

**Collective Violence in the Neolithic of Central Europe.**

**The Analysis of Human Skeletal Remains  
from Complex Burial Features.**

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## **PREFACE**

This thesis presents original research about the Neolithic period of Central Europe, utilizing human skeletal remains uncovered by archaeological excavations as a biogenic record of the past. Several key burial sites of special significance for the central theme of Neolithic collective violence from the current area of Germany have been prominently included in this study (Eulau, Burgenlandkreis; Schöneck-Kilianstädten, Main-Kinzig-Kreis; Halberstadt, Landkreis Harz), with each site representing unique characteristics and containing human skeletal remains in different biocultural contexts. All of these sites have already entered prominently into the international discussion and scientific literature which underscores their importance for the fields of biological anthropology and prehistoric archaeology.

The main trait the selected sites have in common is that all include more than one individual in a single grave feature, thereby providing a view quite different from analyses of more standard cemetery sites which usually contain only one individual per grave. The sites analysed in more detail here, as well as those drawn upon for closer comparison, are characterized as complex mass or multiple graves, which provide a horizontal transect through the respective local Neolithic populations at a given point in time. This allows detailed insights into the biosocial structure and life and death histories of contemporaneous communities; issues which are usually diluted or even completely masked in burial sites with longer duration of active use. The single-event burial sites with violence-related mass and multiple graves, the main focus of this work, which

provide a glimpse of conditions at a precise moment of the distant past (cf. Bentley et al. 2008), are contrasted in detail with multiple-event burial sites.

The osteological analyses of the skeletal remains examined for this study were partly carried out in the formerly existing Laboratory for Human Osteology of the former Institute of Anthropology of the University of Mainz, Germany. For the block-lifted multiple burials from the Eulau site, which, due to the size of the blocks, could not easily be moved, the *in situ*-analyses were carried out in the State Museum of Prehistory of Saxony-Anhalt in Halle (Saale), Germany. The mass grave of Halberstadt, which was initially a block-lift as well, was excavated by the author in the Central Finds Depot of the State Office for Heritage Management and Archaeology of Saxony-Anhalt in Halle (Saale), Germany. After removal of the bones the analysis of the skeletal remains from Halberstadt took place at the State Museum of Prehistory and in the personal office of the author at that time, both located in Halle (Saale), Germany.

The backbone of this thesis (CHAPTERS 3 TO 6) consists of four individual papers which have previously been published in peer-reviewed international journals and peer-reviewed edited volumes. Three papers (CHAPTERS 3, 4, 5) mainly present, analyse and discuss detailed osteological data and provide integrative interpretations of the human skeletal remains of three complex Neolithic burial sites of key importance (Eulau; Schöneck-Kilianstädten; Halberstadt). Besides presenting new bioarchaeological information these papers are also intended to serve as reliable and lasting baselines for further research by the international community. The last paper (CHAPTER 6) is a synthetic and comparative work, in part expanding upon the results obtained earlier (in CHAPTERS 3, 4 AND 5), but

also drawing upon other suitable Neolithic burial features for detailed comparison and discussion.

The first paper, CHAPTER 3 of this work, presents an in-depth osteological analysis and integrative interpretation of the multiple burials of the Corded Ware Culture (German: *Schnurkeramik*) found at Eulau (Burgenlandkreis, Saxony-Anhalt, Germany), mainly focussing on the skeletal evidence for bone trauma and interpersonal violence. At this site a segment of a settled community, including at least one biological nuclear family in addition to further kin-related individuals (Haak et al. 2008), apparently fell victim to a violent and lethal raid. This paper was published in the *Journal of Anthropological Archaeology* vol. 28 (4) and has become a mainstay in the international discussion about collective violence and warfare and the Corded Ware culture in general (e.g. Sosna et al. 2010; Lewis 2013; Schulting 2013; Kristiansen 2014; Sjögren et al. 2016; Vander Linden 2016; Jankovic et al. 2017; Ahola et al. 2018; Fibiger 2018; Madden et al. 2018; Schulting 2018; Rusu et al. 2019).

The second paper, CHAPTER 4 of this work, presents the results of the osteological analysis of the commingled human skeletal remains found in the Early Neolithic mass grave of Schöneck-Kilianstädten (Main-Kinzig-Kreis, Hesse, Germany) and has been published in the *Proceedings of the National Academy of Sciences of the USA (PNAS)* vol. 112 (36). This study has also quickly become a reference piece for international research into (pre)historic collective violence and warfare in very diverse academic disciplines and specifically for the Neolithic *Linearbandkeramik* (LBK) culture in Bioanthropology and Archaeology (e.g. Nakao et al. 2016; Iversen 2016; Dyer & Fibiger 2017;

Gargano et al. 2017; Micheletti et al. 2017; Gronenborn et al. 2017; Jankovic et al. 2017; Palmstierna et al. 2017; Oka et al. 2017; Fibiger 2018; Kissel & Kim 2019). The archaeological information utilised for this site is based upon the results of a previous archaeological M. A. thesis at the University of Mainz by Ch. Lohr (2013), who also did an initial analysis of most of the human skeletal remains (Lohr et al. 2017). For the work included here, the present author carried out a full osteological and palaeopathological re-analysis of the available excavated material, with a special focus upon the evidence for perimortem skeletal trauma, collective lethal violence and the interpretative placement of these results within the Early Neolithic *Linearbandkeramik* of Central Europe.

The third paper, CHAPTER 5 of this work, examines in detail the human skeletal remains recovered from the Early Neolithic mass grave of Halberstadt (Landkreis Harz, Saxony-Anhalt, Germany). Drawing upon extensive previous experience with Neolithic mass graves and other complex burial features (e.g. CHAPTERS 3 AND 4; cf. Meyer et al. 2004, 2008; Meyer & Alt 2012; Meyer et al. 2012a, 2012b, 2012c, 2013a, 2013b, 2014) the focus of attention was put on the demographic structure of the mass grave sample, on the skeletal evidence for traumatic and other pathological lesions, and on the osteological traces of taphonomic alterations, in this case mainly carnivore gnawing. In addition to these osteological analyses carried out by the present author stable isotope analyses (carbon / nitrogen / strontium) were employed by another member of the research team (C. Knipper). The various results were all integrated into the current interpretation of the complex burial feature. This paper was recently published in the journal *Nature Communications* vol. 9.

CHAPTER 6 specifically picks up the thread of Early Neolithic mass graves from CHAPTERS 4 AND 5 again, discussing how systematic analyses of chaotic simultaneous depositions of deceased and often violently killed people can indeed reveal meaningful patterns that may help in the interpretation of these and other enigmatic burial and deposition sites. This chapter therefore focusses on the *Linearbandkeramik* (LBK) again from which several mass graves and related features are now known – two of which are included in the present thesis – and specifically examines and compares the demographic structure of these mass fatality sites. As single-event mass fatality contexts the skeletal assemblages analysed provide unique and direct insights into contemporaneously living population segments that died at the same time, mainly targeted and killed by extremely violent human interaction. This paper has very recently been published in the edited volume *Prehistoric Warfare and Violence. Quantitative and Qualitative Approaches* (cf. Dolfini et al. 2018).

Many thanks are due to all project partners and all people and institutions who have supported and enabled the research presented here.

Goslar, 20 April 2019

Christian Meyer

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## CHAPTER 1

### Introduction:

#### The Neolithic and Human Skeletal Remains

The Neolithic of Central Europe, a period of several thousand years duration, marks a fundamental change in how communities of *Homo sapiens* positioned themselves in the biosphere by cultural means (Larson et al. 2014). The previous Palaeo- and Mesolithic lifestyle of mainly foraging for food in the wild, by hunting big and small game and collecting edible vegetation parts, was forever replaced by harnessing highly selected resources via the complex process of domestication (e.g. Benecke 1994; Dobney & Larson 2006; Gronenborn 2007; Zeder 2008). Although this significant change in lifestyle surely was a complicated and convoluted path with many opportunities for trial, error, and failure over many generations (Larson et al. 2014), it was and still is oftentimes called “The Neolithic Revolution” (e.g. Childe 1936; Uerpmann 2007; Watkins 2010). In foreshortened retrospective view, many aspects indeed seem “revolutionary”, but as the different components of Neolithic life as currently defined were not developed or adopted at a single point in time or at a single location by a clearly defined group of people, the term “Neolithic transition” should objectively be preferred (e.g. Whittle & Cummings 2007). For most contemporary witnesses, the changes so obvious now, which have already been elaborated many times (e.g. Benecke 1994; Dobney & Larson 2006; Zeder 2008), would not have been easily noticeable, if at all. But the progressing mosaic

of transitions from foraging to farming, from hunting to herding, and from nomadism to a settled lifestyle, including the habitual use of pottery, polished stone artifacts and many other smaller changes in life-routines in the end had tremendous effects on many different biological and cultural levels.

The complex process of the neolithization, and especially that of Central Europe, which had its roots in the so-called “Fertile Crescent” east of the Mediterranean Sea, need not be recounted here in full scope, as many scholarly works specifically targeting this theme, as well as many related subthemes, are easily available from a variety of viewpoints (e.g. Benecke 1994; Richards et al. 2003; Dobney & Larson 2006; Gronenborn 2007; Zeder 2008; Schibler et al. 2014). But one characteristic of the Neolithic, not always mentioned in the more encompassing treatments of the first farming cultures, but of great consequence for biological anthropology, is the fact that with the Neolithic, human skeletal remains become much more frequent in the archaeological record than ever before (Meyer et al. 2011; Martin & Harrod 2015; Kissel & Kim 2019). This allows all scientific approaches that utilize the subfossil record of the human past to base their research on much larger sample sizes from this time onwards, thereby significantly increasing the reliability and the general scope of possible results. In fact, several Neolithic burial sites are known which contained hundreds of human skeletal individuals each, while Mesolithic burials from all over Europe just number a few thousand (e.g. Gummesson et al. 2018).

While not all cultures of the European Neolithic seem to have used (semi)permanent cemetery sites as we still know them today, many actually did, as numerous examples demonstrate (e.g. Nieszery 1995; Spatz 1999; Dresely 2004; Alt et al. 2014). It is also quite rare that burial customs, and by extension

at least theoretically also the human remains upon which these customs center, are not part of the wider defining traits of an archaeological “culture” as commonly utilized today. Change in burial rite actually is one of the facets commonly used to identify further assumed changes in these archaeological “cultures” or groups (Fischer 1956; Eggers 1986), and the skeletal remains recovered from these graves are the most important sources for bioanthropological research targeting those “cultures”. Especially the first full farmers active in Central Europe, today subsumed under the label *Linearbandkeramik* (LBK), often buried their dead in dedicated burial areas of differing sizes (e.g. Nieszery 1995), used for decades or even centuries. Over time, several hundred human individuals could thereby accumulate at such places, as various examples show (e.g. Gerling 2007; Ungerath 2014). Later Neolithic groups either continued this tradition of larger cemeteries, switched to the utilization of much smaller ones or, for example, to the construction of collective graves (e.g. Rinne 2003; Doppler 2012). Only few “cultures” of significant size and duration did not leave an easily identifiable burial record. But regardless of the respective differences in detail and the complex question of the numerical relation of known burial sites to estimated population sizes (cf. Nieszery 1995; Pechtl & Hofmann 2013), it usually poses no problem to recognize Neolithic burial places as such. Overall, they are quite common and many sites have been excavated so far. As a consequence, human skeletal remains from the Neolithic period from Central Europe are now also quite common, often enabling research on the group or population level for biological anthropologists (e.g. Carli-Thiele 1996; Nicklisch et al. 2012; Fibiger et al. 2013; see also CHAPTER 2). This is in stark contrast to the preceding periods, which are

characterized by a pronounced scarcity of grave sites and therefore of human remains, precluding many analytical approaches requiring adequately sized and preserved samples reasonably limited in space and time (Meyer et al. 2011; Martin & Harrod 2015).

Subsequent burial events in Neolithic cemeteries increased the sample sizes now available for analysis which in itself is a welcome fact. But over time such practice also potentially averages out all traits that can be studied directly from the skeletons recovered from such sites today if the individuals are later (and most often necessarily) pooled for analysis. Therefore, for example the demographic structure, the genetic make-up, the geographic origin of individuals, data concerning their diet, body height and disease and injury load being reconstructed by various methodologies will not be an accurate reflection of conditions actually having existed at some point in the past. In many cases results from such attritional burial sites will come close enough to past conditions to be of significant scientific value, especially if the research questions take this effect into account, but they still represent only vertical transects through time and therefore a possibly skewed average of what one might actually be aiming for.

But attritional burial sites, like cemeteries or collective chamber tombs, are not the only archaeological contexts in which human skeletal remains are sometimes discovered. For example, features that deviate significantly from the identified norm(s) for a specific cultural group and containing human remains are often called “deviant burials” (e.g. Murphy 2008). This not only reflects their recognizable individuality in appearance, in direct contrast to the more numerous standardized graves, but also their comparative rarity in the

archaeological record. With progress in research, features once considered as deviant may become part of the recognized norm of an archaeological culture though, if their numbers and contexts cannot be called rare or unusual any more upon periodic review. This is suggested for the mostly individual settlement burials of the LBK for example, which are known in increasing numbers and which usually show comparable levels of care and deliberation to those found in a regular cemetery site (Hofmann 2009). While these settlement burials have been regarded in the past as deviant because of their location away from the usual cemetery sites (Peschel 1992; Orschiedt 1998), there is now accumulating evidence for them to be another (if slightly less standardized) variant of the “regular” burial customs (Pechtl & Hofmann 2013; Meyer et al. 2013; Meyer et al. 2014). While also found in settlement contexts, the mass graves, which include higher numbers of erratically commingled bodies, can be considered as deviant burials (Pechtl & Hofmann 2013; Hofmann 2015). The LBK also shows various modes of treatment of the dead, which currently are not fully understood and which directly affect modern bioanthropological analyses (Seregély 2012; Zeeb-Lanz 2009). The most obvious example to date is the large ritual site of Herxheim, Rhineland-Palatinate, Germany, where intentionally modified and disarticulated human skeletal remains were found mixed with animal bones and potsherds (Boulestin et al. 2008; Zeeb-Lanz 2009; Zeeb-Lanz et al. 2013; Boulestin & Coupey 2015). The human bones are routinely fragmented, bodies have been dismembered and skulls have partly been worked into bowl-shaped artifacts. While there is no universal agreement to what these traces of intensive modification of dead bodies might signify (Zeeb-

Lanz 2014), it likely was a guided practice, as recognizable modification patterns suggest (Boulestin et al. 2008).

Other prehistoric cultures, both earlier and later than the Neolithic, also featured enigmatic death rituals leaving behind osteological and archaeological traces which are no less complex (e.g. Meller 2013; Gummesson et al. 2018). All this indicates that the biological components of the human body regularly had a significant role in Neolithic societies surpassing the lifetime of the respective individuals for a variety of reasons (cf. Smith & Brickley 2009; Gresky et al. 2017). While the topics of the spiritual “afterlife” of human remains can and shall only be touched upon within the scope of this work, which is mainly concerned with the biogenic evidence of past populations and the contextual interpretation of collective violence preserved in the skeletal remains, this clearly demonstrates the close-knit interrelations between the biological body and the living culture, with the latter determining the fate of the former, including its possible survival in the biological and archaeological record of the past (cf. Parker Pearson 1999; Parker Pearson et al. 2005; Smith & Brickley 2009; Meyer et al. 2014; Martin & Harrod 2015). In most cases humans deliberately chose when, where, and how to deposit the remains of other deceased human beings. Only in very rare cases, probably mostly as a result of accidents, can human remains be found embedded in the subfossil record by more or less natural means (e. g. Meyer S. et al. 2013; Spindler 2000).

In contrast to the attritional burial sites which mainly allow research on the group or population level with the recognized effects of averaging details over time, certain types of (deviant) burial features allow much more precise insights into defined episodes of Neolithic life and death. These are the single-event

burial features containing more than one individual of which several key examples are analysed in this study. Depending on their layout, size, and general appearance, they are usually termed mass and/or multiple graves (Eggert 2001). Both have in common that the bodies included in the same feature have been deposited simultaneously and not repeatedly over a longer timespan like for example in collective graves, which nevertheless share some similarities with them, not least their overall complexity. Circumstances leading to the utilization of such single-event burial features must have been always special (Keller et al. 2015), but not necessarily similar. This is exemplified by the comparative analysis of the mass grave of Halberstadt (CHAPTER 5) which appears very similar to the previously discovered LBK mass graves on first glance, but which reveals itself as contextually different when examined in fine detail. But in each case the respective lethal circumstances, which may have included natural catastrophes, epidemics or actual collective violence, caused the simultaneous death of a number of people. While such events undoubtedly had significant impact upon the populations concerned on different levels, the skeletal samples thereby assembled now allow glimpses into a variety of contemporary conditions and relations otherwise not directly observable (cf. Bentley et al. 2008). Contemporaneous kinship structures are one important example, which might be preserved in multi-body burials following mass fatality events. This is best exemplified by the four multiple burials found at Eulau as several definite biological kinship ties could be detected there (Haak et al. 2008; 2010).

The Eulau burials, with their clear evidence of collective violence, also demonstrate that the traces of such traumata are another important feature

best observed in single-event mass fatality sites. In fact, skeletal injuries, like those encountered at Eulau, are one of the few causes of death directly evident from the osteoarchaeological record (cf. Walker 2001). This results in the special significance that osteological trauma and its critical evaluation have for the interpretation of complex burial and deposition features, as traumatised human remains are the only direct indicator for actual past violence (e.g. Kissel & Kim 2019). In deep accordance with the aims of bioarchaeology this study shall therefore serve to provide data and informed results “that help unravel large and important questions about humans and their long relationship with violence” (Martin et al. 2012, 2), especially for the Central European Neolithic.

## CHAPTER 2

### **The Contextual Analysis of Human Skeletal Remains and the Central Role of Trauma and Taphonomy**

To make the most of the human skeletal remains discovered in different archaeological contexts it is necessary to fully understand the effects that influenced these finds from the lifetime of the respective individuals up to the point of (repeated) analysis (e.g. Martin & Harrod 2015). Failure to take the precise archaeological context into account can introduce long-lasting errors and misleading interpretations into the literature, which are then sometimes multiplied by various authors over long periods of time. The prehistoric human remains recovered from the cave site “Jungfernhöhle” near Tiefenellern, Bavaria, Germany are a case in point for such a process of continued erroneous interpretation based upon a flawed initial excavation and investigation which disregarded and misinterpreted significant taphonomic factors (e.g. Asmus 1955; Buhmann 1979; Seregély 2012). While the earliest report, by grossly misinterpreting most osteological indicators, claimed that the human skeletal remains found within the cave were the result of human sacrifice and cannibalism (Asmus 1955), later interpretations sought decidedly less violence-dependent explanations in multi-stage burial customs (Orschiedt 1999). A recent re-analysis of the extant skeletal remains utilising current taphonomic concepts and new excavations of the spoil heaps of the 1950ies excavations instead revealed that all earlier interpretations were in fact based on a

misreading of the actual osteological traces and an incomplete skeletal sample, as many smaller bone elements were just ignored during the mid-20<sup>th</sup> century excavations (Seregély 2012; Boulestin 2017). This disregard for small bones skewed the available sample towards larger elements which, in turn, affected the later interpretations. In fact, the presence of small bone elements can indicate if a depositional context is of primary or secondary nature (cf. Meyer & Alt 2012), so the recovery of every skeletal element regardless of its size or condition is extremely important. In addition to their prior incompleteness and indicated by radiocarbon dating the skeletal specimens are also a mix of Mesolithic, Early and Late Neolithic finds which indicates that the original burial context was either disregarded as well or was already destroyed upon excavation. Due to this very unfortunate chain of adverse circumstances and deeply flawed analyses the highly complex burial site of the Jungfernhöhle has now lost much of its original contextual information which cannot be reconstructed (Boulestin 2017). In contrast to that, the documentation and actual utilisation of important contextual information is one of the key issues of the present thesis (see CHAPTERS 3, 4 AND 5, where complex burial features are analysed).

Taphonomy (Efremov 1940), a concept introduced into bioanthropology and archaeology from the fields of palaeontology and geology, and “reinvented” several times under different headers (cf. Duday 2009), has now become a central tool in interpreting the skeletal record, especially of deviant or otherwise unusual burial sites (cf. Martin et al. 2012; Meyer et al. 2012a). The three terms *antemortem*, *perimortem* and *postmortem* are of special significance in this regard, each encompassing different periods in the “life-history”, or

rather “death-history”, of the skeletal specimens under study (cf. Haglund & Sorg 1997; Sauer 1998; Stodder 2008; Martin & Harrod 2015). As numerous examples show, the correct classification of observed skeletal lesions frequently holds the key to unravelling deviant burial features (e.g. Wahl & König 1987; Meyer et al. 2012a; 2012b).

Everything that happens to a living individual until a short time before death and which leaves behind a recognizable imprint in the skeleton (or other preserved tissue types) belongs to the category of *antemortem* (or *intra vitam*) changes. Commonly, these are characterized by a macroscopically observable bodily reaction to e.g. infectious, degenerative or traumatic insults. Within the scope of the present study, especially the last category is of high relevance. Bone trauma most commonly occurs in the form of fractures, which in many cases are easily recognizable even after the healing process has run its course, especially so in prehistoric human remains. Dislocated fracture ends resulting in abnormal bone shape for example are often found in formerly fractured and healed postcranial bones (Ortner 2003; Lovell 2008). If joint spaces are affected as well by the traumatic injuries, degenerative changes will often occur and usually earlier than commonly observed in cases with no prior joint injury (Lovell 2008). In the skull blunt force injuries are the most common traumatic findings in the Neolithic, often relating to the known weapon-tools of the respective cultures (Wahl & König 1987; Teschler-Nicola et al. 1996). If sharp force injuries occur, these will have very likely been caused by sharp-edged flint artifacts, either in the form of hand-held cutting instruments (e.g. knives) or as projectile points (e.g. arrowheads). Sometimes the latter can still be found firmly stuck in the skeleton of victims who survived the arrow injury for years or even decades

(e.g. Guilaine & Zammit 2005; Jeunesse et al. 2014). Such an occurrence then provides unique windows into ancient weapon typology and may even hint at possible groups of perpetrators if the arrowheads are characteristic enough for cultural and functional attribution (cf. Ganslmeier & Literski-Henkel 2014; Iversen 2016). Bony proliferation or other signs of healing or infection caused by such wounds indicate that the individual survived the injury, at least for some time. In most cases with evident signs of healing, the respective trauma will then not have contributed directly to the demise of the individual.

If definite non-postmortem injuries (see below) are present, but no signs of healing can be observed, the trauma might have been lethal, been received around the time of death, or shortly thereafter. The term *perimortem* used in such cases can basically be defined as referring to the period during which the bone (still) had life-like mechanical properties and therefore reacted to physical stresses in a certain way different from dry bone devoid of life-like properties. This generally encompasses the hours or possibly days right before death occurs until an unspecified time after death (e.g. Loe 2009; Symes et al. 2014). The latter timespan is largely determined by the burial conditions, if a burial as such actually took place. As a very general estimate, bone may still retain life-like properties several weeks to months after death even in burial environments common for the Central European Neolithic, depending for example on the burial season (with e.g. humidity and temperature as important factors). This always has to be kept in mind when interpreting bone trauma from archaeological contexts, especially if explanations other than interpersonal violence easily present themselves (e.g. Smith & Brickley 2009; Meyer & Alt 2012). The importance of the specific burial context for the interpretation of

skeletal lesions cannot be stressed enough in this regard (cf. Symes et al. 2014), as for example skull injuries found in repeatedly used chamber tombs constructed of heavy rocks and timber might have another likelihood to have been caused by taphonomic processes than those found in simple earthen graves devoid of constructional elements that may have fallen down, causing *perimortem* damage (cf. Smith & Brickley 2009). Neglect of the possible effects of burial context may lead to false assumptions, which might easily bias the data used for comparative purposes. For this reason alone, burial context and the analysis of human skeletal remains, especially if targeting bone trauma, are inseparable from one another (cf. Buhmann 1979; Haglund & Sorg 1997; Symes et al. 2014; Martin & Harrod 2015). It is therefore always necessary to examine both of these spheres in conjunction if Neolithic (collective) violence is to be understood in a valid and objective way.

For most skeletal remains from archaeological contexts, the *postmortem* period will undoubtedly have been the longest one. While the *antemortem* period will have covered several decades on average, but frequently also much less, depending on the age of the deceased, the *perimortem* period very likely lasted just a few weeks in most cases (Loe 2009). In contrast to that, the *postmortem* period will already have been several thousand years for the Central European Neolithic upon modern discovery, and technically it will never actually end. It is therefore unsurprising that most damage to Neolithic bones stems from the *postmortem* period. For sound interpretations based on the skeletal record this ubiquitous taphonomic “background noise” has to be reliably filtered out accordingly. This is a central point for the topic of identifying evidence of interpersonal violence in the archaeological record, where the most relevant

traces will either be from the *antemortem* (if non-lethal) or the *perimortem* (if lethal) period. In some cases signs of earlier trauma will also certainly have been destroyed by later taphonomic damage (Loe 2009), so that in general the surviving trauma securely identified as either *antemortem* or *perimortem* will always only be the minimum extent of past traumatic lesions. This is in addition to the well-known fact that soft tissue-only wounds will almost always be invisible in the skeletal record although they will have made up the larger part of prehistoric injuries (Milner 2005; Loe 2009; Martin & Harrod 2015). Sometimes projectile points can still be found within the (former) body cavities even if they did not strike bone, indicating such soft-tissue injuries (cf. CHAPTERS 3 AND 4; Pernter et al. 2007; Schulting 2018). But as the same projectiles may be found as intentionally deposited grave goods in many Neolithic cultures, interpretation has to take into account the specific context each time, especially as smaller items like arrowheads might easily be moved by taphonomic factors, like burrowing animals for example (e.g. Meyer et al. 2012a; 2012b).

While reconstruction of the chronological sequence of recognized bone injuries undoubtedly forms the basis of prehistoric violence research (Martin & Harrod 2015), the level on which this research occurs is also of high relevance. Commonly, three levels can be differentiated: individual, group, and population. The first level concerns only single individuals, which may be described in higher detail. This is routinely done if only one individual with relevant changes is available from a burial site or if special cases are selected from a larger group to argue a case in point or to present pathological features that are considered rare but important (e.g. Alt et al. 1997; Orschiedt et al. 2003; Jeunesse et al. 2014). While these case studies inform about very specific conditions, the fact

that only single (or just a few) individuals are affected and described also limits their explanatory power. At the other end of the spectrum are studies on the population level. These usually combine individuals excavated from a number of different burial sites from a wider region and/or a longer timespan (e.g. Fibiger et al. 2013). Various smaller series are routinely pooled to increase sample sizes up to a level suitable for statistical analysis. While this allows to identify and analyse possible patterns in the targeted traits, facilitating objective comparative studies between periods or regions, these population studies are again necessarily based on multi-event burial sites with their averaging effects regarding past conditions (cf. CHAPTER 1).

Intermediate between the individual and the population level is the group level, which facilitates the examination of a defined number of individuals which may just allow careful generalisations about certain aspects. While these individuals may also be from a local attritional burial site of smaller size, thereby probably still varying in their absolute age, mass fatality events resulting in the later utilisation of simultaneously filled mass and multiple graves are another important source of groups of individuals of this size category. The human remains included in such Neolithic burial features will probably stem from a local group in most cases, likely a settled farming community (cf. Bentley et al. 2008). Depending on the numbers of fatalities and the size of the respective grave features, the inhabitants of complete Neolithic hamlets may be represented (almost) in full in some cases (Wahl & König 1987; Düring & Wahl 2014). But even if only a fraction of such a once-living community is included in a mass grave for example, the most relevant aspect is that these persons lived and died at exactly the same time and very likely at the same place, and also

very likely were connected by kin-relations (Johnson & Paul 2015). Therefore the contemporaneous living conditions, their biosocial structure and biological relations all are preserved in the information stored in the human skeleton during the lifetime of the respective individuals. This theoretically allows deep and detailed insights into the past that are neither obtainable by the analysis of single skeletons nor of whole non-contemporaneous population samples assembled from different attritional burial sites.

The complex burial features examined in CHAPTERS 3, 4 AND 5 of this study are of this valuable contemporary group level, intermediate between case and population studies. At all three of the analysed sites mass fatality was clearly caused by lethal collective violence. For the sites of Eulau (CHAPTER 3) and Schöneck-Kilianstädten (CHAPTER 4) it is proven, or at least quite likely, that this violence annihilated a significant part of a local community organized along kinship relations (cf. Alt et al. 1995; Wahl & Strien 2007; Haak et al. 2008; Düring & Wahl 2014), while at Halberstadt such a kin-based community may instead have been responsible for the discovered mass killing (CHAPTER 5). This exemplifies that organized and collective violence in the Neolithic is a complex issue that necessitates an analytical focus on the biological remains of the people killed in mass fatality events. Especially the aspects of trauma and taphonomy, coupled with further analyses and evaluated in direct relation to the specific depositional contexts, are needed to arrive at sound and lasting conclusions and interpretations (e.g. Martin et al. 2012). As will be shown in the following chapters, the detailed bioarchaeological analysis of these sites can reveal significant differences even if they appear quite similar on first glance.

## CHAPTER 3

### **The Eulau Eulogy: Bioarchaeological Interpretation of Lethal Violence in Corded Ware Multiple Burials from Saxony-Anhalt, Germany**

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## **Abstract**

The Corded Ware is one of the major archaeological traditions of Late Neolithic Europe. Its burial customs are characterized by single graves but multiple burials also occur. We present a detailed study of antemortem and perimortem trauma in a group of Corded Ware skeletons from four multiple graves and give the most probable interpretation of the site, based upon all available bioarchaeological evidence. The pattern of observed injuries in male, female, and subadult skeletons, including cranial trauma, arrow wounds, and fractures of the forearm and hands points towards a violent event that resulted in the death of all individuals, most probably a raid. In contrast to comparable Neolithic raid sites, there was no complete extermination of the local population and no use of mass graves. The burials have been arranged with care and detailed knowledge about biological kinship ties [Haak, W., Brandt, G., de Jong, H.N., Meyer, C., Ganslmeier, R., Heyd, V., Hawkesworth, C., Pike, A.W.G., Meller, H., Alt, K.W., 2008. Ancient DNA, strontium isotopes, and osteological analyses shed light on social and kinship organization of the Later Stone Age. *Proceedings of the National Academy of Sciences of the United States of America* 105, 18226–18231]. The combination of clear causes of death and the proven biological relationships among some of the individuals, including a nuclear family, provides new and important insights into Corded Ware mortuary customs and the reasons why and how multiple graves have been utilised.

## **Introduction**

The documentation, analysis, and interpretation of interpersonal violence in the human skeletal record is one of the main topics of palaeopathology and bioarchaeology (e.g. Jurmain, 2001; Walker, 2001; Smith et al., 2007; Judd, 2008) and has profound implications on how archaeological cultures are perceived (Guilaine and Zammit, 2005). Violent behavior has always been one of the ways to resolve intra- and intergroup tensions in human societies and has been described as “a powerful expression of human social interaction” (Schulting and Wysocki, 2005, p. 107). Skeletal remains which bear the scars of injuries have been found in many locations and time periods, from the Palaeolithic onwards to the present day (e.g. Meyer, 2003; Roksandic et al., 2006; Paine et al., 2007). The European Neolithic is no exception in the history of human violence, although sites which have yielded large numbers of affected skeletons are rather rare. In this paper, we present further evidence for directed interpersonal violence during this period and follow up on the biocultural implications of the injuries recorded for the people of the Corded Ware Culture. One of the most significant points that we want to raise is that multiple graves, like the ones encountered at Eulau, may not be mere convenient structures to dispose of several people who all happened to die within a short time period. Instead, here we have definite proof of simultaneous death, cause of death, and the underlying biological and social relations of the buried individuals. Combined with the genetic and isotopic analyses (Haak et al., 2008), the results gleaned from the analysis of the multiple graves from Eulau reveal new and important insights into the Late Neolithic of Central Europe.

Towards the end of the Neolithic, the cultural complex of the Corded Ware forms one of the major archaeological entities of the European continent. First occurring around 2800 cal BC in our study area of the Mittelelbe-Saale, remains of the Corded Ware Culture have been found from Central to Northeastern Europe (Haak et al., 2008). The foremost source of information from this period are the graves and their content as well-preserved settlement structures are rarely encountered. It seems that small villages with houses no larger than about 10 m predominate, and that the Corded Ware people carried out agriculture and animal husbandry on a developed level (Hecht, 2007). In contrast, graves are known in high numbers, either as singular finds or loosely clustering in small cemeteries (Buchvaldek, 1967). Overlapping in time with the Bell Beaker culture, the Corded Ware comes to a close about 2050 cal BC and is followed by the Únětice Culture and the Early Bronze Age.

The burial rites of this culture, which have direct consequences for the amount of information available to bioarchaeological interpretation, follow a rather strict pattern in our region of study. The dead are usually placed in a flexed position in single graves. Males rest on their right side, females on their left side, both sexes facing south. As a result, men have their head to the west, with the heads of women pointing to the east. Exceptions to this rule are rare. It is assumed that most of the graves originally possessed a small mound, which is often unrecognizable today due to centuries of agricultural activity. Multiple Graves, the simultaneous inhumation of several bodies, are a rather rare but constant feature, more so than in other Neolithic cultures of the region (Wahl et al., 1990).

As one of the most important and widespread Neolithic cultures in Europe the skeletal remains of the Corded Ware people have been a focus of scientific attention from an early stage. Questions as to their place of origin and their morphological affinities to other groups played the major role in the earlier investigations. Craniotypology, followed by craniometry were the primary tools of the anthropologists of that age (e.g. Heberer, 1938; Schwidetzky, 1978) and other aspects of anthropological analysis were rarely written about. Recognized palaeopathological changes, whose significance and bioarchaeological interpretation are the main concern of this paper, were only mentioned in passing or presented in short notices. The majority of these short communications deal with trepanations, which are not uncommon in Corded Ware crania (e.g. Bach, 1962/1963, 1963). Fractures and wounds presumably caused by accidents or interpersonal violence form another but related topic, which has received considerably less attention (e.g. Bach, 1963; Feustel et al., 1966). Modern studies explicitly dealing with palaeopathology are quite rare for the Corded Ware (Schutkowski et al., 1996; Dittmar and Teegen, 2003; Dresely, 2004), and attempts to get results at the population level for the whole of the Corded Ware are even rarer (e.g. Bruchhaus and Neubert, 1999). Although this paper is essentially another case study, albeit with a rather high number of individual cases, the quality and condition of the skeletal remains presented below and the high number of recognized violent injuries allow us to draw conclusions which are in fact highly relevant for Corded Ware mortuary customs and society as a whole. The main objectives of the present paper can be stated as the detailed documentation of the violent injuries encountered and their interpretation in a bioarchaeological context as well as highlighting the

importance of interdisciplinary studies when dealing with complex burial situations. Furthermore, regarding the undisputable evidence for Neolithic warfare in its broadest sense in Central Europe, we still only have very scatchy data indeed, as only very few sites with a higher number of violently killed individuals are published in detail (e.g. Wahl and König, 1987). As the Neolithic spans several millennia, it is of the highest importance to add more substantial evidence to the still emerging picture of Neolithic violence and warfare.

### **Multiple Burials of the Corded Ware Culture**

Compared to other major Neolithic cultures without truly collective burial rites, Corded Ware multiple burials appear quite frequently. About 44% of graves in two cemeteries located in the Tauber Valley in southern Germany contain more than one individual, whereas this figure is somewhat lower in another Tauber Valley cemetery with 17%. In other Corded Ware cemeteries, such as Vikletice in Bohemia, multiple burials number about 10% (Dresely, 2004; Menninger, 2008). Well-published cemetery sites from other major Neolithic cultures usually yield no or very few multiple inhumations, rarely exceeding about 3% if they are present at all (e.g. Lambach, 1993; Nieszery, 1995; Spatz, 1999). In most cases these graves include only subadults or a combination of subadult and adult individuals (Bulla, 1998; Meyer et al., 2004). The extremely high number of double and multiple burials in the Tauber Valley can be explained by the fact that most of these graves were actually used as small-scale collective burials, which are known, in larger scale, from other Neolithic cultures (Meyer

et al., 2008). The obvious difference between true multiple and collective burials is the number of inhumation events. Most Neolithic collective burial places are constantly accessible during their functional life-time, and placement of new bodies is carried out repeatedly. True multiple burials are characterized by the simultaneous inhumation of two or more individuals in a grave, which has been prepared for this single event and is closed up permanently afterwards, precluding further use. This contrasts with known Neolithic mass graves, where the bodies form a careless and jumbled heap (Wahl and König, 1987; Meyer et al., 2004), but are nevertheless interred simultaneously. Bodies in multiple burials are usually arranged according to the relevant burial customs of the period.

Two main questions often arising when dealing with multiple graves, are: (1) Why did the individuals buried together die at roughly the same time? (2) Are they biologically related? The answer to the first question often has to remain speculative but can sometimes be answered by osteological analysis. In the case of the Eulau graves, it has been possible to establish a likely cause of death (see below). The question of kinship often invites speculations, especially when adults and children are encountered in a single grave. The most frequent interpretation of such a scenario is that of parents interred with their offspring, and an adult female associated with a subadult is almost certainly regarded as a mother with her child (e.g. Buchvaldek, 1967; Wahl et al., 1990). In most cases final proof for all these assessments is unavailable. In our case, it actually has been possible to prove genetic relationships for some of the individuals buried in the four multiple graves via the analysis of mitochondrial and nuclear DNA. The most relevant result has been the identification of a nuclear family and a

likely pair of siblings (Haak et al., 2008). This amount of detail has up to now not been available for the reconstruction of mortuary practises of the European Neolithic.

### **The Multiple Burials from Eulau, Saxony-Anhalt, Germany**

At Eulau, near the town of Naumburg, excavations in the area of a large open gravel mine revealed four closely grouped multiple burials (Figs. 3.1 and 3.2). Associated artefacts and overlapping radiocarbon dates between 2675 and 2495 cal BC put these graves into the context of the Corded Ware Culture (Haak et al., 2008). Two of the graves contained four individuals, one grave held three bodies and the last one contained the remains of two individuals. There was no archaeological evidence of later disturbance or re-use of the graves, and the size of the grave-pits closely corresponds to the amount of space needed for the placement of the bodies. These facts indicate true multiple burials. The skeletons were lifted as blocks from the field and are presently on permanent display at the State Museum of Prehistory in Halle (Saale), Germany. As a consequence, the skeletons had to remain largely in situ during most of the analyses and only small bones or truly essential elements could be temporarily removed. It was therefore necessary to reach a compromise between a detailed osteological study and the best possible preservation of the original context, the latter being given priority. Following standard osteological procedures (White and Folkens, 2005), the age and sex diagnosis resulted in the identification of two adult males, three adult females, and eight subadults (Table 3.1).



*Fig. 3.1. In situ photographs of the four Corded Ware multiple burials from Eulau, Germany. (A) Grave 6-0099 with Inds. 1–4. (B) Grave 6-0090 with Inds. 5 and 6. (C) Grave 6-0098 with Inds. 7–10. (D) Grave 6-0093 with Inds. 11–13.*



*Fig. 3.2. Map of Central Europe with Germany (dark grey), the state of Saxony-Anhalt (light grey) and the site of Eulau (star) depicted.*

The morphological sex diagnosis was validated and complemented by DNA analyses including the sexing of the subadults (Haak et al., 2008). Trauma

analysis also followed established guidelines (Lovell, 1997; Rogers, 2004).

Radiographic documentation was carried out when possible and deemed necessary.

Ind.	Kin	Sex	Age	Antemortem injury	Perimortem injury
<b>Grave 6-0099</b>					
1	*	F	35-50 y	-	-
2	*	M	4-5 y	-	-
3	*	M	40-60 y	Left humerus, left radius, left hand	Right hand; Left hand
4	*	M	8-9 y	-	Cranial trauma (Os occipitale)
<b>Grave 6-0090</b>					
5		F	25-35 y	-	Arrow wound (Lumbar vertebra 4)
6		-	4-5 y	-	-
<b>Grave 6-0098</b>					
7		F	30-38 y	-	Cranial trauma (Os parietale)
8		-	0.5-1 y	-	-
9	*	M	7-9 y	-	-
10	*	F	4-5 y	-	-
<b>Grave 6-0093</b>					
11		M	25-40 y	Left radius, left ulna, left hand	Right ulna; Right radius; Right hand
12		-	4.5-5.5 y	-	-
13		-	4-5 y	-	-

*Table 3.1*

*Sex, age, genetic kinship, and evidence for ante- and perimortem skeletal trauma for all individuals. Proven kinship within a grave indicated by \*, genetic data from Haak et al. (2008).*

## ***Osteological Results***

Case descriptions are only given for those individuals who show evidence of healed or unhealed trauma. A complete osteological catalog is beyond the scope of this article and will be published at a later date along with more detailed archaeological results for the site. The different traumatic lesions are described in the necessary detail though, to enable an objective evaluation of our interpretation (Lovell, 2008). Although some injuries presented below are unambiguous signs of interpersonal violence, others may well be the result of accidents instead. This has to be kept in mind when attempting a bioarchaeological reconstruction.

### *Grave 6-0099*

*Ind. 2.* This 4–5 year old boy has a small and healed depressed fracture of the frontal bone, measuring about 0.8 - 0.5 cm. As fractures of this type are common results of childhood accidents, it is not believed to be a result of interpersonal violence, which can, of course, not be ruled out entirely (Schulting and Wysocki, 2005).

*Ind. 3.* This 40–60 year old man suffered from several injuries, some received years before death, some perimortem. All lesions are found along the left arm, including the humerus, radius, metacarpals and phalanges. Approximately at mid-shaft, the humerus displays an exostosis about four centimeter in length (Fig. 3.3). The location corresponds to the insertion of the m. deltoideus. An

unspecified trauma to this muscle followed by ossification appears to be the most likely explanation (Mann and Hunt, 2005). Another old injury can be found at the distal radius. The bone had suffered an oblique to spiral fracture about three quarters down the shaft and has healed with a slight medial displacement and negligible misalignment (Fig. 3.4). The more proximal end of the fracture space was located on the medial side of the bone. The third and final healed injury involves the proximal interphalangeal joint of the fourth digit. Bony ankylosis has fused the two bones through the joint, resulting in complete immobilisation. Both bones now share a common medullary cavity (Fig. 3.5). Most likely this finger was subjected to compression forces which resulted in an impacted fracture of these phalanges. As all of these injuries show a similar degree of healing and complete remodelling of cortical surfaces, it may well be that they were received at the same occasion.

Further traumatic lesions, which can be deemed perimortem, involve both hands. The right hand suffered fractures to the metacarpals of the second (distal), third (proximal), and fourth digit (proximal). Also affected is one phalanx, probably of the fifth digit (Fig. 3.6). Fractured bones of the left hand include the metacarpals of the third (distal) and fourth (distal) digit, as well as the basal phalanges of the second (proximal), third (medial), and fourth (proximal) digits. All these fractures of the small bones of the hands are either oblique or spiral fractures. Destruction of the left frontal skull might also be due to perimortem violence, but this could not be securely assessed as the bones had to remain in situ. The same can be said for the destruction of the skull of associated Ind. 1, which showed no further signs of injury. Soil pressure, which

is the evident reason for the destruction of most subadult skulls in this sample, might be an alternative explanation.



*Fig. 3.3. Large exostosis of the left humerus of Ind. 3 most probably due to myositis ossificans. Scale bar length is 3 cm.*



*Fig. 3.4. Left radius of Ind. 3 with evidence of a healed fracture (left). CT image with a slightly different orientation (right). Visible fracture line in the top half of both images is postmortem damage. Scale bar length is 3 cm.*



*Fig. 3.5. Finger bones of Ind. 3 with complete bony ankylosis, most probably due to an old fracture. Scale bar length is 3 cm.*



*Fig. 3.6. Perimortem spiral fracture of a manual phalanx of Ind. 3. Scale bar length is 1.5 cm.*

*Ind. 4.* This 8–9 year old boy suffered a comminuted penetrating wound to the back of the skull, creating a roughly triangular hole measuring about 1.5 x 2.5 cm. Concentric and bending fractures can be seen in the direct vicinity of the impact site (Fig. 3.7). Small bone fragments projecting into the interior of the skull were still visible and adhering to the wound margins on examination.

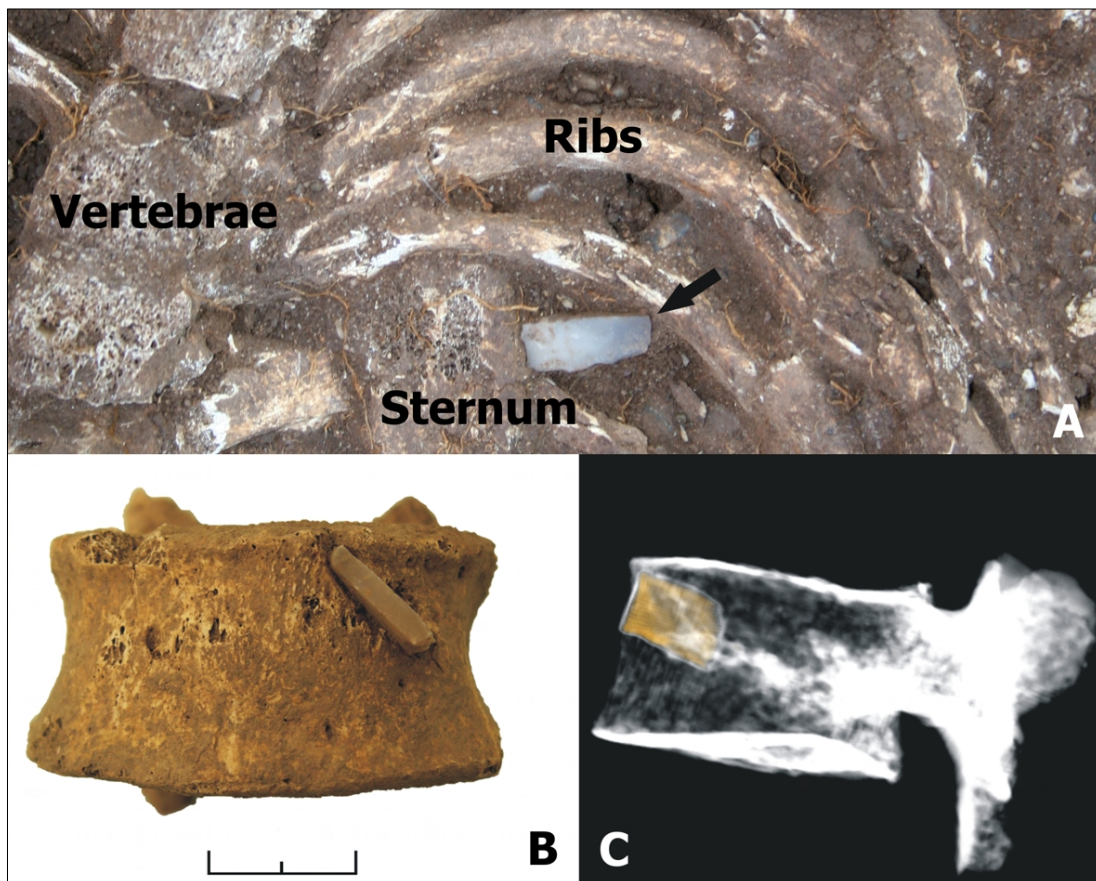


*Fig. 3.7. Perimortem cranial trauma on the occipital bone of Ind. 4. Arrows indicate penetrating fracture margins. Scale bar length is 3 cm.*

*Grave 6-0090*

*Ind. 5.* A transverse flint arrowhead is firmly lodged in the fourth lumbar vertebra of this 25–35 year old woman. The projectile point entered the

vertebral body from the front and left side, indicating a ranged attack from this direction. Neither CT-scans nor macroscopic examination of the dry bone surfaces revealed any bony reaction in the area surrounding the stone tip, indicating that the wound was received around the time of death (Ryan and Milner, 2006). A second transverse arrowhead was found lying between the ribs of the left side and might be evidence of another injury. No bone damage was noted, but the poor preservation of the ribs would certainly have masked any evidence of trauma (Fig. 3.8).



*Fig. 3.8. (A) Transverse flint arrowhead in the left chest area of Ind. 5. (B) Another transverse flint arrowhead lodged in the fourth lumbar vertebra of Ind. 5. (C) CT scan of the same vertebra showing the morphology of the cutting edge of the tip. Scale bar length is 2 cm.*

*Grave 6-0098*

*Ind. 7.* This 30–38 year old woman received two blows to the right upper portion of the cranial vault (Fig. 3.9). The first wound is located on the right parietal, halfway along the sagittal suture and 1.5 cm lateral from it. The outer dimensions of this penetrating and comminuted cranial fracture measure about 6.0 x 1.8 cm. Radiating fractures follow the contours of the vault. The interior of the wound area is made up of four larger bone fragments which have been fractured in a cross-like pattern. The intersection point of the fracture lines has been depressed into the cranium for approx. 1.5 cm and all fragments are tilted towards this central spot. The edges of the bones display internal bevelling, indicating a penetrating force from the outside to the inside of the skull.



*Fig. 3.9. Skull of female Ind. 7 with two cases of perimortem penetrating blunt force trauma to the right parietal bone. Arrows indicate penetrating fracture margins.*

The second wound is located anterior to the first, the coronal suture forming the anterior border of this large defect which measures approximately 6.0 x 2.0 cm. Again, a number of small bone fragments are tilted towards a central spot in the interior of the wound, the deepest point of fragment intrusion into the cranial vault being 2.0 cm. Internal bevelling is evident along the visible rims of the fracture. One fracture line of this wound terminates in the defect described above, indicating that the anterior fracture occurred later than the posterior one (Puppe, 1914; Lovell, 1997). No signs of healing or remodelling are evident, indicating that both blows were delivered perimortem.

*Grave 6-0093*

*Ind. 11.* This 25-40 year old man is the most robust individual of this series, but due to adverse conditions during excavation and preparation of the block also the least well preserved of the adults. Nevertheless, several injuries could be detected. Like the other male (*Ind. 3*) this man has a healed fracture of the left radius. The styloid process has been proximally displaced for up to 0.5 cm and has healed in this position. Osteoarthrosis developed as a direct result of this trauma and the accompanying alteration of the original joint morphology. It affected most of the radial articular surface, which appears extensively remodelled (Fig. 3.10). The displaced fragment of the original articular surface remains largely unchanged. The distal articular surface of the left ulna appears remodelled as well. Further traumatically induced changes affect the scaphoid, which suffered a transverse fracture of the proximal half. The two (or possibly

more) resulting fragments did not fuse during the healing period (Fig. 3.11) and the smaller fragment(s) could not be located during the osteological analysis. The fracture surface of the remaining scaphoid body has been completely remodelled.



*Fig. 3.10. Remodeled joint surface of the left distal radius of Ind. 11 with evidence of trauma-induced osteoarthritis. Scale bar length is 3 cm.*

Injuries received perimortem are found on the right forearm and hand. Both, radius and ulna suffered oblique and comminuted fractures. The separated distal part of the limb, including the hand, has been displaced proximally and medially. Also fractured are the metacarpals of the second (medial), third (medial), and fourth (distal) digit (Fig. 3.12). All fractures are oblique. There is no sign that the observed displacement of elements resulted from postmortem processes or soil movements.



*Fig. 3.11. Unchanged scaphoid bone of Ind. 3 (left) compared to the altered scaphoid of Ind. 11 (right). Part of the bone is missing due to an old fracture. Scale bar length is 3 cm.*



*Fig. 3.12. Right hand and distal forearm of Ind. 11 with displacement of the distal fragments of ulna and radius as well as fractures to some metacarpals. Probable perimortem fractures of the smaller bones are indicated by \*. Note also clearly postmortem damage to bones on the top left. Scale bar length is 3 cm.*

## **Discussion**

Analysis of cranial and postcranial skeletal trauma remains a major focus in palaeopathological research and the most direct evidence for interpersonal violence in the archaeological record. Fractures often result in gross anatomical changes and are therefore rather easily identified (Jurmain, 2001; Lovell, 2008). Trauma is also very well suited to and used as one aspect of bioarchaeological reconstructions of past populations, as it can give insights into the risks of everyday life and episodes of violent behavior in human history. This is especially true when a larger number of people apparently died at the same time and of similar causes (e.g. Wahl and König, 1987; Willey, 1990; Meyer, 2003; Bennike, 2008). This appears to be the case at Eulau.

The burials form true multiple graves, without evidence of postburial disturbance or later re-use of a grave. It could be demonstrated that five out of the 13 skeletons analysed show clear signs of perimortem violent injury, among them most of the adults and one male child. There is at least one individual with perimortem injuries from each of the multiple graves, in the best preserved burial 6-0099 (Fig. 3.1a) there are two. The condition of the more than 4000 year old skeletal remains and the fact that they had to remain largely in situ during the analysis mean that more injuries may be present than could be identified during this study. Although the documentation of skeletal trauma might therefore not be complete, further evidence of trauma would only strengthen the interpretation given here, namely that all of the individuals buried in the multiple graves at Eulau died as a result of a single, violent episode during the Late Neolithic. Further, it is well known that not every violent

encounter or even every killing results in observable lesions on the skeleton (Schutkowski et al., 1996; Rogers, 2004; Smith et al., 2007). In many cases there is no skeletal involvement, leading to the conclusion that the wounds which actually can be observed are only the “tip of the iceberg” (Walker, 2001, p. 584). This is well illustrated by the Neolithic mass grave from Talheim in southwestern Germany, which contained the skeletal remains of 34 individuals. Perimortem injuries of the skull have been found in 59% of this population, as well as some postcranial fractures and arrow wounds. The widely accepted biocultural interpretation of this mass grave is that the almost complete population of a Neolithic hamlet has been killed in a violent attack (Wahl and König, 1987). In this instance, the people without any observable skeletal trauma are believed to have met a violent end as well, as they apparently died at the same time as the persons with clear perimortem injuries. Another illustrative study found that only about a third of historically documented arrow injuries to the human body actually hit bone (Milner, 2005). Therefore the number of lethal injuries in the archaeological record is certainly much higher than can be recognized from osteological analyses alone, especially in the case of arrow injuries. Although massive cranial trauma certainly has a high chance to damage bone and is thus recognized more easily in archaeological human remains, bad preservation of the bones may mask or destroy these signs, which also leads to an underestimation of violence in prehistory.

### ***Antemortem Injuries***

When interpreting trauma in the skeletal record, the distinction between wounds received antemortem, perimortem, or postmortem is of the highest importance, as this forms the basis for reconstruction of events (Bennike, 2008). When looking at the Eulau bones, the injuries observed on the left humerus, radius, and phalanges of Ind. 3 (Figs. 3.3–3.5) and on the left radius and scaphoid of Ind. 11 (Figs. 3.10 and 3.11) clearly occurred antemortem. All are well-healed, indicating that they were received at least some years prior to death. It is important to note that only the two male individuals have healed traumatic injuries and that these injuries are, in fact, very similar. In both cases the left arm was affected with involvement of the distal radius and the hand. In the palaeopathological literature fractures to the distal radius and scaphoid are most often interpreted as a result of falls or other accidents, as is the case in the modern clinical literature (e.g. Grauer and Roberts, 1996; Smith, 1996; Walker, 2001; Lovell, 2008). Although violence cannot be ruled out (Kunter, 1974), the classic mid-shaft parry fractures of the forearm, where the ulna is most commonly affected, are usually seen as better indicators of interpersonal violence (Smith, 1996; Lovell, 1997; Judd, 2008). The parry fracture, as an example of an osteologically visible defense wound, can be explained by raising the arm to deflect an incoming blow during hand-to-hand combat. Fractures of the distal radius are usually explained by a fall on the out-stretched hand. Although such a fall may well have been an accident, it may have also been the result of a violent attack. Chances of stumbling or falling are surely higher while fleeing in panic or trying to defend oneself from an armed attacker. Similar

thoughts have recently been voiced by Judd (2008), who aptly called this an interpretational predicament. While trying to deflect blows delivered with Late Neolithic close combat weaponry, injuries such as classic parry fractures of the forearm as well as fractures to other parts of the arms may certainly occur. The crushing force of stone axes and adzes may well lead to fractures and injuries at the actual point of impact, which is not necessarily at mid-shaft of the ulna.

Another point rarely taken into account when interpreting Neolithic fighting or combat is the possible use of shields or other defensive weapons. Shields attached to the forearm or just held in hand may certainly alter the pattern of fractures seen in skeletal remains; however, battle victims are usually removed from the original context and it is usually impossible to say if a person actually used a shield or similar means of defence. Although there seem to be no archaeological finds of Neolithic shields in Central Europe, these appear in highly developed forms in the following Bronze Age. These finds are made of metal, but there is consensus that many more were made of organic materials like wood or leather, which simply did not survive in the ground. The sudden appearance of fully developed metal shields does strongly suggest a tradition of shield use which may well stretch back into the Late Neolithic (Uckelmann, 2004/2005). Unfortunately, as there is a lack of evidence for the effects of prehistoric shields on the distribution of blunt force trauma, any thoughts on this matter have to remain speculative. Although the radius fractures in the male skeletons from Eulau may of course be the results of everyday accidents or falls, there actually is no easy distinction between postcranial fractures due to interpersonal violence or accidents, as forced and unintended movements resulting in bone trauma may be part of hand-to-hand combat. This is especially

relevant when securely violence-related injuries, such as cranial trauma or projectile injuries, occur along with fractures usually interpreted as accidental. The presence of both helps to support the interpretation of a given injury as non-accidental.

The bioarchaeological interpretation of such injuries has to make use of all available information to arrive at the most plausible explanation. In the case of the Eulau skeletons there is also a healed fracture of a scaphoid bone and an impacted fracture of two manual phalanges. The scaphoid fracture can be explained as a result of the same impact that resulted in the distal radius fracture of Ind. 11, as this bone directly articulates with the radius. The healed trauma to the phalanges of the hand of Ind. 3 may also be related to the same event that caused the other antemortem lesions. Fractures of the hand may be defensive wounds (Milner et al., 1991; Lovell, 1997; Rogers, 2004), or occur while attacking with the unprotected hand (Brink et al., 1998). It is therefore possible that the hand fractures occurred in a combat situation, raising the possibility that the other fractures are non-accidental as well.

In conclusion, one cannot be sure about the events that led to the antemortem lesions observed in the two male individuals. Occupational hazards primarily affecting the male part of the population may be one explanation (Lovell, 2008), injuries received during hand-to-hand fighting may be another. What can be stated is that although they survived these accidental or violent events, both men are likely to have suffered some functional impairment resulting from their injuries as indicated by the presence of ankylosis and osteoarthritis, respectively.

### ***Perimortem Injuries***

Projectile points embedded in bone are universally seen as the best and most direct type of evidence of interpersonal violence in ancient times (Lambert, 1997; Lovell, 1997; Walker, 2001; Milner, 2005; Smith et al., 2007). Neolithic arrowheads were either made of flint (or related material) or bone, the former being by far the most common material in Central and Northern Europe. Cases of embedded projectile points in prehistoric skeletal remains from Europe are relatively rare but constant findings, and are known from a wide range of different archaeological cultures (e.g. Wells, 1964; Wahl and König, 1987; Roksandic et al., 2006). Recently, a comprehensive list of known arrow injuries from European sites has been included in a book by Guilaine and Zammit (2005).

Although prehistoric projectile wounds sometimes also affected the cranium, depressed or comminuted fractures due to blunt force trauma are more common cranial injuries (Wahl and König, 1987; Walker, 1989; Lambert, 1997). When blows were meant to kill, the head was and often is selected as the primary target. Numerous cranial injuries with lethal outcome from different sites and times clearly indicate this pattern (e.g. Wahl and König, 1987; Weber and Czarnetzki, 2001; Ta'ala et al., 2006). The presence of projectile wounds and extensive cranial trauma in a group of skeletons therefore is a good indicator of larger scale violent events most certainly involving more than one attacker (Walker, 2001). In the case of the Eulau multiple burials, both types of injury are represented.

The arrowhead lodged in the L4 vertebral body of Ind. 5 can be seen as the best evidence for violent death among the Eulau individuals (Fig. 3.8). To arrive at its present location, the projectile had to probably penetrate clothing as well as the skin, abdominal wall, small intestines, and most probably at least one of the large blood vessels (abdominal aorta, vena cava) running in front of the vertebral column. The heavy blood loss due to this injury would have been almost instantly fatal, and no signs of bony remodelling could be found. A virtually identical case affecting a lumbar vertebra has been presented by Wells (1964). As the trunk of the human body presents the largest target area for projectile weapons, thorax and abdomen are in fact the most frequent sites for arrow injuries (Wells, 1964; Lambert, 1997; Smith et al., 2007). As has been mentioned above, not all arrows hit bone. This leads to the inevitable conclusion that the number of embedded arrowheads in the abdominal area known from archaeological skeletons truly are only a very small proportion of all the wounds received. Referring again to the analysis of documented historic arrow injuries, only about 2% of arrows hitting the abdominal area embed themselves in bone (Milner, 2005).

The unambiguously fatal arrow wound of the woman from grave 6-0090 is important when considering the other Eulau skeletons. The closely associated remains of the subadult Ind. 6 (Fig. 3.1b) show no signs of violent injury, but the bones are badly deteriorated and the skull could not be removed for detailed analysis. What can be said, though, is that both individuals in this grave died about the same time and were buried simultaneously in a true double inhumation, raising the possibility of a violent death for Ind. 6. Regarding the arrowheads themselves which are associated with the female Ind. 5, both are of

a typical Corded Ware design and therefore are not unusual for this time or region.

Cranial vault injuries which clearly occurred perimortem and most likely had a lethal outcome could be identified in two skeletons from two of the graves. The parietal bone as a classic site for penetrating blunt or sharp force trauma (Bach, 1963; Willey, 1990; Weber and Czarnetzki, 2001; Paine et al., 2007) is affected in Ind. 7. Two separate blows were inflicted on this woman (Fig. 3.9). The similar size of both defects suggests the same or an almost identical weapon was used in both cases. Damage to the brain and associated soft tissues apparently resulted in death, as again, no signs of healing are evident. As both wounds are located on the right parietal, the interpretation of this injury, as commonly done in palaeopathology, would include a probable right-handed attacker and therefore a situation where the victim turned her back to the assailant. A constellation like this is usually reconstructed as an unsuccessful attempt to flee from an attack (e.g. Wahl and König, 1987; Walker, 1989). Similarly to grave 6-0090 the adult female in grave 6-0098 is also associated with a subadult. Again, the skeletal remains of this child are too badly preserved to allow any interpretation of possible trauma, but the close proximity of woman and child is highly indicative of simultaneous burial and hence simultaneous death, possibly by similar causes. The remaining two subadult skeletons in grave 6-0098 bear no clear signs of perimortem trauma. They have been placed to the northwest of the female Ind. 7, who has her back to them. The DNA analyses carried out by Haak et al. (2008) revealed that the two children are most likely siblings but are actually not maternally related to the

woman. Nevertheless, all four individuals have been buried simultaneously, again indicating death within a short period of time.

Another perimortem cranial vault wound is found on the occipital of Ind. 4 (Fig. 3.7). This location may be interpreted as a wound received while fleeing, but could also be the result of an execution. As this boy of 8–9 years reached an estimated body height of about 109 cm while alive, and the attackers were most likely adult individuals, it would be expected that a wound inflicted during a combat situation would have hit the upper parts of the cranial vault, most likely the parietal bones. As this is not the case, the attacker probably either delivered an underhand-blow or the victim was hit with the head held or hanging down or the individual was actually lying on the ground, maybe protecting the face. Since we do not know the relative positions of attacker and victim when the blow hit the child's skull, this interpretation has to remain speculative. That fractures of the occipital bone can actually form evidence for an execution with simple weaponry has recently been shown by Ta'ala et al. (2006). All recognized perimortem cranial wounds are compatible with typical Corded Ware stone axes, three of which have been found as grave goods associated with the three oldest male individuals (Fig. 3.13).

The two adults and the remaining boy from grave 6-0099 show no clear evidence of perimortem cranial trauma; however, this does not necessarily indicate that none was present. Because the skull bones could not be removed for examination, it was not possible to exclude violence as a reason for the observed fragmentation of the skulls. In the case of the adult individuals violent injuries of the cranial vault or face are certainly possible.



*Fig. 3.13. Corded Ware stone axes found with three of the male individuals (Inds. 3, 9 and 11).*

While most cranial vault injuries in prehistory were probably sustained during violent assaults and projectile points embedded in bone are diagnostic of traumatic events with implied lethal intent (Lambert, 1997; Lovell, 1997), perimortem fractures of the forearm and hands are often indicative of attempted defense from hand-to-hand attacks (Wahl and König, 1987; Milner et al., 1991; Rogers, 2004). One example of a well-known defensive wound is the parry-fracture, which has been discussed above. Trauma to the metacarpals and phalanges of the hand can also be taken as good evidence for fights involving bare hands or predominantly blunt force weaponry (Brink et al., 1998). The observed perimortem fractures of the hands of both male skeletons (Inds. 3 and 11), involving both metacarpals and phalanges (Fig. 3.6) are in accordance with defense wounds described in the cited literature. Alternative explanations for these fractures, like post-burial disturbance or soil pressure, can be excluded.

There is no evidence for any disturbance of the graves and most of the numerous postmortem bone breaks can easily be distinguished from the perimortem ones on the basis of their morphology, colour and location. The fractures of the right ulna and radius in Ind. 11 with clear displacement of the distal part of the forearm including the hand are another instance of perimortem trauma (Fig. 3.12). As discussed above, an injury like this might result from a fall, but in the light of all other perimortem trauma noted on these skeletons, it is also likely that the forearm fracture was the result of interpersonal violence. It possibly represents a defense wound as well.

The presence of perimortem violent injuries as well as perimortem defense wounds in this skeletal series is a very strong indicator of a violent event which most probably led to the demise of all the people buried in the multiple graves at Eulau. The presence of old and healed fractures, which are quite similar to some of the perimortem lesions and possibly combat-related further supports a violence-related interpretation, as hostile encounters appear to have been a relatively regular occurrence in the Central European Neolithic (e.g. Wahl and König, 1987; Christensen, 2004).

### **Reconstruction of the Most Probable Scenario**

It has been shown that the context in which the deaths of the Eulau people occurred clearly was a violent one. Still, a number of different scenarios can be imagined that may have resulted in the death of 13 people of different ages and of both sexes. Here, we try to reconstruct the cultural context of the observed

injuries by comparison with other, similar sites from the European Neolithic and elsewhere. The scenario which fits best with all the known osteological and archaeological facts is deemed to be the most probable one (Walker, 2001).

The people under study here were related to one another by social ties, which can be reasonably deduced from the fact that they were buried closely grouped according to Corded Ware customs (Fig. 3.1). Biological kinship has been proven for several individuals by Haak et al. (2008), including a nuclear family (Inds. 1–4). Combined with the archaeological and isotopic evidence there is almost no doubt that these biologically related people lived and died at the same time in the cultural context of the Corded Ware of the third millennium BC. This points logically to a local settlement group, connected by biological and social kinship. The presence of women and children also supports the view that the individuals formed part of a residence group. Based on the strontium isotope evidence, this group most probably was organized patrilocally, as the children and male individuals grew up locally, while the women originally came from somewhere else (Haak et al., 2008).

Some of the observed fractures could be interpreted as defense wounds and were not necessarily deadly by themselves, whereas other injuries consisted of lethal perimortem cranial and postcranial wounds. The combination of both is a strong indicator of homicide (Lovell, 1997; Rogers, 2004). This pattern most probably rules out any interpretation of ritual killings or practises like ritual suicide. Although there have been some theoretical thoughts on this matter regarding multiple burials (Hein, 1987; Dresely, 2004) there is no conclusive evidence for any of the two in the Corded Ware archaeological record. If ritualised killing had been practised as a cultural phenomenon, for example as a

consequence of the death of an important individual, defense wounds would be rather unexpected. Ritual suicide is also highly unlikely, as this is incompatible with the injury patterns of the skeletons and their demographic profile.

The most probable scenario which fits the demography, injury patterns and subsequent burial rites is a raid, carried out by a group of attackers on a small resident community. One characteristic evidence of a raid is a high proportion of subadult and female victims (Christensen, 2004; Guilaine and Zammit, 2005), which is definitely the case at Eulau with 85% of individuals in this category, accepting that all were killed in a single event, as argued here. As shown above, both males had suffered previous wounds which resulted in physical impairment in the form of osteoarthritis of the wrist and interphalangeal ankylosis of the hand (Figs. 3.5 and 3.10). The three adult women were each closely associated with at least one child, which in fact is also true for both men. The proven genetic relationships between some of the individuals, especially in grave 6-0099, suggest that even more individuals in this series are most probably direct kin. Therefore it is likely that all three women were indeed the mothers of the children that were most closely associated with them in the burial record. Positive evidence is available for one pair (Inds. 1 and 2), the children from the other two pairs did not allow a DNA analysis because of their bad preservation (Haak et al., 2008). Maternal responsibilities of the women might have presented a limiting feature in terms of survival of a raid. Thus, all of the adult individuals represented in the multiple graves were most probably either burdened by old injuries or child care and would have been rather easy prey for the unknown attackers (Milner et al., 1991). The absence of adolescents

and healthy men may also be interpreted in this manner, as these would have had the best chances to either flee or fight back and therefore not to die.

The one site from Central Europe with the best parallels to the Eulau skeletons is the Early Neolithic mass grave from Talheim, Germany (Wahl and König, 1987). At Talheim, several dozen people were murdered in a raid that most probably annihilated a whole village. Due to broadly comparable weaponry used, the injuries of the Talheim skeletons also consist of penetrating cranial trauma and arrow wounds, much like those observed in the Eulau skeletons. The 14th century Crow Creek massacre site from South Dakota also has many parallels to the Talheim mass grave, although it resulted in the deaths of several hundred individuals (Willey, 1990). Many crania from Crow Creek showed perimortem traumatic injuries, and men, women, and children were among the victims, which is not surprising when a settlement is overrun (Schulting and Wycsocki, 2005). The physical remains of the people were buried in a common mass grave. While the Crow Creek victims had at least been partially disarticulated upon burial, the Talheim victims were interred as complete and probably fresh bodies. If indeed the whole village population had been killed at Talheim, the question of who actually buried the dead still remains. While the exact answer will probably never be known, it is possible that the attackers or some unrelated inhabitants of neighbouring settlements threw the bodies into the grave pit. The bizarre and haphazard body positions at Talheim have nothing in common with the usual burial customs of that time, indicating lack of care and religious rites. The same is evident for the victims of the Crow Creek raid, as the remains have been thrown into a defensive ditch which had not been intended as a grave site when constructed (Willey, 1990). Another site from the

European Neolithic which has to be mentioned in this context is Asparn/Schletz, which is contemporaneous to Talheim and rather similar to the Crow Creek site (Teschler-Nicola et al., 1996). At Asparn, the partly disarticulated skeletons of at least several dozen victims of a violent attack have been found at the bottom of a defensive ditch. Many show evidence of multiple cranial trauma, including females and children, as well as carnivore gnawing marks. This has been interpreted as evidence that the bodies were lying exposed for some time before the then partly scattered remains were dumped into the ditch. Again, similar to Crow Creek, this ditch was not intended for burial upon its construction (Teschler-Nicola et al., 1999).

Other archaeological sites with human remains which have been interpreted as those of raid victims show a similar pattern of lacking care for the dead (e.g. Owsley and Bass, 1979; Melbye and Fairgrieve, 1994). The care expended for the burial of the dead is the most obvious difference between the Eulau graves and the other sites mentioned. At Eulau, regular graves were dug and the bodies arranged with care and equipped with few, but common Corded Ware grave goods (Figs. 3.1 and 3.13). This indicates that somebody who cared for the dead remained behind. It is therefore highly probable that only part of the original settlement group had been killed in the attack. The survivors apparently had detailed knowledge of the familial relationships between the victims and enough time and motivation for the construction of the multiple graves, which were partly equipped with burial mounds and encircling ditches.

That all people died in a single attack, rather than during repeated violent encounters, cannot be proven without doubt but is in fact the more likely interpretation. The multiple graves were found as closely neighbouring features

and not spread out randomly among the other typically scattered graves of the Corded Ware burial site. In a prehistoric North American cemetery with a high number of violent injuries the latter distribution of burials has been found and interpreted in such a way that people were killed in ambushes on a rather regular basis and not in a single event (Milner et al., 1991).

Putting the anthropological, archaeological and biomolecular information together, the following scenario emerges as the most probable: the healthy and physically fit members of a group of Corded Ware individuals left their settlement for unknown reasons. At least two men with previous, healed injuries as well as three women and at least eight children between 0.5 and 9 years of age remained behind. They became victims of a murderous raid, which was carried out by unknown attackers who seized the chance to assault the now largely unprotected settlement. The assailants used common Late Neolithic weaponry for dispatching their victims (Figs. 3.8 and 3.13). After the attackers left, the rest of the residence group returned to find members of their group murdered. With evident care for the deceased they constructed at least four multiple graves and buried the dead according to their biological and social relationships.

### **Implications for Corded Ware Society and Burial Customs**

The detailed analysis of human remains can give important insights into past events (Jurmain, 2001). While the cause of death remains unknown for most prehistoric humans, including many multiple graves, it was possible to

reconstruct a violent end for the people under study here. Lethal interpersonal violence was part of Corded Ware life and in this case the underlying cause for the construction of the four graves. As true multiple burials are known from a large number of Corded Ware sites (e.g. Buchvaldek, 1967; Wahl et al., 1990; Dresely, 2004), this raises the question if lethal violence and multiple graves are correlated in this culture. A complete survey is beyond the scope of this paper as many of the hundreds of Corded Ware skeletal remains have not been studied in detail (Bruchhaus and Neubert, 1999). There is some evidence for violence in Corded Ware or culturally related graves (e.g. Wahl et al., 1990; Schutkowski et al., 1996; Dresely, 2004), but to date no comprehensive palaeoepidemiological survey for Neolithic skeletal remains has been carried out. Only through such a survey would it be possible to meaningfully compare trauma frequencies (Walker, 2001; Schulting and Wysocki, 2005). Due to the lack of reliable data, we therefore cannot assess if the period of the Late Neolithic was more violent than other times, although our own review of the literature suggests that this might have indeed been the case. What points in this direction is the very high number of known Corded Ware trepanations. In many cases these might have been carried out as a therapeutic measure after cranial trauma occurred (Piek et al., 1999; Smith et al., 2007), and several Corded Ware skeletons with both trepanations and evidence of cranial trauma have been published (e.g. Bach, 1963; Grimm and Asamoia, 1964). While interpersonal violence surely was not the only reason for burying several people in the same grave at the same time (Meyer et al., 2004), increasing violence may well have led to the apparently increasing number of multiple burials in the Corded Ware of Central Europe. The knowledge about biological kinship, which has been proven for at least four

of the individuals (in grave 6-0099) opens a new window into the Late Neolithic, as we now have for the first time definite evidence for the presence of nuclear families in the Corded Ware. This corresponds to the known settlement structures of this culture (Hecht, 2007). Until now, it was only possible to speculate about the significance of multiple graves and who was included in them. With the Eulau graves, we now cannot only glimpse the genetic relationships within a part of the larger population but also one of the possible reasons for the construction of true multiple graves. Both of the questions raised earlier could be answered to a large extent: (1) Why did the individuals buried together die at roughly the same time? They fell victim to a violent raid and were killed by bow, arrow, and axe. (2) Are they biologically related? Yes, in the case of the most intricate burial 6-0099 the two children are the offspring of the adult individuals. In another grave, two children are probable siblings (Haak et al., 2008).

In the case of the Eulau people the analysis and interpretation of all available bioarchaeological data allowed us insight into a short and violent episode of human history. Although certainly the result of a tragic event, the surviving skeletal remains of these 13 individuals reveal important aspects of past human interactions, treatment of the dead, and underlying biological relationships (Walker, 2001). In conclusion, it becomes increasingly evident that studies which combine multiple avenues of research within a bioarchaeological framework emerge as the method of choice for the analysis and interpretation of complex burial situations. Although each scientific study concerned with one type of evidence undoubtedly has its own merits, the ultimate aim of bioarchaeological reconstruction can only be achieved in the highest possible

resolution when results from all relevant subdisciplines are combined (Bentley et al., 2008; Meyer et al., 2008; Haak et al., 2008).

Apart from the important new insights into the mortuary practises of the Corded Ware, the signs of interpersonal violence encountered in these skeletons add to the growing evidence for prehistoric warfare in Europe. Although the available data at present still does not allow a thorough and valid scientific treatment of this topic, the detailed documentation and interpretation of antemortem and perimortem violence in human skeletal remains appears to be the best and most direct way to approach this matter.

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## References

Bach, H., 1962/1963. Ein schnurkeramisches Skelett mit zweifacher Schädeltrepanation aus Wechmar, Kr. Gotha. *Alt-Thüringen* 6, 202–211.

Bach, H., 1963. Die menschlichen Skelettreste. *Prähistorische Zeitschrift* 41, 134–149.

Bennike, P., 2008. Trauma. In: Pinhasi, R., Mays, S. (Eds.), *Advances in Human Palaeopathology*. Wiley, Chichester, pp. 309–328.

Bentley, R.A., Wahl, J., Price, T.D., Atkinson, T.C., 2008. Isotopic signatures and hereditary traits: snapshot of a Neolithic community in Germany. *Antiquity* 82, 290–304.

Brink, O., Vesterby, A., Jensen, J., 1998. Pattern of injuries due to interpersonal violence. *Injury* 29, 705–709.

Bruchhaus, H., Neubert, A., 1999. Zur Rekonstruktion endneolithischer und frühbronzezeitlicher Bevölkerungen im Mittelelbe-Saale-Gebiet – Ergebnisse einer ersten Bestandsaufnahme. *Berichte der Römisch-Germanischen Kommission* 80, 122–161.

Buchvaldek, M., 1967. *Die Schnurkeramik in Böhmen*. Universita Karlova, Prag.

Bulla, A., 1998. Untersuchungen zur Frage der geschlechtsspezifischen Beigabenausstattung bandkeramischer Gräber Mitteleuropas unter besonderer Berücksichtigung der Inventare anthropologisch bestimmter Frauenbestattungen. Shaker, Aachen.

Christensen, J., 2004. Warfare in the European Neolithic. *Acta Archaeologica* 75, 129–156.

Dittmar, K., Teegen, W.R., 2003. The presence of *Fasciola hepatica* (liver-fluke) in humans and cattle from a 4,500 year old archaeological site in the Saale-Unstrut Valley, Germany. *Memorias do Instituto Oswaldo Cruz* 98 (S1), 141–143.

Dresely, V., 2004. Schnurkeramik und Schnurkeramiker im Taubertal. Theiss, Stuttgart.

Feustel, R., Bach, H., Gall, W., Teichert, M., 1966. Beiträge zur Kultur und Anthropologie der mitteldeutschen Schnurkeramiker. *Alt-Thüringen* 8, 20–170.

Grauer, A.L., Roberts, C.A., 1996. Paleoepidemiology, healing, and possible treatment of trauma in the Medieval cemetery population of St. Helen-on-the-Walls, York, England. *American Journal of Physical Anthropology* 100, 531–544.

Grimm, H., Asamoa, A., 1964. Neue schnurkeramische Skelettreste von Schafstädt, Kreis Merseburg. *Jahresschrift für mitteldeutsche Vorgeschichte* 48, 107–115.

Guilaine, J., Zammit, J., 2005. *Origins of War. Violence in Prehistory*. Blackwell, Oxford.

Haak, W., Brandt, G., de Jong, H.N., Meyer, C., Ganslmeier, R., Heyd, V., Hawkesworth, C., Pike, A.W.G., Meller, H., Alt, K.W., 2008. Ancient DNA, strontium isotopes, and osteological analyses shed light on social and kinship organization of the Later Stone Age. *Proceedings of the National Academy of Sciences of the United States of America* 105, 18226–18231.

Heberer, G., 1938. *Die mitteldeutschen Schnurkeramiker*. Gebauer-Schwetschke, Halle.

Hecht, D., 2007. *Das schnurkeramische Siedlungswesen im südlichen Mitteleuropa. Eine Studie zu einer vernachlässigten Fundgattung im Übergang vom Neolithikum zur Bronzezeit*. Dissertation. <<http://www.ub.uni-heidelberg.de/archiv/7313>>.

Hein, M., 1987. *Untersuchungen zur Kultur der Schnurkeramik in Mitteldeutschland*. Habelt, Bonn.

Judd, M.A., 2008. The parry problem. *Journal of Archaeological Science* 35, 1658–1666.

Jurmain, R., 2001. Paleoepidemiological patterns of trauma in a prehistoric population from Central California. *American Journal of Physical Anthropology* 115, 13–23.

Kunter, M., 1974. Über das Vorkommen von Knochenbrüchen im Bereich des Unterarmes bei Skelettfunden. *Homo* 25, 78–96.

Lambach, F., 1993. La necropole rubanee d'Ensisheim "Les Octrois". Description des tombes et anthropologie de terrain. *Cahiers de l'association pour la promotion de la recherche archeologique en Alsace* 9, 17–48.

Lambert, P.M., 1997. Patterns of violence in prehistoric hunter-gatherer societies of Coastal Southern California. In: Martin, D.L., Frayer, D.W. (Eds.), *Troubled Times. Violence and Warfare in the Past*. Gordon and Breach, Amsterdam, pp. 77–109.

Lovell, N., 1997. Trauma analysis in paleopathology. *Yearbook of Physical Anthropology* 40, 139–170.

Lovell, N.C., 2008. Analysis and interpretation of skeletal trauma. In: Katzenberg, M.A., Saunders, S.R. (Eds.), *Biological Anthropology of the Human Skeleton*, second ed. Wiley, Hoboken, pp. 341–386.

Mann, R.W., Hunt, D.R., 2005. Photographic Regional Atlas of Bone Disease. Charles C. Thomas, Springfield.

Melbye, J., Fairgrieve, S.I., 1994. A massacre and possible cannibalism in the Canadian Arctic: new evidence from the Saunaktuk Site (NgTn-1). *Arctic Anthropology* 31, 57–77.

Menninger, M., 2008. Die schnurkeramischen Bestattungen von Lauda-Königshofen. Steinzeitliche Hirtennomaden im Taubertal? Dissertation. <<http://tobiaslib.ub.uni-tuebingen.de/volltexte/2008/3390/>>.

Meyer, C., 2003. Osteological evidence for the Battles of Zürich, 1799: a glimpse into soldiery of the past. *International Journal of Osteoarchaeology* 13, 252–257.

Meyer, C., Kürbis, O., Alt, K.W., 2004. Das Massengrab von Wiederstedt, Ldkr. Mansfelder Land. Auswertung und Gedanken zur Deutung im Kontext der Linienbandkeramik. *Jahresschrift für mitteldeutsche Vorgeschichte* 88, 31–66.

Meyer, C., Kranzbühler, J., Drings, S., Bramanti, B., Nehlich, O., Richards, M.P., Alt, K.W., 2008. Die menschlichen Skelettfunde aus der neolithischen Totenhütte von Benzingerode. Anthropologische Untersuchungen an den Bestattungen eines Kollektivgrabs der Bernburger Kultur. *Archäologie in Sachsen-Anhalt Sonderband* 7, 107–151.

Milner, G.R., 2005. Nineteenth-century arrow wounds and perceptions of prehistoric warfare. *American Antiquity* 70, 144–156.

Milner, G.R., Anderson, E., Smith, V.G., 1991. Warfare in late prehistoric West-Central Illinois. *American Antiquity* 56, 581–603.

Nieszery, N., 1995. Linearbandkeramische Gräberfelder in Bayern. Marie L. Leidorf, Espelkamp.

Owsley, D.W., Bass, W.M., 1979. A demographic analysis of skeletons from the Larson Site (39WW2) Walworth County, South Dakota: vital statistics. *American Journal of Physical Anthropology* 51, 145–154.

Paine, R.R., Mancinelli, D., Ruggieri, M., Coppa, A., 2007. Cranial trauma in iron age samnite agriculturists, Alfedena, Italy: implications for biocultural and economic stress. *American Journal of Physical Anthropology* 132, 48–58.

Piek, J., Lidke, G., Terberger, T., von Smekal, U., Gaab, M.R., 1999. Stone age skull surgery in Mecklenburg–Vorpommern: a systematic study. *Neurosurgery* 45, 147–151.

Puppe, G., 1914. Über Priorität der Schädelbrüche. *Ärztliche Sachverständigen Zeitung* 20, 307–309.

Rogers, J., 2004. Recognizing inter-personal violence: a forensic perspective. In: Roksandic, M. (Ed.), *Violent Interactions in the Mesolithic*, BAR International Series, vol. 1237. Archaeo Press, Oxford, pp. 9–21.

Roksandic, M., Djurić, M., Rakočević, Z., Seguin, K., 2006. Interpersonal violence at Lepenski Vir Mesolithic/Neolithic complex of the iron gates Gorge (Serbia-Romania). *American Journal of Physical Anthropology* 129, 339–348.

Ryan, T.M., Milner, G.R., 2006. Osteological applications of high-resolution computed tomography: a prehistoric arrow injury. *Journal of Archaeological Science* 33, 871–879.

Schulting, R.J., Wysocki, M., 2005. 'In this Chambered Tumulus were Found Cleft Skulls. . .': an assessment of the evidence for cranial trauma in the British Neolithic. *Proceedings of the Prehistoric Society* 71, 107–138.

Schutkowski, H., Schultz, M., Holzgraefe, M., 1996. Fatal wounds in a Late Neolithic double inhumation – a probable case of meningitis following trauma. *International Journal of Osteoarchaeology* 6, 179–184.

Schwidetzky, I., 1978. Anthropologie der Schnurkeramik- und Streitaxtkulturen. In: Schwabedissen, H. (Ed.), *Die Anfänge des Neolithikums vom Orient bis Nordeuropa* 8b. Part 2. Böhlau, Köln, pp. 241–264.

Smith, M.J., Brickley, M.B., Leach, S.L., 2007. Experimental evidence for lithic projectile injuries: improving identification of an under-recognised phenomenon. *Journal of Archaeological Science* 34, 540–553.

Smith, M.O., 1996. 'Parry' fractures and female-directed interpersonal violence: implications from the late archaic period of West Tennessee. *International Journal of Osteoarchaeology* 6, 84–91.

Spatz, H., 1999. Das mittelneolithische Gräberfeld von Trebur, Kreis Groß-Gerau. Landesamt für Denkmalpflege, Wiesbaden.

Ta'ala, S.C., Berg, G.E., Haden, K., 2006. Blunt force cranial trauma in the Cambodian killing fields. *Journal of Forensic Sciences* 51, 996–1001.

Teschler-Nicola, M., Gerold, F., Kanz, F., Lindenbauer, K., Spannagl, M., 1996. Anthropologische Spurensicherung. Die traumatischen und postmortalen Veränderungen an den linearbandkeramischen Skelettresten von Asparn/Schletz. *Archäologie Österreichs* 7 (1), 4–12.

Teschler-Nicola, M., Gerold, F., Bujatti-Narbeshuber, M., Prohaska, T., Latkoczy, C., Stinger, G., Watkins, M., 1999. Evidence of Genocide 7000 BP – Neolithic paradigm and geo-climatic reality. *Collegium Antropologicum* 23, 437–450.

Uckelmann, M., 2004/2005. Schutz, Prunk und Kult – Zur Funktion bronzezeitlicher Schilde. *Anodos* 4–5, 243–249.

Wahl, J., König, H.G., 1987. Anthropologisch–Traumatologische Untersuchung der menschlichen Skelettreste aus dem bandkeramischen Massengrab bei Talheim, Kreis Heilbronn. *Fundberichte aus Baden-Württemberg* 12, 65–186.

Wahl, J., Dehn, R., Kokabi, M., 1990. Eine Doppelbestattung der Schnurkeramik aus Stetten an der Donau, Lkr. Tuttlingen. *Fundberichte aus Baden-Württemberg* 15, 175–211.

Walker, P.L., 1989. Cranial injuries as evidence of violence in prehistoric Southern California. *American Journal of Physical Anthropology* 80, 313–323.

Walker, P.L., 2001. A bioarchaeological perspective on the history of violence. *Annual Review of Anthropology* 30, 573–596.

Weber, J., Czarnetzki, A., 2001. Neurotraumatological aspects of head injuries resulting from sharp and blunt force in the early Medieval period of Southwestern Germany. *American Journal of Physical Anthropology* 114, 352–356.

Wells, C., 1964. *Bones, Bodies, and Disease. Evidence of Disease and Abnormality in Early Man.* Praeger, New York.

White, T.D., Folkens, P.A., 2005. *The Human Bone Manual.* Elsevier, Amsterdam.

Willey, P., 1990. Prehistoric Warfare on the Great Plains. Skeletal Analysis of the Crow Creek Massacre Victims. Garland Publishing, New York.

## CHAPTER 4

# The Massacre Mass Grave of Schöneck-Kilianstädten Reveals New Insights into Collective Violence in Early Neolithic Central Europe

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## **(Abstract)**

Conflict and warfare are central but also disputed themes in discussions about the European Neolithic. Although a few recent population studies provide broad overviews, only a very limited number of currently known key sites provide precise insights into moments of extreme and mass violence and their impact on Neolithic societies. The massacre sites of Talheim, Germany, and Asparn/Schletz, Austria, have long been the focal points around which hypotheses concerning a final lethal crisis of the first Central European farmers of the Early Neolithic Linearbandkeramik Culture (LBK) have concentrated. With the recently examined LBK mass grave site of Schöneck-Kilianstädten, Germany, we present new conclusive and indisputable evidence for another massacre, adding new data to the discussion of LBK violence patterns. At least 26 individuals were violently killed by blunt force and arrow injuries before being deposited in a commingled mass grave. Although the absence and possible abduction of younger females has been suggested for other sites previously, a new violence-related pattern was identified here: the intentional and systematic breaking of lower limbs. The abundance of the identified perimortem fractures clearly indicates torture and/or mutilation of the victims. The new evidence presented here for unequivocal lethal violence on a large scale is put into perspective for the Early Neolithic of Central Europe and, in conjunction with previous results, indicates that massacres of entire communities were not isolated occurrences but rather were frequent features of the last phases of the LBK.

## **Significance**

The Early Neolithic massacre-related mass grave of Schöneck-Kilianstädten presented here provides new data and insights for the ongoing discussions of prehistoric warfare in Central Europe. Although several characteristics gleaned from the analysis of the human skeletal remains support and strengthen previous hypotheses based on the few known massacre sites of this time, a pattern of intentional mutilation of violence victims identified here is of special significance. Adding another key site to the evidence for Early Neolithic warfare generally allows more robust and reliable reconstructions of the possible reasons for the extent and frequency of outbreaks of lethal mass violence and the general impact these events had on shaping the further development of the Central European Neolithic.

## **(Introduction)**

The Neolithic was a time of profound change in Central Europe. The appearance, spread, and subsequent development of the first farmers in this area in the Early Neolithic have attracted continuous attention (1–3). Those first agriculturists (5600–4900 cal BC) (4), whose pottery decoration style has given rise to their modern ascribed name of Linear Pottery culture (in German, Linearbandkeramik, LBK), left a very rich archaeological record including a large number of skeletal remains. In recent years the Early Neolithic also has been targeted by various bioarchaeometric analyses, including studies on

ancient DNA (5, 6) and stable isotopes (3, 7–9). One of the key results has been an apparent genetic discontinuity between Mesolithic and Neolithic populations (10), the latter spreading west into Central Europe from the southeast, bringing with them the well-known “Neolithic package” consisting mainly of domesticated crops and cattle (11). The genetic makeup of these first farmers was different not only from their predecessors in this region but also from their successors, showing complex patterns of movements and migrations over time (5, 6). Strontium isotope analyses have revealed a virilocal residence pattern practiced within the LBK, which also is evident from some later Neolithic periods (12). Furthermore, the deposition of ground stone adzes, the typical weapon-tools of the LBK, in only some male burials seems to indicate the presence of social inequality at the onset of the settled agricultural lifestyle, probably related to inherited access to the most coveted loess soils (9, 13) in which considerable labor and effort was invested over time (14).

Built mainly on several enigmatic sites with clear osteological evidence for lethal mass violence and generalized patterns of increased differentiation and fortification from many others (15, 16), the disappearance of the LBK from the Neolithic landscape often has been portrayed as a result of strife and social unrest, culminating in a far-reaching apocalyptic nightmare of violence, warfare, and cannibalism (15–18). Although such a scenario appears somewhat exaggerated, the proposed “crisis” at the end of the LBK has attracted much attention, speculation, and debate (15–23). Foremost in this discussion is the evidence from the sites of Talheim, Germany, and Asparn/Schletz, Austria, of massacres of probably entire LBK communities (19, 24–26). The dead from these mass fatality events were either left unburied or thrown into a mass

grave, lacking all indications of care or burial ritual.

To these two clear-cut conflict sites we can now add another with unequivocal osteoarchaeological evidence of indiscriminate lethal violence, torture and mutilation, and disposal of the corpses in a commingled and chaotic mass grave (Fig. 4.1). Although isolated cases of interpersonal violence are known from much older periods (27, 28), as are some pictorial representations of possible violent behavior (29), direct evidence for targeted collective violence is very rare in the preagricultural record of Central Europe. One of the most frequently discussed sites in this regard is the Ofnet Cave in Germany, which shows the deposition of selected human remains with clear evidence of perimortem injuries and cut marks in Mesolithic times (30, 31). At that site, however, only detached and ochre-covered heads with articulated vertebrae were deposited carefully along with animal teeth ornaments in a special location, indicating much more complex behavior than a massacre (32).

In the following Early Neolithic mass violence in Central Europe seems to reach unprecedented levels within the later phases of the LBK. Taken together, the reliable evidence now available indicates that mass killings of certain groups within the later LBK *oikumene* apparently were not isolated occurrences but clustered toward the end of the LBK sequence in widely separated localities (Fig. 4.S1). We therefore suggest that massacres were an inherent phenomenon of the later LBK and that the destruction of complete communities as the result of collective lethal violence was indeed a relevant factor of Neolithic life, at least in some periods.



*Fig. 4.1. Composite image of the LBK mass grave of Schöneck-Kilianstädten, Germany (area 4, feature 139). Individual images were adjusted for visualization of the complete feature.*

### **Disposal of the Dead in Early Neolithic Central Europe**

The LBK is often described as one of the best-researched archaeological complexes in Central European prehistory (1, 33). Although overall variation is quite extensive chronologically and geographically (3), most of the deceased LBK individuals known thus far were interred as single inhumations or cremations in dedicated burial areas; multiple burials remain rare (34). Many individuals also were buried carefully within settlements; such burials are regarded as another variant within the commonly encountered array of possible burial practices (35). Bodies usually were deposited in a flexed position on their left side, oriented with the cephalic extremity roughly to the east, but supine positions and other orientations are quite common also. Nevertheless, a pattern of care and deliberation is readily apparent in the deposition of the dead. Grave goods, mainly pottery, shell ornaments, and lithic artifacts, are often present. In male burials polished stone adzes are often found, which have been identified as both woodworking tools and as lethal weapons used repeatedly against human

targets (24, 36). Arrowheads occur in graves as well. Although these arrowheads could be used for hunting game, they also were weapons used against human foes (24, 37), and persons equipped with them have been characterized previously as hunters/warriors (38). Although arrow wounds remain rare in LBK skeletons, they do occur at the known mass violence sites, thereby demonstrating the repeated use of missile weapons against human targets in addition to close-quarter fighting using shock weapons. Usually, direct casualties of violent encounters of whatever extent seem not to have been included in the regular burial places, but survived traumata are sometimes found (39). The known casualties of perimortem violence are found mainly in “deviant” graves instead, i.e., in burials that lack the careful arrangement of the bodies. The Talheim mass grave and the bodies found in the ditches at Asparn/Schletz belong to this category, as well as the LBK mass grave of Wiederstedt, Germany, which lacks obvious signs of violence (35, 40). Other sites that initially were regarded as massacre-related by some, such as the enclosure ditch cemetery of Vaihingen/Enz or the supraregional ritual place of Herxheim (15, 16, 41), are now seen in another light (18, 20, 21).

### **The Mass Grave and Its Analysis**

The chance discovery of another LBK mass grave in 2006, during road-building activity at the site of Schöneck-Kilianstädten (Hesse, Germany) (42, 43), provided a rare and much needed fresh insight into the matter of collective violence at the end of the LBK. Four 14C-samples from different individuals date

the mass grave to 5207–4849 cal BC (Table 4.S1). The site is situated within a region of intense late LBK activity and very near a long-standing border between different flint-distribution systems that might indicate a profound divide between neighboring settlements in this region (44, 45).

The feature containing the commingled skeletal remains was a reused long V-shaped pit measuring ca. 7.5 m in length and 0.3–1.0 m in breadth that could have been part of a larger ditch system at the site (43). It was located within a larger settlement area including up to 18 successively built LBK houses. The southern end of the mass grave pit was trapezoidal in shape and continued as a narrow trench to the north. The human bones were recovered under adverse conditions, and, unfortunately, only rather basic archaeological documentation is available. Bone preservation is poor in parts, taphonomic fragmentation is high, and the bones are very fragile and partly disintegrated. Nevertheless, using standardized and well-tested osteological methods, it was possible to gather reliable information from this assemblage including age and sex determinations (46, 47), calculations of the minimum number of individuals (MNI) represented, and the assessment of taphonomic and pathological changes present on the skeletal remains (48–50). The overall recovery conditions and the low level of detail of the available documentation precluded the reliable determination of individuals from all specimens, so osteological analyses and numerical calculations are based on a skeletal element count in a systematic and standardized way suitable for commingled remains (51, 52). Therefore the main aim is to provide reliable information on the group level, suitable for comparison with similar data from other sites.

In addition to the human bones, which are the most ubiquitous finds, the pit

contained typical settlement refuse, consisting mainly of pottery sherds, pieces of burnt clay, animal bones, and various fragmented stone artifacts (43). All these artifacts show signs of wear, weathering, or other earlier damage; nothing was complete or largely undamaged. Their condition very much suggests that the recovered objects were not grave goods but were accidentally included waste material, as observed at other LBK mass burial sites (24, 40).

The only finds likely directly associated with the human remains are two bone arrowheads. These were discovered during the cleaning process in the laboratory within the soil previously adhering to the human bones (43). Their close proximity to the bones suggests that the arrowheads likely were inside the bodies when the bodies were deposited. Finds of arrowheads within body cavities are known from other Neolithic sites (29, 53) and can be taken as supporting evidence of conflict. When lodged in bone, they are widely regarded as the best indicator for armed conflict (54, 55).

### **Osteological Results**

Based on the proximal left femur and the left femoral diaphysis, a postcranial MNI of 21 was determined (Table 4.S2). The right side of both elements provided an MNI of only 19, as did the diaphysis of the left tibia. Of the major long bones, the proximal left tibia and humerus indicated a lower MNI of only 13. These results indicate quite well that, although the individuals were articulated upon deposition, taphonomic processes typical for the acidic soil of this region have destroyed a large part of the skeletal remains. The articulation

of the skeletons can be observed from the top layers of the feature, and the presence of numerous small bone fragments demonstrates that this location is a primary deposition, because otherwise these fragments would have been lost. Detailed analyses of the crania and especially of the mostly still associated dentitions raised the final MNI to 26, which probably is close to the actual number of individuals originally present.

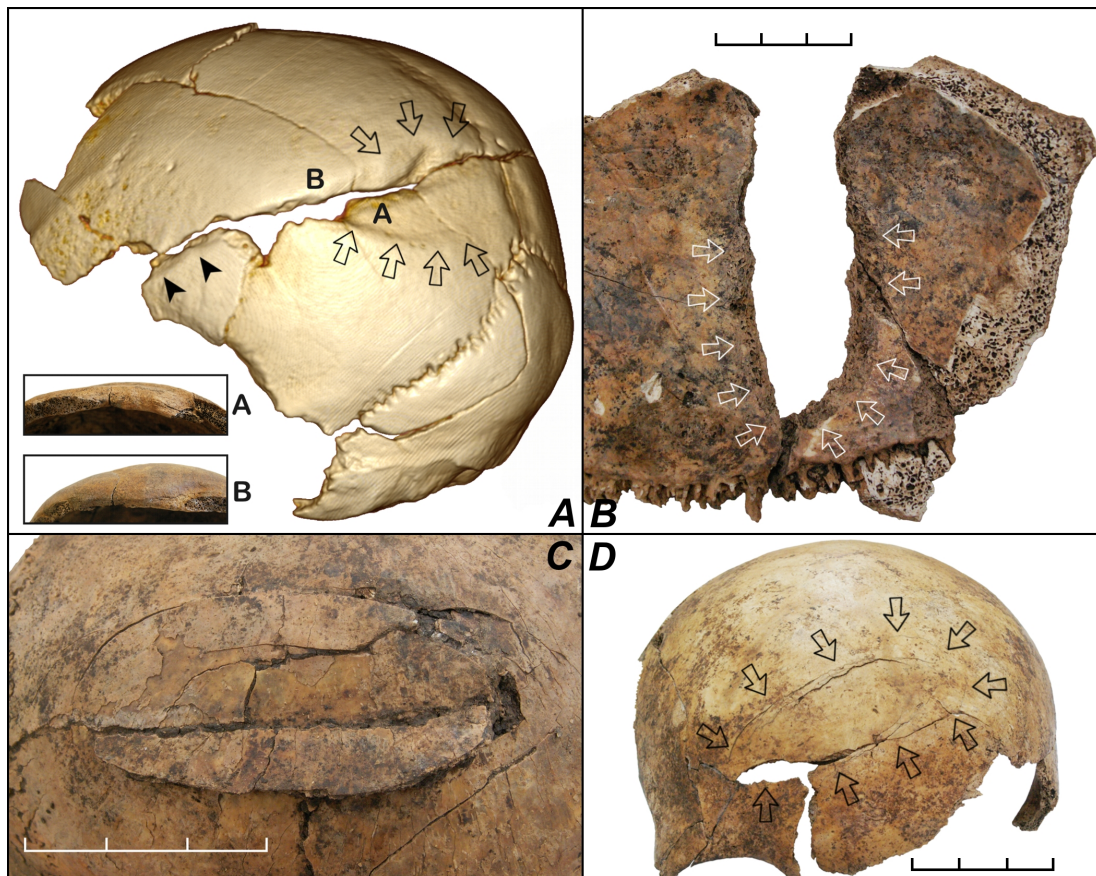
The age structure revealed a balanced ratio of 13 (50%) subadults and 13 (50%) adults (Tables 4.S3 and 4.S4). Of the 13 subadults 10 were less than 6 y old at death, the youngest being represented by two long bones of a maximum age of 6 mo. Only two individuals were children aged between ca. 6 and 8 y. The next youngest individual is a 16- to 21-y-old, classed as subadult biologically but who likely counted as a socially adult member of the LBK community (56). Individuals between the ages of 9 and 15 y seem not to be represented in the mass grave. This peculiar subadult demography pattern is significantly different from the overall 0- to 8-y-old and 8- to 17-y-old LBK samples currently available from both cemetery ( $\chi^2 = 7.684$ ;  $P = 0.006$ ) and settlement burials ( $\chi^2 = 6.109$ ;  $P = 0.013$ ) (57). Among the adults, younger adult individuals predominate; only two were more than 40 y old (Table 4.S4). The sex of nine adult crania including mandibles could be determined as male or likely male; only those of the two oldest individuals are attributed to (likely) females, resulting in a male:female ratio of 1:4.5. Sex could not be determined reliably for two further crania. The postcranial elements also reflect this numerical deficit of females, albeit in lesser detail. Pelvic bones are largely destroyed, and the extant fragments represent only one male and one female individual. This skewed sex distribution is significantly different both from an equal number of male and

female individuals ( $\chi^2 = 4.455$ ;  $P = 0.035$ ) and from the actual sex distributions observed in regular LBK burial places such as the large cemetery of Schwetzingen (Yates'  $\chi^2 = 4.893$ ;  $P = 0.027$ ) (58). In contrast, the male:female ratio at this site is not significantly different from that at the two other massacre sites ( $\chi^2 = 1.909$ ;  $P = 0.385$ ).

Assessing the overall antemortem disease load, we find lesions typical for the LBK: probable signs of tuberculosis in some ribs (50), traces of vitamin C deficiency (48), healed rib and longbone fractures, a likely well-healed cranial surgery following trauma (Fig. 4.2A) (59), and osteomyelitis. Joint and dental diseases remain rare. The general health status therefore is as expected for an LBK group from Central Europe, as previously determined from larger population samples.

The lesions that provide the most telling evidence for the interpretation of this mass grave feature are the very frequent perimortem cranial and postcranial fractures (49). These features characterize the assemblage in a way comparable to the other known LBK massacre sites of Talheim and Asparn/Schletz (24–26). Unequivocal perimortem blunt-force injuries affect most cranial bones and can be securely attributed in part to the known adze weapon-tools of the LBK (Fig. 4.2 B–D). Because most crania were only partly preserved, incomplete, and fragmentary, exact impact sites could not always be determined with confidence. Instead, the overall patterning of perimortem fracture zones was analyzed per cranial element for subadults and adults separately. The highest percentage of traumatized bone was found in the left parietal for both groups, a classic location for blows delivered in face-to-face confrontations during interpersonal violence (60, 61). Injuries to the other larger cranial elements are

prevalent as well (Table 4.1). In the subadult sample, the left halves of the occipital and the frontal are the second and third most frequent cranial injuries (Table 4.2).



*Fig. 4.2. Examples of cranial trauma identified in the mass grave. (A) CT reconstruction of cranial fragment no. 331, displaying a healed depressed fracture on the left parietal (open arrows) with evidence of nonunion of fracture edges (A and B) and surgical treatment (solid arrows). (B) Endocranial view of left adult parietal no. 79 showing a comminuted blunt-force injury with internal beveling. (C) Ectocranial view of skull fragment no. 233 (a child ca. 3–5 y old) showing a shaped, nonpenetrating blunt-force injury of the left parietal. (D) Ectocranial view of skull fragment no. 177 (a child ca. 8 y old) showing a shaped, nonpenetrating blunt-force injury across the frontal bone. (Scale bars, 3 cm each.)*

<b>Element</b>	<b>Side</b>	<b>N</b>	<b>PI A</b>	<b>%</b>	<b>PI B</b>	<b>%</b>
Frontal	R	9	2	22.2	7	77.8
	L	8	1	12.5	6	75.0
Parietal	R	9	3	33.3	7	77.8
	L	8	3	37.5	7	87.5
Occipital	R	6	1	16.7	5	83.3
	L	6	1	16.7	4	66.7
Temporal	R	5	0	-	4	80.0
	L	7	0	-	5	71.4
Zygomatic	R	6	1	16.7	3	50.0
	L	6	0	-	1	16.7
Maxilla	R	5	0	-	3	60.0
	L	5	0	-	2	40.0
Mandibula	R	6	3	50.0	5	83.3
	L	8	2	25.0	6	75.0

*Table 4.1. Extent of perimortem cranial injuries in adult individuals. PI A = Clear perimortem injuries (minimum); PI B = Clear and/or probable perimortem injuries (maximum).*

<b>Element</b>	<b>Side</b>	<b>N</b>	<b>PI A</b>	<b>%</b>	<b>PI B</b>	<b>%</b>
Frontal	R	6	1	16.7	3	50.0
	L	8	1	12.5	5	62.5
Parietal	R	5	2	40.0	2	40.0
	L	8	4	50.0	7	87.5
Occipital	R	4	0	-	2	50.0
	L	6	0	-	4	66.7
Temporal	R	3	0	-	1	33.3
	L	4	0	-	2	50.0
Zygomatic	R	1	0	-	0	-
	L	5	0	-	2	40.0
Maxilla	R	3	0	-	0	-
	L	5	0	-	2	40.0
Mandibula	R	4	0	-	0	-
	L	3	0	-	1	33.3

*Table 4.2. Extent of perimortem cranial fractures in subadult individuals. PI A = Clear perimortem injuries (minimum); PI B = Clear and/or probable perimortem injuries (maximum).*



*Fig. 4.3. Examples of perimortem long-bone fractures identified in the mass grave, often showing the classic butterfly pattern (A-C). (A) Right tibia no. 289. (B) Left tibia no. 20-21. (C) Right tibia no. 374. (D) Right humerus no. 328 with parallel chop marks. (Scale bars, 2 cm each.)*

In addition to the extensive cranial trauma, a very high number of perimortem-fractured long bones were recorded (Fig. 4.3), but traces of carnivore activity could not be identified. Again, because of the high overall fragmentation, an element count based upon anatomically identified and isolated bone units was used for analysis (Table 4.3). The differences in fracture frequency between the major long bones are very apparent. On average, 19% of the fragments of the upper extremity bones show perimortem fracture [including at least one case of intended amputation of a humerus (Fig. 4.3D)], but the fracture frequency is much higher for the distal elements of the lower extremity. Some 31-42% of fibula units and a staggering 53-63% of tibia units show perimortem fractures, double to triple the percentage found in the upper limb bones. The lowest overall frequency was found in the femur, where a maximum of only 7% of identified units show perimortem fractures. This pattern clearly reveals a highly

significant bias toward perimortem fragmentation of the distal segment of the lower limb and, especially, the tibia ( $\chi^2 = 56.011$ ;  $P < 0.001$ ). Suggestive but not definite lesions that could be attributed to arrow injuries were found in two vertebrae.

<b>Element</b>	<b>No of units</b>	<b>PI A</b>	<b>%</b>	<b>PI B</b>	<b>%</b>
Humerus	52	6	11.5	10	19.2
Ulna	39	4	10.3	8	20.5
Radius	42	3	7.1	7	16.7
Femur	56	1	1.8	4	7.1
Tibia	57	30	52.6	36	63.2
Fibula	48	15	31.3	20	41.7

*Table 4.3. Extent of perimortem fractured long bones based on an identified unit count. PI A = Number of units with clear perimortem injuries (minimum); PI B = Number of units with clear and/or probable perimortem injuries (maximum).*

### **Osteoarchaeological Synthesis**

Combining all evidence, the Kilianstädten mass grave is a clear example of an LBK massacre. Massive cranial traumata, affecting all cranial elements and including facial and tooth fractures and caused by the typical weapon-tools of the time, are accompanied by likely arrow injuries and subsequent commingled and careless deposition. In this regard, the Kilianstädten site is most similar to the Talheim massacre site (24), where a complete community of probably biologically related people was wiped out (8, 62, 63). The ratios of subadult to adult individuals are virtually identical at both sites (24), strongly indicating that the community at Kilianstädten was the target of an equally destructive

lethal attack, almost annihilating a complete settlement. The significant absence of younger women in the Kilianstädten mass grave may indicate that these were taken captive by the attackers, as also has been suggested for the Asparn/Schletz site in Austria (19); ethnographic evidence attests to this practice (54, 55, 64). Likewise, the scarcity of teenagers among the victims could reflect their higher chances for escape in comparison with younger children or older adults (65), teenagers being possibly the most nimble demographic segment and unburdened by childcare or physical ailments (53). Alternatively, they could have been captured for forced integration into the attacker's community (60). Interestingly, the age gap in the Kilianstädten sample largely coincides with the proposed LBK middle-childhood period when children seem to have become much more active and recognized members of their communities (57) and thus might have been regarded, like the younger women of reproductive age, as a choice population segment for capture. When these likely missing individuals are taken into account, the overall sizes of the groups at Talheim and Kilianstädten would have been very similar as well, probably suggesting local communities of 30–40 people. Because attempts at unraveling the kinship structure of regular long-term LBK burial sites have been inconclusive so far (5, 66), the mass fatality samples also will play a key role in characterizing the composition of contemporaneous communities. Earlier studies already have indicated that kinship seems to have been one of the organizing principles of LBK life but that overall individual mobility was high over time (8, 63, 66). Therefore the complex interplay between biological and social factors that makes up the concept of prehistoric kinship is best approached via the actually contemporaneous population samples provided by

the mass graves (35, 67).

The truly unique characteristic of the Kilianstädten mass grave, which previously was unknown for the LBK, is the clear pattern of targeted perimortem destruction of the distal segment of the lower limb. Chance damage can be dismissed; therefore an explanation must be sought in the violent events just before the deposition of the corpses (43). Specifically smashing the legs (tibiae and fibulae) certainly conveyed a message, which might be decoded with reference to other sites showing evidence of comparable levels of violence. In fact, torture and mutilation are often found as part of warfare (64, 68–70), and instances in which the lower limbs have been targeted specifically are known both from archaeological sites (71, 72) and recent history (69, 73). Restricting movement, practically and symbolically, may be the main reason for primarily targeting the legs, violently stressing the futility of resistance and escape and adding to the terror of the victims if they were still alive and acting as a subjugated audience (72). Because of the general nature of the osteological evidence for perimortem trauma, it is impossible to determine precisely whether living victims were tortured or their corpses mutilated systematically, or both. However, these possibilities may be understood in a similar manner, because both may convey hatred and contempt in an ostentatious way, as does the usual apparently careless disposal of violence victims in a commingled mass grave in times of lethal conflict (64, 74).

## **Early Neolithic Mass Graves as Evidence for Lethal Collective Violence**

Building on both the evidence previously available for the LBK and the evidence presented here, we suggest that the repeated occurrence of almost indiscriminate massacres, the possible abduction of selected members, and the patterns of torture, mutilation, and careless disposal all fit into the concept of prehistoric warfare as currently understood within anthropology (54, 64, 75). Particular LBK groups were singled out for as yet unknown reasons, attacked with brute force, and annihilated by others, probably close neighbors and very likely other LBK groups of the wider region (25, 76). As has been shown, even within the overall quite homogenous-appearing LBK, recognizable boundaries did exist in many places (77–80). These borders most probably were a result of the spread of different groups without close social or biological kinship ties to one another who came in to close contact as a consequence of the LBK colonization pattern (4, 80). In fact, because the LBK was the first complete Neolithic culture in Central Europe (3), today all farmers of this time and region are classified as members of the LBK by default, regardless of how these people defined themselves and how they differentiated themselves from their contemporaries. Alternative cultural attributions, based almost exclusively on pottery styles, arise only with the decline of the LBK in its final phases (4). The suggested regional differentiation, the possible collapse of previous exchange systems, and increasing defensive architecture are all compatible with increasing levels of widespread social tensions and the looming threat of utmost violence (3). The massacres now known from three widely separated localities but dating to a rather short period give direct evidence that outbreaks of lethal

collective violence unquestionably occurred repeatedly within the later LBK (19, 24–26). Although the particular triggers for each massacre might have been different, the overarching patterns of extreme violence and the atypical treatment of the dead are recognizably similar (35). In this context, it is especially telling that all three of the unequivocal massacre sites currently known date to the later phases of the LBK (17, 25), but there is no evidence for comparable levels of violence in the earlier periods.

The Kilianstädten massacre, which occurred within an archaeologically suggested border zone of different LBK subgroups (43, 80), with its high potential for intergroup conflict (54, 76), provides an illuminating example of characteristics of nonstate warfare identified earlier from the ethnographic record; the abduction of younger women and the torture, mutilation, and killing of enemies can be seen clearly in the osteological record of Early Neolithic Central Europe (54). Although some earlier works supporting the notion of widespread warfare during the later LBK were based, at least in part, on a premature interpretation of several LBK sites (15, 16, 41) that now are interpreted differently (20–23), the evidence has become more conclusive again with the Kilianstädten site. Importantly, more skeletal remains, the only direct evidence for collective lethal violence, are now available (16, 41, 49). Although the underlying supraregional causes for the recognized increase in mass violence in the late LBK undoubtedly were complex and multifactorial, a significant increase in population followed by adverse climatic conditions (drought), possibly coupled with the inability of long-settled farmers to practice the avoidance behavior by which hunter-gatherers typically evade conflict (75), seems to have been an important component of the overall picture (4). As

previous research has shown, climatic changes, especially those leading to increasing unpredictability of or even significant decreases in agricultural production, have played major roles in the change and collapse of societies throughout human history (4, 81, 82). Ecological imbalance and perceived or actual resource stress were suggested previously as some of the main reasons for massacres and warfare in general (55, 64, 83), and at the end of the LBK aggression might have been aggravated further by patrilineally determined social inequality, especially with regard to access to coveted, high-quality farmland, food, and possibly prestige goods (9, 13, 14, 76, 84).

In conclusion, the concerted annihilation of entire social units, one of the hallmarks of early warfare, is now clearly evident from the analysis of human skeletal remains from three separate late LBK localities (19, 24–26). Massacres seem to have been the most powerful strategy in prehistoric warfare (54, 85, 86), and the osteoarchaeological evidence from Early Neolithic Central Europe clearly shows that such acts of mass violence were carried out repeatedly in the deep human past by groups living in pristine prestate conditions (83, 86, 87).

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## (References)

1. Modderman PJR (1988) The Linear Pottery Culture: Diversity in uniformity. *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 38:63–139.
2. Gronenborn D (1999) A variation on a basic theme: The transition to farming in Southern Central Europe. *J World Prehist* 13(2):123–210.
3. Bickle P, Whittle A (2013) *The First Farmers of Central Europe* (Oxbow, Oxford, UK).
4. Gronenborn D, Strien H-C, Dietrich S, Sirocko F (2014) ‘Adaptive cycles’ and climate fluctuations: A case study from Linear Pottery Culture in western Central Europe. *J Archaeol Sci* 51:73–83.
5. Haak W, et al.; Members of the Genographic Consortium (2010) Ancient DNA from European early Neolithic farmers reveals their Near Eastern affinities. *PLoS Biol* 8(11):e1000536.
6. Brandt G, et al.; Genographic Consortium (2013) Ancient DNA reveals key stages in the formation of central European mitochondrial genetic diversity. *Science* 342(6155):257–261.
7. Oelze V, et al. (2011) Early Neolithic diet and animal husbandry: Stable

- isotope evidence from three Linearbandkeramik (LBK) sites in Central Germany. *J Archaeol Sci* 38(2):270–279.
8. Bentley RA, Wahl J, Price TD, Atkinson TC (2008) Isotopic signatures and hereditary traits: Snapshot of a Neolithic community in Germany. *Antiquity* 82(316):290–304.
  9. Bentley RA, et al. (2012) Community differentiation and kinship among Europe's first farmers. *Proc Natl Acad Sci USA* 109(24):9326–9330.
  10. Bramanti B, et al. (2009) Genetic discontinuity between local hunter-gatherers and central Europe's first farmers. *Science* 326(5949):137–140.
  11. Edwards CJ, et al. (2007) Mitochondrial DNA analysis shows a Near Eastern Neolithic origin for domestic cattle and no indication of domestication of European aurochs. *Proc Biol Sci* 274(1616):1377–1385.
  12. Haak W, et al. (2008) Ancient DNA, Strontium isotopes, and osteological analyses shed light on social and kinship organization of the Later Stone Age. *Proc Natl Acad Sci USA* 105(47):18226–18231.
  13. Hedges R, et al. (2013) The supra-regional perspective. *The First Farmers of Central Europe*, eds Bickle P, Whittle A (Oxbow, Oxford, UK), pp 343–384.

14. Bogaard A, et al. (2013) Crop manuring and intensive land management by Europe's first farmers. *Proc Natl Acad Sci USA* 110(31):12589–12594.
15. Farruggia J-P (2002) Une crise majeure de la civilisation du Néolithique Danubien des années 5100 avant notre ère. *Archeologické Rozhledy* 54(1):44–98.
16. Golitko M, Keeley LH (2007) Beating ploughshares back into swords: Warfare in the Linearbandkeramik. *Antiquity* 81(312):332–342.
17. Wild EM, et al. (2004) Neolithic massacres: Local skirmishes or general warfare in Europe? *Radiocarbon* 46(1):377–385.
18. Boulestin B, et al. (2009) Mass cannibalism in the Linear Pottery Culture at Herxheim (Palatinate, Germany). *Antiquity* 83(322):968–982.
19. Teschler-Nicola M, et al. (1999) Evidence of genocide 7000 BP—Neolithic paradigm and geo-climatic reality. *Coll Antropol* 23(2):437–450.
20. Zeeb-Lanz A (2009) Gewaltszenarien oder Sinnkrise? Die Grubenanlage von Herxheim und das Ende der Bandkeramik. *Krisen–Kulturwandel–Kontinuitäten*, ed Zeeb-Lanz A (Marie Leidorf, Rahden, Germany), pp 87–101.

21. Stäuble H (2014) Die Krise am Ende der Linienbandkeramik? Oder ist es am Ende eine Krise der Bandkeramik-Forschung?! *No future?*, eds Link T, Schimmelpfennig D (Welt und Erde, Kerpen-Loogh, Germany), pp 11–49.
22. Zeeb-Lanz A (2014) Gewalt im Ritual – Gewalt an Toten. Die Krise am Ende der Bandkeramik im Spiegel außergewöhnlicher Befunde. *Gewalt und Gesellschaft*, eds Link T, Peter-Röcher H (Habelt, Bonn), pp 257–270.
23. Link T (2014) Gewaltphantasien? Kritische Bemerkungen zur Diskussion über Krieg und Krise am Ende der Bandkeramik. *Gewalt und Gesellschaft*, eds Link T, Peter-Röcher H (Habelt, Bonn), pp 271–286.
24. Wahl J, König HG (1987) Anthropologisch-traumatologische Untersuchung der menschlichen Skelettreste aus dem bandkeramischen Massengrab bei Talheim, Kreis Heilbronn. *Fundberichte aus Baden-Württemberg* 12:65–186.
25. Wahl J, Trautmann I (2012) The Neolithic massacre at Talheim: A pivotal find in conflict archaeology. *Sticks, Stones, and Broken Bones*, eds Schulting R, Fibiger L (Oxford Univ Press, Oxford, UK), pp 77–100.
26. Teschler-Nicola M (2012) The Early Neolithic site Asparn/Schletz (Lower Austria): Anthropological evidence of interpersonal violence. *Sticks, Stones, and Broken Bones*, eds Schulting R, Fibiger L (Oxford Univ Press, Oxford, UK), pp 101–120.

27. Zollikofer CPE, Ponce De Leon MS, Vandermeersch B, Lévêque F (2002) Evidence for interpersonal violence in the St. Cesaire Neanderthal. *Proc Natl Acad Sci USA* 99(9):6444–6448.
28. Sala N, et al. (2015) Lethal interpersonal violence in the middle Pleistocene. *PLoS One* 10(5):e0126589.
29. Guilaine J, Zammit J (2005) *The Origins of War. Violence in Prehistory* (Blackwell, Oxford, UK).
30. Frayer DW (1997) Ofnet: Evidence for a Mesolithic massacre. *Troubled Times*, eds Martin DL, Frayer DW (Overseas Publishers Association, Amsterdam), pp 181–216.
31. Orschiedt J (2005) The head burials from Ofnet cave: An example of warlike conflict in the Mesolithic. *Warfare, Violence and Slavery in Prehistory*, eds Parker Pearson M, Thorpe IJN (Archaeopress, Oxford, UK), pp 67–73.
32. Schulting RJ (2015) Mesolithic skull cults? *Ancient Death Ways*, eds von Hackwitz K, Peyroteo-Stjerna R (Institutionen för arkeologi och antik historia, Uppsala, Sweden), pp 19–46.
33. Petrasch J (1999) Mord und Krieg in der Bandkeramik. *Archäologisches*

*Korrespondenzblatt* 29(4):505–516.

34. Trautmann I (2006) *The Significance of Cremations in Early Neolithic Communities in Central Europe*. PhD thesis (University of Tübingen, Tübingen, Germany). Available at [nbn-resolving.de/urn:nbn:de:bsz:21-opus-30056](http://nbn-resolving.de/urn:nbn:de:bsz:21-opus-30056). Accessed June 30, 2015.
35. Meyer C, et al. (2014) Mass graves of the LBK: Patterns and peculiarities. *Early Farmers*, eds Whittle A, Bickle P (Oxford Univ Press, Oxford, UK), pp 307–325.
36. Villotte S, Knüsel CJ (2014) “I sing of arms and of a man ...”: Medial epicondylitis and the sexual division of labour in prehistoric Europe. *J Archaeol Sci* 43:168–174.
37. Jeunesse C, Barrand-Emam H, Denaire A, Chenal F (2014) Unusual funeral practices and violence in Early Neolithic Central Europe: New discoveries at the Mulhouse-Est Linearbandkeramik. *Antiquity* 342: Online Project Gallery. Available at [journal.antiquity.ac.uk/projgall/jeunesse342](http://journal.antiquity.ac.uk/projgall/jeunesse342). Accessed June 30, 2015.
38. Gronenborn D (2003) Der ‚Jäger/Krieger‘ aus Schwanfeld. Einige Aspekte der politisch-sozialen Geschichte des mitteleuropäischen Altneolithikums. *Archäologische Perspektiven*, eds Eckert J, Eisenhauer U, Zimmermann A (Marie Leidorf, Rahden, Germany), pp 35–48.

39. Petrasch J (2006) Gewalttätigkeiten in der Steinzeit – Archäologisch-kulturgeschichtliche Analysen zur Ermittlung ihrer Häufigkeiten. *Frühe Spuren der Gewalt*, eds Piek J, Terberger T (Landesamt für Kultur und Denkmalpflege, Schwerin, Germany), pp 155–162.
40. Meyer C, Kürbis O, Alt KW (2004) Das Massengrab von Wiederstedt, Ldkr. Mansfelder Land. Auswertung und Gedanken zur Deutung im Kontext der Linienbandkeramik. *Jahresschrift für mitteldeutsche Vorgeschichte* 88:31–66.
41. Christensen J (2004) Warfare in the European Neolithic. *Acta Archaeologica* 75(2): 129–156.
42. Schwitalla G, Schmitt KM (2006) Ein Massengrab aus der Umgehungsstraße oder “Aus der Linearbandkeramik ist alles bekannt.” *hessenArchäologie* 2006:31–32.
43. Lohr C (2013) *Archäologische und anthropologische Untersuchungen des Massengrabes von Schöneck-Kilianstädten (Main-Kinzig-Kreis, Hessen)*. Masters thesis (University of Mainz, Mainz, Germany).
44. Ramminger B (2003) *Zur bandkeramischen Besiedlung im unteren Niddertal* (Habelt, Bonn).

45. Kerig T (2008) *Hanau-Mittelbuchen. Siedlung und Erdwerk der bandkeramischen Kultur* (Habelt, Bonn).
46. White TD, Folkens PA (2005) *The Human Bone Manual* (Elsevier, Amsterdam).
47. Szilvássy J (1988) Altersdiagnose am Skelett. *Anthropologie. Handbuch der vergleichenden Biologie des Menschen* I/1, ed Knußmann R (Fischer, Stuttgart), pp 421–443.
48. Carli-Thiele P (1996) *Spuren von Mangelerkrankungen an steinzeitlichen Kinderskeleten* (Erich Goltze, Göttingen, Germany).
49. Knüsel CJ (2005) The Physical Evidence of Warfare – Subtle Stigmata? *Warfare, Violence and Slavery in Prehistory*, eds Parker Pearson M, Thorpe IJN (Archaeopress, Oxford, UK), pp 49–65.
50. Nicklisch N, et al. (2012) Rib lesions in skeletons from early Neolithic sites in Central Germany: On the trail of tuberculosis at the onset of agriculture. *Am J Phys Anthropol* 149(3):391–404.
51. Schmitt S (2002) Mass graves and the collection of forensic evidence: Genocide, war crimes, and crimes against humanity. *Advances in Forensic Taphonomy*, eds Haglund WD, Sorg MH (CRC, Boca Raton, FL), pp 277–292.

52. Byrd J, Adams BJ (2009) Analysis of commingled human remains. *Handbook of Forensic Archaeology and Anthropology*, eds Blau S, Ubelaker DH (Left Coast, Walnut Creek, CA), pp 174–186.
  
53. Meyer C, et al. (2009) The Eulau eulogy: Bioarchaeological interpretation of lethal violence in Corded Ware multiple burials from Saxony-Anhalt, Germany. *J Anthropol Archaeol* 28(4):412–423.
  
54. Keeley LH (1996) *War Before Civilization* (Oxford Univ Press, New York).
  
55. Maschner HDG, Reedy-Maschner KL (1998) Raid, retreat, defend (repeat): The archaeology and ethnohistory of warfare on the North Pacific Rim. *J Anthropol Archaeol* 17(1):19–51.
  
56. Fibiger L (2014) Misplaced childhood? Interpersonal violence and children in Neolithic Europe. *The Routledge Handbook of the Bioarchaeology of Human Conflict*, eds Knüsel C, Smith MJ (Routledge, London), pp 127–145.
  
57. Bickle P, Fibiger L (2014) Ageing, childhood and social identity in the Early Neolithic of Central Europe. *Eur J Archaeol* 17(2):208–228.
  
58. Gerling C (2007) Der Tod in der jüngeren Bandkeramik. Das Gräberfeld von Schwetzingen. *Denkmalpflege in Baden-Württemberg* 36(3):159–163.

59. Alt KW, et al. (1997) Evidence for Stone Age cranial surgery. *Nature* 387(6631):360.
60. Schulting RJ, Fibiger L (2014) Violence in Neolithic North-west Europe. A population perspective. *Early Farmers*, eds Whittle A, Bickle P (Oxford Univ Press, Oxford, UK), pp 281–306.
61. Fibiger L, Ahlström T, Bennike P, Schulting RJ (2013) Patterns of violence-related skull trauma in Neolithic Southern Scandinavia. *Am J Phys Anthropol* 150(2):190–202.
62. Alt KW, Vach W, Wahl J (1995) Verwandtschaftsanalyse der Skelettreste aus dem bandkeramischen Massengrab von Talheim, Kreis Heilbronn. *Fundberichte aus Baden-Württemberg* 20:195–217.
63. Duering A, Wahl J (2014) A massacred village community? Agent-based modelling sheds new light on the demography of the Neolithic mass grave of Talheim. *Anthropol Anz* 71(4):447–468.
64. LeBlanc SA, Register KE (2003) *Constant Battles. Why We Fight* (St. Martin's, New York).
65. Verwimp P (2004) Death and survival during the 1994 genocide in Rwanda. *Popul Stud (Camb)* 58(2):233–245.

66. Brandt G, et al. (2014) Settlement burials at the Karsdorf LBK site, Saxony-Anhalt, Germany. *Early Farmers*, eds Whittle A, Bickle P (Oxford Univ Press, Oxford, UK), pp 95–114.
67. Meyer C, Ganslmeier R, Dresely V, Alt KW (2012) New approaches to the reconstruction of kinship and social structure based on bioarchaeological analysis of Neolithic multiple and collective graves. *Theoretical and Methodological Considerations in Central European Neolithic Archaeology*, eds Kolář J, Trampota F (Archaeopress, Oxford, UK), pp 11–23.
68. Knüsel C, Smith MJ (2014) Introduction. The bioarchaeology of conflict. *The Routledge Handbook of the Bioarchaeology of Human Conflict*, eds Knüsel C, Smith MJ (Routledge, London), pp 3–24.
69. Ferllini R (2014) Recent conflicts, deaths and simple technologies. The Rwandan case. *The Routledge Handbook of the Bioarchaeology of Human Conflict*, eds Knüsel C, Smith MJ (Routledge, London), pp 641–655.
70. Gronenborn D (2007) Climate change and socio-political crises: Some cases from Neolithic Central Europe. *War and Sacrifice. Studies in the Archaeology of Conflict*, eds Pollard T, Banks I (Brill, Leiden, The Netherlands), pp 13–32.
71. Potter JM, Chuipka JP (2010) Perimortem mutilation of human remains

- in an early village in the American Southwest: A case for ethnic violence. *J Anthropol Archaeol* 29(4):507–523.
72. Osterholtz AJ (2012) The social role of hobbling and torture: Violence in the prehistoric Southwest. *Int J Paleopathol* 2(2-3):148–155.
73. Kimmerle EH, Baraybar JP (2008) *Skeletal Trauma. Identification of Injuries Resulting from Human Rights Abuse and Armed Conflict* (CRC, Boca Raton, FL).
74. Komar D (2008) Patterns of mortuary practice associated with genocide. Implications for archaeological research. *Curr Anthropol* 49(1):123–133.
75. Fry DP (2013) War, peace, and human nature. The challenge of achieving scientific objectivity. *War, Peace, and Human Nature*, ed Fry DP (Oxford Univ Press, New York), pp 1–21.
76. Golitko ML (2010) *Warfare and Alliance Building during the Belgian Early Neolithic, Late Sixth Millennium BC*. PhD thesis (University of Illinois, Chicago).
77. Zimmermann A (1995) *Austauschsysteme von Silexartefakten in der Bandkeramik Mitteleuropas* (Habelt, Bonn).
78. Kneipp J (1998) *Bandkeramik zwischen Rhein, Weser und Main* (Habelt,

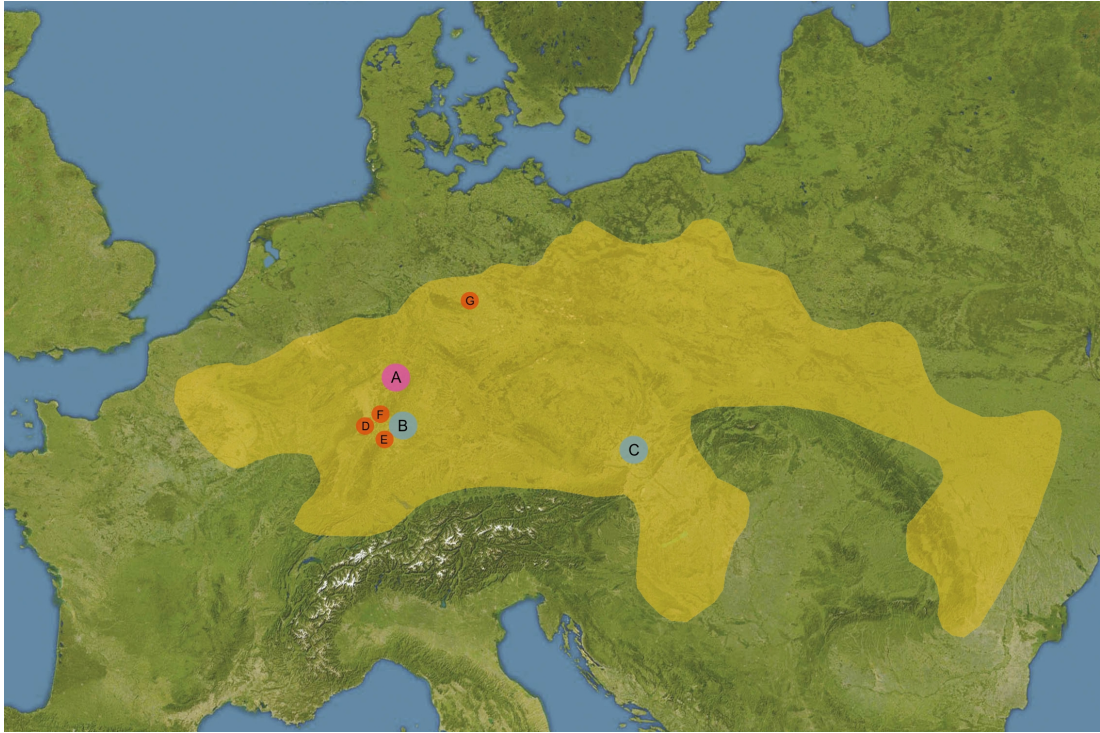
Bonn).

79. Lefranc P (2007) *La Céramique du Rubané en Alsace* (Université Marc-Bloch, Strasbourg, France).
80. Kerig T (2010) Grenzen ziehen: Zur Chronologie regionaler und sozialer Unterschiede im hessischen Altneolithikum. *The Spread of the Neolithic to Central Europe*, eds Gronenborn D, Petrasch J (Römisch-Germanisches Zentralmuseum, Mainz, Germany), pp 475–486.
81. Zhang DD, Brecke P, Lee HF, He YQ, Zhang J (2007) Global climate change, war, and population decline in recent human history. *Proc Natl Acad Sci USA* 104(49):19214–19219.
82. Douglas PMJ, et al. (2015) Drought, agricultural adaptation, and sociopolitical collapse in the Maya Lowlands. *Proc Natl Acad Sci USA* 112(18):5607–5612.
83. Ember CR, Ember M (1997) Violence in the ethnographic record: Results of crosscultural research on war and aggression. *Troubled Times*, eds Martin DL, Frayer DW (Overseas Publishers Association, Amsterdam), pp 1–20.
84. Knüsel C, Smith MJ (2014) The Osteology of Conflict. What Does It All Mean? *The Routledge Handbook of the Bioarchaeology of Human Conflict*,

eds Knüsel C, Smith MJ (Routledge, London), pp 656–694.

85. Willey P (1990) *Prehistoric Warfare on the Great Plains. Skeletal Analysis of the Crow Creek Massacre Victims* (Garland Publishing, New York).
86. Armit I (2011) Violence and society in the deep human past. *Br J Criminol* 51(3): 499–517.
87. Ferguson RB, Whitehead NL (1992) The violent edge of empire. *War in the Tribal Zone*, eds Ferguson RB, Whitehead NL (SAR, Santa Fe, NM), pp 1–30.

## Supporting Information



*Fig. 4.S1. Sites specifically mentioned in the text marked within the approximate distribution of the LBK in Europe. Massacre sites: A, Schöneck-Kilianstädten; B, Talheim; C, Asparn/Schletz. Other sites: D, Herxheim; E, Vaihingen/Enz; F, Schwetzingen; G, Wiederstedt. Sites A, B, and D–G are located in Germany; site C is in Austria.*

Lab no.	Sample	C14 age	±	Cal 1 sigma	Cal 2 sigma
MAMS 14991	Humerus L (KS 174)	6051	29	cal BC 4999-4860	cal BC 5036-4849
MAMS 14992	Humerus R (KS 108)	6120	27	cal BC 5200-4997	cal BC 5207-4961
MAMS 14993	Ulna R (KS 71)	6127	27	cal BC 5202-5000	cal BC 5207-4991
MAMS 14994	Ulna R (KS 152 a,b)	6108	27	cal BC 5193-4989	cal BC 5206-4944

*Table 4.S1. Radiocarbon dating results of four osteological specimens from the mass grave of Kilianstädten.*

<b>Element</b>	<b>Side</b>	<b>Proximal end</b>	<b>Diaphysis</b>	<b>Distal end</b>
Humerus	right	17	20	18
	left	13	15	16
Ulna	right	12	17	8
	left	15	14	13
Radius	right	14	17	11
	left	13	11	11
Femur	right	19	19	17
	left	21	21	14
Tibia	right	16	18	16
	left	13	19	14
Fibula	right	5	9	9
	left	6	8	9

*Table 4.S2. MNI determined from the major long-bone fragments found in the Kilianstädten mass grave.*

<b>Age range</b>	<b>-0.5 y</b>	<b>0.5-2 y</b>	<b>2-3 y</b>	<b>3-5 y</b>	<b>5-7 y</b>	<b>7-9 y</b>	<b>16-21 y*</b>	<b>Total</b>
<b>No of ind.</b>	1	1	2	4	3	1	1	13

*Table 4.S3. Approximate subadult demography of the Kilianstädten mass grave, based primarily on evaluation of preserved cranial fragments and cross-checked with postcranial elements. \* Probably a social adult (62), but counted here as a biological subadult.*

	<b>Male</b>	<b>Male?</b>	<b>Female</b>	<b>Female?</b>	<b>Indet.</b>	<b>Total</b>
<b>20-30 y</b>	3	3	-	-	1	<b>7</b>
<b>25-40 y</b>	2	1	-	-	-	<b>3</b>
<b>40+ y</b>	-	-	1	1	-	<b>2</b>
<b>Indet.</b>	-	-	-	-	1	<b>1</b>
<b>Total</b>	<b>5</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>13</b>

*Table 4.S4. Approximate adult demography of the Kilianstädten mass grave, based primarily on evaluation of preserved cranial fragments and cross-checked with postcranial elements.*

## CHAPTER 5

### **Early Neolithic Executions Indicated by Clustered Cranial Trauma in the Mass Grave of Halberstadt**

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## **(Abstract)**

The later phase of the Central European Early Neolithic witnessed a rise in collective lethal violence to a level undocumented up to this date. This is evidenced by repeated massacres of settled communities of the *Linearbandkeramik* (ca. 5600–4900 cal BC), the first full farming culture in this area. Skeletal remains of several dozen victims of this prehistoric warfare are known from different sites in Germany and Austria. Here we show that the mass grave of Halberstadt, Germany, a new mass fatality site from the same period, reveals further and so far unknown facets of Early Neolithic collective lethal violence. A highly selected, almost exclusively adult male and non-local population sample was killed by targeted blows to the back of the head, indicating a practice of systematic execution under largely controlled conditions followed by careless disposal of the bodies. This discovery significantly increases current knowledge about warfare-related violent behaviour in Early Neolithic Central Europe.

## **(Introduction)**

In Central Europe, the first full Neolithic farming culture is the *Linearbandkeramik* (LBK; ca. 5600–4900 cal BC), which widely replaced the Mesolithic foraging way of life. While the LBK has long been considered well-researched<sup>1-3</sup>, recent studies have revealed substantial differences between the genetic compositions of Mesolithic and Early Neolithic populations. These major

discontinuities were caused by an influx of Neolithic farmers originating from southeastern Europe, where the LBK itself developed<sup>4-7</sup>. Spreading from there, LBK farmers introduced domesticated animals and crops to Central Europe as the economic basis of a new way of life in this region. With time these new settlers colonised large parts of Central Europe, mainly targeting the fertile loess soils<sup>1,2</sup>. By firmly establishing the Early Neolithic agricultural system these people significantly changed their natural environment by clearing forests and establishing permanent settlements and farming plots, in which considerable amounts of time and effort were invested<sup>8</sup>. It is assumed that kinship and membership in probably pioneering lineages played an important part in the organisation of LBK communities<sup>2, 3, 9, 10</sup>. Specific patterns known so far from biomolecular studies include differentiation in the funeral rite connected to the place of origin and very likely virilocal residence patterns in addition to the large-scale genetic changes during the Mesolithic–Neolithic transition<sup>4,9</sup>.

The skeletal remains of the overall LBK population form the biogenic basis of these summary studies, but the specific contexts in which they are discovered also hold key information for characterising their actual life and death experiences as a bioarchaeological record<sup>11</sup>. Detailed analyses of how and why the deceased became part of their respective burial features allow important insights into the complex interplay of actors, factors, and events that shaped the contemporary LBK experience of communities and individuals<sup>12</sup>. Usually, LBK burials are found as individual inhumations or cremations in dedicated cemeteries<sup>13</sup>. Overall, there is a large variety but left-crouched inhumation burials are consistently encountered, often equipped with grave goods. The most common grave orientation is roughly East–West, but extended, right-

crouched, unfurnished, or differently orientated burials do occur as well<sup>14</sup>. A substantial part of the LBK skeletal record stems from settlement burials, which do not differ greatly from the cemetery burials<sup>15</sup>. Multiple burials of carefully arranged bodies are rare<sup>16</sup>.

Also found in various LBK contexts are isolated human body parts and partial skeletons. These occur scattered within settlement pits, in natural caves, or in enclosure pits and ditches and might be the remains of disturbed older burials or have had ritualistic significance. This last point is exemplified by the large enclosure site of Herxheim, Germany, where human bodies were subjected to complex postmortem manipulation and disarticulation before being deposited in mixed assemblages with selected animal bones and various artefacts<sup>17</sup>. The highly intense manipulation of corpses and possible ritualistic cannibalism practised at Herxheim represent behaviours that are still difficult to unravel, but knowledge about them has affected the interpretation of other sites that have long been considered as evidence for LBK warfare and, more specifically, massacres<sup>18, 19</sup>. These sites are the mass grave of Talheim, Germany and the enclosure at Asparn/Schletz, Austria<sup>20-23</sup>. Both yielded human skeletal remains bearing clear signs of perimortem lethal violence such as blunt force cranial injuries and possible arrow wounds. While the bodies at Talheim had been quickly collected and deposited in a disorganised mass grave, those at Asparn show signs of carnivore gnawing and partial disarticulation that occurred before natural sedimentation in the ditches<sup>23</sup>. Recently, a third massacre site has been analysed: the mass grave of Schöneck-Kilianstädten, Germany<sup>24</sup>. It is assumed that at these three sites LBK communities were wilfully destroyed by unknown attackers, most likely members of other groups labelled today as LBK,

possibly even close neighbours. The recent interpretation of the Kilianstädten mass grave as a further violence-related mass fatality site that shows similar patterns to Talheim and Asparn/Schletz again strengthens the interpretation of these massacres as warfare-related<sup>24</sup>.

Signs of careful funeral ritual, clearly evident in the regular graves of the LBK, are absent for the massacre victims. While some younger women might have been captured rather than killed, which is suggested for all three massacre sites currently known<sup>23-25</sup>, the victimised population samples seem to be representative of settled LBK communities, including balanced numbers of children and adults of both sexes. The high percentage of subadults among the massacre victims and their burial within settlement areas are both strongly indicative of surprise attacks on villages, a practice encountered among many different societies<sup>26, 27</sup>. One further LBK mass grave at Wiederstedt, Germany is even dominated by subadult individuals (80%; N = 10), but in the absence of recognisable perimortem injuries another cause of death seems more likely in this case. However, like the other mass graves, it was located in a settlement context<sup>12, 28</sup>, thereby demonstrating again the close association of LBK children with village sites. This is also evident from the settlement burials where they generally dominate<sup>15, 29</sup>.

Lacking from the massacre or mass grave sites is a clearly focussed and patterned postmortem treatment like that found for example at Herxheim. Although targeted destruction of the lower leg bones was observed at Kilianstädten, this apparently occurred within the context of the massacre itself and thereby likely antemortem. It does not fit within a framework of complex long-term cyclic actions like at Herxheim. Mutilation and torture are well known

to occur as part of massacres, which are clearly defined as being limited in time<sup>30</sup>. Once the victims expired, their physical remains likely held no more meaning for the aggressors and apparently were disposed of without further ritual treatment<sup>12</sup>. This postmortem neglect again suggests that the massacre victims were casualties of intergroup warfare rather than part of complex ritual actions charged with greater meaning<sup>31</sup>.

Into this tableau of LBK collective lethal violence and mass burial we add a new site: the mass grave of Halberstadt, Germany. It contained the skeletal remains of irregularly deposited and severely traumatised individuals. Careful excavation of the blocklifted feature and subsequent laboratory analyses revealed some similarities to the other LBK mass fatality sites, but, more importantly, also significant and currently unique deviations from them. By applying osteological, palaeopathological, taphonomic, and isotope analyses (strontium, carbon and nitrogen), this study adds important and previously unavailable information to the discussion of the scope and frequency of Early Neolithic violence and its contextual interpretation.

## **Results**

### ***The archaeological site and feature***

The mass grave was discovered in 2013 during archaeological excavations prior to housing development in the southern outskirts of Halberstadt, a town located just north of the Harz mountains in the German state of Saxony-Anhalt (Fig.

5.S1). This part of the Halberstadt area, called “Sonntagsfeld”, is rich in archaeological remains from various periods and has been settled since the Early Neolithic; traces of six LBK longhouses have previously been identified here<sup>32</sup>. In the same area, at least 38 regular LBK inhumation burials have been excavated so far, which relate spatially mainly to the houses and therefore are examples of settlement burials. Overall, these graves represent a carefully deployed LBK burial site including subadults and adults of both sexes<sup>32, 33</sup>.



*Fig. 5.1. The mass grave feature in situ. Individual skeletons have been coloured and numbered for better visual differentiation.*

The mass grave was located in the southeastern part of the currently known LBK settlement area at the site. As most other features there, the mass grave pit was partially disturbed by later (pre)historic activities. This made it difficult to precisely define the edges of the actual feature (Fig. 5.1), which likely had a

diameter of about two metres. Apart from the human skeletal remains, the pit contained few other finds, mainly small pottery fragments, some of which show typical LBK ornamentation. These fragmentary finds are interpreted as settlement refuse that accidentally became part of the infill. The individuals in the mass grave were not equipped with durable grave goods. Their body positions differed widely between prone and supine, extended, crouched and irregular with no pattern apparent. All this is in stark contrast to regular LBK burials, including those from the same site<sup>32</sup>, but is very similar to the other LBK mass graves<sup>12</sup>. Six radiocarbon samples of human bone give an overall dating range of 5289–4856 cal BC, which can be refined to 5214–4911 cal BC and probably even to 5080–4997 cal BC, confirming the attribution of the mass grave to the late LBK. This dating range also demonstrates chronological overlap with the nearby settlement, which contains both earlier and later inhumations (Table 5.S1; Figs 5.S2 and 5.S3).

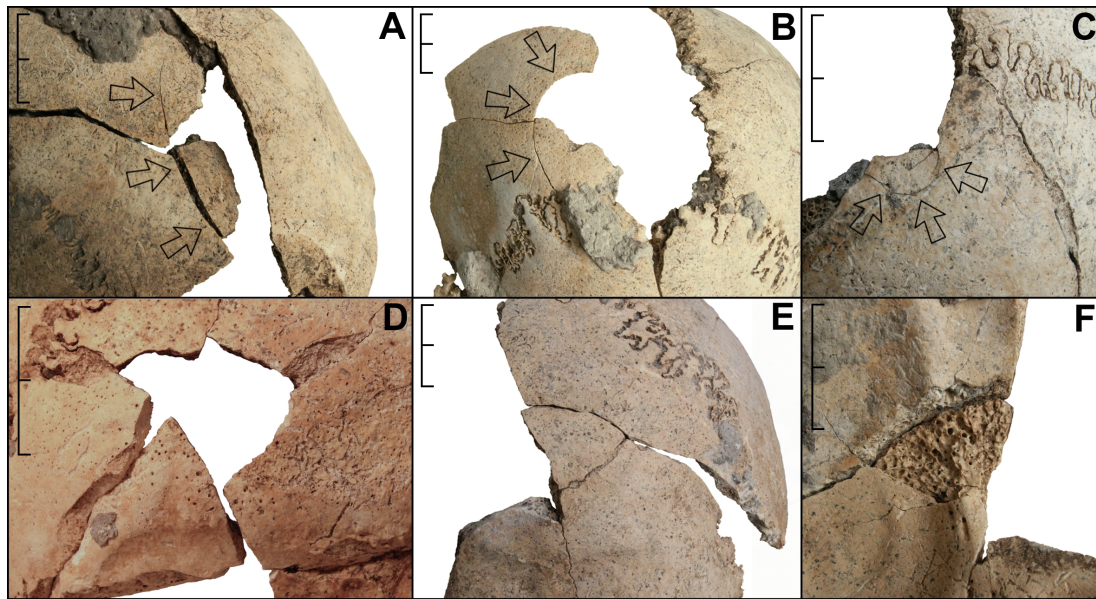
### ***Demography***

The pit contained nine individuals, seven of them diagnosed as male (78%). The remaining two are a probable male (11%) and a probable female (11%). The youngest male was ca. 16–20 years old, the probable female ca. 21–26 years (Table 5.1). Although still subadult in biological terms, as epiphyseal fusion was not complete, the youngest male could have been a social adult in Neolithic society<sup>34</sup>. The remaining seven individuals all fall between 25 and 40 years of age. This highly peculiar, almost exclusively adult male demography (89%) deviates significantly from that of the nearby settlement burial site<sup>32, 33</sup>, which

shows the standard demography of almost equal numbers of male and female and adult and subadult individuals (Fisher's Exact Test; sex:  $p = 0.04$ ; age:  $p = 0.03$ ). The absence of children from the Halberstadt mass grave is especially noteworthy, as these usually are numerous in the regular individual and irregular mass burial sites, as well as in other non-standard deposition types<sup>12, 13, 24, 35</sup>. For example, both massacre mass graves of Talheim and Kilianstädten have balanced ratios of subadults to adults from which the Halberstadt mass grave significantly differs (Fisher's Exact Test;  $p = 0.04$  and  $p = 0.05$ , respectively). The difference to the child-dominated mass grave of Wiederstedt is even more obvious (Fisher's Exact Test;  $p = 0.00$ ). In contrast, the encountered sex ratio with a pronounced lack of females is reminiscent of the massacre sites of Asparn/Schletz and Kilianstädten<sup>23, 24</sup>. But overall, the mass grave of Halberstadt clearly represents a population sample different from all other attritional or catastrophic LBK burial assemblages known so far. The clear dominance of younger adult males and the absence of children have to be especially stressed, as these characteristics, in combination, indicate important contextual differences from the other sites of LBK mass burial and/or collective lethal violence.

### ***Palaeopathology***

The analysis revealed perimortem blunt force cranial injuries as the most numerous lesions in the assemblage (Fig. 5.2). All seven individuals with extant cranial remains show at least one perimortem cranial trauma (Table 5.1).



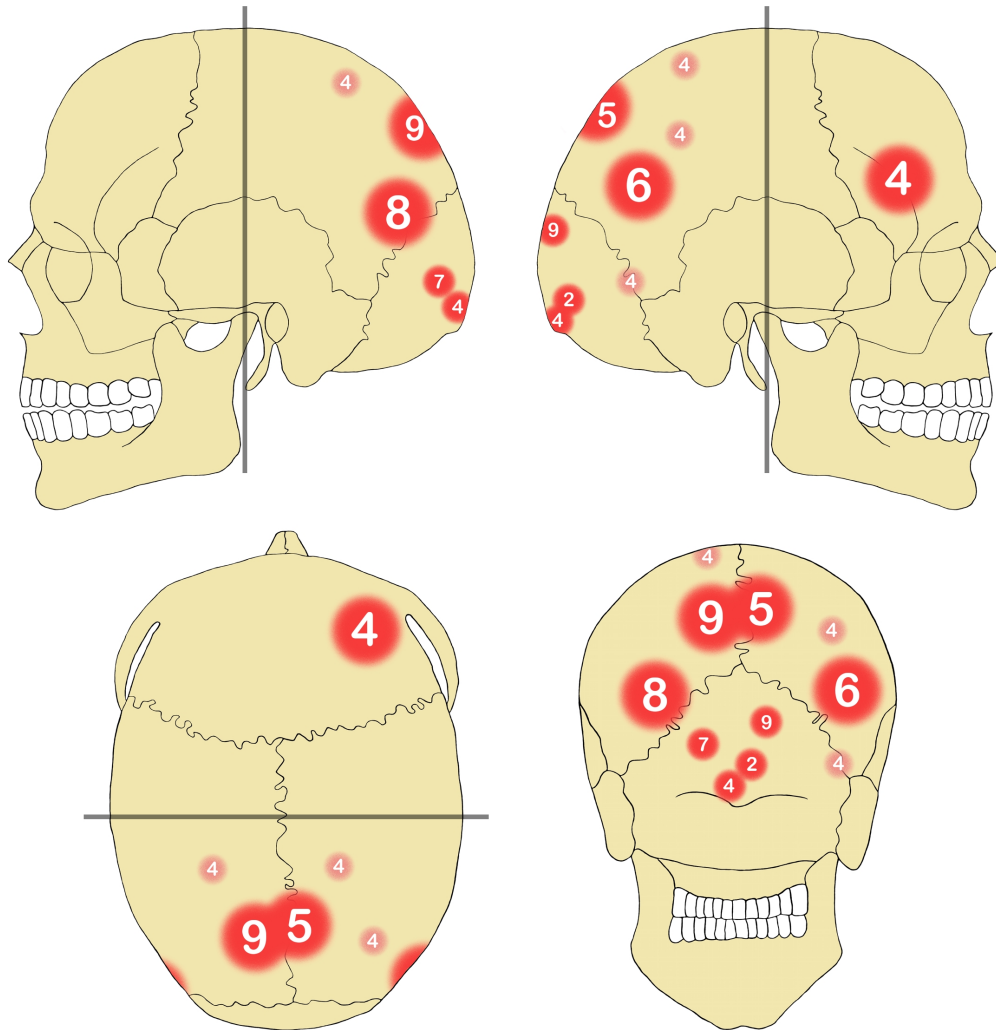
*Fig. 5.2. Examples of cranial perimortem blunt force trauma identified in the mass grave. a Trauma in the right half of the frontal bone in ind. 4. b Trauma in the left parietal bone of ind. 9. c Trauma in the midline of the occipital bone (near bregma) in ind. 5. d Trauma in the left half of the occipital bone of ind. 7. e, f Trauma in the right half of the occipital bone in ind. 9. Panels a-e in ectocranial view; panel f in endocranial view. Scale bar length is 2 cm.*

Ind.	Sex	Age, y	Height, cm	ICT	IPT	ICD
1	M	25-35	166	(no skull preserved)	-	possible
2	M	30-40	171	Occipital R	-	yes
3	F?	21-26	152	(no skull preserved)	-	yes
4	M	25-35	162	Frontal R, Parietal RL, Occipital RL	-	no
5	M	16-20	-	Parietal RL	-	yes
6	M	30-40	161	Parietal R	Humerus R	yes
7	M	25-35	163	Occipital L	Femur R	possible
8	M?	25-40	-	Parietal L, Occipital L	Humerus L, Ribs L	possible
9	M	25-40	-	Parietal L, Occipital R	-	no

*Table 5.1. Osteological characteristics of the individuals found in the mass grave. ICT – identified cranial trauma; IPT – identified postcranial trauma; ICD – identified carnivore damage; y – years; M – male; F – female; R – right; L – left.*

Individuals 5 to 8 have one cranial injury, ind. 9 likely suffered two, and ind. 4 shows at least five or, more likely, six separate traumata. As the skeletal remains are incompletely preserved, it is possible that more injuries had originally been present. Also, due to the fragmentary and fragile condition of some of the bones, cranial trauma has initially been subdivided into securely identified perimortem trauma (9, 69%) and likely perimortem trauma (4, 31%). All instances of the latter are found in ind. 4, who also shows two securely identified perimortem cranial fractures. The recognised injuries as a whole are almost exclusively located in the posterior half of the skull (12, 92%), affecting the posterior parts of the parietal (7, 54%) and the superior parts of the occipital bones (5, 38%) (Fig. 6.3). Only one perimortem trauma is found on a frontal bone (1, 8%). This injury is again found in ind. 4 and represents one of the securely identified fractures. The locations of the likely injury zones of ind. 4, the most traumatised individual in the sample, are within the same areas as in all other individuals, thereby supporting the overall pattern. Therefore, both trauma categories are pooled again for all further discussion. More injuries are found on the right side (8.5, 65%) than on the left side of the cranium (4.5, 35%), which is also the case at Talheim and Asparn<sup>20-22</sup>. Due to incomplete preservation of fracture margins and missing bone fragments, size and shape could not be precisely determined for all traumatic lesions, but at least two of the best preserved traumata appear very similar in their dimensions (Fig. 5.2d-f). Both are roughly triangular in shape and are located in the horizontal midline of the occipital bone slightly above the external occipital protuberance and the superior nuchal line. The fracture in ind. 7 is slightly to the left of the median plane and measures ca. 23.4 × 16.8 mm; the fracture in ind. 9 is slightly to the right of the same plane and

measures ca. 24.4 × 17.7 mm. Several other fractures with incompletely preserved margins located in the occipital bone appear to have been of roughly similar sizes, measuring between ca. 19.4 and 21.4mm in one of their dimensions.



*Fig. 5.3. Compilation of the approximate locations of cranial trauma. Signature size represents general trauma size (large vs. small), darker shading represents securely identified trauma, lighter shading represents likely trauma. Signature locations indicate approximate points of initial impact. Numbers indicate the affected individuals with skulls preserved (ind. 2; inds 4–9).*

In general, the identified cranial injuries show the known characteristics of perimortem blunt force trauma, with internal beveling, concentric and radiating fracture lines, and depressed external fracture margins<sup>36</sup>.



*Fig. 5.4. Examples of postcranial perimortem trauma identified in the mass grave. a Shaft fracture of the right femur in ind. 7. b Shaft fracture of the right humerus in ind. 6. c Cutmarks in two left ribs in ind. 8. Scale bar length is 2 cm.*

In addition, at least three major limb bones of three different individuals show perimortem fractures. The right femur of ind. 7 (Fig. 5.4a) and the left humerus of ind. 8 are fractured about midshaft. The right humerus of ind. 6 has a fracture in the distal third of its shaft (Fig. 5.4b). All three fractures are complete. Two likely cases of similar fractures are present in one fibula fragment and one forearm bone fragment, both of which had been collected as loose finds from the mass grave prior to the block-lift. One further perimortem trauma has been identified in two neighbouring left ribs in ind. 8. In contrast to all other injuries, these lesions resulted from sharp force trauma and seem to have been caused by a single cut orientated vertically to the axis of the affected bones (Fig. 5.4c). Besides the perimortem traumata, very few other pathological conditions could

be identified, none of which seem to be related to the specific burial context under consideration here. These lesions consist of isolated Schmorl's nodes in the vertebral column of ind. 2, healed avulsion injuries of lumbar vertebrae 3 and 4 in ind. 8, and a single caries lesion of the lower right first molar in ind. 9.



*Fig. 5.5. Examples of aberrant positioning of perimortem fractured limbs. In situ positions of the perimortem fractured right upper limb in ind. 6 (humerus; yellow) and right lower limb in ind. 7 (femur; red).*

### ***Taphonomy***

The bodies appear to have been dumped into the pit without care for their individual positions, which differ from those encountered in carefully arranged LBK burials<sup>14, 15</sup>. The spread of the corpses followed the outline of the pit, the limbs apparently remained as they had fallen. This is exemplified most clearly by the aberrant positions of the perimortem fractured arm and leg bones of two of the individuals (Fig. 5.5). The complete fractures of the shafts acted like

additional joints in these cases which resulted in ca. 90° angles between the fracture ends. Their spatial relations also indicate that, although complete osteological discontinuity occurred, soft tissue connections were still in place. In the right femur of ind. 7, the distance between both fracture ends implies that these soft tissue connections were not wholly complete anymore, allowing the proximal end of the distal part of the limb to rotate away from the distal end of the proximal part upon deposition, while still remaining partly attached.

Upon excavation, several major skeletal elements were already missing (Fig. 5.1). These include the complete skulls of inds. 1 and 3, and most of the skull of ind. 2. The upper half of the body of ind. 1 is absent, as well as its left lower leg bones. Ind. 2 is missing the bones of its right leg and most parts of the left lower leg, while the proximal part of the left tibia is still present and articulated. Ind. 4 is missing the left leg bones, ind. 5 the right lower leg bones, ind. 6 the left leg bones including the left pelvic bone and sacrum, ind. 8 the bones of both forearms, the left femur and all right leg bones. In ind. 9, all bones distal to the fifth cervical vertebra are absent. There is a possibility that the remains labelled ind. 1 and ind. 9 are actually part of the same individual, but the distance between these partially preserved remains and their different orientation rather suggest that they belong to different individuals, as all other major body parts actually present in the feature were still articulated upon deposition.

Many smaller elements, especially of the hands and feet, but also cranial fragments, ribs and vertebrae, are missing as well. These elements have most likely been displaced and removed over time by small burrowing animals. Evidence for rodent activity is manifold, and includes smaller bones and pottery

fragments scattered throughout the feature. Infilled rodent tunnels were observed entering the mass grave in different places, rodent skeletal remains were found within the grave fill and several human bones show clear traces of rodent gnawing<sup>37</sup> (Fig. 5.6a). Bone damage typical for perimortem carnivore gnawing activity is evident in several individuals<sup>37</sup> (Fig. 5.6b, c; Table 5.1), and is securely identified in skeletal elements along the north-western edge of the mass grave feature. All affected bones are elements of limbs that are missing their distal parts, for example the left tibia of ind. 2 or the right femur of ind. 5. Both of these gnawed bone ends came to rest right at the edge of the feature in the same spot. It is highly likely that the parts missing distal to securely identified carnivore gnawing traces have been removed by these animals. In cases where no carnivore damage was observed, animals might have been responsible for missing bones as well, but later human activity might also have accidentally removed these elements over the millennia. This is quite likely for example for the right leg bones of ind. 8 and the left leg bones of ind. 4.



*Fig. 5.6. Examples of animal damage to the bones from the mass grave. a Typical rodent gnawing damage above the right orbit in the skull of ind. 7. b Carnivore gnawing damage to the distal right tibia in ind. 3, partly overlain by root etching. c Carnivore gnawing damage to the proximal left tibia in ind. 2. Scale bar length is 2 cm.*

In this area at the southeastern fringe, the edge of the mass grave feature could not be determined anymore, as there is evidence for a later disturbance of significant extent (Fig. 5.1). As both of these legs have been detached at the hip joint, it can be assumed that the bodies had already been skeletonised when this disturbance occurred. Recent mechanical bone damage is evident in several cases, which affected the topmost layer of bones. This damage can in large part be attributed to the routine preparatory utilisation of heavy machinery during the first steps of the excavation before the presence of the mass grave was known.

### ***Stable Isotope Analyses***

Strontium isotope analysis ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) on tooth enamel and carbon and nitrogen isotope analyses ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) on bone collagen disclosed non-local origins and distinct dietary habits of the individuals interred in the mass grave in comparison to the regular settlement burials at the same site (Fig. 5.7; Tables 5.S2–5.S4). The isotopic composition of strontium, which substitutes for calcium in the hydroxyapatite, depends on the geologic conditions in the area from where food and drink were obtained during enamel formation in childhood. Isotope ratios that differ from local baseline data reveal non-local individuals, while isotopic differences between subsequently formed teeth point to residential changes during childhood<sup>38</sup>.  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios were determined for a first and a third molar each from the six individuals where dentitions were available. First molars represent a time span between birth and about 3 years of age, while the crowns of third molars form between about 7 and 14–16 years<sup>39</sup>.

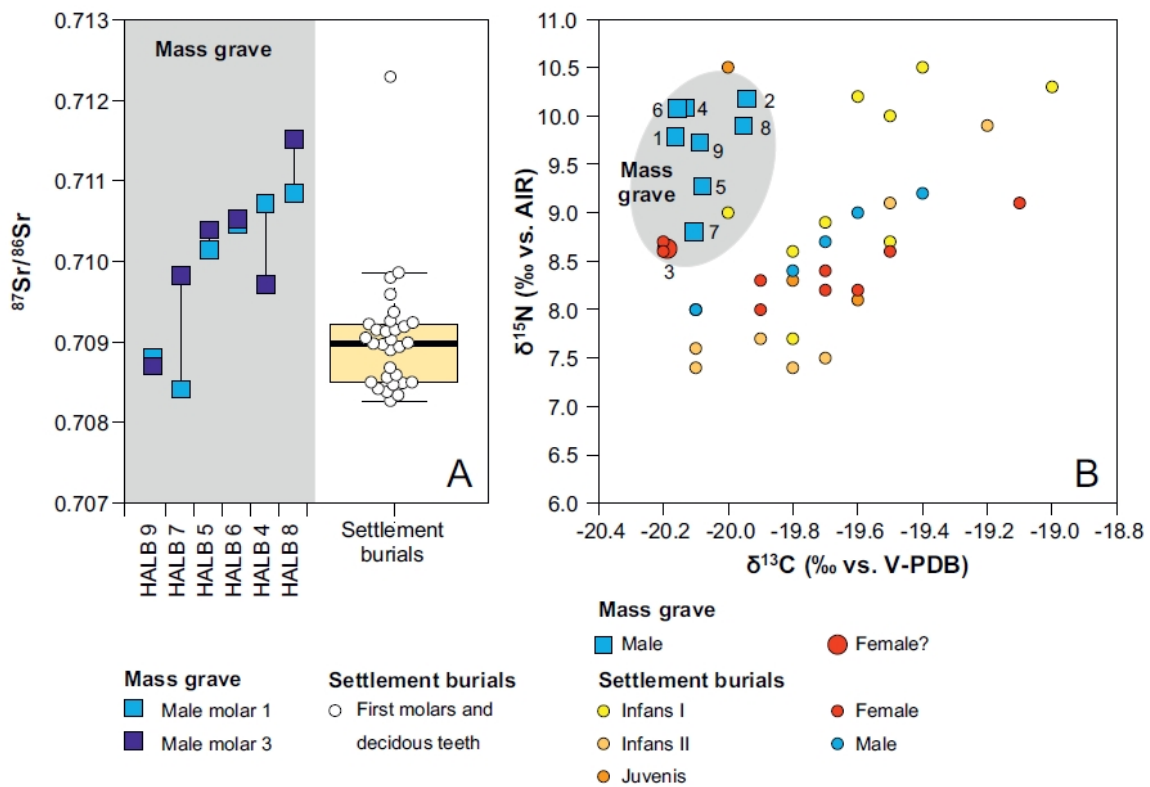


Fig. 5.7. Results of the strontium, carbon and nitrogen isotope analyses. Strontium isotope ratios of enamel (a) and carbon and nitrogen isotope data of bone collagen (b) of the individuals from the mass grave in comparison to data from regular LBK and likely LBK settlement burials at Halberstadt. Both analytical methods show the mass grave individuals to be different from the regular interments implying both non-local origins and distinct dietary habits. Individuals subsequently identified as non-LBK have been removed from the settlement burial dataset published previously.

The  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios of the individuals in the mass burial ranged between 0.70841 and 0.71151. While individuals 4, 5, 6, and 8 exhibited more radiogenic  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios than most of the settlement burials and individual 7 had a rather large difference of 0.00140 between his first and third molar, only the Sr isotope data of ind. 9 were well comparable with those of the settlement burials as a

whole (Fig. 5.7a). Assuming that the regular settlement burials represent the local population, this suggests that the individuals in the mass grave were largely non-local to the site.

Carbon and nitrogen isotope ratios of bone collagen reflect dietary compositions including the contribution of C3 and C4 plants, meat and dairy products, freshwater and marine fish<sup>40</sup>, but also manuring<sup>8</sup>. The  $\delta^{13}\text{C}$  values of the bone collagen from the individuals in the mass grave ranged between  $-20.2$  and  $-19.9\text{‰}$  (vs. V-PDB), while the  $\delta^{15}\text{N}$  exhibited values between  $8.6$  and  $10.2\text{‰}$  (vs. AIR). They form a narrow data cluster of distinctly lower  $\delta^{13}\text{C}$  and higher  $\delta^{15}\text{N}$  values than the settlement burials<sup>41</sup> (Fig. 5.7b). Both the Sr and the C and N isotope data characterise the individuals in the mass grave as clearly distinct from the settlement burial population.

## **Discussion**

The number of LBK sites showing unusual burial practices and lethal collective violence is slowly but steadily growing<sup>20-24, 28, 35</sup>. The mass grave of Halberstadt represents the most recent addition in this regard that can be placed into the general context of Early Neolithic warfare, defined here as violent organised conflict between independently acting and likely territorial groups<sup>42, 43</sup>. Although the general occurrence of warfare in the Early Neolithic of Central Europe is now largely accepted<sup>25, 44, 45</sup>, its scope and overall impact are still sometimes disputed<sup>18, 19, 46</sup>. It is therefore important to briefly consider the general context in which LBK warfare likely occurred. In the Early Neolithic,

political power was not centralised. Rather, local communities, or groups of communities, or maybe even subgroups within settled communities, probably connected by kinship ties regardless of the level of organisation<sup>47</sup>, very likely acted independently from each other as separate political units. Therefore, Early Neolithic warfare as such was necessarily restricted to the same local or regional level and local LBK communities, or possibly alliances of communities, are thought to have been perpetrators and victims alike of the massacres known so far. These also represent the best physical and only direct evidence for actual LBK warfare. In this general context, the massacres have to be taken primarily as separate instances of warfare occurring largely independently from each other and not as part of an all-encompassing, simultaneously occurring pan-LBK conflict. However, as the massacres are not randomly distributed through time, but apparently cluster near the end of the LBK sequence in the decades before 5000 cal BC, it is very likely that they have to be regarded as stark symptoms of profound changes that affected the interlinked social and natural landscapes of large parts of the LBK universe during this time<sup>24, 44</sup>. Climate-induced drops in agricultural production, the mounting consequences of inherited claims to agricultural land and increasing hierarchical differentiation are among the likely factors for furthering the rise of social tensions and, ultimately, of lethal conflicts between independently acting groups<sup>3, 9, 10, 24</sup>.

In addition to the skeletal evidence for perimortem collective lethal violence, as well as possible torture, mutilation, dismemberment and cannibalism<sup>35</sup>, healed injuries are known from skeletons from various LBK burial contexts. These mostly include isolated traces of blunt force and arrow injuries<sup>48, 49</sup>, the same kind of wounds encountered unhealed in higher numbers in the massacre

samples. Generally, these healed injuries indicate that violent interactions were not always fatal, but their specific context cannot be reconstructed anymore for individuals interred long afterwards in regular cemeteries<sup>50</sup>. While such wounds may have been received during massacres, either as an active participant or as a surviving victim, they may also stem from interpersonal violence on an individual or familial level. But taken together, there is now ample evidence that collective violence was a major societal issue at least for later LBK populations.

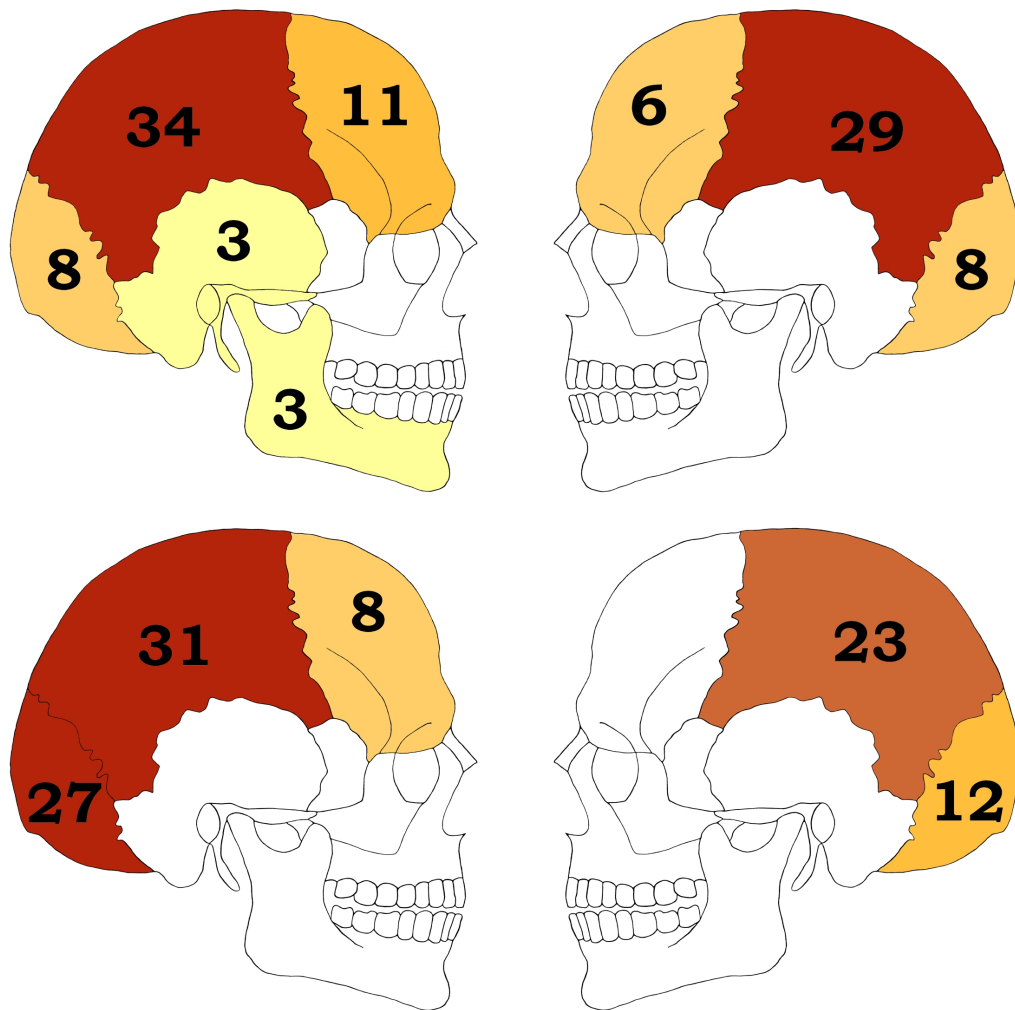
The mass grave of Halberstadt now adds previously undescribed features to LBK collective violence, its context, consequences, and repercussions. The demography is clearly different from the other violence-related mass fatality sites and especially noteworthy is the lack of children. This indicates a context very different from the other sites, as children would undoubtedly have been present in a settlement which came under attack. Children are numerous throughout the known examples of massacres and ritual mass dismemberment<sup>20-24, 35</sup>. This clearly shows that children were not exempt from a violent death but were in fact common casualties<sup>34</sup>. As the Halberstadt mass burial was placed in an LBK settlement area, sound reasons need to be identified for why no children are included. The obvious dominance of younger adult males is equally striking. In contrast to all other sites of LBK regular or irregular burial, the Halberstadt mass grave sample is highly selected towards this group. In fact, the demographic profile rather fits an attacking than an assorted assaulted group<sup>51</sup>. This interpretation is supported by the isotope data, which show that the males in the disorganised mass grave differed from the carefully interred settlement burials regarding geographical origins and dietary

habits. Judging from their bioarchaeological profiles, especially the radiogenic  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios of their enamel, the killed men can be regarded as nonlocals, originating from outside the regular marriage networks and/or recruitment areas of the Halberstadt LBK community.

Massacres and warfare are generally male-dominated activities<sup>30, 45</sup>, and the clear association of weaponry with the male sex supports this view also for the LBK<sup>9</sup>. Furthermore, no significant pathological conditions were found in the skeletal remains that might have had a debilitating effect during life. In contrast, the known Neolithic massacre samples usually contain several individuals handicapped for example by previous traumatic injuries or infectious disease<sup>20, 24, 52</sup>, just like regular attritional burial sites<sup>53, 54</sup>. Such physical handicaps will naturally occur in a cross- or longitudinal section of a settled community as the consequences of an agricultural lifestyle<sup>55</sup>, but not so much in a group of younger men likely chosen for their warfare-related prowess<sup>56</sup>.

Comparing the patterns of perimortem cranial trauma, the Halberstadt sample is again set apart from the previously discovered LBK massacre sites. Injuries cluster almost exclusively at the back of the head at Halberstadt, with only a single deviation from this pattern in the most traumatised individual overall (Fig. 5.3). Such a tightly circumscribed distribution of wounds is not found at Kilianstädten, Asparn, or Talheim, where more blows hit the frontal than the occipital bones (Fig. 5.8). Still, it is thought that the victims at Talheim and Asparn were mostly hit from behind, probably while fleeing from their attackers during the chaotic and uncontrolled massacre<sup>20-23</sup>. In contrast, the tightly clustered injury distribution at Halberstadt indicates the deliberate exertion of control

and a clearly targeted application of lethal blunt force trauma to the back of the head<sup>57</sup>. The regularity in the placement of the killing blows fits the previously formulated expectations for Neolithic mass execution<sup>21</sup>, which have not been identified at the other mass fatality sites.



*Fig. 5.8. Comparison of perimortem cranial trauma distributions in two LBK mass grave sites. Numbers and respective shading depict approximate percentages of overall blunt force cranial trauma identified at Talheim (top) and Halberstadt (bottom). Talheim data adapted from the literature.*

Although the practice of execution has been suggested previously for the LBK and other Neolithic cultures<sup>35, 58</sup>, firm evidence in the form of standardised cranial injury patterns coupled with a highly selected population sample has so far been lacking.

The killing of people, e.g. captured enemies, under controlled conditions has been a feature of many societies and may have included their previous torture and humiliation<sup>27, 59</sup>. The postcranial perimortem injuries in the Halberstadt individuals may have been caused by such actions, but in contrast to the Kilianstädten sample they are far less common and not as systematic. Alternatively, they may be concomitants of the capture of the individuals with injuries occurring either accidentally or intentionally during a violent struggle<sup>50, 52</sup>.

Carnivore damage has also been found in the skeletal remains at Asparn<sup>23</sup>, which indicates a time of exposure of the bodies. But in contrast to Asparn, the Halberstadt dead were collected into the mass grave a short while after death, as the bodies still retained most of their anatomical integrity upon deposition. As all securely identified cases of carnivore damage in the Halberstadt sample have been found right at the edge of the grave feature in three different places, it is conceivable that the bodies were not covered completely at first. Possibly, the distal parts of some limbs remained accessible to carnivores and were gnawed off at the edge of the feature. Alternatively, the carnivore damage occurred prior to deposition in the mass grave.

The general presence of carnivore gnawing adds to the interpretation that the Halberstadt mass grave sample represents the careless disposal of executed others<sup>31, 60</sup>, individuals that were not part of the local community. They might

have been part of a failed and partly captured raiding party attacking the local group that then chose to deny them a regular burial, thereby making a statement out of their violent end<sup>11, 12, 27</sup>. Alternatively, they might have been prisoners brought in from afar, although this does not fit well with the evidence from the other LBK massacre sites, where only women seem to have been captured alive. The lack of postmortem attention given to the bodies rather negates a very significant ritualistic component, as this usually is recognisable in Neolithic contexts either in the careful arrangement or the modification of the remains themselves<sup>35, 61, 62</sup>. Although it may be impossible to differentiate some sort of sacrifice from more pragmatic practises such as execution, the overall evidence gleaned from the mass grave of Halberstadt supports a pragmatic rather than ritualistic interpretation in direct comparison to the other LBK mass fatality sites.

In any case, the controlled and sometimes public killing of individuals or groups carries a serious message about who wields power over life and death<sup>11</sup>. As shown, the Halberstadt mass grave clearly deviates in content and context from the patterns of demography and trauma encountered in other LBK burial or massacre situations and indicates a controlled and systematic killing of a selected group of non-local people<sup>21, 57</sup>. This site therefore adds the previously discussed but so far unrecorded feature of mass execution as a form of culturally sanctioned violence to the known behavioural repertoire of the LBK. Despite being rare and certainly dependent on a suite of predisposing factors, this behaviour may have had a significant impact by solidifying social cohesion and creating an image of a group capable of successful retaliation<sup>27, 63</sup>. While the massacre sites of Talheim, Asparn and Kilianstädten show that warfare and the

destruction of whole communities were indeed part of Early Neolithic life, the mass grave of Halberstadt now elucidates further aspects of violent actions and reactions during the time of the first farming culture of Early Neolithic Central Europe.

## **Methods**

### ***Excavation and block-lifting***

After the mass grave was unexpectedly discovered during regular excavation prior to construction work, the top layer of skeletal remains was exposed on site to assess the overall size and complexity of the burial feature. Already displaced bone fragments were collected by the field team. It was then decided to block-lift the complete feature in one piece to enable a later detailed bioarchaeological dissection of the block-lifted mass grave under controlled indoor conditions. The subsequent further excavation and disassembly of the feature was carried out in the central finds depot of the State Office for Heritage Management and Archaeology in Halle (Saale), Germany and focused on osteologically defined individuals until all skeletal remains and other finds had been removed.

### ***Osteological preparation and analysis***

After the successive removal of the skeletal remains from the block-lifted feature, the adhering loose soil was removed from the bones with cold water

and soft toothbrushes. After this step, most bone surfaces were still covered by extensive and irregular layers of compact calcareous encrustations. In part, these were carefully removed mechanically during the drying process at room temperature. In cases where the encrustations could not thus be removed without damaging the bone substance, the bones were soaked in 10% acetic acid until most of the adhering concretions were dissolved, then rinsed again repeatedly with water and dried at room temperature. Overall, encrustations were removed as far as possible from the diagnostically relevant bones to enable a full osteological analysis. Morphognostic methods were used in age and sex estimation of the individuals, as summarised in detail in the standard manuals<sup>39, 64, 65</sup>. Age estimation was based on a summary assessment of skeletal and dental development, maturation, wear and degeneration of all available skeletal elements. Sex estimation primarily made use of dimorphic pelvic features, followed by cranial features and comparative osteometric assessment of the postcranial skeleton. Body height was calculated using the Pearson formulae also assembled for easy use in the standard manuals<sup>65</sup>. Pathological and taphonomical alterations of the bones were assessed in reference to the respective standards of the field<sup>36, 37, 65, 66</sup>. The bone fragments collected prior to the block-lifting process were reattributed to the respective individuals during the osteological analysis as far as possible. Some bones could not be securely reattributed, but these did not raise the number of individuals represented and did not carry significant further information relevant for this study. For statistical testing Fisher's Exact Test (one-tailed) has been used<sup>67</sup>.

### ***Strontium isotope analysis***

Strontium isotope analysis followed previously established protocols<sup>68</sup>. Enamel samples were cut from tooth crowns and all surfaces and dentine were removed using diamond-coated dental cutting and drilling equipment. The samples were then powdered in an agate mortar, pre-treated with buffered acetic acid and ashed. Sr was separated under clean-room conditions using Eichrom Sr-Spec resin. Sr concentrations were determined by Quadrupole-Inductively Coupled Plasma-Mass Spectrometry (Q-ICP-MS) and  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios by High-Resolution Multi Collector-ICP-MS (Neptune) at the Curt-Engelhorn-Centre for Archaeometry in Mannheim, Germany. Raw data were corrected according to the exponential mass fractionation law to  $^{88}\text{Sr}/^{86}\text{Sr} = 8.375209$ . Blank values were lower than 10 pg Sr during the whole clean lab procedure. The NBS 987 and Eimer & Amend (E & A) standards run along with the human samples yielded  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios of  $0.71024 \pm 0.00001$ ,  $2\sigma$ ;  $n = 5$  and  $0.70802 \pm 0.00001$ ,  $2\sigma$ ;  $n = 4$ , respectively.

### ***Carbon and nitrogen isotope analysis***

Sample preparation for carbon and nitrogen isotope analysis followed previously published protocols<sup>69</sup> with omission of the ultrafiltration step. Compact bone samples were cut, the surfaces removed, and demineralised in 10 ml of 0.5 N HCl at initially 4 °C and later at room temperature for 14 days, rinsed to neutrality and reacted with 10 ml of 0.1M NaOH for 24 h at 4 °C, rinsed again to neutrality and gelatinised in 4ml of acidified H<sub>2</sub>O (pH 2–3) for 48 h at 75 °C.

Insoluble particles were separated using EZEE filter separators, and the collagen frozen and lyophilised. C and N contents and the stable isotopic compositions were determined in triplicates using a Thermo Flash 2000 Organic Elemental Analyzer coupled to a Thermo Finnigan Mat 253 mass spectrometer at the Department of Applied and Analytical Palaeontology, Institute of Geosciences at the University Mainz. The raw data were calibrated against the international Standards USGS 40 and USGS 41. Interspersed samples of IAEA CH6 gave a mean  $\delta^{13}\text{C}$  value of  $-10.35 \pm 0.01\text{‰}$  and IAEA N2 gave a mean  $\delta^{15}\text{N}$  value of  $20.61 \pm 0.06\text{‰}$ .

### ***Radiocarbon dates***

Two independent and securely attributed bone samples were collected from inds 2, 3 and 7 each during excavation and were submitted for AMS radiocarbon dating at the Klaus-Tschira-Laboratory for Radiometric Dating Methods, Mannheim, Germany. Results were calibrated and further analysed using the online version of OxCal v4.3/IntCal13 (Figs 5.S2 and 5.S3; Table 5.S1). Within the text, the  $2\sigma$  date ranges are used.

### ***Data availability***

All relevant data are included in the manuscript and the supplementary information. The human skeletal remains recovered from the mass grave (A6500/D879; feature 100202) are housed at the State Office for Heritage Management and Archaeology of Saxony-Anhalt in Halle (Saale), Germany under

catalogue numbers 6500:100202:1-154.

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## References

1. Modderman, P. J. R. The linear pottery culture: diversity in uniformity. *Ber. Rijksd. Oudheidkd. Bodemonderz.* 38, 63–139 (1988).
2. Bickle, P. & Whittle, A. (eds) *The First Farmers of Central Europe* (Oxbow, Oxford, 2013).
3. Gronenborn, D., Strien, H.-C., Dietrich, S. & Sirocko, F. ‘Adaptive cycles’ and climate fluctuations: a case study from linear pottery culture in western Central Europe. *J. Archaeol. Sci.* 51, 73–83 (2014).
4. Bramanti, B. et al. Genetic discontinuity between local hunter-gatherers and central Europe’s first farmers. *Science* 326, 137–140 (2009).
5. Haak, W. et al. Ancient DNA from European early Neolithic farmers reveals their Near Eastern affinities. *PLoS Biol.* 8, e1000536 (2010).

6. Brandt, G. et al. Ancient DNA reveals key stages in the formation of Central European mitochondrial genetic diversity. *Science* 342, 257–261 (2013).
7. Szécsényi-Nagy, A. et al. Tracing the genetic origin of Europe's first farmers reveals insights into their social organization. *Proc. R. Soc. B* 282, 20150339 (2015).
8. Bogaard, A. et al. Crop manuring and intensive land management by Europe's first farmers. *Proc. Natl Acad. Sci. USA* 110, 12589–12594 (2013).
9. Bentley, R. A. et al. Community differentiation and kinship among Europe's first farmers. *Proc. Natl Acad. Sci. USA* 109, 9326–9330 (2012).
10. Bentley, R. A., O'Brien, M. J., Manning, K. & Shennan, S. On the relevance of the European Neolithic. *Antiquity* 89, 1203–1210 (2015).
11. Martin, D. L., & Harrod, R. P. Bioarchaeological contributions to the study of violence. *Yearb. Phys. Anthropol.* 156, 116–145 (2015).
12. Meyer, C. et al. in *Early Farmers* (eds Whittle, A. & Bickle, P.) 307–325 (Oxford University Press, Oxford, 2014).

13. Trautmann, I. *The Significance of Cremations in Early Neolithic Communities in Central Europe*. PhD thesis, University of Tübingen (2006). <http://nbnresolving.de/urn:nbn:de:bsz:21-opus-30056>
14. Nieszery, N. *Linearbandkeramische Gräberfelder in Bayern* (Marie L. Leidorf, Espelkamp, 1995).
15. Hofmann, D. in *Creating Communities* (eds Hofmann, D. & Bickle, P.) 220–234 (Oxbow, Oxford, 2009).
16. Peschel, C. *Regel und Ausnahme* (Marie L. Leidorf, Buch am Erlbach, 1992).
17. Zeeb-Lanz, A., Haack, F. & Bauer, S. Menschenopfer–Zerstörungsrituale mit Kannibalismus–Schädelkult: Die aussergewöhnliche bandkeramische Anlage von Herxheim in der Südpfalz. *Mitt. Hist. Ver. Pfalz* 111, 385–433 (2013).
18. Link, T. in *Gewalt und Gesellschaft* (eds Link, T. & Peter-Röcher, H.) 271–286 (Habelt, Bonn, 2014).
19. Zeeb-Lanz, A. in *Gewalt und Gesellschaft* (eds Link, T. & Peter-Röcher, H.) 257–270 (Habelt, Bonn, 2014).

20. Wahl, J. & König, H. G. Anthropologisch-traumatologische Untersuchung der menschlichen Skelettreste aus dem bandkeramischen Massengrab bei Talheim, Kreis Heilbronn. *Fundber. Baden-Württemberg* 12, 65–186 (1987).
21. Wahl, J. & Trautmann, I. in *Sticks, Stones, and Broken Bones* (eds Schulting, R. & Fibiger, L.) 77–100 (Oxford University Press, Oxford, 2012).
22. Teschler-Nicola, M. et al. Evidence of genocide 7000 BP–Neolithic paradigm and geo-climatic reality. *Coll. Antropol.* 23, 437–450 (1999).
23. Teschler-Nicola, M. in *Sticks, Stones, and Broken Bones* (eds Schulting, R. & Fibiger, L.) 101–120 (Oxford University Press, Oxford, 2012).
24. Meyer, C., Lohr, C., Gronenborn, D. & Alt, K. W. The massacre mass grave of Schöneck-Kilianstädten reveals new insights into collective violence in Early Neolithic Central Europe. *Proc. Natl Acad. Sci. USA* 112, 11217–11222 (2015).
25. Meller, H. in *Krieg. Eine archäologische Spurensuche* (eds Meller, H. & Schefzik, M.) 109–116 (Theiss, Darmstadt, 2015).
26. Keeley, L. H. *War Before Civilization* (Oxford University Press, New York, 1996).

27. Otterbein, K. F. *How War Began* (Texas A&M University Press, College Station, 2004).
28. Meyer, C., Kürbis, O. & Alt, K. W. Das Massengrab von Wiederstedt, Ldkr. Mansfelder Land. Auswertung und Gedanken zur Deutung im Kontext der Linienbandkeramik. *Jahresschr. Mitteldtsch. Vorgesch.* 88, 31–66 (2004).
29. Veit, U. Burials within settlements of the Linienbandkeramik and Stichbandkeramik cultures of Central Europe. On the social construction of death in Early-Neolithic society. *J. Eur. Archaeol.* 1, 107–140 (1992).
30. Dwyer, P. G. & Ryan, L. in *Theatres of Violence* (eds Dwyer, P. G. & Ryan, L.) xi–xxv (Berghahn, New York, 2012).
31. LeBlanc, S. A. & Register, K. E. *Constant Battles. Why We Fight* (St. Martin's Press, New York, 2003).
32. Fritsch, B., Claßen, E., Müller, U. & Dresely, V. Die linienbandkeramischen Gräberfelder von Derenburg "Meerenstieg II" und Halberstadt "Sonntagsfeld", Lkr. Harz. *Jahresschr. Mitteldtsch. Vorgesch.* 92, 25–229 (2011).
33. Nicklisch, N. *Paläodemografische und epidemiologische Untersuchungen an neolithischen und frühbronzezeitlichen Bestattungen aus dem*

*Mittelelbe-Saale-Gebiet im Kontext populationsdynamischer Prozesse.*  
Ph.D. thesis, University of Mainz (2014).

34. Fibiger, L. in *The Routledge Handbook of the Bioarchaeology of Human Conflict* (eds Knüsel, C. & Smith, M. J.) 127–145 (Routledge, Abingdon, 2014).
35. Boulestin, B. & Coupey, A.-S. *Cannibalism in the Linear Pottery Culture: the Human Remains from Herxheim* (Archaeopress, Oxford, 2015).
36. Knüsel, C. J. in *Warfare, Violence and Slavery in Prehistory* (eds Parker Pearson, M. & Thorpe, I. J. N) 49–65 (Archaeopress, Oxford, 2005).
37. Pokines, J. T. in *Manual of Forensic Taphonomy* (eds Pokines, J. T. & Symes, S. A.) 201–248 (CRC Press, Boca Raton, 2014).
38. Bentley, R. A. Strontium isotopes from the earth to the archaeological skeleton: a review. *J. Archaeol. Method Theory* 13, 135–187 (2006).
39. Szilvássy, J. in *Anthropologie Vol. I* (ed. Knußmann, R.) 421–443 (Fischer, Stuttgart, 1988).
40. Katzenberg, A. M. in *Biological Anthropology of the Human Skeleton* (eds Katzenberg, A. M. & Saunders, S. R.) 413–441 (Wiley, Hoboken, 2008).

41. Oelze, V. M. et al. Early Neolithic diet and animal husbandry: stable isotope evidence from three Linearbandkeramik (LBK) sites in Central Germany. *J. Archaeol. Sci.* 38, 270–279 (2011).
42. Ember, C. R. & Ember, M. in *Troubled Times* (eds Martin, D. L. & Frayer, D. W.) 1–20 (OPA, Amsterdam, 1997).
43. Maschner, H. D. G. & Reedy-Maschner, K. L. Raid, retreat, defend (repeat): the archaeology and ethnohistory of warfare on the North Pacific Rim. *J. Anthropol. Archaeol.* 17, 19–51 (1998).
44. Ferguson, R. B. in *War, Peace, and Human Nature* (ed. Fry, D. P.) 191–240 (Oxford University Press, New York, 2013).
45. Knüsel, C. & Smith, M. J. in *The Routledge Handbook of the Bioarchaeology of Human Conflict* (eds Knüsel, C. & Smith, M. J.) 656–694 (Routledge, Abingdon, 2014).
46. Zeeb-Lanz, A. in *Krisen–Kulturwandel–Kontinuitäten* (ed. Zeeb-Lanz, A.) 87–101 (Marie Leidorf, Rahden, 2009).
47. Bentley, R. A., Wahl, J., Price, T. D. & Atkinson, T. C. Isotopic signatures and hereditary traits: snapshot of a Neolithic community in Germany. *Antiquity* 82, 290–304 (2008).

48. Orschiedt, J., Häußler, A., Haidle, M. N., Alt, K. W. & Buitrago-Téllez, C. H. Survival of a multiple skull trauma: the case of an early neolithic individual from the LBK enclosure at Herxheim (Southwest Germany). *Int. J. Osteoarchaeol.* 13, 375–383 (2003).
49. Jeunesse, C., Barrand-Emam, H., Denaire, A. & Chenal, F. Unusual funeral practices and violence in Early Neolithic Central Europe: new discoveries at the Mulhouse-Est Linearbandkeramik. *Antiquity* 342, Online Project Gallery, <http://journal.antiquity.ac.uk/projgall/jeunesse342> (2014).
50. Judd, M. A. The parry problem. *J. Archaeol. Sci.* 35, 1658–1666 (2008).
51. Pollard, A. M., Ditchfield, P., Piva, E., Wallis, S., Falys, C. & Ford, S. ‘Sprouting like cockle amongst the wheat’: the St Brice’s Day massacre and the isotopic analysis of human bones from St John’s College. *Oxf. J. Archaeol.* 31, 83–102 (2012).
52. Meyer, C. et al. The Eulau eulogy: bioarchaeological interpretation of lethal violence in Corded Ware multiple burials from Saxony-Anhalt, Germany. *J. Anthropol. Archaeol.* 28, 412–423 (2009).
53. Meyer, C. et al. Die menschlichen Skelettfunde aus der neolithischen Totenhütte von Benzingerode. Anthropologische Untersuchungen an den Bestattungen eines Kollektivgrabs der Bernburger Kultur. *Archäol. Sachsen-Anhalt* Sonderband 7, 107–151 (2008).

54. Nicklisch, N. et al. Rib lesions in skeletons from Early Neolithic sites in Central Germany: on the trail of tuberculosis at the onset of agriculture. *Am. J. Phys. Anthropol.* 149, 391–401 (2012).
55. Loe, L., Boyle, A., Webb, H. & Score, D. *'Given to the Ground'. A Viking Age Mass Grave on Ridgeway Hill, Weymouth* (Dorset Natural History and Archaeological Society, Dorchester, 2014).
56. Eerkens, J. W. et al. Isotopic and genetic analyses of a mass grave in Central California: implications for precontact hunter-gatherer warfare. *Am. J. Phys. Anthropol.* 159, 116–125 (2016).
57. Ta'ala, S. C., Berg, G. E. & Haden, K. Blunt force cranial trauma in the Cambodian killing fields. *J. Forensic Sci.* 51, 996–1001 (2006).
58. Narr, K. J. in *Sprache, Symbole und Symbolverwendungen in Ethnologie, Kulturanthropologie, Religion und Recht* (eds Krawietz, W., Pospišil, L. & Steinbrich, S.) 291–305 (Duncker & Humblot, Berlin, 1993).
59. Otterbein, K. F. Killing of captured enemies: a cross-cultural study. *Curr. Anthropol.* 41, 439–443 (2000).

60. Komar, D. Patterns of mortuary practice associated with genocide. Implications for archaeological research. *Curr. Anthropol.* 49, 123–133 (2008).
61. Boulestin, B. et al. Mass cannibalism in the linear pottery culture at Herxheim (Palatinate, Germany). *Antiquity* 83, 968–982 (2009).
62. Robb, J., Elster, E. S., Isetti, E., Knüsel, C. J., Tafuri, M. A. & Traverso, A. Cleaning the dead: Neolithic ritual processing of human bone at Scaloria Cave, Italy. *Antiquity* 89, 39–54 (2015).
63. Armit, I. Violence and society in the deep human past. *Br. J. Criminol.* 51, 499–517 (2011).
64. White, T. D. & Folkens, P. A. *The Human Bone Manual* (Academic Press, San Diego, 2005).
65. Herrmann, B., Grupe, G., Hummel, S., Piepenbrink, H. & Schutkowski, H. *Prähistorische Anthropologie* (Springer, Berlin, 1990).
66. Ortner, D. J. *Identification of Pathological Conditions in Human Skeletal Remains* (Academic Press, San Diego, 2003).

67. Preacher, K. J. & Briggs, N. E. Calculation for Fisher's exact test: an interactive calculation tool for Fisher's exact probability test for 2 x 2 tables. <http://quantpsy.org/fisher/fisher.htm> (2001).
68. Knipper, C. et al. in *Migrations in Prehistory and Early History. Stable Isotopes and Population Genetics* (eds Kaiser, E., Burger, J. & Schier, W.) 293–317 (De Gruyter, Berlin, 2012).
69. Knipper, C. et al. Dietary reconstruction in migration period central Germany: a carbon and nitrogen isotope study. *Archaeol. Anthropol. Sci.* 5, 17–35 (2013).
70. Wahl, J. & Strien, H.-C. *Tatort Talheim* (Städtische Museen Heilbronn, Heilbronn, 2007).

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### **Author Contributions**

C.M., V.D., H.M. and K.A. designed the overall study; V.D., H.M. and K.A. supervised the study; C.M. and N.N. excavated the block-lifted feature and collected samples; O.K., V.D. and H.M. provided background information and facilitated the in situ excavation and analysis; C.M., N.N. and A.M. provided and analysed comparative data; C.M. and C.K. analysed primary data and wrote the manuscript with input from all other authors.

### **Additional Information**

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## Supplementary Information



*Fig. 5.S1. Map of Central Europe showing the site of Halberstadt-Sonntagsfeld (star) located within Germany (dark grey) and the German state of Saxony-Anhalt (light grey).*

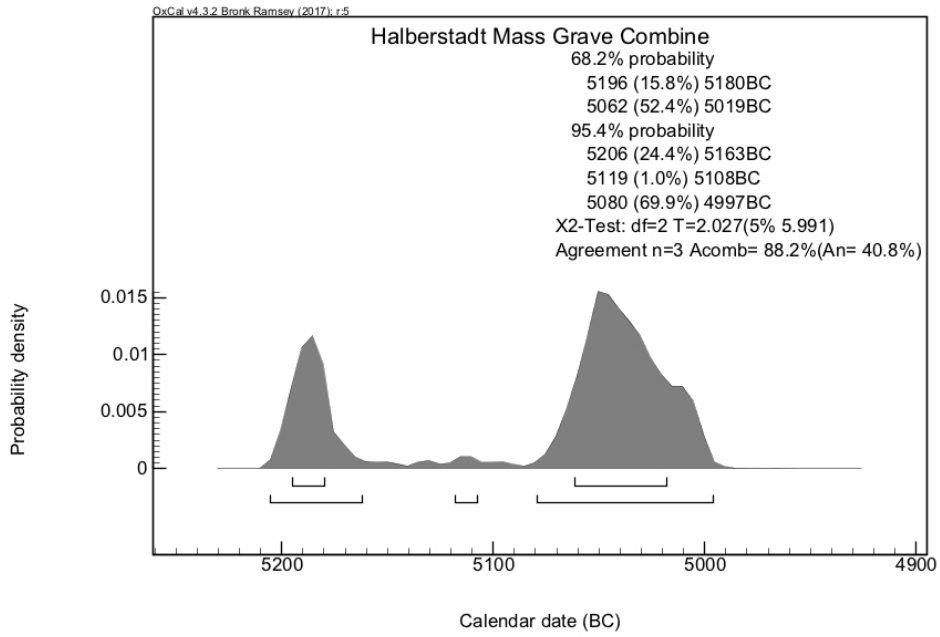


Fig. 5.S2. Single plot of “combined” radiocarbon dating results of six different bones from three different individuals from the mass grave of Halberstadt (using OxCal v4.3/IntCal13)<sup>1,2</sup>.

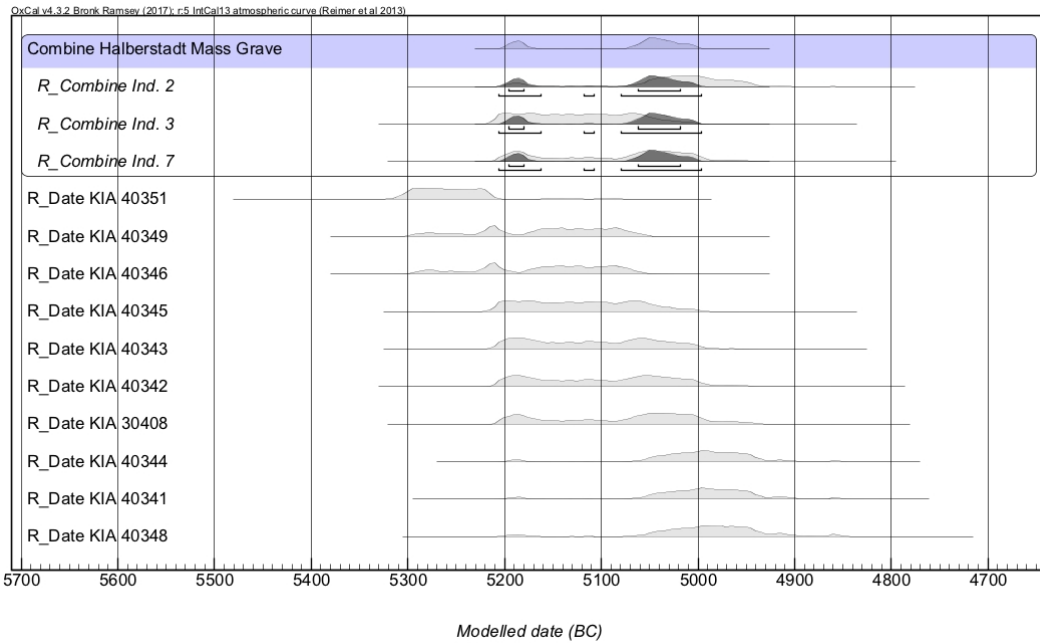


Fig. 5.S3. Multiplot of “combined” radiocarbon dating results of six different bones from three different individuals from the mass grave of Halberstadt (using OxCal v4.3/IntCal13)<sup>1,2</sup>, supplemented by previously published radiocarbon dating results of the regular Halberstadt LBK settlement burials<sup>3</sup>.

Lab no.	Ind.	Sample	14C age, y	±	Cal 1 $\sigma$	Cal 2 $\sigma$
MAMS 23988	2	Vertebra	6093	42	cal BC 5193-4943	cal BC 5208-4856
MAMS 23989	2	Rib	6096	42	cal BC 5194-4944	cal BC 5208-4859
Combined	2	-	6095	30	cal BC 5051-4962	cal BC 5206-4911
MAMS 23990	3	Rib	6141	42	cal BC 5207-5010	cal BC 5215-4965
MAMS 23991	3	Fibula	6183	42	cal BC 5212-5066	cal BC 5289-5004
Combined	3	-	6162	30	cal BC 5207-5056	cal BC 5214-5024
MAMS 23992	7	Fibula	6134	43	cal BC 5207-5000	cal BC 5213-4962
MAMS 23993	7	Rib	6122	43	cal BC 5207-4988	cal BC 5210-4949
Combined	7	-	6128	31	cal BC 5205-4997	cal BC 5210-4986

*Table 5.S1. Radiocarbon dating results of six different bones from three different individuals from the mass grave of Halberstadt, including OxCal v4.3/IntCal13<sup>1,2</sup> “R\_Combine” results for each dated individual. y – years.*

Ind.	Sample	Collagen yield (%)	C (%)	N (%)	Atomic C/N	$\delta^{13}\text{C}$ (‰ vs. V-PDB)	$\delta^{15}\text{N}$ (‰ vs. AIR)
1	Pelvis	8.1	43.1	15.3	3.3	-20.16	9.79
2	Rib	5.7	42.8	15.0	3.3	-19.94	10.17
3	Rib	5.1	41.8	14.7	3.3	-20.19	8.63
4	Rib	5.2	42.5	14.9	3.3	-20.13	10.08
5	Rib	7.3	42.9	15.1	3.3	-20.08	9.27
6	Rib	5.6	42.7	15.0	3.3	-20.16	10.08
7	Rib	8.2	43.3	15.3	3.3	-20.10	8.80
8	Rib	5.5	43.1	15.1	3.3	-19.95	9.90
9	Atlas	9.0	42.9	15.1	3.3	-20.09	9.72

*Table 5.S2. Carbon and nitrogen isotope data of bone collagen of the individuals interred in the mass grave at Halberstadt. The collagen yields, C and N contents and atomic C/N ratios of all samples are in agreement with accepted quality criteria<sup>4</sup>.*

<b>Ind.</b>	<b>Tooth</b>	<b><sup>87</sup>Sr/<sup>86</sup>Sr</b>	<b>2 SD</b>	<b>Tooth</b>	<b><sup>87</sup>Sr/<sup>86</sup>Sr</b>	<b>2 SD</b>
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	M 36	0.71071	0.00002	M 28	0.70971	0.00002
5	M 16	0.71014	0.00002	M 18	0.71039	0.00001
6	M 46	0.71045	0.00001	M 48	0.71052	0.00002
7	M 16	0.70841	0.00001	M 18	0.70981	0.00001
8	M 36	0.71084	0.00002	M 38	0.71151	0.00002
9	M 16	0.70881	0.00002	M 18	0.70870	0.00004

*Table 5.S3. Strontium isotope data of tooth enamel (permanent molars) of the individuals found in the mass grave at Halberstadt.*

<b>Lab no.</b>	<b><sup>87</sup>Sr/<sup>86</sup>Sr</b>	<b>2 SD</b>	<b>Lab no.</b>	<b><sup>87</sup>Sr/<sup>86</sup>Sr</b>	<b>2 SD</b>
HAL_1	0.70894	0.00003	HAL_16	0.70959	0.00001
HAL_2	0.71229	0.00010	HAL_17	0.70980	0.00004
HAL_3	0.70922	0.00003	HAL_18	0.70850	0.00005
HAL_4	0.70915	0.00006	HAL_19	0.70897	0.00006
HAL_5	0.70915	0.00003	HAL_20	0.70903	0.00007
HAL_6	0.70850	0.00003	HAL_21	0.70986	0.00002
HAL_7	0.70919	0.00002	HAL_22	0.70834	0.00004
HAL_8	0.70899	0.00003	HAL_23	0.70838	0.00001
HAL_9	0.70859	0.00002	HAL_24	0.70842	0.00004
HAL_10	0.70898	0.00002	HAL_25	0.70847	0.00004
HAL_11	0.70868	0.00002	HAL_26	0.70905	0.00004
HAL_12	0.70856	0.00005	HAL_27	0.70913	0.00003
HAL_13	0.70890	0.00001	HAL_28	0.70937	0.00006
HAL_14	0.70926	0.00003	HAL_29	0.70827	0.00006
HAL_15	0.70924	0.00002	HAL_30	0.70849	0.00001

*Table 5.S4. Comparative strontium isotope data of tooth enamel (first molars and deciduous teeth) of settlement burials at Halberstadt.*

### ***Supplementary References***

1. Bronk Ramsey, C. Bayesian analysis of radiocarbon dates. *Radiocarbon* **51**, 337-360 (2009).
2. Reimer, P. J. *et al.* IntCal13 and Marine13 radiocarbon age calibration curves 0-50,000 years cal BP. *Radiocarbon* **55**, 1869-1887 (2013).
3. Brandt, G. *et al.* Ancient DNA reveals key stages in the formation of Central European mitochondrial genetic diversity. *Science* **342**, 257-261 (2013).
4. van Klinken, G. J. Bone collagen quality indicators for palaeodietary and radiocarbon measurements. *J. Archaeol. Sci.* **26**, 687-695 (1999).

## CHAPTER 6

# Patterns of Collective Violence in the Early Neolithic of Central Europe

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## **Abstract**

In Central Europe, the Early Neolithic Linearbandkeramik (LBK) is the first archaeological culture that left behind a significant number of standardised grave features. These are mostly individual burials in cemeteries or settlements, in which the deceased were placed with care and were often accompanied by various grave goods. In addition, several sites of mass burial are now known for the LBK, which are mainly characterised by haphazard body positions, the absence of grave goods, and, in most cases, obvious signs of perimortem lethal violence. The number of individuals from the deviant mass burial sites allows the identification of significant demographic and injury patterns, which likely reflect the different contextual backgrounds for each site and may inform about past social practices. These patterns are examined in this paper.

The partial absence of younger women at Talheim, Asparn/Schletz, and Schöneck-Kilianstädten may be an indicator of the selective capturing of prisoners by Neolithic raiders, while people belonging to other sex and age groups were seemingly killed, mainly by blows to the head. Moreover, children are numerous at all three sites, so as to suggest that settled communities came under attack and were possibly wiped out as a result. While these massacre sites are quite similar in their demographic structure and cranial injury patterns, two other sites discussed in the chapter, namely, Wiederstedt and Halberstadt, markedly differ from them, thus suggesting different causes for the mass fatality events. At Wiederstedt, children dominate among the sample, but no clear signs of violence could be found, while at Halberstadt children are absent, younger men dominate the sample, and the cranial injuries are tightly

clustered at the back of the head. It is proposed that disease may have been the cause of death at Wiederstedt, while the Halberstadt men may have been detained and executed. However, despite originating from different events, all these mass fatality sites are unified by the enactment of deviant burial customs, which are quite different from normative LBK burials.

## **Introduction**

Violence targeted at the integrity of the human body may affect both individuals and populations and may be intentionally lethal or non-lethal, depending on scale and specific context. Compared to indirect archaeological evidence of violence, like weapons or defensive structures (Christensen 2004), the human skeleton is the sole direct indicator for violent episodes targeted at people that actually occurred in the prehistoric past and which thereby may provide insight into their social meanings (Martin and Harrod 2015). While isolated cases of individual victims of violence are known for several species of fossil hominids (e.g. Zollikofer et al. 2002; Wu et al. 2011; Sala et al. 2015), the archaeological evidence for collective violence, or warfare, defined here as the conscious application of potentially lethal violence by independently acting groups against other such groups, is currently restricted to roughly the last 10,000 years (e.g. Mirazón Lahr et al. 2016). This is likely influenced, in part, by the nature of the archaeological record itself, as the number and density of sites in any given area or time period are not uniformly distributed, and sites with preserved human

remains become ever sparser with increasing antiquity, thus reducing our chances to uncover solid archaeological evidence for group violence.

In Central Europe, cemeteries or other sites containing high amounts of skeletons only became numerous with the advent of the Early Neolithic and its main cultural group, the Linearbandkeramik (hereafter LBK; c.5600–4900 BC). This is also the time when victims of violence become much more visible in the osteoarchaeological record. This is especially true of the victims of collective lethal violence, for which the LBK has become almost notorious since the discovery of the first Early Neolithic massacre mass grave at Talheim, Germany (Wahl and König 1987; Wahl and Trautmann 2012). Since then, several other such sites have been found and analysed. In fact, the number of individuals excavated from currently known LBK mass violence sites is such that it now allows quantitative analysis. This may be informative not only about the style of warfare practised at the time, and of the weapons used (Wahl and Strien 2007), but also about the demography of victims as well as warfare-related practices such as torture, dismemberment, and mutilation, in short, about the patterns of collective violence practised by the first farmers of Central Europe.

As shown by numerous ethnographic and archaeological studies of ancient warfare, the conscious decision to attack and violently kill others often has its ultimate roots in real or imagined competition over geographically situated and limited resources. This is especially common at times of climatic instability, when the survival of the group is perceived to be threatened by fluctuating and thereby unpredictable, agricultural productivity (e.g. Maschner and Reedy-Maschner 1998; Otterbein 2004). However, unravelling the context of each act of collective violence becomes all the more challenging with increased antiquity

due to the paucity of corroborating information. When considering chronologically remote prehistoric societies, whose environments, worldviews, and perceptions of themselves and others are largely unknown to us, interpretation is difficult and will always remain speculative, at least partly. Nevertheless, robust insights into past societies and the violent events that impacted on them (both as individuals and as members of victimised groups) may be gained by grounding our analyses and interpretations in observable and objectively describable patterns. This chapter attempts such an analysis based on the human skeletal record for collective lethal violence in the Early Neolithic of Central Europe.

### **Burial and Violence in the Linearbandkeramik**

Generally, the identification of patterns of violence is grounded in the reliable recognition of past violence itself. In bioarchaeological terms, this may be evident from either skeletal injuries or the context in which the human skeletal remains of suspected violence victims are found – and occasionally from both (Martin and Harrod 2015). Especially if skeletal remains and burial features are adversely affected by taphonomic damage, opinions are sometimes divided as to what constitutes reliable evidence for lethal violence and what is simply the result of naturally occurring diagenetic processes (e.g. Mirazón Lahr et al. 2016; Stojanowski et al. 2016). Without going into too much methodological detail here, which would be beyond the scope of the present paper, perimortem

skeletal trauma and deviant deposition have to be evaluated as objectively as possible and always within their specific context.

For the LBK, there is a near-perfect overlap between the two, as individuals with lethal perimortem injuries are mostly found as part of larger groups in disorganised mass graves or as scattered remains at conflict sites (Wahl and König 1987; Teschler-Nicola et al. 1999; Meyer et al. 2015a). These depositional contexts differ greatly from the usual single inhumation burials of the LBK, which are mainly characterised by the careful arrangement and patterned orientation of the bodies within dedicated cemetery areas. Furthermore, these graves often contain distinctive grave goods such as pottery, stone tools and weapons, and bone and shell artefacts (e.g. Nieszery 1995). Cremation burials are also known in the LBK, which show significant amounts of care and energy expended in their making (Trautmann 2006). In contrast, all mass graves and massacre sites lack any recognisable evidence for a similarly elaborate treatment of the dead, as bodies were deposited in a disorganised and commingled manner without any recognisable care, if indeed they were gathered in one spot at all. At times, the dead were not deposited in cemeteries but within settlement sites (Meyer et al. 2014). However, the mass graves discussed in this chapter do not fall into this category either due to the higher number of bodies relative to the settlement burials and their seemingly careless disposal. The practice of burying the dead within villages is now understood to be just another type of normative burial in the LBK mortuary “portfolio”, which likely aimed at providing the deceased with a respectful funerary treatment (Meyer et al. 2014). Although cemetery and settlement burials seem to differ slightly regarding demography and the number and frequency of durable grave

goods (Hofmann 2009), they are overall very similar, and sometimes the distinction between them is blurred, for example, when burials are arranged in a cemetery-like pattern within a settlement site (e.g. Krause 1998; Fritsch et al. 2008).

If compared with the normative cemetery or settlement burials, be they cremation or inhumation, the mass graves, as a group, may therefore be regarded as deviant burials, which apparently followed devastating and traumatic events (Meyer et al. 2014; Hofmann 2015) including massacres (i.e. the violent killing of one group of people by another within a very short time and during more or less chaotic circumstances; cf. Dwyer and Ryan 2012) and mass execution (i.e. the systematic killing of restrained victims for reasons deemed more pragmatic than ritual; cf. Otterbein 2000; Meyer et al. in press).

Although individuals showing healed skeletal injuries were sometimes interred in traditional cemetery burials, the victims of lethal violence were only rarely included in such burial sites by LBK communities (Petrasch 2006; Bickle and Whittle 2013). A possible reason for such a differential treatment might be that their social units had been destroyed during collective violence events, leaving the disposal of the corpses to others, perhaps even the perpetrators of the violent acts. These “others” would not be expected to invest the same amount of care and effort into the post-mortem treatment of the deceased, especially if there were larger numbers of them to be disposed of. However, the one LBK mass grave without recognisable perimortem skeletal trauma, namely, Wiederstedt, suggests that disorganised mass graves were possibly also used to quickly dispose of large numbers of deceased from one’s own community under special circumstances (see below). This may be the case with victims of

epidemic disease, starvation, accidental poisoning, or a variety of other accidents and natural catastrophes, which possibly overtaxed the capacity of the surviving community for arranging a proper burial (Meyer et al. 2014).

It is currently unclear whether violently killed people that were not part of mass fatality events received a special treatment in LBK society, as their overall numbers are still too low for meaningful interpretation (Bickle and Whittle 2013; Fibiger 2014). In isolated cases of cranial trauma, it is also difficult, and sometimes impossible, to differentiate between injuries suffered by accident and injuries resulting from interpersonal violence with a lethal intent.

This short summary of the relationship between violence and burial within the LBK shows that – as far as we currently know – the victims of collective lethal violence were usually deposited simultaneously, as a group, and in a deviant manner vis-à-vis the regular and mostly individual burials found in coeval cemeteries and settlements. Additionally, the precisely contemporaneous nature of the mass fatality population samples allows detailed insights into their demographic structure. This kind of information is especially important as it is not normally preserved in traditional burial sites, which lack the unique “snapshot” element of the mass burials (Bentley et al. 2008; Meyer et al. 2014).

### **Sites of Collective Violence and/or Deviant Mass Burial**

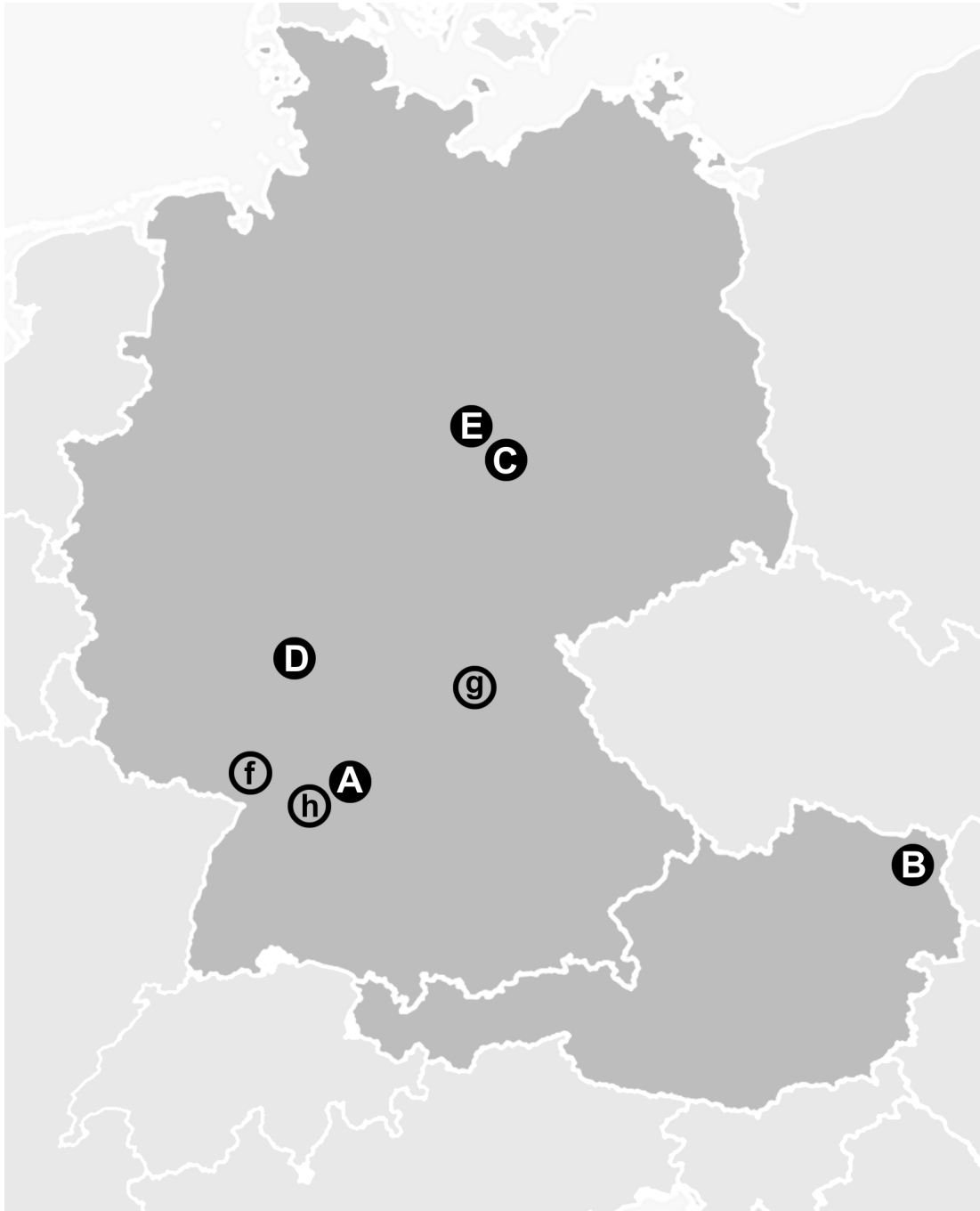
The LBK mass burial sites, which, for the most part, have provided evidence for prehistoric massacres (apparently the most frequent form of lethal perimortem collective violence within LBK communities), are well described in the

archaeological literature. For this reason, this chapter solely provides a brief presentation of these sites (Fig. 6.1), focussing in particular on the human skeletal remains and their cranial injuries, which are the sole lesions to be numerous enough to allow for comparative analyses. Further details are available from the literature cited, which include the original site reports as well as key comparative and analytical works. Only the mass grave site of Halberstadt, Germany, will be presented here in more detail, as it is the most recently discovered and analysed LBK mass fatality site and also displays a unique pattern of demography and skeletal injury (Meyer et al. in press). This mass grave will then be compared to the other sites (all listed below in the chronological order of their discovery), and the results of this comparison will be discussed, paying special attention to key similarities and differences in the osteoarchaeological quantitative data.

### ***Talheim, Germany***

*(Fig. 6.1, Site A) (Wahl and König 1987; Wahl and Strien 2007; Wahl and Trautmann 2012)*

The first evidence of lethal mass violence from the LBK came with the discovery and analysis of the disorganised mass grave at Talheim in southwestern Germany. At this site, about 34 individuals, including similar numbers of subadults and adults of both sexes, were deposited in a pit near a probable LBK settlement. Slightly over half the skeletons showed perimortem injuries consistent with the typical ground stone weapon tools of the LBK.



*Fig. 6.1. Map of Germany and Austria showing the LBK sites mentioned in the chapter. The mass fatality sites are depicted by solid circles and capital letters, while the other sites discussed in the chapter are marked by open circles and lower case letters. A Talheim, B Asparn/Schletz, C Wiederstedt, D Schöneck-Kilianstädten, E Halberstadt, f Herxheim, g Tiefenellern, h Vaihingen/Enz (Image: Christian Meyer).*

Most traumatic lesions were found on the parietal bones of the skulls, while the frontal and occipital bones were affected to a much lesser degree and almost equally. Overall, the right side of the skull showed slightly more injuries than the left, which might suggest that the victims were, in part, struck down from behind by right-handed attackers while fleeing. As the left half of the frontal bone is the least affected of the major skull bones, a classic face-to-face confrontation seems to have been unlikely for most individuals. Otherwise, the left frontoparietal region would likely be the one with the most injuries, as indicated by various studies of the distribution of cranial trauma (e.g. Fibiger et al. 2013). In any case, the pattern of cranial injuries encountered at Talheim, with all major cranial vault bones affected repeatedly, suggests that the blows were received during a largely uncontrolled situation, in which both victims and attackers were likely able to move about without significant restraint.

### ***Asparn/Schletz, Austria***

*(Fig. 6.1, Site B) (Teschler-Nicola et al. 1996, 1999, 2006; Teschler-Nicola 2012)*

The LBK mass fatality site of Asparn/Schletz consists of large ring ditches which contained the partly disarticulated and scattered remains of more than 60 individuals, both subadults and adults. As the site has not been completely excavated, the total number of individuals is currently unknown. Many of the recovered bones show traces of carnivore gnawing, which indicate that the dead had been lying unburied for some time after their violent demise. Apparently, the final layout of the bodies and body parts within the ditches was the result of natural sedimentation following the scattering by carnivores. All of the 33

recovered and analysed skulls from the site show signs of perimortem violence which clearly focussed on the parietal bones, similarly to Talheim. The frontal bones are affected less frequently, followed by the occipital bones, which show the least amount of trauma. The right sides of the skulls show slightly more injuries than the left sides, but the difference is negligible. As slightly more injuries are found on the frontal than the occipital bones, the cranial trauma pattern at Asparn is slightly more indicative of a face-to-face confrontation than that described for Talheim, but overall they appear rather similar, once again suggesting an uncontrolled lethal conflict situation where both attackers and victims were able to move more or less unrestrained.

***Wiederstedt, Germany***

*(Fig. 6.1, Site C) (Meyer et al. 2004, 2013, 2014)*

The disorganised mass grave found at Wiederstedt in Saxony-Anhalt, Germany, contained the articulated skeletal remains of ten individuals, eight of them biological subadults. The osteological analysis revealed no traces of blunt force cranial injuries similar to those found at Talheim or Asparn. This very much suggests that the cause of death was likely non-violent for these individuals; in any case massive cranial trauma can be excluded. Although the absence of violent injuries in skeletal remains does not equate to evidence of the absence of violence, which might have affected soft tissues only, the previously described examples of Talheim and Asparn, along with many other sites, show that Neolithic lethal violence – if present – is usually quite evident in cranial remains. Therefore, epidemic disease, starvation, poisoning, or other catastrophic events,

intentional or accidental, might have been responsible for the deaths of these individuals. Despite the lack of recognisable skeletal trauma, the bodies were collected and deposited in a deviant burial feature like the violence victims from Talheim and likewise did not receive any careful funerary treatment.

### ***Schöneck-Kilianstädten, Germany***

*(Fig. 6.1, Site D) (Lohr 2013; Meyer et al. 2013, 2014, 2015a; Lohr et al. 2017)*

A disorganised mass grave containing the skeletal remains of at least 26 individuals was discovered at the site of Schöneck-Kilianstädten in Hesse, Germany. Preservation of the bones was partly poor; therefore it could not be determined if all remains were still articulated (but most apparently were). Additionally, some evidence of trauma will undoubtedly have been destroyed over time, probably more so than at other mass fatality sites, where bones seem better preserved. Nevertheless, a multitude of cranial injuries were recorded, which not only affected the major bones of the cranial vault but also frequently the mandible and temporal bones. Overall, the left side of the skull shows more injuries than the right side, which is in contrast to the other massacre sites of Talheim and Asparn. With the left parietal and the left half of the frontal bone sustaining most injuries, this pattern is more similar to that expected for a face-to-face confrontation. But apart from the parietal bones, the left-right difference is rather small, resulting, as it does, from a rather uniform distribution of injuries all over the skull. Once again, this indicates that the cranial injuries seem to have occurred within an uncontrolled situation, like at Talheim and Asparn, which is in contrast to the pattern of the numerous perimortem

postcranial fractures that have been observed in this population sample, but not in others. Although some upper limb bones do show perimortem trauma, there is a clear and statistically significant dominance of fractured lower leg bones. As tibia and fibula seem to have been specifically targeted, this strongly suggests a controlled situation for these particular injuries, in which victims were unable to protect their legs, probably because they had already been killed or incapacitated by the cranial blows likely received earlier. Methodologically, ante-mortem torture and post-mortem mutilation cannot be differentiated from skeletal remains; thus this problem cannot currently be resolved with any confidence.

### ***Further Sites***

A few other LBK sites may also be mentioned in the wider context of collective violence, as these were interpreted by certain authors as being connected to Early Neolithic warfare, mainly based on preliminary, outdated, and sometimes misrepresented data (e.g. Golitko and Keeley 2007). The enclosure site at Herxheim in Rhineland-Palatinate, southwestern Germany (Fig. 6.1, Site f), is the most intriguing of these. Here, several hundred individuals have been systematically processed and dismembered, in what is now commonly interpreted as evidence for ritual cannibalism and human sacrifice (Zeeb-Lanz et al. 2016). In addition, some perimortem cranial injuries, which survive underneath the slightly more recent traces of extensive post-mortem dismemberment, might also suggest violent deaths for at least some of the individuals from this site (Boulestin and Coupey 2015). In any case, the

repeated and periodic deposition of the skeletal remains within the pits and ditches of the enclosure, mixed with pottery and selected animal bones, strongly indicates some form of ritual practice focussing on the bodies, which is unlike that encountered at the massacre sites discussed above, all of which lack complex post-mortem treatment. At Herxheim, the bodies and body parts were not just dumped into the nearest conveniently placed pit or left lying where they fell. Instead, a lot of effort and energy were invested into their processing and transformation (Zeeb-Lanz et al. 2016), but such practices are difficult to fathom without any reliable knowledge of the multifactorial and highly complex contextual background surrounding their performance.

The cave site of “Jungfernhöhle” near Tiefenellern, southeastern Germany (Fig. 6.1, Site g), has also been interpreted as a location connected to violence, sacrifice, and possible cannibalism in the earlier literature (Asmus 1955; Buhmann 1979). However, a recent re-examination of the site and of the spoil heaps of the original excavation, along with a re-evaluation of the quality of the old excavation practices, has revealed that many small skeletal elements had been missed or disregarded during the 1950s excavations, so that any modern reinterpretation of the site has to wait until the new finds are analysed (Seregély 2012).

The enclosed LBK settlement and cemetery site of Vaihingen/Enz, southwestern Germany (Fig. 6.1, Site h), has also sometimes been interpreted as violence related (Golitzko and Keeley 2007), as most of the human remains were found in close association with the ditch surrounding the settlement. However, in contrast to the other enclosure sites mentioned above, the skeletons from Vaihingen were mostly found in regular burials, with only a few of them

seemingly being deviant (Bentley et al. 2003). As the results of the osteoarchaeological analysis have not yet been fully published, a final assessment of the site and its burials is still pending (Welge 1997; Krause 1998). In contrast to earlier claims, however, Vaihingen appears to have been, for the most part, a regular burial place, which offers further evidence of the blurred boundaries separating cemeteries and settlements in LBK society.



*Fig. 6.2. The mass grave of Halberstadt, Saxony-Anhalt, Germany, where nine individuals were deposited in a pit feature. Some skeletal elements are missing due to animal activity and later anthropogenic disturbance (Image: State Office for Heritage Management and Archaeology Saxony-Anhalt).*

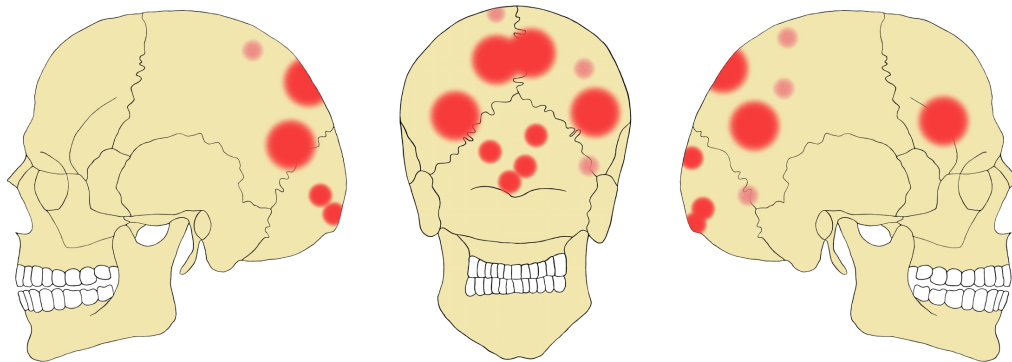
### ***The Mass Grave of Halberstadt***

In 2013, another Neolithic mass grave was discovered at the site of Halberstadt, Saxony-Anhalt, Germany (Fig. 6.1, Site E; Meyer et al. 2015b, in press). The whole feature was block lifted and later meticulously excavated under controlled conditions. The mass grave contained articulated skeletal remains of nine individuals, which were deposited haphazardly in a sub-circular pit (Fig. 6.2). Certain skeletal elements were already missing upon discovery due to post-depositional disturbances of the burial feature. A similar fate had befallen some individuals from the LBK mass grave at Wiederstedt, located c.40 km to the southeast, where the removal of one cranium could be attributed to eighteenth-century grave-digging activity (Meyer et al. 2012). In the case of Halberstadt, however, the observed anthropogenic disturbances could not be traced to a specific event or cause, but it is very likely that they were mainly the result of later (pre)historic farming or settlement activities, as the area was coveted for both throughout the centuries (Meyer et al. 2015b). Durable grave goods were absent from the pit. The small fragments of pottery found scattered throughout the feature are typical of Neolithic settlement debris accidentally included in the infill or later introduced by burrowing animals. Similar observations were made at the other LBK mass grave sites, all located near settlements. The same holds true for the Halberstadt mass grave, which was found only a short distance from a roughly contemporary LBK settlement, which encompassed a rather high number of settlement burials (Fritsch et al. 2008). Except for one individual, a probable female, all other skeletal remains from the mass grave could be determined as male. The age range excludes subadults

below the age of 16 years and does not exceed c.40 years of age at death. Carnivore-gnawing damage was noted on several limb bones, mostly those from the edge of the feature, and the distal parts of the affected limbs were usually missing. Scavenging carnivores seem to be responsible for at least some of the missing elements of the appendicular skeleton. Smaller bones were likely dislocated and scattered by burrowing animals, whose tunnels and skeletal remains were observed throughout the feature during the excavation. The carnivore-gnawing marks found on the human skeletal remains at Halberstadt are reminiscent of those observed on the Asparn skeletons (Teschler-Nicola et al. 1996, 1999), which might indicate that the bodies were not completely covered with soil upon deposition.

A few long bones of the upper and lower extremities showed perimortem fractures which probably occurred before deposition, as suggested by their anomalous layout. Overall, pathological lesions are rare and rather insignificant with the exception of cranial trauma, which could be diagnosed in all seven individuals who still retained complete skulls or skull fragments. Again, as in all other LBK violence-related mass fatality sites (see above), the parietal bones show the highest frequency of injuries. In this, they are closely followed by the occipital bone, while a single instance of perimortem trauma was observed on a frontal bone. The right side of the skull was hit almost twice as often as the left side, which, in accordance with the massacre sites of Talheim and Asparn and assuming largely right-handed attackers, indicates that the trauma was inflicted from behind. This is further supported by the evidence that almost all injuries are located at the back of the head in a tightly circumscribed area (Fig. 6.3), with some of them even being very similar in shape. If we contrast this evidence with

the massacre sites of Talheim, Asparn, and Kilianstädten, the cranial trauma pattern from Halberstadt strongly suggests that these younger men were apparently killed in a much more controlled manner, likely to be an execution (Meller 2015; Meyer et al. in press). As isotope analysis has shown, the individuals buried in the mass grave had a different diet and geographical origins from the village population buried within the settlement, thus indicating that they were outsiders (Meyer et al. in press).



*Fig. 6.3. Compilation of perimortem cranial injury locations of the individuals from the mass grave of Halberstadt. Larger dots signify larger injuries, while smaller dots signify smaller injuries. Likewise, darker spots signify securely identified trauma, while lighter spots stand for likely trauma. With the exception of one instance of trauma on a frontal bone, all cranial injuries identified from the site are clustered at the back of the head (Image: Christian Meyer).*

If we cross-examine this evidence, it appears that the mass grave at Halberstadt did not include massacre victims like those found at Talheim, Asparn, and Kilianstädten and therefore is not representative of a local residential community, but instead possibly contained the remains of a failed raiding party

of outsiders. As already noted, the demography of those killed at Halberstadt is strongly skewed towards young adult males, which is currently unique for the LBK evidence. To explore this further, the demographic patterns established for each mass fatality site will be examined below in more detail and also contrasted with one another.

### **Demographic Patterns of Collective Violence Victims in the Early Neolithic**

Upon comparing the demographic composition of the population samples found at the different LBK mass fatality sites, several patterns do emerge, which can be utilised to support the overall interpretation of the interrelation of collective violence and deviant mass burial in LBK society (Table 6.1). Importantly, the “snapshot” nature of these samples allows a tightly focussed look at people who truly lived and died contemporaneously at each site – something that is impossible to achieve from more traditional burials (Meyer et al. 2014).

<b>Site</b>	<b>Inf. I</b>	<b>Inf. II</b>	<b>Juv.</b>	<b>Ad. Male</b>	<b>Ad. Female</b>	<b>Mat. Male</b>	<b>Mat. Female</b>	<b>Sen. Male</b>	<b>Sen. Female</b>
TH	7	6	3	7	4	2	3	1	-
AS	12.5	8.5	5.5	16.5	5	9.5	8.5	-	-
KS	10	2	1	9	-	-	2	-	-
WS	1	5	2	1	1	-	-	-	-
HS	-	-	1	7	1	-	-	-	-

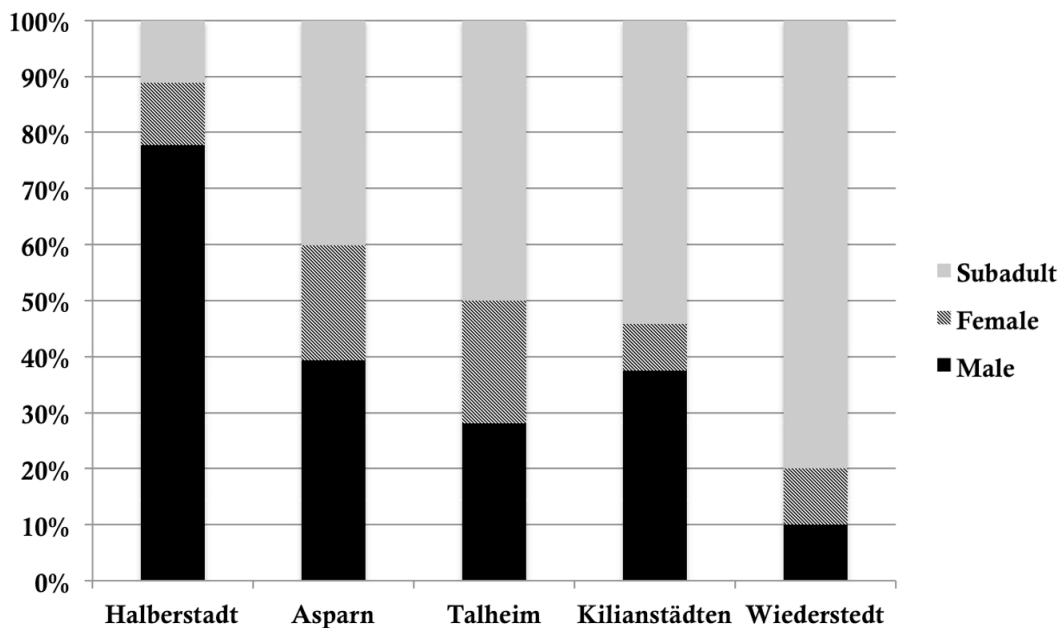
*Table 6.1. Demography of the mass fatality sites discussed in the chapter. Age and sex data have been compiled from the literature cited herein (the few individuals lacking reliable age and sex determinations are not included in the table).*

Firstly, individuals of the senilis age category (older than 60 years) are almost absent from the mass fatality sites – an occurrence that fits well with the average life expectancy known for the Early Neolithic, which was below 30 years (Trautmann 2006). Individuals of the matusus age class (between the ages of 40 and 60 years) are much more common at LBK mass fatality sites but are still less numerous than younger adults or children at most sites. Among the skeletal samples examined here, mature individuals are found at Talheim, Schöneck-Kilianstädten, and Asparn. At the latter location, there is a balanced ratio of males (53%) and females (47%) for this age class, while females slightly dominate at the former two sites. However, as absolute numbers for this age group are very low at both Talheim and Kilianstädten, this datum is not particularly informative. This clearly changes in the adultus age class (between 20 and 40 years); here, the situation is reversed, as there are fewer females than males at all four mass fatality sites. The sex imbalance is least pronounced at Talheim (1.75:1; males 64%, females 36%), is more evident at Asparn (3.3:1; males 77%, females 23%) and Halberstadt (7:1; males 88%, females 13%), and is most obvious at Schöneck-Kilianstädten, where no females of this age group were identified, which is in stark contrast to the nine male individuals of the same age. This discrepancy is commonly interpreted as a result of the differential treatment of younger women during collective violence events. Rather than being killed outright during the massacres, as ostensibly happened with the younger, older, and male population segments, women of reproductive age may have been preferentially captured alive – a practice that is well known from ethnographic studies (Otterbein 2000). This was probably followed by forced inclusion into the attacker’s own communities, although the further fate

and status of these women remains unknown. The selective capture of women is currently the most likely explanation for the imbalanced adult sex ratios encountered at Talheim, Asparn, and Schöneck-Kilianstädten, which also contain numerous subadult individuals who were violently killed just like the adults.

Normally, the sex of subadults cannot be reliably determined by osteological analyses alone, hence the difficulty of knowing if male and female children are equally represented in mass fatality samples. Although some older children might have occasionally been captured (something that is perhaps indicated by an age gap within the Kilianstädten sample; Meyer et al. 2015a), they are among the victims of lethal violence identified at all three massacre sites. However, this was not the case at Halberstadt, where, in contrast to Talheim, Asparn, and Schöneck-Kilianstädten, children were completely missing from the mass burial feature. The youngest individual deposited at Halberstadt has been determined as a 16–20-year-old male. Although this age range is covered by the age class *juvenis* (13–20 years), which technically characterises the individual as a biological subadult, it is highly likely that a person of this age would already be considered a social adult within their LBK community, especially considering the rather low average life expectancy documented for this period (Bickle and Fibiger 2014). Paired with the overall 89% male sex estimation, the demography of the Halberstadt mass grave sample is clearly unusual, highly selective, and thereby different from all the other sites discussed in this chapter (Fig. 6.4). Indeed, the demographic pattern is an important factor in the contextual interpretation of this mass grave as an execution rather than a

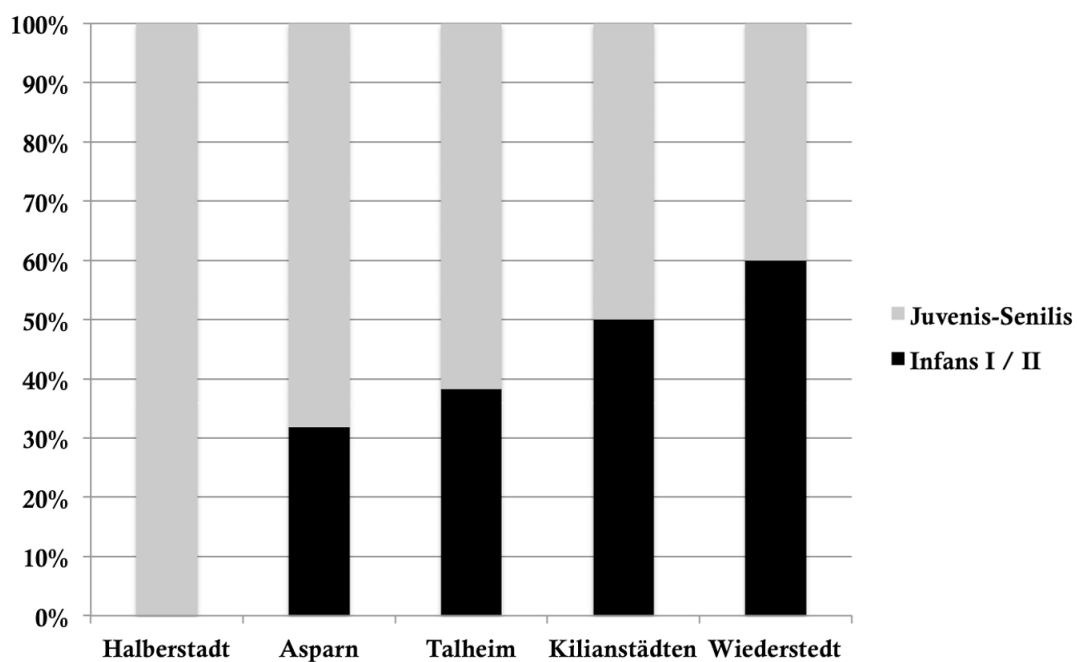
massacre site, which is independently supported both by cranial trauma patterns (see above) and isotope analysis (Meyer et al. in press).



*Fig. 6.4. Relative demographic structure of the mass fatality sites discussed in the text; only precisely age- and sex-determined individuals have been included in the graph. The category “subadult” is used in the biological sense and includes all individuals below the age of c.20 years. This is not necessarily consistent with social understandings of this age group in LBK society (Image: Christian Meyer).*

Focussing specifically on the age classes infans I (0–6 years) and infans II (7–12 years), subadult individuals belonging to either group are numerous at Asparn (32%), Talheim (38%), and Kilianstädten (46%). While they are clearly outnumbered by older individuals at Talheim and Asparn, their ratio is evenly balanced at Schöneck-Kilianstädten (Fig. 6.5). Despite such slight differences between the sites, the respective demographic patterns of subadults vs. adults are very suggestive of complete (or near-complete) settled communities that

were violently destroyed (Duering and Wahl 2014). The only mass fatality site where subadults actually outnumber the older individuals, regardless of whether the age class juvenis is counted as biological subadult (80%) or social adult (60%), is the mass grave of Wiederstedt. As mentioned above, no signs of lethal perimortem violence could be detected in the skeletal remains from this site, which indicates a likely non-violent cause of death for these individuals.



*Fig. 6.5. Percentages of younger children (age classes infans I and II) in relation to older individuals from the mass fatality sites discussed in the chapter. Only precisely age-determined individuals have been included in the graph (Image: Christian Meyer).*

In this regard, Wiederstedt evidently differs from the massacre sites – a fact that is also reflected in the demographic structure of the skeletal sample. It is quite likely that the Wiederstedt mass burial contains some of the physically weakest

members of the community, who were most prone to fall victim to infectious disease, poisoning, or other types of natural catastrophes.

As mentioned above, Halberstadt is the other mass grave whose demographic pattern clearly deviates from the three massacre sites. In contrast to Wiederstedt, however, such skewing towards younger adult males cannot be interpreted as reflecting physical weakness. It is much more likely that the non-local male individuals from this site were originally chosen by their community because of their prowess in warfare (Meller 2015; Meyer et al. in press). If this was indeed the case, these individuals represent a counterpoint to the massacre victims of Talheim, Asparn, and Kilianstädten, by being possible outside aggressors who might have failed in their attack. By comparing and contrasting the patterns of demography, perimortem injury, and deviant burial available for the site, this currently appears to be the most likely explanation, which of course does not mean that alternative interpretations have to be categorically rejected. Further research, re-evaluation of older sites, and new discoveries will in the future doubtlessly refine the picture of LBK collective violence and deviant burial painted in these pages.

## **Conclusion**

Based on the sites discussed above, it is now clear that the victims of mass fatality events display demographic patterns that can be interpreted meaningfully by reference to one another. The mass grave at Halberstadt, in particular, stands out in this cluster of sites in terms of demographic structure

as females are very much underrepresented and children are completely absent from the sample, while conversely both females and children are numerous at all other mass fatality sites. This demographic peculiarity clearly suggests a different context for the violent deaths met by the Halberstadt individuals compared to Talheim, Asparn, and Schöneck-Kilianstädten. Overall, the latter sites appear rather similar to one other in probably representing the remains of near-complete village communities that were destroyed by unknown attackers during short-term massacres. Unlike any of these, Wiederstedt can instead be interpreted as a mass fatality episode, in which a lethal infectious disease or some other non-violent event must have brought death to the weakest members of the community, first and foremost the children.

Generally, the mass fatality sites discussed above show that subadults were frequent targets of lethal collective violence, as indeed were men of all age groups and older women. It would appear that only young women and possibly (female?) adolescents were routinely spared during the attacks, probably to be captured alive. Judging from the cranial trauma patterns, lethal attacks were mostly conducted in largely uncontrolled, chaotic melee clashes, and injuries commonly affected all major skull areas. Once again the mass grave at Halberstadt stands out from this trend. Here, cranial injuries are overwhelmingly clustered at the back of the head as to likely indicate the execution of the victims in a deliberate and controlled manner. Regardless of whether the cause of death was violent or non-violent, however, the post-mortem deposition of mass fatality victims seems to have been a common element at all these sites. This is the lack of careful treatment of the deceased,

which clearly differentiates deviant mass burials from the normative cemetery and settlement interments found throughout the LBK world.

In LBK communities, group deaths seem to have effectively caused the identity and individuality of the victims to be erased. This stands in stark contrast to more traditional burial treatments, in which selected information pertaining to the role and standing of the deceased was routinely preserved through an individualised funeral rite. However, by being denied this treatment, the dead dumped in the mass graves discussed in this chapter have preserved other kinds of information, which can shed new light on the episodes in which lethal collective violence broke out and on the social choices made during these short-lived and dramatic events.

## **References**

Asmus, G. (1955). Die menschlichen Skelettreste aus der Jungfernhöhle. In O. Kunkel (Ed.), *Die Jungfernhöhle bei Tiefenellern. Eine neolithische Kultstätte auf dem Fränkischen Jura bei Bamberg* (pp. 65–77). München: Beck.

Bentley, R. A., Krause, R., Price, T. D., & Kaufmann, B. (2003). Human mobility at the Early Neolithic settlement of Vaihingen, Germany: Evidence from strontium isotope analysis. *Archaeometry*, 45, 471–486.

Bentley, R. A., Wahl, J., Price, T. D., & Atkinson, T. C. (2008). Isotopic signatures and hereditary traits: Snapshot of a Neolithic community in Germany. *Antiquity*, 82, 290–304.

Bickle, P., & Fibiger, L. (2014). Ageing, childhood and social identity in the Early Neolithic of Central Europe. *European Journal of Archaeology*, 17, 208–228.

Bickle, P., & Whittle, A. (2013). *The first farmers of Central Europe. Diversity in LBK lifeways*. Oxford: Oxbow.

Boulestin, B., & Coupey, A.-S. (2015). *Cannibalism in the linear pottery culture: The human remains from Herxheim*. Oxford: Archaeopress.

Buhmann, D. (1979). Paläopathologie im süddeutschen Raum. Ein Beitrag zur Methodik paläopathologischer Forschung. *Sudhoffs Archiv*, 63, 367–391.

Christensen, J. (2004). Warfare in the European Neolithic. *Acta Archaeologica*, 75, 129–156.

Duering, A., & Wahl, J. (2014). A massacred village community? Agent-based modelling sheds new light on the demography of the Neolithic mass grave of Talheim. *Anthropologischer Anzeiger*, 71, 447–468.

Dwyer, P. G., & Ryan, L. (2012). The massacre and history. In P. G. Dwyer & L. Ryan (Eds.), *Theatres of violence. Massacre, mass killing and atrocity throughout history* (pp. xi–xxv). New York: Berghahn.

Fibiger, L. (2014). Misplaced childhood? Interpersonal violence and children in Neolithic Europe. In C. Knüsel & M. J. Smith (Eds.), *The Routledge handbook of the bioarchaeology of human conflict* (pp. 127–145). London: Routledge.

Fibiger, L., Ahlström, T., Bennike, P., & Schulting, R. J. (2013). Patterns of violence-related skull trauma in Neolithic southern Scandinavia. *American Journal of Physical Anthropology*, 150, 190–202.

Fritsch, B., Classen, E., Müller, U., & Dresely, V. (2008). Die linienbandkeramischen Gräberfelder von Derenburg 'Meerenstieg II' und Halberstadt 'Sonntagsfeld', Lkr. Harz. *Jahresschrift für mitteldeutsche Vorgeschichte*, 92, 25–229.

Golitko, M., & Keeley, L. H. (2007). Beating ploughshares back into swords: Warfare in the Linearbandkeramik. *Antiquity*, 81, 332–342.

Herrmann, B., Grupe, G., Hummel, S., Piepenbrink, H., & Schutkowski, H. (1990). *Prähistorische Anthropologie. Leitfaden der Feld- und Labormethoden*. Berlin: Springer.

Hofmann, D. (2009). Cemetery and settlement burials in the Lower Bavarian LBK. In D. Hofmann & P. Bickle (Eds.), *Creating communities: New advances in Central European Neolithic research* (pp. 220–234). Oxford: Oxbow.

Hofmann, D. (2015). The burnt, the whole and the broken: Funerary variability in the Linearbandkeramik. In Z. L. Devlin & E.-J. Graham (Eds.), *Death embodied. Archaeological approaches to the treatment of the corpse* (pp. 109–128). Oxford: Oxbow.

Krause, R. (1998). Die bandkeramischen Siedlungsgrabungen bei Vaihingen an der Enz, Kreis Ludwigsburg (Baden-Württemberg). Ein Vorbericht zu den Ausgrabungen von 1994–1997. *Berichte der Römisch-Germanischen Kommission*, 79, 5–105.

Lohr, C. (2013). *Archäologische und anthropologische Untersuchungen des Massengrabes von Schöneck-Kilianstädten (Main-Kinzig-Kreis, Hessen)*. Masters thesis, University of Mainz, Germany.

Lohr, C., Meyer, C., Alt, K. W., & Gronenborn, D. (2017). Ein zweites Talheim?! Erste Ergebnisse aus dem Massengrab von Schöneck-Kilianstädten. In H. Meller & S. Friederich (Eds.), *Salzmünde – Regel oder Ausnahme?* (pp. 541–547). Halle: Landesmuseum für Vorgeschichte.

Martin, D. L., & Harrod, R. P. (2015). Bioarchaeological contributions to the study of violence. *Yearbook of Physical Anthropology*, 156, 116–145.

Maschner, H. D. G., & Reedy-Maschner, K. L. (1998). Raid, retreat, defend (repeat): The archaeology and ethnohistory of warfare on the North Pacific Rim. *Journal of Anthropological Archaeology*, 17, 19–51.

Meller, H. (2015). Krieg im europäischen Neolithikum. In H. Meller & M. Schefzik (Eds.), *Krieg – eine archäologische Spurensuche* (pp. 109–116). Halle: Landesmuseum für Vorgeschichte.

Meyer, C., Kürbis, O., & Alt, K. W. (2004). Das Massengrab von Wiederstedt, Ldkr. Mansfelder Land. Auswertung und Gedanken zur Deutung im Kontext der Linienbandkeramik. *Jahresschrift für mitteldeutsche Vorgeschichte*, 88, 31–66.

Meyer, C., Ganslmeier, R., Dresely, V., & Alt, K. W. (2012). Die Bedeutung taphonomischer Einflüsse bei der Interpretation neolithischer Grabfunde. In T. Link & D. Schimmelpfennig (Eds.), *Taphonomische Forschungen (nicht nur) zum Neolithikum* (pp. 143–156). Kerpen-Loogh: Welt und Erde.

Meyer, C., Lohr, C., Strien, H.-C., Gronenborn, D., & Alt, K. W. (2013). Interpretationsansätze zu 'irregulären' Bestattungen während der linearbandkeramischen Kultur: Gräber *en masse* und Massengräber. In N. Müller-Scheeßel (Ed.), *'Irreguläre' Bestattungen in der Urgeschichte: Norm, Ritual, Strafe...?* (pp. 111–122). Bonn: Habelt.

Meyer, C., Lohr, C., Kürbis, O., Dresely, V., Haak, W., Adler, C. J., et al. (2014). Mass graves of the LBK. Patterns and peculiarities. In A. Whittle & P. Bickle (Eds.), *Early farmers. The view from archaeology and science* (pp. 307–325). Oxford: Oxford University Press.

Meyer, C., Lohr, C., Gronenborn, D., & Alt, K. W. (2015a). The massacre mass grave of Schöneck-Kilianstädten reveals new insights into collective violence in Early Neolithic Central Europe. *Proceedings of the National Academy of Sciences of the United States of America*, 112, 11217–11222.

Meyer, C., Kürbis, O., Dresely, V., & Alt, K. W. (2015b). Das jüngst entdeckte Massengrab von Halberstadt. In H. Meller & M. Schefzik (Eds.), *Krieg – eine archäologische Spurensuche* (pp. 177–178). Halle: Landesmuseum für Vorgeschichte.

Meyer, C., Knipper, C., Nicklisch, N., Münster, A., Kürbis, O., Dresely, V., Meller, H., & Alt, K.W. (in press). Early Neolithic executions indicated by clustered cranial trauma in the mass grave of Halberstadt, Germany. *Nature Communications*.

Mirazón Lahr, M., Rivera, F., Power, R. K., Mounier, A., Copsey, B., Crivellaro, F., et al. (2016). Inter-group violence among early Holocene hunter-gatherers of West Turkana, Kenya. *Nature*, 529, 394–398.

Nieszery, N. (1995). *Linearbandkeramische Gräberfelder in Bayern*. Espelkamp: Marie L. Leidorf.

Otterbein, K. F. (2000). Killing of captured enemies: A cross-cultural study. *Current Anthropology*, 41, 439–443.

Otterbein, K. F. (2004). *How war began*. College Station: Texas A&M University Press.

Petrasch, J. (2006). Gewalttätigkeiten in der Steinzeit – Archäologisch-kulturgeschichtliche Analysen zur Ermittlung ihrer Häufigkeiten. In J. Piek & T. Terberger (Eds.), *Frühe Spuren der Gewalt – Schädelverletzungen und Wundversorgung an prähistorischen Menschenresten aus interdisziplinärer Sicht* (pp. 155–162). Schwerin: Landesamt für Kultur und Denkmalpflege.

Sala, N., Arsuaga, J. L., Pantoja-Pérez, A., Pablos, A., Martínez, I., Quam, R. M., et al. (2015). Lethal interpersonal violence in the Middle Pleistocene. *PLoS One*, 10, e0126589.

Seregély, T. (2012). Neolithische Siedlungen und vergessene Funde. Neues zur Jungfernhöhle bei Tiefenellern. In F. Falkenstein (Ed.), *Hohler Stein, Rothensteine und Jungfernhöhle. Archäologische Forschungen zur prähistorischen Nutzung naturheiliger Plätze auf der Nördlichen Frankenalb* (pp. 64–73). Institut für Altertumswissenschaften: Würzburg.

Stojanowski, C. M., Seidel, A. C., Fulginiti, L. C., Johnson, K. M., & Buikstra, J. E. (2016). Contesting the massacre at Nataruk. *Nature*, 539, E8–E10.

Teschler-Nicola, M. (2012). The Early Neolithic site Asparn/Schletz (Lower Austria): Anthropological evidence of interpersonal violence. In R. Schulting & L. Fibiger (Eds.), *Sticks, stones, and broken bones: Neolithic violence in a European perspective* (pp. 101–120). Oxford: Oxford University Press.

Teschler-Nicola, M., Gerold, F., Kanz, F., Lindenbauer, K., & Spannagl, M. (1996). Anthropologische Spurensicherung. Die traumatischen und postmortalen Veränderungen an den linearbandkeramischen Skelettresten von Asparn/Schletz. *Archäologie Österreichs*, 7, 4–12.

Teschler-Nicola, M., Gerold, F., Bujatti-Narbeshuber, M., Prohaska, T., Latkoczy, C., Stingeder, G., et al. (1999). Evidence of genocide 7000 BP – Neolithic paradigm and geo-climatic reality. *Collegium Antropologicum*, 23, 437–450.

Teschler-Nicola, M., Prohaska, T., & Wild, E. M. (2006). Der Fundkomplex von Asparn/Schletz (Niederösterreich) und seine Bedeutung für den aktuellen Diskurs endlinearbandkeramischer Phänomene in Zentraleuropa. In J. Piek & T. Terberger (Eds.), *Frühe Spuren der Gewalt – Schädelverletzungen und Wundversorgung an prähistorischen Menschenresten aus interdisziplinärer Sicht* (pp. 61–76). Schwerin: Landesamt für Kultur und Denkmalpflege.

Trautmann, I. (2006). *The significance of cremations in Early Neolithic communities in Central Europe*. PhD dissertation. <http://hdl.handle.net/10900/49077>. Accessed 1 Oct 2016.

Wahl, J., & König, H. G. (1987). Anthropologisch-traumatologische Untersuchung der menschlichen Skelettreste aus dem bandkeramischen Massengrab bei Talheim, Kreis Heilbronn. *Fundberichte aus Baden-Württemberg*, 12, 65–186.

Wahl, J., & Strien, H.-C. (2007). *Tatort Talheim. 7000 Jahre später//Archäologen und Gerichtsmediziner ermitteln*. Heilbronn: Städtische Museen.

Wahl, J., & Trautmann, I. (2012). The Neolithic massacre at Talheim: A pivotal find in conflict archaeology. In R. Schulting & L. Fibiger (Eds.), *Sticks, stones, and broken bones: Neolithic violence in a European perspective* (pp. 77–100). Oxford: Oxford University Press.

Welge, K. (1997). Erste Ergebnisse zu den Bestattungen aus dem Graben der bandkeramischen Siedlung von Vaihingen an der Enz. *Bulletin der Schweizerischen Gesellschaft für Anthropologie*, 3, 55–61.

Wu, X.-J., Schepartz, L. A., Liu, W., & Trinkaus, E. (2011). Antemortem trauma and survival in the late Middle Pleistocene human cranium from Maba, South China. *Proceedings of the National Academy of Sciences of the United States of America*, 108, 19558–19562.

Zeeb-Lanz, A., Arbogast, R.-M., Bauer, S., Boulestin, B., Coupey, A. S., Denaire, A., et al. (2016). Human sacrifices as “crisis management”? The case of the Early Neolithic site of Herxheim, Palatinate, Germany. In C. A. Murray (Ed.), *Diversity*

*of sacrifice. Form and function of sacrificial practices in the ancient world and beyond* (pp. 171–189). Albany: State University of New York Press.

Zollikofer, C. P. E., Ponce de León, M., Vandermeersch, B., & Lévêque, F. (2002). Evidence for interpersonal violence in the St. Césaire Neanderthal. *Proceedings of the National Academy of Sciences of the United States of America*, 99, 6444–6448.

## CHAPTER 7

### Conclusions:

### **Collective Violence in the Neolithic of Central Europe as Illuminated by Complex Burial Features**

The topic of collective violence and its implications for the interpretation of the burial record of the Neolithic of Central Europe have been examined here so far via the detailed analysis of three newly described complex burial sites with mass and multiple graves and one synthetic themed chapter. In CHAPTER 3 the Late Neolithic multiple graves of Eulau have been analysed, where clear signs of perimortem lethal trauma have been identified along with older healed fractures and evidence for close biological kinship ties among some of the victims (cf. Haak et al. 2008; 2010). This is also mirrored in the funerary treatment of the individuals and has made Eulau one of the key sites for studying the burial bioarchaeology of the Central European Neolithic (e.g. Sosna et al. 2010; Lewis 2013; Schulting 2013; Kristiansen 2014; Sjögren et al. 2016; Vander Linden 2016; Jankovic et al. 2017; Ahola et al. 2018; Fibiger 2018; Madden et al. 2018; Schulting 2018). It is one of the rare known post-*Linearbandkeramik* (LBK) mass fatality sites of the Neolithic and therefore central to the comparative analysis of collective violence in prehistoric Europe (e.g. Schulting 2013; Fibiger 2018).

Another of those rare mass fatality sites has been analysed in CHAPTER 4 with the Early Neolithic LBK mass grave of Schöneck-Kilianstädten (cf. Schwitalla &

Schmidt 2006; Lohr 2013; Lohr et al. 2017). Here, evidence of lethal collective violence is even more ubiquitous than at Eulau and is accompanied by numerous perimortem long bone fractures. These latter traumata are not randomly distributed but instead reveal a clear and statistically highly significant pattern of targeted destruction of the major lower limb bones (tibia and fibula) which so far appears to be unique for this time and region. It may be interpreted as targeted torture of the living, as mutilation of the dead, or even as both. Currently, these different possible practises cannot be differentiated by skeletal analyses alone as both would have occurred within the perimortem phase wherein bone behaves the same way prior to and after death (cf. Loe 2009; Symes et al. 2014).

The third mass fatality site clearly related to organized collective violence and analysed in detail in this study is Halberstadt-Sonntagsfeld. While the relevant depositional feature in this case – the mass grave – at first glance very much resembles the other known mass graves of the LBK, like e.g. the one at Talheim (cf. Wahl & König 1987; Trautmann & Wahl 2012), it is very likely very different in its most probable interpretation. This interpretation as a possible execution site contra a massacre site is argued on the basis of current knowledge about LBK deviant burial in CHAPTER 5 of this study. It is thereby proposed that this mass grave might actually represent a counter-point to the other LBK massacre and mass grave sites like Talheim, Asparn/Schletz and Schöneck-Kilianstädten which do share some obvious similarities in their demography and injury patterns (cf. Meyer et al. 2014). The Halberstadt mass grave is called a counter-point here mostly in the sense that this complex depositional feature does not contain the remains of an indiscriminantly massacred local village population

(cf. Düring & Wahl 2014), but a selected and definitely non-local group of mostly younger adult men. Interestingly, the carbon and nitrogen isotope data of the sole female individual in the mass grave (Ind. 3) are virtually identical to two other female individuals buried within the nearby LBK settlement at Halberstadt (Ind. 26 and Ind. 34; cf. Fritsch et al. 2011; Oelze et al. 2011; Brandt et al. 2013), while the male isotope data are all clearly different. It is currently unknown if this sex-specific overlap is just coincidence or actually signifies some shared life or social history in the widest sense between these three individuals. The radiocarbon dates available for two of the individuals certainly allow this latter possibility (cf. Brandt et al. 2013).

It should also be noted here that the modern binary system of “sexing” individuals as either male or female need not be wholly congruent with Neolithic gender roles. It is indeed possible that more than two genders could have been recognized by LBK communities but identifying this would need a dedicated biocultural study of its own and is therefore beyond the scope of the current thesis (cf. Herdt 1993). Here, it shall suffice to at least raise the possibility that there might have been more gender roles than classic “men” and “women” in the Neolithic; gender roles that will mostly be invisible without the proper biocultural context, e.g. a regular, careful burial that indeed recognisably reflects the respective role of the deceased individual (cf. Bentley et al. 2012). In a mass grave, as a victim of collective violence, this original and individual biocultural context has not actively been preserved and is non-existent anymore. The previous societal roles of the deceased have been suppressed or even completely erased by deviant mass burial; the individuals are thereby anonymised by the circumstances of their death (cf. Meyer et al. 2014). This is

especially relevant for Ind. 3 from the Halberstadt mass grave which has been osteologically identified as a probable biological female. In the absence of grave goods the gender of all individuals contained in the mass grave is of course unknown.

Strontium isotope data are unfortunately not available for the likely female Ind. 3 from the mass grave due to the absence of cranial and thereby also dental remains, so a potentially shared place of origin of the three women with similar carbon and nitrogen isotope values can currently neither be proven nor disproven. A direct comparison with the male individuals from the mass grave does not help either as they could have come together, voluntarily or not, for various other reasons than a shared geographical origin. This is actually indicated by the large variation of their enamel strontium ratios which differentiate them, as a contextual sample, from the local LBK community buried in the nearby settlement.

With the bioarchaeological analysis of these three important sites of two major archaeological “cultures” of the Early and the Late Neolithic, the *Linearbandkeramik* (LBK) and the Corded Ware Culture (CWC), this study roughly brackets the duration of the Central European Neolithic. Collective violence is prominently spotlighted by the “burial” sites included here which in turn illuminate very specific episodes of Neolithic life and, especially, violent Neolithic death. The latter came to pass via lethal perimortem trauma for most, if not all, of the individuals recovered from all three analysed burial sites, thereby creating some of the very rare mass fatality samples which are unique resources for gathering information about contemporary conditions characterizing the respective Neolithic communities.

As several mass graves are now known from the LBK, thereby only now providing a sufficiently large baseline and overall sample for further interpretative analysis, these are specifically treated in CHAPTER 6 of this work. At each of the known LBK mass grave sites of Talheim, Wiederstedt, Kilianstädten and Halberstadt (all in Germany) the human remains were likely the only “material objects” consciously deposited in the mass grave features (Wahl & König 1987; Meyer et al. 2004; Lohr 2013), so that the detailed analysis of the skeletal remains represents the most promising and most feasible way to arrive at a sound interpretation of these sites and their complex burial features. This has been successfully shown for two LBK mass graves in CHAPTERS 4 AND 5. It has previously been repeatedly argued that especially for deviant burials, which the mass graves undoubtedly are, in contrast to the previously discussed individual cemetery and settlement burials (cf. Hofmann 2015; Meyer et al. 2013a; 2014), a combined interpretation of the human skeletal remains and the precise burial context is needed. In fact, both have to be regarded as inseparable when dealing with non-standard burials and features that contain the commingled remains of numerous individuals (cf. Buhmann 1979; Martin & Harrod 2015).

When these single-event and violence-related burial features contained a larger and demographic diverse segment of a presumably settled community, like at Talheim or Schöneck-Kilianstädten (cf. Düring & Wahl 2014), it seems that in these cases settlements got wildly attacked, with aggressors very likely utilizing the often sought and very advantageous element of surprise, most likely via a dawn raid (cf. Otterbein 2004; Kelly 2005). If successful, mostly indiscriminate killing took place which is also evidenced by the scattered distribution of lethal

trauma in the skulls of the respective victims. In CHAPTER 6 this has been described as a largely “uncontrolled” conflict situation. Although women and children might be classified as non-combatants in more modern cases of collective conflict, they appear to have been regular targets of lethal violence or capture during enemy raids upon their villages during Neolithic times (Schulting 2013; Fibiger 2014). A similar pattern has been identified from much more recent ethnographic accounts of “early warfare”, where members of communities defined as hostile are substitutable and where sex, gender or age of the victims killed therefore do not matter, as long as they belong to the group of the pre-defined enemy (cf. Keeley 1996; Schulting 2013). This aforementioned, almost indiscriminate killing of local people within or near a settlement is one of the defining characteristics of Neolithic massacres and the subsequently utilised mass or multiple graves. As the example of Eulau shows, this will have the effect that very likely biologically related individuals will be among the victims and will later be included in the respective burial features (cf. Haak et al. 2008; 2010). So, demographic patterns of mass fatality sites that more or less appear to be “taken from life” most likely are just that (cf. Düring 2017), in contrast to features like the Halberstadt mass grave, where victims were clearly selected and killed in a much more “controlled” manner. While in some cases it is suspected that almost the whole community targeted by collective violence has been erased, like at Talheim or Kilianstädten for example (Wahl & König 1987; Trautmann & Wahl 2012; Düring & Wahl 2014), other sites show that there must have been non-captured survivors of the collective violence events. While such a site is so far not known for the LBK, the CWC multiple graves of Eulau, again, are currently the best general example for

prehistoric Central Europe. The bodies of the deceased have clearly been arranged with great care and with detailed knowledge about their biological and social kinship ties. This securely precludes a random burial by strangers (Haak et al. 2008), and might even signify long-term survival of the attacked community. In theory, such burial features, which show clear evidence of both lethal collective violence and careful arrangement of the bodies could also have been part of the overall “burial” portfolio of the LBK which is already known to have been extremely diverse (cf. Peschel 1992; Nieszery 1995; Trautmann 2006; Pechtl & Hofmann 2013; Zeeb-Lanz et al. 2013; Meyer et al. 2014; Boulestin & Coupey 2015; Hofmann 2015). Possibly, such sites will be discovered in the future. If not, this could actually be very informative about LBK attitudes towards collective violent death or collective death in general, even if related individuals might have been involved (cf. Meyer et al. 2014).

Previous studies have also indicated that inheritance of ownership and access to managed and manured high-quality farmland is already suggested for the Early Neolithic and therefore the LBK (Bogaard et al. 2013; Gronenborn 2016), and has likely been passed down the generations along paternal lineages (Bentley et al. 2012). Evidence for some inequality, at least between LBK men, has also previously been identified in an integrative study on regular LBK burials by combining isotope analysis, sex determination and artifacts (Bentley et al. 2012). The presence of adzes in some, but not all, of the men’s graves might actually be a part of such a concept of inherited status in the widest sense that might somehow have been translated into the burial record. How potential social status differences like these could have affected mass burial in the LBK cannot currently be answered, as known mass graves still remain rare. But the

highly complex interrelations of the biological and social spheres of human societies have always to be taken into account when trying to make sense of unusual burial phenomena. The purely physical or biological evidence in human skeletal remains for collective violence, which has been called “a powerful expression of human social interaction” (Schulting & Wysocki 2005, 107) or “a record of social relationships” (Larsen 2012, xii) can therefore not be viewed in isolation but has to be always embedded into its contextual information (cf. Kim & Kissel 2018). Periodic review is also an essential part of the bioarchaeological approach as is well illustrated by the aforementioned examples of the burial site “Jungfernhöhle” or, more generally, the deviant burials of the LBK (Pechtl & Hofmann 2013; Meyer et al. 2013; 2014; Boulestin 2017).

Whereas isolated cases of perimortem blunt force injuries are sometimes ambiguous in their interpretation (Schulting & Fibiger 2014), especially if unsupported by a special or “deviant” burial rite (e.g. Meyer & Alt 2012), the presence of multiple and foremost of multiple cranial injuries more or less rules out accidental events and instead indicates targeted interpersonal violence (cf. Wahl & König 1987; Dyer & Fibiger 2017). If numerous individuals with clear signs of perimortem injuries are found in single or several related contemporaneous burial features, collective lethal violence is the most likely explanation. Although the evidence for this in the archaeological record still has to be called rare overall for the Neolithic of Central Europe, such events seem to have been a repeatedly occurring part of past life-experiences, closely following the patterns identified for “prehistoric” or “early warfare” from ethnographic sources (Keeley 1996; Schulting 2013; Kim & Kissel 2018). With the necessary caution the principle of uniformitarianism can therefore be applied to the

Neolithic mass fatality sites if they show the same characteristics as for example documented village raids from later times carried out with technologically roughly comparable sets of weaponry (cf. Keeley 1996; Walker 2001; Fibiger 2014).

As mentioned earlier, the demographic composition of a mass or multiple grave may indeed be an important factor in the decision if a mass fatality event likely has been such an all-out massacre or raid of a settled community or if other events might be able to better explain the observed trauma patterns. In fact, it has been suggested that massive skeletal trauma might have had a ritualistic background in the European Neolithic (Link 2014), and the enigmatic LBK site of Herxheim certainly proves that human bodies, including the skeletal structure, were at times intensively modified (Boulestin et al. 2008; Boulestin & Coupey 2015). This apparently included dismemberment, deliberate smashing of bones, shaping them into pre-conceived forms, and possibly also ritual cannibalism (Boulestin et al. 2008; Zeeb-Lanz 2009; 2014). The observed diversity of Neolithic burial ritual centering on the human body therefore shows that interpretations have to be based on as much information as can be compiled for each site (cf. Schulting 2018), and that especially unique features are difficult to understand and to untangle in a convincing manner as the osteoarchaeological record of the past will always be incomplete. But if sound patterns emerge from studies of different deviant burial sites (cf. Meyer et al. 2014; CHAPTER 6), these should not be neglected, but made part of future comparative research approaches. It is also advised to periodically and critically re-visit older research results and to re-analyse the extant “material”, e.g. the human skeletal remains in addition to the already mentioned review of the

interpretations. Experience has clearly shown multiple times that theoretical and practical advancement in methods, concepts and the general understanding of the interconnectedness of different factors can lead to significantly new interpretations for important archaeological sites (e.g. Boulestin 2017; Fröhlich & Lüning 2017).

It remains that lasting interpretations need to be based on sound datasets and the reliable identification of valid patterns contained within them. The interpretative bioarchaeological search for patterns on the group level has been an integral part of the present thesis and its respective chapters so far. To conclude the overall study, some more pattern-searching shall be done within the violence-related mass fatality samples:

Comparing the four most unambiguous, collective violence-related, and likely completely excavated Neolithic mass fatality samples currently available for the LBK and CWC, with three of them described in detail in this work, we see some general similarities in the so-called massacre samples (Talheim; Kilianstädten – CHAPTER 4; Eulau – CHAPTER 3) and some differences to these in the presumed execution sample from Halberstadt (CHAPTER 5).

The basic age structure of the three raid and massacre samples is overall very comparable, including roughly similar percentages of adults and subadults. These revolve around a balanced 50 % with an average number of subadult individuals of 53 % and of adult individuals of 47 %. In addition to that the prevalence of clearly traumatized individuals is also very similar for the three sites of Talheim, Kilianstädten and Eulau, ranging from 38 % to 53 % with an average of 47 %. As detailed before, the recognized injuries can only represent a

minimum number of traumatic lesions, as many perimortem wounds do not leave recognizable marks on the skeleton and are therefore usually lost upon decomposition. In Table 7.1, which summarizes the site-specific information, this is addressed by including a “+” with the trauma data.

Site	N	Subadult	Adult	Trauma
Talheim	34	47 %	53 %	53+ %
Kilianstädten	26	50 %	50 %	50+ %
Eulau	13	62 %	38 %	38+ %
Halberstadt	9	11 %	89 %	78+ %

*Tab. 7.1. Overview of four violence-related LBK and CWC mass fatality samples from Germany, showing the relative sizes of the basic biological age classes identified at each site and the respective percentages (ca.) of individuals with securely identified bone trauma. Data for Talheim taken from Wahl & König (1987), the other data taken from CHAPTERS 3, 4 AND 5 of this work.*

Looking again at the individual sites, there is an almost balanced ratio of adult to subadult individuals at Talheim. The Kilianstädten mass grave is very similar to that, with a completely balanced ratio. The group buried in the multiple graves of Eulau even has a slightly higher amount of subadult individuals than the two earlier mass graves. But overall, the differences between these three sites are not very pronounced and there is no statistically significant difference between the ratios of adult to biological subadult individuals between these sites ( $p = 0.67$ ;  $\chi^2 = 0.80$ ). Only the site of Halberstadt really stands out with only one

individual determined as a biological subadult (of ca. 16-20 years) who certainly was already a social adult in his contemporaneous culture. Taking this into account accordingly in the biocultural approach that the author generally employs the Halberstadt mass grave actually contained an all-adult sample and therefore is significantly different from the other sites, even if only the Infans I and Infans II age classes are counted as subadult and all others as (social) adult at all sites (Talheim,  $p = 0.03$ ; Kilianstädten,  $p = 0.01$ ; Eulau,  $p = 0.00$ ; Fisher's Exact Test, one-tailed).

The high percentages of subadults at the first three sites (Talheim, Kilianstädten, Eulau), which also show unequivocal signs of lethal violence, are indeed very indicative of lethal raids which struck the respective settled communities (cf. Keeley 1996; Fibiger 2014; Schulting 2018). As all individuals have been buried simultaneously it can be assumed that they also died around the same time and very likely of the same general causes in these cases: collective lethal violence. Looking again at the frequency of individuals which show clear evidence of perimortem violence at each site, we arrive at an average of 55 % or more when Halberstadt is included with the three massacres samples, compared to the 47 % or more, when this site is excluded. For the general purpose and interpretation of these values here, this slight difference is rather negligible. In any case, it has to be kept in mind that these calculations are very much affected by differing skeletal preservation and completeness and that some of the visible lesions remained ambiguous during analysis due to taphonomic overprinting at each site (cf. Wahl & König 1987). For this reason, statistical testing is not really feasible for these data. It is evident though, which can be regarded as the most important point in this context, that not all

individuals bear unequivocal signs of perimortem injury at each site, not even at Halberstadt, where systematic execution is proposed. This is due to the incompleteness of several of the skeletal individuals, some of which are missing their crania. Regardless if Halberstadt is included or not, about half of the individuals found in complex burial features attributed to lethal collective violence events do show skeletal perimortem trauma, which can therefore be considered as the value to be expected in Neolithic massacre contexts. The close association of individuals with and without clear evidence for trauma within a violence-caused mass fatality feature is a very strong indicator that in fact all individuals included in such mass and multiple graves were likely killed by violence, even if this might not have affected the skeleton but only the non-preserved soft tissues (cf. Wahl & König 1987; Milner 2005; Pernter et al. 2007). Another similarity is the occurrence of arrow injuries at three, possibly even at all four, of the examined sites. These are generally rare in the archaeological record, although some geographical differences seem to exist in the European Neolithic. Especially Central Europe seems to have far less documented cases than the southwestern parts of the continent (cf. Guilaine & Zammit 2005). It therefore appears that the triad of:

- A) a high percentage of ca. 50 % or more of subadults among the violence victims,
  
- B) the presence of perimortem skeletal injury in ca. 50 % or more of individuals,

### C) the general evidence for perimortem arrow injuries

is highly indicative of a successful prehistoric attack or raid upon a settled community with the potential to destroy it completely. If significant deviations from this pattern are discovered in an obviously violence-related Neolithic mass fatality site, a different context has to be seriously considered. The mass grave of Halberstadt examined and discussed in CHAPTER 5 of this study is a good example of such a deviant complex burial feature. On first glance it resembles the previously known LBK massacre sites of Talheim, Asparn/Schletz and Schöneck-Kilianstädten very much, but reveals itself to be very different upon closer bioarchaeological analysis and comparative evaluation within the context of the previously established patterns. The obvious deviance in demography is also independently corroborated by the different distribution of cranial injuries and the non-local isotope signatures of the killed individuals in the mass grave. Summing up, lethal interpersonal violence carried out on the group level so far appears to be the major, but certainly not the only, cause for the existence of Neolithic single-event mass fatality samples (cf. Meyer et al. 2014). The human skeletal remains contained within these complex burial or depositional features tend to show clear osteological signs of violence in about half of the victims, as a consequence of a number of soft-tissue-only injuries and incomplete preservation or recovery. Including ambiguous signs of trauma, the numbers will rise for each site. But taking into account the effects of various taphonomic factors, working with the minimal numbers of clearly traumatized victims seems to be sufficient for valid interpretations. Only if clear signs of perimortem violence whatsoever are completely missing from a mass fatality sample may

collective violence be considered as an unlikely explanation. In these cases, lethal infectious diseases, natural catastrophes or “accidents” in the widest sense probably have been responsible for the simultaneous death of various individuals (e.g. Meyer et al. 2004; Keller et al. 2015). The LBK mass grave of Wiederstedt may represent such a case as both demographic and trauma patterns clearly deviate from the comparatively identified massacre characteristics. In stark contrast, the Halberstadt mass grave shows that a controlled and systematic application of lethal violence, contra a more chaotic massacre, can also be identified in the archaeological record, e.g. by a raised prevalence of perimortem skeletal, and specifically, cranial trauma.

Depending on the number of possible survivors of massacres and similar events of collective violence, and likely being related to the fate of the settlement area formerly occupied by the victims, two different variants of actively treating the dead have emerged from the samples studied here:

- 1) A disorganized mass grave is utilized, likely as a means to quickly dispose of dead bodies with the least possible effort.

- 2) One or more carefully arranged multiple burials are constructed, generally following the respective burial customs, but possibly modifying them to accommodate the unusual numbers of simultaneously deceased persons.

Seemingly total neglect of the regular burial rites known so far may also be indicative of deposition by “others”, while more deliberately organised and carefully arranged burials may have been carried out by people connected to

the deceased by social or biological kinship ties (cf. Komar 2008). For the Central European Neolithic it is highly likely that every individual was part of one or likely several social and biological kinship networks (cf. Strien 2010), and it seems that everyone could indeed become a victim of lethal violence at any time, as obviously shown by slain children, women and men of different ages (cf. Walker 2001). This very much indicates organised warfare between independent communities and may also be taken as evidence for social substitutability, meaning that all members of a targeted community may have been legitimate targets for killing, not just specific individuals.

While some of the patterns identified and analysed in this work may be carefully generalised and applied to other Neolithic or prehistoric burial sites, extensive variations of the examined themes will undoubtedly have existed over time and space. Burial rites in the widest sense actively involving human remains will have been very complex at times (e.g. Parker Pearson 2005; Zeeb-Lanz 2009; Meller 2013), and their osteological residues can mimic non-ritual interpersonal violence, if such did exist in the Neolithic in the first place. While mainly ritualistic motivations are of course difficult if not impossible to prove, objective recurrence to the most likely explanation by using very general ethnographic parallels seems to suggest that lethal collective violence is most commonly applied to enemy “others”, however defined at that time (Keeley 1996; Dwyer & Ryan 2012; Kissel & Kim 2019). These might have been allies or trading partners in other contexts, but most likely they were somehow marked as being different as a group, at least in the perception of the perpetrators of lethal collective violence (Dwyer & Ryan 2012). This does fit with the very general observation that conflict between groups very often arises along ethnic

boundaries which may or may not be visible in the archaeological record (cf. Schleussner et al. 2016; Kim & Kissel 2018).

Following the dictum that the most simple explanations fitting all facts are often the correct ones, it seems overall more likely that most victims of massacres like those analysed in this work were not killed as part of an unknown ritual but as a result of the human potential for ambiguous and extremely violent behaviour towards “others“. This clearly included lethal collective violence as rather pragmatically motivated action to resolve conflicts, whatever these might have been (Walker 2001; Harrod et al. 2012; Martin & Harrod 2015). Although large-scale massacres are now known from several Neolithic sites, their occurrence will nevertheless have been rather rare overall, as certain conditions seem necessary to provoke humans as a group into last-resort actions such as massacres. Most of these conditions, like one group feeling emotionally dominant over another, wishing to subjugate, dehumanize, eradicate, exact revenge or impose power and control over another (Dwyer & Ryan 2012; Klusemann 2012; Kim & Kissel 2018), will not have imprinted themselves unequivocally into the archaeological or osteological record. But the careful analysis of human skeletal remains as direct physical and biological evidence of the past sometimes allows precise insights into the violent actions themselves and also into the subsequent fate of the victims that can be recovered from deviant burial features. The skeletal remains also serve as biogenic repositories for further valuable information which, especially in the cases of simultaneous mass or multiple burials, provide the unmatched opportunity to analyse the contemporaneous biological structure of prehistoric communities in relation to their overall biocultural environment.

Collective violence, as ample evidence now shows, has been an impactful part of Neolithic life and death in Central Europe. Its dedicated documentation and comparative analysis in human skeletal remains is necessary to identify and understand the events that led to the very existence of such enigmatic and complex burial features like mass and multiple graves. While each site has its unique characteristics, partly shaped by the complex web of human interactions and the natural environment, several similarities can be recognised and transcribed into bioarchaeological patterns. Future research and new discoveries will certainly add to that, complementing current knowledge and interpretations.

## **SUMMARY (ENGLISH)**

This work collects and combines four peer-reviewed and internationally published papers that individually examine part of the evidence for collective lethal violence found in human skeletal remains of the Neolithic in Central Europe. Mostly, but not exclusively, built upon the high-profile mass violence sites of Eulau and Halberstadt, Saxony-Anhalt, Germany and Schöneck-Kilianstädten, Hesse, Germany, various aspects of collective violence are examined.

To be able to correctly identify and utilise the osteological and traumatological evidence for lethal violence in prehistoric human skeletal remains, several basic issues have to be recognised and incorporated in interpretations. Most importantly, the point in time when specific bone trauma occurred has to be determined as precisely as possible. The terms *antemortem*, *perimortem*, and *postmortem* are of the highest relevance here, as the correct identification of the respective “injuries” is the cornerstone of the interpretation of possibly violence-related mass fatality sites. Neglect of the always present taphonomical effects may result in flawed analyses and interpretations as classic examples clearly show. Also highly relevant for the reconstruction of prehistoric violence is the level on which theories may be grounded. In pragmatic terms, sample size determines how far-reaching conclusions may be formulated and to what extent they may be generalised.

The first set of violence-related burials examined in detail, the Corded Ware multiple graves of Eulau, Germany, revealed a massacre of part of a settled community. Men, women, and children were killed by lethal violence, including

penetrating cranial blunt force injuries very likely delivered by stone axes as well as arrow injuries. The discovery at this site of an arrowhead still embedded in a vertebra of an adult female individual is clear evidence of directed lethal violence. Perimortem defense injuries have been identified as well. The demographic pattern established for the victims indicates a lethal raid on a settlement, and the extraordinarily careful arrangement of the bodies in the graves encountered in the Eulau multiple burials prove that survivors remained who carried out the elaborate burials. These survivors had detailed knowledge about the biological kinship ties between the killed individuals and arranged their burials accordingly and with considerable effort. This has been expressed most clearly in the very intricate burial arrangement of a biological nuclear family in a four-fold multiple burial.

The second set of human skeletal remains examined are those found in the mass grave of Schöneck-Kilianstädten, Germany. This deviant burial feature has been dated to the later phases of the *Linearbandkeramik* and fits well into the context of later LBK massacres already known from the sites of Talheim, Germany and Asparn/Schletz, Austria. In addition to a high number of cranial injuries numerous perimortem fractures of the major extremity bones have been identified in the commingled skeletal remains. Especially the tibia showed evidence of having primarily been targeted by blunt force violence, which might have either been due to antemortem torture or postmortem mutilation or even both. In contrast to the Eulau multiple burials, the bodies at Kilianstädten have been deposited in a chaotic manner in a disorganized mass grave, devoid of any recognizable burial ritual. The intentional violence is further underscored by the presence of probable arrow injuries. The lack of younger women in the mass

grave also fits quite well with the results obtained at the other LBK massacre sites and might be explained by targeted capture of this demographic segment. This practice is known quite well from ethnographic accounts.

The third set of human skeletal remains examined in detail has been excavated by the author from the block-lifted mass grave of Halberstadt, Germany. This deviant burial feature has been dated to the late LBK as well and contained the largely articulated remains of an almost exclusively young adult male sample. All remaining crania showed evidence of perimortem blunt force injuries which were much more uniform in their distribution than the injuries recorded at the other LBK mass violence sites. This indicates that the lethal violence at Halberstadt was applied in a much more controlled manner than at the chaotic massacre events which are proposed for Talheim, Asparn/Schletz and Kilianstädten. The peculiar demographic structure of the violence victims at Halberstadt further differentiates this feature from the other mass graves as subadult individuals are missing. Strontium, carbon and nitrogen isotope analyses also revealed that the individuals deposited in the mass grave were not part of the local population as evidenced by a comparison with regular graves found in the nearby settlement. Combining all available data it is proposed that at Halberstadt a group of young non-local adults was systematically executed, likely by the local population. It is possible that the Halberstadt mass grave represents the aftermath of a failed attack and thereby a counter-point to the massacre sites.

Looking specifically at Neolithic mass graves and collective violence especially the Early Neolithic *Linearbandkeramik* now allows some deeper insights due to the increasing number of known mass violence sites. In the light of the currently

known funeral rites of the LBK the mass graves may indeed be termed deviant burials and so far they seem to be restricted to settlement contexts where they tend to be discovered accidentally. Within settlement areas singular or probably also multiple burials may be found which usually differ quite clearly from the mass graves in terms of the care given to the overall arrangement of the bodies. The site of Halberstadt-Sonntagsfeld exemplifies this contrast. The culturally expressed individuality of the dead, obvious from most singular burials, is suppressed by inclusion in a chaotic mass deposit. So far, collective violence seems to be the leading cause for both mass fatalities and mass graves and several patterns can now be recognised. The scarcity of younger women among the killed victims is one of the most consistent features as is the application of blunt force to the cranium. The distribution of wounds, which differs among at least some of the sites, may hold further clues to the biocultural context in which the mass violence occurred. The same holds true for the overall demographic structure of each mass fatality sample. By combining all available data the respective sites can be characterised comparatively and interpreted individually at the same time. Given their rather similar dating they can also be combined into an overarching narrative for the later part of the LBK in Central Europe and the role of collective violence during that time.

Helpful in securely identifying the instances of classic collective violence in the archaeological record of Neolithic Europe may be the triad of a high percentage of ca. 50 % or more of subadults among the victims, the presence of perimortem injury in ca. 50 % or more of individuals, and the general evidence for arrow injuries in the sample. These traits are highly indicative of a lethal attack on a settled community. In this vein, the demographic deviation of the Halberstadt

mass grave sample from the massacre sites again underscores its different context while still being a collective violence site. In the aftermath of collective violence, two different variants of actively treating the dead have been identified here: 1) A disorganized mass grave is utilized, likely as a means to dispose of the dead with the least possible effort. 2) One or more carefully arranged multiple burials are constructed, generally following the respective burial customs, but possibly modifying them to accommodate the unusual numbers of simultaneously deceased persons. Neglect of the regular burial rites may furthermore be indicative of deposition by “others”, probably the perpetrators of lethal violence themselves, while more deliberately organized burials will have been carried out by people likely connected to the deceased by social or biological kinship ties. It therefore appears from the samples analysed here, as well as several others, that collective violence was a prominent and impactful aspect of life and death in the Neolithic of Central Europe which can be identified and analysed by careful examination of the human skeletal remains of that era.

## **SUMMARY (GERMAN)**

In dieser Arbeit sind vier international publizierte, englischsprachige und fachlich begutachtete Artikel gesammelt und zusammengefasst, die sich anhand von geeigneten Beispielen mit dem Thema von kollektiver Gewalt im mitteleuropäischen Neolithikum auseinandersetzen. Des Weiteren werden einige nahestehende Themen behandelt. Im Zentrum der Betrachtungen stehen die herausragenden Fundplätze mit kollektiver Gewalt von Eulau (Burgenlandkreis, Sachsen-Anhalt), Halberstadt-Sonntagsfeld (Landkreis Harz, Sachsen-Anhalt) und Schöneck-Kilianstädten (Main-Kinzig-Kreis, Hessen). Andere Fundplätze werden jedoch ebenfalls zum Vergleich herangezogen.

Um insbesondere bei solchen prähistorischen Fällen von perimortaler Gewaltanwendung, wie den hier vorgestellten und rekonstruierten Ereignissen, die osteologischen und traumatologischen Spuren am Knochen richtig deuten zu können, müssen einige grundlegende Sachverhalte und Prinzipien beachtet werden. Die Vergangenheit zeigt, dass andernfalls falsche oder verzerrte Interpretationen vorgelegt werden können, die, vielfach reproduziert, über lange Zeiten hinweg die Forschung behindern können. Von fundamentaler Wichtigkeit ist dabei vor allem der Zeitpunkt, an dem ein spezifisches Knochen trauma entstanden ist. Hier spielen die Begriffe intravital, perimortal und postmortal eine zentrale Rolle und bilden somit das Fundament der Interpretation von Schauplätzen prähistorischer Massaker oder anderweitiger „Sonderbestattungen“ mit bedeutenden Anteilen von physischer Gewalt. Ebenfalls von großer Bedeutung ist die allgemeine Ebene, auf welcher weiterführende Aussagen getroffen werden können. In pragmatischer Hinsicht

bedeutet hier eine höhere Stichprobengröße pro Fundplatz theoretisch eine höhere Sicherheit bei der Interpretation. Die zu Grunde liegenden Zahlen müssen auch bei weiteren Generalisierungen der Ergebnisse stets kritisch berücksichtigt werden.

Die erste hier detailliert behandelte Skelettserie stammt aus den schnurkeramischen Mehrfachbestattungen von Eulau. Durch die osteologische Untersuchung wurde deutlich, dass hier Erwachsene beiderlei Geschlechts sowie eine Reihe von Kindern höchstwahrscheinlich Opfer eines gewaltsamen Überfalls geworden sind. Die festgestellten Traumatisierungen umfassen stumpfe, perimortale Schädelverletzungen, wahrscheinliche Abwehrverletzungen an den oberen Gliedmaßen sowie Pfeilschussverletzungen. Insbesondere der Fund einer noch im Knochen steckenden Pfeilspitze bei einer erwachsenen Frau belegt eindeutig das zielgerichtete, gewaltsame Geschehen vor Ort. Die demographische Struktur der Stichprobe der wohl gleichzeitig verstorbenen Individuen legt sehr nahe, dass es sich bei den Opfern um Angehörige einer lokalen Siedlungsgemeinschaft handelte. Das sehr sorgfältige Arrangement der Toten in den Gräbern belegt weiterhin, dass es Überlebende gegeben haben muss, welche die biologischen Verwandtschaftsstrukturen der Getöteten gekannt haben. Vor allem die komplexe und verschachtelte Lage der in einem Vierfachgrab gefundenen Individuen ist hier besonders hervorzuheben, da es sich nach den Ergebnissen der durchgeführten genetischen Analysen um eine biologische Kernfamilie gehandelt hat.

Ebenfalls detailliert untersucht wurden die Skelettreste aus dem linearbandkeramischen Massengrab von Schöneck-Kilianstädten. Dieser Befund

datiert in eine späte Phase der Linearbandkeramik und fügt sich damit ein in die Riege der bereits bekannten Massakerfundplätze dieser Zeit (Talheim, Deutschland; Asparn/Schletz, Österreich). Neben den typischen perimortalen Schädelverletzungen, welche wohl z. T. auf die bekannten bandkeramischen Waffen und Werkzeuge zurückzuführen sind, konnten auch viele perimortale Frakturen der Extremitätenknochen festgestellt werden. Insbesondere die Tibia ist hiervon betroffen. Ob diese Knochenbrüche noch vor dem Tod der Individuen entstanden sind oder aber erst nach dem Tod den Leichen zugefügt worden sind, lässt sich methodisch nicht mehr feststellen. Im deutlichen Gegensatz zu den sorgfältig bestatteten Toten aus Eulau fanden sich die Gewaltopfer aus Kilianstädten in einem unorganisierten Massengrab, ohne jegliche Anzeichen eines sorgfältigen Bestattungsrituals. Dies unterstreicht noch einmal das Ausmaß der ausgeübten kollektiven Gewalt, ebenso wie das sehr wahrscheinliche Vorhandensein von Pfeilschussverletzungen. Auch das Fehlen jüngerer Frauen fügt sich nahtlos in die bisherigen Ergebnisse zu den bandkeramischen Massaker-Fundplätzen ein. Es ist daher gut vorstellbar, dass dieses Bevölkerungselement von den Angreifern zunächst verschont und dann verschleppt worden ist. Für eine solche Praxis liegen zahlreiche ethnographische Beispiele vor.

Die dritte Gruppe menschlicher Skelettreste, die für diese Arbeit untersucht wurden, entstammt dem Massengrab von Halberstadt, welches ebenfalls an das Ende der Linearbandkeramik datiert. Dieser Befund ist zunächst im Block geborgen worden; die Skelette wurden im Anschluss vom Autor weiter freigelegt und schließlich für weitere Untersuchungen aus dem Block entfernt. Es zeigte sich, dass die im Massengrab deponierten Menschen fast

ausschließlich jüngere Erwachsene männlichen Geschlechts waren. Alle noch vorhandenen Schädel wiesen perimortale Verletzungen durch stumpfe Gewalteinwirkungen auf. Die Verteilung dieser Verletzungen weicht jedoch von denen der anderen bandkeramischen Fundorte ab, indem sie sehr viel stärker, und nahezu vollständig, auf den Hinterkopf konzentriert sind. Dies legt im direkten Vergleich nahe, dass die Gewalt in Halberstadt in einem deutlich kontrollierteren Rahmen stattgefunden hat als während der eher chaotischen Massaker an den anderen Fundorten. Der Unterschied zu den anderen Orten kollektiver Gewalt wird auch durch die besondere Demographie noch einmal unterstrichen, da insbesondere Kinder vollständig fehlen. Strontium-, Kohlenstoff- und Stickstoff-Isotopenanalysen zeigen zudem, dass die Toten aus dem Massengrab nicht der lokalen Bevölkerung angehörten. Sie unterscheiden sich als Gruppe deutlich von den regulären Bestattungen innerhalb der Siedlung am selben Fundplatz. Unter Berücksichtigung aller Ergebnisse, und im Vergleich mit den anderen bandkeramischen Fundplätzen mit kollektiver Gewalt, erscheint es aktuell am wahrscheinlichsten, dass in Halberstadt eine Gruppe ortsfremder, junger Erwachsener systematisch hingerichtet worden ist, wahrscheinlich von der lokalen Bevölkerung. Möglicherweise handelte es sich bei den Opfern selbst um ehemalige Aggressoren, deren Angriff auf die lokale Siedlung allerdings gescheitert war. Sollte dieses Szenario zutreffen, so würde das Massengrab von Halberstadt eine Situation repräsentieren, bei der der Spieß kollektiver Gewalt geradezu umgedreht worden ist.

Betrachtet man gezielt neolithische Massengräber und wiederum deren Hauptverursacher, die kollektive Gewalt, lassen sich insbesondere für die Linearbandkeramik vertiefte Einblicke in diverse Muster gewinnen, die diese

Form der Sonderbestattungen charakterisieren. So treten sie bisher eher in Siedlungs- als in regulären Bestattungskontexten auf und werden zufällig bei archäologischen Maßnahmen entdeckt. Im Gegensatz zu den ebenfalls bekannten, sorgfältig angelegten Siedlungs- bzw. Mehrfachbestattungen weniger Individuen lassen die Massengräber jeweils eine offensichtliche Sorgfalt bei der Deponierung vermissen. Das hier untersuchte Massengrab von Halberstadt zeigt dies eindrücklich durch das Vorhandensein beider Formen auf einem Fundplatz. Während die meisten Einzelbestattungen im Gräberfeld- oder Siedlungskontext durch Beigaben, Ausrichtung und Position die Individualität der Verstorbenen unterstreichen, wird dies in den beigabenlosen, desorganisierten Massengräbern augenscheinlich negiert. Kollektive, tödliche Gewalt erscheint bisher als der Hauptgrund für die Anlage von Massengräbern und die gestiegene Zahl der bekannten Fundorte lässt nun einige verlässliche Muster erkennen. Das weitgehende Fehlen junger Frauen unter den Opfern kann hier genannt werden, wie auch das Zielen von stumpfer Gewalt auf den Schädel. Die Verteilung der Wunden, die sich, wie gezeigt, durchaus zwischen den Fundorten unterscheiden kann, beinhaltet ebenfalls Hinweise auf das ehemalige Geschehen und dessen biokulturellen Kontext. Dasselbe gilt für die allgemeine demographische Zusammensetzung der Opfergemeinschaften. Die Zusammenfassung und gemeinsame Interpretation der vorhandenen Daten kann somit Gemeinsamkeiten wie auch Unterschiede zwischen den Fundplätzen mit kollektiver Gewalt demonstrieren. Aufgrund der jeweils ähnlichen Datierungen können die bandkeramischen Fundplätze zudem in ein gemeinsames Narrativ gestellt werden, welches das Auftreten und die Rolle der

Gewalt gegen Ende der Linearbandkeramik in Mitteleuropa zu charakterisieren sucht.

Um klassische kollektive Gewaltereignisse, wie etwa Massaker, im mitteleuropäischen Neolithikum präziser identifizieren und charakterisieren zu können, kann die hier herausgestellte Triade an Merkmalen hilfreich sein, welche mit einem hohen Prozentsatz subadulter Opfer von ca. 50 % oder mehr, dem Nachweis perimortaler Verletzungen bei ca. 50 % oder mehr der Individuen sowie dem Vorhandensein von Pfeilschussverletzungen umrissen werden kann. Diese Merkmale sind starke Hinweise auf ein gewaltsames Überfallereignis auf eine organische Siedlungsgemeinschaft. Die abweichende Demographie des Massengrabs von Halberstadt, mit dem Fehlen jüngerer Kinder, unterstreicht hier noch einmal dessen von einem Massaker abweichenden Kontext. Im Hinblick auf die Totenbehandlung nach den kollektiven Sterbe-Events lassen sich anhand der untersuchten und zum Vergleich herangezogenen Fundplätze zwei fundamental verschiedene Varianten herausstellen: 1) Ein chaotisches Massengrab wird angelegt, wahrscheinlich um die Toten so schnell und mit so wenig Aufwand wie möglich zu beseitigen. 2) Sorgfältig angelegte Mehrfachbestattungen werden verwendet, welche grundlegend den regulären Bestattungssitten der jeweiligen Kultur folgen, jedoch an die individuellen Umstände angepasst werden können. Das Fehlen jeglicher augenscheinlicher Sorgfalt und das massive Abweichen von den individuellen Bestattungsriten ist dabei ein Hinweis, dass die Deponierung der Toten wahrscheinlich nicht durch die eigene, sozial und biologisch vernetzte, Gemeinschaft erfolgt ist, sondern eher durch andere Personen. Bei Massakern oder ähnlichen Gewalttaten könnten dies die Täter selbst gewesen sein. Im

Gegenzug müssen die Gräber, welche offensichtliche Verwandtschaftsbeziehungen mit Aufwand nachzeichnen, von nahestehenden Personen angelegt worden sein, welche Kenntnis von den jeweiligen sozialen und biologischen Verwandtschaftsbeziehungen hatten. Die hier exemplarisch untersuchten Fundorte, wie auch weitere aus der Literatur, zeigen daher deutlich, dass kollektive Gewalt ein bedeutender Aspekt der neolithischen Lebens- und Sterbenswelt gewesen ist. Sorgfältige Untersuchungen der menschlichen Skelettreste dieser Zeitstellung können hier weitere wichtige und bedeutende Einblicke geben.

## REFERENCES

### (for CHAPTERS 1, 2 AND 7)

Ahola M, Kirkinen T, Vajanto K, Ruokolainen J (2018) On the scent of an animal skin: new evidence on Corded Ware mortuary practices in Northern Europe. *Antiquity* 92, 118-131.

Alt KW, Vach W, Wahl J (1995) Verwandtschaftsanalyse der Skelettreste aus dem bandkeramischen Massengrab von Talheim, Kreis Heilbronn. *Fundberichte aus Baden-Württemberg* 20, 195-217.

Alt KW, Jeunesse C, Buitrago-Téllez CH, Wächter R, Boes E, Pichler SL (1997) Evidence for stone age cranial surgery. *Nature* 387, 360.

Alt KW, Meyer C, Nicklisch N, Becker T, Mörseburg A, Knipper C (2014) Jechtingen - Anthropologie eines mittelneolithischen Gräberfeldes. *Fundberichte aus Baden- Württemberg* 34, 177-298.

Asmus G (1955) Die menschlichen Skelettreste aus der Jungfernhöhle. In: Kunkel O, *Die Jungfernhöhle bei Tiefenellern. Eine neolithische Kultstätte auf dem fränkischen Jura bei Bamberg*. pp. 65-77. München.

Benecke N (1994) *Der Mensch und seine Haustiere. Die Geschichte einer jahrtausendealten Beziehung*. Stuttgart.

Bentley RA, Wahl J, Price TD, Atkinson TC (2008) Isotopic signatures and hereditary traits: snapshot of a Neolithic community in Germany. *Antiquity* 82, 290-304.

Bentley RA, Bickle P, Fibiger L, Nowell GM, Dale CD, Hedges REM, Hamilton J, Wahl J, Francken M, Grupe G, Lenneis E, Teschler-Nicola M, Arbogast R-M, Hofmann D, Whittle A (2012) Community differentiation and kinship among Europe's first farmers. *Proceedings of the National Academy of Sciences of the United States of America* 109, 9326–30.

Bogaard A, Fraser R, Heaton THE, Wallace M, Vaiglova P, Charles M, Jones G, Evershed RP, Styring AK, Andersen NH, Arbogast R-M, Bartosiewicz L, Gardeisen A, Kanstrup M, Maier U, Marinova E, Ninov L, Schäfer M, Stephan E (2013) Crop manuring and intensive land management by Europe's first farmers. *Proceedings of the National Academy of Sciences of the USA* 110, 12589-12594.

Boulestin B (2017) Tiefenellern "Revisited". Ergebnisse einer erneuten Bearbeitung des menschlichen Knochenensembles der Linearbandkeramik aus der Jungfernhöhle bei Tiefenellern (Lkr. Bamberg). *Berichte des Historischen Vereins Bamberg* 153, 7-36.

Boulestin B, Coupey A-S (2015) *Cannibalism in the Linear Pottery Culture: The Human Remains from Herxheim*. Oxford.

Boulestin B, Zeeb-Lanz A, Jeunesse C, Haack F, Arbogast R-M, Denaire A (2008) Mass Cannibalism in the Linear Pottery culture at Herxheim (Palatinate, Germany). *Antiquity* 83, 968-982.

Brandt G, Haak W, Adler CJ, Roth C, Szécsényi-Nagy A, Karimnia S, Möller-Rieker S, Meller H, Ganslmeier R, Friederich S, Dresely V, Nicklisch N, Pickrell JK, Sirocko F, Reich D, Cooper A, Alt KW, The Genographic Consortium (2013) Ancient DNA Reveals Key Stages in the Formation of Central European Mitochondrial Genetic Diversity. *Science* 342, 257-261.

Buhmann D (1979) Paläopathologie im Süddeutschen Raum. Ein Beitrag zur Methodik paläopathologischer Forschung. *Sudhoffs Archiv* 63, 367-391.

Carli-Thiele P (1996) *Spuren von Mangelerkrankungen an steinzeitlichen Kinderskeleten*. Fortschritte in der Paläopathologie und Osteoarchäologie 1. Göttingen.

Childe VG (1936) *Man Makes Himself*. London.

Dobney K, Larson G (2006) Genetics and animal domestication: new windows on an elusive process. *Journal of Zoology* 269, 261-271.

Dolfini A, Crellin RJ, Horn C, Uckelmann M (2018) Interdisciplinary Approaches to Prehistoric Warfare and Violence: Past, Present, and Future. In: Dolfini A,

Crellin RJ, Horn C, Uckelman M (eds) *Prehistoric Warfare and Violence. Quantitative and Qualitative Approaches*. pp. 1-18. Cham.

Doppler T (2012, ed) *Spreitenbach-Moosweg (Aargau, Schweiz): Ein Kollektivgrab um 2500 v. Chr.* Antiqua 51. Basel.

Dresely V (2004) *Schnurkeramik und Schnurkeramiker im Taubertal*. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 81. Stuttgart.

Duday H (2009) *The Archaeology of the Dead. Lectures in Archaeoethanatology*. Oxford.

Düring A (2017) *From Individuals to Settlement Patterns. Bridging the Gap Between the Living and the Dead in Early Medieval Populations Using an Agent-Based Demographic Model*. PhD thesis. University of Oxford.

Düring A, Wahl J (2014) A massacred village community? Agent-based modelling sheds new light on the demography of the Neolithic mass grave of Talheim. *Anthropologischer Anzeiger* 71, 447-468.

Dyer M, Fibiger L (2017) Understanding blunt force trauma and violence in Neolithic Europe: the first experiments using a skin-skull-brain model and the Thames Beater. *Antiquity* 91, 1515-1528.

Efremov JA (1940) Taphonomy: New Branch of Paleontology. *Pan-American Geologist* 74, 81-93.

Eggers HJ (1986) *Einführung in die Vorgeschichte*. München.

Eggert MKH (2001) *Prähistorische Archäologie. Konzepte und Methoden*. Tübingen.

Fibiger L (2014) Misplaced Childhood? Interpersonal violence and children in Neolithic Europe. In: Knüsel C, Smith MJ (eds) *The Routledge Handbook of the Bioarchaeology of Human Conflict*. pp. 127-145. London.

Fibiger L (2018) Conflict and violence in the Neolithic of Central-Northern Europe. In: Fernández-Götz M, Roymans N (eds) *Conflict Archaeology: Materialities of Collective Violence from Prehistory to Late Antiquity*. Themes in Contemporary Archaeology 5. pp. 13-21. Abingdon.

Fibiger L, Ahlström T, Bennike P, Schulting RJ (2013) Patterns of violence-related skull trauma in Neolithic southern Scandinavia. *American Journal of Physical Anthropology* 150, 190-202.

Fischer U (1956) *Die Gräber der Steinzeit im Saalegebiet. Studien über neolithische und frühbronzezeitliche Grab- und Bestattungsformen in Sachsen-Thüringen*. Vorgeschichtliche Forschungen 15. Berlin.

Fritsch B, Claßen E, Müller U, Dresely V (2011) Die linienbandkeramischen Gräberfelder von Derenburg „Meerenstieg II“ und Halberstadt „Sonntagsfeld“, Lkr. Harz. *Jahresschrift für mitteldeutsche Vorgeschichte* 92 (2008), 25-229.

Fröhlich N, Lüning J (2017) Neue Untersuchungen zur absoluten Datierung des Männergrabes und der Siedlung auf dem ältestbandkeramischen Fundplatz Schwanfeld, Ldkr. Schweinfurt, Unterfranken. *Germania* 95, 43-91.

Ganslmeier R, Literski-Henkel N (2014) Die Tatwaffen aus einem Grab der Schnurkeramik von Eulau, Burgenlandkreis. Ein Beitrag zur Verwendung von Pfeilen in den Kulturgruppen des 3. Jts. v. Chr. *Jahresschrift für mitteldeutsche Vorgeschichte* 94, 29-82.

Gargano F, Tamburino L, Bagarello F, Bravo G (2017) Large-scale effects of migration and conflict in pre-agricultural groups: Insights from a dynamic model. *PLoS ONE* 12, e0172262.

Gerling C (2007) Der Tod in der jüngeren Bandkeramik. Das Gräberfeld von Schwetzingen. *Denkmalpflege in Baden-Württemberg* 36, 159-163.

Gresky J, Haelm J, Clare L (2017) Modified human crania from Göbekli Tepe provide evidence for a new form of Neolithic skull cult. *Science Advances* 3, e1700564.

Gronenborn D (2007) Beyond the models: ‚Neolithisation‘ in Central Europe. In: Whittle A, Cummings V (eds) *Going Over: The Mesolithic-Neolithic Transition in North-West Europe*. Proceedings of the British Academy 144. pp. 73-98. Oxford.

Gronenborn D (2016) Some thoughts on political differentiation in Early to Young Neolithic societies in western central Europe. In: Meller H, Hahn HP, Jung R, Risch R (eds) *Arm und Reich – Zur Ressourcenverteilung in prähistorischen Gesellschaften*. Tagungen des Landesmuseums für Vorgeschichte Halle 14. pp. 61-74. Halle (Saale).

Gronenborn D, Strien H-C, Lemmen C (2017) Population dynamics, social resilience strategies, and Adaptive Cycles in early farming societies of SW Central Europe. *Quaternary International* 446, 54-65.

Guilaine J, Zammit J (2005) *The Origins of War. Violence in Prehistory*. Oxford.

Gummesson S, Hallgren F, Kjellström A (2018) Keep your head high: skulls on stakes and cranial trauma in Mesolithic Sweden. *Antiquity* 92, 74-90.

Haak W, Brandt G, de Jong HN, Meyer C, Ganslmeier R, Heyd V, Hawkesworth C, Pike AWG, Meller H, Alt KW (2008) Ancient DNA, Strontium isotopes and osteological analyses shed light on social and kinship organization of the Later Stone Age. *Proceedings of the National Academy of Sciences of the USA* 105, 18226-18231.

Haak W, Brandt G, Meyer C, de Jong HN, Ganslmeier R, Pike AWG, Meller H, Alt KW (2010) Die schnurkeramischen Familiengräber von Eulau - ein außergewöhnlicher Fund und seine interdisziplinäre Bewertung. In: Meller H, Alt KW (eds) *Anthropologie, Isotopie und DNA - biografische Annäherung an namenlose vorgeschichtliche Skelette?* Tagungen des Landesmuseums für Vorgeschichte Halle 3. pp. 53-62. Halle (Saale).

Haglund WD, Sorg MH (1997, eds) *Forensic Taphonomy. The Postmortem Fate of Human Remains*. Boca Raton.

Harrod RP, Martin DL, Pérez VR (2012) Conclusion. Implications and Future Directions. In: Martin DL, Harrod RP, Pérez VR (eds.) *The Bioarchaeology of Violence*. pp. 276-280. Gainesville.

Herdt G (1993) Third Sexes and Third Genders. In: Herdt G (ed) *Third Sex. Third Gender. Beyond Sexual Dimorphism in Culture and History*. pp. 21-81. New York.

Hofmann D (2009) Cemetery and Settlement Burials in the Lower Bavarian LBK. In: Hofmann D, Bickle P (eds) *Creating Communities. New Advances in Central European Neolithic Research*. pp. 220-234, Oxford.

Hofmann D (2015) The Burnt, the Whole and the Broken: Funerary Variability in the Linearbandkeramik. In: Devlin ZL, Graham E-J (eds) *Death Embodied. Archaeological Approaches to the Treatment of the Corpse*. pp. 109-128, Oxford.

Iversen R (2016) Arrowheads as indicators of interpersonal violence and group identity among the Neolithic Pitted Ware hunters of southwestern Scandinavia. *Journal of Anthropological Archaeology* 44, 69-86.

Janković I, Balen J, Ahern JCM, Premužić Z, Čavka M, Potrebić H, Novak M (2017) Prehistoric massacre revealed. Perimortem cranial trauma from Potočani, Croatia. *Anthropologischer Anzeiger* 74, 131-141.

Jeunesse C, Barrand-Emam H, Denaire A, Chenal A (2014) Unusual funeral practices and violence in Early Neolithic Central Europe: new discoveries at the Mulhouse-Est Linearbandkeramik. *Antiquity* 342, Online Project Gallery. <http://antiquity.ac.uk/projgall/jeunesse342>

Johnson KM, Paul KS (2015) Bioarchaeology and Kinship: Integrating Theory, Social Relatedness, and Biology in Ancient Family Research. *Journal of Archaeological Research* 24, 75-123.

Keller M, Rott A, Hoke N, Schwarzberg H, Regner-Kamlah B, Harbeck M, Wahl J (2015) United in Death – Related by Blood? Genetic and Archeometric Analyses of Skeletal Remains from the Neolithic Earthwork Bruchsal-Aue. *American Journal of Physical Anthropology* 157, 458-471.

Kelly RC (2005) The evolution of lethal intergroup violence. *Proceedings of the National Academy of Sciences of the USA* 102, 15294-15298.

- Kim NC, Kissel M (2018) *Emergent Warfare in Our Evolutionary Past*. New York.
- Kissel M, Kim NC (2019) The emergence of human warfare: Current perspectives. *American Journal of Physical Anthropology* 168 (S67), 141-163.
- Klusemann S (2012) Massacres as process: A micro-sociological theory of internal patterns of mass atrocities. *European Journal of Criminology* 9, 468-480.
- Komar D (2008) Patterns of mortuary practice associated with genocide. Implications for archaeological research. *Current Anthropology* 49, 123-133.
- Kristiansen K (2014) Towards a New Paradigm? The Third Science Revolution and its Possible Consequences in Archaeology. *Current Swedish Archaeology* 22, 11-34.
- Larsen CS (2012) Foreword. In: Martin DL, Harrod RP, Pérez VR (eds) *The Bioarchaeology of Violence*. pp. xi-xiii. Gainesville.
- Larson G, Piperno DR, Allaby RG, Purugganan MD, Andersson L, Arroyo-Kalin M, Barton L, Climer Vigueira C, Denham T, Dobney K, Doust AN, Gepts P, Gilbert MTP, Gremillion KJ, Lucas L, Lukens L, Marshall FB, Olsen KM, Pires JC, Richerson PJ, Rubio de Casas R, Sanjur OI, Thomas MG, Fuller DQ (2014) Current perspectives and the future of domestication studies. *Proceedings of the National Academy of Sciences of the USA* 111, 6139-6146.

Lewis ME (2013) Sticks and stones. Exploring the nature and significance of child trauma in the past. In: Knüsel C, Smith MJ (eds) *The Routledge Handbook of the Bioarchaeology of Human Conflict*. pp. 39-63. London.

Link T (2014) Gewaltphantasien? Kritische Bemerkungen zur Diskussion über Krieg und Krise am Ende der Bandkeramik. In: Link T, Peter-Röcher H (2014) *Gewalt und Gesellschaft. Dimensionen der Gewalt in ur- und frühgeschichtlicher Zeit*. Universitätsforschungen zur Prähistorischen Archäologie 259. pp. 271-286. Bonn.

Loe L (2009) Perimortem Trauma. In: Blau S, Ubelaker DH (eds) *Handbook of Forensic Archaeology and Anthropology*. pp. 263-283. Walnut Creek.

Lohr C (2013) *Archäologische und anthropologische Untersuchungen des Massengrabes von Schöneck-Kilianstädten (Main-Kinzig-Kreis, Hessen)*. Master thesis, University of Mainz.

Lohr C, Meyer C, Alt KW, Gronenborn D (2017) Ein zweites Talheim?! - Erste Ergebnisse aus dem Massengrab von Schöneck-Kilianstädten, Main-Kinzig-Kreis, Hessen. In: Meller H, Friederich S (eds) *Salzmünde - Regel oder Ausnahme? Internationale Tagung vom 18. bis 20. Oktober 2012 in Halle (Saale)*. Tagungen des Landesmuseums für Vorgeschichte 16. pp. 541-547. Halle (Saale).

Lovell NC (2008) Analysis and Interpretation of Skeletal Trauma. In: Katzenberg MA, Saunders SR (eds) *Biological Anthropology of the Human Skeleton. Second Edition*. pp. 341-386. Hoboken.

Madden GD, Karsten JK, Ledogar SH, Schmidt R, Sokhatsky MP (2018) Violence at Verteba Cave, Ukraine: New insights into the Late Neolithic intergroup conflict. *International Journal of Osteoarchaeology* 28, 44-53.

Martin DL, Harrod RP (2015) Bioarchaeological Contributions to the Study of Violence. *Yearbook of Physical Anthropology* 156, 116-145.

Martin DL, Harrod RP, Pérez VR (2012) Introduction. Bioarchaeology and the Study of Violence. In: Martin DL, Harrod RP, Pérez VR (eds) *The Bioarchaeology of Violence. Bioarchaeological Interpretations of the Human Past: Local, Regional, and Global Perspectives*. pp. 1-10. Gainesville.

Meller H (2013, ed) *3300 BC. Mysteriöse Steinzeittote und ihre Welt*. Halle (Saale).

Meyer C, Alt KW (2012) Anthropologische Untersuchung der menschlichen Skelettfunde aus dem endneolithischen Kollektivgrab von Spreitenbach: osteologischer Individualbefund und Populationscharakteristik. In: Doppler T (ed) *Spreitenbach-Moosweg (Aargau, Schweiz): Ein Kollektivgrab um 2500 v. Chr.* Antiqua 51. pp. 104-157. Basel.

Meyer C, Kürbis O, Alt KW (2004) Das Massengrab von Wiederstedt, Ldkr. Mansfelder Land. Auswertung und Gedanken zur Deutung im Kontext der Linienbandkeramik. *Jahresschrift für mitteldeutsche Vorgeschichte* 88, 31-66.

Meyer C, Kranzbühler J, Drings S, Bramanti B, Nehlich O, Richards MP, Alt KW (2008) Die menschlichen Skelettfunde aus der neolithischen Totenhütte von Benzingerode. Anthropologische Untersuchungen an den Bestattungen eines Kollektivgrabs der Bernburger Kultur. *Archäologie in Sachsen-Anhalt* Sonderband 7, 107-151.

Meyer C, Nicklisch N, Held P, Fritsch B, Alt KW (2011) Tracing patterns of activity in the human skeleton: An overview of methods, problems, and limits of interpretation. *Homo - Journal of Comparative Human Biology* 62, 202-217.

Meyer C, Ganslmeier R, Dresely V, Alt KW (2012a) Die Bedeutung taphonomischer Einflüsse bei der Interpretation neolithischer Grabfunde. In: Link T, Schimmelpfennig D (eds) *Taphonomische Forschungen (nicht nur) zum Neolithikum*. Fokus Jungsteinzeit. Berichte der AG Neolithikum 3. pp. 143-156. Kerpen-Loogh.

Meyer C, Warnberg O, Alt KW (2012b) Feuer und Stein in der Bronzezeit. Eine rätselhafte Doppelbestattung aus Wennungen. *Archäologie in Sachsen-Anhalt* Sonderband 19, 94-98.

Meyer C, Ganslmeier R, Dresely V, Alt KW (2012c) New Approaches to the Reconstruction of Kinship and Social Structure Based on Bioarchaeological Analysis of Neolithic Multiple and Collective Graves. In: Kolář J, Trampota F (eds) *Theoretical and Methodological Considerations in Central European Neolithic Archaeology*. BAR International Series 2325. pp. 11-23. Oxford.

Meyer C, Lohr C, Strien H-C, Gronenborn D, Alt KW (2013a) Interpretationsansätze zu ‚irregulären‘ Bestattungen während der linearbandkeramischen Kultur: Gräber *en masse* und Massengräber. In: Müller-Scheeßel N (ed) *‚Irreguläre‘ Bestattungen in der Urgeschichte. Norm, Ritual, Strafe ...? Kolloquien zur Vor- und Frühgeschichte* 19. pp. 111-122. Bonn.

Meyer C, Karimnia S, Knipper C, Stecher M, Brandt G, Schlenker B, Ramsthaler F, Alt KW (2013b) Eine komplexe Mehrfachbestattung der Salzmünder Kultur. In: Meller H (ed) *3300 BC. Mysteriöse Steinzeittote und ihre Welt*. pp. 290-299. Mainz.

Meyer C, Lohr C, Kürbis O, Dresely V, Haak W, Adler CJ, Gronenborn D, Alt KW (2014) Mass Graves of the LBK. Patterns and Peculiarities. In: Whittle A, Bickle P (eds) *Early Farmers. The View from Archaeology and Science*. Proceedings of the British Academy 198. pp. 307-325. Oxford.

Meyer S, Reichlin T, Rühli F, Häusler M (2013) Drei Skelettfunde aus Harmettlen, Goldau (Kanton Schwyz): die ersten untersuchten Opfer des

Bergsturzes von 1806. *Bulletin der Schweizerischen Gesellschaft für Anthropologie* 19, 23-35.

Micheletti AJC, Ruxton GD, Gardner A (2017) Intrafamily and intragenomic conflicts in human warfare. *Proceedings of the Royal Society B* 284, 20162699.

Milner GR (2005) Nineteenth-century arrow wounds and perceptions of prehistoric warfare. *American Antiquity* 70, 144-156.

Murphy EM (2008, ed) *Deviant Burial in the Archaeological Record*. Studies in Funerary Archaeology 2. Oxford.

Nakao H, Tamura K, Arimatsu Y, Nakagawa T, Matsumoto N, Matsugi T (2016) Violence in the prehistoric period of Japan: the spatio-temporal pattern of skeletal evidence for violence in the Jomon period. *Biology Letters* 12, 20160028.

Nicklisch N, Maixner F, Ganslmeier R, Friederich S, Dresely V, Meller H, Zink A, Alt KW (2012) Rib lesions in skeletons from early neolithic sites in Central Germany: on the trail of tuberculosis at the onset of agriculture. *American Journal of Physical Anthropology* 149, 391-404.

Nieszery N (1995) *Linearbandkeramische Gräberfelder in Bayern*. Internationale Archäologie 16. Espelkamp.

Oelze VM, Siebert A, Nicklisch N, Meller H, Dresely V, Alt KW (2011) Early Neolithic diet and animal husbandry: stable isotope evidence from three Linearbandkeramik (LBK) sites in Central Germany. *Journal of Archaeological Science* 38, 270–279.

Oka RC, Kissel M, Golitko M, Guise Sheridan S, Kim NC, Fuentes A (2017) Population is the main driver of war group size and conflict casualties. *Proceedings of the National Academy of Sciences of the USA* 114, E11101-E11110.

Orschiedt J (1998) *Bandkeramische Siedlungsbestattungen in Südwestdeutschland. Archäologische und Anthropologische Untersuchungen.* Internationale Archäologie 43. Rahden/Westf.

Orschiedt J (1999) *Manipulationen an menschlichen Skelettresten. Taphonomische Prozesse, Sekundärbestattungen oder Kannibalismus?* Urgeschichtliche Materialhefte 13. Tübingen.

Orschiedt J, Häußler A, Haidle MN, Alt KW, Buitrago-Téllez CH (2003) Survival of a Multiple Skull Trauma: the Case of an Early Neolithic Individual from the LBK Enclosure at Herxheim (Southwest Germany). *International Journal of Osteoarchaeology* 13, 375-383.

Ortner DJ (2003) *Identification of Pathological Conditions in Human Skeletal Remains. Second Edition.* San Diego.

Otterbein KF (2004) *How War Began*. College Station.

Palmstierna M, Frangou A, Walette A, Dunbar R (2017) Family counts: deciding when to murder among the Icelandic Vikings. *Evolution and Human Behaviour* 38, 175-180.

Parker Pearson M (1999) *The Archaeology of Death and Burial*. Thrupp.

Parker Pearson M, Chamberlain A, Craig O, Marshall P, Mulville J, Smith H, Chenery C, Collins M, Cook G, Craig G, Evans J, Hiller J, Montgomery J, Schwenniger J-L, Taylor G, Wess T (2005) Evidence for mummification in Bronze Age Britain. *Antiquity* 79, 529-546.

Pechtl J, Hofmann D (2013) Irregular Burials in the LBK – All or None? In: Müller-Scheeßel N (ed) *„Irreguläre“ Bestattungen in der Urgeschichte. Norm, Ritual, Strafe ...?* Kolloquien zur Vor- und Frühgeschichte 19. pp. 123-138. Bonn.

Pernter P, Gostner P, Egarter Vigl E, Rühli FJ (2007) Radiologic Proof for the Iceman's Cause of Death (ca. 5'300 BP). *Journal of Archaeological Science* 34, 1784-1786.

Peschel C (1992) *Regel und Ausnahme. Linearbandkeramische Bestattungssitten in Deutschland und angrenzenden Gebieten, unter besonderer Berücksichtigung der Sonderbestattungen*. Internationale Archäologie 9. Buch am Erlbach.

Richards MP, Schulting RJ, Hedges REM (2003) Sharp shift in diet at onset of Neolithic. *Nature* 425, 366.

Rinne C (2003) *Odagsen und Großenrode, Ldkr. Northeim. Jungsteinzeitliche Kollektivgräber im südlichen Leinetal*. Beiträge zur Archäologie in Niedersachsen 5. Rahden/Westf.

Rusu I, Modi A, Radu C, Mircea C, Vulpoi A, Dobrinescu C, Bodolică, Potârniche T, Popescu O, Caramelli D, Kelemen B (2019) Mitochondrial ancestry of medieval individuals carelessly interred in a multiple burial from southeastern Romania. *Scientific Reports* 9, 961.

Sauer NJ (1998) The Timing of Injuries and Manner of Death: Distinguishing among Antemortem, Perimortem and Postmortem Trauma. In: Reichs KJ (ed) *Forensic Osteology. Advances in the Identification of Human Remains. Second Edition*. pp. 321-332. Springfield.

Schibler J, Elsner J, Schlumbaum A (2014) Incorporation of aurochs into a cattle herd in Neolithic Europe: single event or breeding? *Scientific Reports* 4, 5798.

Schleussner C-F, Donges JF, Donner RV, Schellnhuber HJ (2016) Armed-conflict risks enhanced by climate-related disasters in ethnically fractionalized countries. *Proceedings of the National Academy of Sciences of the USA* 113, 9216-9221.

Schulting RJ (2013) War Without Warriors? The Nature of Interpersonal Conflict before the Emergence of Formalized Warrior Elites. In: Ralph S (ed) *The Archaeology of Violence. Interdisciplinary Approaches*. pp. 19-36. Albany.

Schulting R (2018) Conclusion: The Science of Conflict. In: Dolfini A, Crellin RJ, Horn C, Uckelman M (eds) *Prehistoric Warfare and Violence*. pp. 345-358. Cham.

Schulting RJ, Wysocki M (2005) 'In this Chambered Tumulus were Found Cleft Skulls. . .': an assessment of the evidence for cranial trauma in the British Neolithic. *Proceedings of the Prehistoric Society* 71, 107-138.

Schulting RJ, Fibiger L (2014) Violence in Neolithic North-west Europe. A Population Perspective. In: Whittle A, Bickle P (eds) *Early Farmers. The View from Archaeology and Science*. pp. 281-306. Oxford.

Schwitalla G, Schmitt KM (2006) Ein Massengrab aus der Umgehungsstraße oder 'Aus der Linearbandkeramik ist alles bekannt'. *hessenArchäologie* 2006, 31-32.

Seregély T (2012) Neolithische Siedlungen und vergessene Funde. Neues zur Jungfernhöhle bei Tiefenellern. In: Falkenstein F (ed) *Hohler Stein, Rothensteine und Jungfernhöhle. Archäologische Forschungen zur prähistorischen Nutzung naturheiliger Plätze auf der nördlichen Frankenalb*. pp. 64-73. Würzburg.

Sjögren K-G, Price TD, Kristiansen K (2016) Diet and Mobility in the Corded Ware of Central Europe. *PLoS ONE* 11, e0155083.

Smith M, Brickley M (2009) *People of the Long Barrows. Life, Death and Burial in the Earlier Neolithic*. Stroud.

Sosna D, Sládek V, Galeta P (2010) Investigating Mortuary Sites: The Search for Synergy. *Anthropologie (Brno)* 48, 33-40.

Spatz H (1999) *Das mittelneolithische Gräberfeld von Trebur, Kreis Groß-Gerau*. Materialien zur Vor- und Frühgeschichte von Hessen 19. Wiesbaden.

Spindler K (2000) *Der Mann im Eis. Neue sensationelle Erkenntnisse über die Mumie aus den Ötztaler Alpen*. München.

Stodder ALW (2008) Taphonomy and the Nature of Archaeological Assemblages. In: Katzenberg MA, Saunders SR (eds) *Biological Anthropology of the Human Skeleton. Second Edition*. pp. 71-114. Hoboken.

Strien H-C (2010) Ein komplexes Geflecht: Bandkeramische Kommunikationsnetze. In: Matuschik I, Strahm C, Eberschweiler B, Fingerlin G, Hafner A, Kinsky M, Mainberger M, Schöbel G (eds) *Vernetzungen. Aspekte siedlungsarchäologischer Forschung*. pp. 75-80. Freiburg.

Symes SA, L'Abbé E, Stull KE, Lacroix M, Pokines JT (2014) Taphonomy and the Timing of Bone Fractures in Trauma Analysis. In: Pokines JT, Symes SA (eds) *Manual of Forensic Taphonomy*. pp. 341-365. Boca Raton.

Teschler-Nicola M, Gerold F, Kanz F, Lindenbauer K, Spannagl M (1996) Anthropologische Spurensicherung. Die traumatischen und postmortalen Veränderungen an den linearbandkeramischen Skelettresten von Asparn/Schletz. *Archäologie Österreichs* 7 (1), 4-12.

Trautmann I (2006) *The significance of cremations in Early Neolithic communities in Central Europe*. PhD dissertation, University of Tübingen. <http://hdl.handle.net/10900/49077>.

Uerpmann H-P (2007) Von Wildbeutern zu Ackerbauern – Die Neolithische Revolution der menschlichen Subsistenz. *Mitteilungen der Gesellschaft für Urgeschichte* 16, 55-74.

Ungerath O (2014) Das Gräberfeld zur bandkeramischen Siedlung. In: Cziesla E, Ibeling T (eds) *Autobahn 4. Fundplatz der Extraklasse. Archäologie unter der neuen Bundesautobahn bei Arnoldsweiler*. pp. 125-150. Langenweissbach.

Vander Linden M (2016) Population history in third-millennium-BC Europe: assessing the contribution of genetics. *World Archaeology* 48, 714-728.

Wahl J, König HG (1987) Anthropologisch–Traumatologische Untersuchung der menschlichen Skelettreste aus dem bandkeramischen Massengrab bei Talheim, Kreis Heilbronn. *Fundberichte aus Baden-Württemberg* 12, 65-186.

Wahl J, Strien H-C (2007) *Tatort Talheim. 7000 Jahre später // Archäologen und Gerichtsmedizinier ermitteln*. Museo 23. Heilbronn.

Walker PL (2001) A Bioarchaeological Perspective on the History of Violence. *Annual Review of Anthropology* 30, 573-596.

Watkins T (2010) New light on Neolithic revolution in south-west Asia. *Antiquity* 84, 621-634.

Whittle A, Cummings V (2007, eds) *Going Over: The Mesolithic-Neolithic Transition in North-West Europe*. Proceedings of the British Academy 144. Oxford.

Zeeb-Lanz A (2009) Gewaltszenarien oder Sinnkrise? Die Grubenanlage von Herxheim und das Ende der Bandkeramik. In: Zeeb-Lanz (ed) *Krisen – Kulturwandel – Kontinuitäten. Zum Ende der Bandkeramik in Mitteleuropa*. Internationale Archäologie. Arbeitsgemeinschaft, Symposium, Tagung, Kongress 10. pp. 87-101. Rahden/Westf.

Zeeb-Lanz A (2014) Gewalt im Ritual – Gewalt an Toten. Die Krise am Ende der Bandkeramik im Spiegel außergewöhnlicher Befunde. In: Link T, Peter-Röcher

H (2014) *Gewalt und Gesellschaft. Dimensionen der Gewalt in ur- und frühgeschichtlicher Zeit*. Universitätsforschungen zur Prähistorischen Archäologie 259. pp. 257-270. Bonn.

Zeeb-Lanz A, Haack F, Bauer S (2013) Menschenopfer – Zerstörungsrituale mit Kannibalismus – Schädelkult: Die aussergewöhnliche bandkeramische Anlage von Herxheim in der Südpfalz. *Mitteilungen des Historischen Vereins der Pfalz* 111, 385-433.

Zeder MA (2008) Domestication and early agriculture in the Mediterranean Basin: Origins, diffusion, and impact. *Proceedings of the National Academy of Sciences of the USA* 105, 11597-11604.