

Multiple graves from Corded Ware sites in Eulau, Oechlitz, and Szczepanowice

Wolfgang Haak, Mirosław Furmanek, and Harald Meller

Zusammenfassung

Mehrfachbestattungen der schnurkeramischen Fundstellen Eulau, Oechlitz und Szczepanowice

Mehrfachbestattungen sind wichtige Beispiele für die Erforschung biologischer und sozialer Verwandtschaftsverhältnisse und haben schon immer Archäologen und Anthropologen veranlasst, über die Beziehungen zwischen gemeinsam bestatteten Individuen und deren Gründe zu spekulieren. Die schnurkeramischen Mehrfachbestattungen in Eulau, Burgenlandkreis, waren Bestandteil einer der ersten Studien zu biologischer Verwandtschaft mithilfe alter DNA. Seither sind sie ein sinnbildliches Beispiel für ›Kernfamilien‹ und Verwandtschaftsanalysen in vorgeschichtlichen Gesellschaften geworden. Zwischenzeitlich sind weitere schnurkeramische Mehrfachbestattungen gefunden worden, die Eulau in ihrer gesamten Bestattungspraxis sehr ähnlich sind. Zwei von diesen, die in Oechlitz, Saalekreis, in Sachsen-Anhalt und die in Szczepanowice, Woiwodschaft Kleinpolen, sind nun unter der Verwendung von neuesten Genomsequenzierungstechniken und anschließenden populationsgenetischen und biologischen Verwandtschaftsanalysen untersucht worden. Wir stellen hier zunächst einen Vergleich der drei Fundstellen vor, erfassen die Gemeinsamkeiten und Unterschiede, und erörtern anschließend die Rekonstruktion von Verwandtschaftspraktiken in den spätneolithischen schnurkeramischen Gemeinschaften in Mitteleuropa. Gemeinsame Merkmale sind die Ähnlichkeit der Lage der Bestatteten und das Vorhandensein von Anzeichen perimortaler Gewalt an allen drei Fundstellen. Dennoch gibt es feine Unterschiede, was die Architektur und den Grabtypus sowie die darin vorkommenden Grabbeigaben betrifft. Schließlich zeigt die genetische Analyse sehr enge biologische Eltern-Kind-Beziehungen zwischen Individuen in jeder der drei Bestattungen an. Allerdings fehlen zwei Mütter an zwei Fundstellen und es wurden einmal Halbgeschwister nachgewiesen.

Introduction

Recent methodological advances in ancient DNA analysis and bioinformatics have made it possible to generate and co-analyse hundreds of ancient human genomes from various time periods and regions around the world. The considerable success rates of retrieving ancient human DNA also enable intra-site studies, i.e., the analysis of several or all individuals buried at the same site or from a similar burial

Summary

Multiple burials are prime examples for biological relatedness and kinship studies, and have always triggered archaeologists and anthropologists to speculate about the relationships between individuals that were buried together and how this might have come about. The multiple Corded Ware-associated burials from Eulau, Burgenlandkreis district, were the subject of one of the first studies of biological relatedness through ancient DNA, and have since become an emblematic example for ›nuclear families‹ and kinship analyses in pre-historic societies. Meanwhile, other Corded Ware-associated multiple burials have been found, which are very similar in the overall funerary layout to Eulau. Two of these, Oechlitz, Saalekreis district, in Saxony-Anhalt and Szczepanowice, Lesser Poland Voivodeship, have now been studied using state-of-the-art genome sequencing techniques followed by population genetic and biological kinship analyses. Here, we present a comparison of the three sites and discuss the commonalities and differences, and the implications for the reconstruction of kinship practices in Late Neolithic Corded Ware communities in Central Europe. Common features are the striking resemblance in the layout of the bodies and the presence of signs of perimortem violence in all three sites. However, subtle differences exist with respect to the architecture and type of graves and the associated grave goods. Lastly, the genetic analyses reveal very close biological parent-offspring relationships between individuals from each burial, with two mothers missing at two sites and one case of half-siblings.

context, i.e., entire graveyards, necropolises, or other burial communities. To date, a considerable number of aDNA-aided biological relatedness studies have been conducted, which prompted the topic of this volume and the conference held in October 2022. In this context, the multiple burials of Eulau have provided the foundation for research on intra-site demographic structures and inferences about kinship based on biological relatedness.

Multiple burials are defined as the (often simultaneous) inhumation of two or more individuals according to culturally prevailing burial rites in the same earthen grave or grave structure. This is different from collective, communal grave structures, e.g., megalithic cairns, which can include dozens or even hundreds of individuals and have been used for several decades. By contrast, mass graves, which can also include more than a handful individuals, such as the Globular Amphora site Koszyce, Lesser Poland Voivodeship (Schroeder et al. 2019), describe a single tragic event (of violent or pandemic nature) and often do not display signs of specific burial rites or care in the deposition of the deceased.

Double burials are the most common form of multiple burials. Depending on the age-at-death and anthropological sex of the co-buried individuals, these burials have often been readily interpreted by excavators. Two adult individuals of opposite sex and gender are often interpreted as couples, while two subadults would often be considered as being siblings. Likewise, the combination of a subadult and an adult would often invoke a parent-offspring relationship, which in the case of adult females and newborns is hardly questioned at all. As a consequence, it is then considered as surprising when close biological relatedness is not confirmed despite a common burial, as in the case of the 5th millennium BC grave clusters from Krusza Zamkowa, Kuyavian-Pomeranian Voivodeship, in Poland (Juras et al. 2017). The source of the existence of more complex social kinship systems beyond biological relatedness can be traced back to the early Neolithic of central Anatolia (Chylęński et al. 2019; Yaka et al. 2021; Pearson et al. 2023). Cases with more than two individuals, sometimes up to nine (e.g. Salzmünde, Saalekreis district; Alt et al. 2017) or more (Eulau; Haak et al. 2008)¹ are less common but also provide more room for interpretation and speculation. Multiple burials of three, four, or five individuals, as presented here, come with a particular appeal to the archaeologist, researcher, or museum's visitor alike, and naturally spark curiosity as to what might have caused such a particular burial situation. This fascination is further enhanced by the observed context, i.e., the way in which the bodies were oriented, often ›facing‹ each other, seemingly ›holding hands‹, or laid out in ›eternal embrace‹. Additional evidence, e.g., from paleopathologies, healed or *perimortem* injuries, sparks further interest.

As a consequence, researchers are confronted with a considerable number of immediate questions: Who are these people? How and why did they die? Did all of them die at the same time, on the same day? If not, when? What happened on that day? Are the individuals biologically related to each other? Who buried them? Or, when a non-natural cause of death is suspected, what or who killed them? Thanks to the numerous state-of-the-art methods available today, nearly all of these questions can be addressed by integrated, multidisciplinary research, and every participating discipline can contribute to answering the bigger questions

of who, where, when, what, how, and why? Beyond the immediate questions, there are meta-level questions that require specialist knowledge, e.g., about the material and cultural background, economy or subsistence of the buried persons. For example, can burial rites be confirmed by genetic sexing? Other questions pertain to the observation of overarching, generalisable trends, which can only be observed when many comparable contexts are analysed.

Here, we focus on multiple burials from three sites from Central Europe, in today's Germany and Poland, which are associated with the Corded Ware cultural complex. The Corded Ware (also known as Single Grave, Battle Axe) cultural complex is an archaeological stratum on the basis of similarities in material cultural remains that are found in continental North-central, Northeast, and Eastern Europe, and dates to ~2900–2200 BC, broadly covering the Final Neolithic, Copper Age, or Early Bronze Age chronological periods of the various geographic regions².

The Corded Ware complex is named after characteristic pottery imprints. A distinctive feature of this period is a consistent set of artifacts in the burial context, consisting of typologically similar stone axes, amphoras and beakers that are decorated with cord impressions and ornamentation composed of cuts and stamps. During its early phase, the material culture is relatively uniform, which is often interpreted as a consequence of the relatively rapid expansion process of the new population. Over time, regional variation becomes more pronounced, which is thought to have resulted from influences of earlier, local cultural traditions, embedded in a network of relationships within which new practices and symbols circulated (Furholt 2014). The emergence of the Corded Ware cultural complex is linked to a major change in the cultural landscape of Central Europe and coincides with the collapse of previous cultural centers with their socio-economic systems.

The carriers of this culture are thought to have had a semi-pastoral subsistence and evidence of agricultural activities is less frequently recorded than in earlier Neolithic societies. Corded Ware-associated settlements, or housing complexes, are also very rare. Gimritz, Saalekreis district, and Vliněves, Central Bohemian Region, are examples of sites where settlement and burial ground are clearly linked (Friederich/Jarecki 2019). More recently, it has also been possible to identify trapezoidal houses in excavations, which are attributed to the Corded Ware cultural complex (Risch et al. 2021; Risch et al. 2022).

The Corded Ware funeral rites were a reflection of the ideological changes of the time, through which gender, individual and group identities, and social roles were expressed. This was done by varying the ways in which the dead were placed in the grave and in the composition of grave offerings. These regularities were observed throughout the 3rd millennium BC, but the way in which they were implemented was cultural, and perhaps of ethnic nature. They expressed a sense of group membership, which led to

¹ E.g. Bronocice, Świętokrzyskie Voivodeship, pit 36-B1 with 17 individuals; Milisaukas et al. 2016; Cienkosz-Stepanczak et al. 2017.

² Glob 1945; Fischer 1958; Strahm/Buchvaldek 1992; Furholt 2014; Schwarz 2015; Schwarz 2021.

the observed spatial and chronological variability. Corded Ware burials are usually recognised by the assembly of characteristic artifacts, which follows a certain pattern and has more or less standardised grave goods: drinking sets (e.g., typical cord-ornamented pottery), weaponry (e.g., battle-axes, arrowheads), ornaments (e.g., tooth pendants from dog, wolf, wild boar or deer), and food offerings. From the beginning, the orientation and positioning of the bodies in crouched position, together with type and placement of furnishings primarily emphasised gender differentiation (Bourgeois/Kroon 2017). These characteristics are more pronounced in the western part of its distribution, where they differ strikingly from neighbouring, and potentially competing, groups that are associated with the so-called Bell Beaker phenomenon. Here, Corded Ware-associated males are buried with the head toward the west, in a right-side-flexed position, facing south. Females are buried with the head toward the east, in a left-side-flexed position, facing south. By contrast, males associated with the Bell Beaker phenomenon are often buried in north-south orientation with the head toward the north, in a left-side-flexed position, facing east. Accordingly, Bell Beaker-associated females are buried in south-north orientation with the head toward the south, in a right-side-flexed position, facing east (Fischer 1956; Häusler 2008; Wentink 2020).

The Corded Ware complex, while being a readily recognisable cultural horizon in Europe's prehistory, has moved again into the spotlight through archaeogenetic studies³. These studies uncovered a genomic transformation in Europe that equals the one of the preceding Meso-Neolithic transition in magnitude. Corded Ware-associated individuals were shown to carry a specific type of genomic ancestry, the so-called steppe-related ancestry, which was maximised in emerging pastoralists in the Eastern European steppe and forest steppe belt, but was not found among the local Late Neolithic groups that were derived culturally and genetically from early European farmers. Corded Ware-associated individuals carried approx. 70–80% of this steppe-related ancestry, which showed that the discontinuity and succession of cultures during the early 3rd millennium BC was driven by expanding semi-pastoralist groups from the northeastern parts of temperate Europe (Papac et al. 2021). More broadly, the arrival of genetic ancestry associated with steppe pastoralists attests to a substantial genetic transformation in Europe that started around 5000 years ago, the aftermath of which still resonates strongly in genomes of all present-day Europeans (Olalde et al. 2018; Olalde et al. 2019; Villalba-Mouco et al. 2021). By mixing with local European farmers, they formed a genetic gradient from North-East to South-West Europe and as such the basic genetic makeup of most modern-day Europeans.

In contrast to the preceding cultural assemblages of central Europe, for which collective burials were the predominant form, single graves are a distinctive feature of the Corded Ware and more generally the societies of the 3rd millennium BC (Furholt 2019). They were part of often complex

funerary constructions, frequently with burial mounds (kurgans). After -2600/2500 BC, multiple burials appear more frequently, often with two or three but rarely with more individuals. However, in contrast to collective burials, which were used over generations, these describe singular temporal entities. The Corded Ware Culture graves, whether flat or with mounds, form smaller or large cemeteries, e.g., at Profen, Burgenlandkreis district, Lauda-Königshofen, Main-Tauber-Kreis district (Ortolf 2014), Vlnětice, Ústecký Region (Buchvaldek/Koutecký 1970), Vliněves (Dobeš/Limburský 2013) and Żerniki Górne, Lesser Poland Voivodeship (Kempisty/Włodarczyk 2000). As a result, and despite the above-mentioned pioneering study on Eulau, surprisingly little is known about the demographic features and social organisation of the Corded Ware communities. The three multiple burials presented here thus provide a first foray into biological relatedness and kinship structures among Corded Ware groups. It should be noted that similar Corded Ware sites with multiple burials are known, e.g., from Hanau-Mittelbuchen, Main-Kinzig-Kreis district, Dittigheim, Main-Tauber-Kreis district, Gaimersheim, Kösching, both Eichstätt district, and Bergrheinfeld, Schweinfurt district (Heyd 2021), but these have not yet been subject to multi-disciplinary investigations.

Eulau

The four multiple Corded Ware-associated burials from Eulau, Saxony-Anhalt, were the subject of one of the first studies of biological relatedness through ancient DNA analysis prior to the high throughput sequencing era (Haak et al. 2008; Meyer et al. 2009). These studies highlight the integrated efforts and lines of evidence of various disciplines, including use of stable isotopes, paleopathologies, typologies of artifacts and involvement of experts from modern-day crime scene investigation. Overlapping radiocarbon dates point to a relatively precise date between 2675 and 2495 cal BC. Three of the four multiple burials from Eulau are featured in the permanent exhibition at the State Museum of Prehistory in Halle (Saale) in Germany. For detailed results on these investigations and the resulting interpretation we refer to the original studies. For the purpose of comparison in this manuscript, we will focus predominantly on burial 99 from Eulau, which contains four individuals – two adults and two subadults buried closely together – and thus provides the blueprint for the layout of the characteristic Corded Ware multiple burials. While the original genetic study was carried out with PCR-based methods, i.e., prior to the ›genomic revolution‹ in ancient DNA research, the results still hold firmly and do not raise doubts about the assignments of biological relatedness. Briefly, the two adult individuals, a female and a male are buried according to the prevailing burial rites described above (Fig. 1a). The two subadult individuals were found to be boys, who shared the mitochondrial DNA haplogroup with the adult

³ Allentoft et al. 2015; Haak et al. 2015; Saag et al. 2017; Saag et al. 2021; Papac et al. 2021.

female, while the STR (short tandem repeat) profiles of the Y-chromosome are shared with the adult male (consistent with Y-chromosome lineage R1a). The allelic profiles of the autosomal STRs further show that the boys each share alleles with both adults. Together, the combined results indicate that the burial consists of adult parents and their two sons. Paleopathological evidence for healed fractures, but also perimortem violence (blunt force trauma to skulls, arrowheads embedded in vertebra or chest), suggest an untimely death of all individuals from the four multiple burials from Eulau (Meyer et al. 2009). The close grouping of all burials points to a single violent event, e.g., a raid or an attack, that affected the entire, or large parts, of the local Corded Ware community. Further, the generally careful arrangement of the burial situation hints at in-depth knowledge about the relationship between the individuals and their cultural/spiritual background and thus suggests that some members of the community had survived the attack and buried the dead according to the funerary rites.

It is interesting to note that the two subadult sons were not oriented according to the standard practices used for Corded Ware males, but instead each was oriented toward a parent. It is possible that this was done to express the close kinship between the children and their parents, or, alternatively, that the two sons were too young, and thus possibly not yet initiated to be granted the full burial rite of adult males.

Oechlitz

The second Corded Ware-associated multiple burial is from the site Oechlitz (feature 25645), also located in Saxony-Anhalt, and not too far away from Eulau (Fröhlich/Becker 2017; Mühlenbruch 2020). The grave includes five individuals and was surrounded by a characteristic ring ditch. Radiocarbon dates range between 2558 and 2207 cal BC. According to the orientation of the skeletons, two of the adult individuals could be recognised as potential males, but are tilted towards southwest, while the other individuals are oriented 90 degree off-axis, tilted southeast (Fig. 1b). Genetic sexing and biological relatedness testing on the basis of genome-wide autosomal SNP data, mitochondrial genome and Y-chromosome SNP data revealed that all individuals are first-degree-related to each other, and represent either a parent-offspring or sibling relationship. Taking the age at death of the individuals into account, we were able to reconstruct a sin-

gle unambiguous pedigree, which centers around a male adult (individual 4), who holds his youngest daughter (individual 3), while his adolescent son (individual 5) is buried behind him, and his two older daughters (individuals 1 and 2) at their feet. Both daughters would match the canonical orientation of females but are tilted southwards. Interestingly, the biological mother of the four children is missing, but we can infer that she carried mitochondrial DNA haplogroup U4a2 like her children. By contrast, the father carries U5a1a2b, and Y-lineage R1a-M417, which he also passed on to his son. R1a-M417 is by far the most common Y-chromosome lineage among Corded Ware individuals and attains a frequency of ~90 % among the males of the later classical Corded Ware period between ~2700–2400 BC. Standard pathogen screening of the shotgun genome data did not yield any significant hits that could be assigned to common bloodborne pathogens. However, similarly to the Eulau individuals, the anthropological report describes evidence for blunt end or semi-sharp trauma to the skull bones, also indicating a violent death. Again, the constellation, the ceremonial artifacts and the intentional, careful placement of the dead (e.g., individual 1 embraces individual 3) suggest that those who buried the five individuals not only knew about their cultural and spiritual background, but also about their biological relationships.

Szczepanowice

A third example is the multiple burial from the site Szczepanowice in Lesser Poland in today's Poland (Fig. 1c)⁴. This grave contains four individuals and the layout of the bodies very closely resembles grave 99 from Eulau. The catacomb grave with a depth of 180 cm has a clearly marked entrance corridor and it featured numerous grave goods that can be ascribed to the Kraków-Sandomierz group of the Corded Ware complex: six vessels (an amphora and five beakers), an axe made of serpentinite (from Lower Silesia), a flint axe, two retouched flint blades, four flint arrowheads, five flint flakes, bone artefacts (a chisel, two awls, an antler wedge, a punch, a bone tube), a copper lunula (in association with eastern European metallurgy, especially with Yamnaya), three copper earrings, oval bone beads, and a figure-eight bone pendant. Overlapping radiocarbon dates point to an absolute date between 2450 and 2300 cal BC.

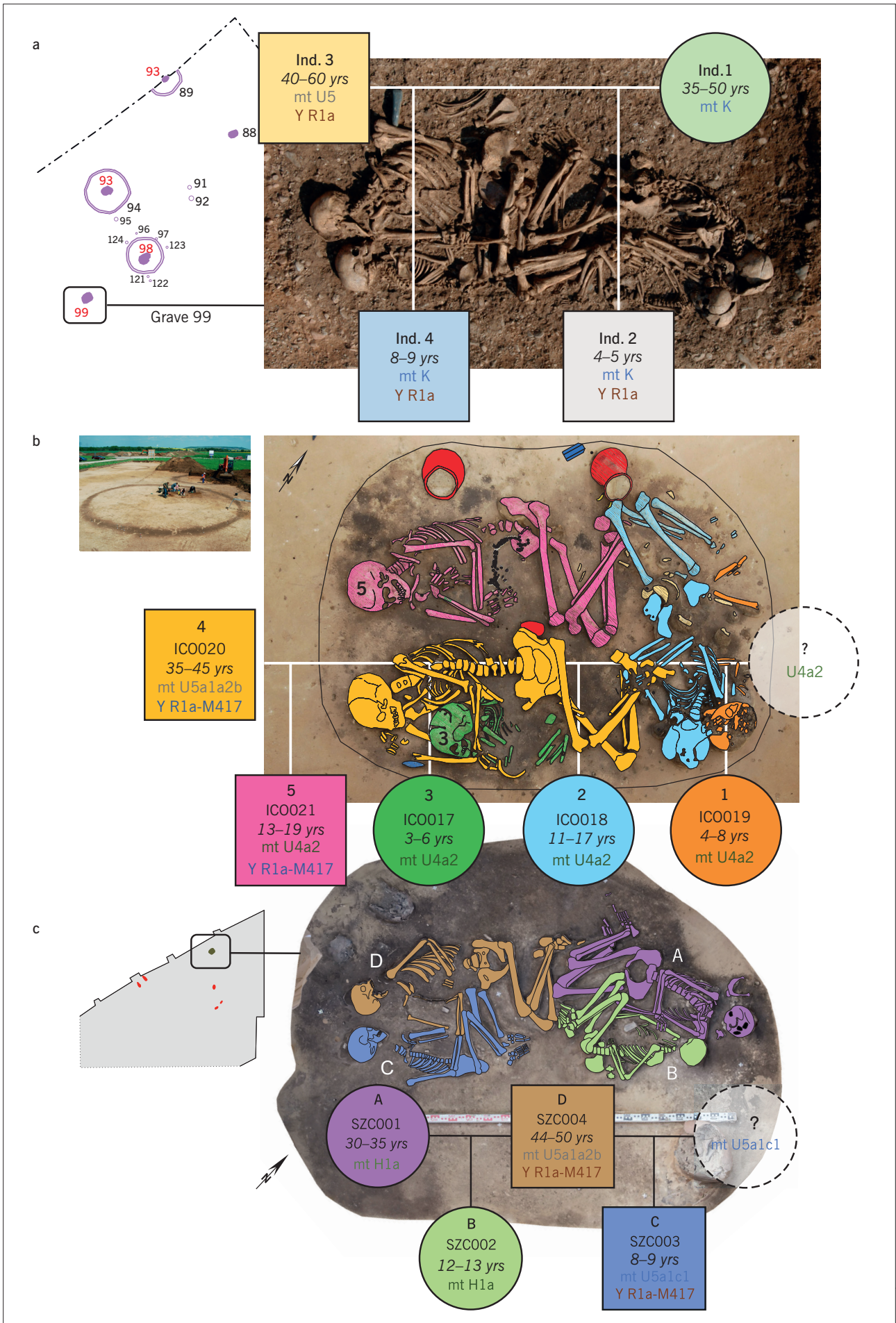
We found that individuals A and B are genetically female and share the same mitochondrial haplogroup, while indi-

Fig. 1a–c (right page) Corded Ware-associated multiple burials. a Eulau, Burgenlandkreis district (Germany); b Oechlitz, Saalekreis district (Germany); c Szczepanowice, Lesser Poland Voivodeship (Poland). Filled coloured squares and circles indicate biologically male and female individuals, respectively. Open circles with dashed lines indicate inferred individuals that were missing from the graves. The estimated age at death is given in years (yrs); mt = mitochondrial haplogroup; Y = Y-chromosomal haplogroup.

Abb. 1a–c (rechte Seite) Schnurkeramische Mehrfachbestattungen. a Eulau, Burgenlandkreis (Deutschland); b Oechlitz, Saalekreis (Deutschland); c Szczepanowice, Woiwodschaft Kleinpolen (Polen). Die ausgefüllten farbigen Quadrate und Kreise stellen jeweils biologisch männliche und weibliche Individuen dar. Offene Kreise mit gestrichelten Linien symbolisieren hergeleitete Individuen, die in den Gräbern fehlten. Das geschätzte Alter zum Zeitpunkt des Todes ist in Jahren (yrs) angegeben; mt = mitochondriale Haplogruppe; Y = Y-chromosomale Haplogruppe.

4 For a photogrammetric model of the grave by Maksym Mackiewicz see: <[https://sketchfab.com/3d-models/corded-](https://sketchfab.com/3d-models/corded-ware-multiple-burial-szczepanowice-pl-b964d2f65fad4f33be415970eee559bc)

[ware-multiple-burial-szczepanowice-pl-b964d2f65fad4f33be415970eee559bc](https://sketchfab.com/3d-models/corded-ware-multiple-burial-szczepanowice-pl-b964d2f65fad4f33be415970eee559bc)> (16.03.2023).



viduals C and D are genetically male and carry Y-haplogroup R1a-M417, which matches well with the males from the two other sites and Corded Ware-associated males more broadly. Detailed analyses of biological relatedness between individuals revealed a 1st-degree relationship between individuals A and B, B and D, C and D, and a 2nd-degree relationship between individuals B and C. Combining the results from the uniparentally inherited mitochondrial and Y-chromosome haplogroups, the genetic sex, and the age at death of the individuals, we were able to unambiguously reconstruct a pedigree as shown in Fig. 1c. The subadult female individual B is the daughter of individual A (mother, adult female) and individual D (father, adult male). The subadult individual C is the son of individual D but unrelated to individual A, the adult female. Hence, the biological mother of C is unknown and not buried at the site, making the two subadult individuals B and C half-siblings, which is consistent with the 2nd-degree relationship between the two subadults.

As for Oechlitz, standard pathogen screening of the shotgun genome data also did not yield any significant hits that could be assigned to common bloodborne pathogens. However, as described in both examples above, there is also evidence for interpersonal violence at Szczepanowice in the form of perimortem traumata. One arrowhead was found very close to the femur of a female (adult female; individual A) and was probably stuck in the body of the victim at the time of inhumation. The adult male's skull shows traces of a double trepanation, with signs of wound healing. However, he also has a fractured nose and a perimortem fracture of the femur. Both subadults have fractures of the *cervical vertebrae* which may be perimortem.

Like at the two other sites, and despite the untimely death of the individuals, the layout and the orientation of the dead indicate knowledge about the kin relations and the cultural/spiritual background.

Side-by-side comparison and discussion

When the combined evidence from the three sites is compared, we observe a number of similarities, but also differences (Tab. 1). The analysis of biological relatedness shows that all individuals are closely related to each other, with the exception of the parent pair (where present), and all three burials include individuals from two generations. From a modern-day, Western perspective, this constellation would be recognised as a core or 'nuclear' family, consisting of a pair of parents and their offspring. However, this only holds true for Eulau and the genetic results show that a swift assessment based on preconceived ideas could lead to a wrong perception. For example, at Oechlitz we find that the oldest female (individual 2) is not the partner of any of the two male individuals, but instead the daughter and sister, respectively. The osteological age at death estimates between 11–17 years and indicates that the proposed age would possibly lie below the reproductive age at the time, at least for having given birth to two younger children. However, this was previously impossible to verify or refute. The unambiguous constellation of a father buried with his son and three

daughters, while the actual biological mother is missing from the grave, would have been only one of many possible, and perhaps not the most plausible, scenarios.

The same can be said about the burial from Szczepanowice, which at face value appears to be identical to Eulau. The integrated results instead show that the grave contains a trio of mother-father-daughter, but that the second and youngest child (a boy; individual C) is only related to the adult male, and thus the step-brother of individual B. The mother of this boy is not buried in the grave. Under the assumption that the boy was the offspring from a previous partnership, and that his mother potentially passed away during childbirth, it is interesting to note that this boy is in fact younger than his half-sister. This makes a scenario of serial monogamy in the suggested order less likely, but it is not possible to make further generalising inferences from a single observation.

Taken together, it becomes clear that a simple *a priori* assessment of multiple burials of comparable layout and form as 'nuclear families' cannot always be inferred, and thus is not an advisable conclusion. However, given that all children and adolescents are oriented towards a parent seems to emphasise the social (and perhaps known biological) bonds and indicates the recognition of the subadults as kin. In turn, based on the context, the subadults cannot be considered to constitute socially and economically independent entities, and this allows us to refer tentatively to 'family graves', but by applying the necessary caution, which involves the recognition that these 'family units' can take on and be expressed in different forms.

The intentional arrangement of the bodies, the evidence of perimortem violence and the absence of evidence for secondary inhumations or later disturbances suggest a single event horizon for each of the three burials. The perimortem fractures and traumata indicate acts of interpersonal violence, potentially as part of group conflicts, but it remains unclear why these individuals faced a premature death. Potential scenarios were discussed for the site of Eulau, where grave 99 is interpreted in context with three other multiple burials, which are highly likely contemporaneous and also show evidence of violence. On the basis of the demographic structure of the buried, which represents children and older adults, and typological examination of the purported murder weapons (arrowheads in chest and *lumbar vertebrae*) it was suggested that the Corded Ware community at Eulau faced a hostile attack by a competing group (of the Globular Amphora Culture or Schönfeld group), in which the young and fit fought back or fled, and eventually buried their dead according to Corded Ware burial rites and with inside knowledge about the kinship structure (Meyer et al. 2009; Ganslmeier/Literski-Henkel 2014).

Whether interpersonal violence in the form of an attack of an outside party was the primary cause of death is a central question pertaining to all individuals from all three sites. At Eulau, evidence of perimortem violence is only evident from adult individuals, while the subadults buried at Oechlitz (4 out of 5) and Szczepanowice also show evidence of perimortem violence. Was the Corded Ware period a particularly unruly time? Is this evidence for competition between groups, as suggested for Eulau, or internal strife?

Site	Eulau, Burgenlandkreis district	Oechlitz, Saalekreis district	Szczepanowice, Lesser Poland Voivodeship
Individuals	4	5	4
Simultaneous inhumation	yes	yes	yes
Orientation adults	According to burial rite	According to burial rite, tilted SW/NE, subadults off-axis	According to burial rite, tilted SW/NE
Grave type	Simple grave pit	Simple grave pit, ring ditch	Catacomb grave
Grave goods	Stone axes, bone pin, flint blades, meat offerings	Pottery, stone axes, flint blades, bone beads, dog teeth pendants, boar teeth, shell beads	Pottery, stone axes, arrowheads, flint, adzes, bone tools, lunula, bone pendants, copper rings, etc.
Perimortem violence	yes	yes	yes
Pathogens	Unknown	no	no
Biological Relatedness	yes	yes	yes
Interpretation	›Nuclear family‹	›Nuclear family‹? Biological mother is missing	›Patchwork family‹ One of the biological mothers is missing
Lineality/locality	Unknown/patrilocal based on Strontium isotope data	Likely patrilineal/unknown	Patrilineal/unknown

Tab. 1 Comparison of the main features and observation for the three multiple burial sites.

Tab. 1 Vergleich der Hauptbefunde der drei Fundstellen mit Mehrfachbestattungen und Bemerkungen dazu.

Alternative explanations for an overkill, that is more deaths than expected from single combat, could involve executions, which could be interpreted as *Totenfolge*, i.e., the ritual practice of voluntary or involuntary ›following into death‹. In both cases, this would mean the termination of a lineage, either by deliberate (hostile) elimination at the hands of the attackers, or by economic necessity on behalf of the resident community. In the latter case, it remains unclear whether this was an integral part of the rites and rules of the Corded Ware communities.

Whether the three burials allow generalisable inferences to be made about kinship practices and the social organisation also needs careful discussion. Evidence for patri- or matrilineality or -locality cannot be expected to be strong when made on the basis of only two generations per site. At Oechlitz, and in particular at Szczepanowice, we observe that the pedigree is linked through the paternal line, with one adult female (a mother) missing in each case. It is possible that this happened simply by chance. If a group with patrilocal and patrilineal organisation with reciprocal female exogamy is assumed, then it is also possible that the missing females were buried elsewhere, possibly following a return to their place of birth. Likewise, it is possible that both female individuals were among the survivors, or socially sanctioned to be co-buried, which would explain the apparent first-hand knowledge about the relations of the deceased. At the same time, this would mean that *Totenfolge* (in this case of the widows as in *sati*; Fisch 2005; Schneewind 2007) was not a common practice and could be rejected for the Corded Ware communities.

Further evidence in support of patrilocality comes from the analysis of stable isotope data, such as $^{87}\text{Sr}/^{86}\text{Sr}$ (Strontium), which can also inform on patterns of mobility and in turn locality. To date, Sr data is only available for the four multiple burials from Eulau (Haak et al. 2008), where

it could be shown that male individuals and children present the local Sr ratio, while the female individuals (including individual 1 from grave 99) show a non-local Sr signature. Clearly, although more data is needed, this example shows that Sr and dietary isotopes form a critical part of integrated bioarchaeological studies. Additional evidence for patrilineality and patrilocality comes from other Corded Ware sites with predominantly single graves, e.g., Esperstedt, Saalekreis district, in Saxony-Anhalt. The biological relatedness of the genomic data available thus far shows that many male individuals buried at the site are related to each other in the first or second degree (Monroy Kuhn et al. 2018). However, on the basis of this and additional unpublished data, we also noticed a stark deficit in female burials, which could certainly bias our interpretation toward patrilineality, even though the absence of female burials remains unexplained.

The strongest evidence for a patrilineally organised society comes from the population genetic analyses of genome-wide data from all Corded Ware-associated individuals available thus far. As shown by L. Papac and colleagues (Papac et al. 2021) in a transect through time study in Bohemia, Czech Republic, which included 31 and 21 individuals from the early and late Corded Ware phases, respectively, the Y-chromosome lineage diversity was reduced sharply by the time of the late Corded Ware phase. This situation was continued, albeit with a different lineage in the overlapping and succeeding phase of the Bell Beaker phenomenon, before the strict reduction was broken up and replenished by the time of the Early Bronze Age starting ~2200 BC. This marked reduction in Y-chromosome lineage diversity was shown not to be a random process, as the autosomal diversity was not affected, but must have been driven by the establishment of strict social conventions that controlled kinship and mating practices.

The example of the Bohemian site Vliněves, Central Bohemian Region, in the same study also shows an initially large genetic diversity among individuals that were granted a Corded Ware burial according to the local customs. Interestingly, the most extreme cases in a gradient of genomic ancestry distribution (i.e., with and without steppe-related ancestry) are all female individuals, which shows that the expanding Corded Ware society not only included lineage females, but also integrated local non-lineage females, which argues against the model of an exclusively male-driven expansion from regions in eastern Europe. However, also here the genetic homogenisation during the following consolidation phase of the Corded Ware period hints at an increase of patrilocality and patrilineality.

In conclusion, the currently available data suggests that the communities associated with the Corded Ware cultural complex were likely organised in patrilineal and patrilocal groups with a certain extent of female exogamy, also involving the integration of local females during the initial expansion phase. The insights gained from the integrated analysis of the three multiple burials show that the Corded Ware-associated groups valued lineage, i.e., familial ties

formed by biological and social bonds, as far as the situation of the funerary expression is concerned. Whether these bonds were also the foundation of the Corded Ware society of the living and thus formed an integral part of the socio-cultural profile requires further investigation, ideally by combining as many lines of evidence and as many different types of contexts as possible.

Acknowledgments

The authors are indebted to Lena Semerau, Sandra Penske, Adam Ben Rohrlach, Johannes Krause, Agata Hałaszkó, Piotr Włodarczak, Maksym Mackiewicz, Mirosław Masojć, Izabela Gomułka, Robert Ganslmeier, K. Dietrich, Madeleine Fröhlich, Matthias Becker, Jan-Heinrich Bunnefeld, Nicole Nicklisch, Jörg Orschiedt, Kurt W. Alt, Guido Brandt, Christian Meyer, Alistair Pike, Hylke de Jong, and Volker Heyd. This study was funded by the Max Planck Society and the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program under grant agreement no, 771234-PALEoRIDER (to W. H.).

Bibliography

- Allentoft et al. 2015**
M. E. Allentoft/M. Sikora/K.-G. Sjögren/S. Rasmussen/M. Rasmussen et al., Population genomics of Bronze Age Eurasia. *Nature* 522,7555, 2015 167–172, <https://doi.org/10.1038/nature14507> (17.03.2023).
- Alt et al. 2017**
K. W. Alt/C. Meyer/B. Schlenker/S. Karimnia/C. Knipper et al., Eine Neunfachbestattung der Salzmünder Kultur am eponymen Fundplatz Salzmünde. In: H. Meller/S. Friederich (eds.), *Salzmünde – Regel oder Ausnahme? Internationale Tagung vom 18. bis 20. Oktober 2012 in Halle (Saale). Tagungen Landesmus. Vorgesch. Halle 16 (Halle [Saale] 2017)* 53–70.
- Bourgeois/Kroon 2017**
Q. Bourgeois/E. Kroon, The impact of male burials on the construction of Corded Ware identity: Reconstructing networks of information in the 3rd millennium BC. *PLOS ONE* 12,10, 2017, e0185971, <https://doi.org/10.1371/journal.pone.0185971> (17.03.2023).
- Buchvaldek/ Koutecký 1970**
M. Buchvaldek/D. Koutecký, *Vikletice. Ein Schnurkeramisches Gräberfeld. Præhist. 3 (Praha 1970).*
- Chyleński et al. 2019**
M. Chyleński/E. Ehler/M. Somel/R. Yaka/M. Krzewińska et al., Ancient Mitochondrial Genomes Reveal the Absence of Maternal Kinship in the Burials of Çatalhöyük People and Their Genetic Affinities. *Genes* 10,3, 2019, <https://doi.org/10.3390/genes10030207> (17.03.2023).
- Cienkosz-Stepanczak et al. 2017**
B. Cienkosz-Stepanczak/A. Lisowska-Gaczorek/E. Haduch/R. Allam/G. Cook et al., Nitrogen and Strontium Isotopes as Tools for the Reconstruction of Breastfeeding Practices and Human Behavior – A Neolithic Collective Grave in Bronocice (Poland). *Collegium Antr.* 41,3, 2017, 191–199, <https://hrcak.srce.hr/200341> (17.03.2023).
- Dobeš/Limburský 2013**
M. Dobeš/P. Limburský, Pohřebišťe staršího eneolitu a šňůrové keramiky ve Vliněvsi. *Arch. Stud. Mat. 22 (Praha 2013).*
- Fisch 2005**
J. Fisch, Dying for the Dead: Sati in Universal Context. *Journal World Hist.* 16,3, 2005, 293–325, <https://www.jstor.org/stable/20079331> (17.03.2023).
- Fischer 1956**
U. Fischer, Die Gräber der Steinzeit im Saalegebiet. Studien über neolithische und frühbronzezeitliche Bestattungsformen in Sachsen-Thüringen. *Vorgesch. Forsch.* 15 (Berlin 1956).
- Fischer 1958**
U. Fischer, Mitteldeutschland und die Schnurkeramik. Ein kultursoziologischer Vergleich. *Jahresschr. Mitteldt. Vorgesch.* 41/42, 1958, 254–298.
- Friederich/Jarecki 2019**
S. Friederich/H. Jarecki, Die schnurkeramische Siedlung von Gimritz, Saalekreis. In: H. Meller/S. Friederich/M. Küßner/H. Stäuble/R. Risch (eds.), *Siedlungsarchäologie des Endneolithikums und der frühen Bronzezeit. 11. Mitteldeutscher Archäologentag vom 18. bis 20. Oktober 2018 in Halle (Saale). Tagungen Landesmus. Vorgesch. Halle 20,1 (Halle [Saale] 2019)* 217–237.
- Fröhlich/Becker 2017**
M. Fröhlich/M. Becker, Die endneolithische Mehrfachbestattung von Oechlitz, Saalekreis – Eine gemeinsame Grablege der Schnurkeramik und Glockenbecherkultur. In: H. Meller/M. Becker (eds.), *Neue Gleise auf alten Wegen II. Jügendorf bis Gröbers. Band II. Arch. Sachsen-Anhalt, Sonderbd. 26,2 (Halle [Saale] 2017)* 308–314.
- Furholt 2014**
M. Furholt, Upending a 'Totality': Re-evaluating Corded Ware Variability in Late Neolithic Europe. *Proc. Prehist. Soc.* 80, 2014, 67–86.
- Furholt 2019**
M. Furholt, Re-integrating Archaeology: A Contribution to aDNA Studies and the Migration Discourse on the 3rd Millennium BC in Europe. *Proc. Prehist. Soc.* 85, 2019, 115–129, <https://doi.org/10.1017/ppr.2019.4> (17.03.2023).
- Ganslmeier/Literski-Henkel 2014**
R. Ganslmeier/N. Literski-Henkel, Die Tatwaffen aus einem Grab der Schnurkeramik von Eulau, Burgenlandkreis. Ein Beitrag zur Verwendung von Pfeilen in den Kulturgruppen des 3. Jts. v. Chr. *Jahresschr. Mitteldt. Vorgesch.* 94, 2014, 29–83.
- Glob 1945**
P. V. Glob, Studier over den Jyske Enkeltgravskulturen. *Aarb. Nordisk Oldkde. og Hist.* 1944, 1945, 1–283.
- Haak et al. 2008**
W. Haak/G. Brandt/H. N. de Jong/C. Meyer/R. Ganslmeier et al., Ancient DNA, Strontium isotopes, and osteological analyses shed light on social and kinship organization of the Later Stone Age. *Proc Nat. Acad. Scien. USA* 105,47, 2008, 18226–18231, <https://doi.org/10.1073/pnas.0807592105> (17.03.2023).
- Haak et al. 2015**
W. Haak/I. Lazaridis/N. Patterson/N. Rohland/S. Mallick et al., Massive migration from the steppe was a source for Indo-European languages in Europe. *Nature* 522,7555, 2015, 207–211, <https://doi.org/10.1038/nature14317> (17.03.2023).
- Häusler 2008**
A. Häusler, Beiträge zur vergleichenden Untersuchung von Bestattungssitten vom Neolithikum bis zur frühen Bronzezeit. *Jahresschr. Mitteldt. Vorgesch.* 92, 2008, 309–385, <https://doi.org/10.11588/jsmv.2008.1.88667> (17.03.2023).

Heyd 2021

V. Heyd, Yamnaya, Corded Wares, and Bell Beakers on the move. In: V. Heyd/G. Kulcsár/B. Preda-Bălănică (eds.), *Yamnaya Interactions*. Proceedings of the International Workshop held in Helsinki, 25–26 April 2019. *Archaeologia 44* (Budapest 2021) 383–414, <<https://real.mtak.hu/id/eprint/139036>> (17.03.2023).

Juras et al. 2017

A. Juras/M. Chyleński/M. Krenz-Niedbała/H. Malmström/E. Ehler et al., Investigating kinship of Neolithic post-LBK human remains from Krusza Zamkowa, Poland using ancient DNA. *Forensic Scien. Internat. Genetics* 26, 2017, 30–39, <<https://doi.org/10.1016/j.fsigen.2016.10.008>> (17.03.2023).

Kempisty/Włodarczak 2000

A. Kempisty/P. Włodarczak, Cemetery of the Corded Ware Culture in Żerniki Górne. *Światowit Suppl. Ser. P 5* (Warsaw 2000).

Meyer et al. 2009

C. Meyer/G. Brandt/W. Haak/R. Ganslmeier/H. Meller et al., The Eulau eulogy: Bioarchaeological interpretation of lethal violence in Corded Ware multiple burials from Saxony-Anhalt, Germany. *Journal Anthr. Arch.* 28,4, 2009, 412–423, <<https://doi.org/10.1016/j.jaa.2009.07.002>> (17.03.2023).

Milisauskas et al. 2016

S. Milisauskas/J. Kruk/M.-L. Pipes/E. Haduch, Neolithic human burial practices. The interpretation of funerary behaviors at Bronocice, Poland (Kraków 2016).

Monroy Kuhn et al. 2018

J. M. Monroy Kuhn/M. Jakobsson/T. Günther, Estimating genetic kin relationships in prehistoric populations. *PLOS ONE* 13,4, 2018, e0195491, <<https://doi.org/10.1371/journal.pone.0195491>> (17.03.2023).

Mühlenbruch 2020

T. Mühlenbruch, Vereint im Tode – Eine Gruppenbestattung aus Oechlitz. In: M. Meller/M. Schefzik (eds.), *Die Welt der Himmelscheibe von Nebra – Neue Horizonte*. Begleitband zur Sonderausstellung im Landesmuseum für Vorgeschichte Halle (Saale), 4. Juni 2021 bis 9. Januar 2022 (Halle [Saale] 2020) 38–41.

Olalde et al. 2018

I. Olalde/S. Brace/M. E. Allentoft/I. Armit/K. Kristiansen et al., The Beaker phenomenon and the genomic transformation of northwest Europe. *Nature* 555, 2018, 190–196, <<https://doi.org/10.1038/nature25738>> (17.03.2023).

Olalde et al. 2019

I. Olalde/S. Mallick/N. Patterson/N. Rohland/V. Villalba-Mouco et al., The genomic history of the Iberian Peninsula over the past 8000 years. *Science* 363,6432, 2019, 1230–1234, <<https://doi.org/10.1126/science.aav4040>> (17.03.2023).

Ortolf 2014

S. E. Ortolf, Das schnurkeramische Gräberfeld von Lauda-Königshofen im Taubertal. *Fundber. Baden-Württemberg* 34, 2014, 409–528, <<https://journals.ub.uni-heidelberg.de/index.php/fbbw/article/download/44479/37944>> (17.03.2023).

Papac et al. 2021

L. Papac/M. Ernée/M. Dobeš/M. Langová/A. B. Rohrlach et al., Dynamic changes in genomic and social structures in third millennium BCE central Europe. *Scien. Advances* 7,35, 2021, <<https://doi.org/10.1126/sciadv.abi6941>> (17.03.2023).

Pearson et al. 2023

J. Pearson/J. Evans/A. Lamb/D. Baird/I. Hodder et al., Mobility and kinship in the world's first village societies. *Proc. Nat. Acad. Scien. USA* 120,4, e2209480119, <<https://doi.org/10.1073/pnas.2209480119>> (17.03.2023).

Risch et al. 2021

R. Risch/S. Friederich/M. Küßner/H. Meller, Die Entwicklung und Struktur des Siedlungswesens zwischen dem Endneolithikum und der frühen Bronzezeit in Mitteleuropa. In: H. Meller/S. Friederich/M. Küßner/H. Stäuble/R. Risch (eds.), *Siedlungsarchäologie des Endneolithikums und der frühen Bronzezeit*. 11. Mitteldeutscher Archäologentag vom 18. bis 20. Oktober 2018 in Halle (Saale). Katalog, Tagungen Landesmus. Vorgesch. Halle 20,3 (Halle [Saale] 2021) 11–35.

Risch et al. 2022

R. Risch/S. Friederich/M. Küßner/H. Meller, Architecture and Settlement Dynamics in Central Germany from the Late Neolithic to the Early Bronze Age. *Proc. Prehist. Soc.* 88, 2022, 123–154, <<https://doi.org/10.1017/ppr.2022.10>> (17.03.2023).

Saag et al. 2017

L. Saag/L. Varul/C. L. Scheib/J. Stenderup/M. E. Allentoft et al., Extensive Farming in Estonia Started through a Sex-Biased Migration from the Steppe. *Current Biol.* 27,14, 2017, 2185–2193.e6, <<https://doi.org/10.1016/j.cub.2017.06.022>> (17.03.2023).

Saag et al. 2021

L. Saag/S. V. Vasilyev/L. Varul/N. V. Kosorukova/D. V. Gerasimov et al., Genetic ancestry changes in Stone to Bronze Age transition in

the East European plain. *Scien. Advances* 7,4, 2021, <<https://doi.org/10.1126/sciadv.abd6535>> (17.03.2023).

Schneewind 2007

S. Schneewind, Reconsidering »Sati in Universal Context«. *Journal World Hist.* 18,3, 2007, 353–360, <<https://www.jstor.org/stable/20079436>> (17.03.2023).

Schroeder et al. 2019

H. Schroeder/A. Margaryan/M. Szmyt/B. Theulot/P. Włodarczak et al., Unraveling ancestry, kinship, and violence in a Late Neolithic mass grave. *Proc. Nat. Acad. Scien. USA* 116,22, 2019, 10705–10710, <<https://doi.org/10.1073/pnas.1820210116>> (17.03.2023).

Schwarz 2015

R. Schwarz, Kultureller Bruch oder Kontinuität? – Mitteldeutschland im 23. Jh. v. Chr. In: H. Meller/H. W. Arz/R. Jung/R. Risch (eds.), *2200 BC – Ein Klimasturz als Ursache für den Zerfall der Alten Welt? 7. Mitteldeutscher Archäologentag vom 23. bis 26. Oktober 2014 in Halle (Saale)*. Tagungen Landesmus. Vorgesch. Halle 12,2 (Halle [Saale] 2015) 671–713.

Schwarz 2021

R. Schwarz, Strukturierung und Hierarchisierung neolithischer Gesellschaften in Mitteldeutschland. In: H. Meller (ed.), *Früh- und Mittelneolithikum*. Kat. Dauerausstellung Landesmus. Vorgesch. Halle 2,1 (Halle [Saale] 2021) 217–264.

Strahm/Buchvaldek 1992

C. Strahm/M. Buchvaldek (eds.), *Die kontinentaleuropäischen Gruppen der Kultur mit Schnurkeramik*. Schnurkeramik-Symposium 1990. Praehist. 19 (Praha 1992).

Villalba-Mouco et al. 2021

V. Villalba-Mouco/C. Oliart/C. Rihuet-Herrada/A. Childebayeva/A. B. Rohrlach et al., Genomic transformation and social organization during the Copper Age-Bronze Age transition in southern Iberia. *Scien. advances* 7,47, 2021, eabi7038, <<https://doi.org/10.1126/sciadv.abi7038>> (17.03.2023).

Wentink 2020

K. Wentink, Stereotype. The role of grave sets in Corded Ware and Bell Beaker funerary practices (Leiden 2020), <<https://www.sides-tone.com/books/stereotype>> (17.03.2023).

Yaka et al. 2021

R. Yaka/I. Mapelli/D. Kaptan/A. Doğu/M. Chyleński et al., Variable kinship patterns in Neolithic Anatolia revealed by ancient genomes. *Current Biol.* 31,11, 2021, 2455–2468.e18, <<https://doi.org/10.1016/j.cub.2021.03.050>> (17.03.2023).

Source of Figures

- 1 a photo J. Lipták, München;
excavation map LDA;
pedigree W. Haak
b photo A. Moser,
S. Gottwald, LDA;
pedigree W. Haak
c photo and map M. Furmanek;
pedigree W. Haak

Tab. 1 W. Haak

Addresses

Dr. Wolfgang Haak
Max Planck Institute for Evolutionary
Anthropology
Department of Archaeogenetics
Deutscher Platz 6
04103 Leipzig
Germany
wolfgang_haak@eva.mpg.de
ORCID: <https://orcid.org/0000-0003-2475-2007>

Dr. Mirosław Furmanek
University of Wrocław
Institute of Archaeology
Szewska str. 48
50-139 Wrocław
Poland
miroslaw.furmanek@uwr.edu.pl
ORCID: <https://orcid.org/0000-0002-3558-3440>

Prof. Dr. Harald Meller
Landesamt für Denkmalpflege und Archäologie
Sachsen-Anhalt
Richard-Wagner-Straße 9
06114 Halle (Saale)
Germany
sekretariat@lda.stk.sachsen-anhalt.de
ORCID: <https://orcid.org/0000-0002-7590-0375>