremation cemetery of Herstal, Belgium, showing that the remains of at least three individuals are present in that grave. Top: OxCal plot showing the calibrated radiocarbon dates, each colour corresponding to a different individual, and the $^{87}Sr/^{86}Sr$ (modified after Sabaux *et al. 2021); bottom: scatterplot with $^{87}Sr/^{86}Sr$ versus medians of calibrated radiocarbon dates.*

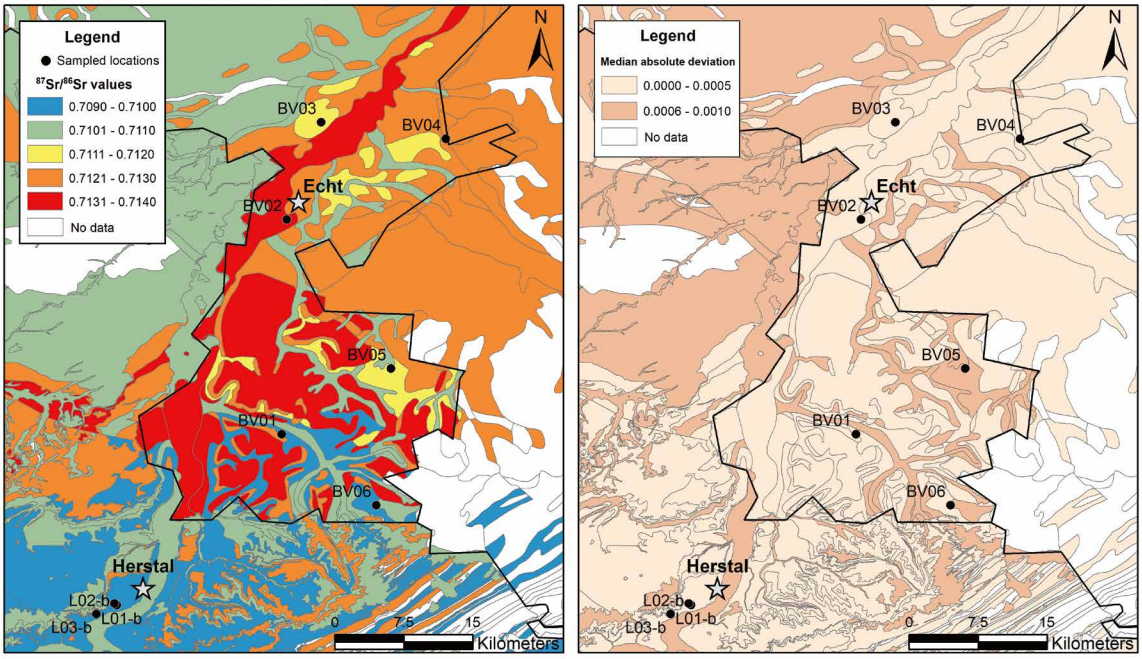


Fig. 6. Locations of Herstal and Echt (grey stars) and plant sampling locations (black dots) with information on the biologically available strontium; left: median values; right: median absolute deviation (MAD) (modified after Veselka *et al. 2021b).*

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(*c.* 800–500/450 BC) that a few cremation graves suggest the presence of people from a different region. The funerary practices reveal no differences within and between the urnfields, except that one of the cremations with a different origin was covered by a plate and the urn contained the fragments of three additional vessels that had been burned (De Mulder et al. 2021b).

Looking at the data from a diachronic point of view, a clear change in mobility and/or dietary patterns can be ascertained during the Roman Period (Fig. 7; Dalle et al. 2022). Indeed, increased mobility during the Roman Period was expected, but instead $^{87}Sr/^{86}Sr$ present the narrowest range in values compared to all other periods, close to 0.7092 that is the values of seawater and marine resources (Hess et al. 1986). At the same time, Roman individuals have the highest [Sr] compared to the other periods, which suggests an unprecedented increase in consumption of sea salt and marine resources (preservative, garum, salt, etc.). This highlights the need to contrast dietary and mobility information to fully interpret strontium isotope results (Dalle et al. 2022; 2023a). The $^{87}Sr/^{86}Sr$ and [Sr] data from the CRUMBEL project (see Snoeck et al. 2021; 2022, and references therein; Dalle et al. 2023b) are openly shared in the IsoArcH database (Salesse et al. 2018; Plomp et al. 2022), providing accessible and unrestricted access to the information.

Funerary practices

Cremation is a multifaceted mortuary practice involving various activities performed by the living towards the dead before, during, and after burning. However, limited information derived from pyre remains and cremation deposits hampers the reconstruction of how corpses were handled during this process. As part of the CRUMBEL project, an experimental pilot study was conducted to assess the feasibility of reconstructing the initial positioning of the body on or within the pyre, as well as to provide evidence of the presence of worn footwear. To achieve this, indoor and outdoor experimental burnings were performed using pig legs as proxies for human remains, followed by isotopic ($\delta^{13}C$, $\delta^{18}O$) and infrared (ATR-FTIR) analyses as these analytical tools have been shown to provide information about pyre conditions (Snoeck et al. 2014; 2016). The findings of these experiments reveal that both the positioning of the feet on or within the pyre and the presence of leather footwear can significantly influence the oxygen isotope ratios of bone apatite carbonates ($\delta^{18}O_{carb}$) and the cyana-

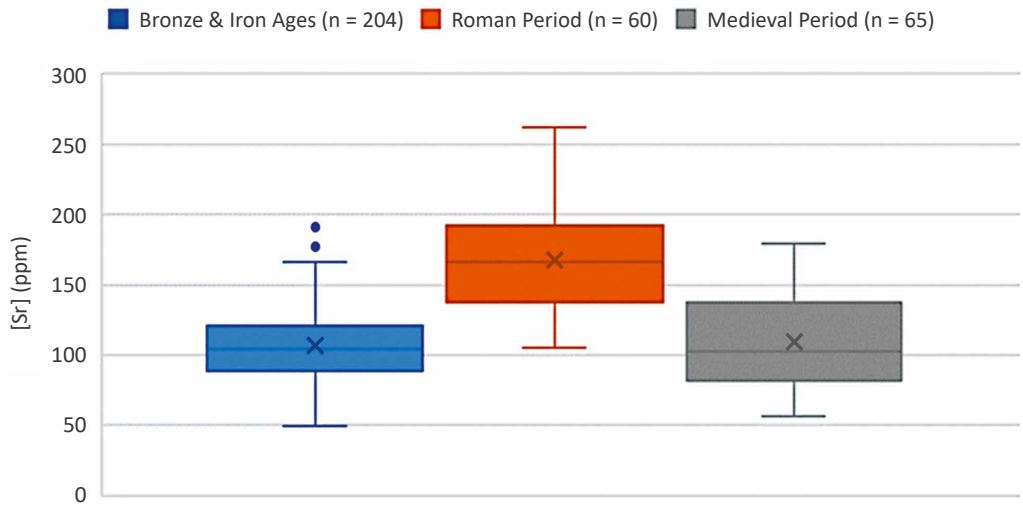


Fig. 7. Strontium concentrations ([Sr]) for 329 cremated individuals from different periods (data after Dalle et al. 2022; 2023a; Sabaux et al. 2021; Veselka et al. 2021c).

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mide content of calcined bone (CN/P) under specific circumstances. Closed shoes create a protective layer, delaying the burning of underlying pig tissues and intensifying the heat-shielding effect of soft tissues on the bone mineral fraction. Consequently, bioapatite bone carbonates interact with a relatively more ^{18}O-depleted atmosphere (attributed to lignin-derived oxygen rather than cellulose-derived oxygen), resulting in a more pronounced decrease in $\delta^{18}O_{carb}$ values when burning shoed feet compared to unshod feet. This shift can reach up to 2.5 ‰. Furthermore, the initial placement of the feet in the pyre exhibits a concomitant isotopic effect, leading to a top-to-bottom decrease difference of approximately 1.4 ‰ in $\delta^{18}O_{carb}$ values among shoed feet at different levels of deposition. Lastly, the presence of cyanamide (CN/P ≥ 0.02) that can be used as a proxy for oxygen available during cremation, appears to indicate the use of closed footwear, as such conditions create favourable circumstances for its incorporation into bone apatite (Salesse et al. 2021).

Furthermore, it has been demonstrated by Stamataki et al. (2021) that applying these methods (FTIR-ATR, carbon, and oxygen isotope analysis) on archaeological cremated human remains can provide important information regarding the variations in the way cremation was performed in different sites. The aim of this study was to assess the variability in cremation conditions (i.e. temperature, body positions, pyre structure, and location) among four sites dating to the Late Bronze Age/Early Iron Age (*c.* 1200–500/450 BC) located in two culturally distinct river basins (Scheldt and Meuse basins) in Belgium. The linear discriminant analyses (LDA) and the principal component analyses (PCA) of the infrared and isotope results clearly demonstrate that there is a statistically significant difference among the sites of the Scheldt and Meuse basins (Fig. 8; Stamataki et al. 2021). These differences indicate that the burning process was not homogeneous in the Belgian region, but it was correlated with the two cultural traditions observed in ceramics and bronze artefacts from the same period. The differences in cremation practices observed between the two basins could be linked to different pyre sizes and their location in the landscape (on top of a hill or in a valley), the amount and type of fuel used, the position of the body on the pyre, the temperature, etc. Finally, it seems that although cremation was the dominant funerary rite in Belgium during the Late Bronze Age/Early Iron Age, the location of Belgium at the crossroads between two cultural traditions (Atlantic and Continental) influenced the way cremation was performed. Other factors such as the wood availability in each region as well as the skills and/or the experience of the cremation operator could also affect the variation in pyre technology.

Conclusions and future perspectives

The CRUMBEL project aimed at gathering more information about the cremated individuals recovered in Belgium from archaeological contexts dating from the Neolithic to the Early Middle Ages by applying existing methods and testing new ones. A large radiocarbon dating campaign revealed important changes in funerary practices in the Bronze and Iron Ages and confirmed the almost absence of cremation burials pre-dating the Middle Bronze Age. The combined use of osteology, radiocarbon dating, and strontium isotope ratio further highlighted the complexity in Metal Ages cremation burial with the presence of bones belonging to up to three individuals in a single cremation burial. The intentionality (or not) of the presence of different individuals in a single burial requires further detailed research. The cremation practices differ between the Scheldt and the Meuse basins in Belgium, which seems to be linked to the different cultural groups settling these two basins. Finally, the transition from the Metal Ages to the Roman period appears to be linked to a drastic shift in food selection and procurement with a significant increase in salt consumption (preservative, garum, salt, etc.) in Roman times. Overall, the CRUMBEL project has shed new light on those individuals that were cremated in Belgium in the past, and more research will soon provide even more information

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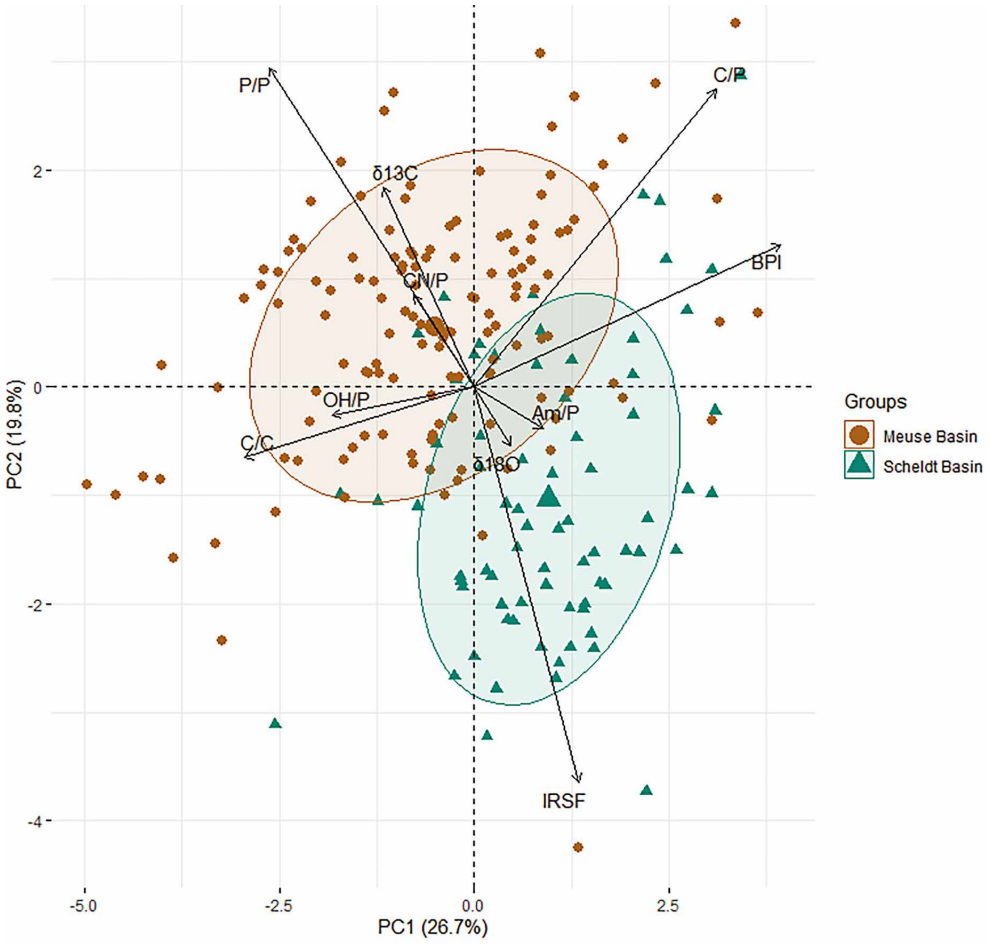


Fig. 8. Principal components analysis (PCA) results showing the differences between individuals cremated during the Bronze and Iron Ages in the Meuse (brown) and Scheldt (green) basins (modified after Stamataki *et al. 2021).*

and contrast between regions, countries and periods. Methods and approaches developed in the CRUMBEL project are therefore a first step to unravel the mysteries hidden within the cremated human remains, and in this way they set the path to follow, opening new research possibilities and being potentially extended to the study of many prehistoric and historic communities in Europe and abroad that practiced cremation.

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This volume presents the results of an international network project on Late Bronze Age and Early Iron Age urnfields from northwest Europe.
Individual chapters present the archaeological material and its research history within a local, regional, or supra-regional context, demonstrating the wide range of nuances contained by the funerary phenomenon. The volume provides the first comprehensive overview of the urnfield funerary phenomenon in northwest Europe and forms the foundation for future research across national and disciplinary boundaries.
This volume successfully demonstrates that the inconspicuous urnfields of northwest Europe are not as anonymous as previously assumed but hold valuable information about life and death in the Late Bronze Age and Early Iron Age.

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