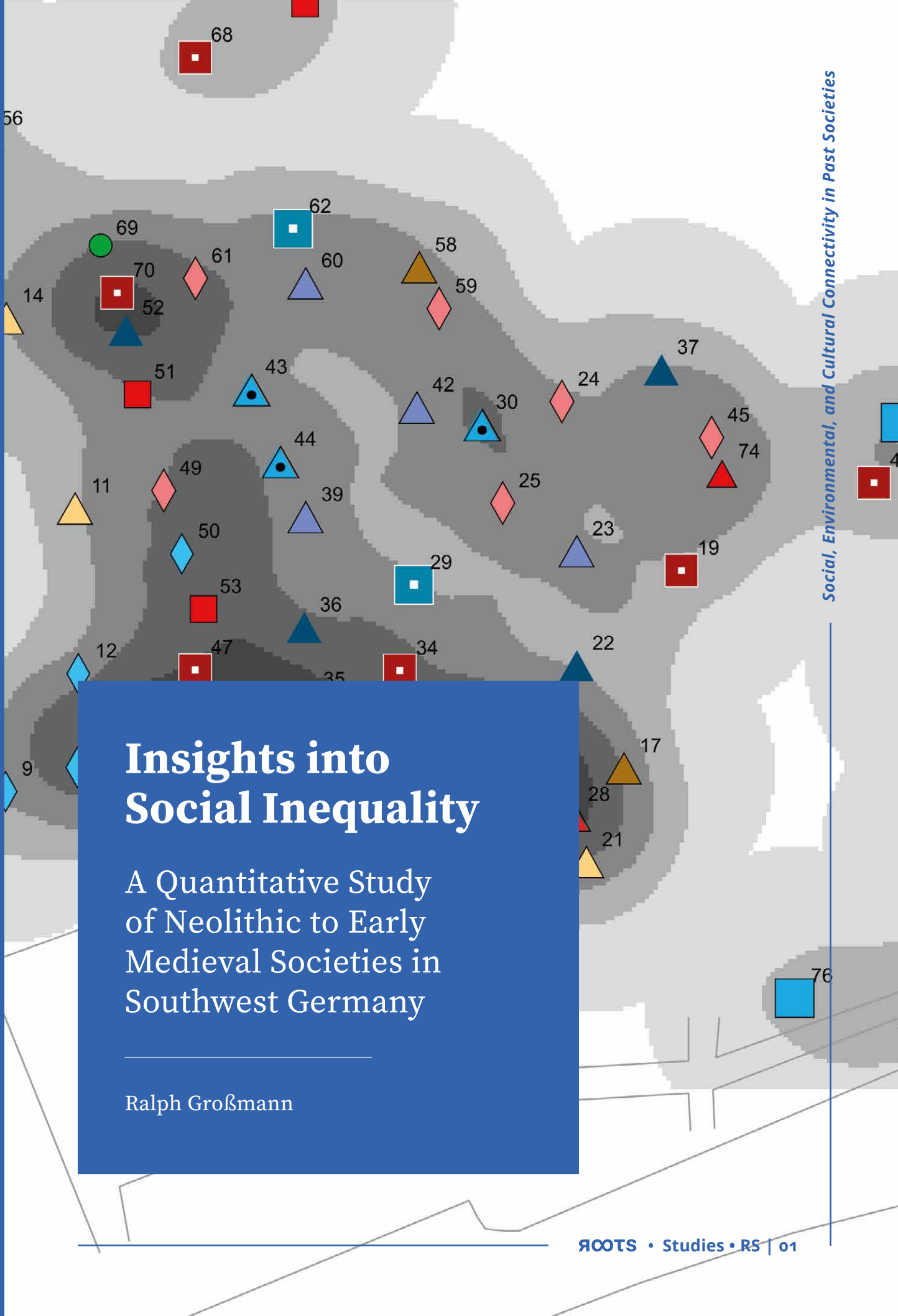

Insights into Social Inequality

A Quantitative Study of Neolithic to Early Medieval Societies in Southwest Germany

Ralph Großmann

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CAU Kiel University Christian-Albrechts-Universität zu Kiel

JMA

Preface of the series editors

As the outcome of overarching, interdisciplinary scientific research efforts within the Excellence Cluster 'ROOTS – Social, Environmental and Cultural Connectivity in Past Societies' at Kiel University, we are pleased to introduce the first volume of the new book series **ROOTS Studies**. The book series of the Cluster of Excellence ROOTS addresses social, environmental, and cultural phenomena as well as processes of past human development in light of the key concept of "connectivity" and presents scientific research proceeding from the implementation of individual and cross-disciplinary projects. The results of specific research topics and themes across various formats, including monographs, edited volumes/proceedings and data collections, are the backbone of this book series. The published volumes serve as a mirror of the coordinated concern of ROOTS researchers and their partners, who explore the human-environmental relationship over a plurality of spatial and temporal scales within divergent scientific disciplines. The associated research challenges revolve around the premise that humans and environments have interwoven roots, which reciprocally influence each other, stemming from and yielding connectivities that can be identified and juxtaposed against current social issues and crises. The highly dynamic research agenda of the ROOTS cluster, its diverse subclusters and state of the art research set the stage for particularly fascinating results.

At the outset of the new book series, the first volume by Ralph Großmann titled *Insights into Social Inequality: A Quantitative Study of Neolithic to Early Medieval Societies in Southwest Germany* is closely embedded within one of the key

subcluster concepts of ROOTS: inequality. It deals in great detail with the diversely examined archaeological remains that were excavated in Southwest Germany at cemeteries from five different historical epochs, ranging from the Neolithic to the Early Medieval period. In this investigation, inequality is surveyed as a phenomenon that can be quantitatively pinpointed within the burial grounds of burial communities. Each archaeological site is examined by the author by means of multi-proxy analyses in order to identify hierarchical and heterarchical differences. The study identifies disparity on the basis of a comparison of specific processes, objects and human remains that reveal dissimilarities between and within the specific cemeteries. The author's analyses are characterised by the implementation of archaeological and bioanthropological data, more specifically, by providing values of grave goods, sizes of grave pits, grave distributions and data on, i.a., age, sex, height, health status and diet of the interred individuals. Nitrogen and strontium isotope data, correspondence analyses as well as the application of Gini indices and spatial analysis through kernel density and distance analyses enable the author to identify and thus make inferences about the presence and extent of social inequality for the respective research contexts.

The editors of the ROOTS Studies series would like to take the opportunity to thank those colleagues involved in the successful realisation of the first volume. We are very grateful for the detailed and well-directed work of the ROOTS publication team. Specifically, we thank Andrea Ricci for his steady support and coordination efforts during the publication process, Tine Pape for the preparation of the numerous figures and the cover design and Eileen Küçükkaraca for scientific editing. Moreover, we are indebted to the peer reviewers and our partners at Sidestone Press, Karsten Wentink, Corné van Woerdekom and Eric van den Bandt, for their support and commitment at the outset of this new book series.

Kiel, November 2020
Lutz Käppel, Johannes Müller, Wolfgang Rabbel

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Preface of the author

Social inequality is an all-encompassing phenomenon and just as this work was being completed, social inequality again became an integral part of the current scientific and public discourse due to the effects of the corona pandemic.

This project is embedded in the subcluster Social Inequality of the Cluster of Excellence ROOTS (EXC 2150 ROOTS) at Kiel University. This work was initiated in 2017 and from the beginning, it was designed with a multivariate approach, so that different proxies that illustrate social inequality can be applied. For me, it was clear that different perspectives are required to demonstrate the complexity of inequality in grave field contexts. This includes not only archaeological and bioanthropological data but also data that reflects the spatial reference of graves within cemeteries. This work tries to fulfil the claim of the Cluster of Excellence ROOTS to illustrate the connectivity between different proxies and different scientific disciplines as well as to provide a diachronic point of view.

After the comprehensive database had been created, which can be viewed on the website of the Johanna Mestorf Academy (https://www.jma.uni-kiel.de/en/research-projects/data-exchange-platform), it became clear that the results of the multivariate analyses could not be published in one single article, but that a monograph could only achieve this. The fact that the results are now published within the ROOTS series makes me proud and I would like to explicitly thank the speakers and responsible persons within the ROOTS Cluster for valuable advice and intense discussions. In particular, I would like to thank Prof. Dr. Johannes Müller, Dr. Nils Müller-Scheeßel (both from the Institute of Prehistoric and

Protohistoric Archaeology, Kiel University) and Prof. Dr. Sebastian Köhne (Institute for Economics, Kiel University) for their helpful comments. Furthermore, I express my gratitude to Ties Morten Heuer (Kiel University) for the collection and input of data, Tine Pape (Kiel University) for her graphic design support, Dr. Eileen Küçükkaraca (Kiel University) for scientific editing and the two reviewers for their valuable comments. Finally, I would like to thank my friends and family for their support, especially Marie, Johann and Jonas Klabunde.

Ralph Großmann

Introduction

On the basis of five cemeteries that can be assigned to different epochs, the following work attempts to highlight social inequalities in several contexts. The investigation is based on the use of different theories, proxies, methods and research questions. In general, the diachronic development of social inequality will not be the main focus, since we are dealing with very different material cultures and the cemeteries cannot be understood as representative samples for each epoch. Nevertheless, a working hypothesis is established in the synthesis of this monography concerning the development of social inequality based on the grave pit size distribution of adult individuals. The results are compared to Gini indices reflecting house size distributions and results from strontium isotope analyses.

Apart from data that concerns values of grave goods and sizes of grave pits, this monography includes bioanthropological data of the buried persons, including data on sex, age, body height, physique, epigenetic features, health status, diet and trauma. This measurable data is available through physical anthropology and stable isotope analysis to an increasing extent and through constantly improved methodologies. These attributes are not subject to selection by the burial community and cannot be readily manipulated by it.

In particular, recorded nitrogen isotope data is applied, as this information indicates good access to animal proteins during the lives of the buried persons and can be used as an indicator of social status. In the case studies, where a sufficiently large sample is available, nitrogen samples are correlated with grave pit sizes and values of grave goods. Furthermore, when possible, these ratios are correlated with specific

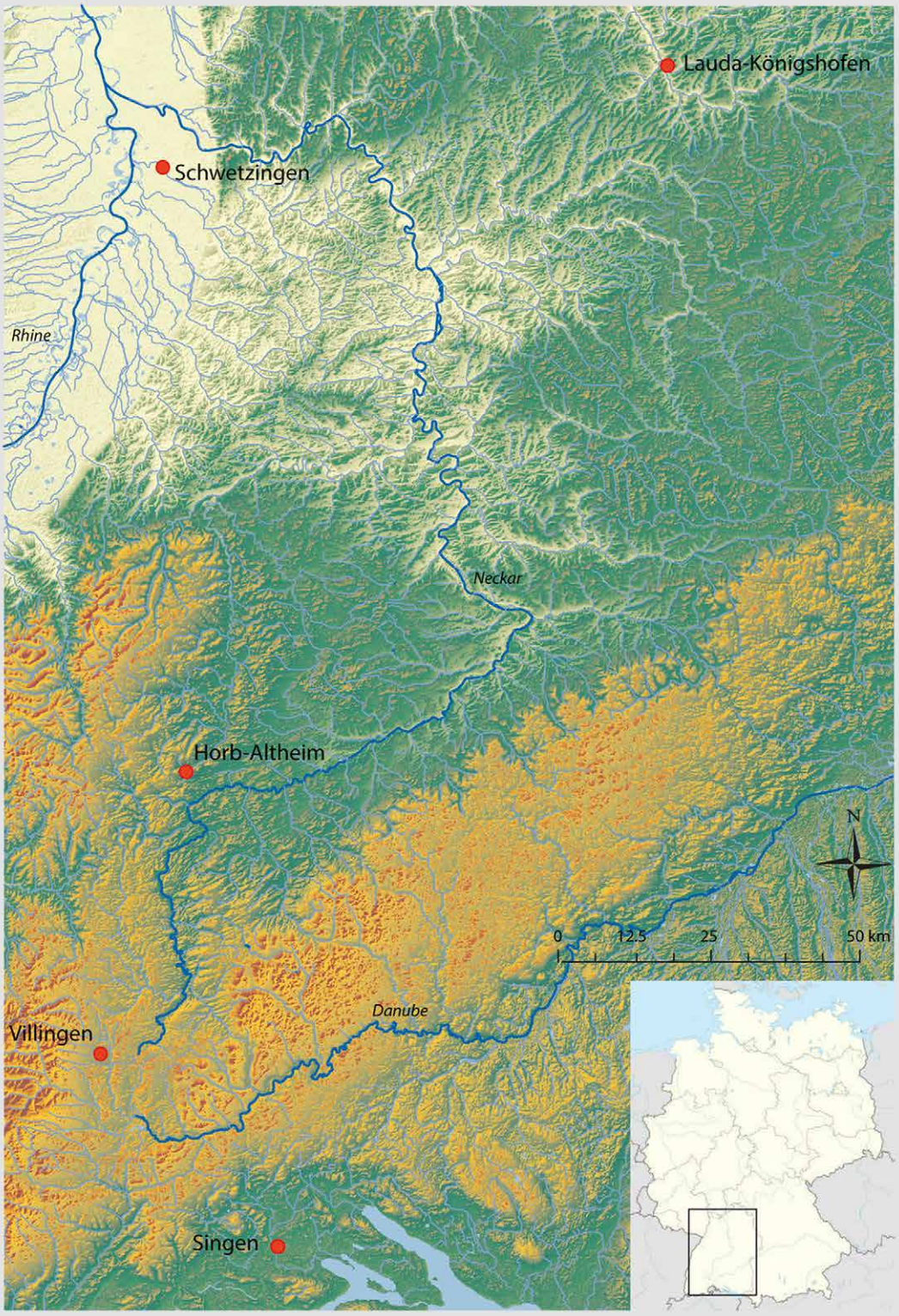


Figure 1. Working area. Southwest Germany (Baden-Württemberg) with the analysed sites that are mentioned in the text.

categories of grave goods to determine which types of grave goods can be associated with a high or low social status. Furthermore, strontium isotope ratios, if available, are used to demonstrate whether the origin of the buried persons plays a role with regard to grave goods, the size of a pit or the location of the burial within the cemetery.

The chronological factor, which is included in this analysis by available relative and absolute chronological data, is an additional essential consideration when regarding furnishings and the direction of occupation.

In addition to hierarchical aspects of social inequality, diversity and diachronic aspects are also included in the study of the burial grounds. In this context, multivariate analyses (such as correspondence analyses) are used to detect differences in grave goods that are not only based on hierarchical factors. Finally, the results provided here will be transferred into the model of power strategies constituted by G. M. Feinman (2000).

For the outlined investigations, five cemeteries belonging to different archaeological groups and periods were selected. The cemeteries of Schwetzingen (archaeological group: Linearbandkeramik, Early Neolithic, ca. 5200 BCE), Lauda-Königshofen (Corded Ware phenomenon, Final Neolithic, ca. 2600 BCE), and Singen, Hohentwiel (Singen group, Early Bronze Age, ca. 2200 BCE), the tumulus Magdalenenbergle, Villingen (West Hallstatt, Early Iron Age, ca. 600 BCE), and finally the cemetery Horb-Altheim (Alemannic, Early Medieval period, ca. 500 CE) were chosen. All sites are located in Southwest Germany (Fig. 1).

These burial grounds were selected for three reasons. First, with more than 75 individuals each, they provide an adequate number of burials that allows the analysis of the burial grounds with respect to inequality. Second, they are relatively close to each other and all cemeteries are located in Southwest Germany. Although the burial grounds are partly located about 200 km apart, a limited diachronic comparison is nonetheless possible. Third, the availability of various data that has already been published was of particular importance for the selection. This includes archaeological data, bioanthropological data, such as data regarding the biological sex of the interred, as well as isotope data. However, apart from the material culture, the cemeteries vary concerning the number of detected burials, the proportion of subadults and the existing bioanthropological data. A common factor is represented by the presence of inhumations and burial goods (Tab. 1).

The distribution of males and females is well-balanced in the Early Neolithic site Schwetzingen and the Early Iron Age site Magdalenenbergle. At the Early Bronze Age site Singen, males predominate, whereas females predominate at the Final Neolithic site Lauda-Königshofen and the Early Medieval site Horb-Altheim. With respect to age, the highest proportion of subadults was found in Lauda-Königshofen. In contrast, the tumulus Magdalenenbergle, Villingen provides the lowest proportion of subadults.

Social inequalities of each of the burial grounds are examined under the same recurrent research questions and aspects that enable a comparison of the results. We calculate social inequalities both on the basis of burial goods, since objects likely mirror social norms and degrees of inequality, and on the basis of burial pit sizes that provide us with more direct information about social differences.

The results regarding the differences in values of grave goods and burial pit sizes are summed up in a further step in order to obtain an overall result regarding both factors. Both data sets are also correlated with each other in order to verify to what extent grave pit sizes are related to the quantity and quality of the furnishings.

Site	Individuals (n)	Females /prob. Females (n)	Males /prob. Males (n)	Proportion of subadults	Publications
Schwetzingen Early Neolithic (LBK) ca. 5200-5000 BCE	203 inhumations + 15 cremations	76	72	37%	Francken 2016; Francken *et al*. 2015; Bickle 2013; Bentley *et al*. 2013; Gerling 2012; Francken and Wahl 2007
Lauda-Königshofen Final Neolithic (Corded Ware) ca. 2600-2500 BCE	91	38	30	66%	Sjögren *et al*. 2016; Ortolf 2014; Trautmann 2012; Menninger 2008
Singen at Hohentwiel Early Bronze Age ca. 2200-1900 BCE	97	31	46	44%	Oelze *et al.* 2012b; Kupke 2010; Sprenger 1995; 1994; Bertemes 1992; Krause 1988; Gerhardt 1964
Magdalenenbergle, Villingen Early Iron Age (West Hallstatt) 616 – ca. 550 BCE	136 inhumations + 8 cremations	55	54	26%	Zäuner and Wahl 2013; Oelze *et al.* 2012a; Kupke 2010; Spindler 2004; 1980; 1977; 1976; 1973; 1972; 1971; Burmeister 2000; Müller 1994; Parzinger 1986; Gallay 1977
Horb-Altheim Early Medieval period (Alemannic) ca. 450-510 CE	76	44	32	38%	Beilharz and Peek 2011; Obertová 2008; Obertová and Wahl 2007

Table 1. Summarised data of archaeological groups, number of individuals, females and males for this project, proportion of subadults and main publications.

Inequality calculations are also correlated with gender and age data in order to determine which age cohorts have the highest values of grave goods and the largest grave pit sizes according to the respective genders.

In addition, inequality indices in the form of Gini indices will be calculated based on the distributions of values of grave goods in order to show whether there is a higher amount of inequality among females or males.

An essential part of this work also includes the spatial analysis of the cemeteries and the application of, *e.g.*, kernel density analysis and distance analysis, specifically, the calculation of the distance to the nearest burial. By using these methods, it is possible to integrate the space covered by the cemetery as a social inequality factor. This investigation suggests that individuals, genders or age cohorts that were buried relatively close to or at a distance from the next burial had a relatively low or high social status. In order to verify this assumption, the data has to be correlated with other independent data, such as the values of grave goods, grave pit sizes or independent bioanthropological data.

Moreover, models of the spatial social structure of the burial grounds will be designed and presented for all obtained results and aspects.

Theories of social inequality

Social inequality is a subject of contemporary concern. Life capabilities vary significantly in rich and poor countries and between elites and others. Gender inequalities are almost universal and the concentration of wealth is increasing almost everywhere. These pronounced inequalities are the result of interpersonal interactions between individuals, which are shaped by the constraints of resources, technology and institutions, including stable social systems that encourage the inheritance of wealth from one generation to the next. Thereby, inequalities develop through historical processes that operate on many levels, from the individual to the society, from the kin group and neighbourhood to the state (Kohler and Smith 2018, 5).

Social inequality is described by specific terms that are used frequently within this text, among others, dominance, social status, prestige and authority. Prestige is freely awarded. People, to whom prestige is conferred, are honoured or revered. In contrast, dominance is enforced through agonistic behaviour and fear. Authority is the ability to channel the behaviour of others – also in the absence of power. Social status refers to a social position within a social ranking. A variety of factors can influence status. These include power, authority, income, assets, prestige and similar criteria. Individuals with a similar status form status groups. Furthermore, high status is usually invested with moral worth, which may vary culturally (Ames 2007, 487f.; Hradil and Schiener 2001, 256ff.).

This concept of inequality has its origins, among others, in the books of the Geneva philosopher Jean-Jacques Rousseau, in particular in *Discourse on the Origin and Basis of Inequality among Men* (1755/2012) and *The Social Contract* (1762/2018).

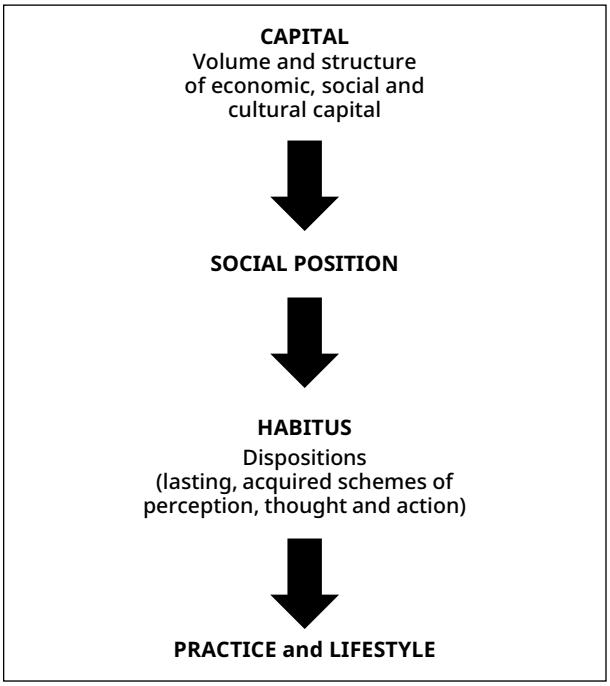


Figure 2. A theory of habitus according to P. Bourdieu (1982).

In these works, the factors for the origin of inequality are described precisely. Rousseau distinguishes two forms of inequality: 1) the first is natural or physical and has to do with the person, *i.e.* differences in age, health, physical strength, and spirit, whereby gender remains unmentioned; and 2) the second is moral or political and includes differences in privileges, wealth, power, and honour. Rousseau is not concerned with the natural type of inequality because he claims it does not represent the root of inequality found in civil society. Instead, he argues that moral inequality is unique to civil society. This type of inequality is established by convention (Rousseau 2012; Rousseau 2018).

When we investigate social inequality, the Marxist approach also has to be mentioned. According to this approach, social inequalities are created due to the (mis)regulated access to resources and the means of production. K. Marx and F. Engels (1848/2016) identified exclusionary power, which is gained when one privileged group possesses and transfers the majority of commodities or when one group consolidates resources in a way that excludes another group. They argued that the building blocks of social complexity, *i.e.* social inequality, are constituted by the dynamics among those who have versus those who have not. This regulation fosters classes and class consciousness.

If we look at P. Bourdieu's approach (Bourdieu 1982; Schwingel and Bourdieu 2011) (Fig. 2), classes are based on habitus. Habitus is composed of a system of durable, transposable dispositions that generate and organise practices and lifestyles. In the development of habitus, its incorporation is significant. Here, similar living conditions shape similar habitus forms. Furthermore, the social world is a multidimensional field; actors or groups of actors are defined on the basis of their relative position within this field. Analogous to Marx, a social position is determined by various types of capital. Bourdieu distinguishes between economic, cultural and social capital. The different types of capital are mutually convertible, whereas the structure and volume of capital influences habitus and habitus, in turn, affects practices and lifestyles.

Archaeologists and anthropologists often explore the emergence of social inequality. Studies of social inequality have often been entangled in cultural discourses, such as in theories of social evolutionism of the nineteenth and early twentieth centuries (Childe 1952), as well as in the positivist and teleological focus of early processual archaeology.

In the 1960s, archaeologists and anthropologists differentiated between egalitarian, ranked, and stratified societies. Anthropologists formerly believed that all hunter-gatherers were egalitarian until both archaeological and ethnographic fieldwork demonstrated the opposite (Flanagan 1989). Paralleling this differentiation, various socio-political organisations, such as bands, tribes, chiefdoms, and states, are mentioned. Scholars once assumed that the constructing typologies of monolithic social systems and inequality developed following a sequence of social organisations, leading from egalitarian to ranked and subsequently to stratified and state societies (Fried 1967) or from bands and tribes to chiefdoms and states (Service 1962; Service and Fliessbach 1977). In 1987, neo-evolutionary social typology was further supplemented by A. W. Johnson and T. Earle (1987) with a finer specific subdivision ranging from the foraging group to the agrarian state. Modern archaeological fieldwork and analyses revealed, however, a far more complex human past (Flannery and Marcus 2012; Trigger 1989).

With post-processual archaeology, the focus has shifted to more pattern-seeking approaches with respect to contemporary social concerns and ancient cultural contexts. Evolutionary typological labels, such as "chiefdoms" or "states", have been avoided in the wake of the critique of positivist and neo-evolutionary conceptions. Instead, more flexible forms of organisation types, reflected in terms such as trans-egalitarian, middle-range societies, and complex societies, have been developed (Wengrow and Graeber 2015; MacGuire and Saitta 1996; Price and Feinman 2010; Flannery and Marcus 2012; Ames 2007; Klaus *et al.* 2018; Testart 2005).

In the current discussion, the theory of anarchism is increasingly relevant. Instead of the top-down perspective in which the social agency of non-elite actors is neglected, an alternative theory of anarchism focuses on the bottom-up perspective in which power is socially embedded and decisions are negotiated. The anarchic approach presents a framework to analyse decentralised societies without the centralisation of authority. The tradition of anarchism is interested in how individuals could form cooperative social groups without coercion. However, anarchism assumes a level of order and cooperation among consenting parties. Moreover, active resistance to concentrations of power is also a focus of the theory. The theory of anarchism is also applied for an understanding of networks and complex intergroup relations that aim to avoid the establishment of a centralised political authority (Angelbeck and Grier 2012; Borck and Sanger 2017).

Strongly related to the theory of anarchism are heterarchical approaches, which refer to multiple sources and appearances of inequality in the same society. In this context, heterarchy denoted the relation of elements to one another when they are unranked or when they possess the potential to be ranked in a number of different ways. Heterarchy distributes privilege and decision-making among participants, while a hierarchy allocates more power and privileges to the members at a high position in the structure. Nonetheless, hierarchy and heterarchy are not mutually exclusive, but can occur together and form complex organisational forms. As a consequence, social inequalities were and are practiced in heterarchical and hierarchical dimensions or in combinations of both (Ehrenreich *et al.* 1995; Kohler and Smith 2018; Crumley 1995).

An often-cited phenomenon that has been often transferred into archaeology is the so-called big-man system, an ethnographically documented phenomenon in Melanesia and Polynesia. In contrast to a chief that is embedded in a rank and hereditary based society, the big-man does not inherit his leadership position or have special material possessions. His leadership position is not ascribed, but is rather gained through action and competition with other ambitious men. He acts as a skilful and exceptional entrepreneur and grants protection and economic aid to his clan or tribe followers and in return receives support, which he uses to raise his status. A big-man must constantly maintain his recognition through skilful persuasion and leadership (Sahlins 1963; Řidký *et al.* 2019).

If we return to the term "social inequality", the question remains, however, what does it actually mean? In short, R. J. Holton notes that social inequality involves:

> *"[...] differences that create and reproduce systemic inequalities in the life chances of populations over time [...]" (Holton 2015, 61).*

Of special interest here are inequalities that are produced by uneven access to and control of material and non-material resources that are considered to be valuable, whereby the value of resources is co-determined by natural, cultural and societal contexts.

Concerning non-material wealth, Monique Borgerhoff Mulder and colleagues distinguished between embodied and relational wealth (Borgerhoff Mulder *et al.* 2009; Smith *et al.* 2018, 12). Embodied wealth consists, for instance, of body weight, grip strength and practical skills. Relational wealth includes social ties in networks and other forms of assistance. In contrast, material wealth embraces, for example, land, livestock, and household goods. Moreover, higher degrees of inequality were more likely to be found among those societies with a greater intergenerational transmission of wealth. In many examples, this is the case for agriculturalists and pastoralists, but not for the more mobile horticulturalists and foragers.

A further aspect involves the unequal distribution of valuable resources on a regular basis. C. Tilly focuses on sustainable social inequality over time (Tilly 1998/2009; Smith *et al.* 2018, 13). He refers to four causal mechanisms that generate inequality. The most powerful mechanisms are, on the one hand, exploitation that occurs when persons, who control a resource, enlist the efforts of others in the production of value by means of that resource, but exclude the others from the full value added by their efforts. On the other hand, opportunity hoarding is a further mechanism, which operates when members of a categorically bounded network acquire access to a resource that is valuable, subject to monopoly, supportive of network activities, and enhanced by the network's *modus operandi*. Two further mechanisms, such as emulation and adaptation, work to cement processes of inequality into durable phenomena.

Social inequality is closely connected with the terms hierarchy and power. Hierarchy, or vertical differentiation, includes rank stratification and asymmetrical, status-based distributions of power, resources, and privilege (*e.g.* Fried 1967). Power is associated with the dynamic in which one social entity coerces another into an action that they might not typically carry out or that might not be in their best interest (Miller and Tilley 1984). Frequently, ruling parties show power by using ideology articulated through unshared and monopolised ritual knowledge. This manufactures the ideology of one group's right to control or rule (Foucault and Gordon 1980).

In addition, inequality is influenced by social determinants (*e.g.* perceived gender, race, age, ethnicity, kinship, and ancestry), norms and ideologies, which also influence access to and control of resources (Smith *et al.* 2010; Hansen and Müller 2011; Hradil and Schiener 2001; Borgerhoff Mulder *et al.* 2009). Biological sex and socially constructed gender are important determinants in constructing social inequalities. Anthropologists have observed that females of complex societies belong to a disadvantaged category in comparison to males in that females' social existences may involve comparatively lower status advantages, especially in patriarchal cultures (Kellogg 2005). Yet, archaeological and bioarchaeological studies of power, sex, and gender disparities must preclude simplistic and paternalistic tendencies in light of critical anthropological emic and etic definitions of gender. The conception and practice of gender and gender inequality in other cultures may not be as dichotomous as in our idealised Western sense (Miller 1993; Klaus *et al.* 2018, 8).

Regarding the origins of social inequality, archaeologists and anthropologists outlined different reasons. First, the development of relative scarcities in productive land or high-ranked wild game likely supported wealth inequality. Furthermore, inequality also derives from the practice that resources are owned, controlled, exchanged, and inherited, whereby the level of inequality does indeed fluctuate systematically with subsistence type. B. Milanović and colleagues (2011), for instance, assume that horticultural production increases the usual surplus beyond foraging surplus, and agriculture increases the available surplus yet again. T. D. Price and O. Bar-Yosef (2010) argue that the rise of agriculture coincided with the creation of status differentiation linked to the emergence of surplus foods. Along these lines, varying access to and control of food or arable land appear to be major factors in the establishment of social ranks. Thereby, perceived differences lead to the formulation of hereditary rank in varied ways (Flannery and Marcus 2012; Hayden 1995).

Moreover, any mechanism increasing group size in the past also increased the probability of inequalities within groups. Whether population is measured as regional population, settlement population, or density, there are great amounts of data and numerous studies that support this relationship and corresponding models to explain it (Smith *et al.* 2018, 12). Additionally, political complexity tends to increase with societal scale and the degree of political complexity, in turn, influences the level of inequality (Scheidel 2018; Flannery and Marcus 2012).

A further factor concerns technology. The introduction of new production techniques, such as agriculture and metallurgy, which can lead to changes in the organisation of work and shifts in land use, has been associated with unequal relations between humans (Meller *et al.* 2016; Kienlin and Zimmermann 2012). A link between the mode of production and the degree of inequality is expected if greater productivity increasingly reproduces larger surpluses, enabling more extensive inequities in distribution. Furthermore, the introduction of specific technologies can affect the materialisation of resources and labour, thus creating greater concentrations of wealth (Smith *et al.* 2018, 16).

W. Scheidel (2018) traced the global history of inequality from the Stone Age to today. He demonstrates that inequality declines when conflicts and disaster strike, and increases when peace and stability return. He identified, in particular, four scenarios that lead to a decline of inequality. These include mass-mobilisation warfare, transformative revolutions, state collapse, and catastrophic plagues.

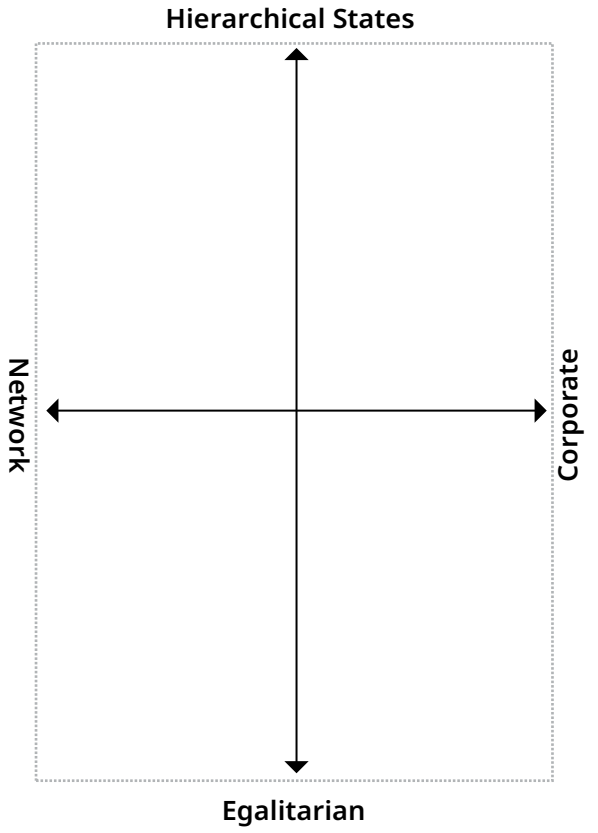


Figure 3. Strategies of power according to G. M. Feinman (2000).

However, explanations for the extent of inequality require more than a concern about which societal scale, political complexity, available technologies, or modes of production prevail; they necessitate an understanding of societal institutions and regimes. For instance, R. Blanton and L. Fargher (2008) point out that regimes, which are more collective, have lower levels of inequality than regimes that are more autocratic.

Overall, it may be more accurate to approach the history of social inequality in terms of a variability between greater and lesser degrees of social complexity amid the cyclic rise, collapse, and reorganisation of complex societies (Scheidel 2018; Schwartz and Nichols 2006).

With regard to an interpretation of social inequality, G. M. Feinman's model of power is noteworthy (Feinman 2000) (Fig. 3). In order to contrast a monolithic perspective on hierarchies, G. M. Feinman and colleagues (Feinman 2000; Blanton 1998/2000) widened the perspective and developed a multidimensional theory of power strategies. They distinguished between two power strategies, which embrace the network or exclusionary mode and the corporate mode. In the former, power is focused among individuals and their personal networks, which can be expressed, for example, in concentrated wealth, individual power, exchange partners, lineal kinship systems and princely burials. In the latter, power is shared and is a product of group membership. A corporate labour system focuses on food production and on monumental ritual spaces. This concept considers the corporate and network modes as the polar ends of a continuous dimension. Both strategies pursue the goal to reach and/or to maintain hierarchical organisation. In addition, both power strategies are integrated on a hierarchical and egalitarian continuum and are considered to be independent of the prevailing organisation-

al form. Moreover, corporate and network strategies have different degrees of relative importance cross-culturally and their relative significances may vary in a single region over time. Therefore, either one or the other mode often dominates and is emphasised in any particular spatio-temporal setting. Accordingly, specific cases can be defined along a corporate and network continuum. Overall, the integration of a multidimensional power theory enables investigations to take account of the diversity of social organisations (Feinman 2000, 32).

Apart from inequality approaches, which focus on economic levels, there is, as Stiglitz (Sen *et al.* 2010, 61) notes, a full range of factors that influences what we value in life, reaching beyond material aspects (Sen *et al.* 2010, 61). Within the capability approach, further aspects beyond economic aspects are addressed, which are important to fulfil aspirations for a comfortable life. These include, for instance, health care, life expectancy and educational levels. The unequal distribution of these fundamental requirements leads to conflict situations within and between societies (Arponen *et al.* 2016; Smith *et al.* 2018, 23).

Empirical approach to social inequality

In studies of prehistory, there is a huge challenge when researching inequality due to the lack of written sources. Thus, the calculation of social inequality has to focus on material resources. Within social archaeology, there are numerous attempts to quantify social inequalities based on mortuary practices and burial ground analyses (Binford 1971; Saxe 1970; Chapman 2003). For these quantifying efforts, the material wealth of a buried individual and wealth discrepancy within the buried community have been measured. Studies for the Early Bronze Age (Bösel 2008; Sprenger 1994; 1995) and for the Early Iron Age (Müller 1994; Burmeister 2000) are worth mentioning. Various indices for wealth have been included, for instance, the scarcity of objects, the plurality of grave goods, the metal weight, the number of different used materials, grave constructions and grave volumes.

Currently, methods, such as the Gini index, which provides a single summary measure of inequality, are frequently applied in economics and have gained increasing relevance (Ames 2007; Litchfield 1999; Kohler and Smith 2018). Of the many quantitative measures of inequality used by economists and sociologists today, the Gini coefficient is the most widespread (Cowell 2011; Milanović *et al.* 2011; Milanović 2018). Named for its inventor, the Italian sociologist C. Gini (1921), this index is both easy to calculate and intuitive. It measures the degree of concentration of a quantity among the units of a population.

The Gini coefficient simplifies the measurement and comparison of inequality in different archaeological groups. It does not consider the size of the economy or the relative richness and size of the group to which it is applied (Smith *et al.*

2014; Litchfield 1999; Ames 2007; Credit Suisse Research Institute 2017). In addition to the Gini coefficient, the so-called Lorenz curve, which displays the distribution of wealth and is the fundament of the Gini coefficient, is often used.

In archaeology, the Gini coefficient has been used to measure social inequalities based on variations in house sizes (Kohler *et al.* 2017; Smith *et al.* 2014) and burial goods (Müller and Windler 2016; Windler *et al.* 2013). For example, T. A. Kohler and his colleagues (2017), who compared the development of settlement inequality between the "old" and the "new" world, came to the conclusion that there is first a coherence between the expansion of agriculture and increasing wealth inequality and second a stronger increase of inequality in Eurasia based on domestic mammals. The challenge in ancient wealth inequality research pertains to the availability of relevant information for different indicators of wealth, *e.g.*, dwelling and storage area size or grave goods, and to compare measured inequality indices from different sources through time (Fochesato *et al.* 2019).

Since its first use by R. H. McGuire (1983), who measured the Gini index for burial goods, there have been numerous further applications of this index, especially for North- and Mesoamerican regions (Kohler *et al.* 2017; Smith *et al.* 2014; Müller and Windler 2016; Windler *et al.* 2013). However, there is still a need for empirically obtained inequality data from different regions and sources.

Furthermore, the difference in diet of buried individuals increasingly serves as a proxy for the reconstruction of social inequality. Several studies analysing carbon and nitrogen isotopes in human bone collagen have shown that certain groups of people particularly interred in elaborated burials consumed more foods from higher trophic levels (*e.g.* containing a higher proportion of animal proteins) in comparison to contemporaneous "normally" buried groups of people (Le Huray and Schutkowski 2005; Kinaston *et al.* 2013; Knipper *et al.* 2015). The reconstruction of diet proves in the mentioned cases that there were enduringly different lifestyles and privileges for the representatives of the respective highest social class, despite very different prehistoric and historic contexts. Thus, the title of the analysis by C. Knipper and her colleagues (2015) "Superior in life – Superior in death" is evidently true for many cases.

Regarding the relation between social complexity and nutrition supply, M. E. Danforth (1999) found that the subsistence economy associated with prehistoric egalitarian societies guaranteed adequate nutrition for most members. In trans-egalitarian and chiefdom-level societies, nutritional differences were discernible only sporadically, despite greater degrees of material culture differentiation and inequality. This suggests that in order to remain in power, elites in chiefdoms did a relatively effective job of sharing resources with those that they ruled. In state-level societies, different mechanisms were at play and great differences existed in nutrition and health between high-status and low-status individuals.

Moreover, based on the development of bioarchaeological studies, human bones and teeth shed new light on core anthropological questions about the nature, development, and consequences of social inequality. The outcomes of many studies refer to high-ranking or elite individuals, who experienced better health than that of their subordinates. Indications of such inequality are represented in the patterns of diverse skeletal phenomena, which induce enamel hypoplasia, anaemia and other metabolic disorders. This can also be traced through signs of traumatic injury, oral health problems, infectious diseases, degenerative joint disease as well as by terminal adult stature measurement, bone chemistry

and genetic variation (*e.g.* Crane-Kramer and Cohen 2007; Larsen 2015; Schepartz *et al.* 2009; Klaus *et al.* 2018).

However, it is problematic to argue that health equals wealth. Skeletal correlates of social status should not be seen in a one-to-one relationship with archaeologically defined social categories, just as such social categories may not always correlate well with skeletal variation (*e.g.* Robb *et al.* 2001; Saitta 1999). Using bioarchaeology to understand social complexity will never be a straightforward task. Skeletal samples often present only snapshots of individual biographies (Cohen and Armelagos 1984). We must also emphasise that the quality of a bioarchaeology of social inequality is dependent on ample contextual data and should be embedded in an understanding of the regional historical and social contexts (Larsen 2015; Larsen and Walker 2010).

As a further empirical approach to detect social inequalities, the spatial analysis of burial grounds serves as a useful method and can be applied as a helpful tool to detect social differences. In the 1970s and based on a long history of spatial analysis in social anthropology, L. R. Binford (1971) emphasised that archaeological sites are often the product of human agency and social decisions and therefore contain spatial structuring which can be investigated accordingly. Similarly, J. A. Tainter (1975) applied statistical analysis to the problem of understanding social complexity from cemetery data. Likewise, L. Goldstein (1981) combined an examination of the material contents of graves with their spatial orientation using cluster analysis. She investigated two Mississippi Valley cemeteries and looked at clustering in "elite" and "non-elite" graves.

Moreover, Geographic Information System (GIS) is often employed to understand human agency and the social aspects of burial practice, for example, the prevalence of weapons in graves (Härke 1992) or the association of age categories and gendered objects (Huggett 1996). GIS is also routinely engaged to understand ancient landscapes, or as a digital tool that can plot multiple grave variables spatially across large cemetery sites in an adequate way (Sayer 2010; Šmejda and Turek 2004; Sayer and Wienhold 2012).

Methods

Within this work, multiple methods were used to identify social inequalities. These include methods that focus on the quantification of grave goods and their unequal distribution as well as methods that consider differences in burial efforts and specific characteristics of the interred such as nutrition, health status, growth and origin. In addition, methods were also applied that take a closer look at the burial space.

Differences in the values of grave goods and burial pit sizes

In modern societies, income or asset inequality is usually measured in US dollars (Haughton and Khandkar 2009). Given that such data is not available for archaeological contexts, we have to calculate with other resources such as burial goods (Müller and Windler 2016; Müller 1994; Hodson 1990; Freudenberg 1989; Orton and Hodson 1981). However, burial goods have to be quantified and assigned with values (Hodson 1990; Freudenberg 1989) that function as comparable means and statistical approximations (Bernbeck 1997).

There are multiple socio-structural approaches, in which burial goods have been quantified to calculate social indices (*e.g.* Freudenberg 1989; Sprenger 1994; Bösel 2008; Müller 1994). In this project, the calculation of individual wealth was kept simple and a focus was placed on the *scarcity* of object types within the cemetery and the number of burial goods per individual. Thus, a category of grave goods is assigned a high or low value, depending on how seldom it occurs. Further

factors were excluded (*e.g.* material substance, origin of an artefact, and the efforts needed for the production of burial goods, cf. Risch 2016), since scarcity is related with these factors in most cases. The integration of many factors would also cause an artificial increase in "rich" burials and a decrease of "poor" burials.

To calculate the individual value of grave goods, the number of individuals interred in a cemetery was divided by the number of a certain object type. Second, this value was multiplied by its number in a grave. Finally, the values for each object type in a grave were summed. If only few objects of similar artefact types, such as different kinds of beads, were present, they were combined into a single, broader category.

An example: The value of an adze in the Early Neolithic cemetery of Schwetzingen is 8.2 due to the fact that there are 24 adzes with an analysed burial number of 197 individuals (197 : 24 = 8.2). The value of an arrowhead is 5.6 because there are 35 arrowheads within the cemetery (197 : 35 = 5.6). The male adult burial 26 has 4 arrowheads (4 * 5.6 = 22.4) and one adze (1 * 8.2 = 8.2). Thus, the individual grave value is 30.6 (22.4 + 8.2), normalised thus in relation to the burial with the highest grave value (grave 36 = 107.8) = 0.28 (30.6 : 107.8). In some cases, the values of the individual categories of grave goods appeared to be too high or too low and thus not plausible. Therefore, plausibility conflicts sometimes occurred. Occasionally, grave goods, such as simple tools, which are relatively rare in cemeteries, were associated with relatively high values, for example, awls in Final Neolithic and Early Bronze Age contexts or boulder mallets in an Early Iron Age context. With these objects, however, it is not necessarily the material value or the amount of work that has to be done to produce these objects that had to be emphasised. Instead, the focus was placed on the identified social role of the buried persons to whom such objects were assigned as burial objects. Conversely, objects that are considered as particularly valuable in a common sense were sometimes assigned relatively low values because they were deposited quite often, such as bronze daggers at Early Bronze Age Singen. Despite all the challenges, an attempt was made to apply the simplest possible principle to calculate the values of grave goods, which could then be consistently applied across epochs and enable comparability.

The distribution of values of grave goods is shown in the form of Lorenz curves. In the examination, the realisation was made with MS Excel. Hereby, the x-axis represents the cumulative population and the y-axis the cumulative values of burial goods. In order to ensure comparability, the values of grave goods are converted into normalised values. When considering Lorenz curves, the so-called 45-degree line is included. This line represents a theoretical uniform distribution of goods. In most cases, the larger the area between the Lorenz curve and the 45-degree line, the higher the degree of inequality. A so-called Lorenz dominance exists if the Lorenz curve for distribution "A" is above the Lorenz curve for distribution "B" at every point of the proportion of the total population and thus closer to the 45° line (Atkinson 1970).

As a concise measure, the so-called Gini coefficient was applied (Haughton and Khandker 2009). The Gini coefficient, which is frequently used by economists, measures the degree of inequality with respect to certain attributes such as income or assets. The higher its value (specified as a normalised value between 0 and 1), the higher the inequality coefficient. It is the result of comparing the area between the Lorenz curve and the theoretical line of an absolute equal distribution (45-degree line) with the total area under the 45-degree line. Within statistics,

there are different formulas for calculating the Gini index. For this analysis, the formula presented by T. C. Stocker and I. Steinke (2017) was applied.

$$G = \frac{2\sum_{i=1}^{n} ix(i)}{n\sum_{i=1}^{n} x(i)} - \frac{n+1}{n}$$

Where: n = the sample size
i = units sorted by value
x = individual value of an attribute (wealth, income, *etc*.).

This investigation includes not only the burial goods but also the distribution of burial pit sizes as an indicator for the calculation of the Gini coefficient and the determination of the level of social inequality (cf. 'Synthesis' chapter). As a reference for the calculation of social inequality, the distribution of square metre sizes or the volume, when available, of the grave pits were included.

While the distribution of grave goods has been used, in particular, to assess differences in social inequality between males and females, the distribution of burial pit sizes was used for a diachronic comparison of social inequality to highlight differences in social inequality between epochs and material cultures. However, only the grave pits sizes of adults were considered. It should be taken into account that only one burial ground was analysed for each material culture. Therefore, the diachronic comparison should initially only be seen as a first point of reference for further investigations. In the author's opinion, grave goods are only of limited suitability for a diachronic comparison due to the different material cultures.

In addition to the calculated value of grave goods and the size of the burial pit, a further value was integrated into the work. This value, called "burial value", describes the added summands of values of grave goods and pit sizes. The aim is to obtain a cumulative value that considers both the values of grave goods and the pit sizes and focuses on those burials that have both high values of grave goods and pit sizes. To obtain a total value, both the values of grave goods and the burial pit size values have been normalised to a value that ranges between 0 and 1.

With respect to the reconstruction of social structures, certain preconditions should be considered. First, a social norm and a standardisation of the burial ritual must be recognised in order to allow identifications of deviations. Second, the entire population must be studied, or at least the sample must represent a cross section of the entire population. Third, the inexplicable absence of burials, such as the low incidence of subadults or individuals of a certain sex, could point to exceptional burials that are not known and thus to exceptional social positions of the individuals, which might cause a bias in the reconstruction of degrees of inequality. We are also aware that calculations of inequalities might be biased due to the different use of material throughout time, e.g., the lack of metal products in Neolithic societies (Link and Schimmelpfennig 2012; Waldron 2007; Deininger and Squire 1996; Härke 1993).

Moreover, it was decided to exclude some graves and individuals due to their poor state of preservation, inadequate documentation, and/or collective inhumation disallowing the measurement of individual values. Which burials were included or excluded in the calculations is noted in the data base, which can be viewed on the homepage of the Johanna Mestorf Academy (https://www.jma.uni-kiel.de/en/research-projects/data-exchange-platform).

Bioanthropological data

Information on sex/gender and age was also integrated into the analyses. The term sex is used in connection with a biological category, the term gender in connection with a social category. Here, the applied social gender is derived from the documented burial form and grave goods custom (cf. Hofmann 2009). The sex and age data in the respective case studies was based on the results of various researchers (for Schwetzingen: Francken 2016; Francken and Wahl 2007; for Lauda-Königshofen: Menninger 2008; Trautmann 2012; for Singen: Gerhardt 1964; for Magdalenenbergle, Villingen: Gallay 1977; Zäuner and Wahl 2013; and for Horb-Altheim: Obertová 2008). For the determination of sex and age, the respective researchers referred (with the exception of Singen) to established bioanthropological studies, among others to D. Ferembach and colleagues (Ferembach *et al.* 1979; Herrmann 1990; Buikstra and Ubelaker 1994). The assessment of sex in subadults is difficult due to the lack of robustness and pelvic characteristics. However, the characteristics of the internal auditory *meatus* and teeth have proven to be applicable for age determination (Menninger 2008; Trautmann 2012; Francken and Wahl 2007).

Body height is a further anthropological variable. This variable and the growth of individuals represent potential proxies for physical condition, since stature and growth correlate, among other things, with physical stress, health and the quality of nutrition. Furthermore, the correlations of body height with individual material wealth have provided information about the coherence of physical conditions with material wealth and facilitated interpretations about social structures (Steckel 2012). Calculated body heights are based on the basics and formulas of G. Olivier *et al.* (1978), E. Breitinger (1937) and H. Bach (1965).

Stable isotope analyses

Additionally, a link between diet and social inequality was also established, since the form of nutrition could be regarded as a proxy for inequality (Twiss 2012; Knipper *et al.* 2015). Stable isotopic ratios of $\delta^{13}C$ (per mil relative to V-PDB) and $\delta^{15}N$ (per mil relative to AIR) in bone and teeth collagen originate from dietary proteins and their degrees reflect, amongst other things, different dietary patterns (Ambrose 1993; Münster *et al.* 2018). Based on bone collagen, nutritional patterns can be reconstructed for the last living years of an interred individual and stable isotope measurements on teeth provide indices for nutrition in early years during the formation of dental roots (Münster *et al.* 2018; Ambrose 1993; Kupke 2010). Relative high $\delta^{13}C$ and $\delta^{15}N$ ratios compared to local human and faunal samples could indicate a higher trophic level and a higher supply of animal-based food, including meat, milk and dairy products, or fish. Differences in the supply of animal-based food among a community function in current archaeological discourses as proxies for the assessment of the status of individuals. In addition, the carbon isotope ratios of human remains provide information about the plant proteins in food, such as the proportion of C_3 (*e.g.* wheat and barley) and C_4 crops (*e.g.* millet) (Knipper *et al.* 2015; Twiss 2012; Le Huray and Schutkowski 2005).

However, it should also be noted that $\delta^{13}C$ isotope signatures are also influenced by terrestrial, marine, and aquatic food resources and different ecological habitats, whereby $\delta^{15}N$ isotope signatures are affected by water availability, temperature, and different digestive systems of animals as well as through breast-feeding,

starvation, and modern fertilisation. Furthermore, characteristics of the measured individual (such as sex or age) and additional factors that can influence the nitrogen isotopic composition, such as the local environmental setting, must be taken into account (Ambrose 1993; Kupke 2010; Makarewicz and Sealy 2015).

In addition to $\delta^{13}C$ and $\delta^{15}N$ stable isotope ratios, the examination here also included strontium isotope ratios in order to test whether local or non-local individuals were treated unequally. Strontium isotope analysis is a robust way to examine past mobility. In principle, humans adopt strontium by sediments through food and deposits in tooth enamel. Strontium isotope ratios ($^{87}Sr/^{86}Sr$) in rock and sediments depend on their age and composition. Bones undergo continuous chemical and structural changes during life. By contrast, the enamel in teeth is formed in infancy and remains unchanged, thus documenting the isotopic signal of early childhood. Therefore, if an individual migrates to or is buried at a new site in a dissimilar geologic context, the enamel isotopes will differ from those of the new site and identify that individual as non-local (Knipper *et al.* 2017a; Sjögren *et al.* 2016).

According to P. Bickle and D. Hofmann (2007), strontium isotope data has proven crucial in raising questions about social organisation and mobility with renewed emphasis and has opened up new avenues of thinking. Here, it is pre-assumed that different forms of movement, such as large-scale, one-off migrations or routine patterns of mobility, must be considered in current discourses about social inequality. The preferred interpretations of strontium isotope patterns partially depend on specific cultural theories or the importance of spatial patterns. Hence, they are not independent from other archaeological data, but must be carefully integrated with them (cf. Knipper 2017).

Pathologies

In addition to the above-mentioned proxies, pathologies were included and material inequality was compared with pathological evidence. Caries, *cribra orbitalia*, trauma, and *spondylarthrosis* were integrated in the study as pathological forms.

Orbital lesions termed as '*cribra orbitalia*' probably reflect multiple conditions and causes. Given the association with anaemia as well as scurvy and rickets, some sort of dietary deficiency (iron, vitamin C and D, respectively) probably plays some role in a majority of *cribra orbitalia* cases. Such dietary insufficiency could stem from restricted access to resources, nutrient deficiency or malabsorption as would occur in the case of diarrheal disease. Furthermore, parasitic and infectious diseases could also be causal factors (Obertová 2008; Larsen and Walker 2010; Walker *et al.* 2009).

Tooth decay or caries is caused by oral bacteria and is one of the most common infectious diseases in children. Carious lesions can occur as small white spots on the enamel surface or as fully formed cavities. Since certain bacteria digest food carbohydrates on tooth surfaces, they excrete acid that can dissolve the calcium phosphate from tooth crowns and roots. Untreated caries can cause tooth decay, exposing the pulp cavity, causing pain and abscesses that may require removal. Sugar in nutrition is the main source of these bacteria, and therefore a high-sugar diet, including fruits, grains and milk, is a risk factor. The presence of higher levels of animal protein in a diet and a reduced carbohydrate content can lead to a reduction in dental caries. The prevalence of tooth decay is very variable and differs between sex, age group, population and social class (Schimmel 2003; Featherstone 2000; Roberts and Manchester 2007).

With the Early Medieval burial ground of Horb-Altheim, *spondylarthrosis* is also included in this analysis. It is associated with degenerative joint diseases and can be detected by a degenerative change of the spine and of the articular surfaces of *apophyseal* joints. In addition to the inevitable signs of aging, some diseases can promote *spondylarthrosis*. If the spinal column is overburdened by certain activities, but also by overweight, *arthrosis* of the back occurs more quickly (Obertová 2008).

Overall, both bioanthropological, stable isotope data and data with respect to pathologies are appropriate to provide data necessary to compare whether inequality or equality in the lived experience of individuals corresponded with inequality or equality in burial treatments, such as furnishings with burial goods and the type of burial construction. The question arises whether the performed inequalities in mortuary practices are coherent to the lived inequalities materialised in skeletons (cf. Quinn and Beck 2016, 35).

Spatial analyses

A further question of concern is the spatial character of a mortuary site. There is a long tradition of successful applications of spatial analysis in settlement site studies, but fewer attempts to use similar methods in the research of cemeteries. A mortuary site reflects a differentiation in the performing activities of the involved social units. Mortuary practices represent interpersonal and intergroup relationships and the reflected social organisation. Examinations of the spatial component can provide information concerning spatial separation and ordering of the burial area, which may enable an interpretation of the principles of social organisation. In this regard, spatial relations may represent status differentiation, family groups, descent groups or special classes. The utilisation of space may indicate the placement of associated graves in relation to an individual, the placement of the individual in relation to others, the placement of groups of individuals, and the placement of the deposition area itself. Therefore, the spatial component of mortuary sites is multidimensional. The various dimensions may represent different elements, and thus should be carefully sorted out and analysed in a broad approach (Goldstein 1981; Saxe 1970).

A first step in the application of spatial elements is the creation of a descriptive database of sites, which contains information on the two-dimensional position of every grave. A list of finds associated with the grave pits constitutes another part of the database. A pair of coordinates referring to a grave's central point (the crossing of diagonals) is sufficient for the purpose of recording the position of every burial assemblage. A table containing analytical descriptions of burials can be linked to these points correspondingly in the course of the subsequent analyses (Neustupný 1993; Šmejda and Turek 2004).

The applied kernel density estimation in this examination was carried out with the program ArcGis (ESRI Company) and describes the density of find points within a selected search radius. The statistical mathematical implementation is set out, for example, in B. W. Silverman (2018).

Statistical procedure

With respect to the results, multiple statistical tests were applied in order to test their significance. In some cases, the results of statistical tests need to be regarded with reservations, since small sample sizes were also used in the study.

For the statistical analyses, the program PAST (PAleontological STatistics) Version 4.02 was applied. PAST offers a comprehensive statistics package used not only by palaeontologists but also in many fields of life science, earth science, engineering and economics (Hammer and Harper 2006).

The T-Test compares the mean values of two samples. It measures the probability whether the difference of means is significant or not. Concerning the criteria for the T-Test: the samples must have a normal distribution. Furthermore, it has to be considered whether the standard deviation of samples is the same. If several samples are tested, the one-way ANOVA (analysis of variance) test is applied. It is a statistical procedure to test the null hypothesis that several univariate samples are taken from populations with the same mean. The samples are assumed to be close to normally distributed and have similar variances (Groß 2010; Hammer 1999-2019).

In contrast to the T-Test, the Kruskal-Wallis test is a non-parametric method used for the comparison of two or more independent samples of equal medians or different sample sizes. The Kruskal-Wallis test does not presume a normal distribution of samples. Analogue to the Kruskal-Wallis test, the Mann-Whitney pairwise test is applied, which includes the same preconditions as the Kruskal-Wallis test (Groß 2010; Hammer 1999-2019).

We also used linear regression models in order to illustrate the degree of a relationship between two variables. Linear regression represents a linear approach to model the correlation between a dependent variable y and one or more independent variables denoted as x (Yan and Su 2009). The independent variable is represented by anthropological data such as body height and stable isotope data ($\delta^{13}C$ and $\delta^{15}N$ ratios). Individual values of grave goods or burial sizes represent dependent variables (as normalised values) of the respective graves. The degree of correlation can be found in J. Cohen and P. Cohen (1983), who differentiated between a small ($> \pm 0.10$), moderate ($> \pm 0.30$), and large ($> \pm 0.50$) correlation.

Furthermore, box plots are frequently applied in this examination, particularly in correlations between gender/ages and values of grave goods or burial sizes. In descriptive statistics, a box plot is a method of graphically representing groups of numerical data. A box plot is created on the basis of the median values and the quartiles. The median indicates the middle of the values to be observed, *i.e.* the values are divided exactly in the middle. The upper and lower limits of the box indicate the quartiles. The vertical lines outside the boxes, the so-called whiskers, indicate the inconspicuous scattering. It is defined by 1.5 times the quartile distance. All values that lie outside the 1.5-fold quartile distance can be regarded as outliers (Wickham and Stryjewski 2011).

Another descriptive method is represented by correspondence analyses. Correspondence analysis is a method of multivariate statistics that graphically represents the relationships between the variables of a contingency table. The more often objects, such as burials, have identical variables, such as grave goods, the closer both objects and variables are spatially related. Correspondence analysis thus serves to illustrate complex facts and can be classified as a method to discover structures (Backhaus *et al.* 2008, 544). For this examination, the program CAPCA Version 3.1 (copyright by Torsten Madsen) is used.

Source critique

When analysing and interpreting the data, a number of assumptions and limitations must be considered. In early processual archaeology, burials were considered in direct relation to the social structure of a society and burials and their contents have often been regarded as direct reflections of the living world. In contrast to cultural historical approaches, however, one did not look for "norms" in funeral practices, but concentrated on variability in burial customs and tried to draw conclusions about intrasocial differences. Very generalising hypotheses were mostly tested on ethnographic case studies and attempts to verify them were made by intercultural comparisons (Bernbeck 1997, 49-64, 251-255; Saxe 1970; Binford 1971; Tainter 1975; Goldstein 1981). Researchers assumed that burials at least in complex societies tend to be "total social phenomena" that integrate many aspects of social life with a variety of messages, which the living encode in funerary rituals (cf. Tarlow and Stutz 2013; Beck 1995). Moreover, according to T. Oestigaard and J. Goldhahn (2006), a strong relationship exists between burial rituals and social and religious institutions, since burials are the institutionalised occasion for the transmission of property and power as well as the renewal of social and economic ties (cf. Kristiansen *et al*. 2017).

However, the dead cannot bury themselves. Death, the treatment of the body and burials are social events and processes that can affect the material culture with which archaeologists are confronted. The intentions of the bereaved are the deciding factors in the furnishing of burials. Frequently, burial goods are embedded in already existing social, regulative norms, which are predetermined by societies. Particularly in pre- and protohistoric societies, the distribution of grave goods followed social norms in which gender and age-specific role models played a major role. Furthermore, the grave goods of a deceased person do not have to indicate that they were his or her entire property, but rather represent the portion of his or her possessions that was given to him or her as part of the burial ritual. They may also be the artefacts that were given to him by the community to reflect his social role and certain meanings (Quinn and Beck 2016; Blischke 2002, 35; Veit 2003).

Moreover, due to ideas of the afterlife and the intervention of the bereaved, real power relations can be obscured and distorted (Burmeister 2000, 97). Thus, mortuary practices reflect the thinking of the community, but not necessarily the real social positions of the deceased (Popitz 2006; Müller-Scheeßel 2018; Wason 1994; Härke 1993). Thus, mortuary practices reflect the thinking of the community, but not necessarily the real social positions of the deceased (Popitz 2006; Müller-Scheeßel 2018; Wason 1994; Härke 1993).

Various post-processual studies demonstrate that mortuary symbolisms may be manipulated to intentionally obfuscate social heterogeneity or symbolically negate social inequality. In other settings, burials may embody between-group competition and negotiation of heterarchical relationships. In this context, B. G. Trigger notes:

> *"[…] simple correlations between archaeological interpretations and social conditions are encountered only rarely: There is always the concern that archaeological visions of social complexity may reflect the categories of the investigator rather than the original emic perspective that we should seek." (cf. Trigger 1989, 380; cf. Shanks and Tilley 1982; Parker Pearson 2000; Tarlow and Stutz 2013; Klaus et al. 2018, 10ff.).*

Post-processual archaeologists, such as I. Hodder, have a critical view of the reference to ethnographic comparisons. He tried to demonstrate that human actions differ according to context. Material legacies represent relics of symbolic communication and can only be understood in multi-layered (spatial, temporal, ideological, religious, social, etc.) and contextual analyses. The contextual analysis of burial places provides insights into social circumstances and social structures of a community (Hodder 1980, 161). Furthermore, a contextualisation of mortuary practices with further archaeological and environmental sources, such as settlement and economic conditions, may uncover actual social realities. Settlement and depot structures are equally important, since the conditions represented in the burial rite do not have to reflect the prevailing reality at the time and theories about social structures can only be established by including further sources (Bernbeck and Müller 1996, 18).

This leads to the question to what extent grave analyses can be used for the reconstruction of social structures (Bernbeck and Müller 1996, 17-18). In order to reconstruct the role of the deceased in the community, data is needed that is functional or at least non-intentional, which can provide a further approximation of the actual social position of a person or group of persons. In contrast to intentional data, which reflects burial customs and ideologies such as the choice of burial and forms of grave goods and types, quantifiable data, such as the identification of traces of abrasion on grave goods, the scarcity of specific artifacts in a cemetery, the pluralism of grave goods within a burial, and the distribution of burial pit sizes, can frequently be included and regarded as disconnected from, for example, gender or age norms (Bernbeck and Müller 1996, 18; Burmeister 2000, 99-100; Härke 1993).

Non-intentional data is also represented by bioanthropological, embodied data of the buried persons. Summarised here is data concerning sex, age, body height, physique, epigenetic features, health status, diet and trauma. These measurable data sets are available from physical anthropology and isotope analysis in an increasing number and with constantly improved methodology. They are not subject to selection by the burial community and cannot be readily manipulated by it. Thus, they are rather a reflection of real conditions of social life. Furthermore, the inclusion of external, functional data, such as settlement data, is also a useful corrective tool for the gained burial data and analyses (Borgerhoff Mulder *et al*. 2009; Müller-Scheeßel 2018; Härke 1993).

Moreover, there are certain preconditions that are needed for the reconstruction of social structures. These include the comparability of the burials. Primarily, rather rich and rather poor burials will only be identified if a standardisation, *i.e.* a social norm of the burial ritual, is recognisable for the majority. Conclusions about social positions can only be drawn by deviations, such as deficient or excessive furnishings, when a standardised interpretable ritual is present that reflects mortuary practices of the buried majority. When observing "special treatment" in the burial rituals of certain groups of people, one can conclude that a social order has been established. This can be the social status of the bereaved or the buried persons. It is possible to locate the identified groups on a hierarchical level, but their competencies within society cannot always be clearly determined on the basis of archaeological findings.

Furthermore, as far as possible, the entire population must be present and documentable by the archaeologist – or at least an actual cross section of the population. The inexplicable absence of burials, such as the low incidence of sub-

adults or of a certain sex, could bias the reconstructed social structure. In addition, regarding the documentation of findings and the analysis of social inequalities, there is a need to consider taphonomic processes and disturbances such as grave robbery (*e.g.* Link and Schimmelpfennig 2012; Sprenger 1999).

Social structures and inequalities can only be assessed when these preconditions are fulfilled – or at least considered – and the grave field analysis focuses not only on functional but also on non-intentional data. When comparing data and inequality results between cemeteries of different cultures, the archaeologist has to regard the temporal depth and, associated with it, changing material culture and social norms. If these concerns are taken into account, the structural and quantifiable distribution of "wealth" among cemeteries in terms of, *e.g.*, gender and age can be compared diachronically.

The same is true for the results of nitrogen and carbon isotope analyses. Although it is possible to establish tendencies based on changes in subsistence strategies using isotope analyses, the results can predominately be evaluated within the respective cemetery. Only the structural and relative distribution of stable isotopic ratios can be compared with other sites, since nitrogen and carbon ratios, for example, depend not only on diet and access to animal proteins but also on the environmental and temperature conditions of the respective regions and times (cf. Makarewicz and Sealy 2015).

Schwetzingen (Early Neolithic, 5200-5000 BCE)

The Early Neolithic Linearbandkeramik (LBK) is the first sedentary culture group in Southern Central Europe whose subsistence relied upon the cultivation of cereals and domesticated animals. Characteristic are permanent settlements represented by single farmsteads, hamlets, and villages. Longhouses, wells, and in some cases, enclosures are also typical features of LBK contexts. The common burial type is represented by an individual flat grave with grave goods made up of daily items and ornaments. To a small extent, people were buried within settlements, in the long pits of houses or in other settlement pits. By far the largest number of all burials is found in cemeteries of various sizes, from small grave groups with 5-10 graves to very large cemeteries with more than 200 graves. Cremation burials are only found on these cemeteries (Gerling 2012; Jeunesse 1997; Nieszery 1995; Veit 1996).

Early assumptions interpreted the LBK as simple, closely related agricultural communities of equals, in the terms of M. H. Fried (1967) as an egalitarian society (Childe and Ogden 1925; Piggott 1965; Fried 1967). Within such communities, no social group had more or less access to wealth, power or prestige. Inequalities may have emerged, but they did not exist as permanent social institutions or structures. There was no political specialisation, and leadership roles were available to all members of the community, although positions could be restricted to a certain age or gender.

However, later studies on burials and settlements have increasingly provided evidence of social inequalities, both temporary and structural, within the

LBK. Recent studies viewed the LBK as a kind of 'tribal', segmentary society and maintained that social control and authority seemed to rest with the local heads of families or lineages. Probably, a certain hierarchy and social control was exercised primarily by older individuals (gerontocracy). Some evidence has been put forth indicating inherited status, particularly towards the end of the LBK. Clear evidence of elite lineages, including a small group of extremely rich males, females and children graves, is provided, for instance, in the Bavarian cemetery at Aiterhofen (Bickle 2013; 2020; Lüning 2000; Terberger and Gronenborn 2014; Zimmermann and Gaffrey 2009; van de Velde 1990; Petrasch 2012; Giddens 2015; Nieszery 1995; Jeunesse 1997; Kerig 2003; Strien 2005; Frirdich *et al.* 1994).

Additionally, archaeobotanical examinations at the LBK site Vaihingen suggested that particular local clans may have had access to the more productive field plots, leading to possible inequalities and eventual abandonment by other groups (Bogaard *et al.* 2011).

Furthermore, several authors link households with larger houses and additional economic assets, which are thus capable of exerting more influence (*e.g.* van de Velde 1990). However, houses and households have been also regarded as evidence for an egalitarian social structure (Gomart *et al.* 2015; Hachem 2018; Kohler *et al.* 2017; Smolnik 2012).

The cemetery of Schwetzingen (Baden-Württemberg) represents one of the largest known cemeteries of the Early Neolithic LBK in Germany (Gerling 2012). It is located south of the Neckar inlet on the eastern bank of the Rhine. In the course of work for a new residential area, first finds were made in September and December 1988. An extensive excavation of the cemetery took place from the end of January to the end of September 1989.

The excavation area consists of a northern and a southern part, separated by a disturbance in form of a modern street. The burial ground had also suffered greater damage due to the heavy agricultural use of the area and due to trenches from the Second World War, which had cut and destroyed individual graves. During the excavation, damage was also caused by nightly vandalism and robbery of skeletons and belongings. These circumstances led to a partial too hasty recovery of the skeletons, which resulted in a considerable loss of information (Gerling 2012, 10; Francken and Wahl 2007, 43).

Based on different ceramic decorations, the cemetery was dated to the younger Linearbandkeramik (5200-5000 BCE). The deceased were placed in grave pits, mainly in left crouched positions, and oriented northeast-southwest. Approximately half of the buried individuals were furnished with grave goods, such as ceramic vessels (mostly females), and artefacts made of flint, bone, antler, seashell, and *spondylus* (spiny oyster). Artifacts of snails and *spondylus* are relatively rare in Schwetzingen compared to other cemeteries in Bavaria, Moravia and Slovakia (Bickle 2013). A few graves had polished stones, such as adzes, flint blades, and arrowheads of flint and bone, which are associated with adult or mature males (Gerling 2012). In addition to the nearly 203 body graves, the burial ground also contains 15 cremation remains and so-called "cenotaphs". Within the buried population, the number of females exceeds that of males (cf. Tab. 1). The mortality probability curve in Schwetzingen shows a deficit in subadults and late-mature individuals due to a comparison with recent comparative samples (Weiss 1973). With an assumed period of use of about 100 years, the size of the burying population at Schwetzingen was calculated to ca. 60 inhabitants living at the same

time (Francken and Wahl 2007; Francken *et al.* 2015; Francken 2016; Gerling 2012; Bickle 2013; Bentley *et al.* 2013; Acsádi and Nemeskéri 1970).

Besides comprehensive archaeological analyses by C. Gerling (2012), osteological examinations and stable isotope analyses of carbon, nitrogen strontium and oxygen were performed by M. Francken and J. Wahl (2007), subsequently published in R. A. Bentley *et al.* (2013). In addition, there are further carbon and nitrogen analyses by A. Hujić (2015) concerning allometry and pathological patterns.

Spatial analysis

The density of burials within the burial ground was analysed by kernel density analysis. The analysis reveals three clusters of burials, each cluster demonstrating higher concentrations of burials. With a search radius of 10 m, the highest occupancy density is documented within the southernmost part of the cemetery.

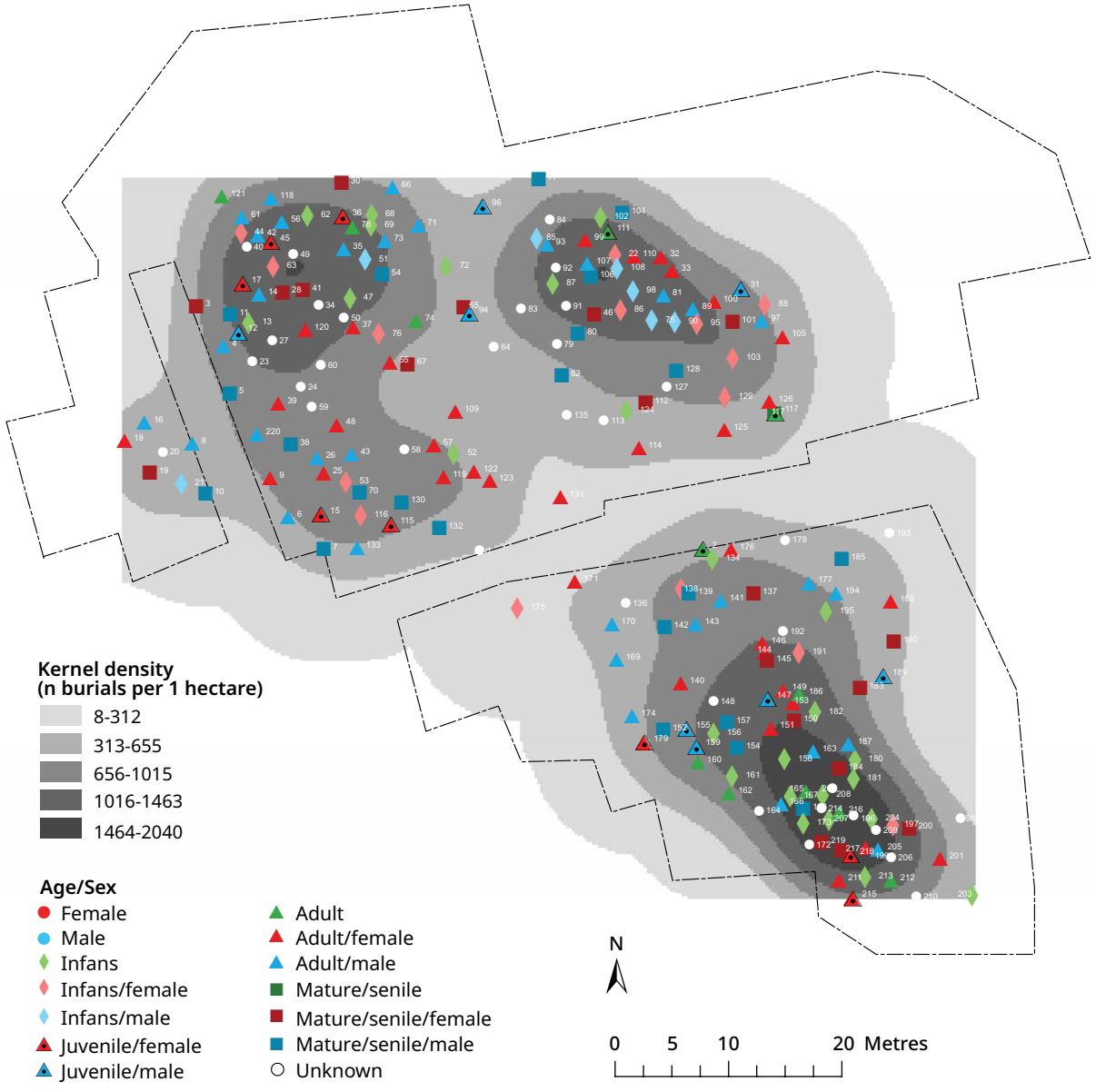


Figure 4. The cemetery of Schwetzingen with kernel density analysis and evidence of the age and sex of the buried individuals. Cemetery plan after C. Gerling (2012).

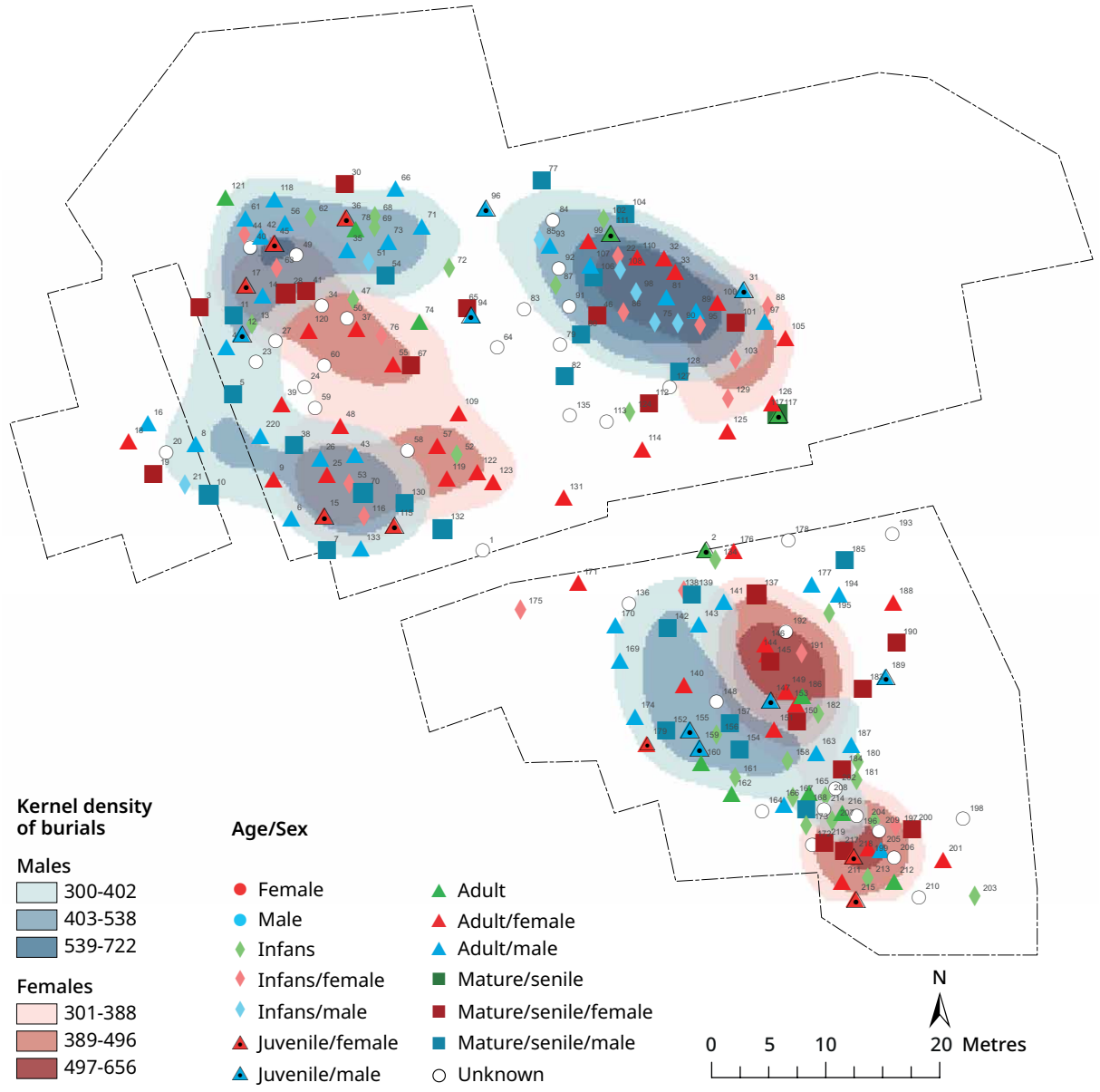


Figure 5. The cemetery of Schwetzingen with kernel density analysis of females and males including information concerning gender and age of each individual.

Extrapolated, this area demonstrates about 1251 to 1563 buried persons per hectare (100m * 100m). Furthermore, the outmost northeastern and northwestern parts of the cemetery show high concentrations of buried persons. These main areas of occupancy that led to a division of the cemetery into a northern and a southern section cannot be explained by the disturbance alone (Fig. 4).

Conspicuously, particularly subadults comprise the high-density concentrations, while adults and especially mature/senile individuals reflect areas with lower densities. Regarding gender distribution, the kernel density analysis shows concentrations of females and males that differ and are not congruent, but reveal spatial organisation rules for the burial locations. Anthropologically determined females or individuals that are interpreted as females based on archaeological findings were predominantly interred at the eastern or southeastern side of the anthropologically determined males or individuals that can be interpreted as males due to the combinations of their grave goods (Fig. 5).

Values of grave goods

197 burials were included in the calculation of values of grave goods. 21 graves were excluded, since they show disturbances or were destroyed. As mentioned in the 'Methods' chapter, the values of grave goods are based on the scarcity of the respective object types within the cemetery and on the number of grave goods assigned to each individual. Table 2 provides the calculated values of object types.

Based on the range of values and the included natural breaks (Jenks), five value categories have been identified. For the first category, five burials with the

Object types	Calculated value
Sherd (backfill)	0.3
Vessel	3.0
Antler toggle	28.1
Bone arrowhead	4.2
Flint arrowhead	5.6
Flint blade	6.4
Adze/antler hoe/mace head	8.2
Grinding stone	21.9
Hematite/seashell/*spondylus*	11.6
Graphite bead/manganese oxide bead/ *spondylus* bead/shell	2.9

Table 2. Calculated values of object types.

Table 3 (below). Burials of first and second categories with information on grave no., values of grave goods (normalised), age, sex and grave goods.

Grave no.	Values of grave goods	Age	Sex	Grave goods
36	1.00	Juvenile	Female	Vessel, shell necklace
106	0.99	Mature	Male	Bone arrowheads, grinding stone, red chalk, seashell, silex blade
133	0.90	Adult 1	Male	Adze, vessel, antler toggle, silex arrowheads, supine position
98	0.81	Infans 1	Male	Shell necklace, silex blade, graphite bead, bone arrowheads, adze
37	0.79	Adult 2	Female	Bone pins, seashell
43	0.52	Adult 2	Male	Silex arrowheads, adze, deep bowl, grinding stone
70	0.48	Adult-mature	Male	Silex arrowheads, adze, antler toggle, bone pin, pebbles
56	0.47	Adult 2	Male	Sherds, antler toggle, grinding stone
154	0.44	Mature	Male	Adze, deep bowl, sherds, silex blade, pebbles, seashell
203	0.39	Infans 2	?	Bone arrowheads, deep bowl, ceramic, sherds
200	0.38	Senile	Male	Adze, deep bowl, silex blade, seashells
142	0.36	Mature	Male	Bone arrowheads, sherds, seashells
58	0.35	?	Male	Deep bowl, antler toggle, silex blade
33	0.32	Adult 1	Female	Deep bowl, ceramic sherds, silex blade, grinding stone

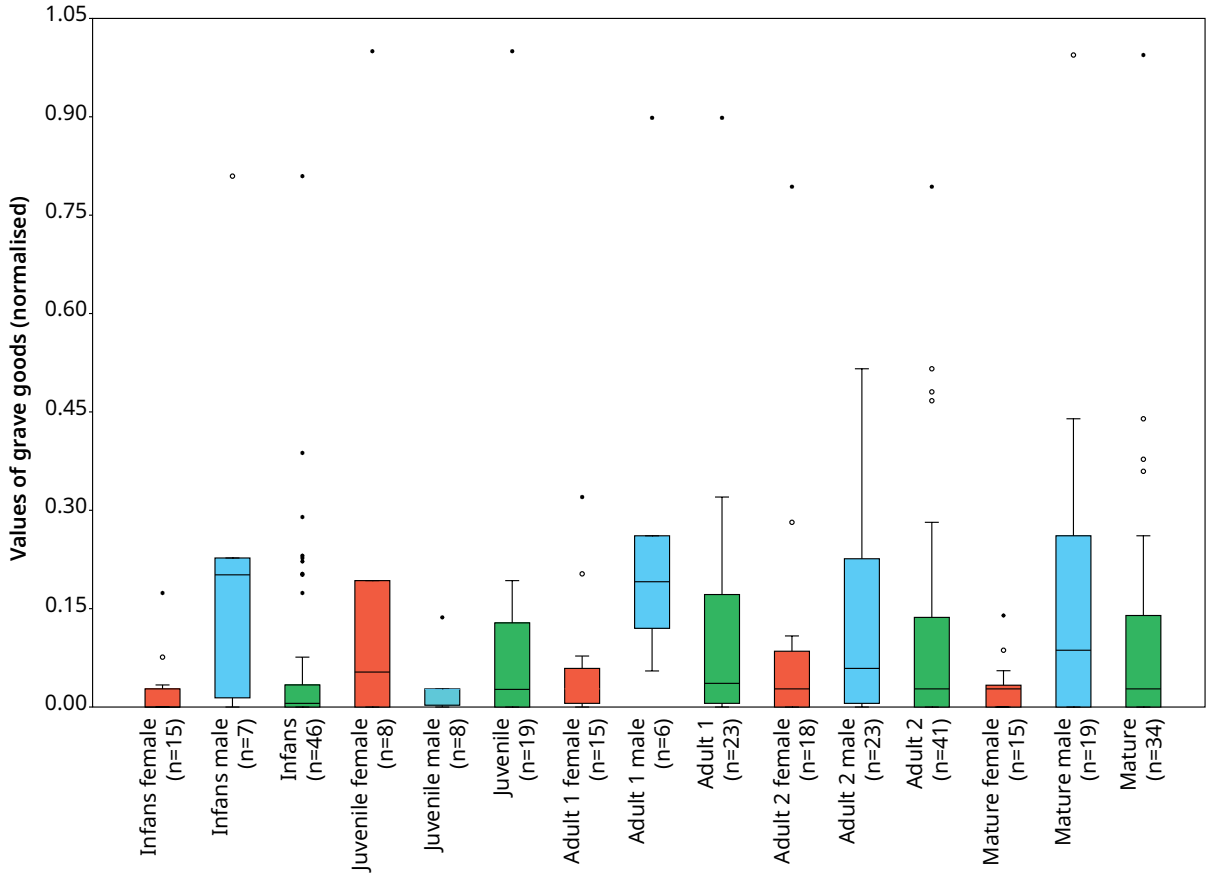


Figure 6. Values of grave goods associated with age and sex categories. Red = female, blue = male, green = total.

highest grave values and for the second category nine burials were identified. In table 3, the burials with high values are listed.

In total, three (probable) female and ten (probable) male burials belong to the burials with the highest grave values of grave goods of the first and second categories. One individual is undetermined with respect to gender. All age groups are represented within the highest categories. However, late-adult and mature burials are overrepresented. The graves show an overall heterogeneous composition of grave goods. Male burials frequently contain combinations including adzes and arrowheads or adzes and deep bowls. Additionally, antler toggle and grinding stone grave goods often appear in male contexts. In one case, a female burial exhibits a grinding stone in combination with a deep bowl. Moreover, two outstanding necklaces of shells are assigned to a juvenile female and to an infans male.

The results of the computed values of grave goods were correlated with the respective genders and ages in order to point out wealth inequalities among age and gender groupings (Fig. 6).

Regarding the total sample, infans demonstrate a lower range of values than juvenile and adult individuals. The differences are significant in comparison to the adult age cohorts (Mann-Whitney pairwise test: infans (total) – adult 1 (total): $p = 0.03617$; infans (total) – adult 2 (total): $p = 0.01887$; infans (total) – mature (total): $p = 0.04167$). Between the adult cohorts, there are no recognisable differences with respect to the values of grave goods.

In comparison to female burials, male burials provide in total higher values of grave goods. With respect to the median, early-adult males provide the highest, ju-

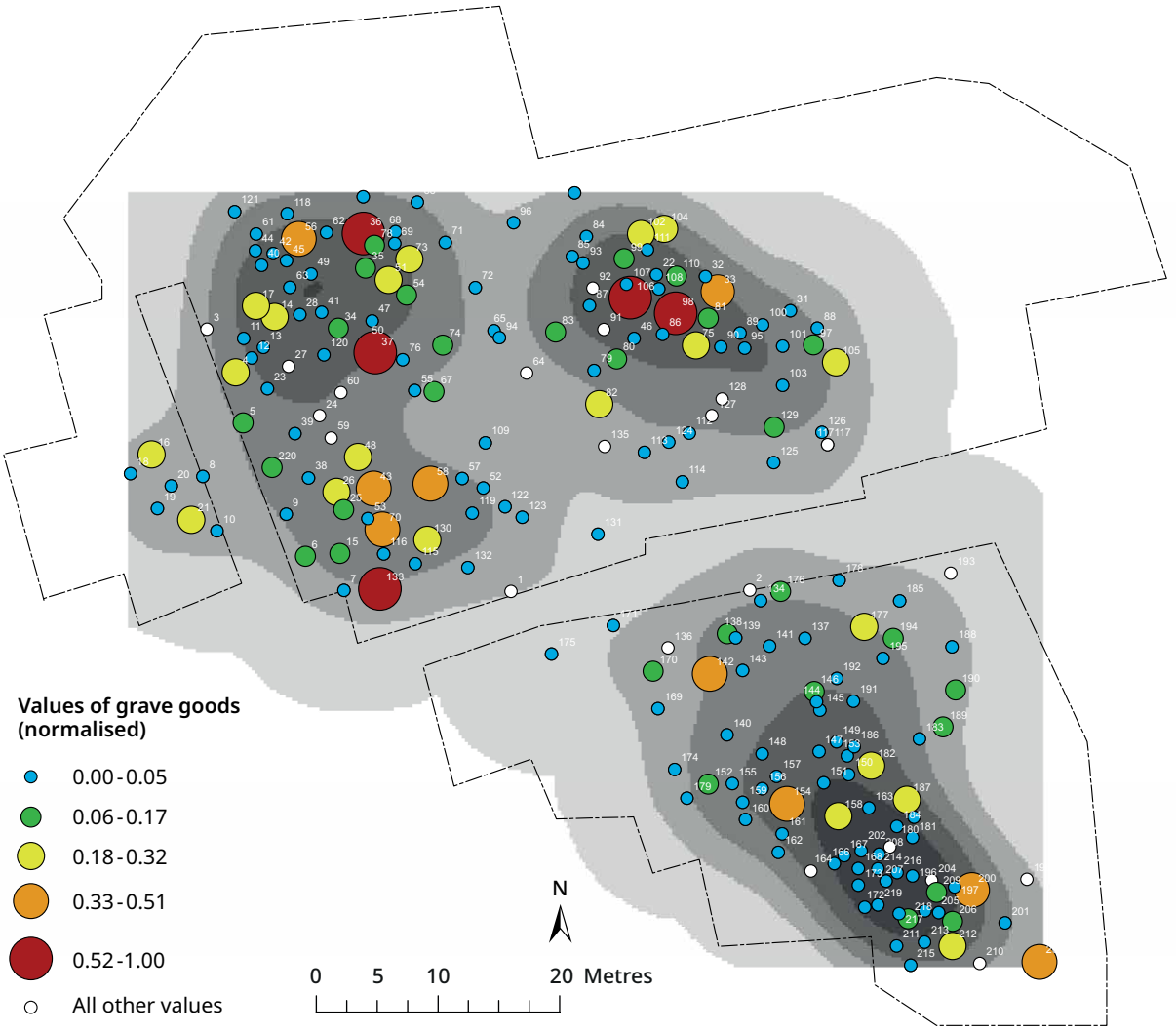


Figure 7. Distribution of the values of grave goods within the cemetery according to categories and in combination with the total kernel density of graves.

venile individuals the lowest median of normalised values of grave goods. The high median within the infans group is conspicuous. The interquartile distances of all age cohorts are relatively large, indicating large differences in the quantity and quality of the distribution of grave goods within these age cohorts. A significant difference among the age cohorts is revealed in the value ranges between the juvenile and the early-adult age cohorts, referring to a rapid increase in the social status at the onset of adulthood (Mann-Whitney pairwise test: juvenile (male) – adult 1 (male): $p = 0.05305$).

Concerning females, juvenile females provide the highest, infans females – in contrast to males – the lowest median of normalised values of grave goods. In comparison to males, juvenile females demonstrate a relatively high range of values of grave goods that reflects potentially high social positions of females at an early age. Moreover, there is a significant difference in grave goods among females between the infans and the early-adult age cohorts (Mann-Whitney pairwise test: infans (female) – adult 1 (female): $p = 0.04759$), which is due to the constant low values within the infans category that practically has no furnishings.

Figure 7 shows the distribution of the values of the grave goods within the burial ground. Burials of the first category are all located in the northwestern and northeastern parts of the cemetery. Burials of the second category are addition-

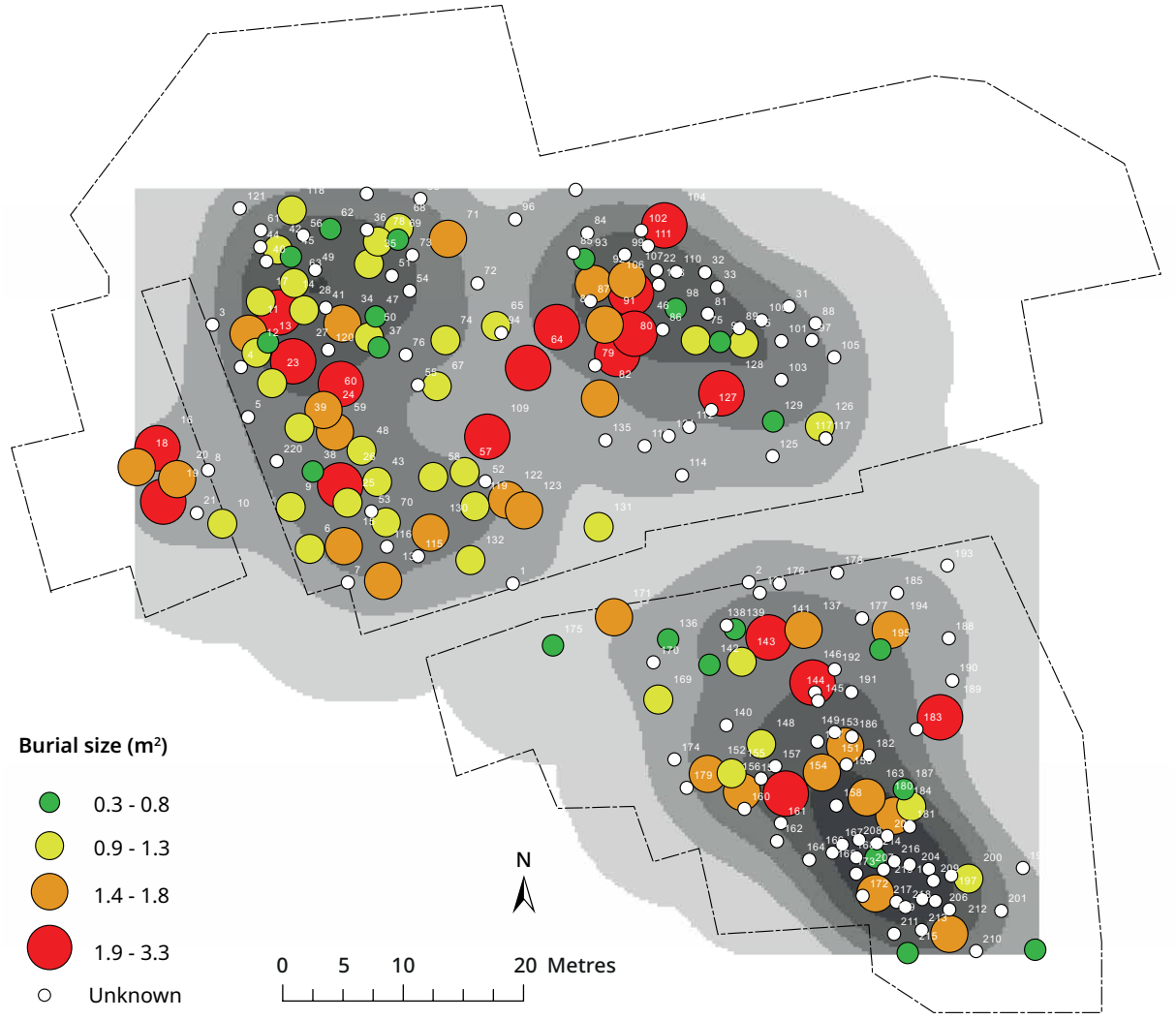


Figure 8. Distribution of burial size categories associated with the kernel density based on burials.

ally situated in the southern area. Burials of both first and second categories lie seldom within areas in which a high density of graves is present.

Burial pit sizes

The differences in the sizes of the burial pits serve as another indication of the unequal treatment of the deceased. Here, it was analysed to what extent the grave sizes correlate with certain age cohorts. In addition, it was examined in which areas of the burial ground the largest burials are located. However, when interpreting the results it must be taken into account that grave pits were partly not recognised due to difficult soil conditions and due to the fact that grave pit boundaries were documented that appear very unlikely with respect to their shape and size (Gerling 2012, 17). Naturally, grave pit volumes would represent a better inequality proxy. However, the burial depth of the buried individuals was not recorded due to insufficient documentation.

Figure 8 clearly shows that the largest burials, marked in red, are located at the edges of larger burial clusters. Graves without a visible burial pit are located within

Grave no.	Burial size (m²)	Age	Gender	Grave goods
60	3.3	?	?	Ceramic sherds
146	2.8	Adult 2	Female	Ceramic sherds, deep bowl
109	2.6	Adult 1	Female	Ceramic sherds, deep bowl, bone disc (lost)
128	2.6	Mature	Male	Modern robbery
80	2.5	Mature	Male	Ceramic sherds, adze
154	2.5	Mature	Male	Ceramic sherds, silex blade, adze, shell, pebble stones
104	2.4	Mature	Male?	Silex blades
106	2.4	Mature	Male	Bone arrowheads, silex blade, grounding stone, seashell, raddle
26	2.3	Adult	Male	Adze, silex arrowheads, pebble stones
16	2.2	Adult 2	Male	Adze, bone and silex arrowheads, silex blade
19	2.1	Mature	Female	?
46	2.1	Mature	Female	?
189	2.1	Juvenile	Male	Bone arrowheads, silex blade
83	2.1	?	?	?
14	2.1	Adult 2	Male	Bone and silex arrowheads, silex blades
141	2.1	Adult 2	Male	Miniature vessel, pebble stones

Table 4. Burials of the first category regarding burial sizes, including information on grave no., burial size (m²), age, gender and grave goods.

the central zones of the respective burial clusters. The largest number of burial pits that belong to the first category are located in the northern part of the cemetery.

In table 4, burials with the largest grave pits, including graves 60, 80, 109, 128, 146, 154, 104, 106, 26, 16, 19, 46, 189, 83, 14 and 141, are listed.

Numerous entries are conspicuous in this list. First, it contains a predominant number of male, mature and late-adult individuals, among which one burial is robbed. If grave goods are documented, large grave pits appear particularly with interred males, including a combination of bone or silex arrowheads and silex blades. Furthermore, adzes and pebbles are relatively often found in the largest grave pits. Among males, graves 154 and 106 stand out due to the relatively high number of different grave goods (cf. Gerling 2012, 117). In comparison, there are large grave pits that belong to four individuals representing adult and mature female individuals. Burials 109 and 146 include deep bowls. Burial 109 also includes a bone disc, which is believed to be lost. No grave goods have been documented for female burials 19 and 46.

Burials without a visible grave pit, marked with white dots on figure 8, and belonging to the fourth burial pit category, marked with green dots, correlate strongly with subadults, especially with individuals of the infans age cohort.

Naturally, specific factors, such as age and gender as well as body height, influence the size of burial pits. However, C. Gerling pointed out that many adult individuals were also buried in relatively small grave pits although they are furnished with numerous grave goods (graves 43, 70 and 187). Vice versa, some infans individuals exhibit a relatively large burial pit (*e.g.* grave 95 and 180). Accordingly, bioanthropological prerequisites should not be ignored in this grave size analysis, but they do not

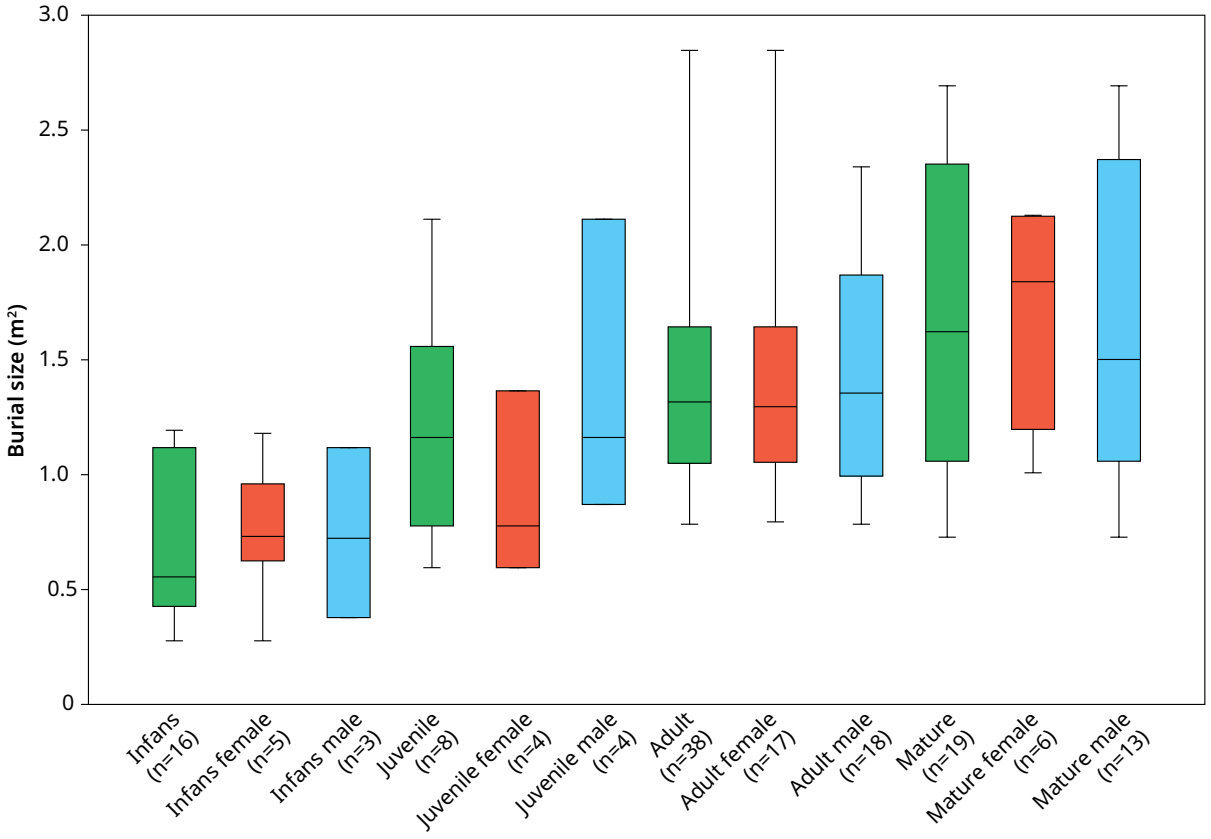


Figure 9. Distribution of burial pit sizes in relation to age cohorts, sexes and the total number of burials.

exclusively influence the grave pit size of buried individuals. Therefore, differences in burial pit sizes also demonstrate differences concerning social positions.

The factor burial pit size was correlated with age cohorts in order to detect inequalities in this context. The boxplot diagram (Fig. 9) clearly shows that an increase in the average grave pit size goes along with an increase in age. The largest grave pits are associated with mature or senile individuals. The high variance within the mature age cohort is conspicuous and can be interpreted as an indication that a high degree of inequality prevailed with regard to the workload of burial construction for this age cohort. Among females, the relationship between advanced age and burial pit size is particularly obvious, although two adult burials (graves 109 and 146) show the largest grave pits. In contrast, the differences between the juvenile, adult and mature cohorts are not as pronounced among males. Accordingly, juvenile males already demonstrate relatively large burial pits. In turn, the difference from juvenile to infans burial sizes is more pronounced among males when compared to that of females. Overall, it is evident that the differences, in particular within adult age cohorts, cannot be attributed solely to biological factors, but were also socially motivated.

Values of grave goods and burial pit sizes

Subsequently, the calculated normalised values of grave goods were added to the normalised grave pit size values in order to receive an overall burial value (Tab. 5). In this table, the burial goods belong to the burials that have the highest burial values, combining burial goods and burial size (m^2):

Grave no.	Values of grave goods + Burial pit sizes (normalised)	Age	Sex	Grave goods
106	1.82	Mature	Male	Seashell, bone arrowhead, silex blade, grounding stone, red chalk
133	1.55	Adult 1	Male	Antler toggle, vessels, silex arrowheads, adze
154	1.32	Mature	Male	Seashell, adze, vessels, silex blade, pebble stone
36	1.21	Juvenile	Female	Shell necklace, vessels
26	1.11	Adult	Male	Adze, silex arrowheads, pebble stone
146	1.09	Adult 2	Female	Vessel
104	1.09	Mature	Male?	Silex blades
37	1.07	Adult 2	Female	Bone pins, seashell
98	1.06	Infans 1	Male	Adze, bone arrowhead, silex blade, graphite bead, shell necklace
16	1.01	Adult 2	Male	Adze, bone and silex arrowheads, silex blade
14	1.01	Adult 2	Male	Bone and silex arrowheads, silex blades
80	0.99	Mature	Male	Adze
109	0.98	Adult 1	Female	Adze, vessel, bone disc
43	0.91	Adult 2	Male	Adze, vessel, silex arrowheads, grounding stone

Table 5. Summarised and normalised values of grave goods and normalised burial sizes with additional information concerning age, sex and grave goods.

Regarding males, mature and late-adult individuals are predominantly included among the burials that show the highest combined values. Only one presumable male child has a very high burial value due to the presence of a snail shell chain (grave 98). The outstanding male burials often show grave goods consisting of adzes, arrowheads, seashells, and silex blades in combination with further grave goods.

Only four women demonstrate high burial values. Among them are one juvenile, two late-adults and one early-adult individual. In contrast to males, the composition of the grave goods varies more among females. Only vessels seem to be constant grave goods that are included in three of the four listed graves. The female with the highest burial value (grave 36, Fig. 10) shows a conspicuous necklace with snail shells.

Only burials 106 (Fig. 11) and 154 belong both to the burials with the highest grave goods and grave size values. Each of these burials includes a mature male interment and a heterogeneous grave good assemblage, whereby seashells are part of both graves. Burial 106 is located at the centre of the northeastern group of graves, whereas burial 154 is located within the southern cluster of graves. In contrast to the richly furnished burials, poorly furnished burials that include no burial goods were excavated both for females and males (Fig. 12; 13).

Values of grave goods and burial pit sizes were correlated (Fig. 14). As a result, positive correlations both with the total sample as well as with the male sample are revealed. Regarding the sample composition, infans burials were excluded in this analysis. For the total sample, a small correlation can be observed (Linear r (Pearson) = 0.15227 ($p = 0.18915$), whereas for males a moderate cor-

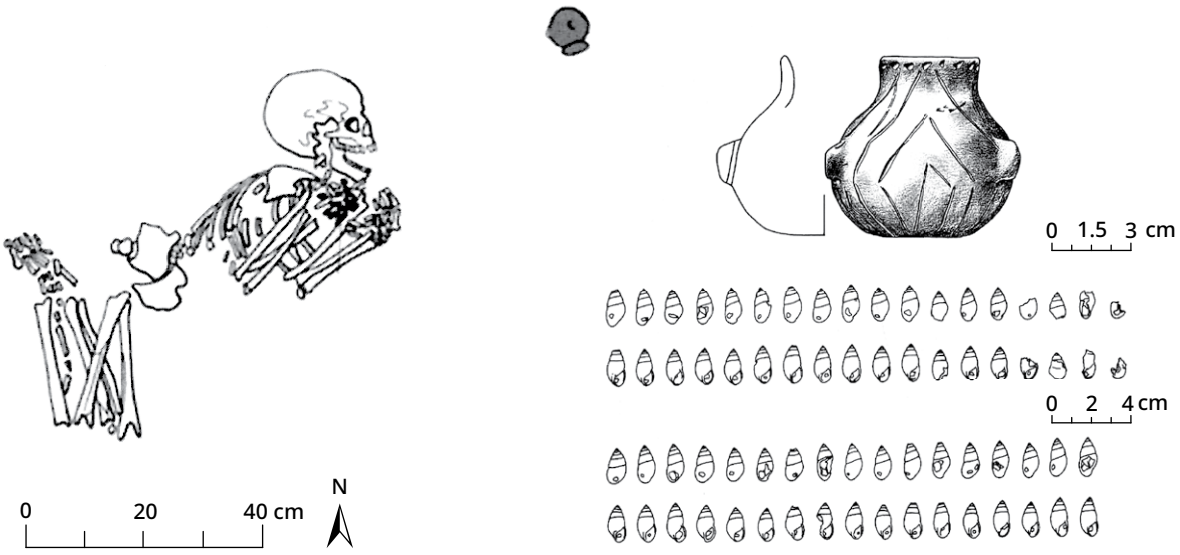


Figure 10. Female burial 36 (cf. Tab. 5) with the highest value regarding the combination of normalised values of grave goods and burial pit size (after Gerling 2012, 201; 235).

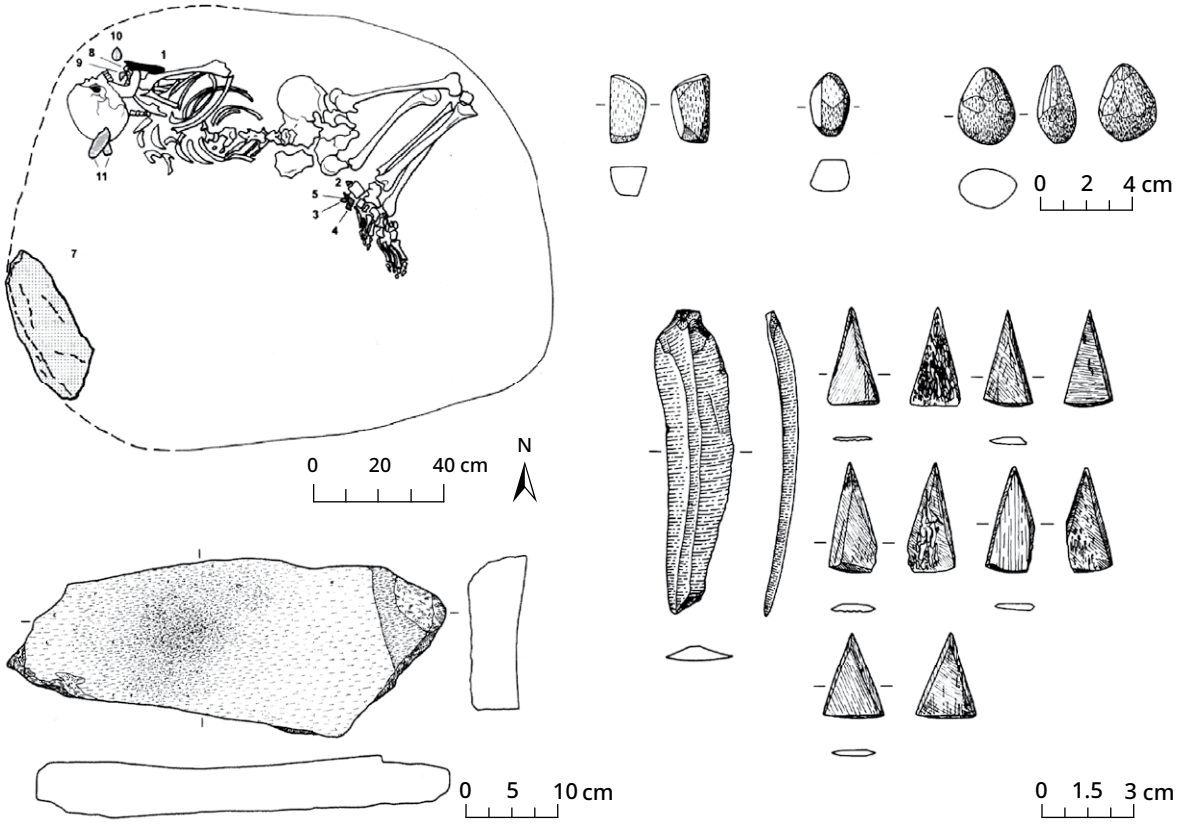


Figure 11. Male burial 106 (cf. Tab. 5) with the highest value regarding the combination of normalised values of grave goods and burial pit size (after Gerling 2012, 212; 248).

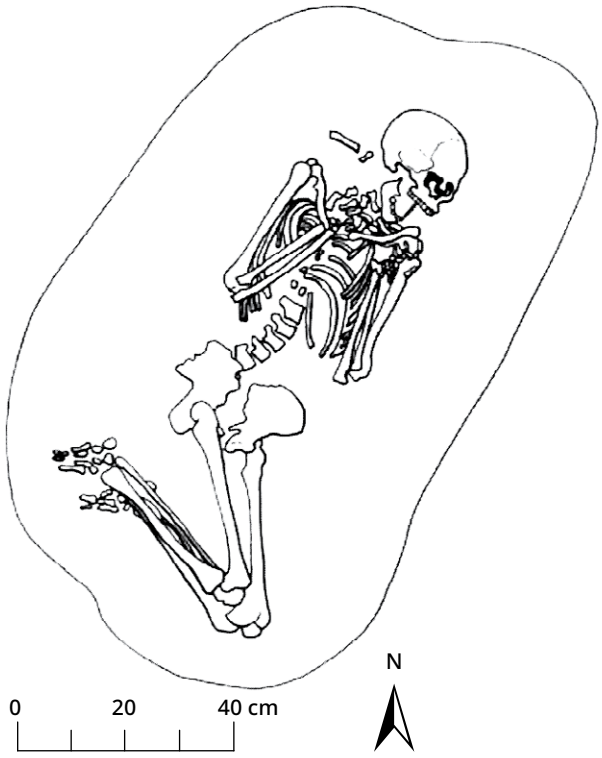


Figure 12. Female burial 119 (adult 2) belongs to the graves with the lowest value (after Gerling 2012, 214).

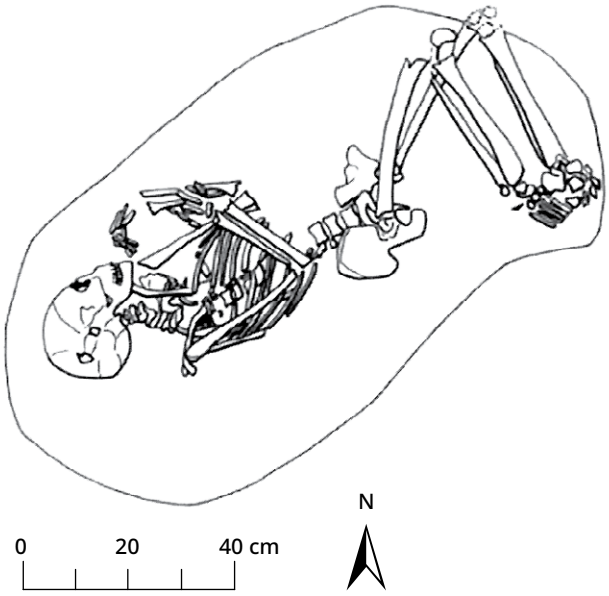


Figure 13. Male burial 38 (mature) belongs to the graves with the lowest value (after Gerling 2012, 202).

relation can be found (Linear r (Pearson) = 0.31513 (p = 0.053963). In contrast to males, females demonstrate, however, a small negative correlation (Linear r (Pearson) = -0.26356 (p = 0.16713). Overall, females show lower values of grave goods and smaller grave pit sizes. Only four burials have grave pits that are larger than 2 m^2. Among males, nine burials exhibit such large grave pits. To the burials that have both high values of grave goods and high burial pit sizes belong, among females, late-adult burial 146, which is furnished with a deep bowl and proba-

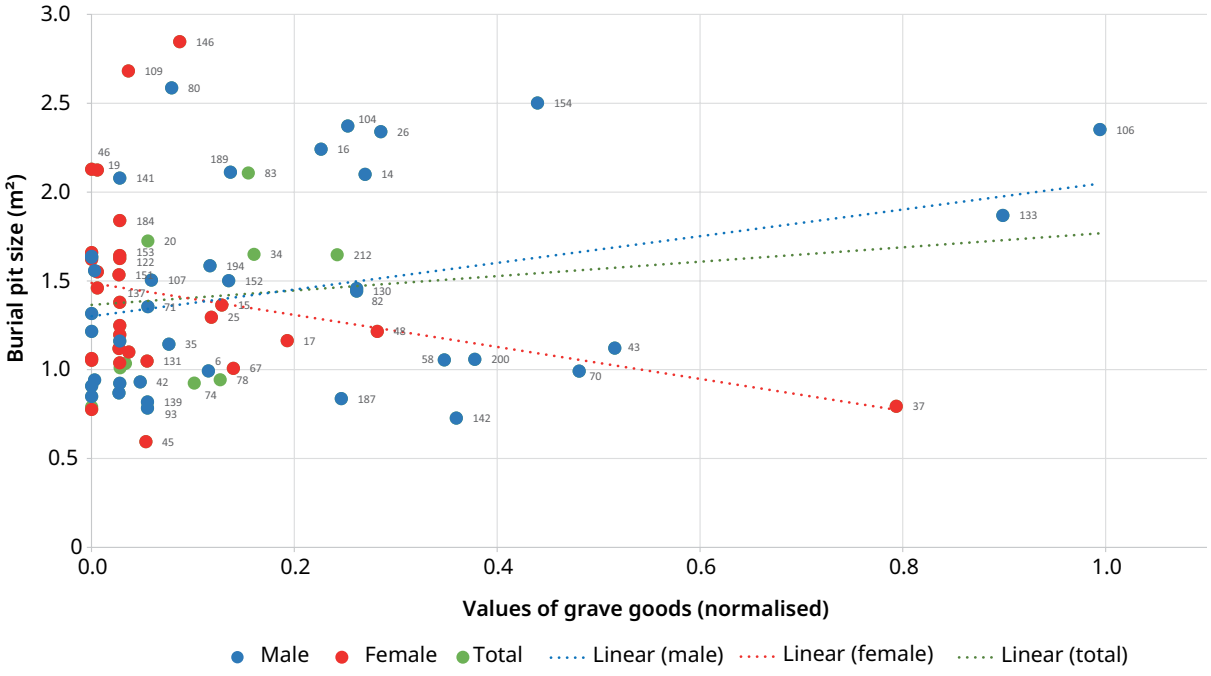


Figure 14 (above). Correlation of normalised values of grave goods and grave sizes (m²) according to sexes. Also depicted are linear tendency lines.

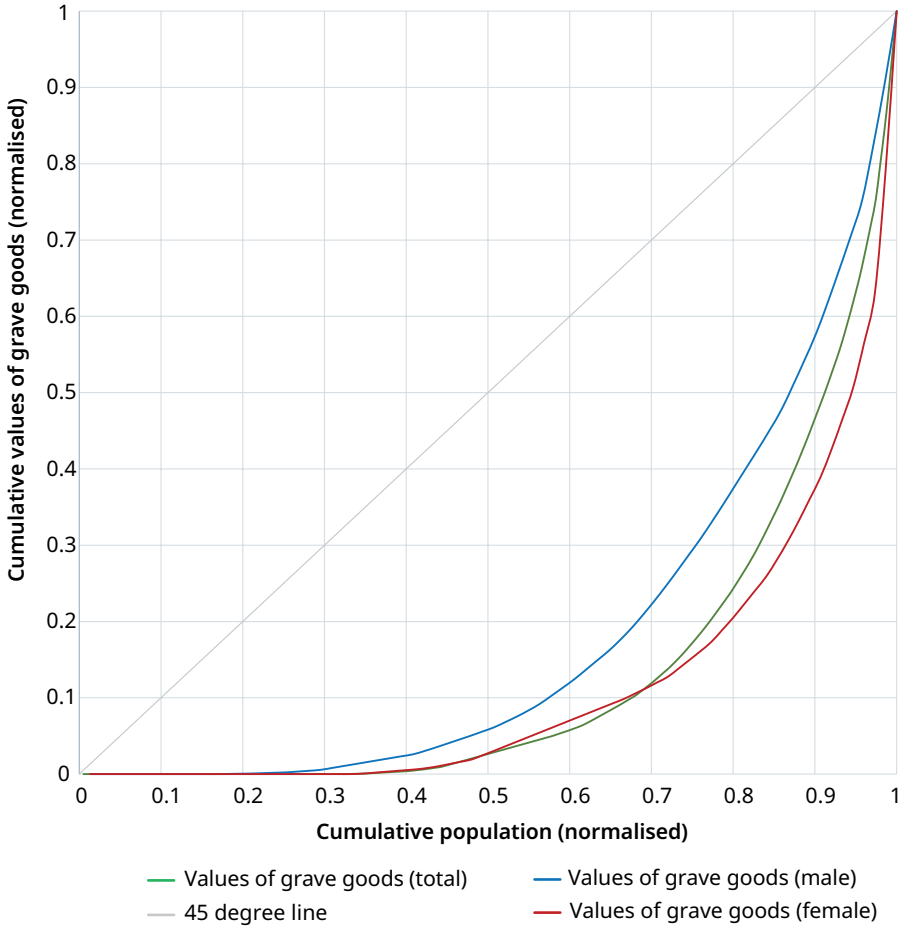


Figure 15. Distribution of values of grave goods displayed as Lorenz curves with regard to the total number of individuals, females and males.

bly with further vessels, and among males, burials 14, 16, 26, 104, 154 and 106. These graves consist almost exclusively of late-adult and mature individuals (see Tab. 5). Arrowheads and seashells are included as characteristic burial goods of these burials.

Lorenz curves and Gini indices

In the following, the distribution of values of grave goods is calculated and presented as Gini indices with respect to the total population sample, the female sample, and the male sample. As a result, the male Lorenz curve is dominant in comparison to the Lorenz curves of females and it is located closer to the equal 45-degree line (Fig. 15). As a consequence, a so-called Lorenz dominance is provided. Thus, males reveal a lower inequality index in comparison to that of females. The calculation of the Gini index for the total distribution of values of grave goods resulted in a total value of 0.74 for Schwetzingen. A calculation for females yielded a value of 0.77 and for males a value of 0.64. Therefore, the Gini index and thus the inequality distribution of grave goods is higher among females than males. The reason for the higher inequality distribution here is the higher number of burials without grave goods associated with predominately infans burials among females.

Distance to the next burial

In the following, the closest distance of the respective burials to the next neighbouring burial will be demonstrated in order to reveal indications of social differences between the buried persons based on spatial burial ground analyses. The question arises whether burials that are located relatively separate have a special position within the cemetery. Concerning the distance analysis, the aspect of body height and burial pit size differences between adults and subadults must also be taken into account.

With regard to the relationship between the age at death of the buried and the average distance to the nearest burial, the following results have emerged. The boxplot diagram (Fig. 16) clearly shows that subadults were placed much closer to the nearest adjacent burial, which may be explained by family ties and also by their smaller burial pit sizes. In contrast, adult individuals were documented somewhat further away from the next adjacent burial. In terms of the total value and median (green boxplots), late-adult and mature individuals exhibit the highest distance to the nearest adjacent burial.

With one exception, the differences between most of the age cohorts are not significant. However, the Mann-Whitney pairwise test shows that graves of late-adult individuals demonstrate a significantly longer distance to the closest neighbouring grave compared to graves that belong to the juvenile age cohort (late-adult – juvenile: $p = 0.04539$).

Furthermore, the distance to the next adjacent burial is analysed in terms of gender and age. No significant differences could be found among both females and males. In the case of females, the median of the infans individuals shows the highest distance to the next burial. Moreover, a high variance among the early-adult females is evident. In addition, an early-adult female represents the burial with the highest distance to next burial. Regarding males, early-adult individuals were buried, in relation to the median, at the greatest distance from the next

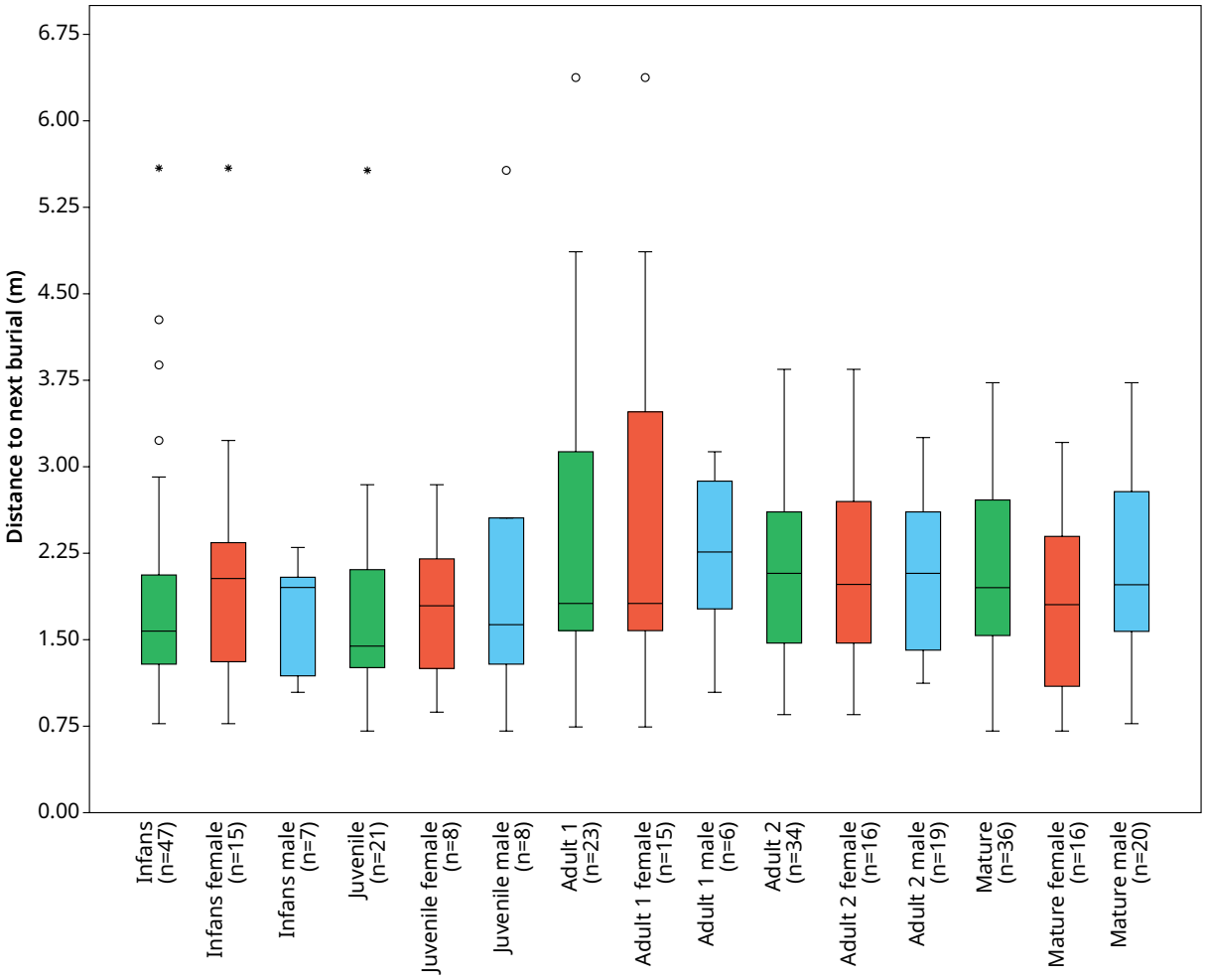


Figure 16. Distance ranges to the next burial according to the total number of burials, genders and age cohorts.

burial. It is also noticeable that mature male graves tend to show a much longer distance to the next adjacent burial in comparison to that of mature females.

As a further step, the distance to the next adjacent burial was correlated with the values of grave goods, on the one hand, and with the size of the grave pits on the other (Fig. 17). In this context, infans burials were excluded, as these burials are assumed to be too greatly dependent on the grave pit size.

Graves 96, 131, 132, 171 and 178 belong to the adult burials that show the largest distance to the next adjacent burial. None of these burials stands out with high values for grave goods. Burials 131 and 171 probably include early-adult females, whereas burial 96 includes a juvenile male. No anthropological data is available regarding the other mentioned burials. As a result, there is no correlation between the values of grave goods and the distance to the next burial (Linear r (Pearson) = -0.07467; p = 0.36218).

Similarly, there is no correlation (Linear r (Pearson) = 0.040213; p = 0.71153) with regard to the size of the grave pits. Furthermore, in this case, if data is available, burials that are located relatively distant to the next burial (graves 131, 132 and 171) do not reveal a significantly large pit size. Accordingly, it cannot be assumed that individuals, who held a high position or were ascribed a high position by their bereaved, were buried spatially separate from the remaining members of the buried community.

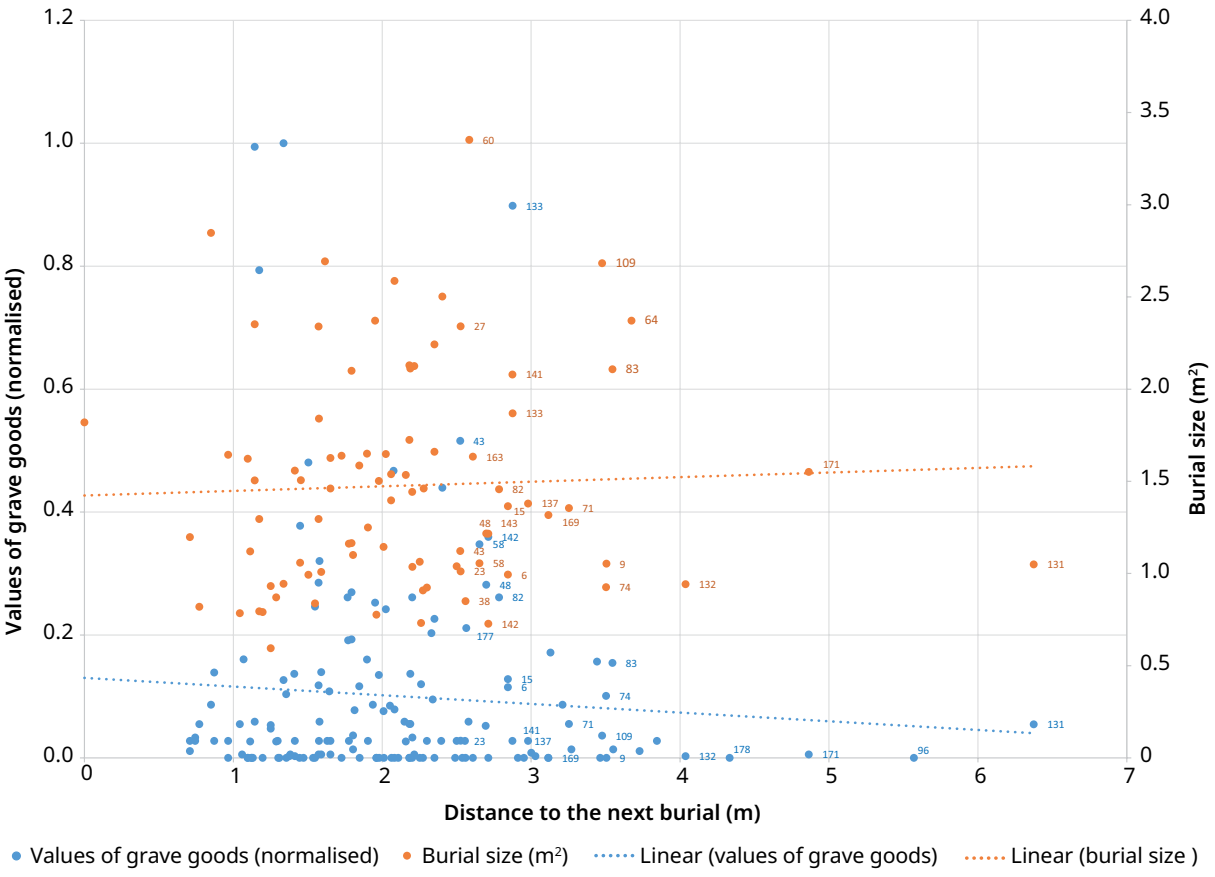


Figure 17 (above). Linear regressions between burial sizes/values of grave goods (both y-axis) and distances to the next burial (x-axis).

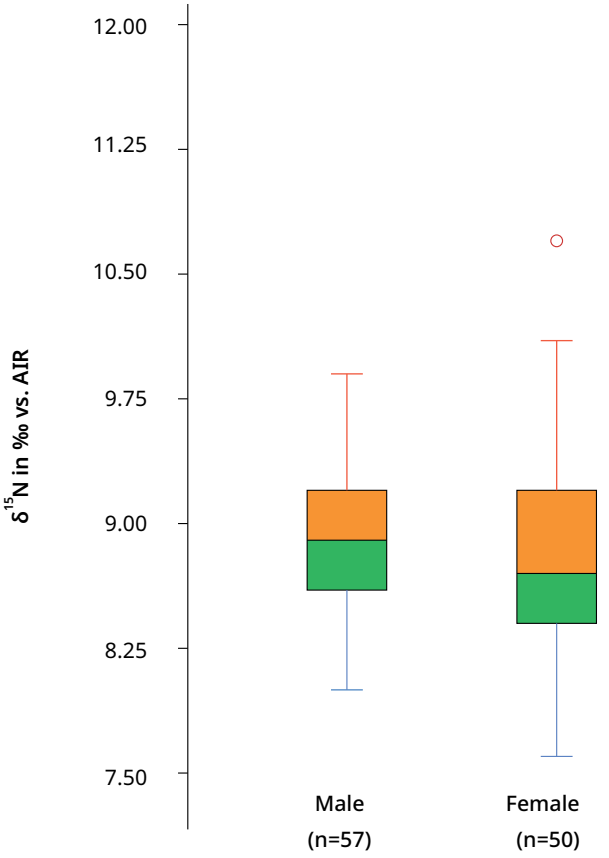


Figure 18. Nitrogen values according to sexes and divided into value ranges.

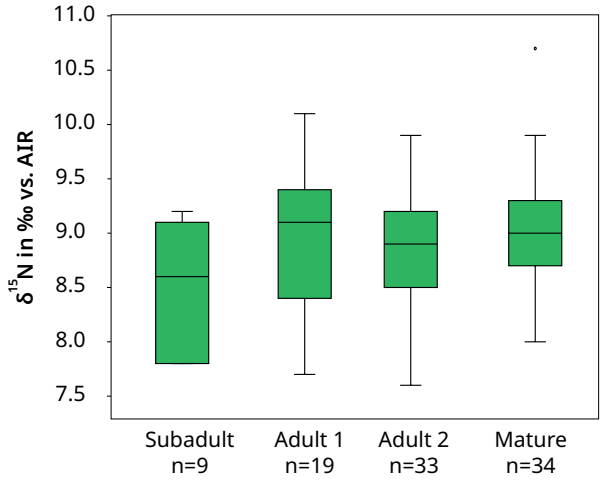
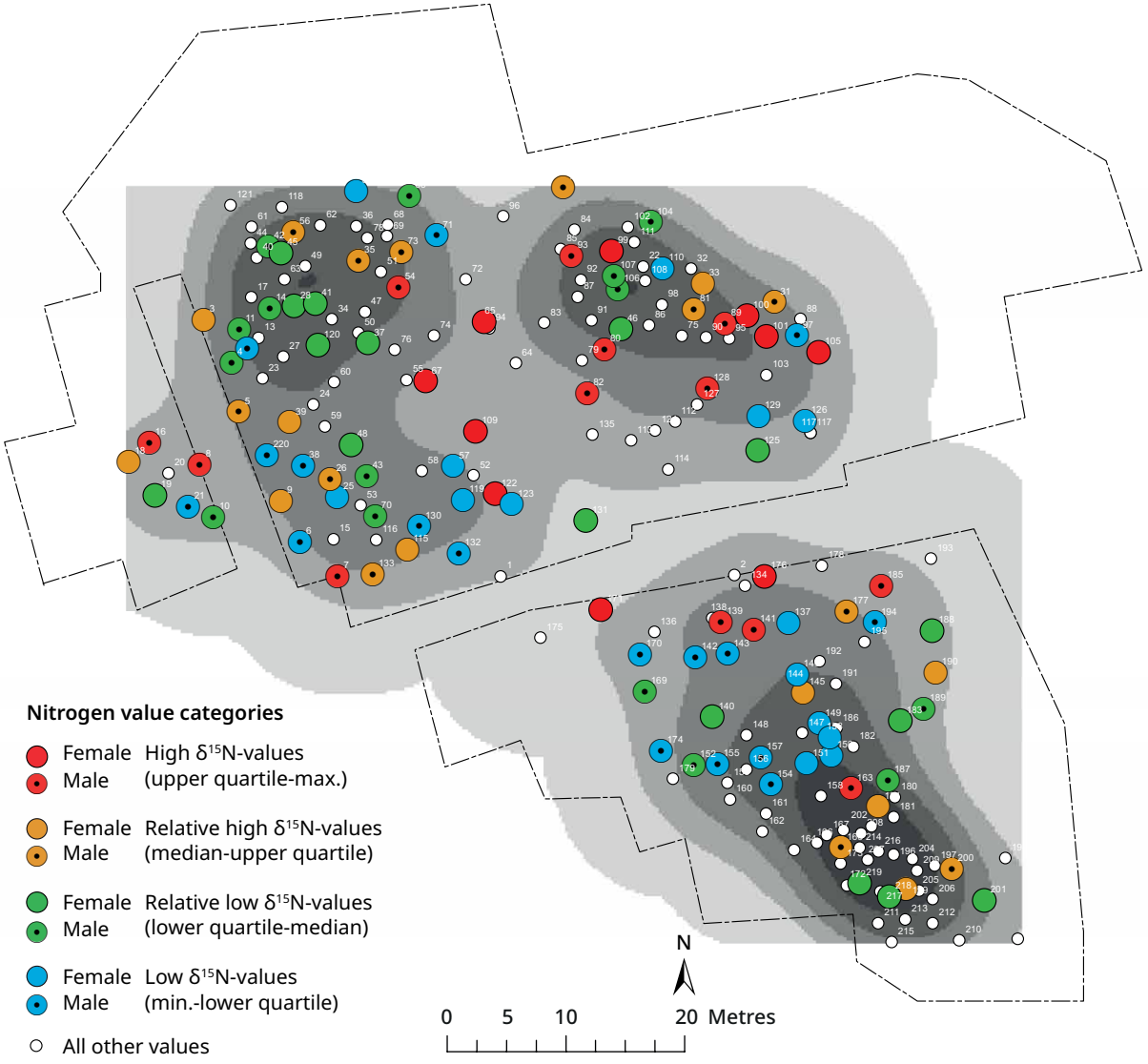


Figure 19. Nitrogen values ($\delta^{15}N$) according to age cohorts.

Figure 20 (below). Distribution of nitrogen ratios within the burial ground. Value ranges are divided into four quartiles.



Diet and status

A further aspect that was analysed in relation to social inequalities concerns the diet of the interred individuals. In order to emphasise differences in access to high- or low-quality nutrition, which also provides information concerning social inequality, 109 individuals were sampled for $\delta^{13}C$ and $\delta^{15}N$ collagen ratios, including 50 females, 57 males, and 2 undetermined individuals. The samples were mainly taken from ribs. As a result, the sampled individuals consumed, in general, similar diets in the form of an omnivore C3 diet (Bentley *et al.* 2013, 281).

No evidence was provided linking differences in diet between females and males. What is conspicuous, however, is that females show an overall wider range of $\delta^{15}N$ values than males, speaking for a larger heterogeneity concerning the nutrition composition (Fig. 18).

R. A. Bentley and colleagues (2013, 280) did not detect any differences between age cohorts. However, they did not make differentiations within adult age cohorts. As a result, the boxplot graph shows that there are discrepancies between the value ranges of subadult individuals and adult age cohorts as well as differences within adult age cohorts (Fig. 19). The early-adult age cohort shows the highest median value. Furthermore, the Mann-Whitney pairwise test shows that the difference between the subadult individuals (infans, juveniles) and the mature age cohort is significant ($p = 0.02042$), which points out that mature individuals had better access to an animal-based nutrition.

Numerous isotope samples have been collected for the Schwetzingen cemetery (Bentley *et al.* 2013). Consequently, a spatial analysis of the obtained values seems to be worthwhile. Figure 20 shows the distribution of nitrogen values within the cemetery, according to the ranked categories 1 to 4. The categories 2 and 3 include the interquartile distance, category 4 the values between the lower quartile and the minimum value, whereas category 1 demonstrates the value range between the upper quartile and the maximum value. Additionally, the outlier value is included in this category.

In principle, the highest $\delta^{15}N$ values, marked in red, were documented in the northern part of the cemetery and at the peripheries of the larger grave group clusters. The lack of high nitrogen values within the southern part of the cemetery, with one exception (grave 163), is evident. Furthermore, there are concentrations for the lowest values. These values are more clustered in the southern and western areas of the cemetery.

The female individuals that belong to the highest category include a remarkably high number of early-adult individuals. In contrast, mature and late-adult individuals predominate among males that have the highest nitrogen values (Tab. 6-7).

With regard to the grave goods, the individuals of the highest nitrogen category show a distinct furnishing compared to the other categories. R. A. Bentley and his colleagues (Bentley *et al.* 2013, 286) have already pointed out that males with adzes tend to have higher nitrogen levels and thus consumed a different diet with a higher proportion of animal proteins. It is also evident that high nitrogen levels also appear among males furnished with silex arrowheads (Fig. 21), for example, in graves 8, 16, 93 and 139. Here, the average nitrogen isotope value $\delta^{15}N$ in adult male individuals with silex arrowheads amounts to 9.24‰. In comparison, the average value for the remaining male adults is 8.90‰. The difference is significant (t: 2.2007; p (same mean): 0.0325).

Although mature individuals show the highest nitrogen values on average, predominantly adult individuals with silex arrowheads demonstrate high nitrogen

Male grave no.	^{15}N	Age	Grave goods
128	9.9	Mature	Modern robbery
16	9.9	Adult 2	Bone arrowhead, silex arrowhead, adze, silex blade
185	9.8	Mature	-
82	9.8	Mature	Antler toggle
54	9.7	Mature	Ceramic sherds, silex blade
163	9.7	Adult 2	Disturbance
8	9.6	Adult	Silex arrowhead
7	9.5	Mature	Disturbance
89	9.5	Adult 2	-
93	9.5	Adult 1	Silex arrowhead, ceramic sherds
80	9.4	Mature	Adze
141	9.4	Adult 2	Bone arrowheads, silex arrowhead
139	9.3	Mature	Silex arrowhead, ceramic sherds

Table 6. Nitrogen values of males and the first category according to grave no. and information about grave goods.

Female grave no.	^{15}N	Age	Grave goods
101	10.7	Mature	Vessel
176	10.1	Adult 1	Bone arrowheads
67	9.7	Mature	Miniature pot, sherds, *metapodia* points
99	9.5	Adult 2	Ceramic vessel, sherds, *spondylus* bead, pebble
171	9.5	Adult 1	Ceramic sherds
109	9.5	Adult 1	Vessel, ceramic sherds, bone disc
100	9.4	Adult 2	-
105	9.4	Adult 1	Grinding stone
65	9.3	Mature	Miniature pot
122	9.3	Adult 1	Bottle-like vessel

Table 7. Nitrogen values of females and the first category according to grave no. and information about grave goods.

values. Grave 133, which is decentrally located in the northwestern part of the cemetery, should be emphasised in this context. It has 10 (!) arrowheads, a rare antler toggle, an adze, a deep bowl and further ceramic fragments of a vessel. Only one other burial (grave 70 with a male-adult individual) in direct neighbourhood shows a similar furnishing including the combination of a silex arrowhead, an adze and an antler toggle. Overall, adzes, antler toggles and silex arrowheads are predominantly

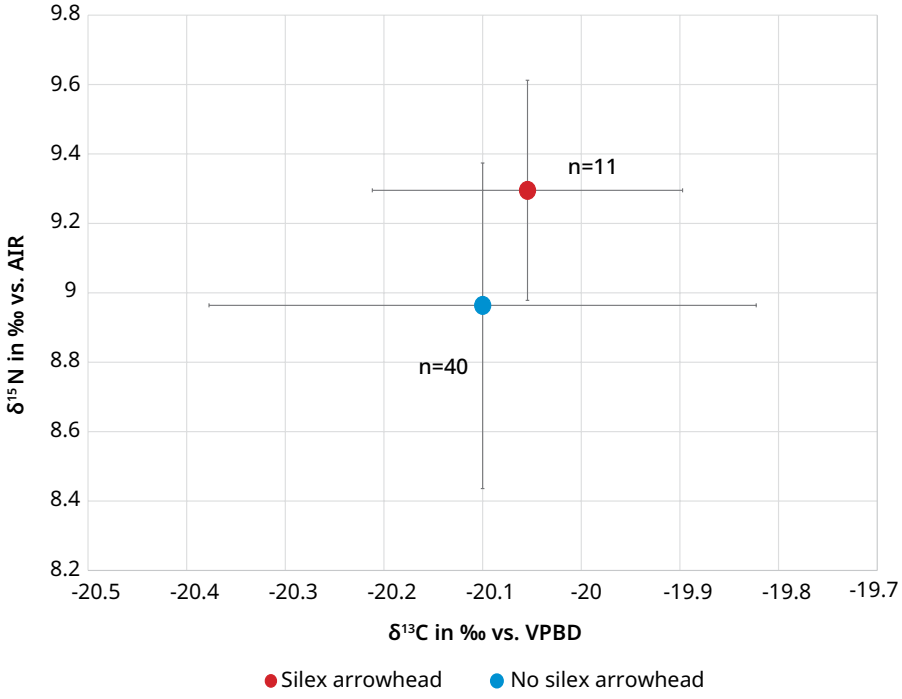
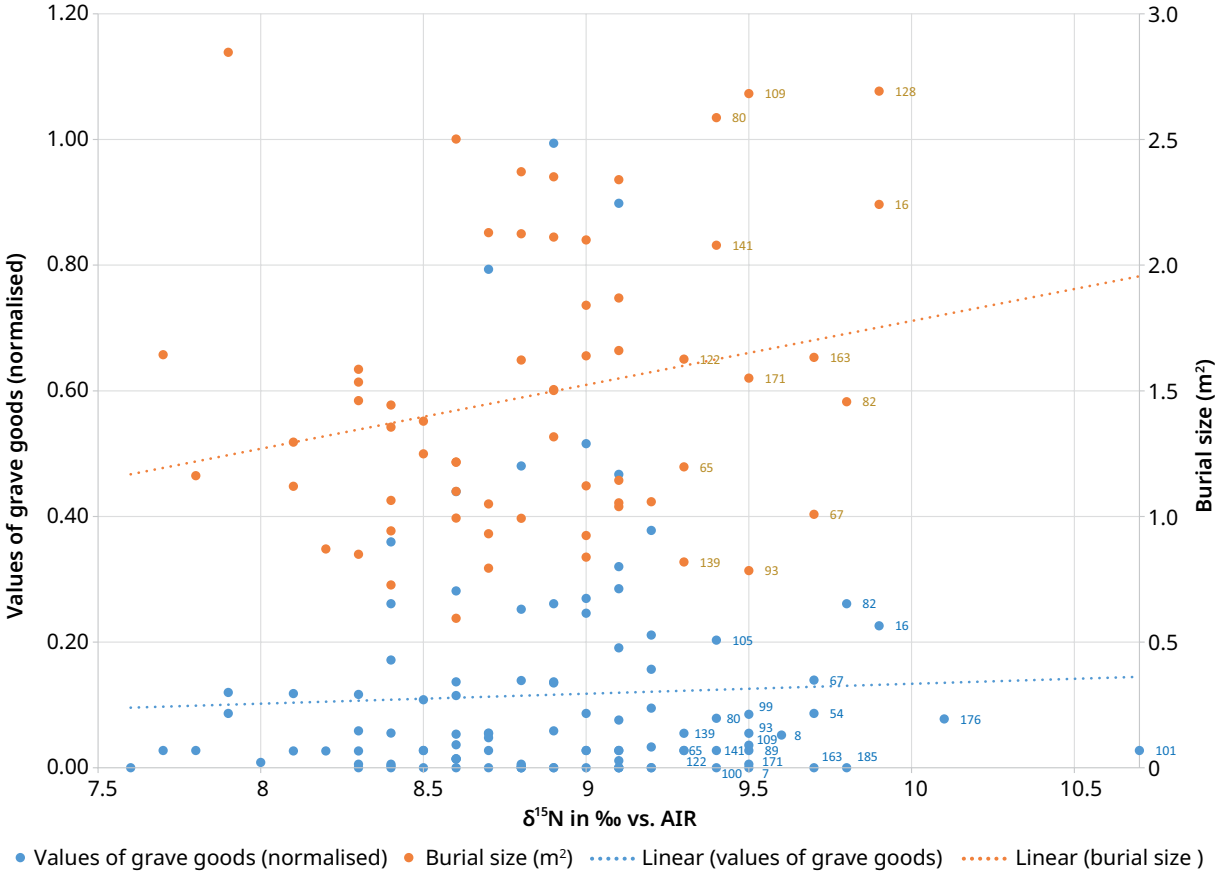


Figure 21 (above). Nitrogen values of males furnished with and without silex arrowheads.

Figure 22 (below). Correlation between $\delta^{15}N$ ratios (x-axis) and values of grave goods/burial sizes (m^2) (both y-axis). Burials with high nitrogen levels are numbered.



located in the northwestern part of the cemetery. This cannot solely be explained by the fact that a relatively high proportion of male adults are buried in this area.

In contrast, burials furnished with bone arrowheads reveal a $\delta^{15}N$ ratio mean of only 8.84‰. This is much lower than male burials furnished with silex arrowheads. Likewise, the different location of flint arrowheads in comparison to bone arrowheads is evident. In contrast to flint arrowheads, arrowheads made of bone are mainly located in the eastern part of the cemetery (Gerling 2012).

When looking at the grave goods of females with high nitrogen ratios, it becomes obvious that they are often associated with ceramic vessels. The senile female (burial 101), who demonstrates the highest $\delta^{15}N$ value (10.7‰), was furnished with a deep bowl and was buried in a southeast-northwest orientation that is unusual at Schwetzingen (Bentley *et al.* 2013, 282). Furthermore, females that are furnished with a miniature vessel exhibit a higher $\delta^{15}N$ mean in comparison to the remaining adult/mature females (9.33‰ *vs.* 8.77‰). However, the difference is not significant (T-Test: p (same mean) = 0.087, n = 46). Moreover, females that are endowed with miniature vessels are located in the northwestern and southeastern areas of the burial ground and not in the northeastern part. Overall, the results indicate that certain grave goods characterise diverse social groupings and positions with unequal access to animal proteins.

With respect to the correlation of the nitrogen ratios with values of grave goods, the results indicate no correlation (Linear r (Pearson): = 0.05, p = 0.60809). With regard to the correlation between the grave pit sizes of adult individuals and the nitrogen isotope values, a small positive correlation can be observed (Linear r (Pearson): 0.22506, p = 0.07863) (Fig. 22). Burials that display large burial pits and high nitrogen values include graves 128, 109, 80, 16 and 141. In these graves, predominantly male late-adult and mature individuals are interred. Only grave 109 includes an early-adult female individual. The burials are relatively well-furnished. This applies, in particular, to the female burial (grave 109 with a deep bowl and a bone disk) and to the male burials 16 (with an adze, a silex arrowhead, and a silex blade) and 80 (with an adze and ceramic sherds). Burial 128, however, was robbed in modern times.

Body height

In addition to the above-mentioned aspects, the extent to which the growth and body height of a buried person correlates with the quality of the grave goods is investigated. It is shown that this is the case with males. The correlation between body height and values of grave goods demonstrates a moderate positive correlation for males (Linear r: 0.3238, p = 0.37229, n = 9) that is demonstrated by the tallest man (grave 133), representing the second richest male burial furnished with an adze and ten flint arrowheads (Gerling 2012). In contrast, females show a small negative correlation (Linear r (Pearson): -0.19976, p = 0.60635, n = 9) at the Early Neolithic site of Schwetzingen.

Hierarchy, heterogeneity and transformation

Furthermore, it will be examined here whether heterogeneous population structures become visible within the burial community, which could indicate different social roles. To do so, the burials are transferred to a correspondence analysis containing information about the grave goods. In order to include

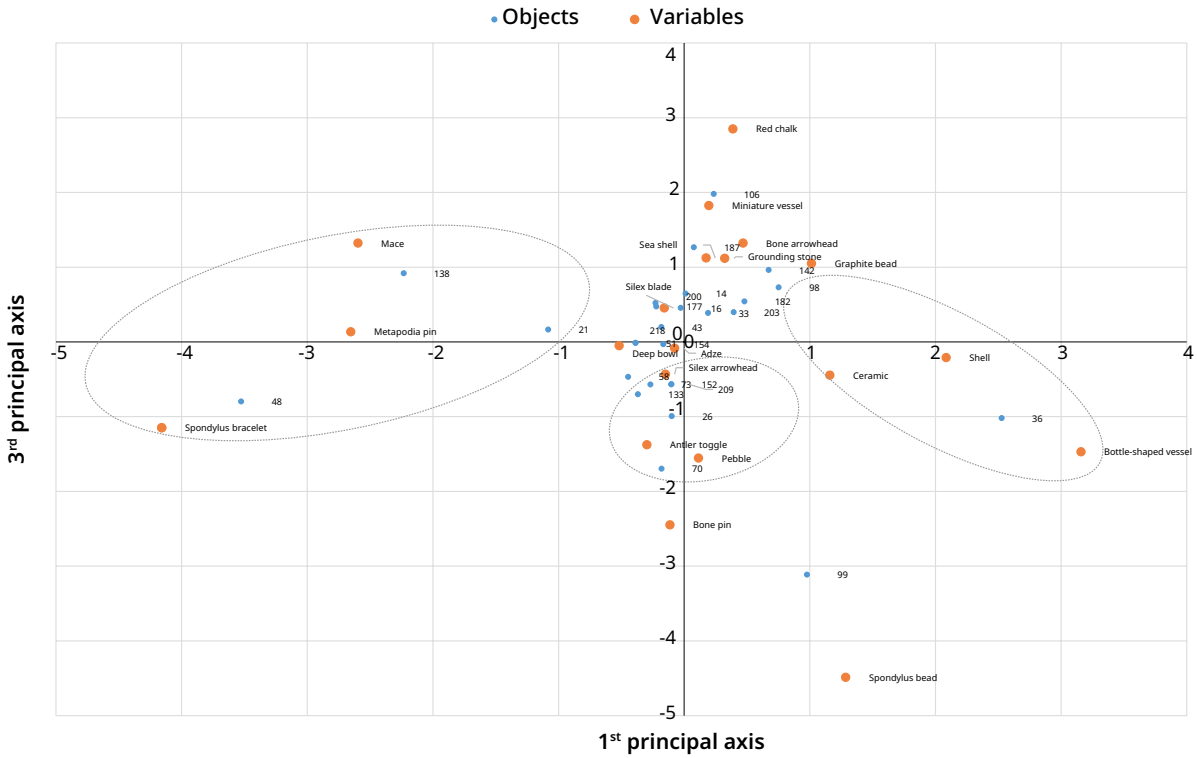


Figure 23. Correspondence analysis (CA) of grave goods (variables) and burials (objects). The CA includes the 1st and 3rd axes. The cumulative explanation in percentage, which is expressed by the first and third axes, equals 25.

outstanding, singular objects, it was sufficient in this context that the variable sum of the analysis amounts to one.

In order to identify differentiable clusters, the analysis concentrates on burials with at least three different burial objects. Accordingly, the result shows clusters amongst better-endowed graves. At the first and third principal axes of the correspondence analysis, the following clusters are particularly evident: In the negative area of the first principal axis, burials with *metapodia* tips are included, which were combined with *spondylus* ornaments or a mace head. These are primarily burials of women. In the positive area of the first principal axis and in the positive area of the third principal axis, a cluster of variables is located that is characterised, in particular, by bone arrowheads. This cluster, also including shells, millstones, red chalkstones, graphite beads and miniature vessels, is exclusively associated with males. A further cluster at the negative area of the third axis is characterised by silex arrowheads, antler toggles and pebbles. Frequently, these grave goods are associated with adzes and deep bowls. This cluster also correlates predominantly with male individuals. It is remarkable that the clusters with bone arrowheads and silex arrowheads exclude each other except in two cases. Two burials include necklaces of snail shells; one is associated with a bottle-shaped vessel. These graves located at the positive range of the first axis represent an additional group of outstanding burials (Fig. 23).

The distribution map of the cemeteries shows the identified clusters in different areas of the cemetery. Regarding male burials, arrowheads made of bones, seashell ornaments and grindstones are mainly located in the eastern part of the cemetery; silex arrowheads and antler toggles are mainly localised in the western part of the burial ground.

Female burials that are furnished with *metapodia* points and *spondylus* ornaments are concentrated in the western side of the cemetery; accordingly, they

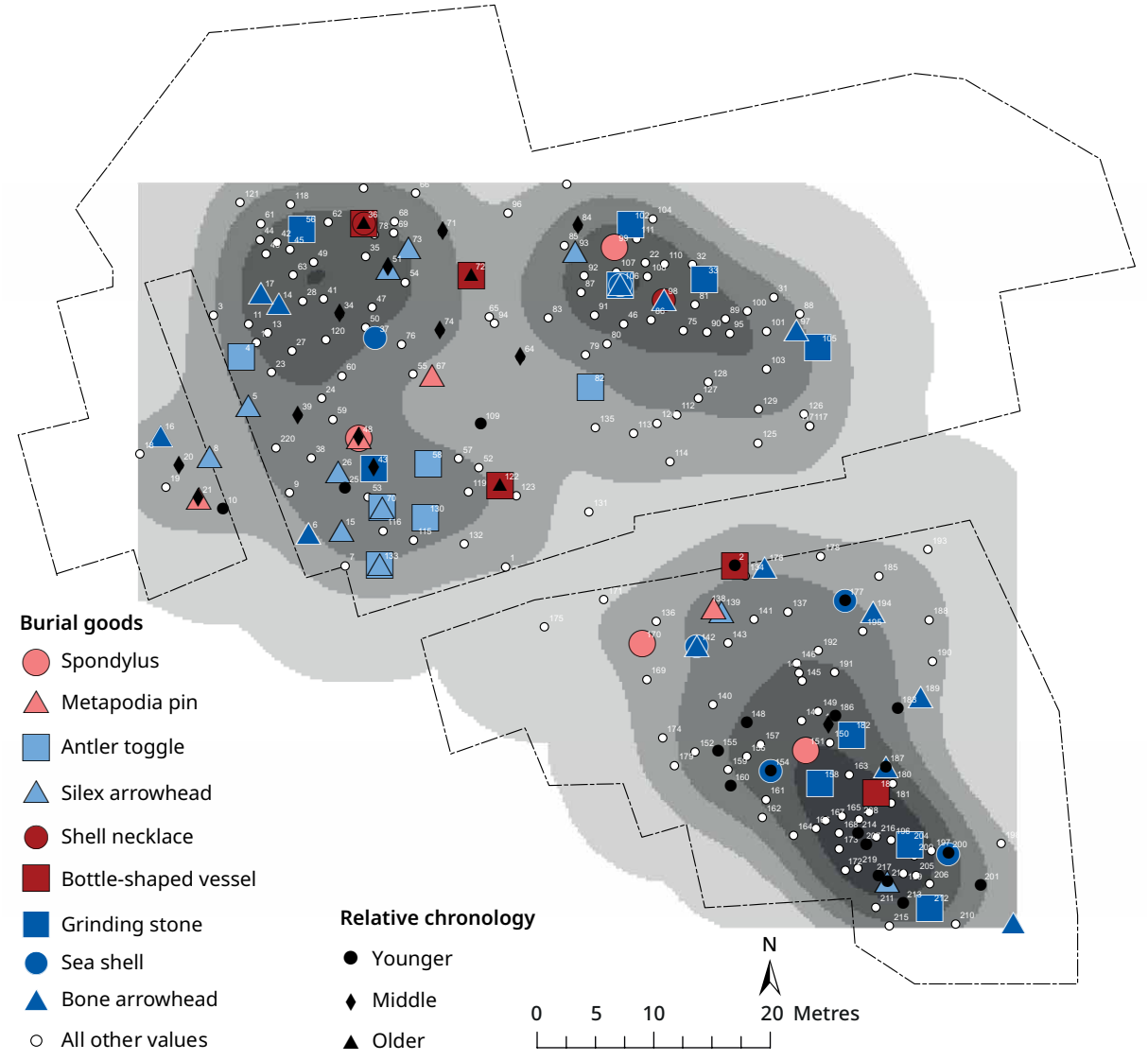


Figure 24. Distribution of objects that are located relatively distant from each other in the correspondence analysis. Also included is a chronological phase based on deep bowl ornaments.

occupy the same space as male burials that are furnished with silex arrowheads and antler toggles. This group of females is separate from female burials that are endowed with bottle-shaped vessels and necklaces of snail shells.

Overall, two heterogeneous groups were identified that could be differentiated based on the assemblages of their grave goods. One group is characterised by antler toggles, silex arrowheads (men), *spondylus* jewellery and *metapodia* points (women). In contrast, another group demonstrates arrowheads made of bone, seashell ornaments, and grinding stones (males) as well as bottle-shaped vessels and necklaces made of snail shell (females) (Fig. 24).

Now the question arises whether we are dealing with an occupancy sequence, thus with a temporal difference between the identified groups, or with two different social associations which express themselves differently in the funeral ritual. C. Gerling (2012, 117) has presented a distribution tendency based on the ceramic motifs, according to which older graves are found mainly in the northwest part of the cemetery – and there predominantly in the southern section – whereas the

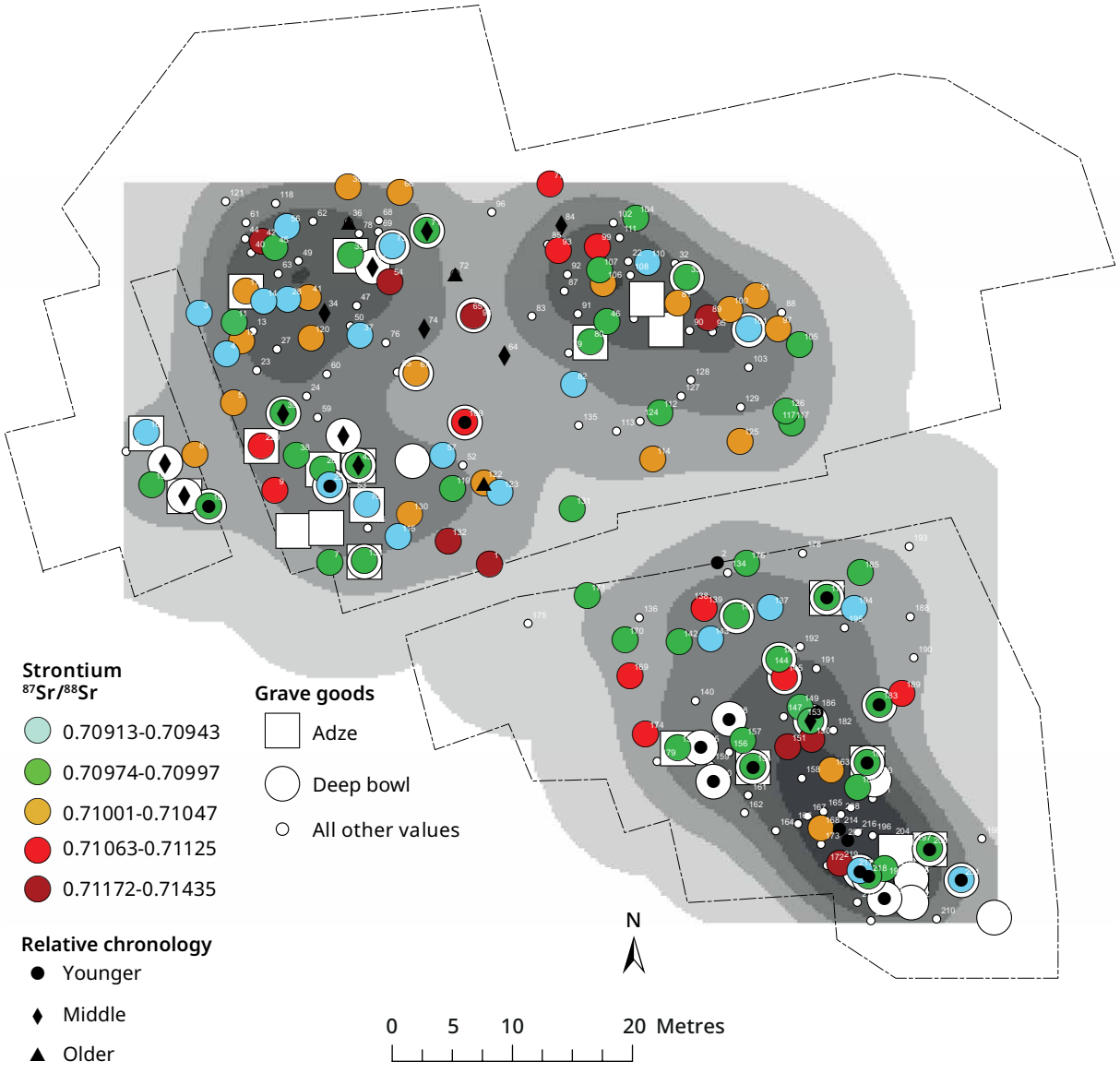


Figure 25. Distribution of strontium isotope categories in combination with certain grave goods and relative chronological findings.

majority of the younger graves are concentrated in the southern part. The explanations in the text by C. Gerling (2012, 116) regarding the occupancy sequence within the burial ground contradict the text of the caption of Gerling's figure 60. Probably, the explanations in the caption are wrong. The chronological position of the northeastern part is left open. Based on the presented distribution map, a similarly young position of the northeastern area seems very probable.

The projection of the relative chronological results of C. Gerling (2012) in figure 24 shows that the bottle-shaped vessels correlate mainly with an older phase, whereas silex arrowheads, *spondylus* ornaments and *metapodia* tips mainly correlate with the middle phase, and arrowheads of bone as well as seashells are associated with a younger phase.

In order to highlight heterogeneous groups with respect to their origin, the use of strontium isotope analysis provides a useful tool. The local strontium ratios of Schwetzingen agree with the prevailing geologies. Regarding the strontium isotope ratios from Schwetzingen, the local ratios were identified between 0.7085

and 0.7113, characterising local lowland loess subsoil. Ratios above this refer to another geological subsoil – rather adjacent red sandstone (*Buntsandstein*) or granitic areas such as the mountains of the Odenwald (Bentley *et al.* 2013).

According to R. A. Bentley *et al.* (2013, 285), nine burials above the 0.7113 ratio are identified as definitely non-local individuals (5 females, 3 males, 1 unsexed), representing about 9 percent of the population. Furthermore, R. A. Bentley and colleagues (2013, 283) emphasised that the strontium mean value among females is significantly higher in comparison to that of males.

Figure 25 shows a distribution map of strontium isotope data. The values are categorised according to natural breaks among the values. The lowest ratios (marked in blue) are located mainly in the northwestern area of the burial ground that also represents the older part. Furthermore, strontium isotope ratios that belong to the middle range (marked in orange) are seldom located in the southern part of the cemetery, in contrast to the relatively high values (marked in red) and, in particular, to the individuals considered as "foreign" (marked in dark red) that do not show any noticeable concentration within the cemetery.

If strontium isotope ratios are correlated with certain burial objects, such as adzes and deep bowls, the results demonstrate significant differences between local and foreign individuals. It is evident that burials with values above 0.7100 and, in particular, burials with values above 0.7113 very seldom include deep bowls, adzes and seashells. Accordingly, only four burials (11%) of the buried persons with high strontium values (>0.7100) have documented deep bowls/miniature vessels as well as only one burial (3%) that includes adzes and only one burial exhibiting a seashell (3%). In contrast, 32% of the buried persons with values below 0.7100 have deep bowls/miniature vessels, whereas 20% of the buried persons includes adzes and 8% seashells (cf. Bentley *et al.* 2013, 287).

Accordingly, the correlation of the strontium isotope values with the values of grave goods shows that among the burials with strontium values higher than 0.710, only one individual reveals a relatively high value of grave goods (>0.2). This includes grave 106, a mature male burial that is furnished with numerous bone arrowheads, a seashell, a grinding stone and red chalkstones. Overall, only burials that have local strontium values demonstrate relatively high values of grave goods above 0.2. This is predominantly the case with male burials that are furnished with adzes, grindstones, seashells and antler toggles, among other things (Fig. 26).

The correlation with nitrogen values provides similar results: It is obvious that no burial with foreign strontium isotope ratios that lie above 0.71 reaches a nitrogen isotope ratio above 9.8‰. Thus, local individuals buried at the cemetery had better access to animal-proteins than foreigners. Graves 16, 82, 101, 176 and 185 belong to the local individuals that demonstrate low strontium isotope ratios. They represent predominantly late-adult and mature males and females. In particular, grave 16 was richly furnished with flint and bone arrowheads and an adze (cf. Tab. 6).

Furthermore, no nitrogen isotope ratio can be detected in the strontium isotope range above 0.71 that lies under 8.4‰. Therefore, the differences and the inequality degree with respect to the furnishings and diet of the local individuals are significantly higher (Fig. 26).

With grave orientation, a further issue is to be addressed, which could be connected with possible hierarchical, heterogeneous or chronological aspects of the burial community. In the projection of the data available from the catalogue, several distribution clusters of certain orientations stand out.

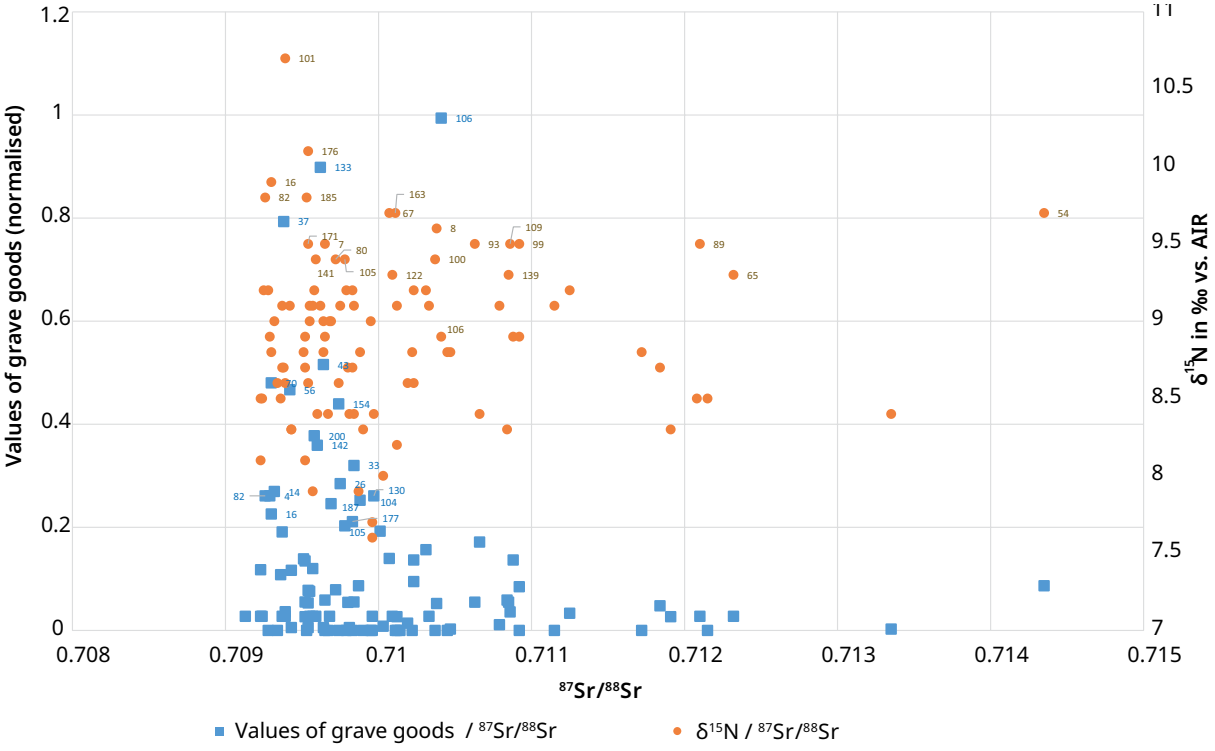


Figure 26. Correlation between $^{87}Sr/^{88}Sr$ (x-axis) and values of grave goods/$\delta^{15}N$ ratios (both y-axis). Numbered are burials that show high values of grave goods and nitrogen isotope ratios.

First, it becomes clear that an orientation with the head of the interred in the northeast and the legs in the southwest is most frequently represented (cf. Gerling 2012, 18). Some orientations show distinct clusters within the cemetery. For example, east-west, west-east, northwest-southeast and southeast-northwest oriented burials are mainly located in the northern area of the cemetery. In contrast, north-south oriented burials are mainly documented in the most southern part of the cemetery. Additionally, together with the orientations, chronological determinations are illustrated. It can be seen that almost all orientations correlate with all phases. However, it is noticeable that north-south oriented graves and east-west oriented burials in the south of the cemetery correlate exclusively with deep bowls of the younger phase (Fig. 27-28).

With regard to the body position of the buried persons, it is conspicuous that the majority of the individuals was buried in a left crouched position. There are only few individuals that were buried on the right side. These individuals are predominantly located in the southern part of both the northwestern and southeastern burial groups. There are also very few individuals with a supine or prone position. They tend to be located at the edge of the cemetery. Individuals that show a supine position are located predominantly in the southwestern area. It is noticeable that within the southeastern part of the cemetery buried individuals that demonstrate the right crouched position are mainly associated with vessels that belong to the younger phase.

From the distribution of the orientations and burial positions in combination with the typo-chronological results of C. Gerling (2012), the following thesis can be postulated: With the younger occupation phase of the cemetery, the most frequent burial orientations (northeast, southwest and northwest) and the left crouched position of the buried individuals are supplemented by further orientations (east and north) and a right crouched position of the buried individuals.

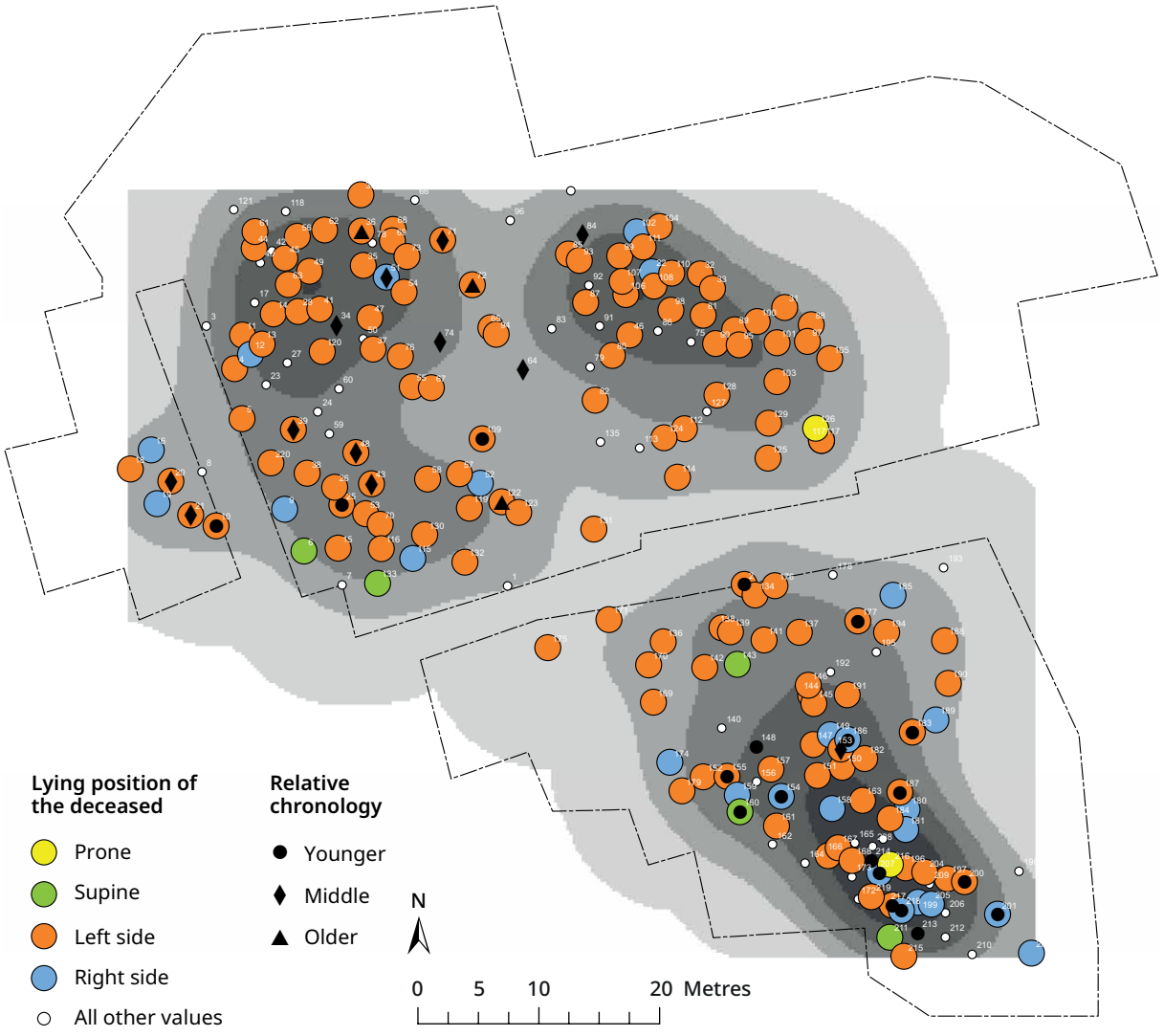


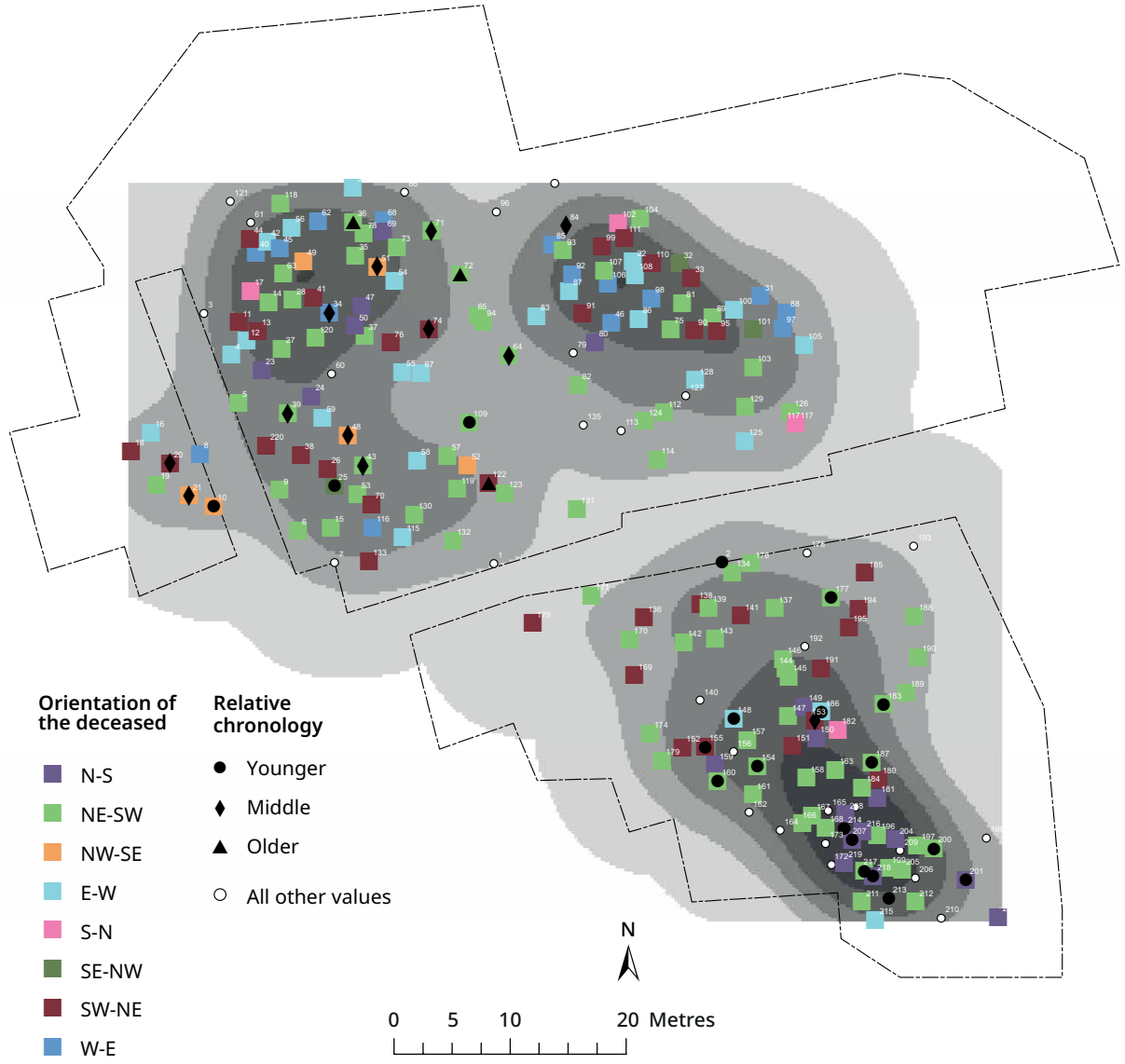
Figure 27. Distribution of burial positions of the individuals in combination with relative chronological findings.

Thus, a sequence of occupation from the northwest to the southeast of the cemetery with a simultaneous spread towards the peripheries of the cemetery can be assumed. If we include the distribution pattern of the grave goods in figure 24, it can also be concluded that silex arrowheads, *spondylus* ornaments, *metapodia* points and antler toggle rather belong to an older phase. In contrast, arrowheads made of bone and seashells predominantly belong to a younger phase.

Summary

The cemetery reveals three clusters of burials. Each cluster demonstrates higher concentrations of burials. The distribution of ages within the burial ground demonstrates that subadults, in particular, are responsible for the high-density concentrations.

Regarding gender distribution, it is noticeable that the concentrations of females and males differ and show no congruent distribution, but reveal gender specific location rules within the burial ground (Fig. 5; 29). Anthropologically de-



termined females or individuals that can be interpreted as females based on archaeological findings were buried predominantly to the east and/or to the south of the anthropologically or archaeologically determined males.

Regarding total values of grave goods, infans demonstrate a lower range of values than juveniles and adult individuals. Among the adult cohorts, there are no recognisable differences with respect to grave furnishings. Males display in total higher values of grave goods. With respect to the median, early-adult males provide the highest and juvenile individuals the lowest median of normalised values of grave goods. The partly well-furnishing within the male infans group expressed by adzes is conspicuous. Concerning females, juvenile females display the highest and infans females the lowest median of normalised values of grave goods. In contrast to males, juvenile females show a relatively high range of values of grave goods, suggesting a possible high social position of females at an earlier age. The Gini indices reveal a higher inequality degree among females in the context of values of grave goods.

Figure 28. Distribution of burial orientations of the individuals in combination with relative chronological findings.

The boxplot diagrams show that the increase of the average grave pit size corresponds with age. Mature or senile individuals exhibit the largest grave pits – both in total and for females and males.

The highest values for grave goods are found in the northwestern and northeastern parts of the cemetery. The biggest burial pit burials are located at the edges of dense burial clusters and are also located in the northern part of the cemetery (Fig. 7-8; 29).

Only burials 106 and 154 belong to the burials with both the highest values of grave goods and burial pit sizes. Each of these burials is associated with mature males that include diverse grave goods consisting of weapons and seashells, which are included in both graves.

In total, subadults were placed much closer to the next adjacent burial, which may also be explained by family ties. In contrast, the oldest individuals demonstrate the longest distances to the next burials. Regarding gender, no significant differences can be found among both females and males.

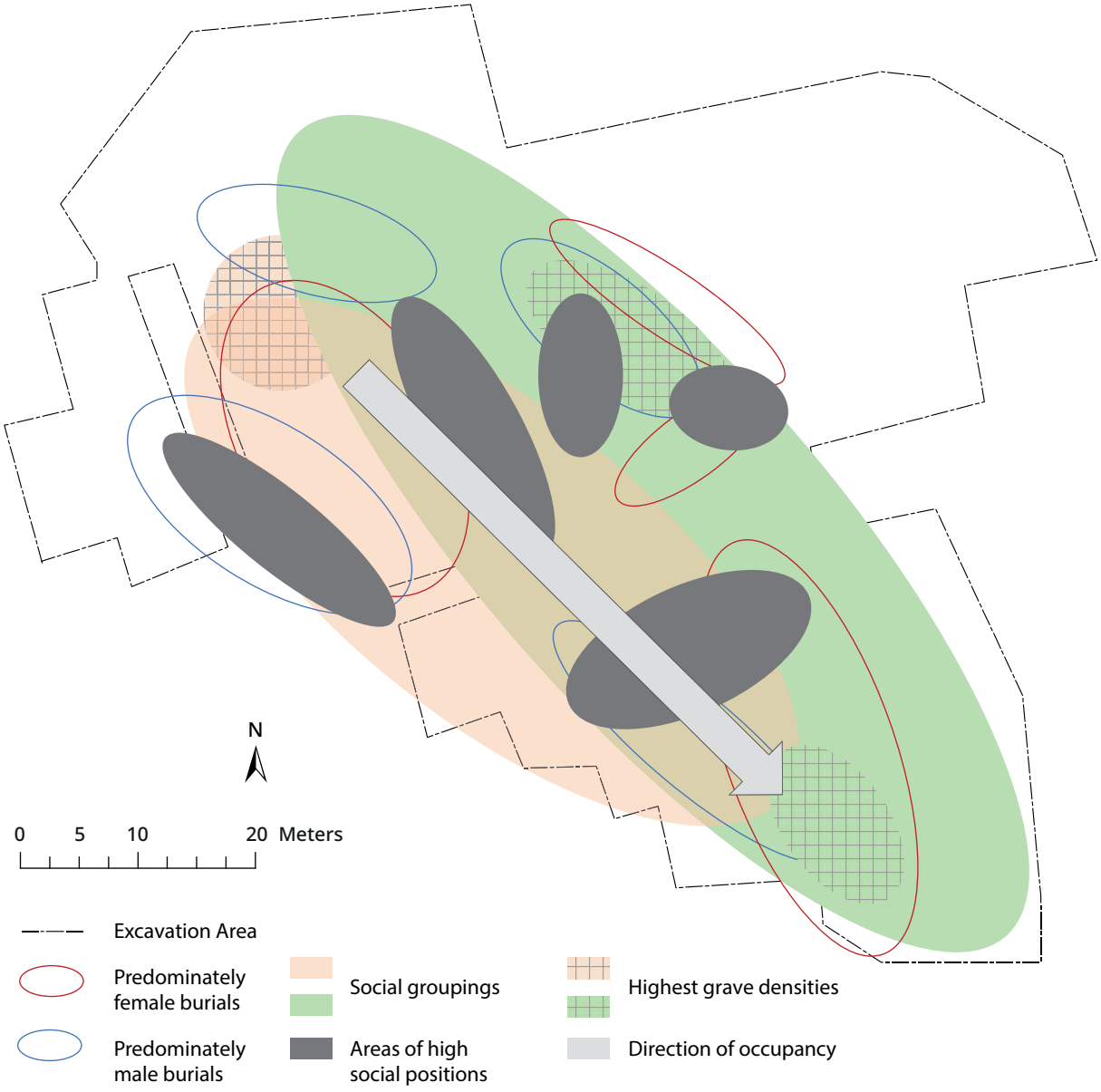


Figure 29. Model of the social organisation of the burial ground of Schwetzingen. Illustrated are two social groupings (in pale pink and green), the direction of occupancy (arrow), areas of highest grave densities (checked patterns), areas of predominately female and male burials (blue and red circles), and areas of burials that demonstrate high social positions (dark grey).

Regarding diet, females show a wider range of $\delta^{15}N$ values than males, speaking for a higher degree of inequality concerning access to animal-based food. Female individuals with the highest nitrogen values include a remarkably high number of early-adult individuals. Among males, predominantly mature and late-adult individuals show the highest nitrogen ratios. In principle, the highest $\delta^{15}N$ ratios were documented in the northern part of the cemetery and at the peripheries of larger grave group clusters. This distribution correlates roughly with the distribution of high values of grave goods and the biggest grave pit sizes. Males that are furnished with adzes and silex arrowheads or the combination of both and females endowed with ceramic vessels have higher nitrogen levels and better access to animal proteins. In this context, it is conspicuous that the tallest man (grave 133) represents the second richest male burial furnished with an adze and ten flint arrowheads. With regard to the correlation between grave pit sizes of adult individuals and the nitrogen isotope values, a small positive correlation can be observed. In contrast, the correlation of nitrogen ratios with values of grave goods indicates no correlation.

Regarding the question on the heterogeneity of the burial community, different social roles could be identified. Based on a correspondence analysis, it can be seen that there are different groups of furnishings that have different focus areas within the burial ground. Moreover, the strontium isotope analyses demonstrate that individuals with local values reveal higher values of grave goods and are more often furnished with adzes, deep bowls/miniature vessels, and seashells and also have better access to animal proteins in comparison to the probable "foreign" individuals.

Regarding orientation, the most frequent alignment is represented by interments with the head of the interred in the northeast and the legs in the southwest. The more seldom orientations are found among distinct clusters within the cemetery. With respect to the position of the interred, the majority of the individuals were buried in a left crouched position. Right side orientations as well as individuals buried in a prone or a supine position are seldom and are predominantly located in the southern part of both the northwestern and southeastern groups.

Concerning the chronological occupation, a sequence from the northwest to the southeast of the cemetery with a simultaneous spread towards the peripheries of the cemetery can be suggested (Fig. 27-29).

Lauda-Königshofen (Final Neolithic, 2600-2500 BCE)

During the third millennium BCE, different supra-regional phenomena are observed in the archaeological record. The Corded Ware phenomenon ranged from the Volga in the east to the Rhine in the west and over large areas between Southern Scandinavia, the Alps, and the Carpathians. Most characteristic is the clearly defined burial practice with mostly individual flat burials. A gender division both in the spatial orientation of the skeletons and the burial items is observed. Compared to the LBK, the material culture and subsistence economy is heterogeneous, which led to the definition of regional cultural groups by archaeologists (*e.g.* Single Grave Culture, Battle Axe Culture, and Fatjanovo Culture). Traces of settlements occur rarely. Exceptions are wetland settlements, for example, in Switzerland or in the Netherlands. Large burial grounds, such as those found in LBK contexts, are unknown. The economy seems to be mainly pastoral and mobile, whereas subsistence seems to have consisted of a variable mix of cultivation, husbandry and some hunting and gathering. However, the focus of subsistence is determined regionally. Moreover, the appearance of the Corded Ware phenomenon is linked with one of the major demographic processes in the northern areas of Europe as it is associated with the first occurrence of steppe-related ancestry (Malmström *et al.* 2019; Furholt 2014; Buchvaldek 1992; Furholt *et al.* 2016; Furholt 2003; Kristiansen *et al.* 2017; Müller *et al.* 2009).

The Corded Ware site of Lauda-Königshofen "Wöllerspfad" is situated in the Tauber Valley in northeastern Baden-Württemberg and lies on the terrace of the Tauber River. The geology is characterised by loess soils. The site, which

was not completely excavated by C. Oeftiger from 1998-2000, covered an area of at least 150 x 120 m. S. E. Ortolf (2014) was responsible for the archaeological workup. A comprehensive osteological analysis was made by M. Menninger (2008) and M. Trautmann (2012). Further stable strontium analyses, referring to diet and mobility questions, were published by K. G. Sjögren and colleagues (2016). The mortuary practices consist of single and some multiple burials with inhumations in crouched positions, usually oriented with the head to the east (females) or to the west (males), both looking to the south. However, some of the individuals were not interred following this gender specific burial tradition (Ortolf 2014). The number of females exceeds that of males (Trautmann 2012; Menninger 2008; Ortolf 2014). There are about 30 graves that are probably male burials and 38 graves, which are determined as female burials. Noticeable are the large number of graves containing subadults (53/91) and the absence of senile individuals (Tab. 1) (Ortolf 2014, 446ff.; Trautmann 2012). In addition, there are 22 graves, which show indices for wooden grave installations, and 21 graves, which probably have a circular ditch and formerly had a mound (Ortolf 2014; Menninger 2008; Trautmann 2012).

The ^{14}C data suggests use of the cemetery between 2620 and 2480 BCE (Sjögren *et al.* 2016). Moreover, a burying population size of ca. 20 contemporaneous individuals for this time period was calculated (Trautmann 2012).

Burials were furnished with grave goods, which followed mainly gender specific traditions. Stone axes and adzes were mainly associated with males, whereas ceramics, mainly beakers, were associated with females. Other artefacts, such as flint (arrowheads, blades) and bone tools (awls), were common for both sexes. An assemblage of 75 canine teeth in one grave is noteworthy.

Corded Ware cemeteries from Southern Germany demonstrate that exogamy, which has an integrating mechanism, was a common practice among Corded Ware groups. Mostly adult females were of non-local origin and, due to the nutrient evidence, probably originated from farming communities (Sjögren *et al.* 2016; Kristiansen *et al.* 2017). Based on archaeological and historic evidence, Kristiansen supported the existence of migration processes with bands of young males that could also have functioned as organised war-bands and migration pioneers who settled in new territories (Kristiansen *et al.* 2017, 340).

In contrast to the collective megalithic mortuary practice, Corded Ware groups shared individual burials under small family mounds that represent the transmission of animals and other property between generations of individual families (Kristiansen *et al.* 2017, 343). Males were probably considered to be higher ranked than females due to the higher proportion of single burials and the lower proportion of male infans burials. Status seems to have increased with age for both sexes and C. Strahm postulated a big-man system with the authority of few mature individuals for the Corded Ware phenomenon (Ortolf 2014; Strahm 2002).

Spatial analysis

For spatial analyses, the density of burials within the burial ground was examined by kernel density analysis. In this analysis, multi-person burials were regarded as single burials. Based on a search radius of 10 m, the highest occupancy density is revealed in the western part of the cemetery. High-density concentrations are formed, in particular, by subadults and some mature individuals. If these areas are extrapolated, between 233 and 359 interred persons per hectare (100 m * 100 m)

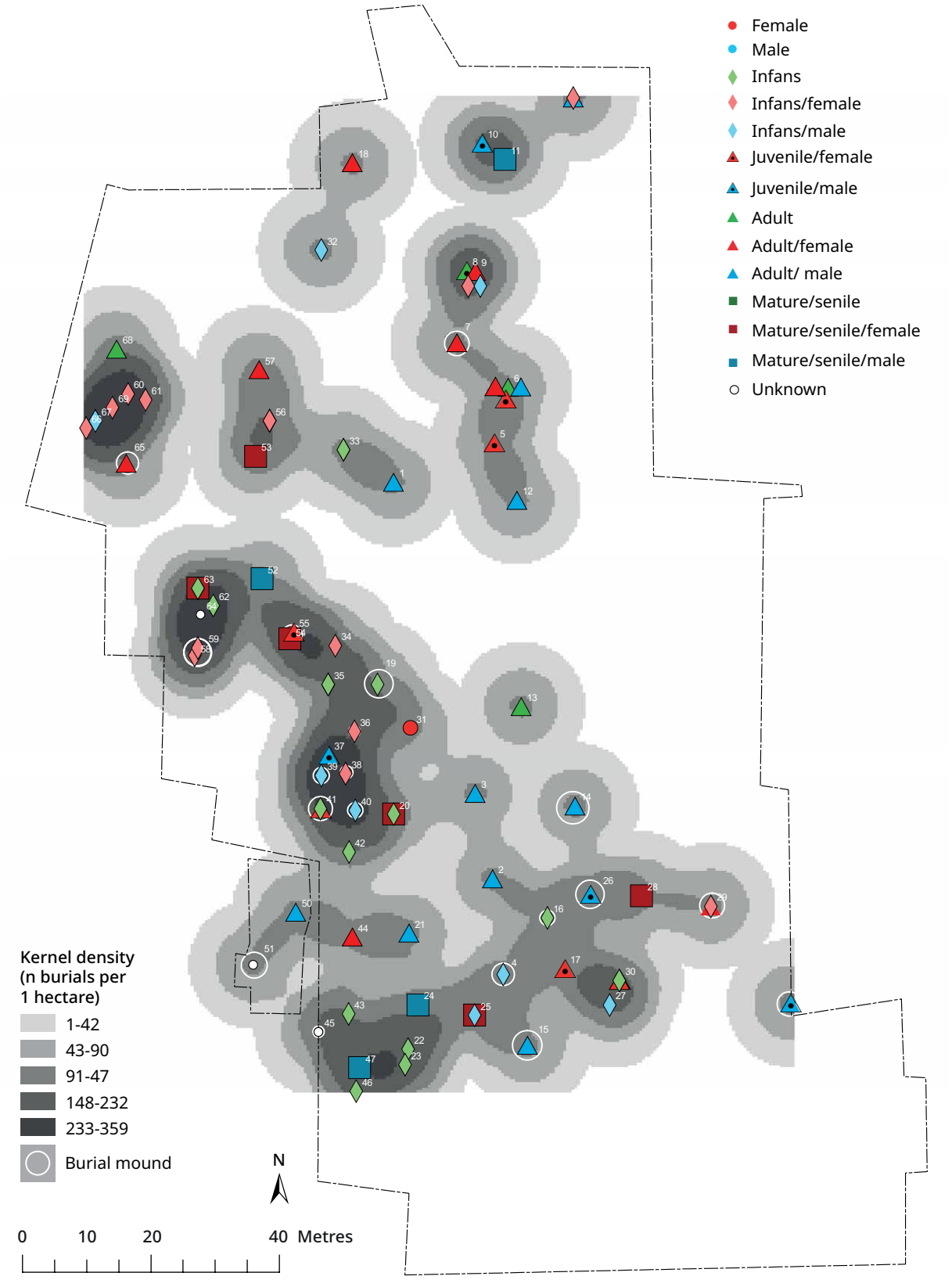


Figure 30. The cemetery of Lauda-Königshofen with kernel density analysis and evidence of the age and sex of the buried individuals. Cemetery plan after S. E. Ortolf (2014).

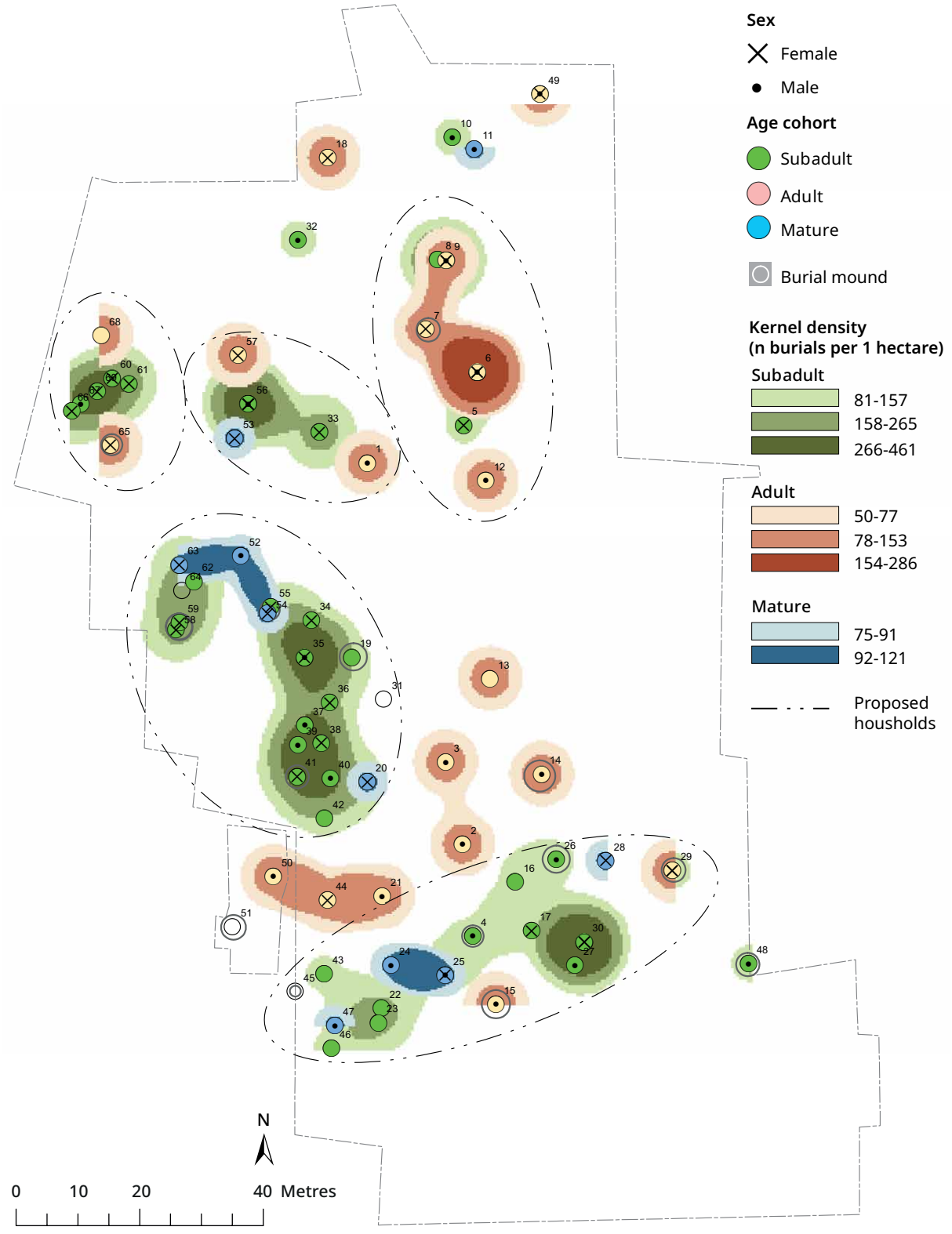


Figure 31. The cemetery of Lauda-Königshofen with kernel density analysis of age cohorts, including information concerning sex of the buried individuals. In addition, proposed households are marked by dashed circles.

would be observed. Burials of the eastern part of the excavation area are located in a rather dispersed manner. Moreover, there is a low concentration of burials between graves 52 and 53. This horizontal open space seems to separate two groups: a northern and a southern group (Fig. 30).

Based on the density analysis, a couple of clusters can be identified that probably represent households. These households consist of clusters of subadults that are surrounded by adult and mature individuals. Frequently, the assumed households include circular ditches that could be interpreted as the founder burial of each household. In an examination about Corded Ware complexes in Southeastern Poland, E. Linderholm *et al.* (2020, 8) proved the close proximity of kindship graves, too, and emphasised the special meaning of kinship among the Corded Ware society. Additionally, a dispersed group of adults – mainly males – seems to be separated from the household clusters at Lauda-Königshofen. As will be shown in the following, these male adults could represent an independent social group with a special economic or warlike function (Fig. 31).

Values of grave goods

Values of grave goods were calculated for 85 burials that are included in the analysis. These values are based on the scarcity of the respective object types within the cemetery and on the number of grave goods assigned to each individual (cf. 'Methods' chapter). Table 8 provides the calculated values of object types.

Five categories were distinguished that are based on natural breaks (Jenks) in the value range. The first category that shows the highest values includes two burials and the second category includes nine burials (Tab. 9).

Overall, these burials consist of six females or probable females and four males or probable males; the sex or the assigned gender of one burial is unknown.

Frequently listed are mature or late-adult individuals. Among them, the outstanding burials 57 and 28 reveal an animal tooth chain and a heterogeneous furnishing with a decorated bone disc. The additional females frequently exhibit a combination of awls and ceramics (graves 7, 8, 25.1 and 53). The richly endowed male burials include axes and adzes. For example, burials 11 and 15 display two axes/adzes that are combined with further burial objects.

In order to emphasise inequalities regarding age and gender furnishings, the results of the computed values of grave goods were correlated with the available bioanthropological data (Fig. 32).

The boxplots of the values illustrate that the medians of values of grave goods and the value ranges in total increase with age. The medians among the mature

Table 8. Calculated values of object types.

Object types	Calculated value
Beaker/vessel	3.0
Axe/adze/grindstone	2.3
Flint blade/flint arrowhead	2.2
Awl	14.2
Canine teeth/bone disc/necklace	15 (necklace = 55)
Animal bones/food item	5.0

Grave no.	Value of grave goods	Age	Sex	Grave goods
57	1	Adult 2	Female?	Canine teeth necklace, ceramic
28	0.68	Mature	Female	Grinding stone, silex blade, red chalk, food item, beaker, bone disc
20.1	0.43	Mature	Female	Canine tooth, ceramic, silex
52	0.40	Mature	Male?	Adze, silex blades
21	0.37	Adult 2	Male	Adze, awl
25.1	0.33	Mature	Female	Beaker, silex, awl
7	0.33	Adult 1	Female	Beaker, sickle blade, awl
53	0.29	Mature	Female	Awl, ceramic
8	0.29	Juvenile	?	Awl, ceramic
11	0.25	Mature	Male	Axe, adze, silex blade, food item
15	0.25	Adult 1	Male	Two axes, silex arrowheads, food item

Table 9. Burials of the first and second categories with information on grave no., values of grave goods (normalised), age, sex and grave goods.

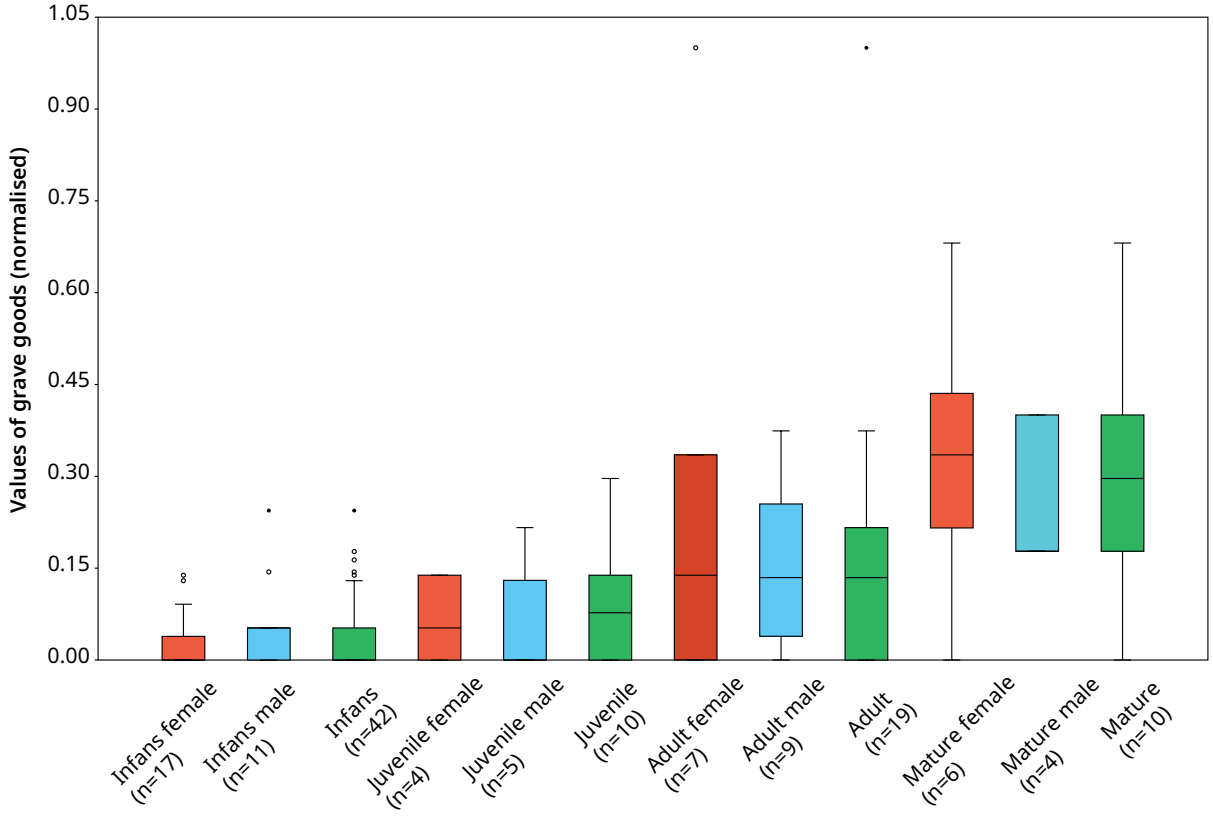


Figure 32. Values of grave goods associated with age and sex categories. Red = female, blue = male, green = total.

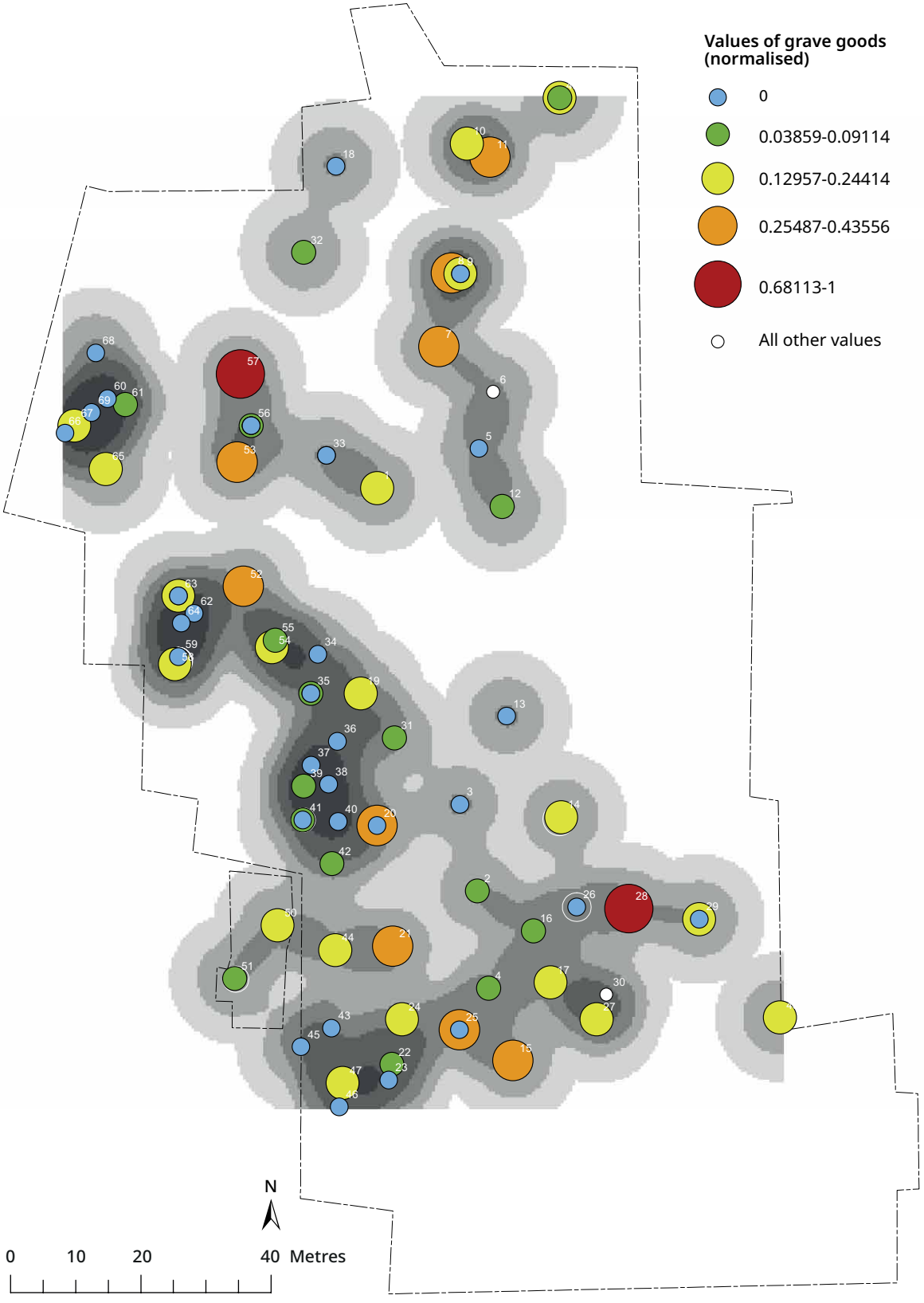


Figure 33. Distribution of values of grave goods within the cemetery according to categories and in combination with the kernel density of graves.

age cohort represent the highest values in relation to both females and males and to the total population. However, the highest value reveals a late-adult woman furnished with an elaborate animal tooth chain. The lowest value range demonstrates infans both among females and males and within the total population. The difference between the age cohorts is significant (Kruskal-Wallis test for equal medians: p (same): 6.193E-06).

Figure 33 demonstrates the distribution of the values of grave goods within the cemetery. There is a conspicuous location of the graves with the highest values of grave goods. They are located outside of the highest grave densities on an imaginary line spanning from north to south. In contrast, the burial areas that show a relative high density of graves demonstrate mainly values of grave goods, which are assigned to the lowest category of grave goods. They are situated in the western part of the burial ground.

Burial pit sizes

The differences in the grave pit sizes of the interred individuals serve as a further indication of unequal treatment of the deceased. Thus, it is analysed to what extent the grave pit sizes correlate with certain gender age cohorts. In addition, it is also examined where the largest burials are spatially located on the cemetery. As a criterion, the square metres of the grave pit areas are considered. Of course, grave volumes would be more suitable. However, the burial depth of buried persons was either not securely recognised or documented.

In a further calculation version, the area of circular trenches has also been included. A circular ditch indicates a mound and it is assumed that buried persons, who were assigned a burial mound, had a special position within the burial community. As expected, burials with circular ditches belong to the largest burials (Tab. 10).

Figure 34 shows that the largest burials that belong to the first category (marked in dark red) are each located in the southern part of the cemetery and on the peripheries of bigger grave groups. Burials without larger grave pits were recorded in the western part of the cemetery and are also part of bigger grave clusters. As expected, burials with small pit sizes (marked in blue) correlate with subadult and especially infans individuals. The burials that demonstrate the largest burial construction are observed for graves 14, 15, 29 and 51.

Based on circular ditches, the four burials that represent the largest burial constructions include mainly early-adult individuals (cf. Ortolf 2014, 437). The biggest circular ditches are associated with male burials. In one case, a multi-person burial is recorded, consisting of an early-adult female together with an infans 1 individual. No assessments can be made about sex and age for burial 51. Among burials with large circular ditches, only grave 15 demonstrates an above-average burial endowment.

Table 10. Burials of the first category regarding burial sizes (including circular ditches) as well as information on grave no., circular ditch size (m^2), age, sex and grave goods.

Grave no.	Circular ditch (m^2)	Age	Sex	Grave goods
14	23.75	Adult 1	Male	Adze, silex blade, food item
15	17.72	Adult 1	Male	Two axes, silex arrowheads, food item
51	17.72	?	?	Silex, beaker, ceramic
29	15.55	Adult 1/Infans 1	Female/Female	Small dish, food item

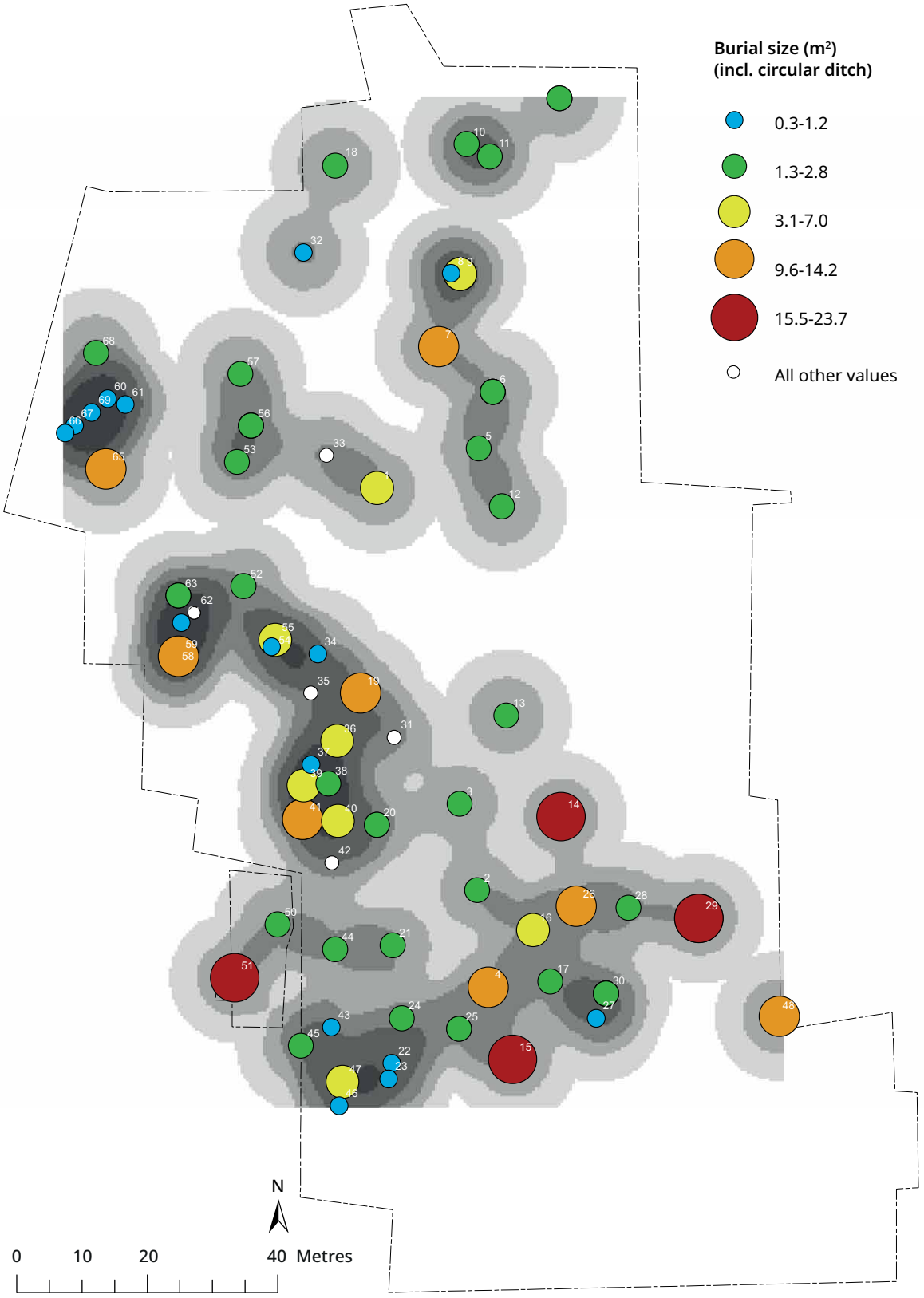


Figure 34. Distribution of burial sizes, including circular ditches associated with the kernel density based on burials.

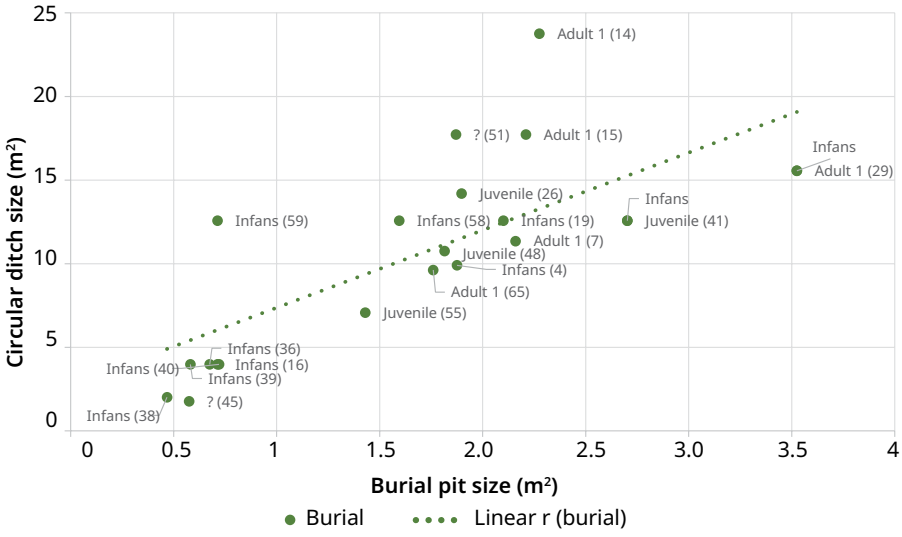


Figure 35. Correlation of burial pit size and size of circular ditch.

Grave no.	Burial pit size (m²)	Age	Sex	Grave goods
29	3.50	Adult 1/Infans 1	Female	Small dish, food item
1	3.40	Adult 2	Male	Two axes, sickle blade, food items
9	3.18	Adult 2, Infans 1, Neonates-Infans 1	Female, Male, ?	Ceramic, food items
47	3.12	Mature	Male	Adze, food items
24	2.80	Mature	Male	Two axes, food items

Table 11. Burials of the first category according to burial sizes (excluding circular ditches) as well as information on grave no., burial pit size (m²), age, sex and grave goods.

This grave includes two axes, silex arrowheads, a food item and an unusual supine position of the individual. Otherwise, there is not necessarily a direct link between the existence of a circular ditch/burial mound and above-average furnishings.

Moreover, a strong and significant correlation exists between burial pit size and size of circular ditch (linear r (Pearson): 0.67586, p = 0.0010719). Interestingly, no interred individual that is associated with a circular ditch is older than an early-adult age. Considering figure 35, it seems that there is also a strong coherence between age and size of the burial pit and size of the circular ditch.

In table 11, the circular ditches are excluded when regarding the calculation of burial pit sizes. Only the grave pits that are also located within the circular trenches are included in the analysis. Without considering the circular ditches, in table 11 the burials with the largest grave pits are listed.

Due to the required space, it is obvious that multi-person burials, for example graves 9 and 29, have the largest grave pits. However, this is not always the case. There are also multi-person burials (*e.g.* graves 30 and 63) that do not belong to the largest burials. In contrast, there are also big single burials. They are associated with late-adults and mature males (burials 1, 47 and 24) and in two cases, they demonstrate profuse armament endowments (cf. Ortolf 2014, 434).

Compared to the list in which circular ditches are included, early-adult individuals are seldom associated with the first category, but rather relatively old individuals of the late-adult and mature age cohorts. Graves that have the largest burial pits are

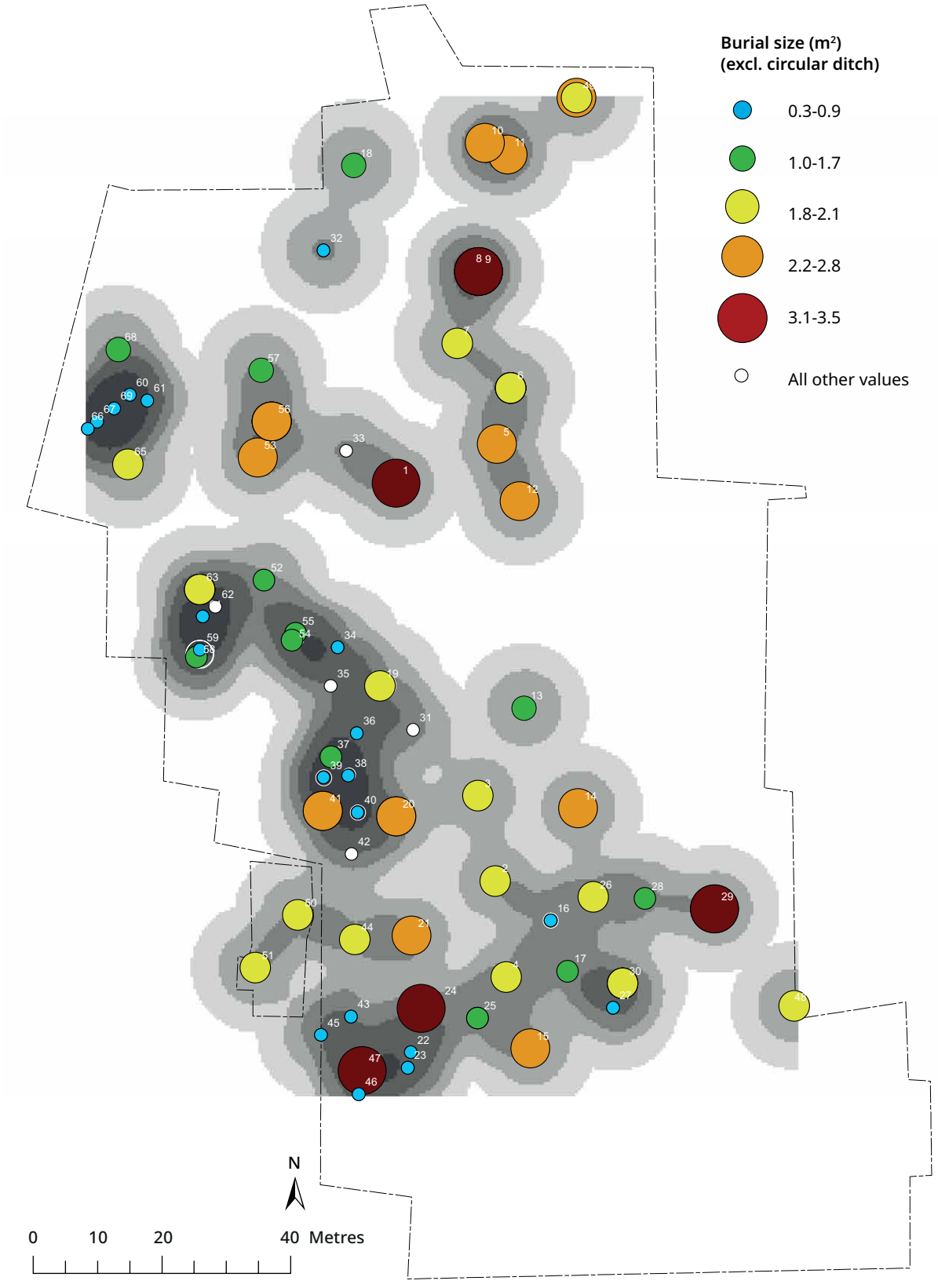


Figure 36. Distribution of burial sizes (excluding circular ditches) associated with the kernel density based on burials.

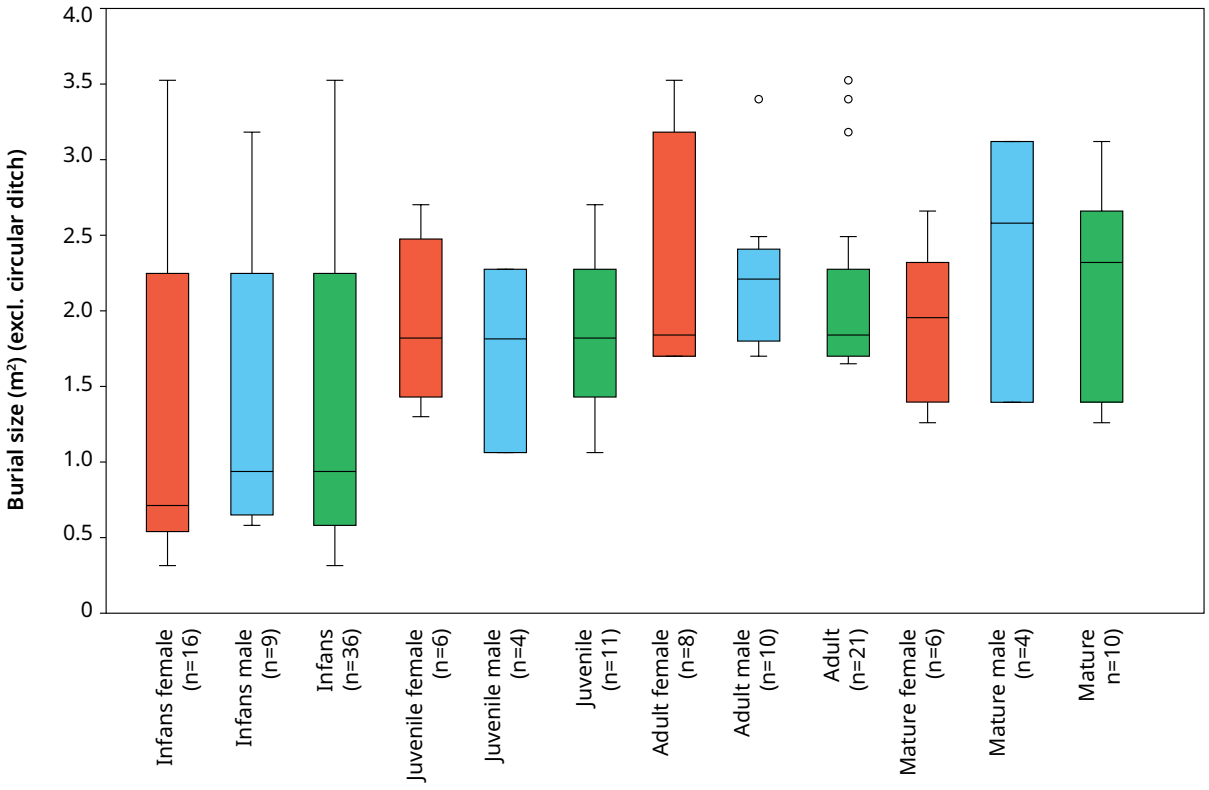


Figure 37. Distribution of burial pit sizes in relation to age cohorts, sexes and the total number of burials.

located in the southern and eastern parts of the burial ground and with one exception are not located in areas with a high density of graves (Fig. 36). With burial 29, there is one grave that is part of the first category of graves in both calculations in which circular ditches are included and in which they are not.

In the following, burial pit sizes are correlated with the age and gender of the buried persons. In this context, the circular ditches are excluded (Fig. 37). As a result, infans show the lowest range and the lowest median. A high interquartile distance among the results for infans emerges because there are some infans that have a big burial pit, which is also connected with a visible circular ditch. Furthermore, many infans are part of a multi-person burial and therefore have a relatively large burial pit.

Mature individuals tend to have the largest grave pits among both females and males and in total. Among females, no major differences exist among juvenile, adult and mature individuals in relation to the median value. In contrast, there are more pronounced differences among males. Here, the increase in grave pit sizes from juvenile to mature is clearly discernible. In relation to the total number of individuals, there are significant differences between the infans age cohorts and the adult and mature age cohorts, respectively (Mann-Whitney pairwise test: adult-infans: $p = 0.01714$; mature-infans: $p = 0.0471$).

Values of grave goods and burial pit sizes

As a next step, the normalised values of grave goods are summed up with the normalised values calculated from the grave pit sizes that result in overall burial values (Tab. 12). The calculation relates to grave pit sizes that do not include the circular ditches. The graves that belong to the burials with the highest burial values, combining burial goods and burial size (m^2), are listed in table 12.

Grave no.	Burial value (value of grave goods + burial size)	Age	Sex	Grave goods
57	1.48	Adult 2	Female	Canine teeth necklace, ceramic
20.1	1.19	Mature	Female	Canine tooth, ceramic, silex
1	1.18	Adult 2	Male	Two axes, sickle blade, food items
29.1	1.14	Adult 1	Female	Small dish, food item
21	1.08	Adult 2	Male	Adze, awl
28	1.08	Mature	Female	Grinding stone, silex blade, red chalk, food item, beaker, bone disc
47	1.06	Mature	Male	Adze, food item

Table 12. Summarised and normalised values of grave goods and normalised burial sizes (circular ditches excluded) with additional information concerning age, sex and grave goods.

Four females and three males belong to the burials with the highest burial values. Almost all of these individuals belong to older individuals associated with the age cohorts late-adult and mature.

Females are characterised by conspicuous ornaments such as animal teeth chains (grave 57, Fig. 38), animal teeth pendants (grave 20.1) or jewellery discs (grave 28). Apart from the richly furnished burials, there are also poorly furnished burials without any or with fewer burial goods, such as early-adult female burial 18 (Fig. 39).

Regarding males, rich male burials are indicated by weaponry. Grave 1 (Fig. 40), for instance, shows two axes that are combined with a sickle blade. In burial 21, an adze is combined with an awl, whereby awls usually represent typical grave goods of women. As in female burials, there are also male burials without or with only few furnishings such as late-adult burial 2 (Fig. 41).

As a further step, the values of grave goods were correlated with the grave pit sizes (Fig. 42). One analysis includes the circular ditches, whereas in the other case they are excluded. Infans are excluded in both correlations, since the smaller body heights would bias the results. Moreover, in the case of females, the high presence of multiple burials has to be considered.

Regarding the correlation with grave pits that exclude circular ditches (Fig. 42), it can be seen that the sampled adult population demonstrates a slight positive correlation (Linear r (Pearson): 0.12, p = 0.42603). Females show a small negative correlation (Linear r (Pearson): -0.28502, p = 0.26749), males a moderate positive correlation (Linear r (Pearson): 0.42392, p = 0.079566).

When considering the burials with the largest grave pits, it is evident that both females and males have grave pits of more than 2.5 m^2. It is noticeable that in the case of females large grave pits are only present in connection with multiple burials consisting of an adult and an infans individual. With the exception of burial 20.1, which includes an animal tooth, no burials show special outstanding grave goods. For males, graves 1, 47, 24 and 11 have relatively large grave pits (≥ 2.5 m^2). These exclusively late-adult and mature burials were furnished with above-average grave goods consisting of double axes (except grave 47) and food items.

With regard to the correlation with grave sizes in which the circular ditches are taken into account (Fig. 43), the entire adult population does not reveal a correlation (Linear r (Pearson): -0.029035, p = 0.85337). Females reveal a small negative correlation (Linear r (Pearson): -0.21317, p = 0.41138) and males demonstrate no correlation (Linear r (Pearson): 0.093505, p = 0.7121). Early-adult female

Figure 38. Female burial 57 (cf. Tab. 12) with the highest value regarding the combination of normalised values of grave goods and burial pit size (after Ortolf 2014, 459; 522).

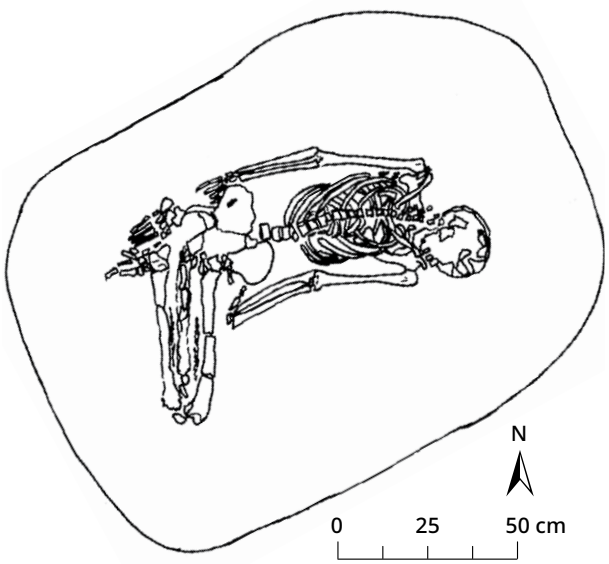


Figure 39. Female burial 18 belongs to the graves with the lowest value (after Ortolf 2014, 502).

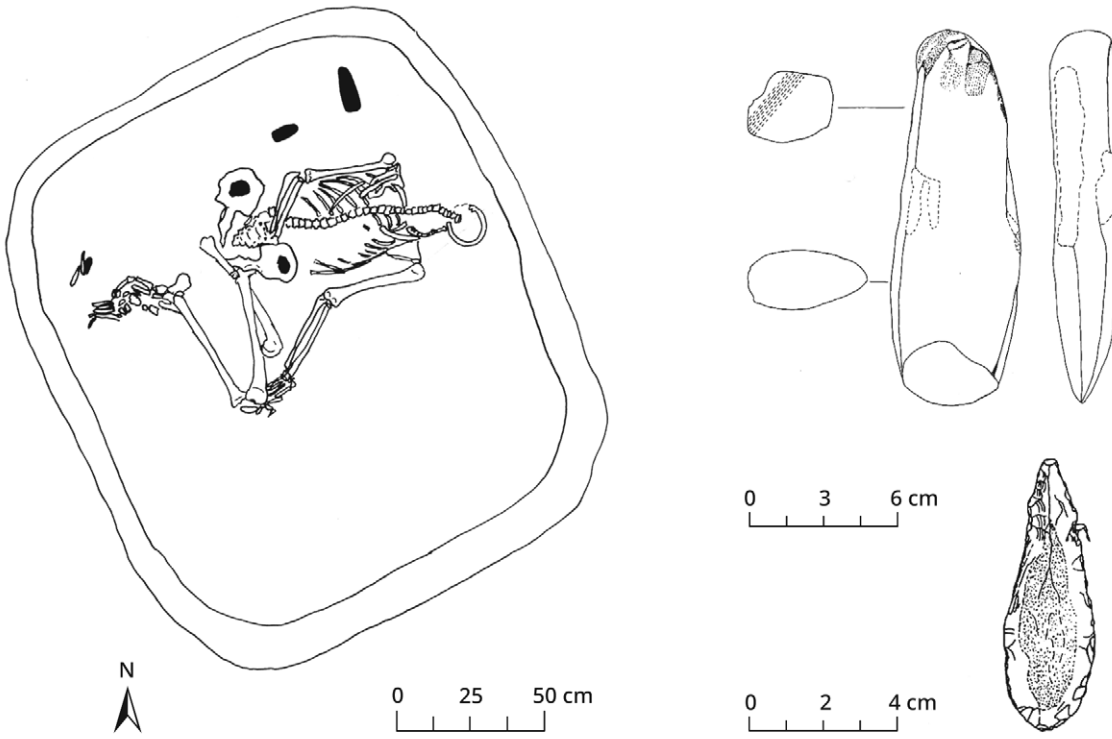


Figure 40. Male burial 1 (cf. Tab. 12) with the highest value regarding the combination of normalised values of grave goods and burial pit size (after Ortolf 2014, 491-492).

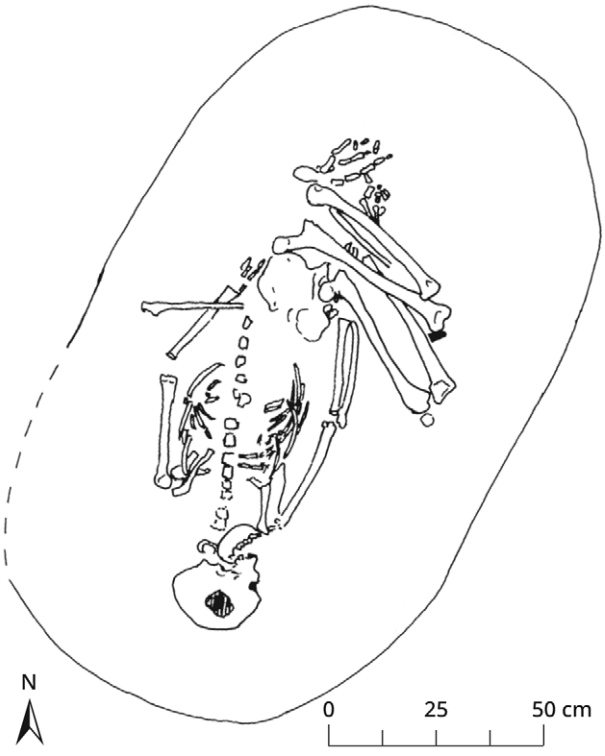


Figure 41. Male burial 2 belongs to the graves with the lowest value (after Ortolf 2014, 492).

grave 7 and early-adult male graves 14 and 15 demonstrate both relative wealthy furnishings (consisting of the combination of axes/food items in male graves and beaker/awls in female graves) and relatively large burial sizes.

Overall, it can be seen that male interments demonstrate a correlation between furnishing quality/quantity and burial pit sizes. However, the correlation is more conspicuous without taking the circular ditches into account. Males with large grave pits are characterised by the presence of two stone axes or adzes and food items. This correlation cannot be determined for females. In this case, there

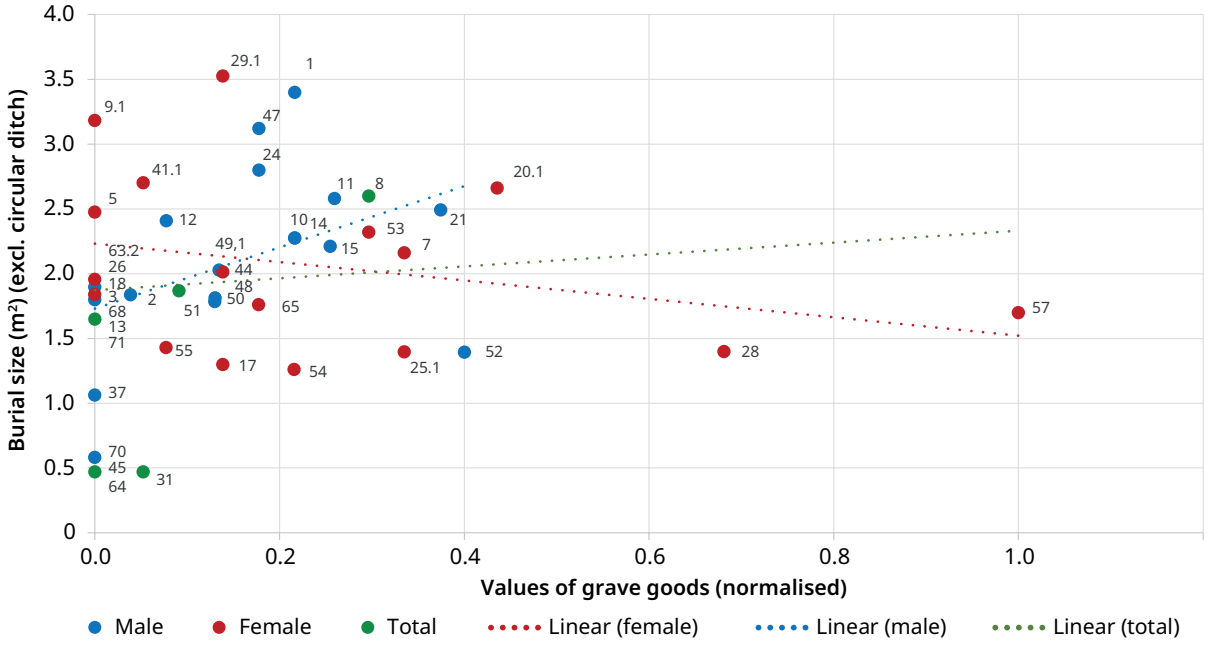


Figure 42. Correlation of normalised values of grave goods and burial sizes (m², circular ditches excluded) according to sex, also including integrated linear tendency lines.

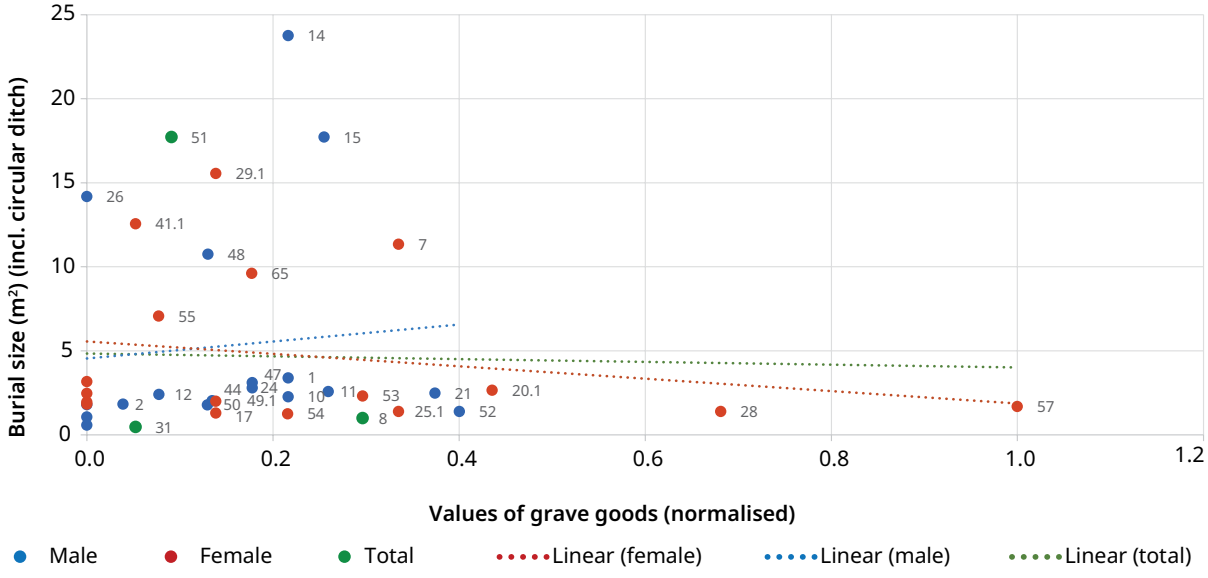


Figure 43. Correlation of normalised values of grave goods and burial sizes (m², circular ditches included) according to sex, also including integrated linear tendency lines.

is only a small correlation between the size of the pit and the quality and quantity of the furnishings. In contrast, the best-furnished female burials (graves 28 and 57) do not exhibit circular ditches or particularly large grave pits.

Lorenz curves and Gini indices

In the following, degrees of inequality within the cemetery are discussed, which are expressed as Gini indices. The Gini indices were calculated for the distribution of values of grave goods with respect to the total population, to females and to males.

The Gini index for the total population amounts to 0.69 in Lauda-Königshofen. The Gini index for females amounts to 0.62 and for males to 0.45. In relation to the distribution of values of grave goods, the Gini index is therefore larger among females. The fact that the male curve always dominates the female curve (Lorenz dominance) demonstrates the higher degree of inequality among females (Fig. 44). The decisive factors influencing this are, in particular, the high number of female or presumably female infans, who received fewer furnishings than male infans, as well as the richly furnished late-adult and mature females from graves 57 and 28.

Distance to the next burial

In the following, we attempt to identify the social differences among the buried based on the distance between burials and the measured distance to the closest neighbouring burial. The question is posed, whether burials, which are relatively isolated, have a special social position within the cemetery.

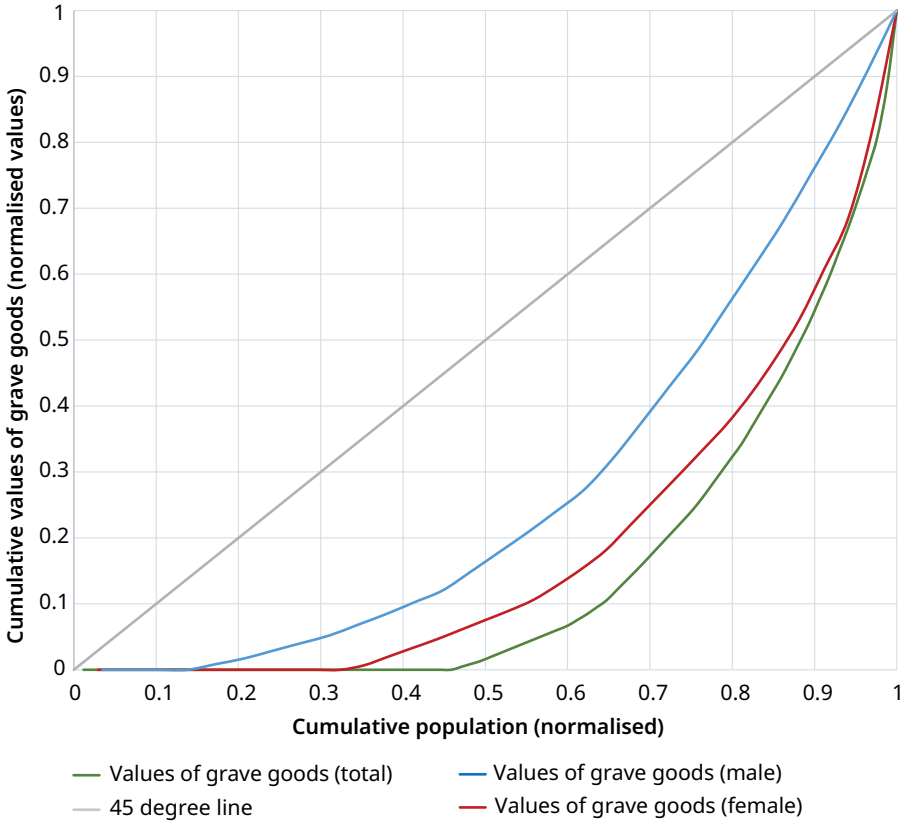


Figure 44. Distributions of grave goods are displayed as Lorenz curves with regard to the total number of individuals, females and males.

Firstly, females and males demonstrate different spatial locations within the cemetery. It is apparent that males show a longer distance to the next neighbouring burial. In contrast, females were buried closer to the next adjacent burial. The difference with regard to this comparison is significant (t: -2.0135, p (same mean): 0.048631) (Fig. 45).

With regard to the relationship between age at death of the buried and the median distance to the nearest burial, the following results have been obtained: The boxplot diagram (Fig. 46) shows that adult individuals have been interred at a much larger distance to the next adjacent burial in comparison to the younger age cohorts and also in comparison to the mature age cohort. This is the case for both females and males as well as the total number. Among the adult burials that are interred at the highest distances, the biggest proportion belongs mainly to male

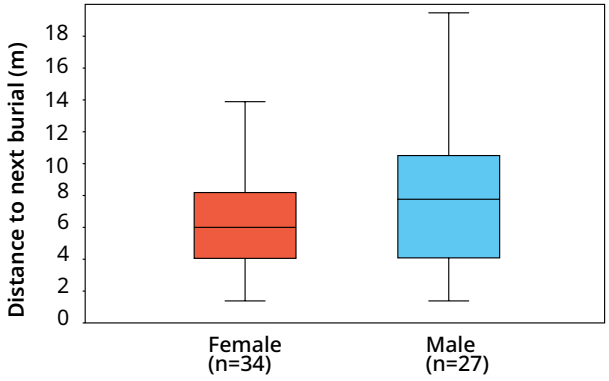


Figure 45. Distance ranges to the next burial according to sex.

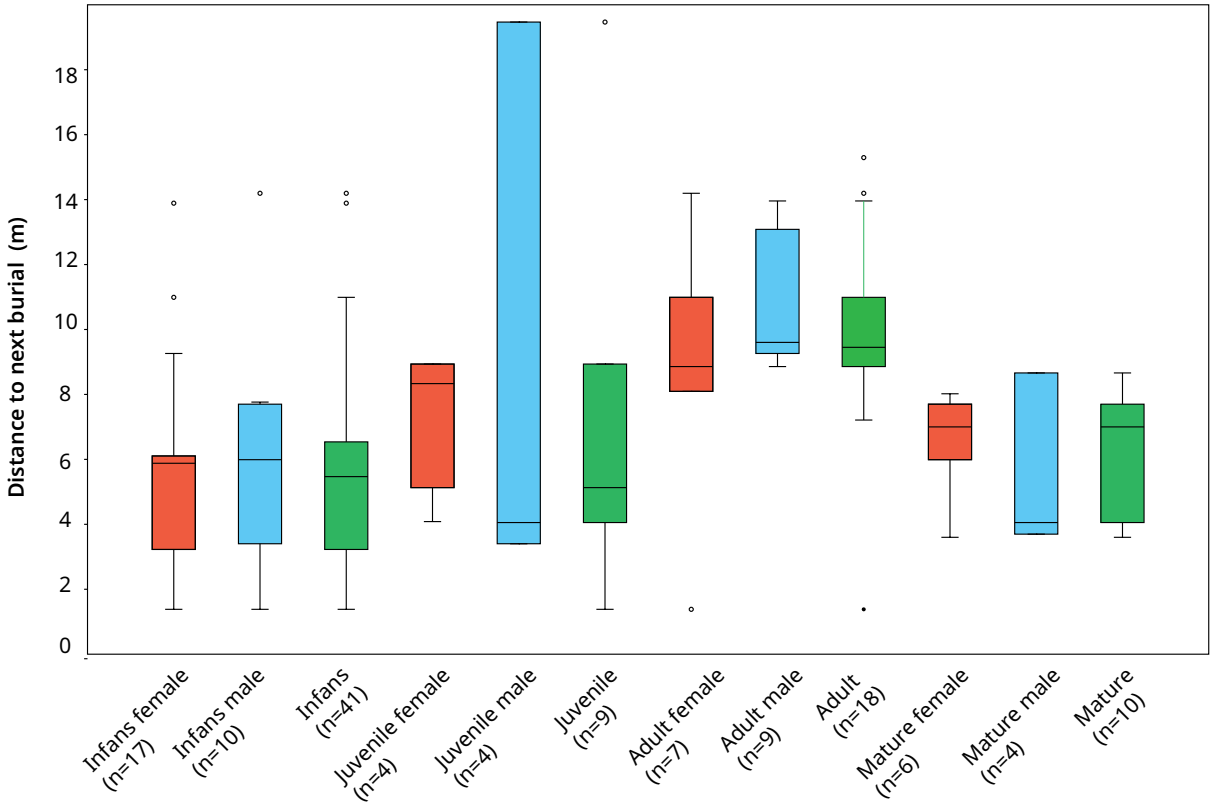


Figure 46 (below). Distance ranges to the next burial according to the total number of burials, sex and age cohorts.

adult burials (graves 3, 13, 14 and 49.1). Possibly, they represent a kind of "warrior caste". One of these burials, grave 49.1, for example, includes two axes.

In relation to the total number of individuals, the difference between the adult cohort and the other age cohorts is significant (Mann-Whitney pairwise Test: adult/infans: p = 1.30E-05; adult/juvenile: 0.01021; adult/mature: p = 0.007259). Naturally, with the distance analysis, aspects such as body height and differences in burial pit sizes between adults and subadults have to be considered.

One juvenile burial was buried at the highest distance to the next burial (grave 48). However, this burial is located at the edge of the excavation area and it must be noted that the cemetery originally could have extended much further.

If the distance ranges are separated into five categories based on natural breaks within the values, it becomes clear that in combination with the results of the density analysis, burials are most distant from the next adjacent burials in the northern and eastern areas of the burial ground (Fig. 47). The male graves that are most distant to the next adjacent burial are frequently furnished with two axes/adzes and do not correspond to a particular age cohort. Furthermore, burials of the second distance category predominantly include adult male individuals. This can be particularly demonstrated in the southern part of the cemetery. Burials among the fourth and fifth categories include mostly infans individuals. These distance categories are predominately located in the western part of the cemetery and correlate with clusters of burials as expected.

Moreover, the distances to the next adjacent burials were correlated with the values of grave goods and the grave pit sizes without consideration of the circular ditches (Fig. 48). The correlation between the values of grave goods and the distance to the next adjacent burial resulted in a small positive correlation (Linear r (Pearson) = 0.18117; p = 0.08747). A small and significant positive correlation (Linear r (Pearson) = 0.22202; p = 0.035457) can be observed in relation to the size of the grave pits.

Burials that have a large burial pit, high values of grave goods and a high distance to the next burial include, for example, the early-adult burials 7 and 14. Grave 14 contains a male burial with adzes, silexes and food items. Grave 14 also includes the largest circular ditch. In grave 7, a female is interred that has a circular ditch. This burial includes a beaker, a sickle blade and an awl.

Assuming an assigned, high-quality furnishing represents a personality with a high position in the burial community, this also becomes evident in relation to the spatial position within the cemetery. Burials with high-quality grave goods and a large burial pit have been buried at a greater distance from the nearest adjacent neighbours. This is especially true for adult individuals. Accordingly, they probably represented individuals with a higher position in society. Naturally, it must be considered that burials with circular ditches, which are associated with a high social position, occupy a larger area within the cemetery. It is also clear that subadults that have, in most cases, smaller graves, have fewer furnishings and are buried much closer to the next neighbouring burial.

Diet, growth and status: Nitrogen ($\delta^{15}N$)

Overall, $\delta^{13}C$ values are consistent with a terrestrial diet based on C3 plants and/or animals feeding on them. Furthermore, there are relatively high $\delta^{15}N$ values within the Corded Ware phenomenon as a whole, compared to preceding Early Neolithic and following Bronze Age cultures, suggestive of a difference in diet and/or in cultivation practices. Several different explanations exist for this shift,

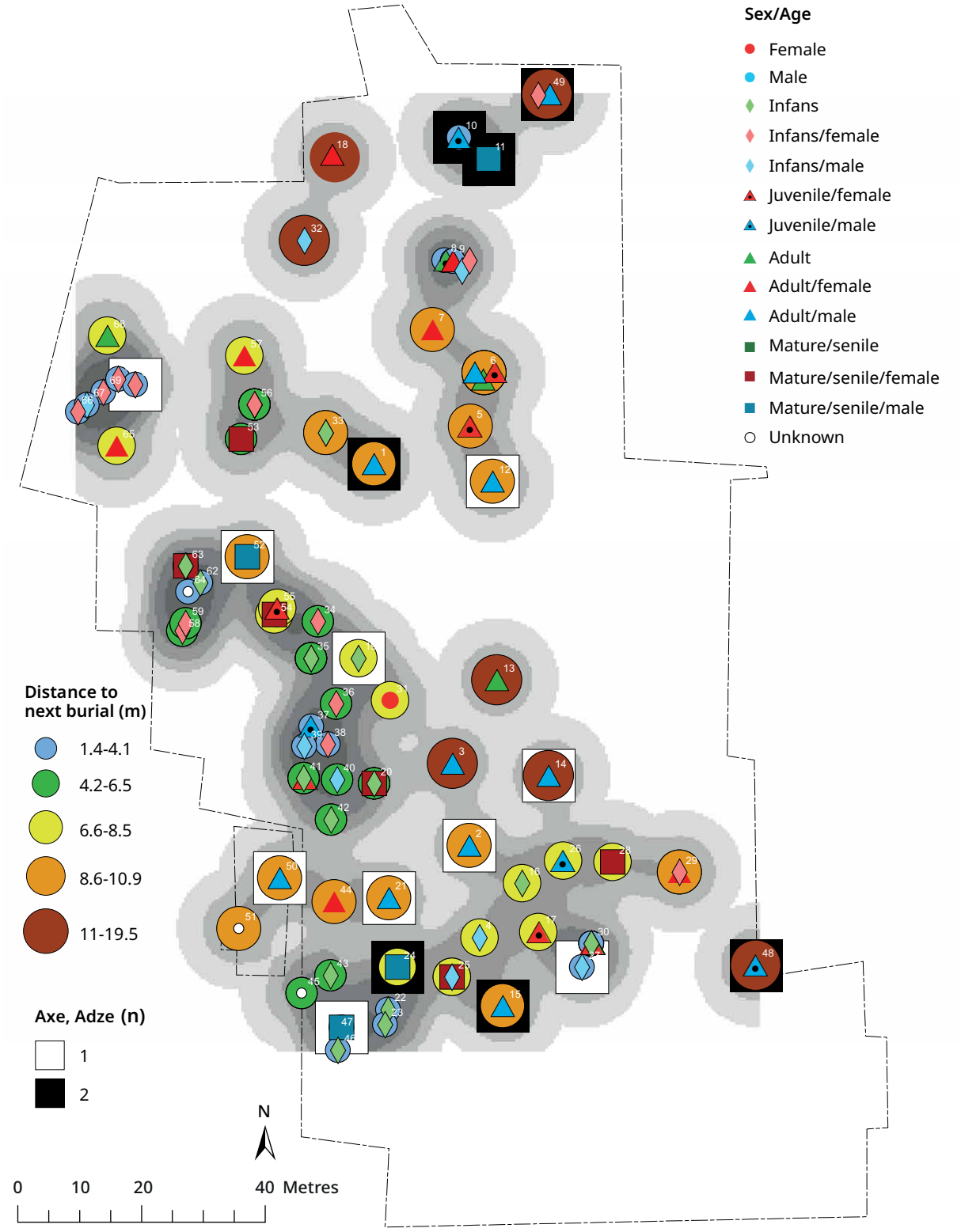


Figure 47. Spatial analysis with respect to distances to the next adjacent burials. Included are distance categories, sex and age of individuals and axes.

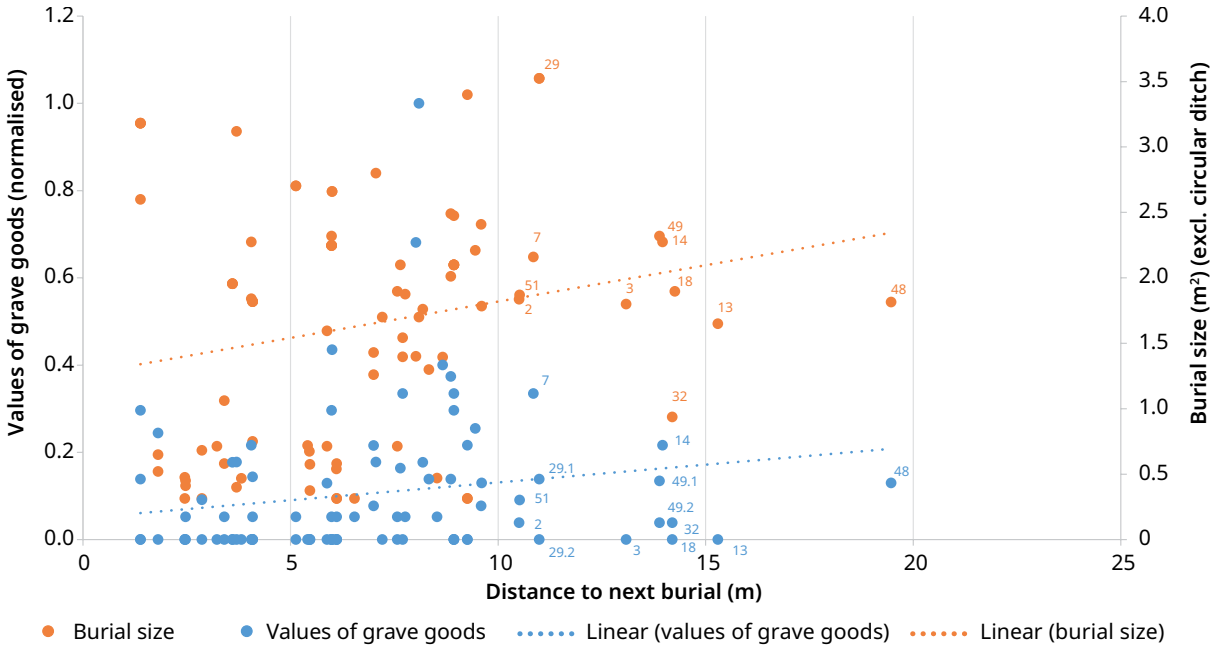


Figure 48. Linear regressions between burial sizes (excluding circular ditches), values of grave goods (both y-axis) and distances to the next burial (x-axis).

such as intense forms of cultivation, manuring, a higher reliance on freshwater fish or on animal versus vegetable protein, or a greater reliance on milk and milk products. The latter is supported by a widespread opening up of landscapes for grazing animals in some regions (Linderholm *et al.* 2020; Szczepanek *et al.* 2018; Kristiansen *et al.* 2017; Doppler *et al.* 2017; Dietre *et al.* 2016).

The Final Neolithic site Lauda-Königshofen reveals the highest $\delta^{15}N$ ratios when compared to other sites in this study. If isotope ratios from the neighbouring sites Bergrheinfeld and Wolkshausen are added, the median amounts to 11.2‰ (SD = 0.59‰, n = 9) among males and is slightly higher than among females (11.1‰, SD = 0.64‰, n = 11). However, the difference is not significant

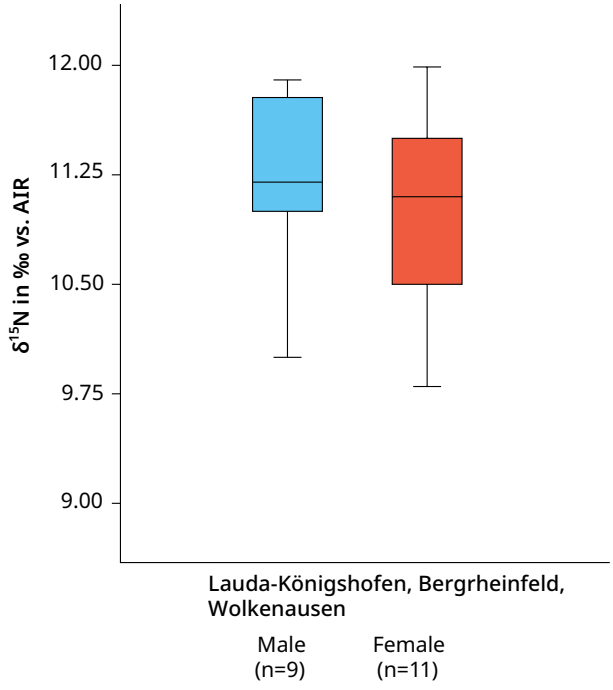


Figure 49. Nitrogen ratios ($\delta^{15}N$) of males and females sampled from Lauda-Königshofen and from the neighbouring burial grounds of Bergrheinfeld and Wolkshausen.

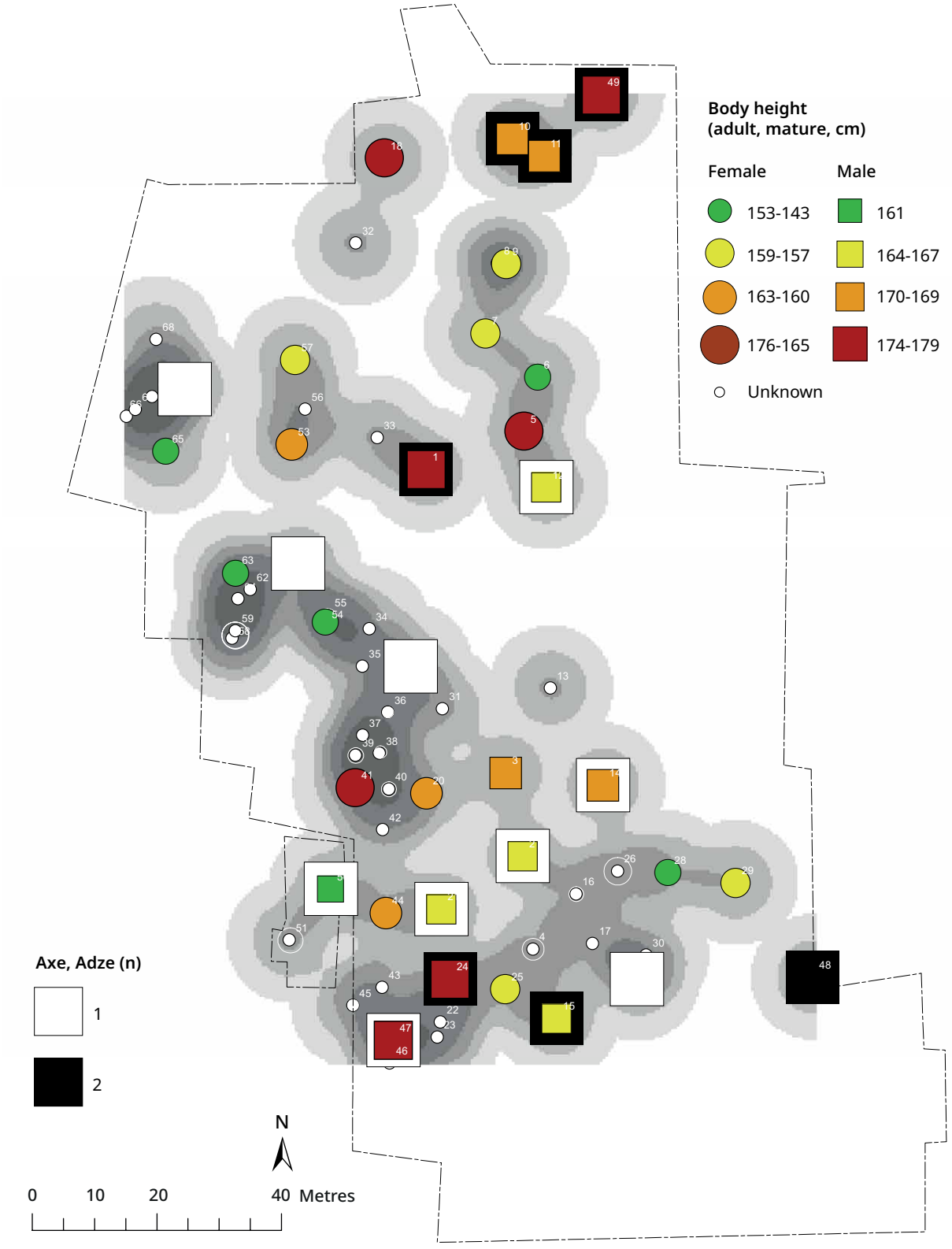


Figure 50. Sampled body height data within the burial ground of Lauda-Königshofen according to sexes, also including burials with axes or adzes.

(T-Test, two-tailed: p = 0.4303, n = 20) (Fig. 49). The high $\delta^{15}N$ values of Southwest Germany (Lauda-Königshofen, Bergrheinfeld and Wolkshausen) are not unique. The Corded Ware sites of Central Germany exhibit similar high $\delta^{15}N$ ratios (Münster *et al.* 2018; Sjögren *et al.* 2016; Asam *et al.* 2006).

A relatively high quantity of growth data is available for Lauda-Königshofen (Menninger 2008; Trautmann 2012). The question arises to what extent access to quality food influenced the growth and body height of the buried persons and to what extent the estimated growth data can be correlated with the social positions of the buried persons.

In Lauda-Königshofen, the overall mean body height of males is 170.1 cm and that of females is 157.4 cm (according to methods of Bach 1965; Breitinger 1937). Compared to other Neolithic societies, males in Corded Ware contexts are relatively tall. However, compared to males, females in Lauda-Königshofen exhibit no extraordinary tall sizes for Neolithic contexts (Siegmund 2010, 81ff.).

The measured body sizes of adults have been classified into four categories according to sex. Males of the first category, who measure at least 174 cm, are more likely to be situated at the edges of the cemetery. This category includes burials 1, 24, 47, and 49.

Figure 50 illustrates that males of the first and second highest categories were more frequently furnished with two axes. Furthermore, it is conspicuous that small females (fourth and lowest category) are predominantly located in the western part of the cemetery, where the highest density of burials exists.

Hierarchy, heterogeneity and transformation

Beyond the above-mentioned analyses, the author also investigated where hierarchical or heterogeneous population structures become visible within the burial community, which may indicate different social roles. Based on a seriation of the grave goods, regular combinations of grave goods could be identified. In addition to different combinations of grave goods, which are understood as age or gender diversity, the exclusivity or number of grave goods also demonstrates social inequalities. Only those individuals/graves enabling an unambiguous allocation of grave goods were integrated into this analysis. Accordingly, some multiple burials were not covered by the seriation (*e.g.* graves 6 and 30). Table 13 provides the combinations of grave goods that are derived from the seriation.

With regard to diversity, burials without grave goods and those with ceramics, axes and ornaments are each linked to either gender-specific or age-specific characteristics. Apart from this, differences in combinations of grave goods and the number of grave goods could demonstrate social inequalities. Thus, burials with ceramics in combination with tools (awls, flint blades) or an axe as well as double axe combinations can be interpreted as higher valued burials than those containing merely ceramics or axes. Another social group is represented by jewellery-bearing graves, which also include ceramics and silexes in addition to ornaments in the form of canid teeth and ornamental discs. These burials are linked with older, late-adults or mature females, who also occupied elevated social positions.

Furthermore, there are also burials without grave goods or those that only include ceramics that can be assigned to a lowest social position. In this case, these burials are mainly represented by infans interments. With regard to the location of the grave goods according to categories, it is obvious that the so-called "double axe graves" (cf. Ortolf 2014, 453; map 5) are predominantly documented

Grave goods	Age	Sex
Canine teeth, ornament disc + ceramic + silex	Mainly mature	Female
Ceramic + awl	Adult + Mature	Female
Ceramic + silex	-	Female
Ceramic	Mainly infans	-
Ceramic + axe/adze	Mainly adult	Male
One axe/adze	Mainly adult	Male
Two axes/adzes	-	Male
Unfurnished	Mainly infans	-

Table 13. Differentiated grave goods and combinations of grave goods based on a seriation.

in the outermost northern and southern areas of the cemetery. These graves are not represented in the central and western burial areas, where high occupancy density prevails. Here, rather male adult individuals are represented, who have only one axe. In the southern part of the cemetery, close to the double axe burials, there are some further richly furnished male burials that demonstrate an axe in combination with pottery (Fig. 51).

Likewise, women with a combination of ceramics and awls – a combination that is interpreted as high valued – are buried in a more decentralised manner. With one exception, they are not documented in the areas with a high density of findings, but lie predominantly in the northern area of the cemetery. The outstanding female burials with animal teeth ornamentation (graves 20.1 and 57) as well as the decorated bone disk (grave 28) are located outside the burial clusters and lie rather evenly distributed over the burial ground. In contrast, female burials with a combination of ceramics and silex tools and pure ceramic-bearing burials are rather represented in the western burial clusters. Burials without grave goods represent the largest group. They constitute the largest part of the dense burial clusters in the western and central areas of the cemetery and are linked mainly with infans individuals (Fig. 51).

Overall, several heterogeneous social groups are visible among females. In this context, age affiliation plays a particularly important role. Accordingly, the three older females with ornaments probably held a particularly high position. Concerning males, such heterogeneous groupings cannot be identified. Here a hierarchical stratification dominates, which is based on the number of axes/adzes and the presence of a circular ditch, thus a mounding of the grave. Regarding the group that probably includes the highest social position, *i.e.* the group that has double axe endowment, the affiliation to a certain age cohort is not such a decisive factor, but rather the affiliation to a closed social grouping, *e.g.*, family and the social position that is held in it.

In addition, the strontium isotope analysis demonstrates – aside from the question of an individuals' origin – further insights into the question of heterogeneity. The burial ground Lauda-Königshofen provides samples for 21 individuals (10 males, 10 females, and 1 indeterminate individual). The data is included in different investigations: Data for nine individuals was published by M. Trautmann (2012) and 16 by K.-G. Sjögren *et al.* (2016). 4 individuals (9.1, 12, 24, and 44) were analysed both by M. Trautmann (2012) and K.-G. Sjögren *et al.* (2016).

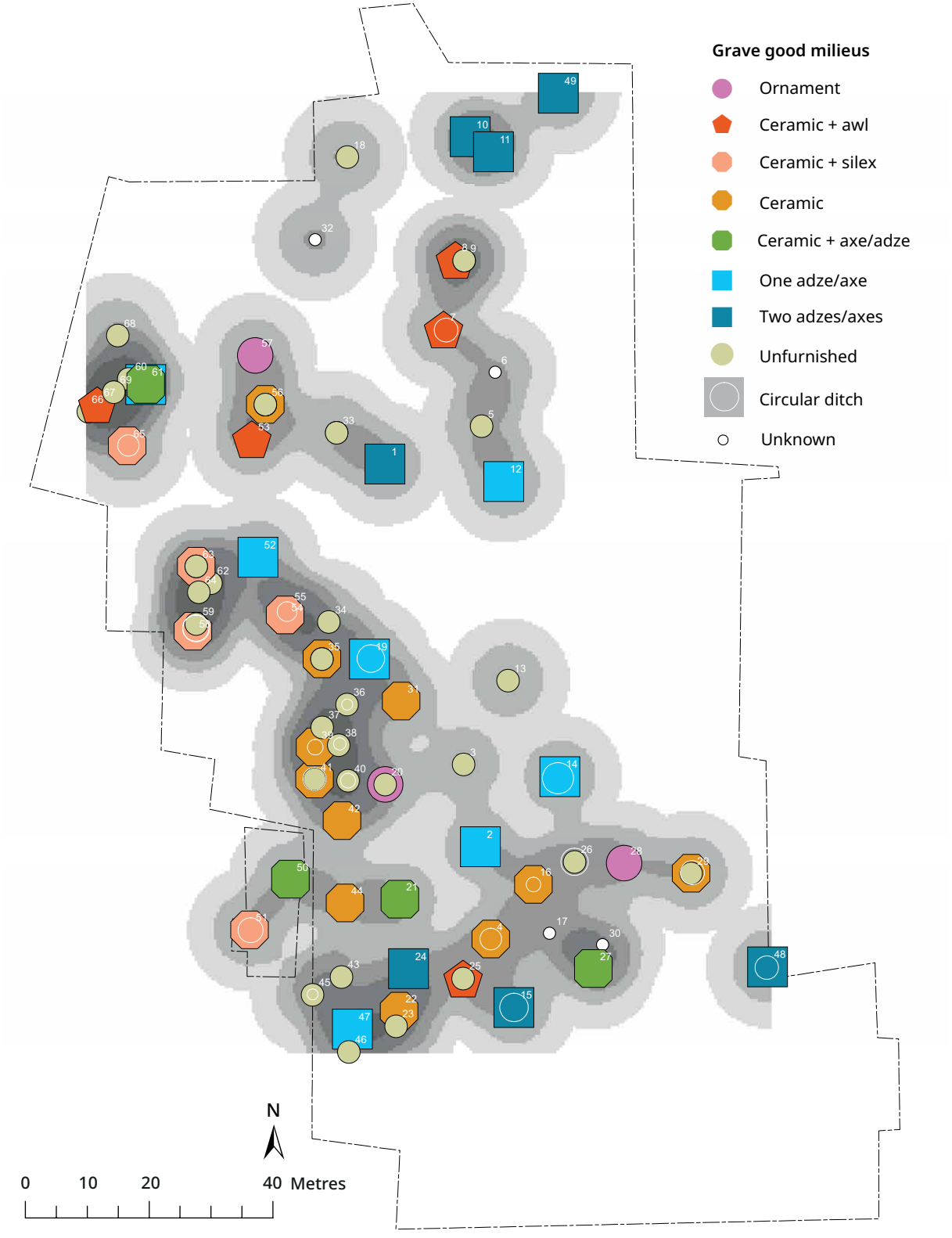


Figure 51. Distribution of various milieus of grave goods.

K.-G. Sjögren and colleagues (2016) pointed out that the local strontium values at Lauda-Königshofen range between 0.7086 and 0.71. These values represent the local loess and shell limestone. Values between 0.71 and 0.712 are considered as possible, whereas isotope ratios that lie over 0.712 certainly do not belong to local individuals. These values are rather related to regions with higher red sandstone (*Buntstandstein*) levels. Four female individuals are considered as certain non-local individuals (Sjögren *et al*. 2016, 23).

Considering the distribution of strontium values, the local strontium isotope ratios differ in terms of their location in the cemetery (Fig. 52). Strontium isotope ratios that are found within the southern area of the burial ground belong to the lowest ratios. The isotope ratios range here from 0.7086 to 0.709. In contrast, the local values in the northern part of the cemetery range from 0.70930 to 0.7098. Although both value ranges are local, the difference is notable. It is striking that double axes in this sample are exclusively associated with these local strontium values. By contrast, the values between 0.71 and 0.7106 are only recorded in the southern part of the cemetery. Among them are two males that could possibly be considered as "foreign". The highest strontium isotope ratios (≥ 0.7122) are considered as attested "foreign" females. They are mostly located in the northern part. It is conspicuous that two of them represent females that have the uniquely occurring tooth ornaments within the burial ground.

The correlation between grave goods and strontium isotope ratios demonstrates that burials that are furnished with two axes are exclusively associated with local strontium values. In contrast, the highest – thus foreign – strontium isotope ratios belong to females and two of them represent females that have uniquely occurring teeth ornaments (Fig. 52). These two interred persons could be interpreted as females, who were probably part of exogamic processes coupled with patrilocal residence. Probably, they come from Corded Ware communities that are located in Central Germany, where canine teeth ornaments are frequently linked to females. Whether they were married with local males that held similar high social positions (*e.g.* grave 57 with grave 1) still has to be proved.

A further reference to identify heterogeneous population structures is represented by decoration techniques and motifs of ceramic beakers, which can act as a means of creating group identities (cf. Assmann 1998). Figure 53 shows the projection of the different beaker ornaments within the cemetery. The northern part includes two simple chisel stamp beakers and a singular beaker with a corded triangular ornamentation. In the southern part of the cemetery, simple chisel stamp beakers, but also chisel stamp beakers with incised line decorations, chisel stamp beakers with foot ornamentations, beakers with ribbed decorations and beakers with simple, horizontal cord ornamentation are located. The concentration of beakers with horizontal cord ornamentation and chisel stamp beakers with incised ornamentations in the southern part of the cemetery is obvious. This project also includes the ^{14}C data from K.-G. Sjögren and colleagues (2016) and J. Müller *et al.* (2009). As a result, a large simultaneousness is shown by the ^{14}C data. The data lies in the time range between 2570 and 2480 BCE. Only the southernmost part of the burial ground with the horizontal cord ornamentations could be interpreted as the youngest phase within the cemetery. For example, the cord ornamented beaker from grave 44 points to the 1-sigma range up to 2409 BCE.

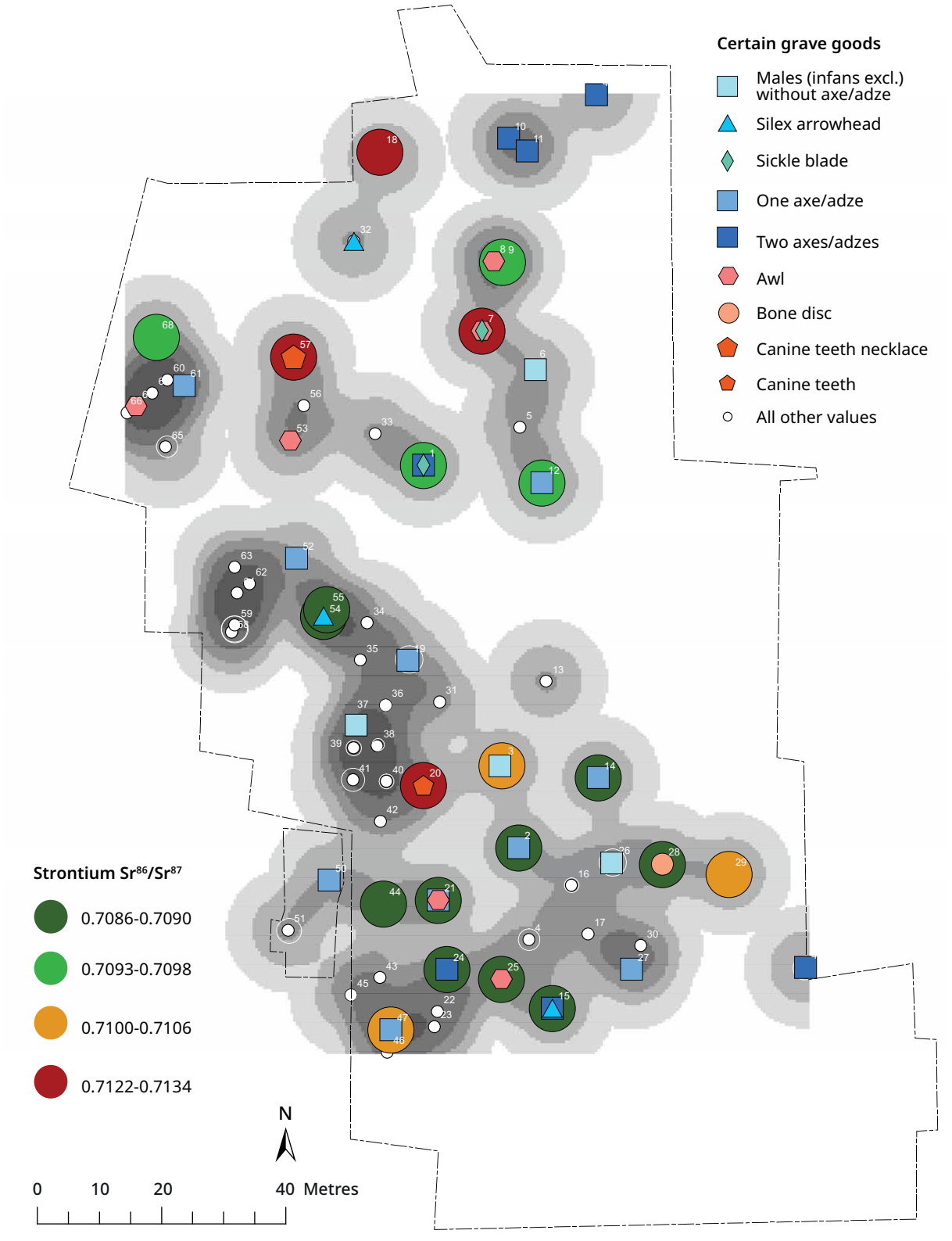


Figure 52. Distribution of strontium value ranges within the burial ground in combination with certain objects.

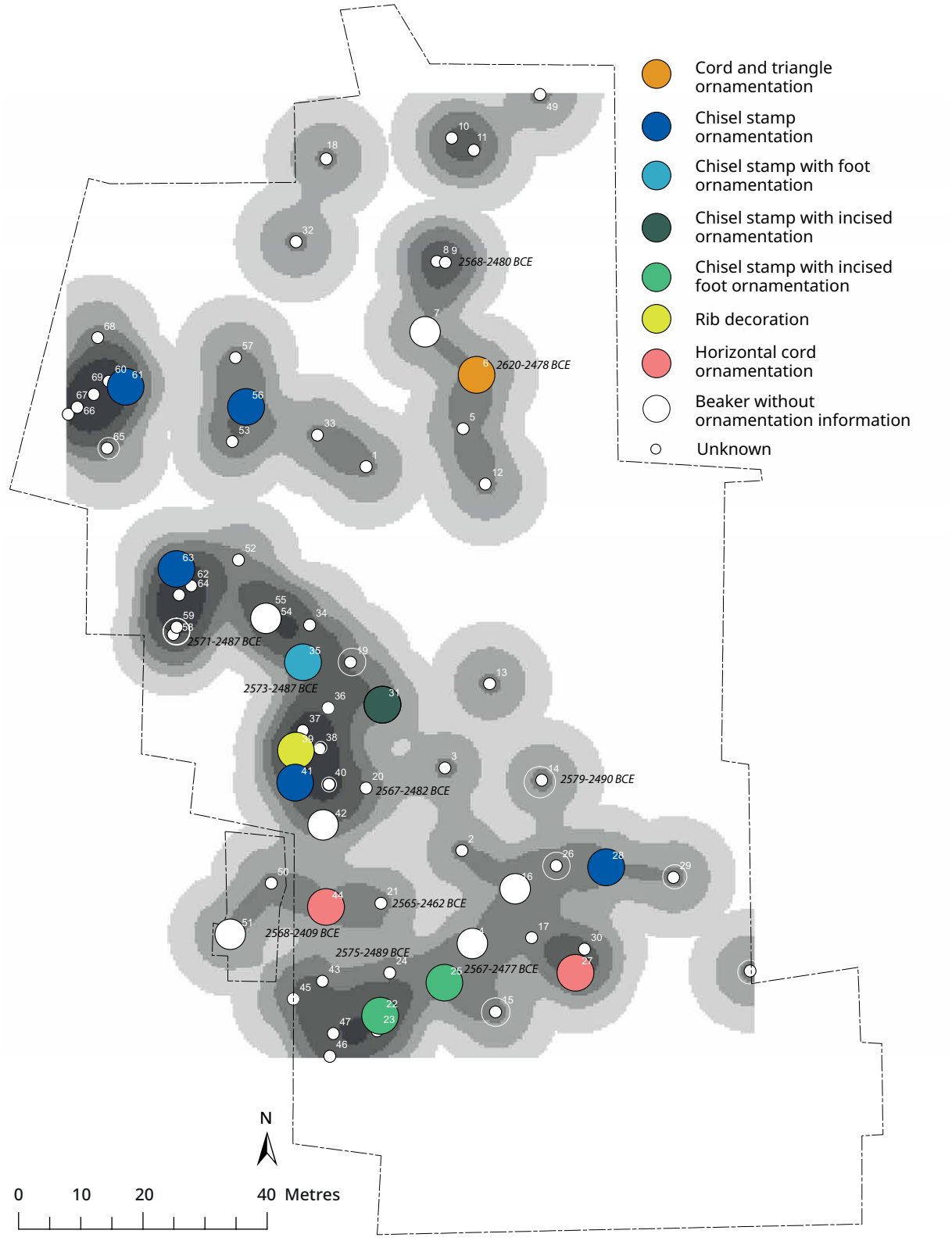


Figure 53. Distribution of beaker ornamentation and ^{14}C data within the burial ground.

Summary

The highest occupancy density is revealed in areas of the western part of the cemetery. Overall, the burial ground appears to be separated into a northern and a southern group and the single burial clusters seem to demonstrate different households. Additionally, a concentration of dispersed male adults within the southern area could be interpreted as a separated social group, probably a group of warriors (Fig. 31; 54).

The calculation of values of grave goods demonstrates an increase of the values according to the age of the individuals. The value ranges and medians among the mature age cohort represent the highest values with respect to both females and males as well as the total population. The upper category of female graves includes ornaments, beakers and awls; the upper category of males exhibits (double)-axes or adzes.

Graves including the biggest burial pits are located in the southern and eastern parts of the burial ground and with one exception they are not located in areas with a high density of graves. Similar to the values of grave goods, both mature males and females tend to display the biggest burial pit sizes. However, some infans also have a big burial pit and a visible circular ditch. In this context, it is striking that only subadults and early-adult individuals received a circular ditch in Lauda-Königshofen. Since circular ditches correlate with the size of the burial pits, early-adult individuals demonstrate the largest pits. However, a direct link between the existence of a circular ditch/burial mound and above-average furnishings does not necessarily exist. Thus, the burials with circular ditches probably represent the founder burials of each household and represent them, not really indicating individual inequality. The fact that only relatively young passed members of the community received a circular ditch probably also means that the loss of certain young or relatively young individuals within the society represented a great loss for the bereaved.

The summation of values of grave goods and values calculated from the burial pit sizes shows that for both females and males the late-adult and mature individuals display the highest total values. The included females were interred with mainly relatively rich ornamentations. In contrast, males show an over-average furnishing of weapons.

If assumed infans and circular ditches are excluded in the analysis, the correlation of burial pit sizes and values of grave goods shows a moderate positive correlation among male graves, in which large grave pits more frequently display two stone axes or adzes and food items, whereas a slight negative correlation is demonstrated for female graves and a slight positive correlation for the total population.

Overall, the richest furnished individuals that demonstrate a high social position were interred more decentralised and are located at the edges of the burial ground within the southern and northern areas. However, the two ornamented females interred with canine teeth are located more centrally (Fig. 51; 54). Moreover, the Lorenz dominances and the Gini indices demonstrate a higher inequality degree among females.

The distance analyses demonstrate that male burials generally have a longer distance to the next neighbouring burial. Concerning age, adult individuals, including both females and males, are located much more distant from the next adjacent burial compared to the younger age cohorts and the mature age cohort. As already mentioned, the male adults probably represent a kind of “warrior caste”.

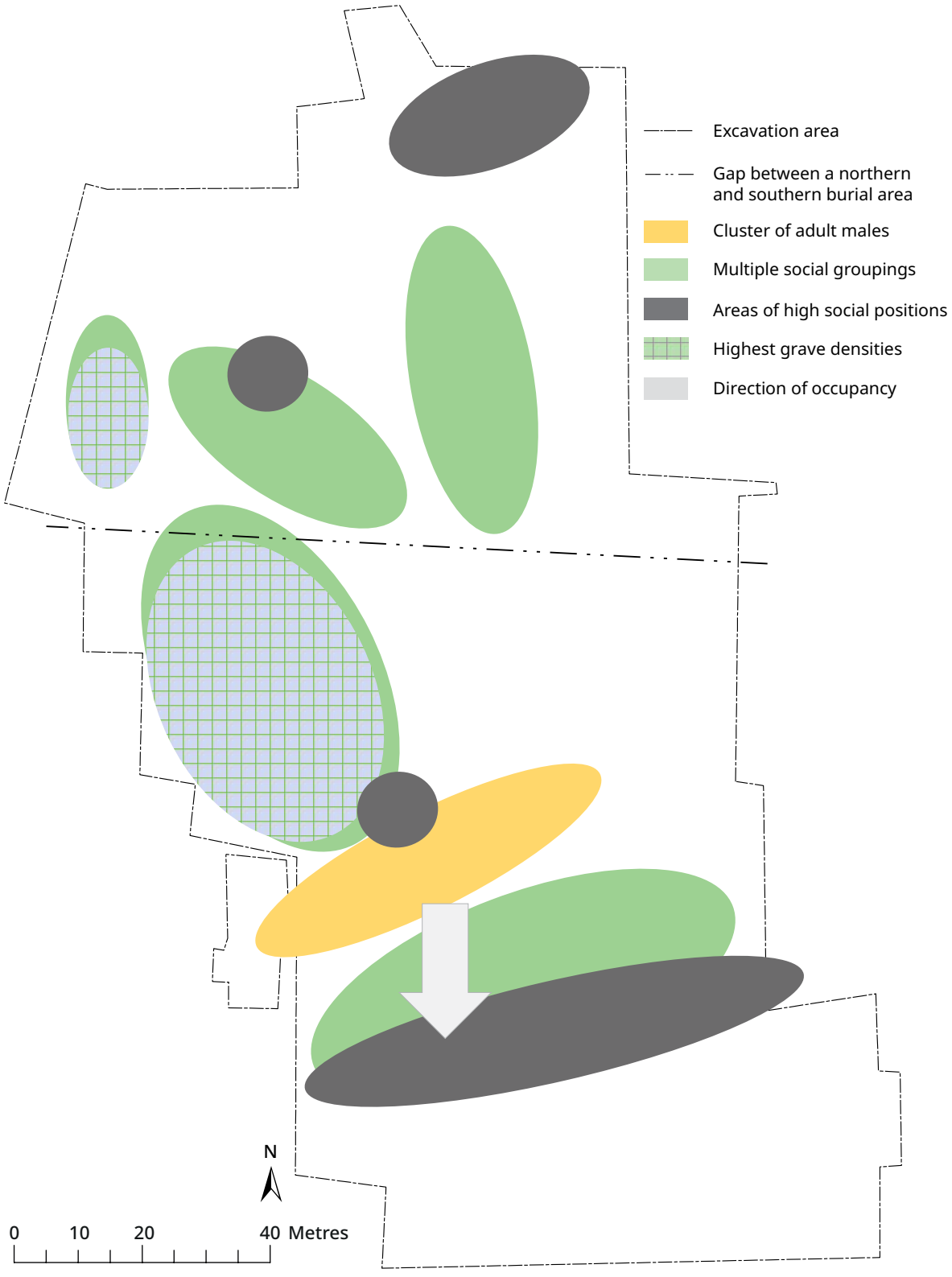


Figure 54. Model of the social organisation of the burial ground of Lauda-Königshofen. Illustrated are multiple social groupings (green), a cluster of adult males (yellow), the direction of occupancy (arrow), areas of highest grave densities (checked patterns), and areas of burials that demonstrate high social positions (dark grey).

Furthermore, a significant positive correlation exists between the distance to the next burial and the size of the burial pits.

The bioanthropological data displays the following results: Final Neolithic males in the Corded Ware society seem to be relatively tall in comparison to other prehistoric societies. Likewise, tall males are frequently situated at the edges of the cemetery and males that belong to the tallest individuals were frequently furnished with two axes. Possibly these tall men acted as authorities and can be interpreted as 'big-men'.

A further question regards the origin of the buried individuals. The distribution of local strontium ratios differs within the burial ground, whereas the lowest local values are located exclusively in the southern area of the cemetery. Moreover, burials that are furnished with two axes are exclusively associated with local strontium values. In contrast, the highest strontium isotope ratios belong to foreign females and two of them represent females that have uniquely occurring teeth ornaments. These two females could be interpreted as females that were probably part of exogamic processes with Corded Ware communities that are located in Central Germany, where canine teeth ornaments are frequently linked to females.

Considering decoration techniques and motifs of ceramic beakers that can be connected to group identities, the distribution demonstrates that in the southern part of the cemetery a higher heterogeneity of techniques and motifs exists from which horizontal cord ornamentation probably belongs to the last occupancy phase.

Overall, a southern and a northern area can be identified, which were used by multiple social groupings, kinships or households as a burial place at the same time. Likewise, the southernmost part of the cemetery may have been occupied last (Fig. 53-54).

Singen at Hohentwiel (Early Bronze Age, 2200-1900 BCE)

The Central European Early Bronze Age is characterised by a widespread introduction of tin bronze technology combined with extensive trade. This epoch also reveals isotopic evidence for the existence of long-lasting exogenous marriage networks that strengthened contacts over wide regions. In addition to settlements with longhouses and enclosures, ingot hordes of torques and axes are documented for the Central European Early Bronze Age.

The Central European Early Bronze Age delivers a heterogeneous picture of social systems. While Únětice societies in Central Germany developed elaborate giant burial mounds that point, in combination with flat grave cemeteries, to a strong hierarchical system, in Southern Central Europe such a hierarchical system is hard to prove since only flat burial cemeteries are known (Vandkilde 2016; Harding 2000; Kristiansen and Larsson 2005; Krause 1988; Bartelheim 1998; Bartelheim and Stäuble 2009; Schefzik and Küster 2001).

In the case of the Bavarian Lech Valley complex, A. Mittnik and colleagues (2019) could, however, discern a hierarchical system by kinship-based analyses. The researchers could verify households that consisted of a higher-status core family, passing on wealth and status to descendants, unrelated, wealthy, and high-status non-local women, and finally to local, low-status individuals. They also proposed this kind of social system for a much broader area.

Singen at Hohentwiel is one of the biggest and best examined Early Bronze Age cemeteries in Southwest Germany. Even though Singen contains elements of

the Corded Ware, Bell Beaker, Urnfield and La Tène cultures (Kimmig 1958), it is best known for its Early Bronze Age finds (Krause 1988).

Based on the private collection activities of the pharmacist A. Funk, the Early Bronze Age cemetery of Singen at Hohentwiel was excavated from 1950-1958 by the State Office for Prehistory in Freiburg. The graves were comprehensively presented by R. Krause in his thesis (1988). Further studies regarding the chronology and the social structure of the burial ground are provided by F. Bertemes (1992) and S. Sprenger (1995; 1994). Moreover, K. Kupke (2010) and V. M. Oelze and colleagues (2012b) published stable isotope studies regarding diet and mobility.

The site dates to the Early Bronze Age phases A1a and A1b (Ruckdeschel 1978; Reinecke 1902; Stockhammer *et al.* 2015) and, according to new ^{14}C data, it is absolutely dated between 2200-1900 BCE (Stockhammer *et al.* 2015). The cemetery consisted of 97 inhumation graves spread over five areas. Overall, not all burials of the burial community have been excavated and recorded and some of the graves were detected in a disturbed and destroyed condition (Krause 1988).

The deceased were buried, with a few exceptions, in a gender-specific crouched position. Females lay on their right side with a north-south orientation, males on their left side with a south-north orientation. The majority of the deceased were anthropologically defined as males and about half of the population was determined to be subadults (cf. 'Introduction' chapter; Tab. 1) (Krause 1988; Kupke 2010; Gerhardt 1964).

All graves were provided with stone settings, whereas differences were recognisable concerning type, size and building efforts for the construction of these settings. The stone settings probably also had the function to stabilise the burial pits. In addition to the stone settings, some burials showed traces of tree coffins and wooden coffins (Krause 1988, 32ff.).

Males were furnished, among other things, with bronze triangular daggers, little bone ornaments, and ceramics. Females were endowed with awls, bronze pins ("*Ruderkopfnadeln*", "*Horkheimer Nadeln*"), ingot torques ("*Ösenhalsringe*"), spiral arm-rings, and lunulae. Among the burial goods deposited with both interred genders are "*Scheibenkopf*" pins, bone rings, jet pedants, silver wire rings and tutuli. Due to the established relative chronology by Ruckdeschel that is based on the robe pins (phase A1a = "*Ruderkopf*" pins with a large or small head, bone pins and boar tusk pins; phase A1b = "*Schleifenkopf*" pins and "*Horkheimer*" pins; phase A2a = "Ösenkopf" pins, "*Hülsenkopf*" pins and cross-perforated "*Kugelkopf*"pins), R. Krause (1988) suggested that the occupancy sequence of burials in the cemetery proceeds from north to south (cf. Koch and Kupke 2012; Sprenger 1994; Ruckdeschel 1978). However, P. W. Stockhammer and colleagues (2015) revised the relative chronology of Ruckdeschel. Based on ^{14}C data from Singen (grave 79), they suggested an earlier dating of the "*Horkheimer*" pins, a type which originally belongs, according to Ruckdeschel, to Phase A1b. Summarising all ^{14}C data that includes "*Horkheimer Nadeln",* Stockhammer and colleagues proposed a long use of this particular type of pin spanning a wide range of the Early Bronze Age. In contrast, bone and boar tusk pins, originally part of phase A1a, are not amongst the earliest pin types. Thus, Stockhammer and colleagues see a coexistence of robe pins belonging to phases A1b and A2a.

Overall, they interpret the Early Bronze Age as a complex coexistence of contemporaneously existing, multiple folk costume components and objects that also represent different bronze technologies. Hereby, Southern Germany demonstrates rather A1 types, whereas Eastern Germany, Bohemia, Moravia, Western

Poland, and parts of Slovakia and Austria, which represent the Únětice culture, show mainly casted types that belong to the A2 phase (Stockhammer *et al.* 2015).

Regarding the social structure of the burial ground of Singen at Hohentwiel, S. Sprenger (1994) calculated social indices within her unpublished Master's thesis. She concludes that particularly subadult females reveal a higher index compared to that of the interred male individuals. Although male burials are also represented in the highest category of social indices, the social indices of subadult males never exceed the average index value, which indicates that subadult males and females were treated differently. In the case of female burials, a norm concerning the combination of grave goods, especially in well-furnished burials, can be detected which is not linked to age, in contrast to males, where no norm in mortuary practices can be observed. According to S. Sprenger (1994), differently furnished groups with similarly high social indices are documented that are composed of both different gender and age groups. However, there are no senile persons included. Overall, no burial group can be identified that points to a ruling class and disadvantages for females in mortuary treatment cannot be ascertained.

Compared to the Early Bronze Age in Central Germany, no evidence for tumuli have been detected in Southern German mortuary practices, such as in the Early Bronze Age Únětice group (*e.g.* Leubingen, Helmsdorf, and Bornhöck) (cf. Meller *et al.* 2016), which shows that the Únětice group was a highly stratified society.

Spatial analysis

With regard to the spatial analyses of the burial ground and using a search radius of 10 m, the kernel density analysis reveals a relatively high occupancy density within both grave group I, which is located at the northern area of the burial ground, and particularly within grave group IV, which is situated at the southern area of the burial ground. In contrast, a relatively low grave density exists, however, within burial groups II and III. Thus, there are differences that cannot be explained by different preservation conditions and disturbances, *e.g.*, by modern road construction.

The projection of individuals according to age data demonstrates that subadult individuals are located predominantly within grave groups Ia and IV. By contrast, senile and mature individuals are mainly documented in grave groups IIa and III (Koch 2014, fig. 4). Based on anthropological determinations and the assumption that the majority of burials correspond to the Early Bronze Age burial norm of Southern Germany (north-south oriented burials = male; south-north oriented burials = female), male individuals dominate primarily in both the northern grave group I and in grave groups II and III, whereas in southern grave group IV mainly female individuals prevail (Fig. 55). Worth mentioning are the male mature/senile individuals in burial group III, where a relatively low density of burials exists that are interpreted as individuals with an outstanding position (Krause 1988, 127).

Values of grave goods

In order to emphasise inequalities concerning furnishing quality, values of grave goods for each burial were calculated. Ninety burials were included in the analysis. The values of grave goods are based on the scarcity of the respective object types within the

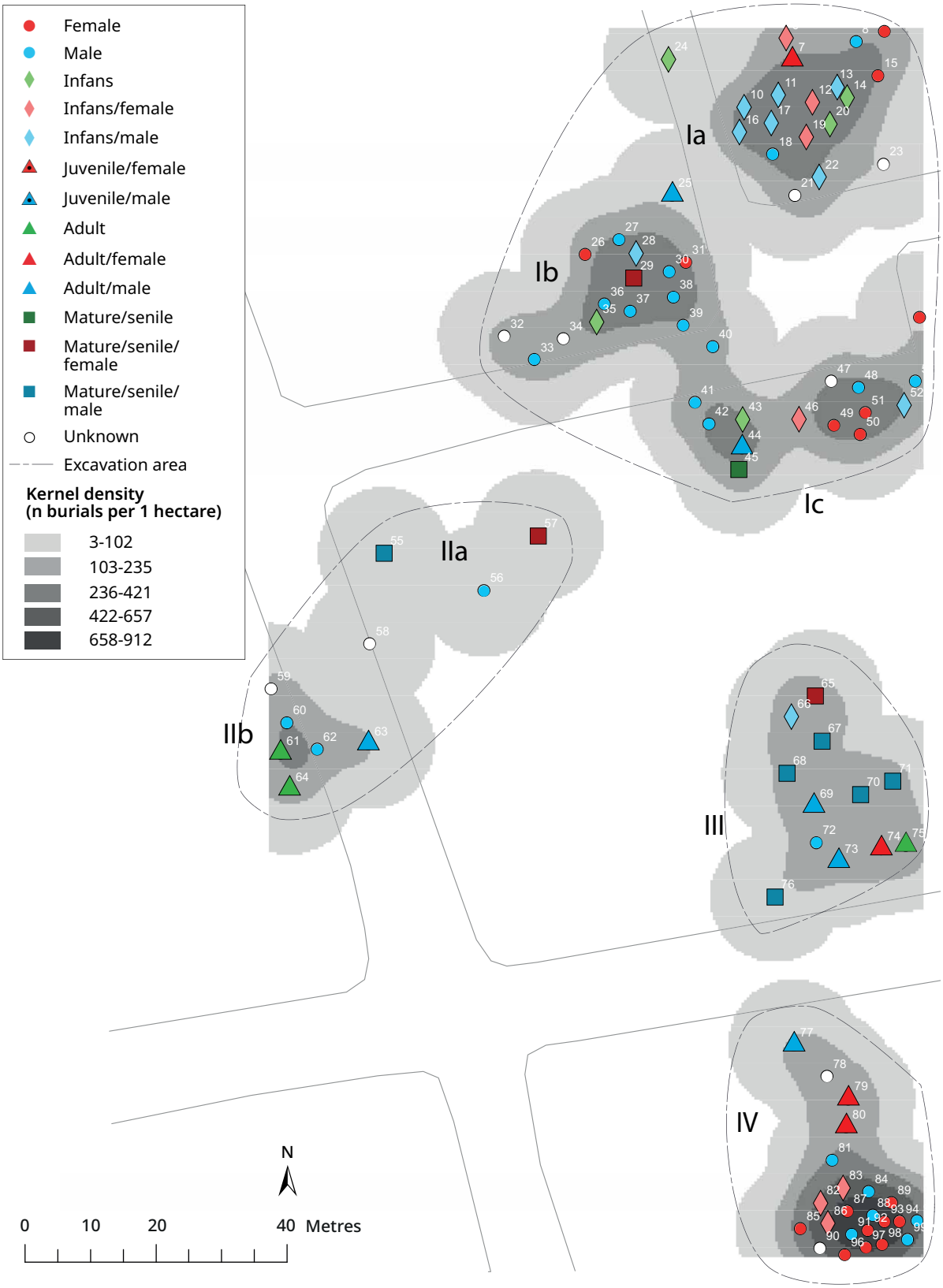


Figure 55. The cemetery of Singen at Hohentwiel with kernel density analysis and evidence of the age and gender of the buried. Cemetery plan after R. Krause (1988).

Object types	Calculated value
Robe pin	2.9
Arm spiral	3
Dagger <3 rivets	10
Dagger >3 rivets	10
Wire jewellery/tutuli	5.3
Lunulae/neck ring	11.3
Awl	9
Bone bead/bone ring/button/jet pendant/canine tooth/faience bead	5.3

Table 14. Calculated values of object types.

Grave no.	Values of grave goods	Age	Gender	Grave goods
63	1.00	Adult	Male	Dagger (4-5 rivets), ceramic, tutuli
73	0.74	Adult	Male	Dagger (4-5 rivets), bracelet, spiral ornament, silver ornament, jet pendant
82	0.66	Infans	Female?	Bracelet, jet and faience pendant, bone ring, awl
83	0.63	Infans II	Female?	"*Horkheimer Nadel*", bracelet, "*Ösenhalsring*", tutuli, awl
7	0.60	Adult	Female	"*Ruderkopfnadel*", dagger (2-3 rivets), silver ornament, awl, bone button

Table 15. Burials of the first category with information regarding grave no., values of grave goods (normalised), age, gender and grave goods.

cemetery and on the number of grave goods that are assigned to each individual (cf. 'Methods' chapter). Table 14 shows the calculated values of object types.

Based on natural breaks within the values (Jenks), five ranked categories were constituted. Five burials with the highest values of grave goods were identified for the first category. The burials are listed in table 15.

The burials with the highest grave values include adult male interments, each of which were furnished with large four to five-pointed daggers. Regarding females, two infans and one adult show the highest values of grave goods. The female furnishings consist, in general, of numerous different ornaments and folk costume components.

Furthermore, the results of the computed values of grave goods were correlated with the respective gender and age cohort in order to point out wealth inequalities among age groups (Fig. 56). Overall, the number of individuals in Singen is relatively small and no juvenile individuals could be identified. Regarding the total values, the boxplot diagram shows that adult individuals tend to have the highest values of grave goods. Moreover, the median values within the mature age cohort are approximately the same values as the median within the adult age cohort.

Differences in values of grave goods are observable between the genders: Regarding females, each age cohort demonstrates high values of grave goods. In particular, infans and mature age cohorts exhibit the highest median values. The high values of grave goods within the infans age cohort of females belong to

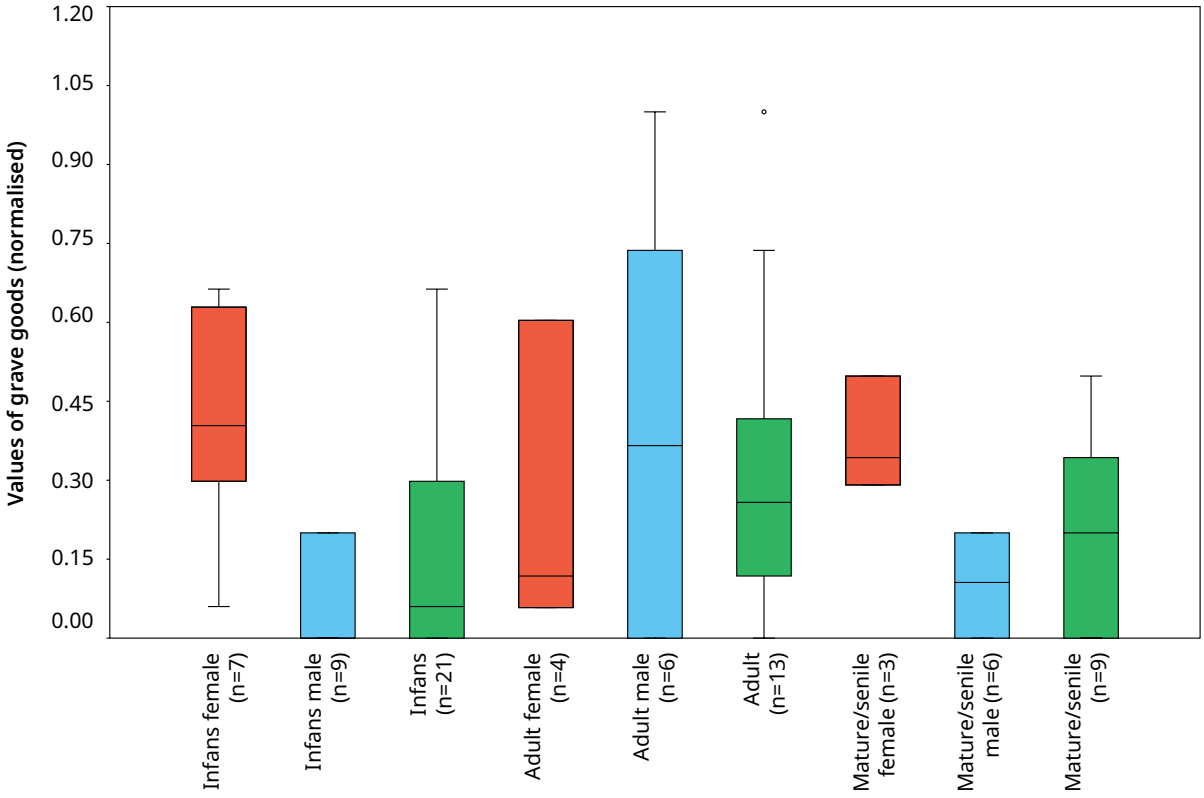


Figure 56. Values of grave goods linked with age and gender categories. Red = female, blue = male, green = total.

burials 82 and 83. Both burials were not only furnished with different kinds of ornaments but also with awls.

For males, the highest range and median are recorded within the adult age cohort. Also located in this age cohort are the males that have the highest values of grave goods. These interments are each composed of large daggers that consist of four to five rivets (burials 63 and 73). A striking feature of the adult age cohort is the high heterogeneity of values of grave goods. Accordingly, the male adult cohort particularly demonstrates an unequal treatment of the deceased.

Figure 57 demonstrates the distribution of the values of grave goods within the cemetery. The burials with the highest values of grave goods are distributed throughout the entire cemetery and tend to be located at the edges of grave groups rather than directly in their centres. It is striking that no grave of the first and second categories is included within the burial groups Ib and Ic.

Burial pit sizes

In the following, social differences of the interred individuals will be shown based on the burial pit size distribution or on the stone setting size distribution, respectively. S. Sprenger (1994, 147) already demonstrated that grave volumes do not correlate significantly with the body size, age or gender of the buried individuals. Accordingly, the author starts from the axiom that the size of the grave is predominantly independent of biological categories and can rather be traced back to social differences (*e.g.* rank or descent differences). Since R. Krause was able to demonstrate that burials within grave group IV were buried deeper in comparison to the other grave groups, the burial depth is accordingly rather group-specific/culturally determined. Thus, the area of the grave pit size in square metres – and if this information is not available –

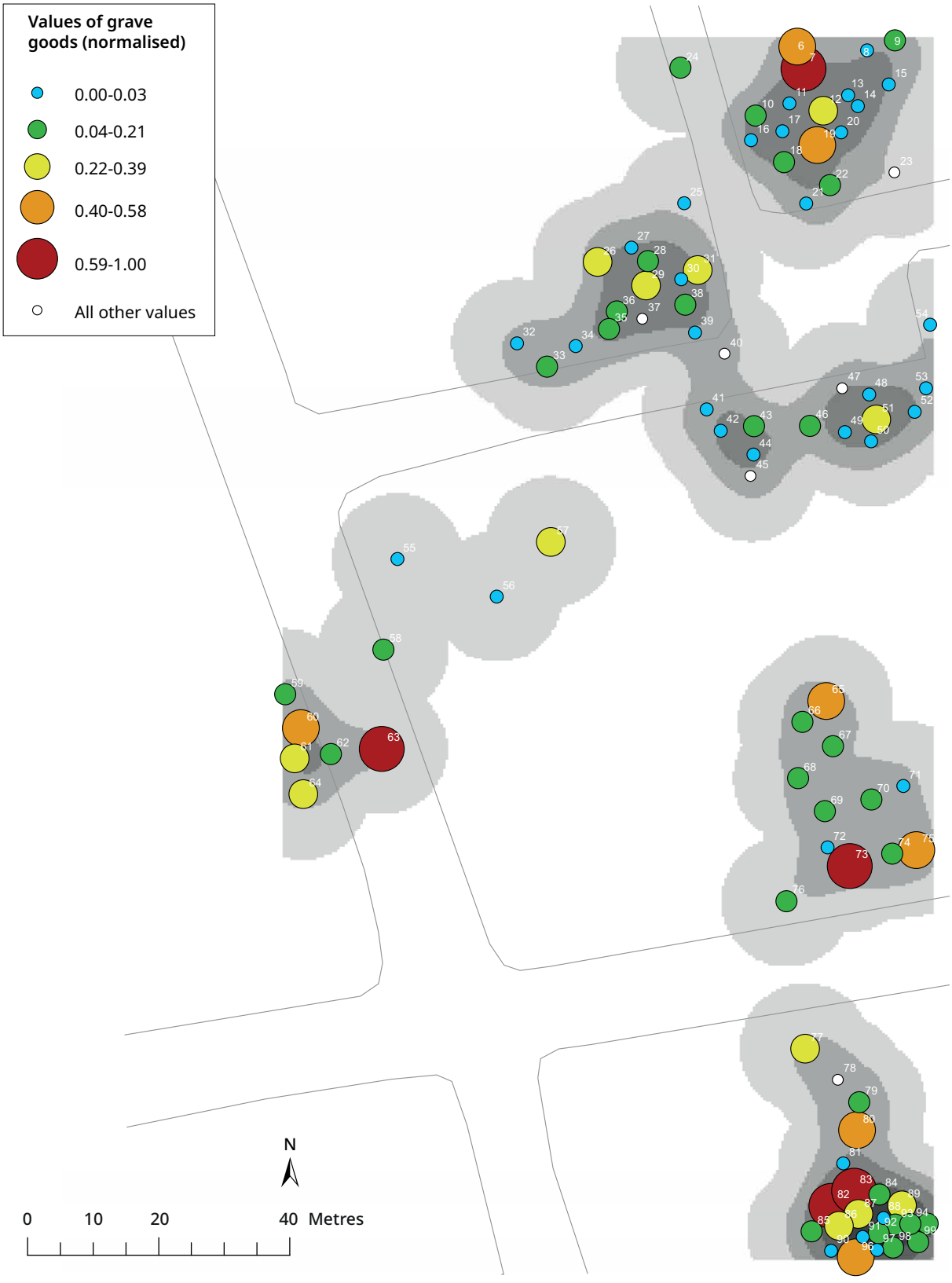


Figure 57. Distribution of values of grave goods within the cemetery according to categories and in combination with burial densities.

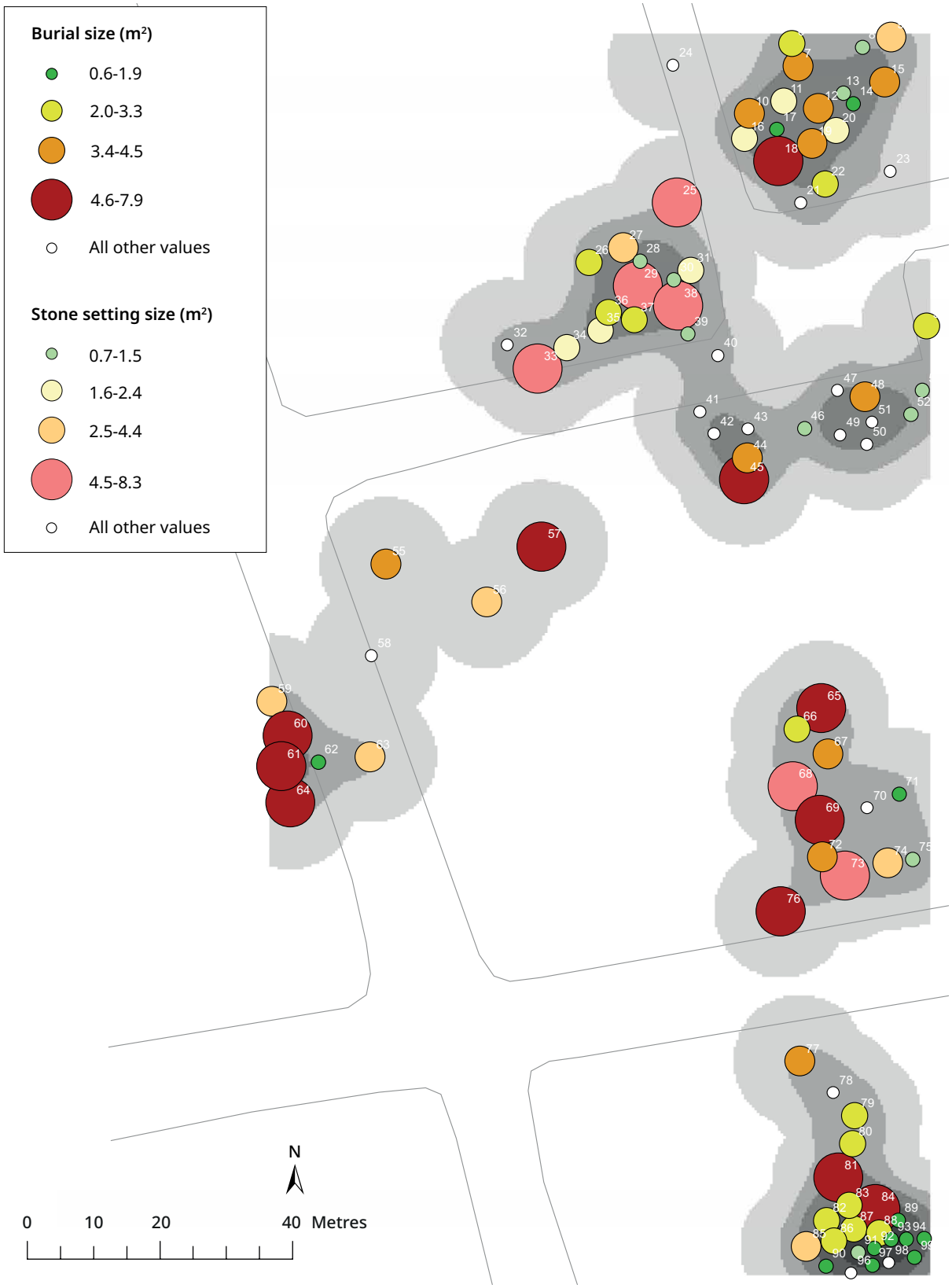


Figure 58. Distribution of burial size and stone setting categories associated with densities of burials.

Grave no.	Burial size (m²)	Age	Gender	Grave goods
60	7.92	?	Male?	"*Scheibenkopfnadel*", dagger (4-5 rivets, Atlantic), spiral ornament
64	7.44	Adult	?	"*Scheibenkopfnadel*", dagger (2-3 rivets)
57	6.39	Mature	Female	"*Scheibenkopfnadel*", tutuli, awl
76	6.24	Mature	Male	Dagger (4-5 rivets, Atlantic)
69	6.19	Adult/Mature	Male?	Dagger (4-5 rivets), ceramic
61	5.60	Adult/Mature	?	"*Scheibenkopfnadel*", tutuli, bracelet
81	5.60	?	Male?	-
65	5.40	Senile	Female	"*Ruderkopfnadel*", bracelet, dagger (2-3 rivets), awl
18	5.40	?	Male?	Dagger (2-3 rivets)
84	5.28	?	Male?	Dagger (4-5 rivets, Atlantic)
45	5.27	(Early)-adult Female? + Late-adult (-mature) Male?	?	-

Table 16. Burials of the first category related to burial sizes including information regarding grave no., burial size (m²), age, gender and grave goods.

Grave no.	Stone setting size (m²)	Age	Gender	Grave goods
29	8.28	Mature	Female	"*Ruderkopfnadel*", bracelet, "*Ösenhalsring*"
38	6.49	?	Male?	Bracelet, ceramic
33	5.94	?	Male?	Dagger (4-5 rivets)
25	5.88	Adult	Male?	-
73	5.60	Adult	Male	Dagger (4-5 rivets), bracelet, spiral ornament, silver ornament, jet pendant
68	5.40	Mature	Male	Bone ring

Table 17. Burials of the first category related to stone setting size, including information regarding grave no., burial size (m²), age, gender and grave goods.

the size of the stone setting is used as a reference measure.

Figure 58 illustrates that the largest burial pits are located within grave groups II and III. In the northernmost and southernmost areas of the burial ground (Ia and IV), the grave pit sizes and stone setting sizes are rather small. It is also obvious that within these burial clusters the more the graves lie on the edges of the burial ground, the larger the pits; a fact that cannot be explained by the presence of infans burials in this area alone.

In table 16, the graves are listed that are included among the burials with the largest grave pits.

Burials without information about the size of the burial pits, but with information about the size of the stone settings, are listed in table 17.

With respect to the largest grave pits/stone setting sizes (category 1), tables 16 and 17 include a very high proportion of mature or senile individuals, even though anthropological age determinations are not available for each individual. However, only three burials from both tables are considered to be definitely younger.

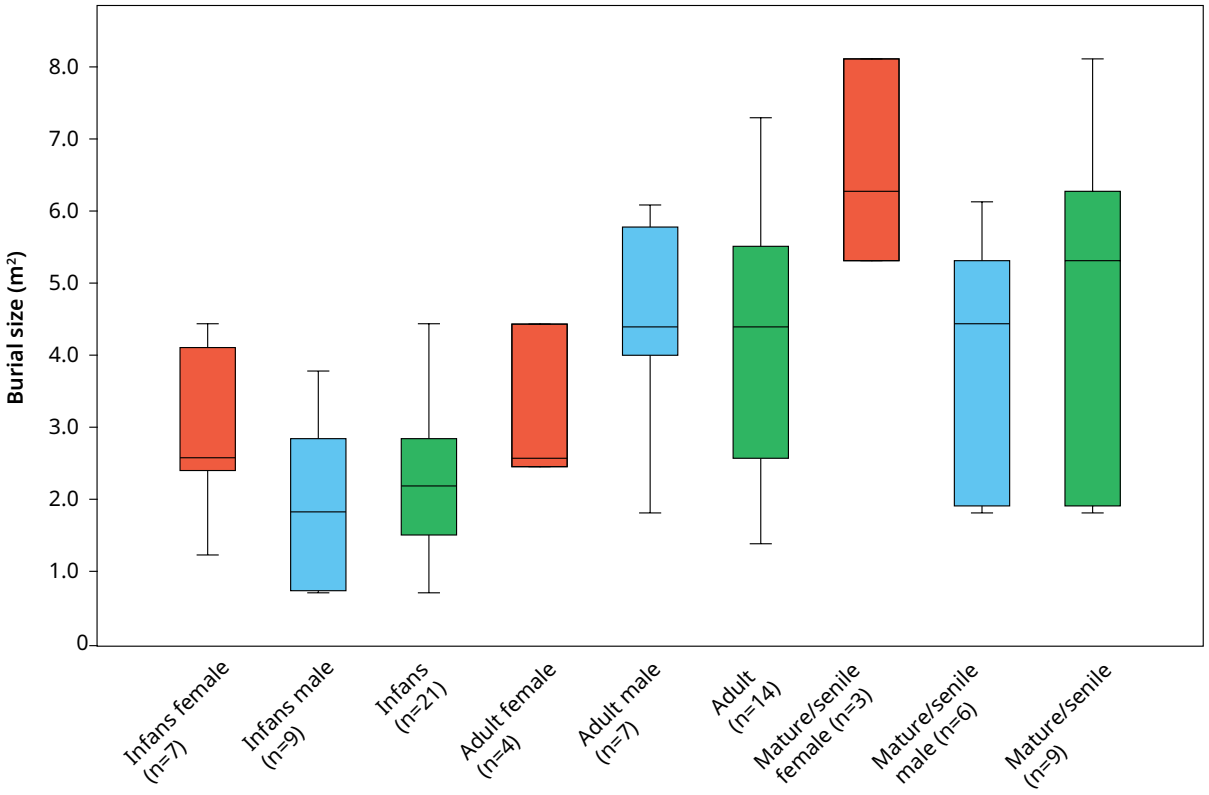
The largest burials are assigned mainly to males and only to three determined females. The three females were buried at a mature or senile age, respectively (Kupke 2010; Sprenger 1994; 1995).

It is evident that males that show large graves relatively often include large daggers that have more than four rivets. Graves 33, 60, 69, 73, 76, and 84 are among the burials exhibiting such a dagger. The daggers in graves 60, 76 and 84 are also so-called Atlantic daggers that have their origin abroad – in Brittany or southern English regions. Burial 18 includes a dagger with three rivets (Krause 1988, 57).

Belonging to the few females that have a large burial pit or stone setting area are burials 29, 57 and 65. In addition to their old age, these females are associated with the presence of extraordinary pins. Burials 29 and 65 each exhibit a large decorated "*Ruderkopf*" pin; burial 57 includes a singular shaped pinhead within the interment. All these burials are characterised by overall rich furnishings, consisting of arm spirals (tombs 29, 65), a dagger (tomb 65), tutuli (tomb 57) and awls (tombs 57, 65) (Krause 1988).

The high status of mature cohorts is shown as well by the comparison of adult and mature grave pits and stone settings within the boxplot graph (Fig. 59). Mature individuals tend to have larger grave pits than adults and subadults. The difference between the subadult and the adult or mature age cohorts, respectively, is significant (Mann-Whitney pairwise test: infans-adult, p = 0.0008961; infans-mature, p = 0.00242).

Figure 59. Distribution of burial pit and stone setting sizes in relation to age cohorts, genders and the total number of burials.



If genders are considered separately, differences emerge similarly. Even though there are only a few burials for each age and gender cohort, it is nevertheless obvious that mature females tend to have relatively big burial pits/stone settings. In contrast, the grave pit/stone setting sizes of infans and adult females are smaller and differ little in interquartile distances. Regarding males, infans tend to have small grave pits/stone settings – even smaller in comparison to female infans. In comparison, adult and mature/senile male individuals have relatively similar big burial pits/stone settings. However, they are significantly smaller in comparison to female mature graves.

Of course, age and gender as well as body height influenced the extent of a burial. However, there are also comparatively large infans burials (grave 19, probably female) and many adult burials, such as graves 71, 79 and 80, which were kept relatively small. Accordingly, bioanthropological conditions should not be disregarded in the analysis of burial size, but they did not exclusively influence the size of the burial pits or the stone setting sizes of the interred individuals. Consequently, the social positions of the buried individuals also have to be considered in the context of burial pit sizes.

Values of grave goods and burial pit sizes

As a further step, the calculated values of grave goods and the grave pit/stone setting sizes were summarised as converted, normalised numbers. Included in the burials in table 18 are the individuals with the highest values in the summation of the two factors.

Three males and three females are included among the buried persons with the highest values. For one individual, the anthropological and archaeological gender could not be defined. The individuals belong to the age cohorts adult and mature/senile. The high burial values result among females from the deposited "*Ruderkopf*" and "*Scheibenkopf*" pins in combination with small daggers (graves 64, 65, and 7; Fig. 60); among males, apart from large burial pits/stone settings, from the deposit of four-five rivet daggers (graves 63, 60 and 73; Fig. 61). Accordingly, both in male and female contexts, daggers represent a status symbol for high-ranking individuals that are associated with the adult and mature/senile age cohorts.

Table 18. Summarised and normalised values of grave goods and normalised burial sizes with additional information concerning age, gender and grave goods.

Grave no.	Value of grave goods + burial size (normalised value)	Age	Gender	Grave goods
63	1.49	Adult	Male	Dagger (4-5 rivets), ceramic, tutuli
60	1.48	?	Male?	"*Scheibenkopfnadel*", dagger (4-5 rivets, Atlantic), spiral ornament
73	1.41	Adult	Male	Dagger (4-5 rivets), bracelet, spiral ornament, silver ornament, jet pendant
29	1.34	Mature	Female	"*Ruderkopfnadel*", bracelet, "*Ösenhalsring*"
64	1.16	Adult	?	"*Scheibenkopfnadel*", dagger (2-3 rivets)
65	1.15	Senile	Female	"*Ruderkopfnadel*", bracelet, dagger (2-3 rivets), awl
7	1.15	Adult	Female	"*Ruderkopfnadel*", dagger (2-3 rivets), silver ornament, awl, bone button, bracelet

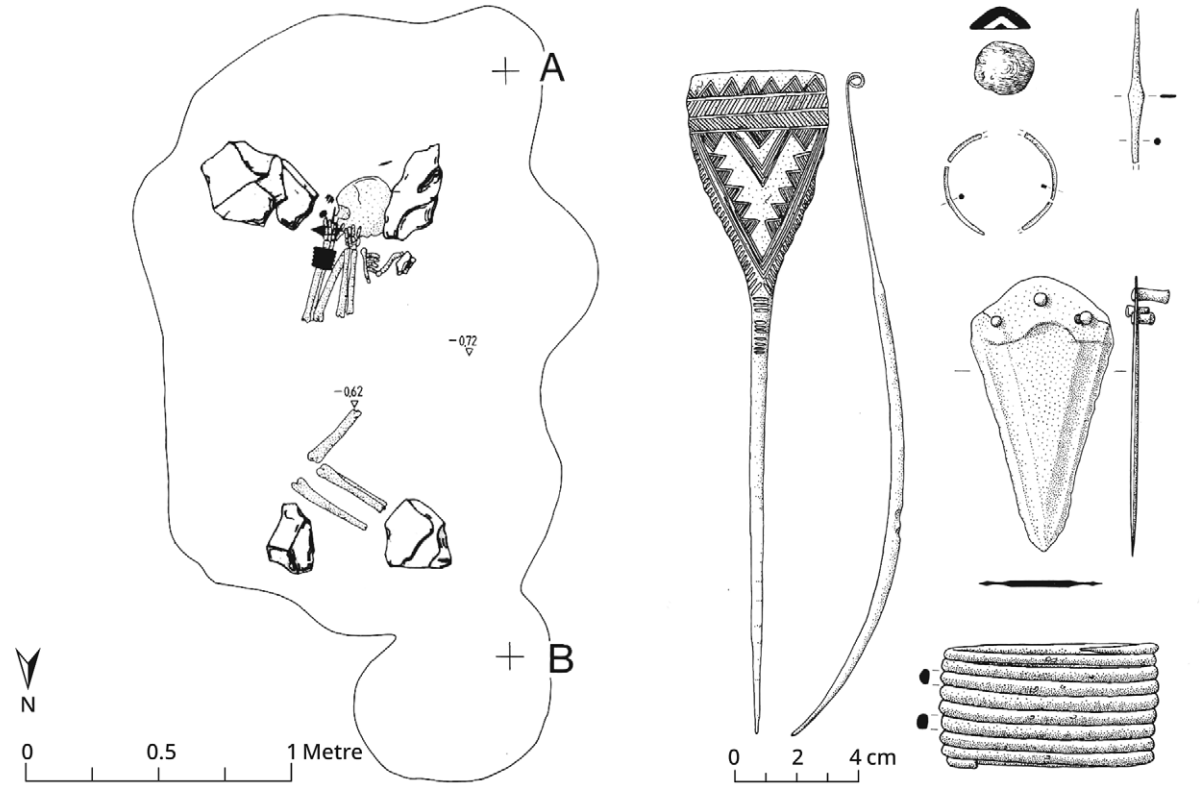


Figure 60. Female burial 7 (cf. Tab. 18). One of the burials with the highest burial value (sum of normalised values of grave goods and burial pit size) (Krause 1988, 299, Taf. 2).

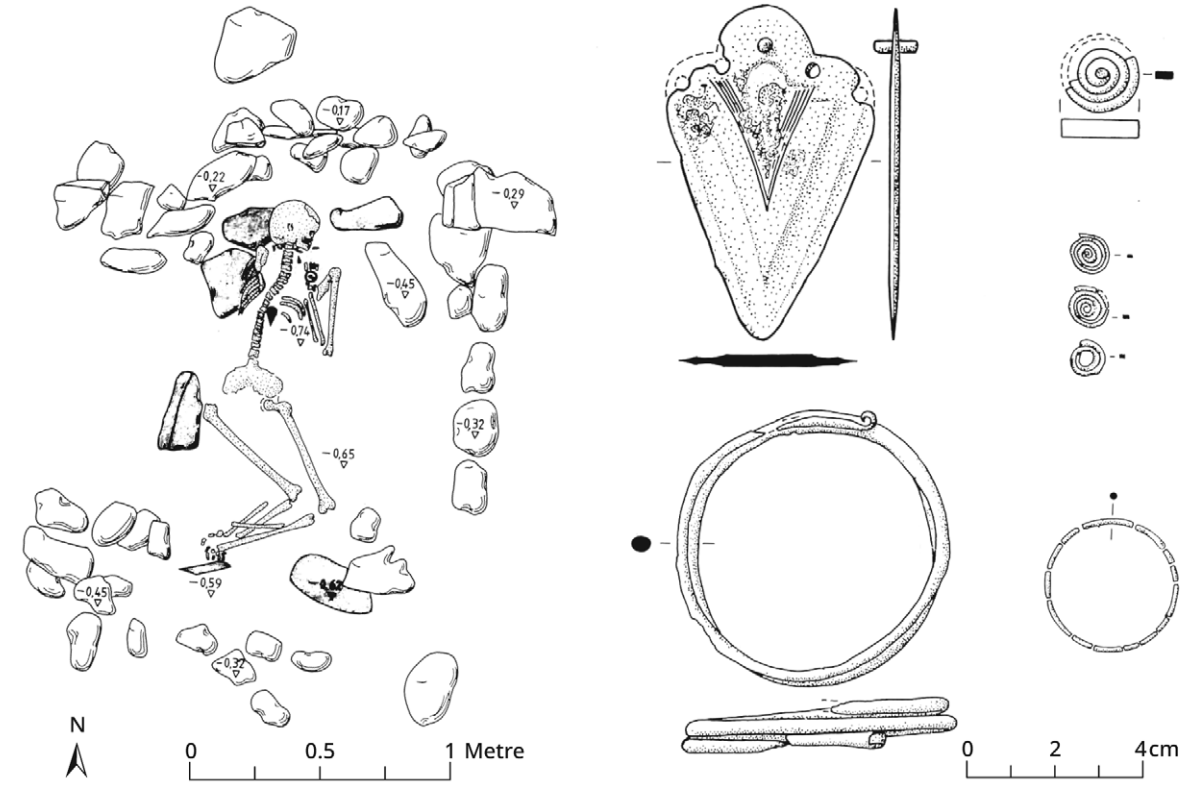


Figure 61. Male burial 73 (cf. Tab. 18). One of the burials with the highest burial value (sum of normalised values of grave goods and burial pit size) (Krause 1988, 328, Taf. 7).

The burials with the highest burial values are located especially in the middle areas of the cemetery in grave groups IIb and III. In the southern area within burial group IV, no burials of the highest category are located. This includes burials that have no or rare burial goods (Fig. 62; 63).

In a further step, it was analysed to which extent the size of the burial pit or the stone setting size correlates with the values of the grave goods (Fig. 64). Secure infans burials are excluded. The correlation of all burials results in a moderate and significant positive correlation (Linear r (Pearson): 0.32695, p = 0.013912). A moderate and positive correlation (Linear r (Pearson): 0.3856, p = 0.103) was also observed among the female and among the male sample (Linear r (Pearson): 0.37215, p = 0.039248). Both demonstrate significant results. Overall, females show lower values of grave goods and smaller grave pit sizes. Only three female burials have grave pits that are larger than 5 m^2; among males, eleven burials exhibit large graves that are bigger than 5 m^2. All female burials, which are associated with large burial pits, show relatively high values of grave goods (graves 29, 57, and 65). Characteristic items in these mature and senile burials are, among other burial goods, "*Ruderkopf*" pins (graves 29 and 65) and awls (graves 57 and 65). Regarding males, seven of eleven burials (18, 33, 60, 69, 73, 76 and 84) display large burial pits (≥ 5m^2) and relatively high values of grave goods (≥ 0.2). Characteristic objects of these burials are big daggers with four to five rivets.

Lorenz curves and Gini indices

In the following, degrees of social inequality within the cemetery are presented, which are represented as Gini indices. Gini indices for the distribution of grave goods in the cemetery are shown for both females and males and for the total sample. The calculation of the Gini index for the distribution of the values of grave goods results in a total value of 0.64; the Gini index for females amounts to 0.46 and for males 0.73. Therefore, the Gini index and the inequality distribution are higher among males than among females. This is already evident from the fact that the Lorenz curve for females lies much closer to the 45-degree line and does not intersect the Lorenz curves for males (Fig. 65). Thus, a Lorenz dominance is given. Furthermore, the Lorenz curve concerning males demonstrates that about 50% of the male population did not have grave goods compared to female graves where a lower proportion was interred without grave goods. Moreover, the high inequality degree with regard to males is also caused by the furnishing or non-furnishing of daggers.

Distance to the next burial

As a next step, the distance to the next neighbouring burial is investigated. It is assumed that the distance to the next adjacent burial is linked to certain social positions. Moreover, it may correlate with the degree of both burial pit and stone setting sizes and/or with values of grave goods. From this, we infer further observations regarding the social position of individuals within the burial community.

First, with regard to the correlation between values of grave goods and the distance to the next adjacent burial, no positive correlation can be demonstrated. Only male mature burial 76, which is furnished with an Atlantic dagger, and female mature

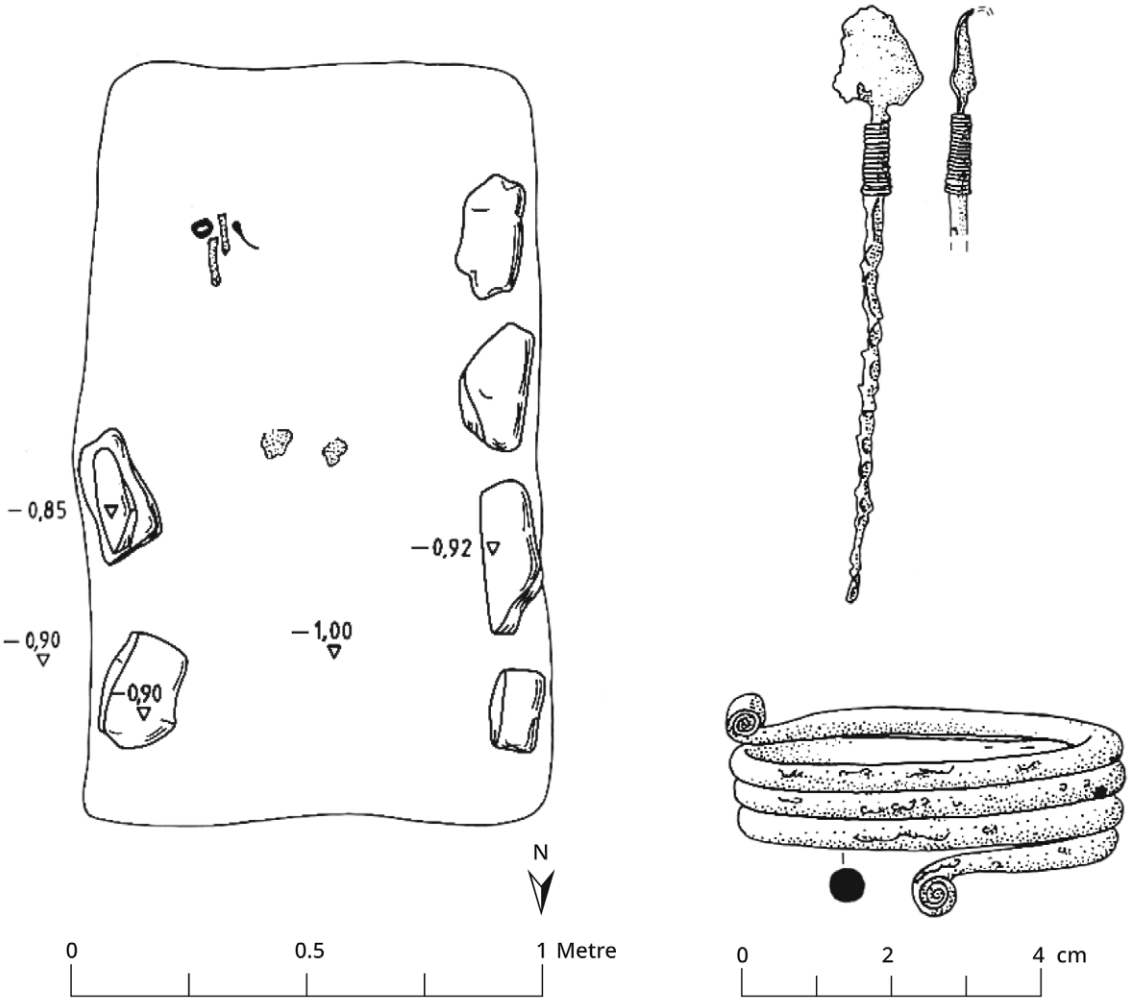


Figure 62. Female burial 92 belongs to the graves with the lowest burial value (Krause 1988, 341, Taf. 8).

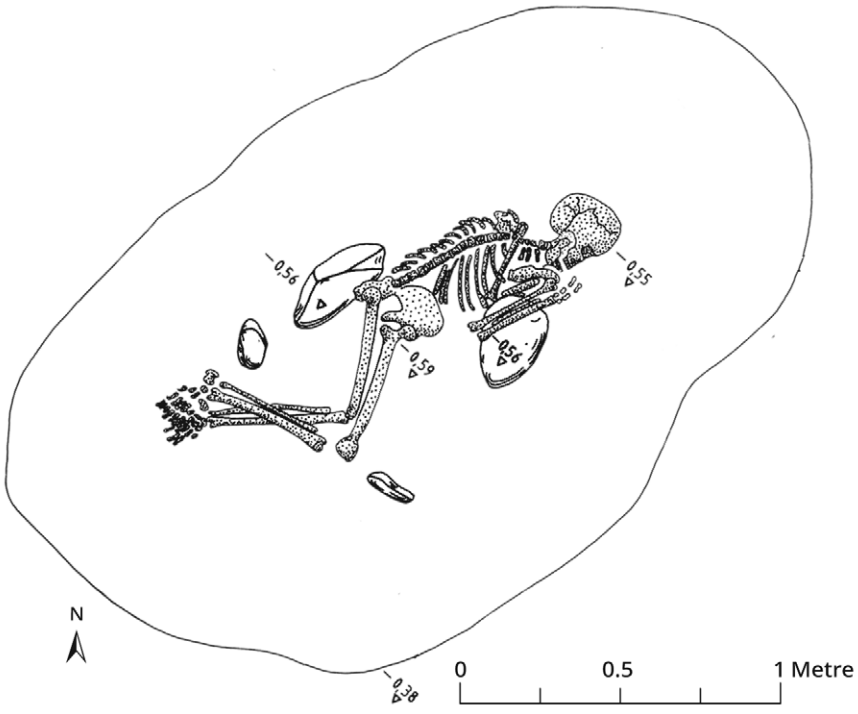


Figure 63. Male burial 55 belongs to the graves with the lowest value (Krause 1988, 317).

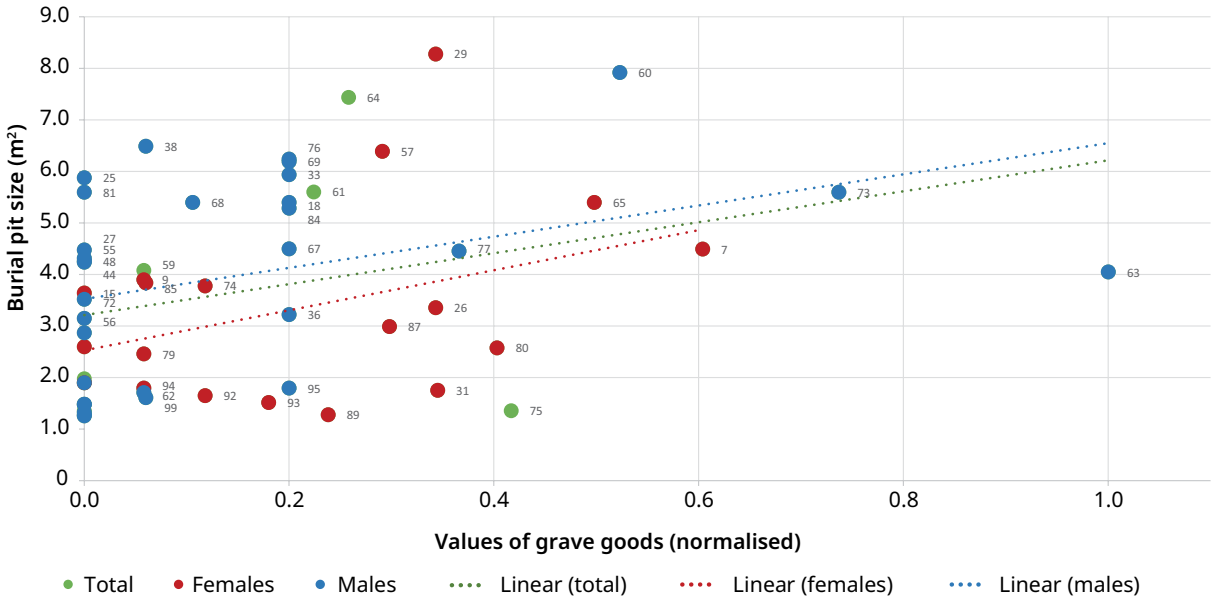


Figure 64. Correlation of normalised values of grave goods and grave sizes (m²) according to genders. Also depicted are linear tendency lines.

burial 57, which is furnished with a "*Scheibenkopf*" pin, a tutuli and an awl, show an above-average ensemble of grave goods and a high distance to the next burial.

In contrast, figure 66 shows a moderate and significant positive correlation between burial pit/stone setting size and the distance to the next burial (Linear r (Pearson) = 0.36789; p = 0.00099585; n = 77). In particular, male adult/mature burials 25, 56, 63, 76 and 77 show both large grave pits and a high distance to the next burial, whereas the mature male burials from graves 63, 76 and 77 combine all three aspects: high distance to the next adjacent burial, large burial size and a rich furnishing with, among others, four-rivet daggers.

Naturally, it should be considered that the size of the burial effects the distance to the next burial. However, relatively large grave pits have also been laid out relatively close to the next burial.

A further question relates to the relationship between the age cohort of the interred individuals and the distance to the next burial. As a result, the boxplot diagram (Fig. 67) shows that in context of the total number, the distance to the next burial increases with age.

In general, infans burials are located relatively close to each other, which may also be explained by family ties. On the other hand, mature/senile burials are situated with the highest distance to the next burial in relation to the median value. Accordingly, the difference between the age cohorts is significant (Kruskal-Wallis test for equal medians: p (same): 0.003385).

Even though the number of burials is relatively low in relation to genders, there are still differences. It can be observed that adult and mature males were buried much more distant from the next adjacent grave than adult and mature females. However, the three mature females demonstrate a relatively high interquartile distance containing high and low values. For both females and males, infans burials show a pronounced proximity to the next burial.

Diet, growth and status: Nitrogen ($\delta^{15}N$)

The following chapter integrates differences concerning diet into the inequality analysis. K. Kupke (2010) provided 25 samples for $\delta^{13}C$ and $\delta^{15}N$ analyses, extracted

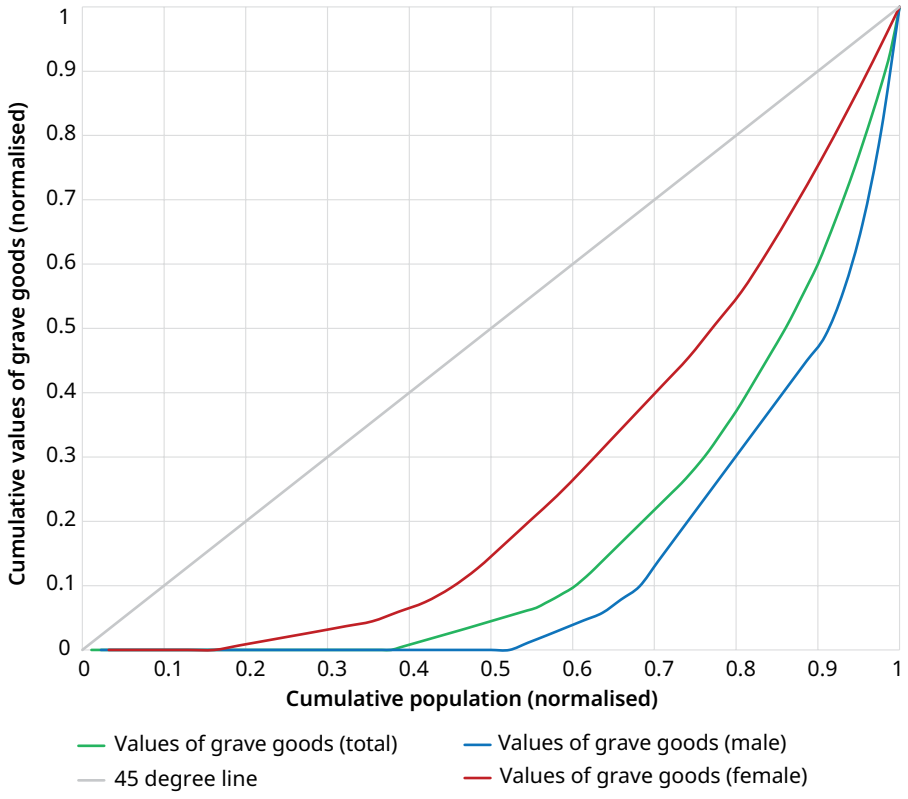


Figure 65. Distribution of values of grave goods displayed as Lorenz curves considering the total number of individuals, females and males.

from bones – mainly ribs. The burial community in Singen subsisted on a C3 omnivore diet. The $\delta^{15}N$ ratios in Singen range between 7.9‰ and 10.5‰ (Kupke 2010) with a higher mean in males compared to females (males: 9.85‰, SD = 0.49‰, n = 12; females: 9.3‰, SD = 0.67‰, n = 11). However, the difference is not significant (T-Test, two-tailed: p = 0.065, n = 23). Moreover, the sample standard deviation is higher among females, which points to a higher inequality in diet among women. Furthermore, K. Kupke (2010) has established a relation between intake of meat and age: The older the individuals, the more meat they consumed. According to K. Kupke (2010), the difference, however, is not significant in this context.

In order to emphasise the dissimilar access to animal proteins, the nitrogen isotope ratios were categorised that confidently demonstrate the consumption of animal proteins. Since the nitrogen value ranges differ between females and males, the value ranges are divided into quartiles separately from each other. Category 1 includes the value range between maximum and upper quartile (including outliers), category 2 the range between upper quartile and median, category 3 the range between median and lower quartile and category 4 the value range between lower quartile and minimum.

Figure 68 shows the distribution of classified nitrogen values in order to detect category clusters among the cemetery. In table 19, the burials that include the highest nitrogen isotope ratios are listed.

Strikingly, both male and female burials that have the highest nitrogen isotope ratios demonstrate similarities with the furnishing of grave goods. Male burials 33 and 77 each include a five-rivet dagger that has the same triangle decoration. In contrast, female graves 86 and 87 are furnished with identical grave goods consisting of "*Scheibenkopf*" pins, small bracelets and awls.

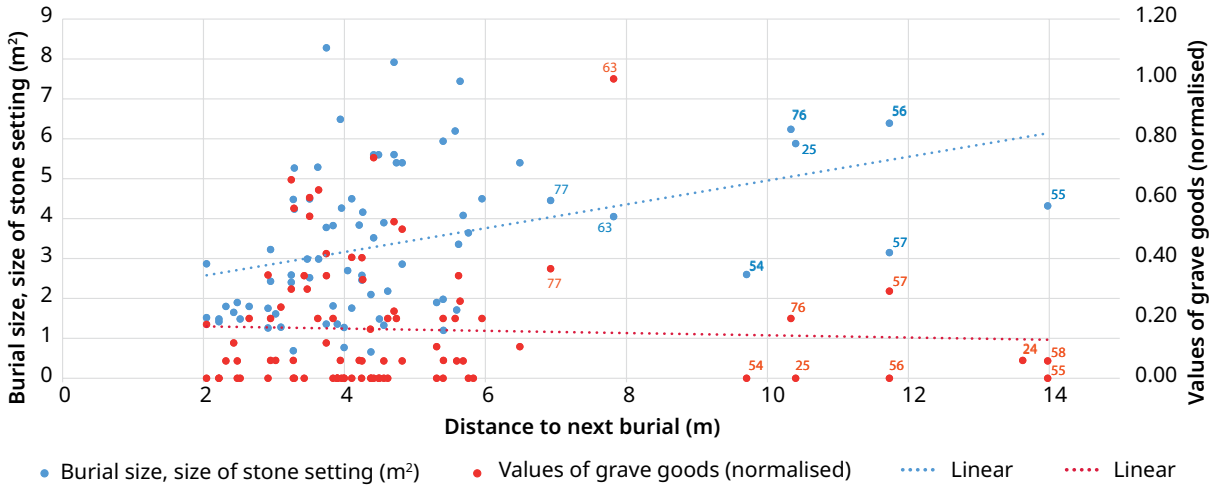


Figure 66. Linear regression between distances to the next burial (x-axis) and burial size/value of grave goods (both y-axis).

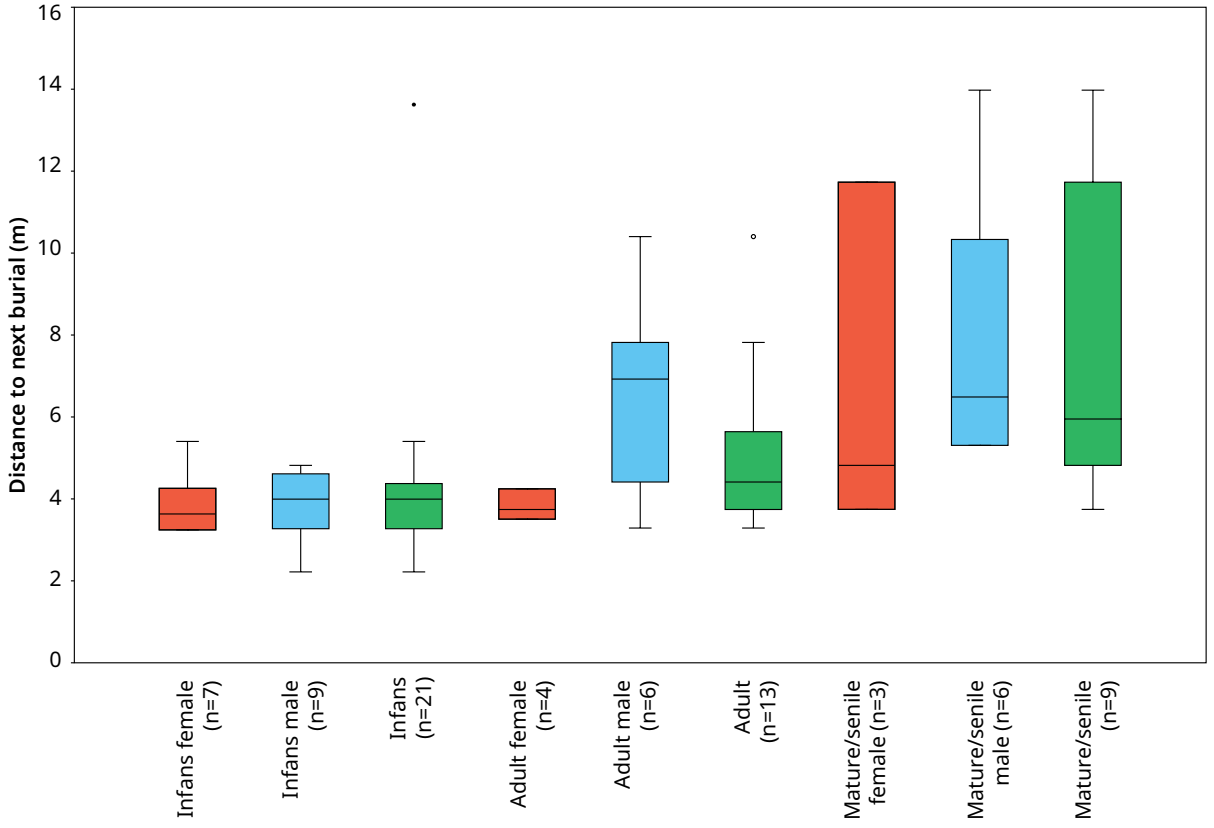


Figure 67. Ranges of distances to the next burial according to the total number of burials, genders and age cohorts.

Although a low number of stable isotope ratios was sampled, it is nevertheless obvious that the highest $\delta^{15}N$ values, marked in red, are rather documented in the southern part of the cemetery (grave group IV). In contrast, grave group III demonstrates relatively low values (marked in blue and green). This result is rather unexpected since the large daggers in grave group III therefore also demonstrate low nitrogen ratios. It was assumed that they are also associated with relatively high nitrogen isotope ranges.

According to table 19, awls and large daggers belong to the objects linked to individuals that are associated with high nitrogen isotope ratios. Therefore, the question arises, what nitrogen isotope ratio relation is found among the remaining individuals that are not furnished with such objects. Among females, the relation between awls and high $\delta^{15}N$ ratios is evident. Females furnished with awls yield a mean of 9.82‰, compared to the remaining female individuals, which yield a mean of only 8.8‰. The difference in mean is significant (T-Test: $p = 0.004$, $n = 11$) (Fig. 69).

Although males that display large daggers as well as Atlantic daggers with four to five rivets show relatively high nitrogen isotope ratios, the difference to the remaining males is not significant (dagger: mean: 9.86‰; no dagger: mean 9.58‰, t: 0.94929, p (same mean): 0.37027) (Fig. 69).

With respect to the correlation between $\delta^{15}N$ ratios, values of grave goods (Linear r (Pearson) = 0.060071; p = 0.78038) and burial pit/stone setting sizes (Linear r (Pearson) = 0.091594; p = 0.67035), small correlations can be observed that are, however, less than r = 0.10 (Fig. 70). Graves 57, 63 and 65 belong to the burials that reveal large burial sizes, high values of grave goods and high ratios of nitrogen stable isotopes. The adult male grave 63 exhibits, among other goods, a big four-five rivet dagger and numerous tutuli. Senile female grave 65 has, among other burial objects, a "*Ruderkopf*" pin, an awl and a small dagger. Burial 57 includes, among other burial objects, a "*Scheibenkopfnadel*" ("*Scheibenkopf*" pin), an awl and one tutuli.

Heterogeneity and transformation

In contrast to the hierarchical approach, the following analysis will examine to what extent heterogeneous population structures become visible within the burial community. The aim is to identify different clusters of grave goods that could point to different social roles within the community. For this purpose, the burials with information on grave goods were transferred to a correspondence analysis.

As a result, the correspondence analysis (Fig. 71) shows the following clusters at the 1st and 2nd principal axes: In the negative area of the 1st principal axis and the positive area of the 2nd principal axis, burials with large daggers, ceramics and also wire jewellery are located. This concerns mainly male burials of grave group IIb. In the negative area of the 1st and 2nd principal axes, different decorative elements and tools are located. These include silver wire jewellery, jet pendants, bone rings, awls, shorter bracelets, "*Scheibenkopf*" pins and smaller daggers. All grave groups are located here with the exception of Ib and Ic. In the positive area of the 1st principal axis and in the negative area of the 2nd principal axis, the variable "*Ruderkopf*" pin is situated. It is mainly associated with grave group Ia. The variables "*Horkheimer*" pins, "*Ösenhalsringe*" and large bracelets are located in the outermost positive area of the 1st principal axis. Especially female burials of grave group IV – but also Ib and Ic – are located here.

Also projected into the correspondence analysis is ^{14}C data by P. W. Stockhammer and colleagues (2015). Overall, the range of the ^{14}C data overlaps. However, the location of the data in the analysis shows slight foci. Daggers with four-five rivets, tutuli as well as burials that are assigned to grave group IIb (at the negative range of the 1st principal axis, positive range of the 2nd principal axis) are linked with absolute data that ranges to an earlier occupation. Probably, the carriers of these daggers are part of founder burials (graves 63 and 69). In contrast, "*Ruder-*

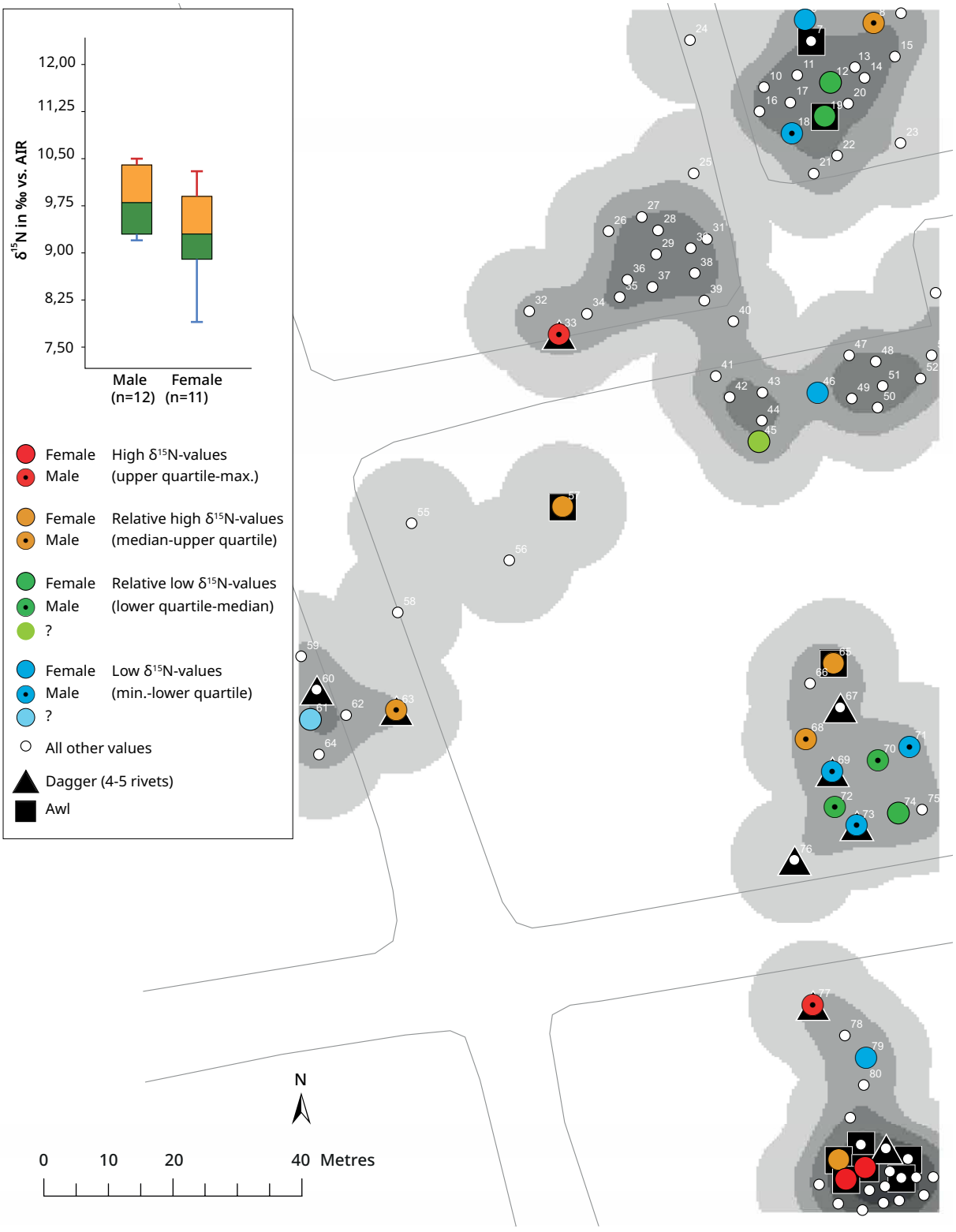


Figure 68. Distribution of $\delta^{15}N$ ratios categorised by value level and gender. Additionally, daggers (4-5 rivets) and awls are depicted.

Grave no.	$\delta^{15}N$	Grave group	Age	Gender	Grave goods
33	10.4	1b	?	Male?	Dagger (4-5 rivets)
77	10.4	4	Adult/Mature	Male?	Dagger (4-5 rivets), small bracelet, bone ring
87	10.3	4	?	Female?	Awl, "*Scheibenkopfnadel*", small bracelet
86	10.1	4	Infans	Female?	Awl, "*Scheibenkopfnadel*", small bracelet
101	10.5	-	Adult	Male	Robbed, ceramic sherds

Table 19. Burials with the highest $\delta^{15}N$ ratios.

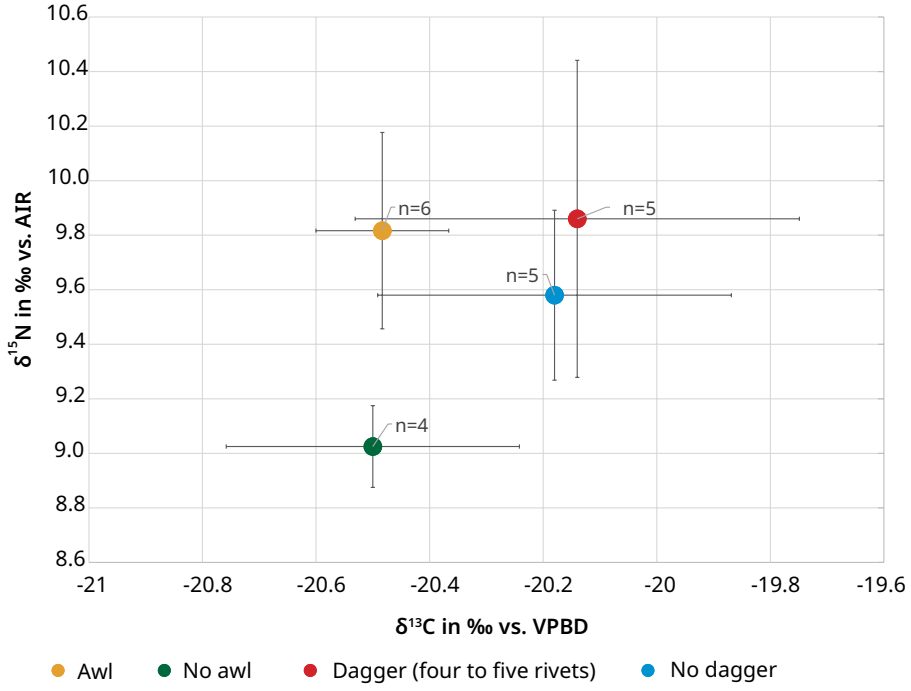


Figure 69. Correlation between individuals who have big daggers and awls according to respective genders as compared to individuals without daggers and awls.

kopf" pins (positive range of the 1st principal axis, negative range of the 2nd principal axis) tend to be connected to ^{14}C data that ranges to a later phase within the burial ground. However, with respect to the linkage between "*Ruderkopf*" pins and a relatively late chronological phase, it has to be considered that, for instance, the relatively late dated grave 65 that is furnished with a "*Ruderkopf*" pin is also linked with the oldest senile individual of the entire burial community.

Representing the four described clusters, the distribution map in figure 72 shows the distribution of the large (4-5 rivets) and small daggers (2-3 rivets) as well as of the "*Ruderkopf*" and "*Horkheimer*" pins. Included in the map is also ^{14}C data in BCE and 1-Sigma range. The map illustrates that the emphasised objects are represented within different areas of the cemetery. Large daggers are mainly located in grave groups IIb and III, smaller daggers in grave group Ia, "*Ruderkopf*" pins in grave group Ia and "*Horkheimer*" pins in grave group IV (cf. Krause 1988).

In order to expand the question whether we are dealing with different social groups (*e.g.* family associations, clans) interred in different areas or whether other, *e.g.*, chronological factors are responsible for the dissimilar distributions of different objects within the burial ground, ^{14}C data from R. Krause's publication, on the one hand, and from P. W. Stockhammer and colleagues, on the other

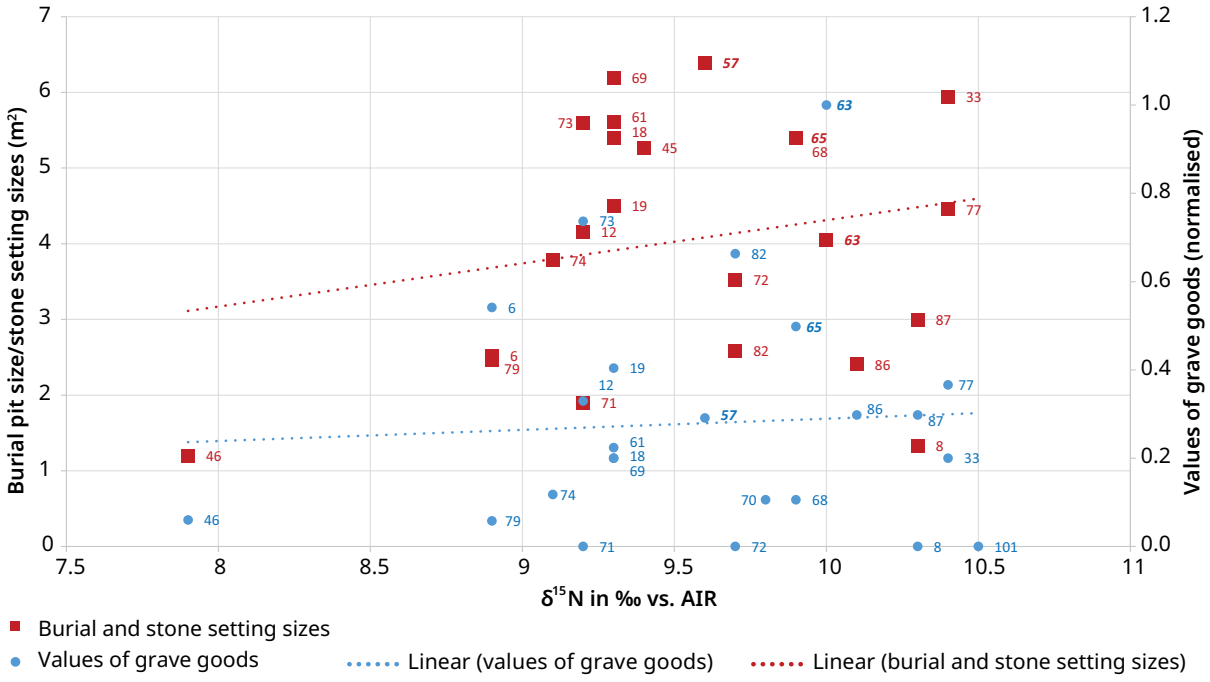


Figure 70. Linear regressions between burial sizes, values of grave goods (both y-axis) and nitrogen ratios (x-axis).

hand, are compared with each other concerning affiliations in the grave groups (Fig. 73). The mentioned publications compiled ^{14}C data using new, improved methods in the form of AMS (Accelerator Mass Spectrometry) datings.

Even though the ^{14}C data from Singen at Hohentwiel covers a relatively narrow time corridor and overlaps, it can be observed that there are slight chronological differences with regard to the occupancy of the individual grave group areas. With regard to the sum data of the more recent dating, it can be discerned that grave groups I, II and IV begin at about the same time at approximately 2200 BCE and end at about the same time at approximately 1950 BCE. This contrasts to grave group area III, in which the occupancy phase tends to start later at about 2100 BCE and end later at about 1900 BCE. Likewise, the older ^{14}C dates from R. Krause demonstrate that the youngest ^{14}C dates are included in grave group III. This appears in burials 68 and 74.

However, it is also recognisable that the dates within grave group area III cover both earlier and later ^{14}C data. Regarding the ^{14}C data from R. Krause, graves 65 and 70 differ and point to an earlier occupation phase in contrast to the ^{14}C data of P. W. Stockhammer and colleagues, in which grave 69 differs and points to an earlier stage. Grave 69, which includes a big five-rivet dagger, probably represents one of the founder graves.

The fact that grave group III demonstrates a higher dating variance, however, also has to do with the fact that this grave group tends to contain the oldest individuals in the sample (Fig. 72-73).

Strontium isotope analysis

The next section refers to the strontium isotope ratios and the question whether there are differences concerning the origin of the buried individuals. V. M. Oelze and colleagues (2012b) sampled 22 individuals, probably 13 males, 8 females, and 4 indeterminate individuals. In relation to the complete burial ground, this

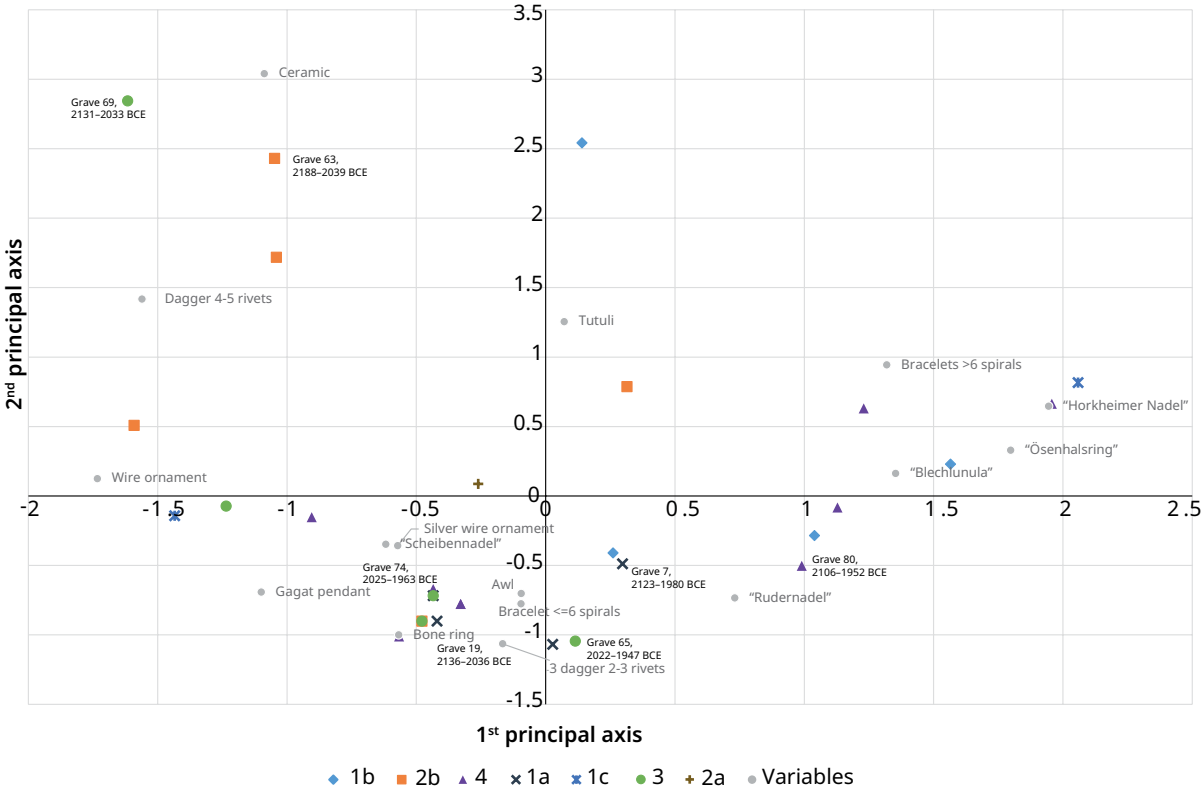


Figure 71. Correspondence analysis (CA) of grave goods (variables) and burials (objects). The CA includes the 1st and 2nd axes. The cumulative explanation in percentage, which is expressed by the first two axes, equals 31. Burials include information regarding grave group and absolute dating if existing.

is a relatively low sample size. The minimum value amounts to 0.7074 and the maximum to 0.7094. V. M. Oelze and colleagues (2012b, 758) suggest that no value showed clear evidence for distant residence during the phase of tooth formation and that the locations of residence of the interred were connected to the region around Singen with its moraine, limestone, and tuff geology. That is unexpected, since evidence for far-reaching connections, such as typological parallels of Singen daggers to Brittany and Britain, lead one to expect a high proportion of non-locals at the site (Reiter and Frei 2019, 457). Hence, the mobility pattern exhibited by the inhabitants of Singen seemed to be non-migratory. In contrast, the investigations of the Lech Valley in Southern Germany disclosed an unexpectedly large number of females that were non-local (Knipper *et al.* 2017a).

The following analysis of the strontium isotope results from Singen aims to include a further interpretation and maintains that there are at least indications of different social groupings linked with different strontium isotope values.

Figure 74 shows the distribution of strontium values separated into four value ranges. For this, the data ranges were divided, based on natural breaks. The distribution of data shows a clustering based on the data range. The lower strontium values, up to 0.780, are located without exception in the southern and, in particular, in the western part of the cemetery within grave groups II, III and IV. The values between 0.70821 and 0.70853, marked in orange, are located in the northern part of the burial ground within grave group I. The highest strontium isotope values that range between 0.70877 and 0.70940 (marked in brown) are located within the northern part of grave group III and within grave group IV.

There are some differences concerning the furnishings of burials that have the lowest and highest strontium isotope ratios. Graves that have low ratios demon-

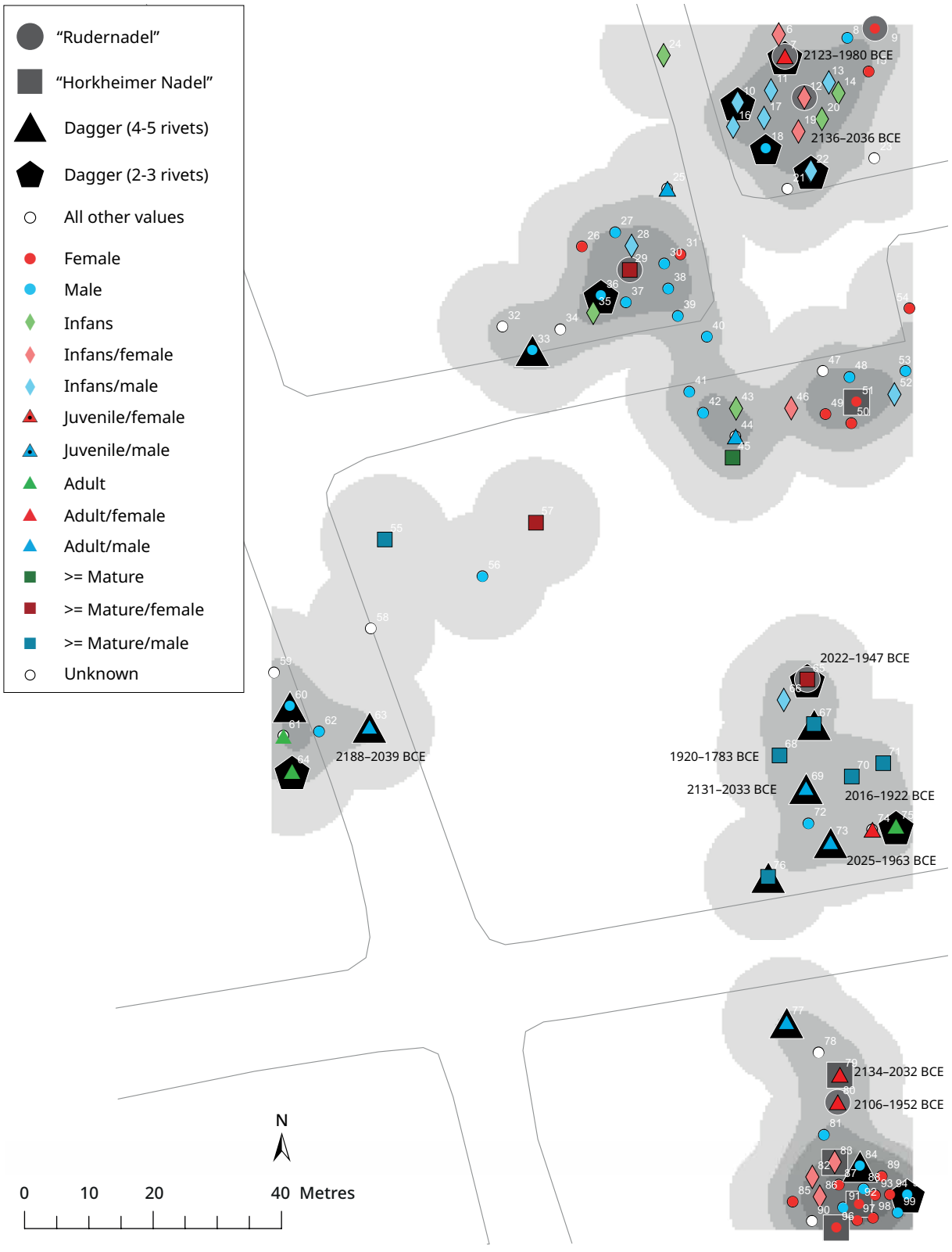


Figure 72. Distribution of dagger and pin types within the burial ground in combination with age and gender information. Also added is ^{14}C data by P. W. Stockhammer *et al.* (2015).

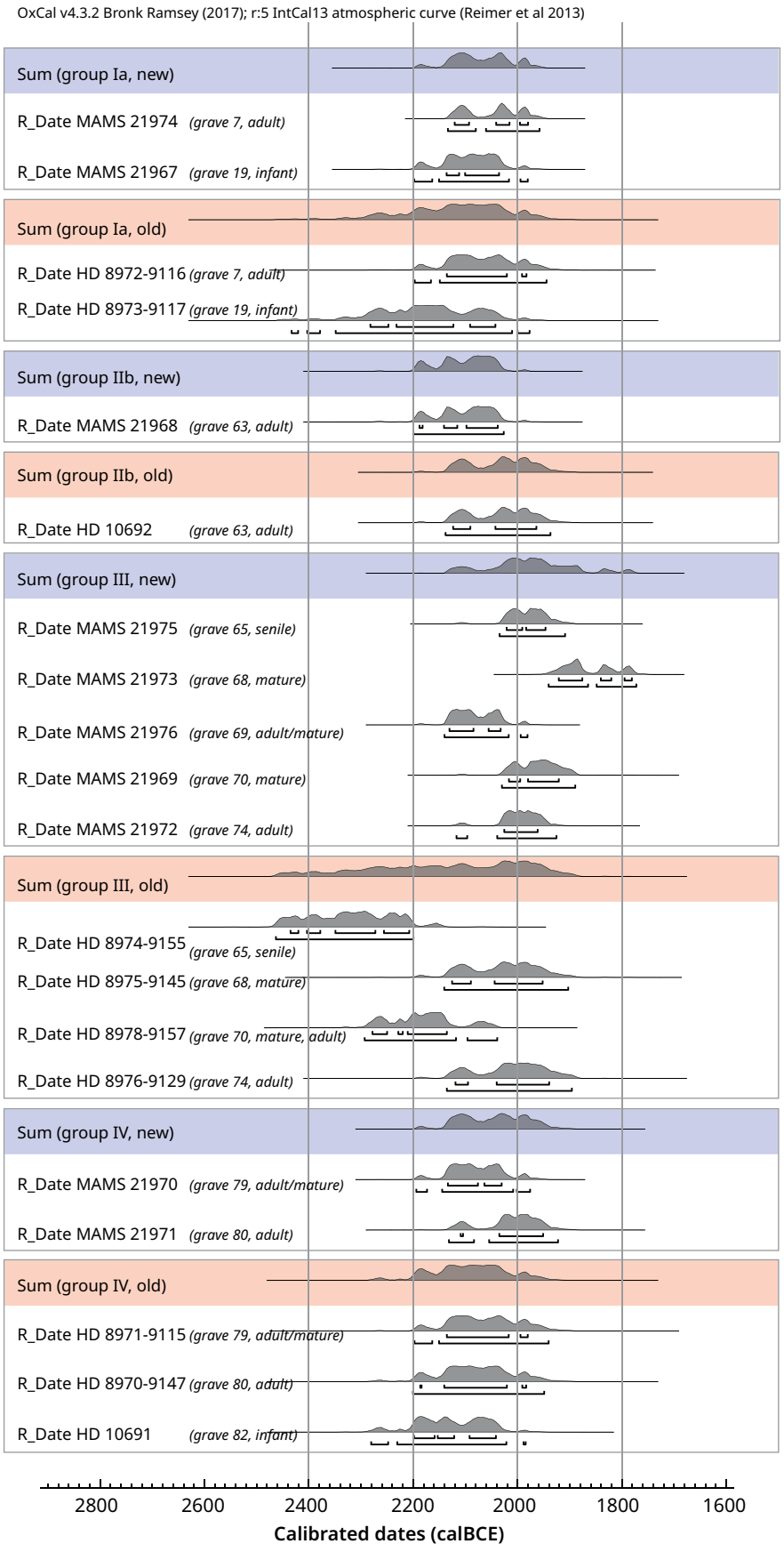


Figure 73. ^{14}C data published in R. Krause (1988) and P. W. Stockhammer *et al.* (2015). Sum data is based on grave group affiliation.

strate tutuli as unique grave goods. They are associated with burials 57, 61 and 63 and are all located within the western part of the burial ground in grave group II.

Belonging to the characteristic burial objects that are associated to the highest strontium isotope ratios are small daggers that have two to three rivets (graves 7 and 65) and bone rings made out of deer antlers (graves 68, 70 and 77). Moreover, burial 74 also demonstrates a high strontium isotope ratio. This grave is special since it represents one of two deceased, who were buried in an extraordinary way. Anthropologically, the interred person is defined as female (Gerhardt 1964), but the burial orientation follows the male tradition (north-south orientation in a left flexed position). All of these burials are generally located at the eastern part of the burial ground.

Concerning the correlation between strontium and nitrogen isotopes, it is remarkable that higher strontium values tend to be associated with higher nitrogen isotope ratios (Fig. 75). The correlation shows a moderate positive correlation (Linear r (Pearson) 0.43314, p = 0.20361). Accordingly, it can be assumed that not only the individuals' diet but also the environment and the area of origin could have had an influence on the nitrogen isotope ratios. Grave group III shows a relatively high variance with respect to the strontium isotope data. However, burials of grave group III that have relatively low strontium isotope ratios also show relatively low nitrogen isotope ratios and vice versa. This includes grave 73, which is furnished with a 4-5 rivet dagger.

Furthermore, the correlation of absolute data with strontium isotope ratios shows a trend for a chronological order (Fig. 76). It seems that the higher the strontium ratios, the younger the chronological affiliation. Low strontium isotope ratios are observed from grave groups IIb (grave 63), Ia (grave 19) and IV (grave 79) and show relatively early ^{14}C dates, whereas the high strontium isotope ratios, which are linked to burials 65 and 74 and come from grave group III, exhibit rather late ^{14}C data.

Summary

The burial ground Singen at Hohentwiel demonstrates a relatively high occupancy density within the northern area and, in particular, within the southern area of the burial ground. In contrast, in the area in between there is a relatively low density of graves. The high density of graves results from infans individuals, whereas areas of low densities are mainly occupied by adult and mature burials. Male individuals dominate predominantly in both the northern and middle areas of the cemetery, whereas mainly female individuals prevail in the southern area of the burial ground (Fig. 55; 77).

Adult individuals tend to have the highest values of grave goods for both the total and the male population. Rich adult males are characterised by big daggers that have four to five rivets. Females demonstrate high values of grave goods in each cohort. Two infants and one adult individual belong to the females that have the highest values. They are furnished with multiple ornaments, dress components and awls. The burials with the highest grave values are distributed throughout the cemetery (except in the areas Ib and Ic) and tend to be located at the periphery of grave groups.

Regarding the distribution of burial pit and stone setting sizes, the largest burial pits are located within grave groups II and III. In contrast, the northernmost and southernmost areas demonstrate rather small grave pits and stone set-

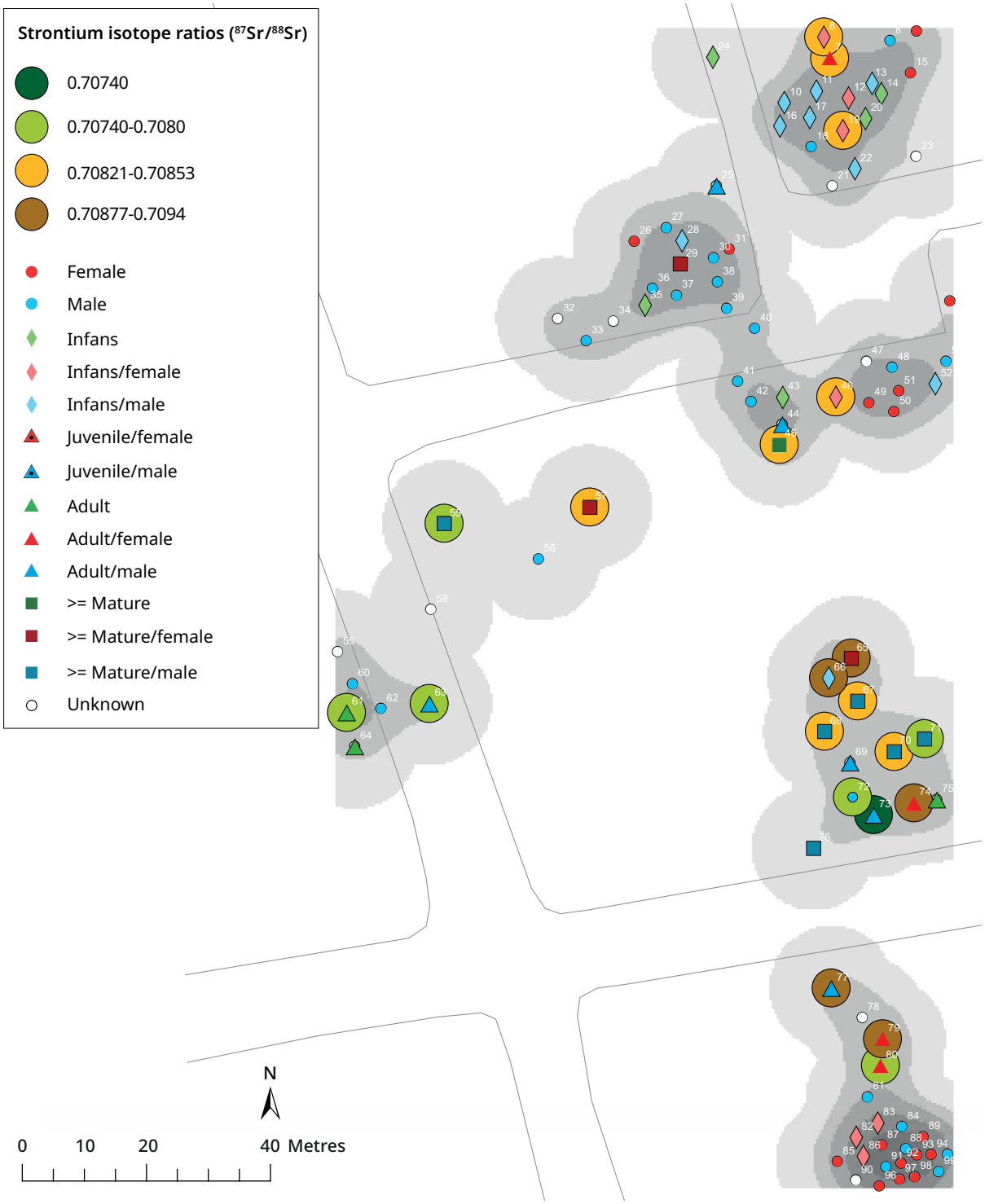


Figure 74. Distribution of strontium isotope ratios within the burial ground.

tings. Grave group IV shows that the more southwards the burials are situated, the smaller the grave. Concerning the total and the female population, mature individuals tend to have larger grave pits than adults and subadults. Males – both adult and mature individuals – are associated with high burial size values. In general, mainly males received larger burial pits or stone settings than females.

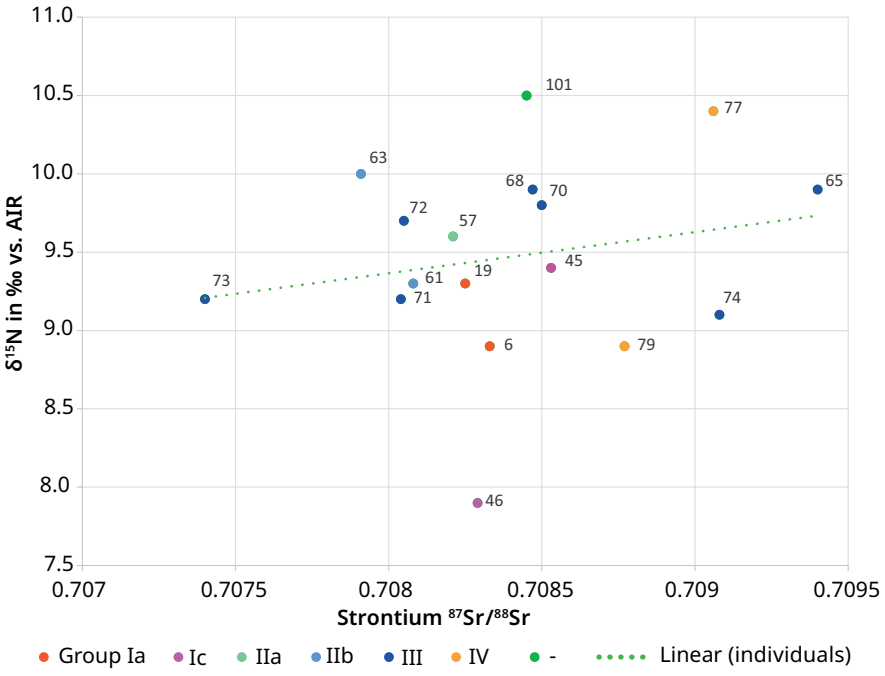


Figure 75. Correlation of strontium and nitrogen isotope ratios.

For males, large burials correlate frequently with four-five rivet daggers; females that received relatively large burials also demonstrate extraordinary pins.

The summation of burial size and values of grave goods shows that for both males and females, daggers represent a status symbol for high-ranking individuals from the adult and mature/senile age cohorts. Burials that show the highest values in summation are located especially in the middle areas of the cemetery (Fig. 77). The correlation between values of grave goods and burial sizes demonstrates moderate significant positive correlations with regard to the total population and males and a moderate positive correlation with respect to females. Regarding the inequality calculation, the measurement of Gini indices of the grave good distributions reveals a higher inequality degree for males.

Regarding the factor of distance to the next burial, it can be summarised that no correlation could be identified concerning values of grave goods. However, a significant positive correlation could be detected between burial pit/stone setting size and the distance to the next adjacent burial.

The males from graves 63, 76 and 77 combine all three aspects: High distance to the next burial, large burial size and a rich furnishing with a big dagger. The so-called Atlantic dagger of grave 76 – based on the metal composition – originates from Brittany or Southern England. Additionally, two of these graves have high nitrogen ratios. Thus, the author assumes that the three mentioned male graves represent the authorities of the grave groups II, III and IV and probably the founder graves. Probably, grave 33 also has this function in relation to grave group I. The mature/senile female burials 29, 57 and 65, which are all well-furnished and demonstrate large burial pits/stone settings, may represent the female counterpart for the grave groups I, II and III.

Moreover, the distance to the next adjacent burial increases with age and the distance to the next burial correlates with gender. For instance, adult and mature males were buried much further away from the next adjacent grave than adult and mature females.

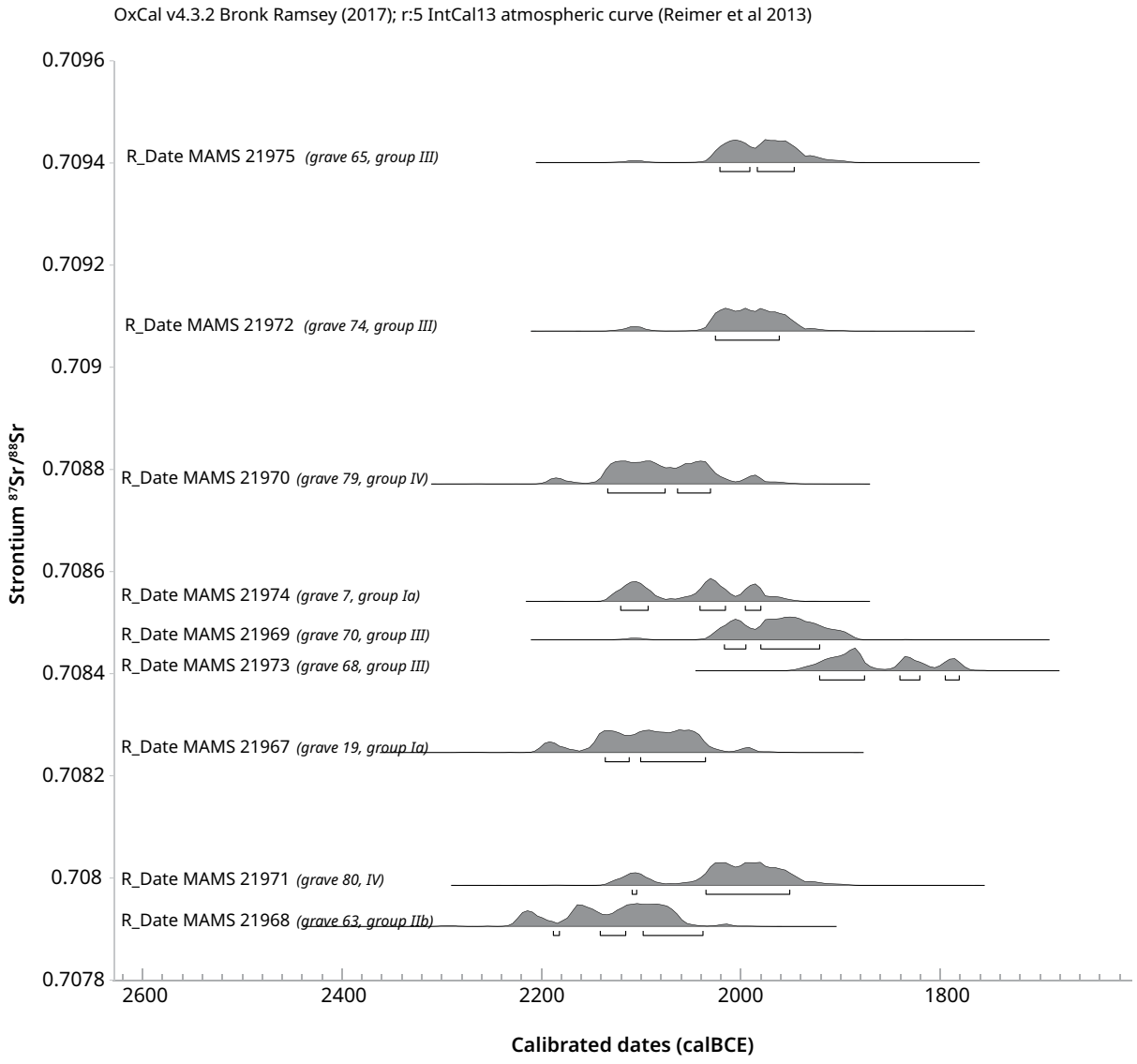


Figure 76. Calibrated datings correlated with strontium isotope ratios.

The burial community in Singen subsisted on a C3 omnivore diet. Males demonstrate a higher mean value than females and tend to have had better access to animal proteins than females. Remarkably, both male and female burials that have the highest nitrogen isotope ratios demonstrate characteristic grave furnishings. Each of the male interments includes a five-rivet dagger that has the same triangle decoration (graves 33 and 77). Female interments include grave goods consisting of "*Scheibenkopf*" pins, small bracelets and awls (graves 86 and 87). Overall, especially awls and daggers belong to the objects that are linked to individuals that are associated with high nitrogen isotope ratios. In general, the highest $\delta^{15}N$ values are predominantly documented in the southern part (grave group IV) of the cemetery. Regarding the correlation between nitrogen isotope ratios and both values of grave goods and burial pit sizes, slight positive correlations are detectable in each case.

Based on correspondence analysis, clusters of multiple grave goods could be identified and were projected by representative objects onto a distribution map. Belonging to the representative objects of clusters of grave goods are daggers that

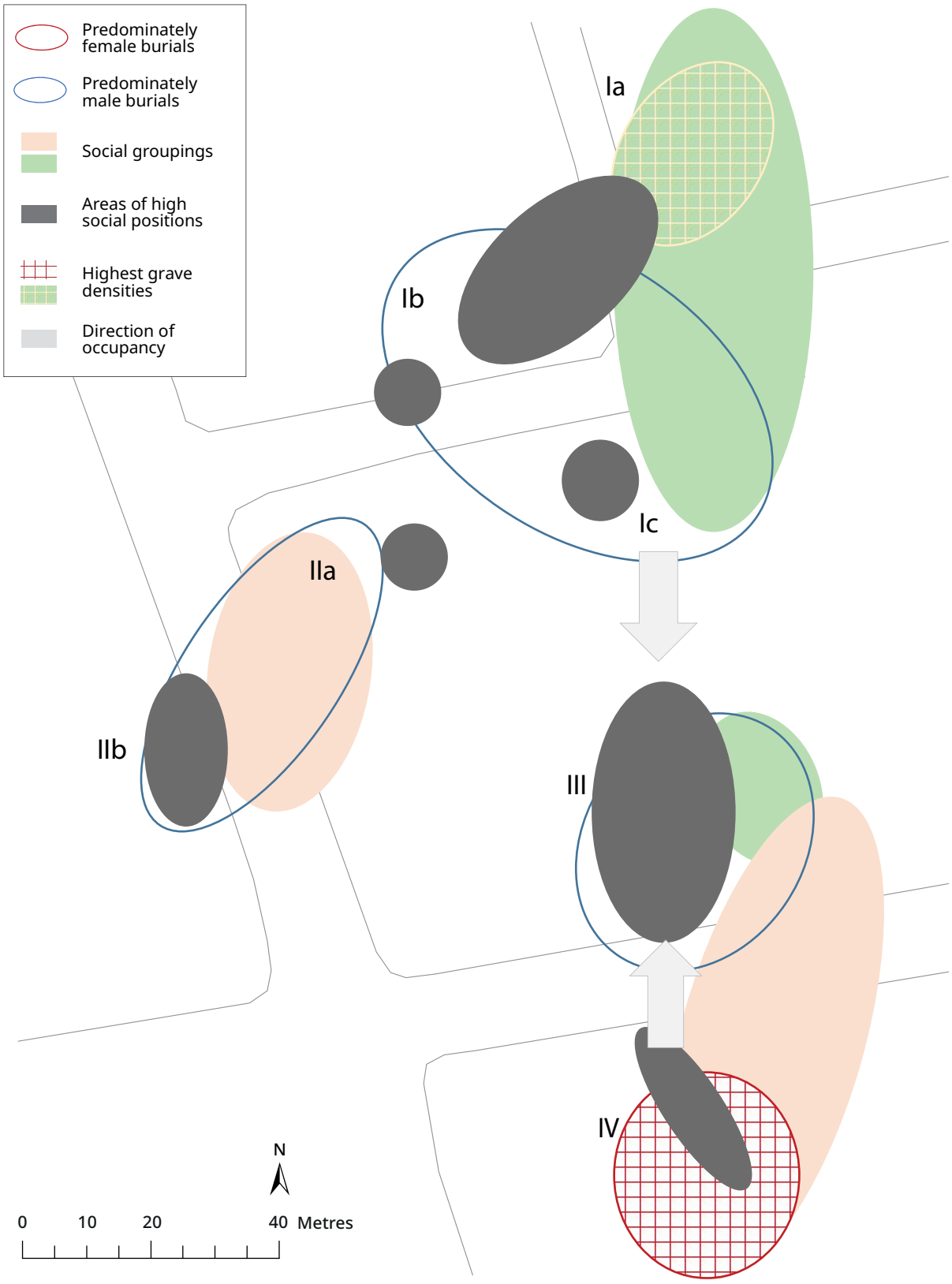


Figure 77. Model of the social organisation of the burial ground of Singen. Illustrated are two social groupings (pale pink and green), the direction of occupancy (arrow), an area of highest grave densities (checked patterns), areas of predominately female and male burials (red and blue circles), an area of predominately subadults (yellow circle), and areas of burials that demonstrate high social positions (dark grey).

have four to five rivets, smaller daggers, "*Ruderkopf*" pins and "*Horkheimer*" pins. The objects are distributed differently within the cemetery. Daggers that have four to five rivets are located mainly in grave groups IIb and III, smaller daggers in grave group Ia, "*Ruderkopf*" pins in grave group Ia and "*Horkheimer*" pins within grave group IV.

The difference between the grave groups is particularly evident in the northern group (group I) and the southern group (group IV), which are characterised by "*Ruderkopf*" pins and small triangular daggers, on the one hand, and "*Horkheimer*" pins on the other. Burial 80, belonging to grave group IV, unites elements of both groups and thus represents a connecting element. However, this connection is not to be interpreted as a chronological transition, but as an expression of a possible social exchange between different social groupings. Analogous to this, in the northern area of the burial ground, within grave group Ic, there is a burial (grave 51) that shows a supposedly spatially foreign "*Horkheimer*" pin and could, as it were, represent exchange, possibly in the form of exogamic relationships between the north and the south group. In contrast to the heterogeneous expression between grave groups I and IV, grave groups II and especially III show a predominant group, which stands higher in the hierarchy, buried with large daggers/Atlantic daggers or large "*Ruderkopf*" pins.

Regarding the chronological occupancy of the burial ground, the ^{14}C data by P. W. Stockhammer and colleagues (2015) demonstrates that grave groups I, II and IV begin roughly contemporaneous. In contrast, grave group area III seems to end a bit later. Overall, the horizontal stratigraphic sequence of burials from north (group Ia) to south (group IV), which R. Krause (1988) based on the relatively favoured pin chronology, has to be rejected. This conclusion also coincides with the result of F. Bertemes (1992), who assumes different social units by means of combination statistics of the burial ground of Singen. In his review of R. Krause (1988), W. Schier (1991) also questioned a sequence of occupations from north to south, since grave groups II and III consist almost exclusively of male graves (Schier 1991, 224-225).

Concerning the origin of buried individuals, the strontium data distribution demonstrates a clustering based on the data range: Low ratios are more highly distributed in the southern and western part of the burial ground, high ratios more in the northern part. The highest ratios lie rather in the middle part of the burial ground. The distribution of the strontium values within the burial ground underpins the existence of different social groupings originating probably from different natural areas/geologies.

Furthermore, based on absolute data, the slight tendency exists that the higher the strontium ratios, the younger the chronological affiliation. The highest strontium isotope ratios are located mainly within grave group III.

Overall, the absolute data and strontium isotope data suggest, in general, that we are dealing with at least two roughly contemporaneous heterogeneous social groups (a north and a south group) with dissimilar material habitus and with a younger burial community that is located within grave group III. Likewise, grave group III represents both a high variance of strontium isotope ratios and absolute chronological ^{14}C data. In addition, it includes well-furnished, mainly mature individuals that probably represent the leading heads for both the north and the south group.

Magdalenenbergle, Villingen (Early Iron Age, 620-550 BCE)

Within the Early Iron Age in Southern Central Europe, fortified central sub-urban sites, such as the Heuneburg, and giant elite tumuli with extremely well-equipped single burials are known. According to several authors, such settlements represent a process of differentiation and hierarchisation that was an expression and a catalyst for increasing social inequality. Common to almost all of the sub-urban sites is the fact that they were only settled for a relatively short period, generally for about 100-200 years. Characteristic for such places is also the presence of workshops for specialised craftsmen and imported goods from the Mediterranean region. The Heuneburg is one example that exhibits an extraordinary mudbrick wall from one construction phase that points to the Mediterranean region. Such a construction phase demonstrates power and status as well as the role of a political and economic centre of an extensive region, probably the territory of a polity. Outside excavations also revealed an enormous area of some 100 hectares of the Heuneburg plateau that represent outer settlements. The identification of cemeteries with elite burials in the environs of the central places suggests that the interred persons assumed political and administrative functions. Characteristic for the elite burials are richly-equipped, wooden chamber tombs, which were furnished with golden objects, wagons, horse gear, and bronze vessels (Burmeister 2000; Müller 2006; Fernández-Götz 2017; Fernández-Götz 2015).

The rich "princely burials" stand in contrast to less well-equipped flat graves and burial mound cemeteries next to small settlements. The special position of the central sites is obviously linked to their control of superregional trade with

utilitarian and status items. The import of goods from Etruria and Greece is proven. With new commodities, such as iron, trade routes changed and goods, such as salt, gained importance (Nakoinz 2013; Nakoinz and Lüth 2018; Steffen 2012; Müller-Scheeßel 2013).

The tumulus of Magdalenenbergle, Villingen is embedded in the Early Iron Age western Hallstatt culture (Oelze *et al.* 2012a; Wells *et al.* 2018). It is one of the outstanding tumuli that was used from 616 BCE (dendrochronologically dated) until ca. 550 BCE (Ha D1), and is located south of the town Villingen-Schwenningen at the eastern edge of the Black Forest of Southwest Germany. The first archaeological excavation near Magdalenenbergle was carried out by K. Schumacher. In 1890, he concentrated his investigations on the central burial. Decades later, K. Spindler carried out the complete excavation of the Magdalenenbergle in several excavation campaigns. In several publications, he disclosed the results, which particularly included the post burials (Trachsel 2004; Müller 1994; Koch 2017b; Parzinger 1986; Spindler 1971; 1972; 1973; 1976; 1977; 1980; 2004).

The tumulus is approximately 100 m wide in diameter and contained a central wooden chamber with a robbed 'princely burial' (grave 1). A total of 129 graves with 144 individuals were documented, consisting mainly of single but also of 14 multiple burials. These include the antique central grave, two graves without grave goods in the middle of the mound and 126 tangentially-set graves. The mound was divided into two halves by wooden pole settings. In the northern half, the dead were buried tangentially in a clockwise direction, in the other half they were buried in the opposite direction. According to R. Meyer-Orlac (1983, 16), this separation could point to a dual organised society; a theory that M. Jung (2006, 95) questioned. Instead, he sees two principles in the orientation: on the one hand, the orientation of the body's longitudinal side towards the middle of the hill and, on the other hand, the orientation of the head towards the east.

Mainly inhumation burials were recorded. In addition, eight cremation graves were documented. It is likely that graves near to the centre were destroyed due to erosion, grave robbery, and early excavations in the late 19th century (Müller 1994; Spindler 1971; 1972; 1973; 1976; 1980; 2004; Zäuner and Wahl 2013; Brather 2004, 495).

In the 1970s, body and cremation burials were anthropologically investigated for the first time (Gallay and Spindler 1971; Gallay 1977; Kühl 1977). A second study was accomplished four decades later by S. Zäuner and J. Wahl (2013). According to the second anthropological study, Magdalenenbergle includes 123 adults, 16 children and four persons without age information. Based on anthropological but also on archaeological data, 55 females and possible females as well as 54 males and possible males could be identified. According to J. K. Koch (2017a; 2017b), there are individuals for whom there are discrepancies between anthropological and archaeological gender determinations or within archaeological gender determinations, who have to be defined as cross-gender persons. Further 16 persons cannot be assigned to any social gender group.

The male burials are furnished with weapons, including bow and arrow equipment, daggers, lances, toiletry utensils, and vessels. Typical for female burials are ornaments such as necklaces, hair pins, earrings, and bracelets. Both genders were furnished with fibulae, miniature vessels, pendants, and dress pins. Noteworthy are exotic burial goods indicating mobility and networks throughout the western Hallstatt culture. These include, among other things, a belt hook of Acebuchal type originating from Spain (grave 65), a drago type fibula, typically found in Northern Italy (grave 81), a lancet-shaped belt hook, associated with the

Golasecca culture in Southern Switzerland and Northern Italy (grave 96), and an amber bead necklace made from raw material originating from the Baltic Sea (grave 97). The Magdalenenbergle site is characterised by an outstanding preservation of organic material such as wooden construction planks, furniture, wagon wheels, woven baskets, and remains of fur (Rieckhoff *et al.* 2001; Spindler 2004; Koch 2017a; Oelze *et al.* 2012a; Müller 1994).

Multiple socio-structural analyses were conducted at the burials. Using a social index calculation, J. Müller created a ranking of the individuals, which he subdivided into four ranked groups. J. Müller suggests a social demarcation only for the buried individuals without grave goods of the fourth rank. His calculation was based on grave goods (number, plurality, material, scarcity) and on the burial size (grave pit volume, stone packing volume). As a result, rankings tends to correlate with age and the very well-furnished burials could represent mature/senile individuals. According to J. Müller (1994, 210), high status was expressed among females by the abundance of grave goods and, in contrast, among males by the efforts made in grave construction (*e.g.* grave volume). Furthermore, based on the distribution of the richest burials, J. Müller (1994, 210) separated the tumulus into groupings that he interpreted as family districts, a thesis that Spindler (2004) took up and M. Jung criticised (2006, 114). Finally, J. Müller (1994, 213) assumed that older members of the community were interred closer to the central burial.

A further social index calculation is available from S. Burmeister (2000). His aim was to describe the vertical social structure of the late Hallstatt period in Southwest Germany. Accordingly, the Magdalenenbergle was integrated into his investigation. In contrast to Müller (1994), S. Burmeister (2000) focused his analysis on the inventory and did not integrate characteristics for the workload of grave construction, for example, volume and stone settings. S. Burmeister determines the overall 15 richest graves as well as the 15 richest female and male individuals (Burmeister 2000; cf. Brather *et al.* 2009).

Spatial analysis

For the spatial analysis of the burial mound, kernel density analyses were applied. With regard to the density of the graves, the analysis did not differentiate between single and multiple burials. The following results were accomplished: The secondary burials were concentrated differently within the burial mound. Based on the kernel density analysis, the highest concentration of secondary burials could be identified in the southern and northern areas of the burial mound (Fig. 78). Following the classification of K. Spindler (cf. 2004), the highest density of burial pits is recorded particularly in sections I, IV and VI. Here, grave pit density reaches up to 331-529 hypothetical burials per hectare. In contrast, the south-southeast and north-northeast sections of the burial mound (sections II and V) demonstrate lower densities. The kernel density analysis demonstrates that the thesis of family districts as put forward by J. Müller (1994) and K. Spindler (2004) cannot be maintained. Although burial gaps between districts can be identified (*e.g.* between I and VIII or V and VI), they can largely be explained by erosion and ploughing as well as by ancient plundering and by the old excavation of K. Schumacher (Spindler 1972, 15ff.). Only one gap at the eastern and south-eastern area (between burials 117 and 124 and between burials 126 and 127) could be intentional. Accordingly, the sectioning according to J. Müller (1994) and K. Spindler (2004) is no longer displayed in the following plans of the burial mound.

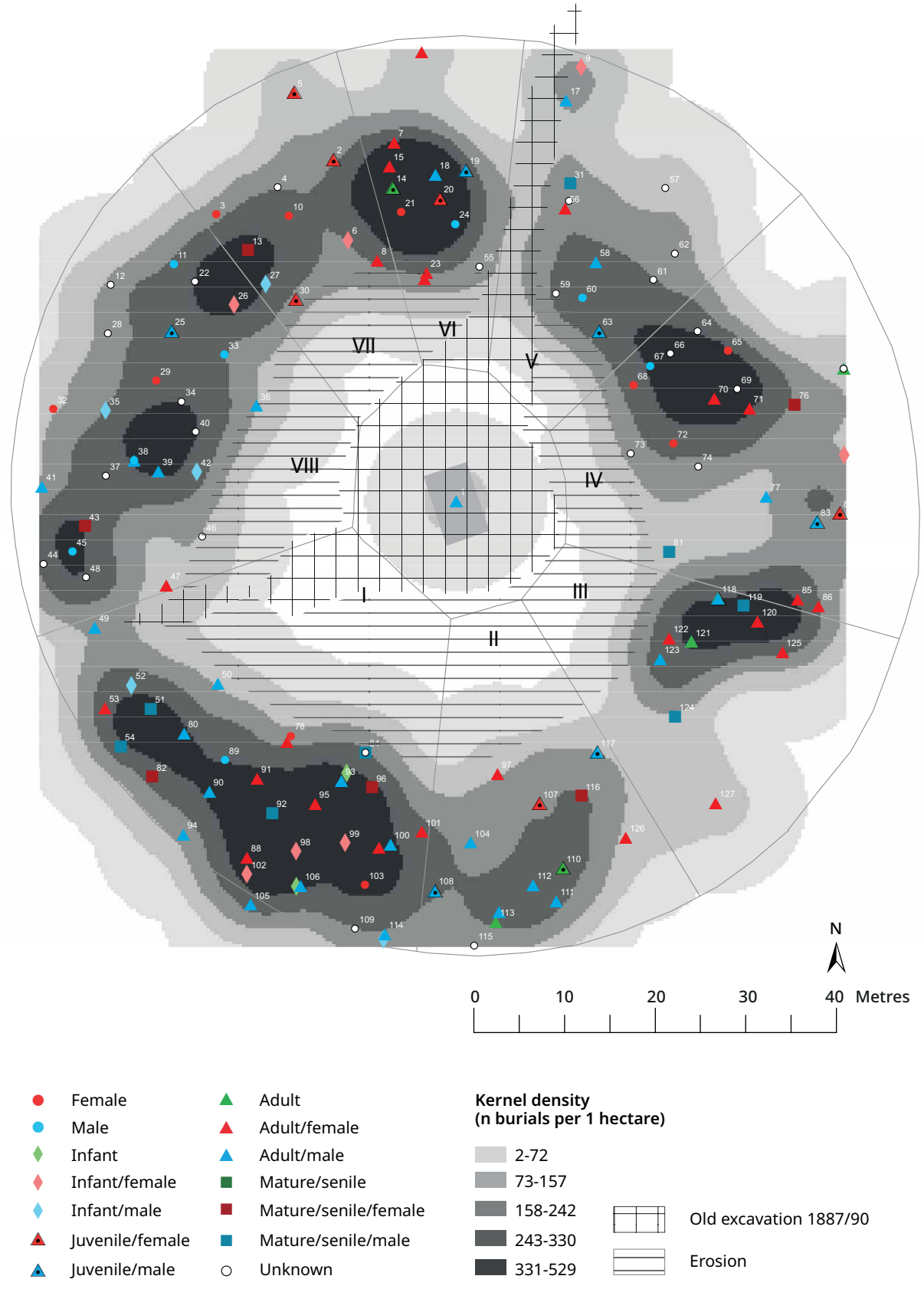


Figure 78. Burial mound including kernel density analyses, ascribed genders, age cohorts, disturbances in the form of erosions and old excavations as well as the sectioning according to J. Müller (1994) and K. Spindler (2004).

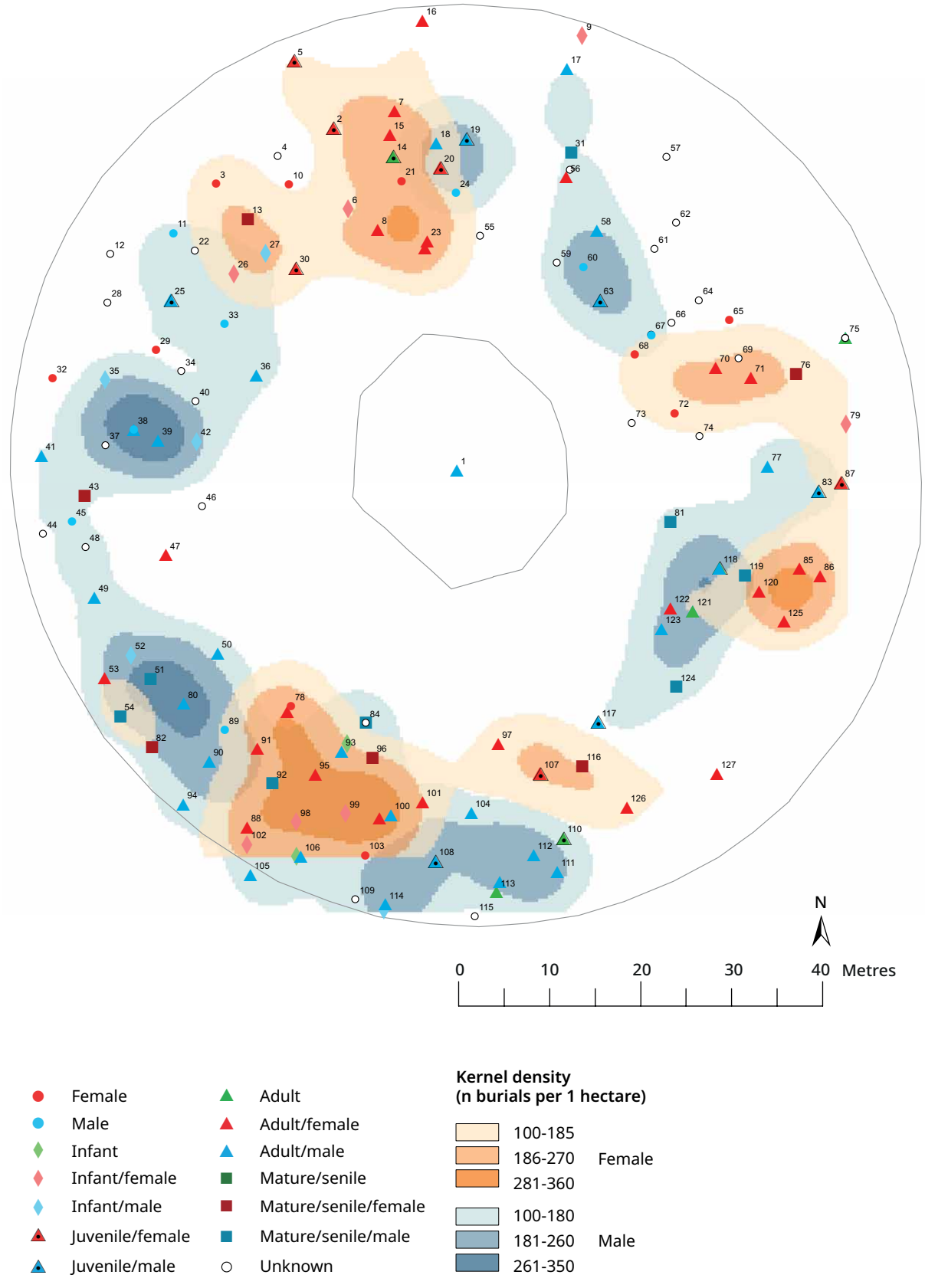


Figure 79. Graves with the ascribed genders, age cohorts as well as the representation of grave densities related to females and males.

Taking into account the gender distribution (Fig. 79), clusters of female and male burials could be identified, which mostly alternate. The highest female density is found in the southern area of the burial mound. Regarding males, the highest densities are revealed in the southwest and west of the burial mound. The distribution of burials suggests that male burials prevail in the western part of the mound. Since some burials, however, cannot be assigned to any gender, it is very likely that there are a number of female burials amongst them.

Values of grave goods

In order to demonstrate inequalities associated with the furnishing of the burials, the values of grave goods were calculated (Tab. 20). 137 burials were included in the analysis. The values of grave goods of each grave are based on the scarcity of the respective object types within the cemetery and on the number of grave goods that are assigned to each individual. Table 20 provides the calculated values of object types.

Object types	Calculated value
Hair pin	1.3
Earring	0.6
Necklet	6.2
Chest ornament	6.5
Fibula	2.3
Arm ornament	0.6
"***Tonnen***" bracelet	3.1
Belt sheets	3.7
Belt accessory and hook	1.2
Leg/foot ornament	9.1
Robe pin	15.2
Simple pendants	1.2
Special pendants	8.6
Amulet	12.5
Toilet utensils	13.7
Lance tip	12.5
Arrowhead	17.1
Dagger	27.4
Vessel	9.8
Miniature vessel	1.6
Drilling hammer	45.7

Table 20. Calculated values of object types.

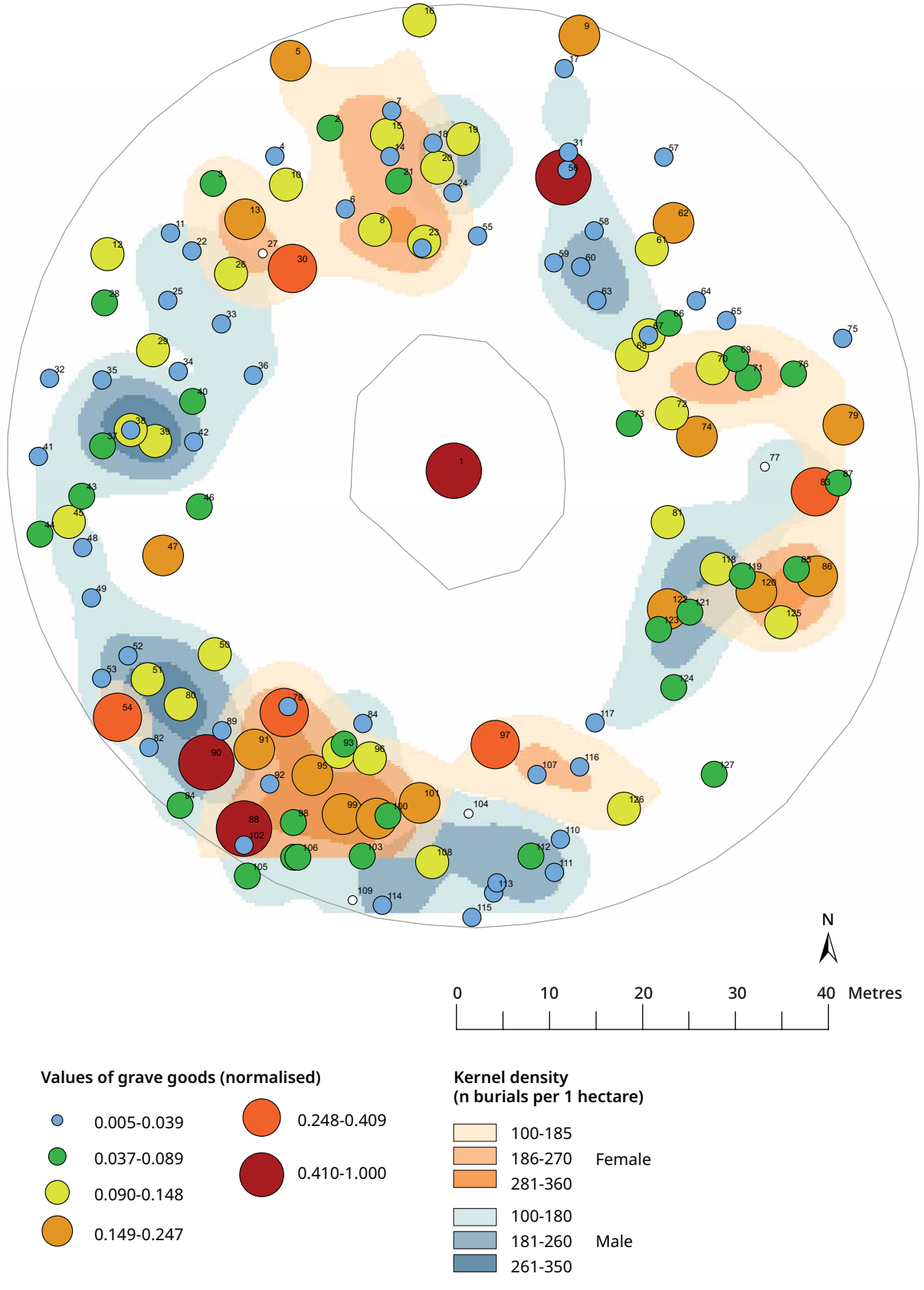


Figure 80. Distribution of the values of grave goods within the cemetery in combination with burial densities of males and females.

Grave no.	Values of grave goods	Age	Gender	Grave goods
90	0.659	Adult 2	Prob. Male	Dagger, arrowheads, belt sheet, miniature vessel
88	0.640	Adult 1	Female	Hair pins, earrings, fibula, bracelets, belt sheet and belt accessories, pendants and amulets, miniature vessel
56.1	0.419	Adult 2	Female	Many hair pins, chest ornaments, bracelets, belt accessories, leg ornament, robe pin, pendants
54	0.320	Mature	Male	Dagger, miniature vessel, stone mallet
78.2	0.297	Adult 1	Prob. Female	Hair pins, earrings, bracelets, "*Tonnen*" bracelets, belt sheet, belt accessories, vessel
97	0.288	Adult	Female	Hair pins, earrings, chest ornaments, amber necklace, bracelets, "*Tonnen*" bracelets, belt sheet, belt accessories
30	0.266	Juvenile-Adult	Female	Hair pins, bracelets, pendants, amulets, arrowhead
83	0.261	Juvenile-Adult	Male	Robe pin, stone mallet

Table 21. Burials of the first and second categories with information regarding grave no., values of grave goods (normalised), age, gender and grave goods.

Figure 80 illustrates the distribution of the calculated values of grave goods within the burial mound. Based on natural breaks (Jenks) within the value ranges, six interval categories were provided. For the highest category, the analysis identified four burials and for the second category five burials. The plundered central burial is not discussed in this context. In table 21, the listed graves belong to the secondary burials of the highest and second highest categories.

The burials with the highest and second highest grave values include late-adult and mature males (graves 90 and 54), who each were provided with daggers. In addition, a juvenile to adult male with a robe pin and a stone mallet also exhibits high values for grave goods. Females are characterised by rich and varied ornamentation. Belonging to the outstanding accessories are, in particular, the amber necklace from grave 97 and the "*Tonnen*" bracelets from burials 78.2 and 97. Females that demonstrate the highest values for grave goods roughly belong to the juvenile to late-adult age cohorts.

Burials with the highest values of grave goods are widespread throughout the burial mound, but are especially located in the southwestern area.

With regard to the correlation between values of grave goods and age cohorts, the following conclusions can be drawn: Concerning the total number of burials, each age cohort shows relative similar value ranges except the late-adult age cohort that displays a higher median and range of values of grave goods (Fig. 81).

In terms of gender, it is evident that females demonstrate roughly an age-independent distribution of values of grave goods. This is particularly evident considering the fact that even female infans possessed rich jewellery furnishings in the form of traditional dresses. Late-adult females also exhibited relatively high value ranges. In contrast, the value of grave goods tends to decrease again with the oldest females (adult-mature/mature). However, female values are demonstrably higher in comparison to male values.

Among males, the situation is more differentiated. Overall, males reflect a rather sparse furnishing norm. Only the late-adult central burial (grave 1) and

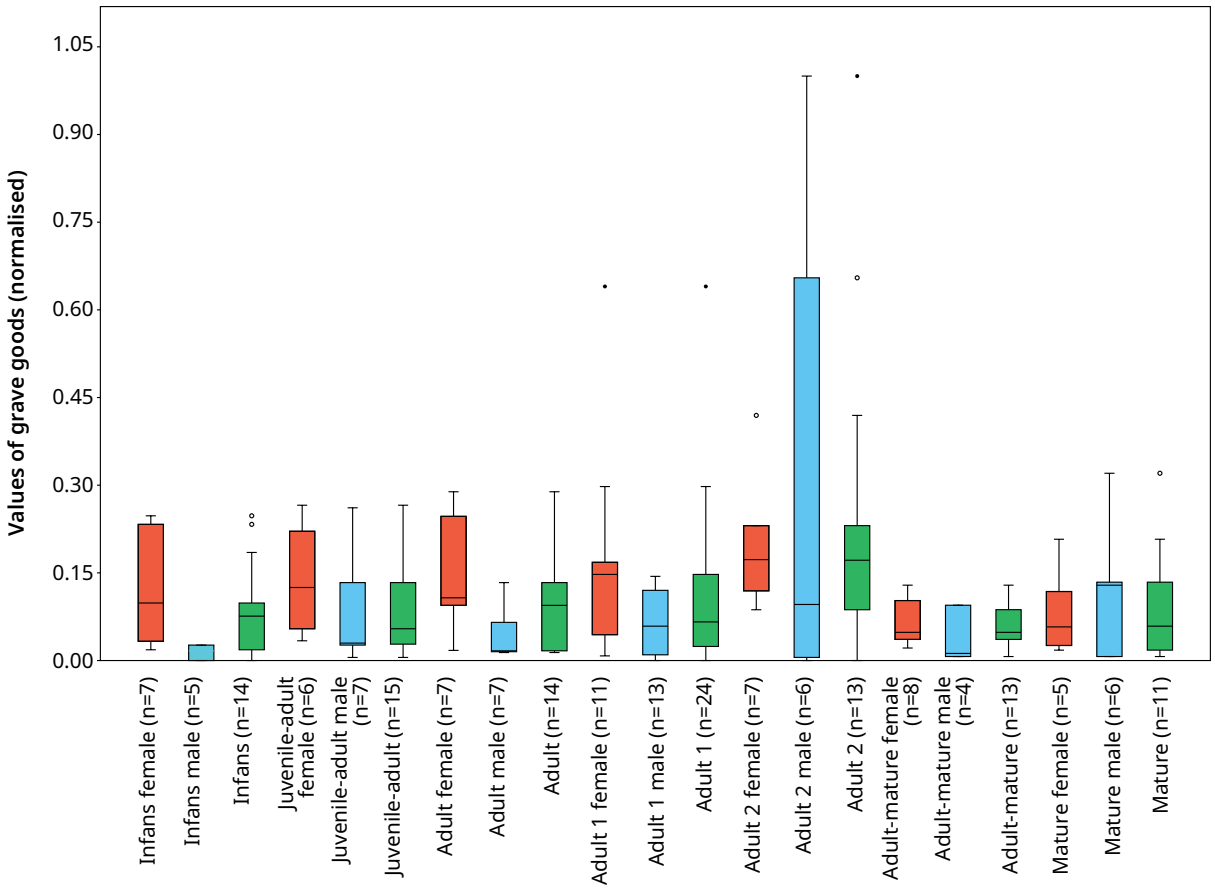


Figure 81. Values of grave goods associated with age and gender categories.

the late-adult secondary burial (grave 90) reveal high values of grave goods with over-average weaponry furnishings. Consequently, the interquartile distance in the late-adult age cohort is very high. This high interquartile distance in this cohort indicates that other social factors, besides biological factors such as age, are responsible for differences in social positions. Additionally, grave goods, such as daggers, lances and razors, only became part of the burial equipment when the carrier reached adulthood. Accordingly, the difference in the values of grave goods among males is higher between subadults and adults in comparison to females. Furthermore, besides the late-adult age cohort, the mature age cohort shows, in contrast to females, a relatively high range of values of grave goods.

Burial pit sizes

In the following, apart from the distribution of grave goods, differences of the interred individuals will be demonstrated by using burial pit sizes. It has to be considered that gender, age and the presence of a multi-person or single burial, in addition to ascribed status or prestige, represent equal factors for the construction and size of a burial pit. Just as with the values of grave goods, the classification of burial pits into six categories is based on natural breaks among the value range (according to F. Jenks). Apart from the central burial chamber, which represents by far the biggest burial and is allocated to category 1, the secondary burials in table 22 are assigned to the second biggest burial category 2.

Grave no.	Burial size (m²)	Age	Gender	Grave goods
1	45.00	Adult 2	Male	Robbed
78.2	15.00	Adult 1	Prob. female	Hair pins, earrings, bracelets, "*Tonnen*" bracelets, belt sheet, belt accessories, vessel (Alb-Hegau)
97	9.13	Adult	Female	Hair pins, earrings, chest ornaments, amber necklace, bracelets, "*Tonnen*" bracelets, belt sheet, belt accessories
123	8.91	Adult 1	Male	Fibula, pendant, vessel (Alb-Hegau)
24	7.04	?	Male	Fibulae, miniature vessel
39	6.97	Adult (1)	Male	Dagger, fibulae, miniature vessel

Table 22. The first and second categories representing burials with information regarding grave no., burial size (m²), age, gender and grave goods.

Figure 82 illustrates that the biggest burials pits are distributed in all directions and are located relatively close to the main burial. In contrast, small burials were rather placed at the edge of the burial mound – a fact that cannot only be explained by the frequent presence of infans burials in these areas. To the burials with the biggest graves belong – without exception – adult burials, also with a tendency to early-adult burials. The big female burials 78.2 and 97 represent individuals that include multiple ornaments and also have the highest values of grave goods. Secondary male burials that have the largest grave pits include individuals with daggers (grave 39) and a rare vessel of the Alb-Hegau type (grave 123). According to Spindler, due to its ceramics, grave 123 could also be the oldest one among the secondary burials.

The boxplot diagram (Fig. 83) shows that with respect to the total number of burials, adult individuals tend to have the biggest graves. However, in correspondence with the age of the buried individuals, the size of the grave pits decreases again to the level of subadult burials. Accordingly, a similar correlation is discernible with regard to burial pit sizes and age cohorts as also with the values of grave goods.

When comparing the factors gender/age and burial pit sizes, it is noticeable that in female burials a tendency towards a parabolic development of grave pit sizes from the infans to the mature age cohort can be observed. The burial pit size tends to be the largest among early-adult females. This is particularly demonstrated in the outlier grave 78.2, which represents the largest female grave with 15 square metres. Furthermore, the largest interquartile distance is also documented among the early-adult age cohort. With the mature age cohort, however, the burial pit size of females becomes smaller again.

A similar parabolic development is also observable among males. However, the largest burials belong to the late-adult age cohort, which is impressively shown by the central burial. In contrast to females, the differences in burial pit sizes among males in terms of age are not very pronounced. For example, the value ranges in the context of infans and mature males are higher in comparison to females.

Values of grave goods and burial pit sizes

In order to point out burials that include both high values of grave goods and large burial pits, the normalised values of grave goods and the normalised burial pit sizes of the buried individuals were summarised. In table 23, the graves that belong to the burials with the highest burial values and combine both aspects are listed.

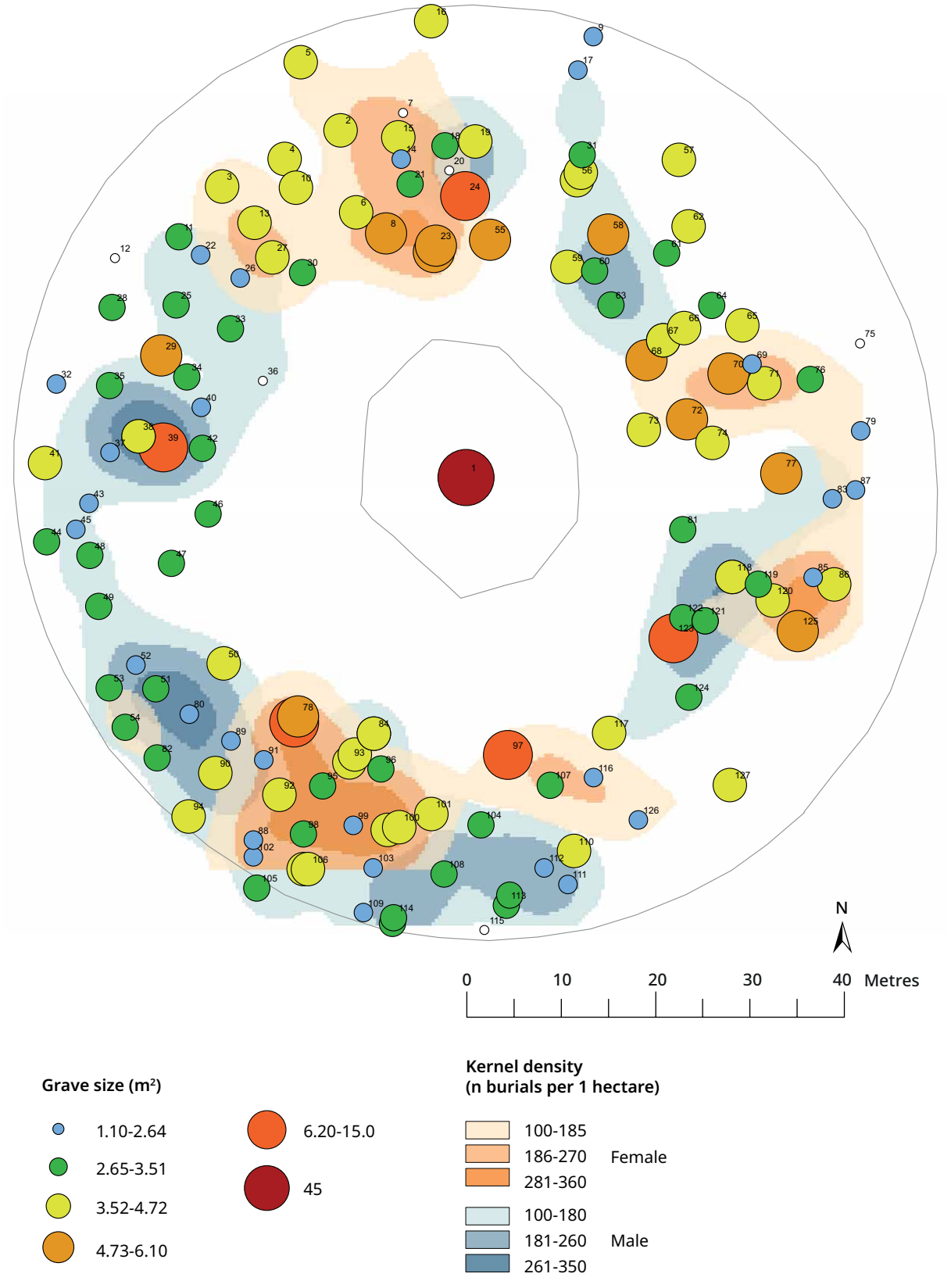


Figure 82. Distribution of burial size categories associated with densities of burials based on gender.

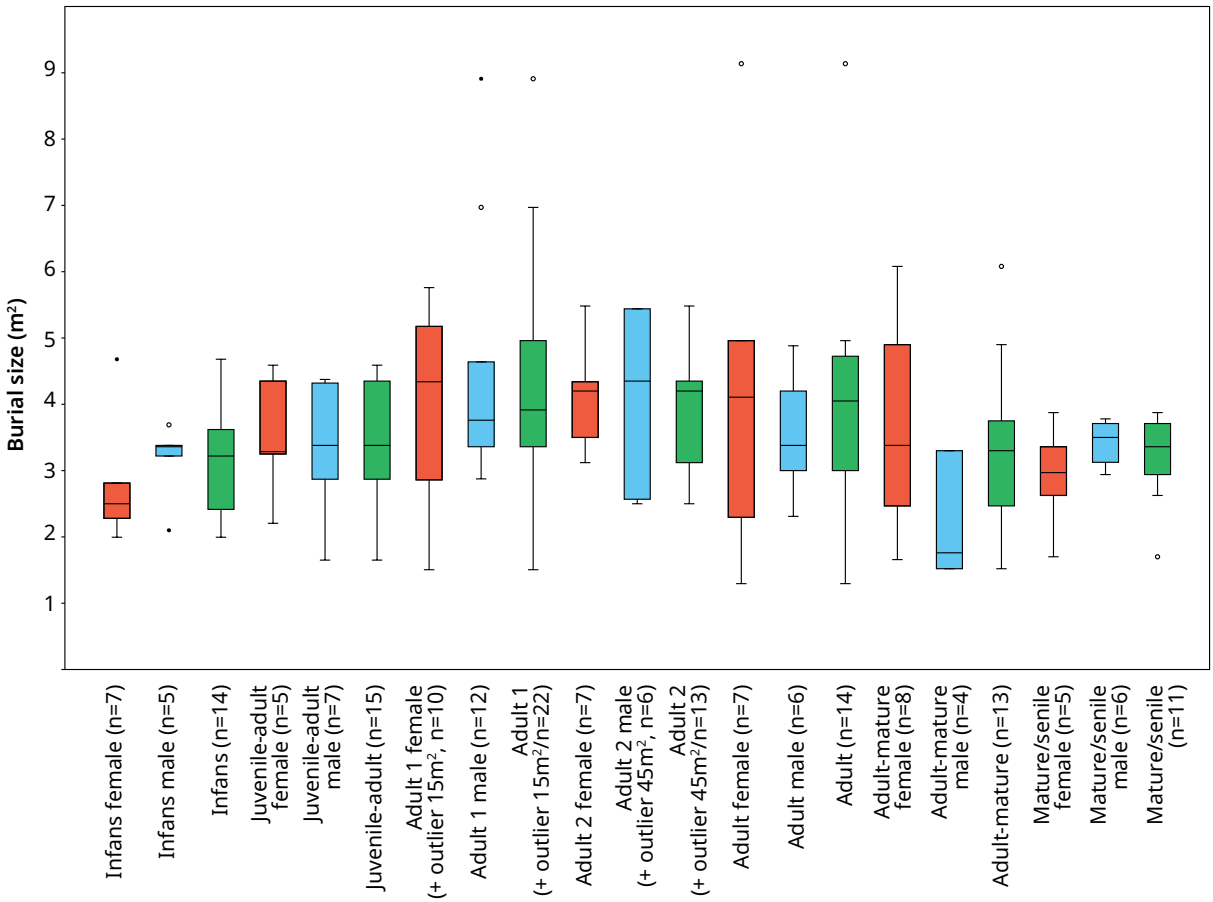


Figure 83. Distribution of burial sizes in relation to age cohorts, genders and the total number of burials.

Grave no.	Burial value	Age	Gender	Grave goods
1	2	Adult 2	Male	Robbed
90	0.751	Adult 2	Prob. Male	Dagger, arrowheads, belt sheet, miniature vessel
88	0.684	Adult 1	Female	Hair pins, earrings, fibula, bracelets, belt sheet and belt accessories, pendants and amulets, miniature vessel
78.2	0.631	Adult 1	Prob. Female	Hair pins, earrings, bracelets, "*Tonnen*" bracelets, belt sheet, belt accessories, vessel
56.1	0.503	Adult 2	Female	Many hair pins, chest ornaments, bracelets, belt accessories, leg ornament, robe pin, pendants
97	0.492	Adult	Female	Hair pins, earrings, chest ornaments, amber necklace, bracelets, "*Tonnen*" bracelets, belt sheet, belt accessories

Table 23. Summarised and normalised values of grave goods and normalised burial volumes. In addition, information concerning age, gender and grave goods is provided.

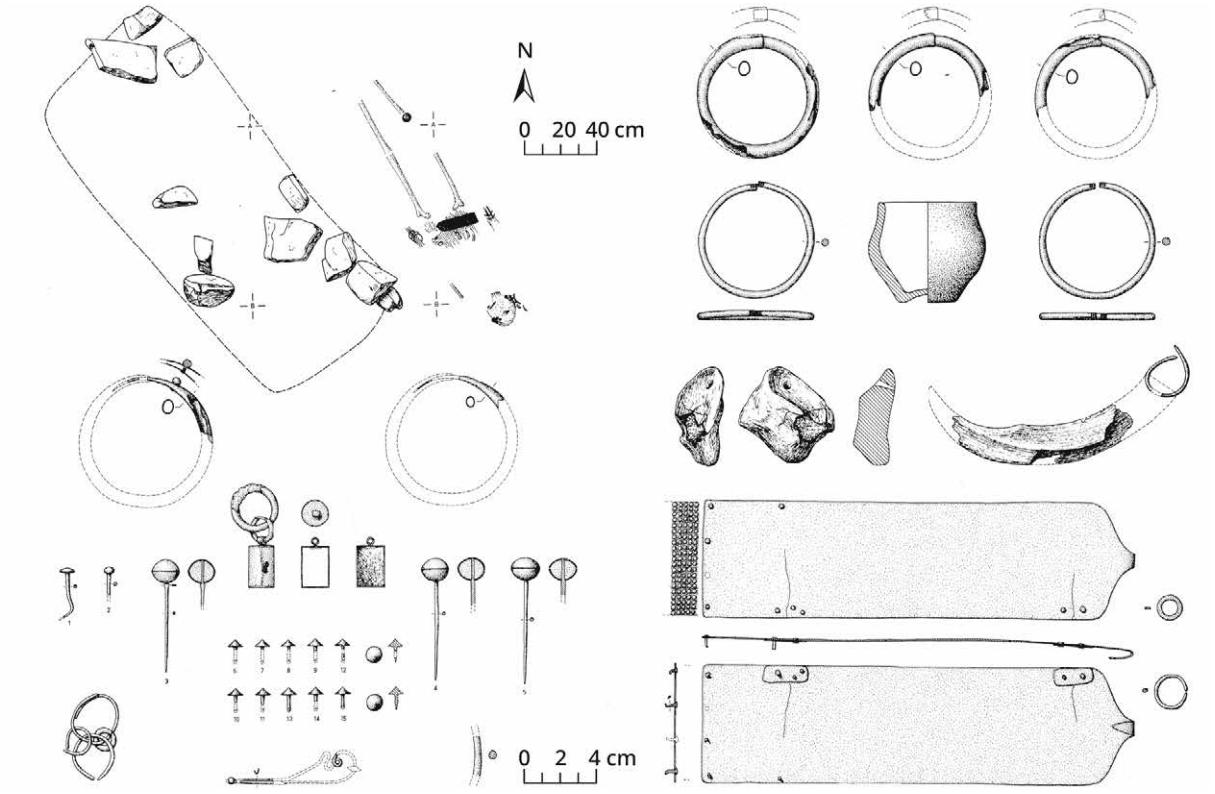


Figure 84. Female burial 88 (cf. Tab. 23). One of the burials with the highest burial value (sum of normalised values of grave goods and burial pit size) (Spindler 1976, Taf. 7 und 8).

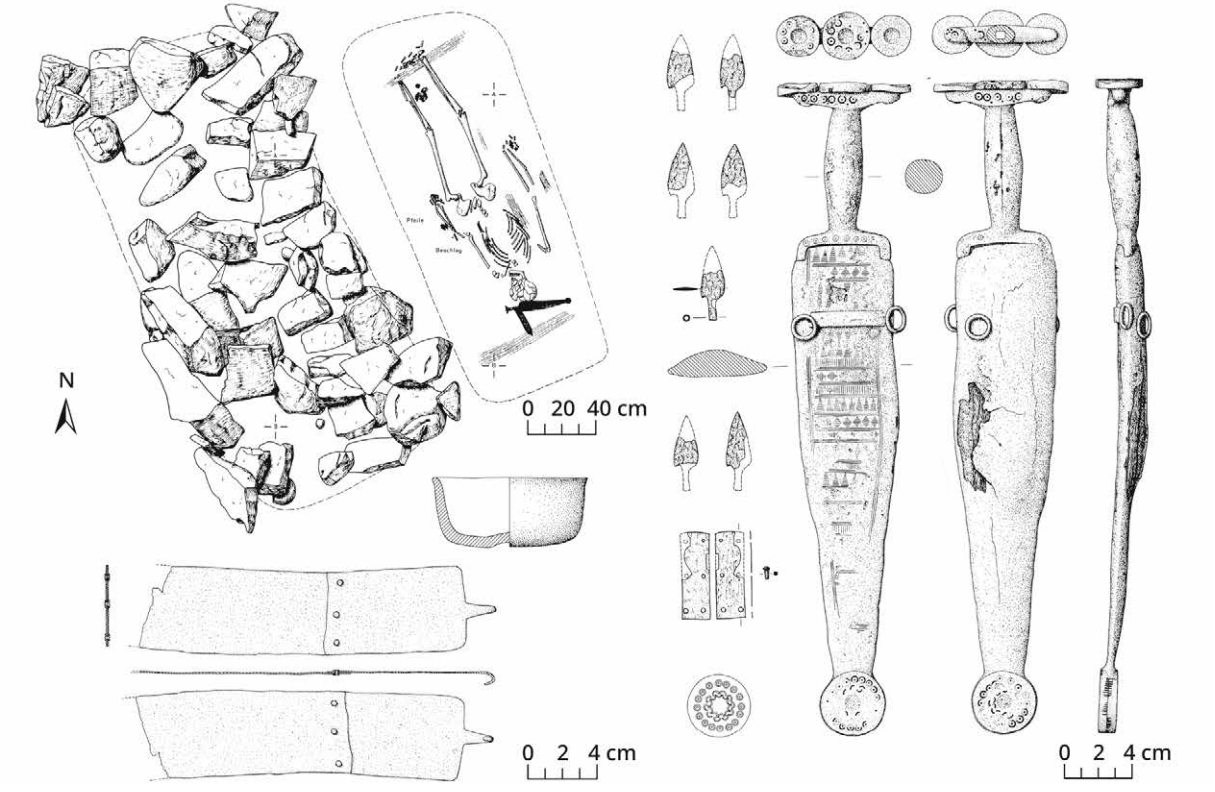


Figure 85. Male burial 90 (cf. Tab. 23). One of the burials with the highest burial value (sum of normalised values of grave goods and burial pit size) (Spindler 1976, Taf. 9 und 10).

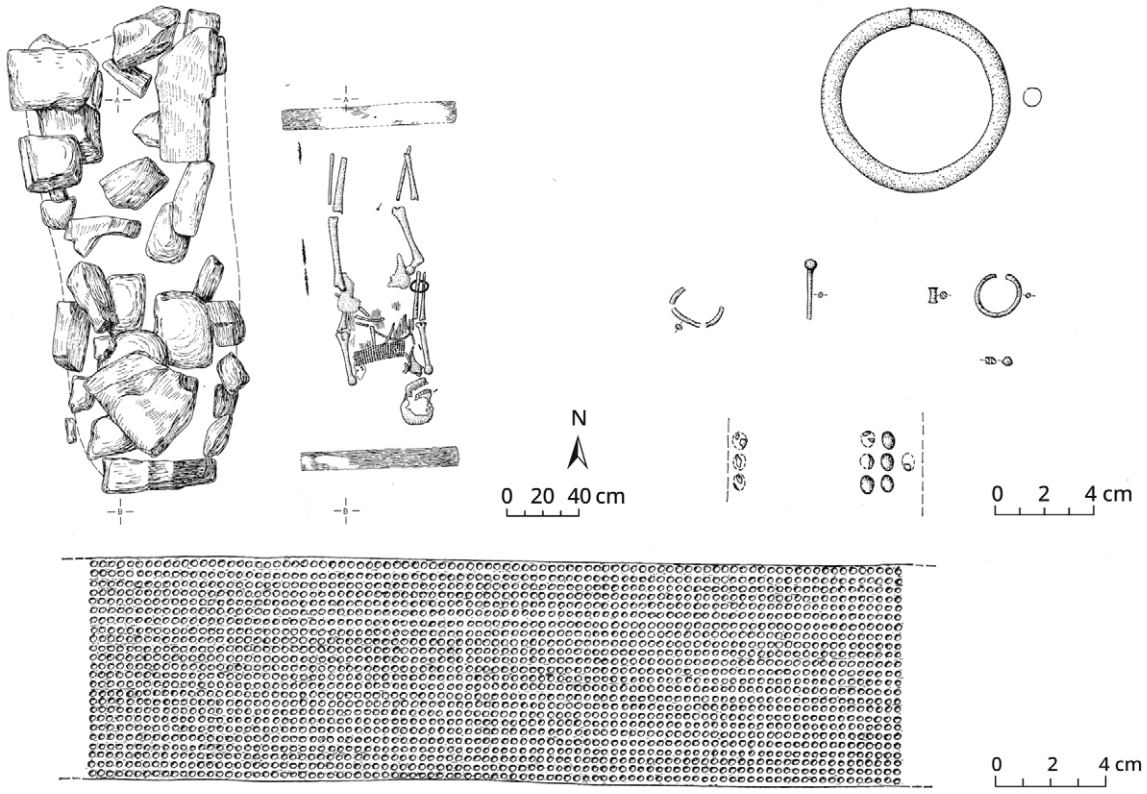


Figure 86. Female burial 53, which belongs to the graves with the lowest value (Spindler 1972, Taf. 34).

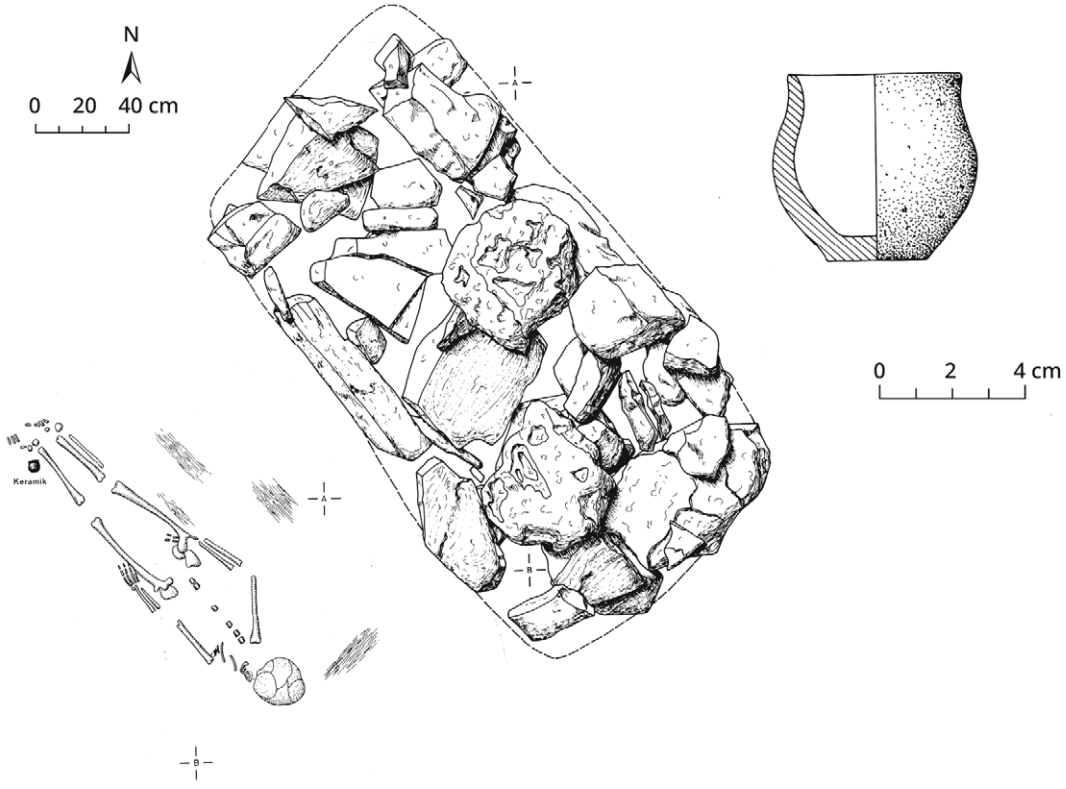


Figure 87. Male burial 92, which belongs to the graves with the lowest value (Spindler 1976, Taf. 14).

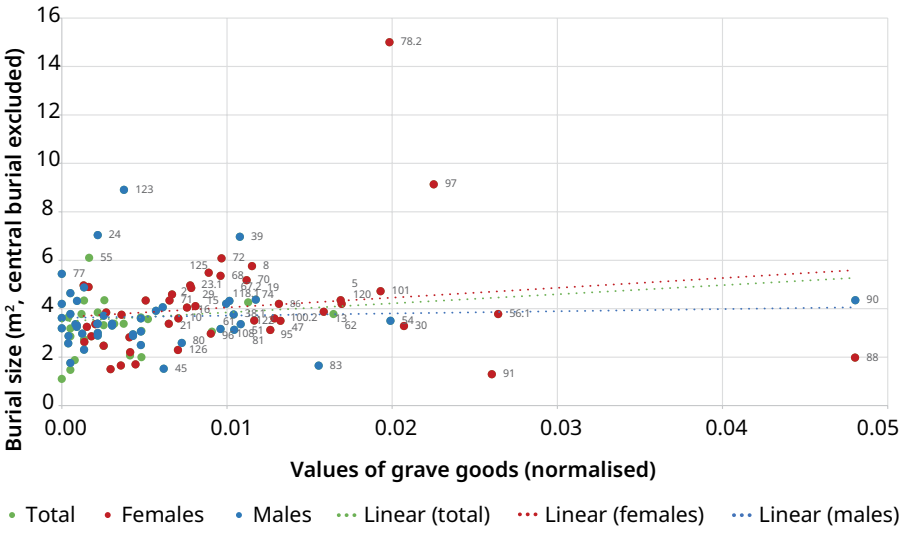


Figure 88. Correlation of normalised values of grave goods and grave sizes (m²) according to genders, also depicted as linear tendency lines.

As table 23 illustrates, two males and four females belong to the highest burial category. The listed female burials demonstrate well-furnished interments that include multiple ornaments, such as those of burial 88 (cf. Fig. 84). All listed individuals died at an adult age – two as early-adults and one as a late-adult.

Among the males, there is, on the one hand, the central burial and, on the other hand, a rich secondary burial furnished with multiple weapons (cf. Fig. 85). Both died at a late-adult age. In contrast to the richly furnished burials, there are, of course, poorly furnished burials with few or no burial goods, such as burials 53 and 92 (Fig. 86; 87).

Furthermore, it was analysed to what extent the burial pit sizes correlate with the values of grave goods. Since infans burials and the large and originally well-endowed central burial would bias the results, they were excluded. The total sample provides a small correlation between the values of grave goods and the grave pit sizes (Linear r (Pearson): 0.17872, p = 0.057098). A small positive correlation is also observed for females (Linear r (Pearson): 0.22182, p = 0.12972), however, no correlation is found for males (Linear r (Pearson): 0.039399, p = 0.79034) (Fig. 88). Among females, burials 72, 78.2 and 97 show large burial pits (≥ 6 m²). These adult females were provided with rich jewellery and as common elements "*Tonnen*" bracelets. Among males, burials 24, 39 and 123 have large burial pits. All these adult male burials include bow fibulae (graves 24 and 39 – two in each case), but only burial 39 demonstrates an actual wealthy furnishing that includes a dagger.

Lorenz curves and Gini indices

In the following, the degree of inequality within the burial community is measured, expressed as Gini indices. Gini indices have been measured for the distribution of values of grave goods associated with the total sample, as well with respect to the female and male samples. The robbed central grave was also integrated into the calculation. The value of this grave was extrapolated based on the average grave size and value of grave goods of adult males. Values of grave goods could be assigned to 137 individuals, of which 55 individuals represent females and 54 males.

With regard to the Lorenz curves of the values of grave goods (Fig. 89), the curve of females always lies above the male curve and thus dominates the Lorenz

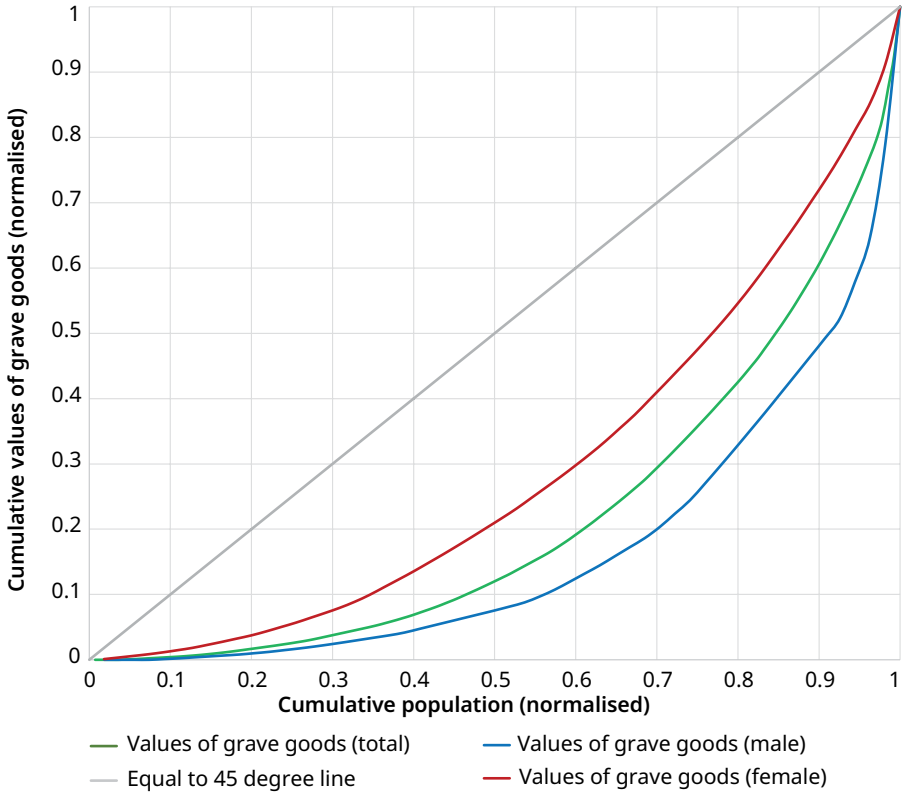


Figure 89. Distribution of values of grave goods displayed as Lorenz curves with regard to the total number of individuals, females and males.

curve of males. Accordingly, a so-called Lorenz dominance exists. The inequality degree is therefore higher among males in comparison to females. This is also reflected with respect to the calculated Gini indices. The Gini index for females amounts to 0.42 and for males to 0.66. The total Gini index amounts to 0.56. The higher inequality degree among males is particularly due to the fact that the central male burial and the secondary male grave 90 demonstrate by far higher values for grave goods than the remaining burials and that the few burials without grave goods appear exclusively in male burials.

Distance to the central burial

As a next step, the distance to the central burial is included. The initial hypothesis is postulated as follows: the distance of a burial to the central burial is related to the social position of the buried individuals. Both the values of grave goods and the burial pit sizes were thus correlated with the respective distance to the central burial (Fig. 90).

The results show that there is a moderate and significant correlation between the size of a burial pit and the distance to the central burial (Linear r (Pearson) = -0.37197; p = 0.00013865; n = 100). In contrast, there is no correlation between the values of grave goods and the distance to the central burial. Belonging to the burials that include both relatively high values of grave goods, large burial sizes and a close distance to the central burial are graves 74, 67.2, 72 and 68. They are all located in the eastern part of the mound. One reason for this could be the fact that erosion in this area is not very distinct. Two of them are represented by richly ornamented female graves (graves 68 and 72) that include jet "*Tonnen*" bracelets and two of them are represented by male graves that are furnished with a dagger (grave 67.2) and a stone mallet (grave 74).

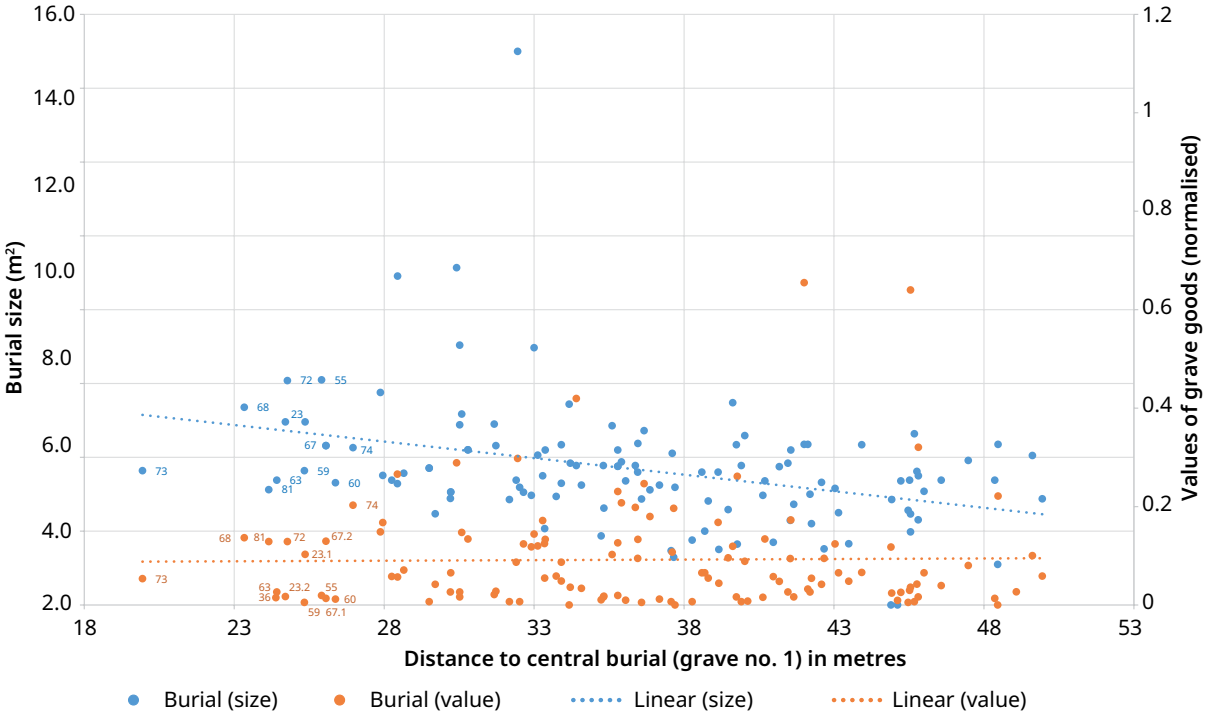


Figure 90. Linear regression between burial sizes/values of grave goods (both y-axis) and distances to the central burial (x-axis).

Another question is concerned with the relationship between the age cohort of the buried and the distance to the central burial. The boxplot diagram (Fig. 91) shows that the distance to the central burial tends to be shorter with aging. Accordingly, individuals of the mature and senile age cohorts were located closest to the central burial. In contrast, infans burials tend to be situated more distant from the central grave. However, the differences between the samples are not significant (One-Way-ANOVA: p = 0.8046).

With regard to genders, differences can be observed. For females, the boxplots show that the distance to the centre of the mound tends to decrease with age. However, with the exception of the age cohorts late-adult and mature/senile, there are clear differences in each age cohort. For instance, the infans and early-adult cohorts demonstrate high interquartile distances that indicate a high inequality degree within these age cohorts.

In contrast, there is no trend indicating a correlation between age at death and distance to the centre of the mound in relation to males. However, it is conspicuous that late-adult individuals are all located relatively far from the centre of the mound. This result stands in contrast to the outcomes of the correlation between values of grave goods and age cohorts.

A further question concerns the proximity of the burials to the central burial chamber in relation to the occupancy sequence. H. Parzinger identified three chronological phases Ia, I and II based on the combinations of grave goods. First, figure 92 shows once again the decreasing tendency of grave pit sizes from inside to outside and it also demonstrates the close arrangement of the burial that is allocated to the oldest phase (Ia: mean = 30.3 m) to the centre grave. In contrast, burials of phase I (mean = 37.9 m) were arranged both close to and more distant from the central burial. Burials that belong to phase II are mainly situated at a mean distance of 38.3 m from the central burial. In analogy to H. Parzinger (1986, 404), a sequence of occupations from the inside to the outside can be traced to

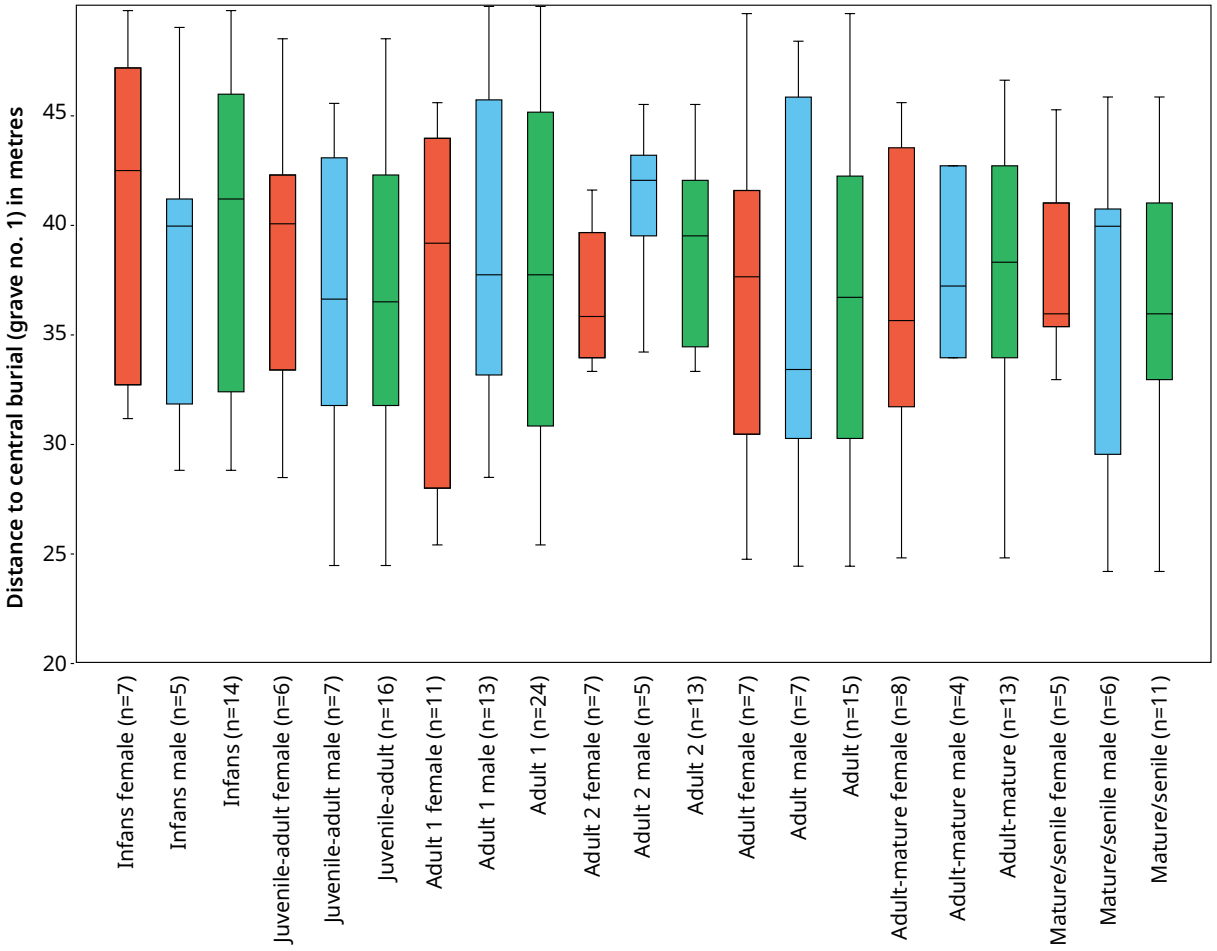


Figure 91 (above). Ranges of distances to the central burial according to the total number of burials, genders and age cohorts.

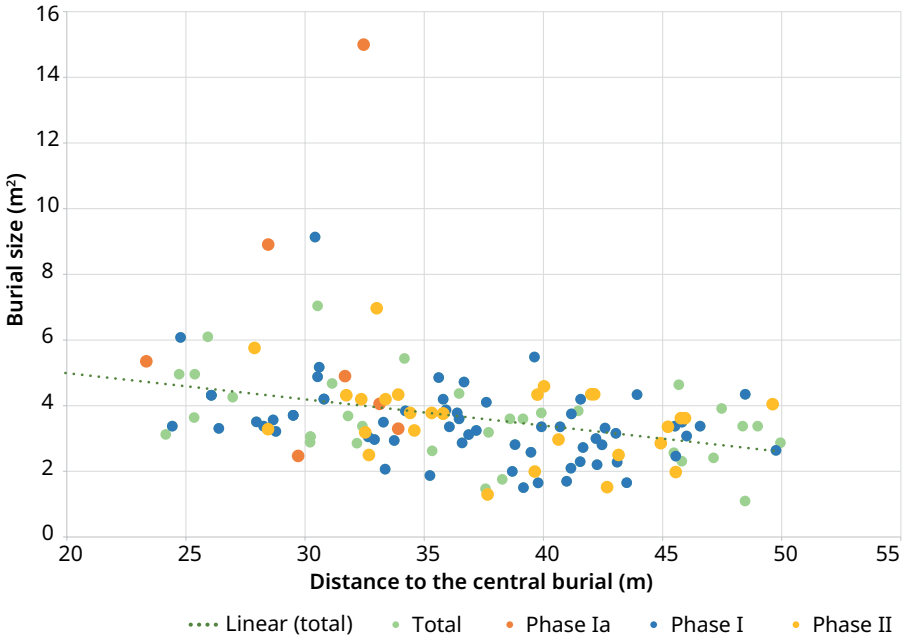


Figure 92. Correlation between the distance to the central burial (x-axis) and the burial sizes (y-axis) in combination with the chronological phases.

some extent. In total, however, two factors must be applied: the time factor and the status factor. More high-ranking burials tend to be closer to the central burial, but at the same time, more high-ranking individuals from phase II onwards tend to be more distant from the central burial.

Diet and social position: Nitrogen isotope analysis ($\delta^{15}N$)

In order to determine differences with regard to nutrition and especially the consumption of animal proteins, the $\delta^{15}N$ ratios that were sampled by K. Kupke (2010) are included and categorised below. Overall, the $\delta^{15}N$ and $\delta^{13}C$ values of adult individuals from Magdalenenbergle demonstrate a terrestrial and omnivorous nutrition, based on C3 plants and herbivorous animals. In contrast to the almost contemporaneous Iron Age "princely seat" of Glauberg, Magdalenenbergle does not show evidence for millet. However, the results of Glauberg suggest a diet probably poorer in meat and dairy products than at Magdalenenberg (Knipper et al. 2014, 830).

K. Kupke (2010) sampled 50 individuals (22 males, 25 females, 3 indeterminate individuals) for $\delta^{13}C$ and $\delta^{15}N$ collagen analyses, extracted from bones – mostly ribs (Kupke 2010, 95ff.). The following analyses do not consider the $\delta^{13}C$ ratios, since the $\delta^{15}N$ ratios demonstrate a higher variance compared to the $\delta^{13}C$ ratios and rather adequately indicate the consumption of animal proteins. In order to

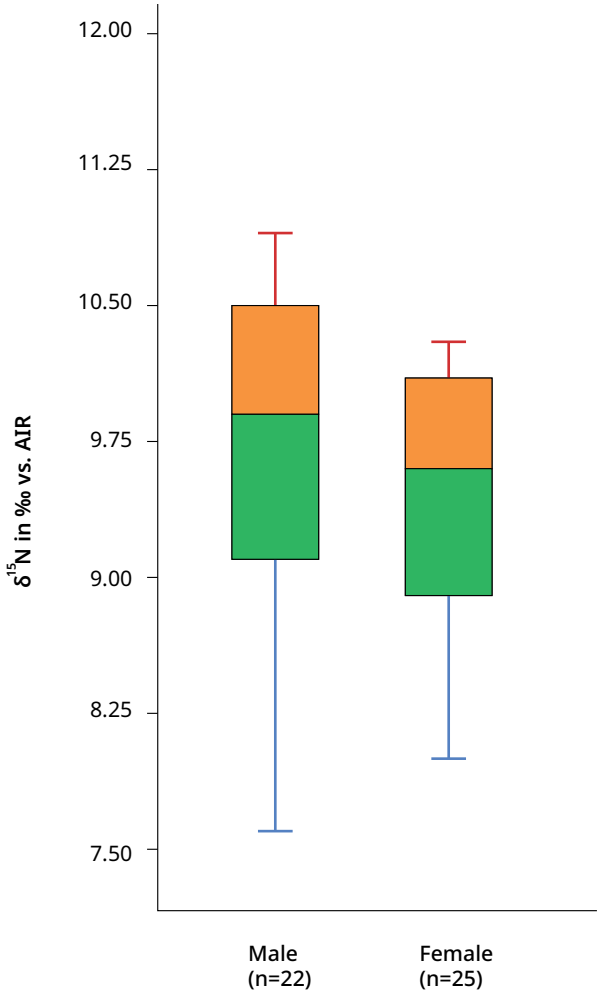


Figure 93. Nitrogen ($\delta^{15}N$) categories according to genders. Coloured quartiles are also depicted.

Table 24. Nitrogen ratios of sampled individuals of Magdalenenbergle according to sexes and categorised to quartiles.

Nitrogen ($\delta^{15}N$) categories	Females	Males
1. High (third quartile-max.)	9.9-10.3 (n = 5)	10.7-10.9 (n = 6)
2. Medium-high (median-third quartile)	9.7-9.8 (n = 3)	9.9-10.5 (n = 7)
3. Medium-low (first quartile-median)	8.9-9.6 (n = 10)	9.1-9.8 (n = 7)
4. Low (min.-first quartile)	8-8.5 (n = 5)	7.6-9 (n = 6)

Table 25 (below). Female burials with the highest nitrogen ratios (1st category).

Grave	96	120	122	126	127
Age	Mature	Adult 2	Adult 1	Adult	Adult 1
$\delta^{15}N/\delta^{13}C$ (highest nitrogen ratios)	10.2/-19.6	9.9/-19.6	10.2/-19.6	10.1/-19.9	10.3/-19.7
Strontium/oxygen group (Oelze 2012a)	Black Forest east	-	Hegau Keuper/ Braunjura	Heuneburg	Kapf group
Inventory	10 earrings, 1 spiral roll (chest pendant), 2 forearm bracelets, 2 "*Tonnen*" bracelets (jet), 1 clamp belt hook, belt accessories, 1 miniature vessel	1 hairpin, 1 earring, 3 bracelets, 2 "*Tonnen*" bracelets (jet), belt sheet (rectangular shaped), belt accessories, amulet, 1 vessel, 1 miniature vessel	2 hair pins, 7 earrings, 2 bracelets, 2 "*Tonnen*" bracelets (bronze), 4 upper arm spiral, 1 belt sheet (tongue shaped), belt accessories, 2 simple pendants, 1 miniature vessel	2 hair pins, 9 earrings, 1 necklace with closure sleeve, 2 "*Tonnen*" bracelets (bronze)	12 earrings, 2 forearm bracelets, belt sheets (tongue shaped), belt accessories, 1 miniature vessel
Individual difference	Lancet-shaped belt hook of the Golasecca culture	"*Tonnen*" bracelet (jet)	Coral beads and ornamented "*Tonnen*" bracelets	Ornamented "*Tonnen*" bracelets	-
Occupancy phase (Parzinger 1986)	I	I	I	I	I
Rank (Müller 1994); "rich" female inventory (Burmeister 2000)	3; yes	1; yes	2; yes	3; -	3; -
Distance to central grave (m)	33	36	28	42	44
Burial size (m^2) Average: 3.5	3	4.2	3.5	2.3	4.3

Grave	7	32	88	102	103
Age	Adult 1	≥Adult	Adult 1	Infans 2	Adult 1
$\delta^{15}N/\delta^{13}C$ (highest nitrogen ratios)	8.3/-19.8	8.4/-19.5	8.5/-19.5	8/-19.6	8.2/-20.2
Strontium/oxygen group (Oelze 2012a)	Black Forest east	-	Superregional	-	-
Inventory	1 forearm bracelet, belt accessories,	4 earrings, 5 forearm bracelets, 1 belt hook (tongued shaped), belt accessories, 1 miniature vessel	5 hair pins, 2 earrings, 1 "*Schlangen*" fibula, 6 forearm bracelets, 1 belt sheet (rectangular, narrow), belt accessories, 6 simple pendants, 11 simple pendants with conical heads, 2 amulets, 1 miniature vessel	3 forearm bracelets, 2 simple pendants	1 hair pin, 2 earrings, 1 necklace with closure sleeve, 2 forearm bracelets, belt accessories
Individual difference	-	Belt hook = Southern Alpine type, import	Iron soldered amulet capsule, Eastern Hallstatt element	-	-
Occupancy phase (Parzinger 1986)	-	I	II	-	I
Rank (Müller 1994); "rich" female inventory (Burmeister 2000)	3;-	?;-	2; yes	3;-	3;-
Distance to central grave (m)	40.1	45.6	45.6	47.1	43.5
Burial size (m^2) Average: 2.1	-	2.5	2	2.4	1.7

Table 26. Female burials with the lowest nitrogen ratios (4th category).

demonstrate differences in nutrition, the nitrogen ratios were ranked into four categories. The categorisation of the $\delta^{15}N$ ratios is based on their overall standard deviation (Tab. 24). The values are shown according to gender, since males show overall distinct higher value ranges than females – even if there is no significant difference (Fig. 93).

Regarding one burial, there is a contradiction between anthropological and archaeological gender. Grave 117 represents the inventory of a male individual, although it is anthropologically classified as a female. This cross-gender individual (Koch 2017b, 95) is allocated to females due to the low $\delta^{15}N$ value.

In tables 25, 26, 27, and 28, we compare males and females with the highest $\delta^{15}N$ values (Tab. 25 and 27) in contrast to males and females with the lowest $\delta^{15}N$ values (Tab. 26 and 28).

Grave	39	45	54	104	123
Age	Adult	≥Adult	Mature	Adult 1	Adult 1
$\delta^{15}N/\delta^{13}C$ (highest nitrogen ratios)	10.8/-20	10.9/-18.9	10.9/-19.2	10.8/-19.9	10.8/-18.9
Strontium/oxygen group (Oelze 2012a)	Kapf group	-	Hegau Keuper/ Braunjura	Kapf group	Hegau Keuper/Braunjura
Inventory	2 "*Bogen*" fibulae, 1 antenna dagger, 1 miniature vessel	2 forearm bracelets, 1 belt hook (tongue shaped), 2 simple pendants	1 antenna dagger, 1 miniature vessel, 1 boulder mallet	-	1 "*Bogen*" fibula, 1 simple pendant, 1 vessel (Alb-Hegau-ceramic)
Individual difference	-	-	-	-	-
Occupancy phase (Parzinger 1986)	II	II	I	-	Ia
Rank (Müller 1994); "rich" female inventory (Burmeister 2000)	1; -	3;-	3; yes	4; -	2; -
Distance to central grave (m)	33	42.7	45.8	37.7	28.4
Burial size (m^2) Average: 4.8	7	1.5	3.5	3.2	8.9

Table 27. Male burials with the highest nitrogen ratios (1st category).

Of the 23 females, five provide $\delta^{15}N$ ratios of the highest category (values between the 3rd quartile and the maximum). These include graves 96, 120, 122, 126 and 127. The listed individuals have similarities, which are interpreted in the following as characteristic for a higher ranking. They are well-furnished in quantity and quality and show, for instance, a high number of earrings (n > 7) (except grave 120), "*Tonnen*" bracelets (except grave 127), belt accessories, and miniature vessels (except grave 126).

Graves 96, 120, 122 and 126 additionally display southern alpine import items. Grave 96 includes a lancet-shaped belt hook of the Golasecca culture, which is comparable to items in Southern Switzerland and Northern Italy. Grave 122 includes maritime coral beads. Furthermore, the "*Tonnen*" bracelets made of jet (graves 96 and 120) and the decorated bronze "*Tonnen*" bracelets (graves 122 and 126) count as imports.

In addition to the import items, the large number of earrings in grave 127 has to be emphasised, which only occurs to the same extent within one further burial (grave 95). For grave 120, an amulet in the form of an ammonite has to be highlighted. Moreover, exceptional pieces from tomb 122 include decorated upper arm jewellery and a small bow fibula.

Additionally listed in table 26 are the burials with the lowest nitrogen isotope ratios that range between the minimum and the first quartile of the samples (4th category; graves 7, 32, 88, 102, and 103). Compared to the graves with the highest nitrogen isotope ratios, the greatest differences for the individuals in the 4th category

Grave	52	94	106.1	108	114	124
Age	Infans 2	Adult 1	Adult 1	Juvenile-Adult	Adult	≥Adult 2
$\delta^{15}N/\delta^{13}C$ (highest nitrogen ratios)	7.9/-20.1	7.6/-20	8.8/-19.6	9/-19.7	8.5/-19.8	8.9/-20.6
Strontium/oxygen group (Oelze 2012a)	-	Black Forest west	Black Forest west	-	-	Black Forest west
Inventory	2 "*Schlangen*" fibulae, 1 miniature vessel	1 iron necklace, 1 robe pin, 1 simple pendant, 1 miniature vessel	2 "*Bogen*" fibulae, 1 belt sheet (rectangular), 1 miniature vessel	1 robe pin, 1 razor	2 miniature vessels	1 vessel (Alb-Hegau-ceramic), 1 miniature vessel
Individual difference	-	Iron necklace with imitated torsion	-	-	-	-
Occupancy phase (Parzinger 1986)	I	-	II	I	-	Ia
Rank (Müller 1994); "rich" female inventory (Burmeister 2000)	3;-	3; yes	3; yes	3;-	3;-	3;-
Distance to central grave (m)	41.2	47.4	45.8	43	48.3	33.9
Burial size (m^2) Average: 3.1	2.1	3.9	-	3.2	-	3.3

Table 28. Male burials with the lowest nitrogen ratios (4th category).

can be observed in the lower abundance of grave goods (except grave 88), the lower number of earrings and the absence of "*Tonnen*" bracelets. Moreover, in contrast to burials that have the highest $\delta^{15}N$ ratios, imported items are less common. The Southern Alpine belt hook of type 1 and the iron amulet capsule, which presumably originates from the Osthallstatt district (cf. Trachsel 2004), represent exceptions.

Of the 27 individuals that are archaeologically classified as males (cf. Zäuner and Wahl 2013, tab. 1/2), 5 individuals show $\delta^{15}N$ ratios between the 3rd quartile and the maximum value (category 1). Belonging to the males with the highest $\delta^{15}N$ ratios are the central burial 1 and graves 39, 45, 54, 104 and 123.

Compared to females, males do not show such a large number of preserved object categories and objects. Two of five burials include antenna daggers, which have been regarded as prestige objects for a long time (Sievers 1980). They belong to graves 54 and 39. Remarkable concerning grave 54 is its assigned stone mallet, which is documented only three times within the burial mound. In grave 123, the so-called Alb-Hegau pottery stands out. This pottery belongs to the oldest category of grave goods at Magdalenenbergle (Parzinger 1986), occurs relatively seldom (n = 5) and is not considered to be a typical male grave object. Moreover, the well-furnished female burials 68 and 78.2 equally demonstrate this pottery. Another outstanding feature of grave 123 is its covering with limestone instead of sandstone, which indicates, according to K. Spindler (1972), a very early burial. Furthermore, grave 45 shows a fragmented belt hook (Koch 2018). Belt hooks

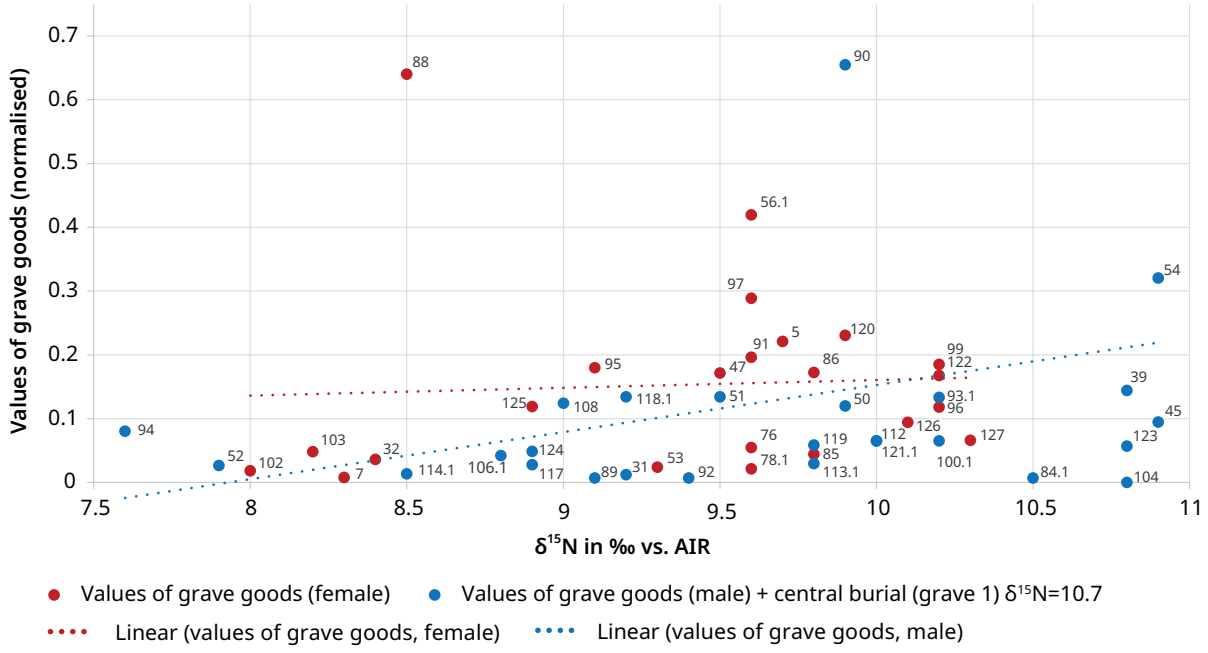


Figure 94. Correlation between $\delta^{15}N$ ratios and values of grave goods according to gender.

are relatively rare and occur only with 11 individuals. Finally, grave 104 does not include any grave goods although it shows a high $\delta^{15}N$ ratio.

Belonging to the male individuals that can be assigned to the lowest nitrogen group (values between the minimum value and the first quartile, 4th category) are the interments from graves 52, 94, 106.1, 108, 114 and 124. Compared to the group with the highest $\delta^{15}N$ ratios, none of these individuals reveals an antenna dagger among its furnishings. In contrast, miniature vessels and robe pins are more common in the group with low nitrogen isotope ratios. In comparison to the group with the highest $\delta^{15}N$ ratios, there is no major difference when considering grave goods. Related to graves 52, 94 and 106.1, even relatively well-furnished graves are represented, since they are furnished with fibulae (graves 52 and 106.1) or with a necklace and a robe pin (grave 94).

Comparing the extent to which the individuals with high and low nitrogen ratios are represented in the social index studies of J. Müller (1994) and S. Burmeister (2000), there appear to be rather loose linkages. However, among the group of highest female nitrogen ratios, for instance, good matches are observed.

Two female (120 and 122) and two male (39 and 123) burials demonstrate the highest $\delta^{15}N$ ratios and likewise belong to the highest rank groups (ranks 1 and 2) according to J. Müller (1994, 200ff.). The remaining individuals that have the highest $\delta^{15}N$ ratios are affiliated, in particular, with his third rank group. Grave 104, which does not show any grave goods, belongs to his fourth rank group. Females and males with the lowest $\delta^{15}N$ values almost belong to his third rank group. An exception represents grave 88 that J. Müller assigns to his second rank group, as it represents a relatively well-furnished female grave. Since this woman is classified as non-local due to its unusual $\delta^{18}O$ value, the low $\delta^{15}N$ ratio could also result from other environmental conditions and eating habits.

With respect to the investigation of S. Burmeister (2000), three females that represent high ranked individuals belong to the burials that demonstrate high $\delta^{15}N$ ratios. These include burials 96, 120 and 122. The already mentioned grave 88

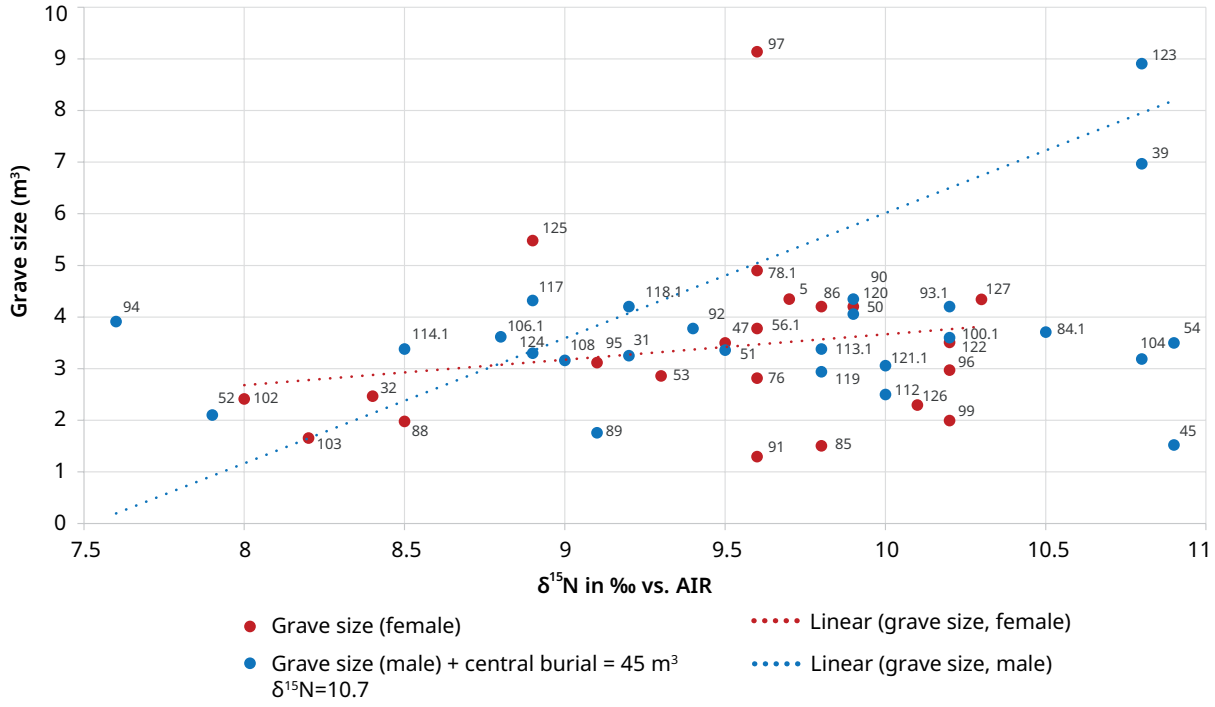


Figure 95. Correlation between $\delta^{15}N$ ratios and grave sizes (m^2) according to gender.

belongs to the females with low $\delta^{15}N$ ratios that S. Burmeister likewise allocates to the richest female burials. Among the male burials that show high $\delta^{15}N$ values, only grave 54 corresponds to the emphasised well-furnished male individuals according to S. Burmeister. In contrast, low $\delta^{15}N$ values correlate in two cases with rich male inventories according to S. Burmeister. This is the case at graves 94 and 106.1.

Figures 94 and 95 demonstrate the correlations between all nitrogen ratios and values of grave goods and between all nitrogen ratios and grave pit sizes. For both analyses, there are positive correlations, however, this is especially the case for males.

With regard to the values of grave goods, a moderate positive correlation (Linear r (Pearson): 0.30899; p = 0.11682) was detected for males. Female individuals show no correlation in this context (Linear r (Pearson): 0.058502; p = 0.7909).

With respect to the size of the burial pits, small positive correlations were observed for both males and females: (Linear (Pearson) males: 0.27331, p = 0.16777; Linear r (Pearson) females: 0.1939; p = 0.38724). The positive tendency line for males is influenced, in particular, by the central burial (Fig. 95).

Belonging to the burials that include high nitrogen ratios, high values of grave goods and big burial pit sizes are, *e.g.*, male grave 39 that is furnished with a dagger and female burial 122 that is endowed with "*Tonnen*" bracelets.

In comparing the categories of nitrogen ratios with the different grave pit sizes, the differences become obvious. The average grave size of individual burials among the 1st nitrogen category amounts to 4.8 m^2 for males and 3.5 m^2 for females. Among males, the pit sizes of burials 39 and 123 and among females the pit sizes of burials 120 and 127 are particularly noteworthy. In contrast, the average pit size in the 4th nitrogen category amounts to 2.1 m^2 for females and 3.1 m^2 for males. Thus, there is a positive correlation regarding inequality in the consumption of animal proteins and inequality related to burial pit sizes.

With respect to the age spectrum of male and female individuals related to the highest $\delta^{15}N$ values, it is clear that subadult individuals are not included. Based on anthropological age data from S. Zäuner and J. Wahl (2013), it is obvious

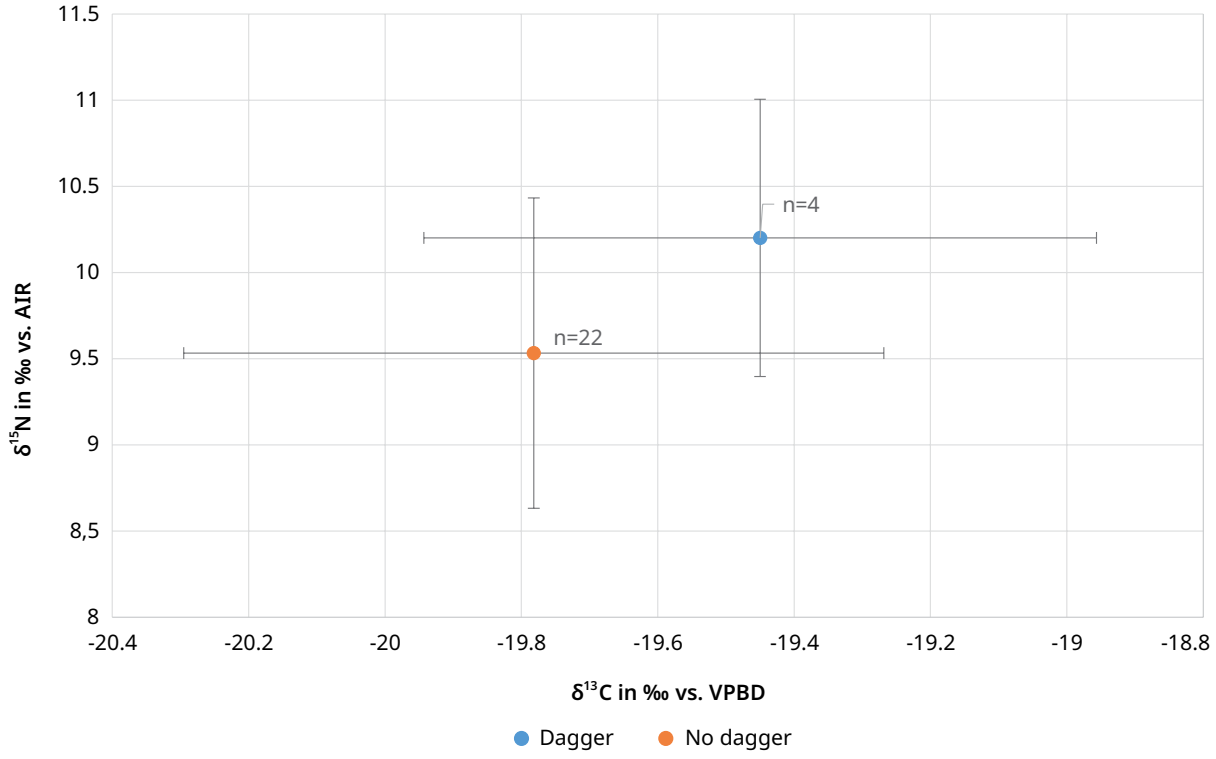


Figure 96. Nitrogen $\delta^{15}N$ and carbon $\delta^{13}C$ ratios in the context of adult male burials that have daggers and adult male burials that do not have daggers.

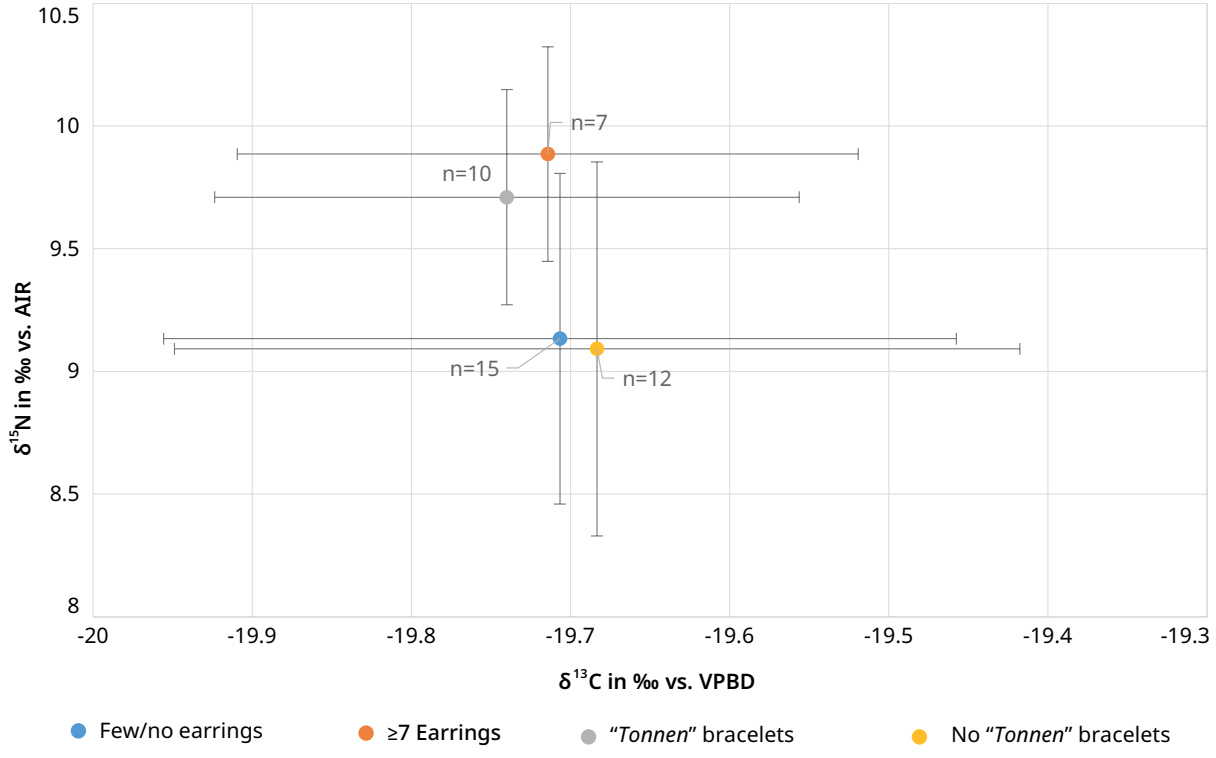


Figure 97. Nitrogen $\delta^{15}N$ and carbon $\delta^{13}C$ ratios in the context of adult female burials that have many earrings/"*Tonnen*" bracelets and adult female burials that do not have these burial goods.

that late-adults (grave 120), mature-adults (graves 96 and 54) and especially early-adults (graves 100.1, 122, 127, 104 and 123) demonstrate the highest $\delta^{15}N$ values. Overall, there is no single age or adult cohort that stands out among the individuals with the highest $\delta^{15}N$ values. However, K. Kupke (2010, 89ff.) demonstrated that adult individuals show, in total, a lower $\delta^{15}N$ mean degree and a higher variance in the $\delta^{15}N$ values in comparison to mature individuals.

The males and females with the lowest $\delta^{15}N$ values include individuals that are allocated to the age cohorts infans (graves 52 and 102), early-adult (graves 7, 88, 94, 103, 106.1), juvenile-adult (grave 108), adult (graves 32 and 114), and late-adult (grave 124). However, there is no individual who can be assigned to the age cohort mature.

Based on the results of the previous section, the following analyses demonstrate to what extent groups with certain grave goods differ in $\delta^{15}N$ ratios and $\delta^{13}C$ ratios from those groups that do not have these grave goods. Since the furnishings have a clear gender-specific reference, the comparison is also gender-specific.

The male burials with the highest $\delta^{15}N$ values and $\delta^{13}C$ values show no clear congruence to certain objects. Most likely, daggers, Alb-Hegau pottery and stone mallets can be linked to high nitrogen isotope values. However, all the latter are only present once in connection with isotope analyses and are excluded in the following analysis.

However, differences can be demonstrated when comparing isotope ratios of individuals who are furnished with antenna daggers with those who are not furnished with them (Fig. 96). The average $\delta^{15}N$ value for burials with antenna daggers amounts to 10.2 (±0.8). This is a higher average value (+0.7) compared to those males (≥ adult) without daggers (9.5, ±0.9). The average $\delta^{13}C$ value of males with a dagger amounts to -19.5 (± 0.5) and is in average higher (+0.3) in comparison to males that are not furnished with daggers (-19.8, ± 0.5).

Nevertheless, the difference between males with an antenna dagger and males without an antenna dagger is not significant for both the $\delta^{15}N$ ratios and the $\delta^{13}C$ ratios (nitrogen: t: 1.3828; p (same mean): 0.17947; carbon: t: 1.195; p (same mean): 0.24375).

In relation to the $\delta^{15}N$ and $\delta^{13}C$ ratios of females, the individuals that have a high number of earrings (≥7) and/or "*Tonnen*" bracelets differ from those that do not have these characteristics (Fig. 97). The infans 1 burial 99 is not included in the comparison, since its values could be influenced by breastfeeding (cf. Kupke 2010, 86).

Especially concerning nitrogen ratios, the average value for burials with many earrings is significantly higher. For burials with many earrings, the $\delta^{15}N$ value amounts to 9.9 (± 0.4). This value is higher (+ 0.8) compared to the females that have few or no earrings (9.1; ± 0.7). The difference in the $\delta^{15}N$ ratio is significant (T-test: -2.6838, p (same mean): 0.014275). The average $\delta^{13}C$ value for females with many earrings amounts to -19.7 (± 0.2) and is equal to that of females that have no or few earrings (-19.7; ± 0.3).

A similar result is provided by the analysis of female individuals with "*Tonnen*" bracelets compared to those individuals that are not interred with them. Females with "*Tonnen*" bracelets demonstrate an average value of 9.7 (± 0.4) and thus a higher $\delta^{15}N$ ratio (+ 0.6) compared to females without "*Tonnen*" bracelets (9.1; ± 0.8). The difference is significant (t: 2.2667; p (same mean): 0.034655). The $\delta^{13}C$ values provide almost identical values for both females with "*Tonnen*" bracelets (-19.7; ± 0.2) and those without (-19.7; ± 0.3).

The fact that females that are furnished with "*Tonnen*" bracelets and many earrings had a high social position is confirmed by the inclusion of the burial pit size factor. If we consider all adult female burials with "*Tonnen*" bracelets and/

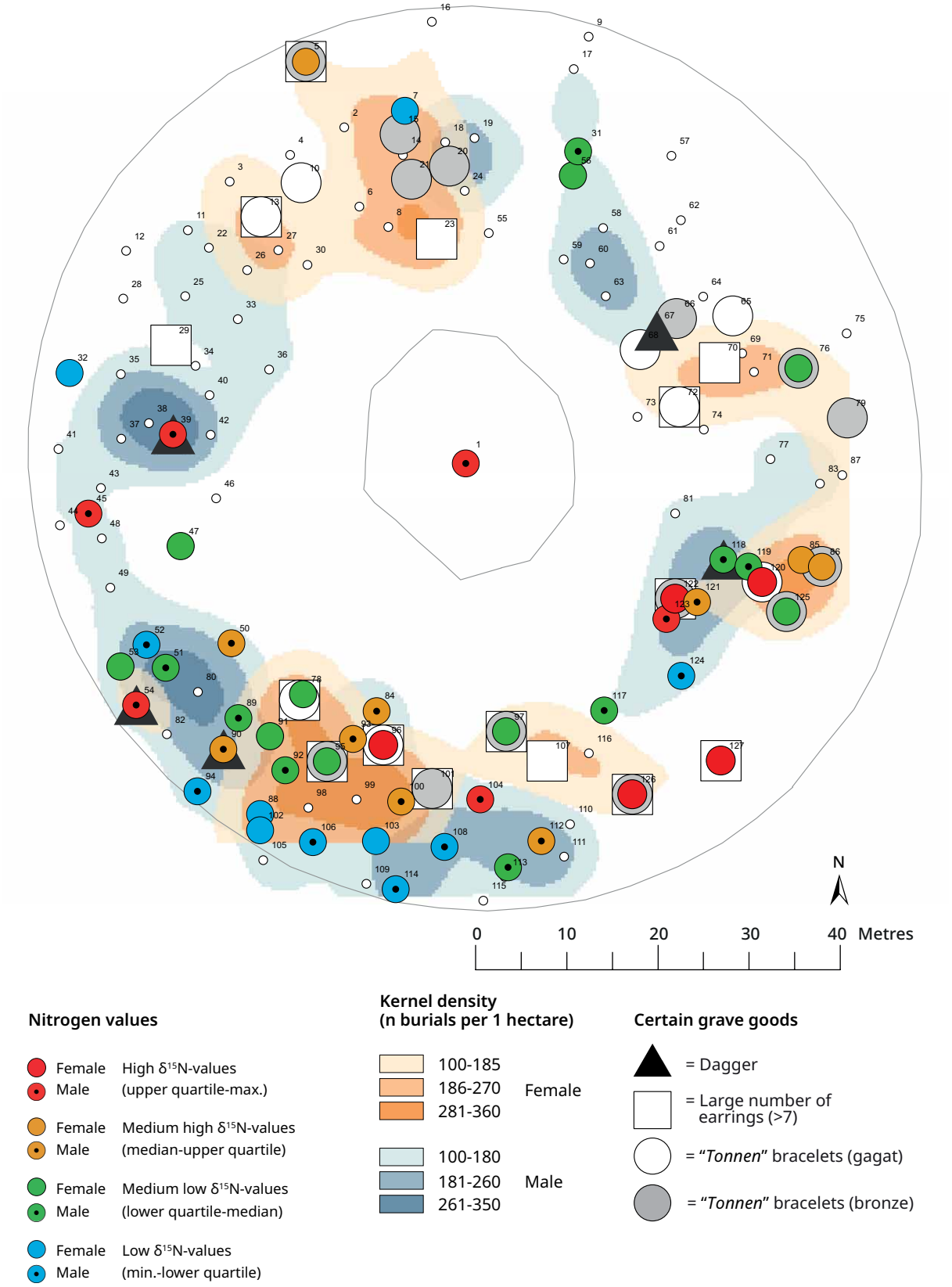


Figure 98. Distribution of $\delta^{15}N$ ratios categorised by value level and gender. Additionally depicted are grave goods, including daggers, a large number of earrings and "*Tonnen*" bracelets.

or burials with many earrings, the average grave size is 4.4 m^2 (n = 19). All other female graves demonstrate an average size of 3 m^2 (n = 17). The difference is significant (tests for equal means; t: 3.0406; p (same mean): 0.0045232).

As shown among males, the nitrogen analysis does not clearly indicate a category of grave goods that is equated with an elevated position. This applies most likely to antenna daggers. The average burial pit size for adult males, who have antenna daggers, amounts to 4.9 m^2. For the corresponding comparison group that does not have antenna daggers the burial pit size measures 3.5 m^2. Since only a few single burials with antenna daggers are available (n = 3), a statistical significance test, however, is not possible.

With regard to the correlation between the $\delta^{15}N$ values and the distance to the central grave, first the number and the location of the isotope samples in the burial mound have to be taken into account. It is noticeable that the southern and southeastern parts of the burial mound are very well covered with samples, while the remaining areas are relatively poorly represented (cf. Fig. 98).

The question whether burials that show high $\delta^{15}N$ ratios were placed closer to the central burial chamber is calculated, based on the horizontal distance without considering the depth of the burial pits. The middle of the central burial chamber serves as a reference point.

According to the comparison of the nitrogen categories, no differences between the first three nitrogen categories with respect to the distance to the central burial are observable. The average distances amount to 37 m (category 1), 37.9 m (category 2) and 36.8 m (category 3). In contrast, individuals with $\delta^{15}N$ ratios that lie between the minimum value and the 1st quartile (category 4) are buried, on average, at a much longer distance from the central burial (43.8 m). The T-test reveals significant differences in the average distance between the $\delta^{15}N$ values of the 1st and 4th categories (t: -2.9137, p (same mean): 0.0089059), 2nd and 4th categories (t: -2.5669, p (same mean): 0.018868) and 3rd and 4th categories (t: -4.0641, p (same mean): 0.00039549). Thus, only the social group with the lowest nitrogen levels and the poorest access to animal proteins correlates with a higher distance from the centre of the burial mound and probably has a lower social position.

In addition to the $\delta^{15}N$ values, the average distances from selected object categories to the central grave are demonstrated. For this, the previous emphasised objects, including antenna daggers, "*Tonnen*" bracelets and/or a large number of earrings, are integrated into the analyses. The average distance of burials that include antenna daggers to the central burial amounts to 35.5 m (n = 5). In contrast, the average distance to the central grave of the adult male burials that do not have daggers amounts to 37.3 m (n = 43). As a consequence, burials that include daggers tend to be closer to the central grave. However, the difference is not significant (t: -0.51602; p (same mean): 0.53592).

Female burials that have many earrings (≥7) and encompass the juvenile to mature/senile age cohorts are located much closer (34.5 m, n = 15) to the central burial than females (juvenile and older) who do not have earrings or only a few (37.7 m, n = 29). The difference, however, is not significant (t: -1.5585; p (same mean): 0.12662).

With regard to the "*Tonnen*" bracelets, bronze and jet objects are analysed in this context separately from each other. Females that are decorated with bronze "*Tonnen*" bracelets are situated, on average, at a distance of 38 m (n = 12) from the central burial. With the remaining female burials, a slightly closer average distance could be detected with a distance of 36.8 m (n = 35). In contrast, females that have "*Tonnen*" bracelets that are based on jet (n = 6) were buried at an average distance of

30.9 m from the central burial, whereas the compared female group that does not have this type of grave goods demonstrates a distance of 38 m (n = 41) to the central burial. This difference is significant (t: 2.6258; p (same mean): 0.01177).

Tooth decay

Dental status is another indicator of the social status of individuals. In 33 individuals for whom dental status data is available, tooth decay was found in almost half (n = 15) of them. The data demonstrates that tooth decay was much more common in females (58%) in comparison to males (28%) (14% undetermined).

For females, a distinct correlation between material furnishings and the presence of caries and periodontal disease was detected (Gallay 1977, 110), an aspect that J. Müller (1994) and S. Burmeister (2000, 153) already emphasised. Females with above-average furnishings tend to have tooth decay. For example, almost all females with caries exhibit "*Tonnen*" bracelets and necklaces in their burials. These objects are missing in interments of females without caries. Moreover, the spatial distribution of caries within the Magdalenenbergle mound shows clearly that it correlates with the spatial distribution of female burials.

Among males, the correlation between grave goods and caries is not that clear for burials with an overall lower quantity and quality of furnishings. However, males that include razors as furnishings show individual caries in three out of four cases.

Strontium/oxygen isotope analysis

In order to analyse the origin and heterarchical structure of the buried community, strontium in combination with oxygen isotope ratios are integrated since they provide helpful information in this context (cf. 'Methods' chapter). V. M. Oelze (2012a) integrated samples of 76 individuals for $^{87}Sr/^{86}Sr$ analyses, which represent 38 female, 30 male, and 8 indeterminate individuals. The strontium isotope values from the burials of Magdalenenbergle, Villingen range from 0.70725 to 0.71923. The Early Iron Age society and, in particular, the individuals that were interred in the tumulus of Magdalenenbergle were highly mobile and belonged to a socioeconomic network. Based on the range of the strontium ratios and comparing samples from the surrounding landscapes from Southwest Germany, V. M. Oelze emphasised three different origins of the buried individuals. Local values are associated with characteristic red sandstone (*Buntsandstein*) strontium ratios (from 0.7118 to 0.71411). These individuals probably originated from the close hill fort settlement "Kapf" (Oelze *et al*. 2012a). V. M. Oelze (2012a, fig. 1.5) identified two further bigger strontium isotope clusters that originated from the wider region of Southwest Germany. She interprets the group of individuals with the highest values (from 0.71454 to 0.71923) as a group coming from the Black Forest region (granite, gneiss geology), and a further group with rather low values (from 0.71 to 0.70725) as a group that originated from the Lake Constance/Hegau area.

In this context, the first question concerns the location of the different groups within the burial mound (Fig. 99). According to V. M. Oelze (2012a), there is no association between the location and the strontium isotope ratio level. However, due to the kernel density analysis, these strontium isotope groupings emphasised by V. M. Oelze do cluster in certain areas. Lower $^{87}Sr/^{86}Sr$ ratios that are allocated to the "Hegau group" are primarily located in the eastern and southwestern parts of the burial mound, while the strontium isotope ratios of the "Kapf" group are located

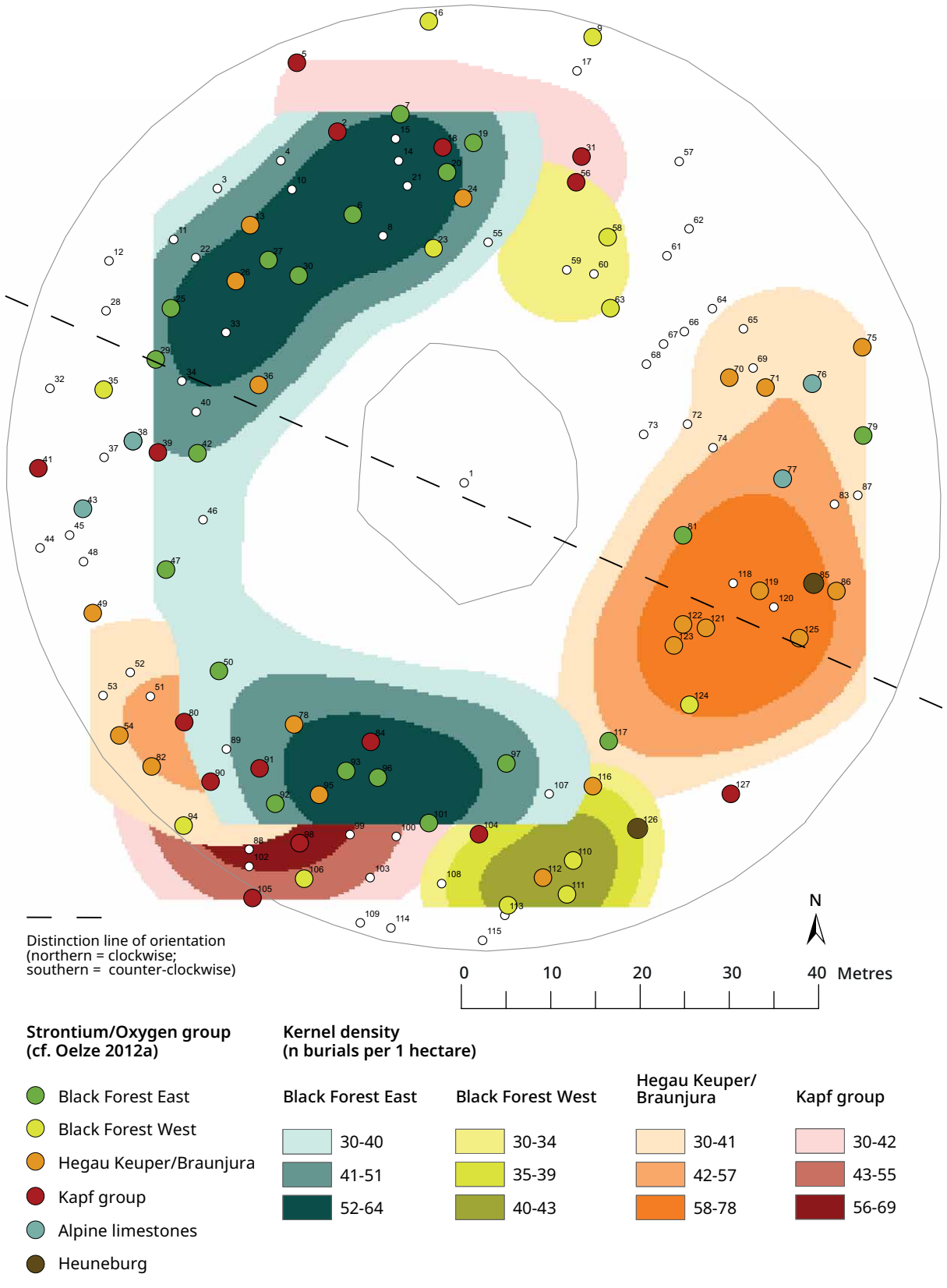


Figure 99. The distribution and kernel densities of strontium/oxygen isotope ratios associated with strontium/oxygen isotope groups emphasised by V. M. Oelze (2012a).

mainly in the southern and northern areas. Data of the "Black Forest East group" is mainly situated in the western, southern and northern areas and strontium isotope ratios of the "Black Forest West group" are located mainly in the southeast and northeast areas. Strikingly, a kind of mirroring across the west-east axis is observable. Therefore, the members of the respective strontium isotope groups, with exception of the "Hegau group", are located roughly opposite from each other.

This kind of separation is also represented if we consider the orientation of the deceased. As mentioned, the mound was divided by wooden pole settings into two halves. Buried individuals of the northern half represent interments in a clockwise arrangement, whereas interred individuals in the southern part include burials ordered in counter-clockwise formation. Thus, according to the strontium isotope ratios, one part of each community is buried in the northern section of the mound and one part in the southern section. This fact is also obvious if we consider the four burials that belong to the alpine limestone strontium/oxygen group, which are located opposite from each other: two in the southwestern part (graves 38 and 43) and two in the northeastern part (graves 76 and 77).

In order to demonstrate which types of grave goods correlate frequently with certain strontium/oxygen isotope groups, the objects were transferred to correspondence analyses set up for each archaeological gender. Figure 100 shows the results of the analysis on the first and second principal axes. Firstly, it can be demonstrated that with respect to females certain ornamental elements appear together and other ornamental objects, which are located at a greater distance from each other, cannot be associated with each other.

Accordingly, the grouped items in the negative area of the first principal axis demonstrate a hollow jewellery character. These include hairpins with hollow heads, hollow earrings and hollow bracelets. Hollow earrings are combined with the strontium/oxygen "Hegau group" and the "Kapf group". In contrast, "*Tonnen*" bracelets, open necklaces and clamp belt hooks are grouped in the positive area of the first principal axis. They appear in combination with both the strontium/oxygen isotope "Hegau group" and the "Black Forest East group". The same also applies to the wide band earrings, which can be associated – especially if they appear in a high number – with the strontium/oxygen "Hegau" and "Black Forest East" groups. In the positive range of the second principal axis, the characteristics leg/foot jewellery, thread distributor rods and wire earrings are located. Leg/foot jewellery correlate with the "Kapf" group and the "Black Forest West group". Pendant and amulet objects are arranged in the negative area of the second principal axis. Pendants and amulet objects include beads, bronze rings and boar tusks. These elements are often combined with the strontium/oxygen "Black Forest West group" and the "Black Forest East group". At the centre of the correspondence analysis, tongue-shaped belt sheets are located. They appear frequently with the "Hegau group" and the "Kapf group".

In the following, representative objects that are located within the correspondence analysis more distant from each other and thus rarely correlate, such as hollow arm rings, foot/leg jewellery, "*Tonnen*" bracelets and tongue-shaped belt sheets, are displayed in the grave mound overview (Fig. 101). The overview shows clusters of female burials and strontium/oxygen groups worked out by V. M. Oelze *et al.* (2012a). The mentioned ornaments are distributed differently. For example, in the eastern part of the burial mound, there are very few hollow bracelets and no foot/leg ornaments compared to the southern and northern parts of the mound. In contrast, "*Tonnen*" bracelets made from bronze in combination with tongue-shaped belt sheets are frequently distributed in the eastern area of the

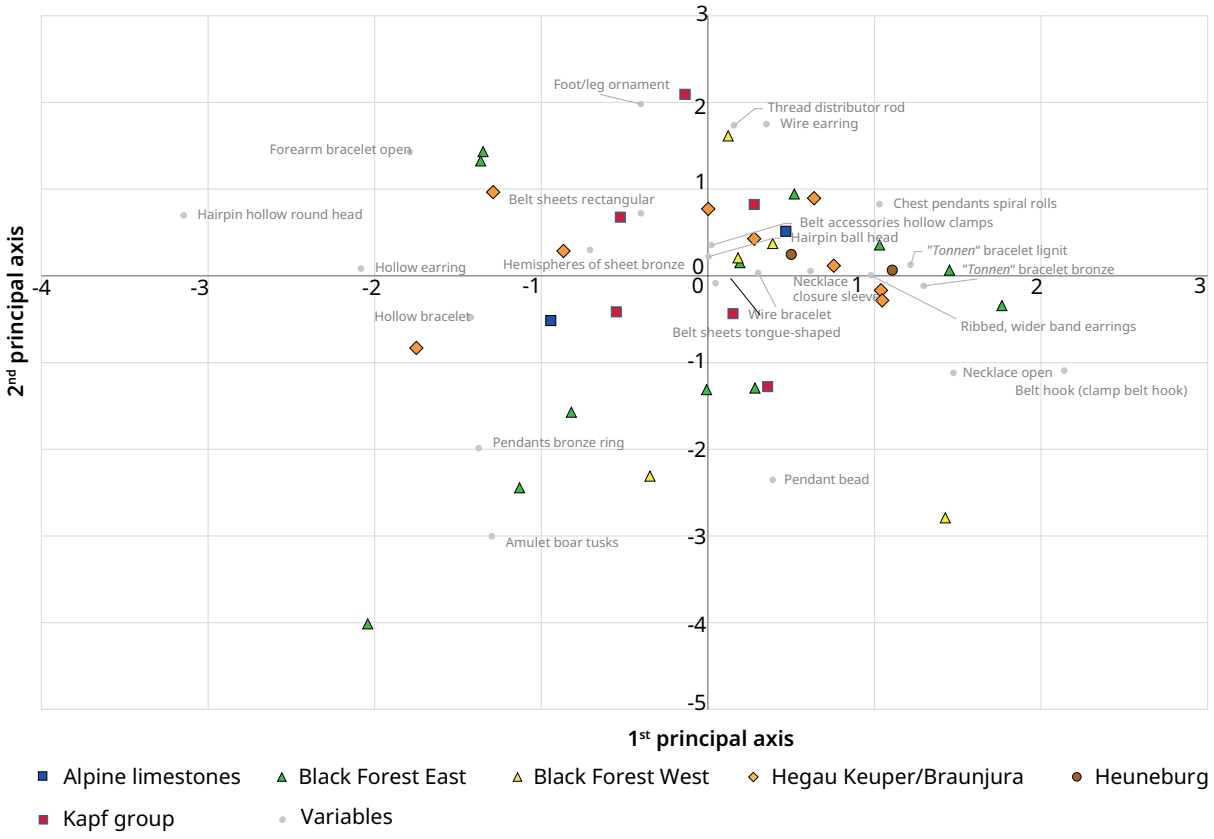


Figure 100. Correspondence analysis (CA) of categories of grave goods (variables) associated with female burials (objects), depicting only individuals that belong to strontium/oxygen groups. The CA includes the 1st and 2nd axes. The cumulative explanation in percentage, which is expressed by the first two axes, equals 27.

burial mound. The distribution map (Fig. 101) demonstrates that this combination of objects is especially associated with the strontium/oxygen "Hegau" group.

If we consider the correspondence analysis, in which the grave goods of males have been integrated, we also can see objects and object combinations that can be assigned to certain strontium/oxygen isotope groups (Fig. 102). For instance, the lance tip is located in the negative area of the second principal axis. This object is exclusively present in the "Black Forest East group", whereas the dagger is located in the positive area of the second principal axis. Daggers, however, are mostly connected with the "Kapf group".

In the most negative area of the first principal axis, the robe pin is situated. It is associated with all groups. In the positive area of the first principal axis, the belt sheet with a rectangular form is located. They occur both in male and female contexts. In male contexts, they correlate predominately with the "Black Forest West group".

Analogous to the female analysis, certain male furnishings, which are widely separated in the correspondence analysis and therefore do not or rarely correlate, are also shown in the burial mound overview (Fig. 103). These elements include daggers, lance tips, robe pins and rectangular belt sheets. Also included are vessels from interments with undetermined gender of type "Alb-Hegau". The grave mound overview also displays the kernel density concentrations of the strontium/oxygen groups identified by V. M. Oelze.

The above-mentioned grave goods occur in few cases in combination. In burial 90, a dagger is combined with a rectangular belt sheet, whereas in burial 62 a lance tip is combined with a rectangular belt sheet.

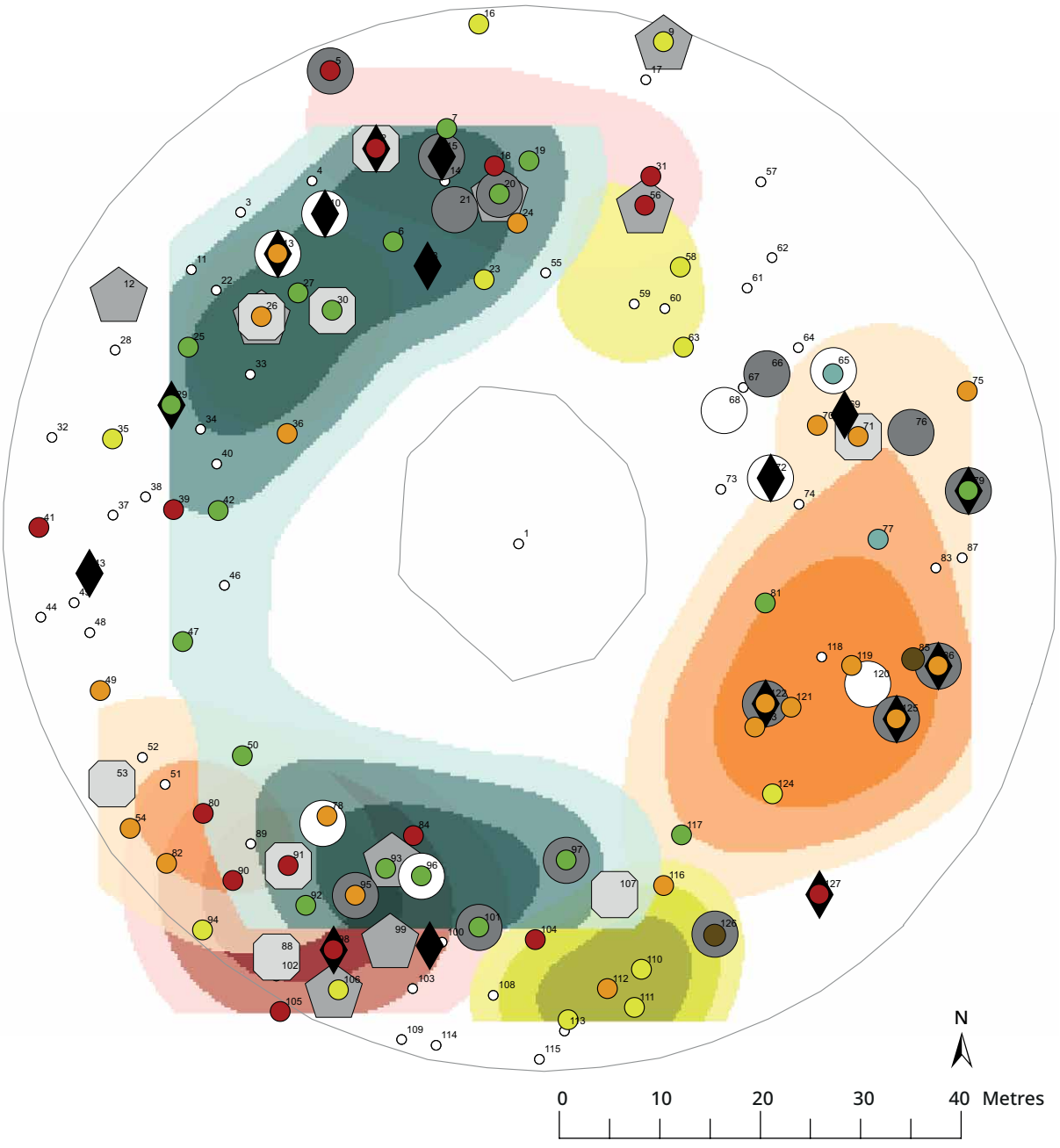


Figure 101. Distribution of strontium/oxygen values and kernel densities of strontium/oxygen groups in combination with female objects.

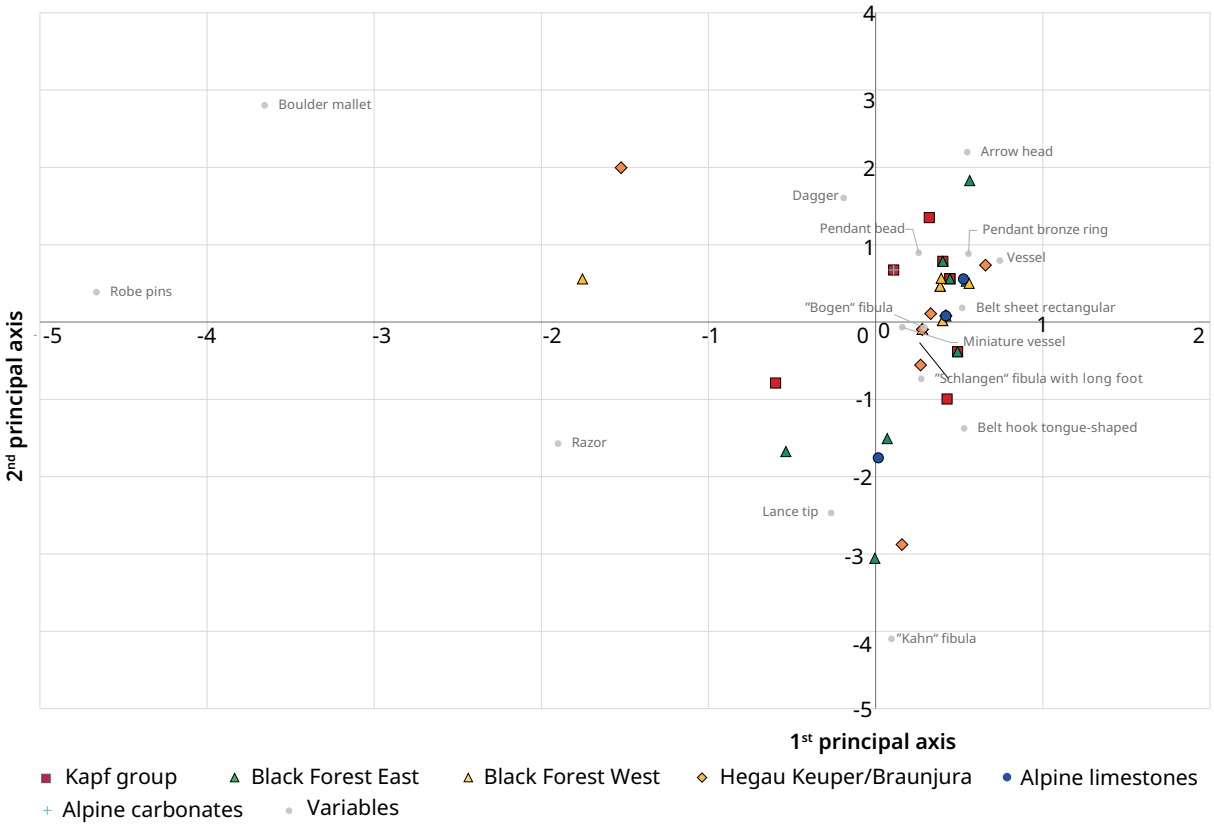


Figure 102. Correspondence analysis (CA) of categories of grave goods (variables) associated with male burials (objects), depicting only individuals that belong to strontium/oxygen groups. The CA includes the 1st and 2nd axes. The cumulative explanation in percentage, which is explained by the first two axes, equals 32.

Overall, the mentioned objects are equally distributed among the male clusters. What is noticeable, however, is that robe pins are not represented in the northwestern part of the burial mound and rectangular belt sheets are not represented in the eastern part.

As already mentioned, certain strontium/oxygen groups tend to be associated to certain object groups. Robe pins are combined with all groups. In contrast, vessels of type "Alb-Hegau" are mainly combined with the "Hegau group", whereas daggers are mainly combined with the "Kapf group", lance tips with the "Black Forest East group" and rectangular belt sheets tend to be combined with the "Black Forest West group".

In the following, the individual values of strontium/oxygen groups are correlated with nitrogen isotope ratios to test whether the individual groups have different nitrogen isotope ranges, which may indicate differential access to animal proteins or different environmental conditions.

With regard to the strontium/oxygen groups that were emphasised by V. M. Oelze, there are noticeable differences especially among males in relation to the highest and lowest $\delta^{15}N$ values (Fig. 104). Males with the lowest $\delta^{15}N$ values have a clear regional focus. Three of the six individuals belong to the "Black Forest West group" that was defined by Oelze. In contrast, males with the highest $\delta^{15}N$ values belong to the "Kapf group" and to the "Hegau/Keuper/Braunjura group" (cf. Tab. 27-28) (Oelze *et al.* 2012a).

Since isotope ratios of carbon and nitrogen are influenced not only by food but also by the living and economic conditions of the last years of living, the question arises whether individuals that originally come from the Black Forest region reveal lower $\delta^{15}N$ values in general. A comparison of nitrogen isotopes

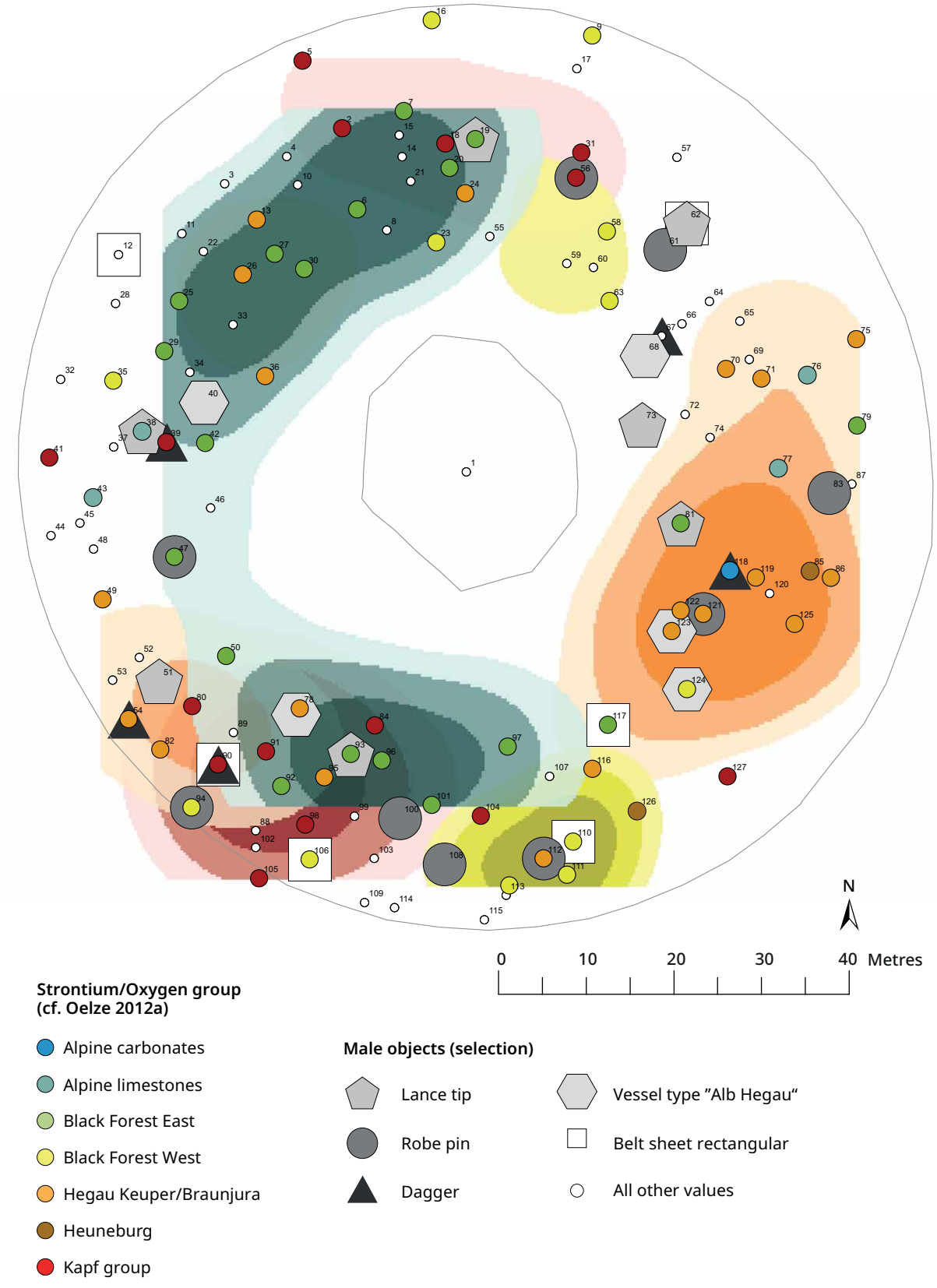


Figure 103. Distribution of strontium/oxygen values within the burial mound in combination with male objects and male burial densities.

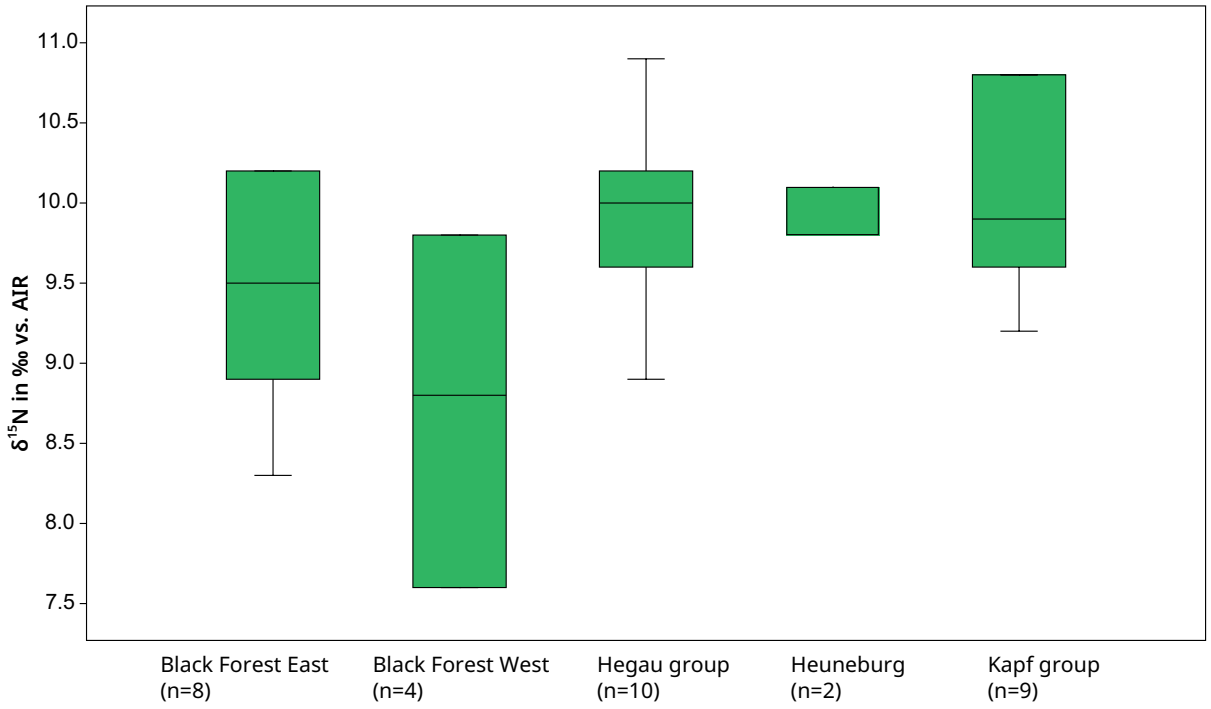


Figure 104. Strontium/oxygen groups in correlation with nitrogen values.

reveals significant differences with regard to strontium/oxygen groups. Individuals, who could come, according to the strontium isotope ratios, from the Black Forest region (east + west) demonstrate lower $\delta^{15}N$ values than those individuals who presumably belong to the "Kapf group" and the "Hegau/Keuper/Braunjura group". The Mann-Whitney pairwise test shows a significant difference between the "Black Forest group" and the "Hegau group" ($p = 0.03272$).

As a consequence, not only the social position but also the living and economic conditions may have had an impact on the $\delta^{15}N$ ratios of the buried persons. However, it has to be emphasised that probable status objects, such as antenna daggers, are not connected with males of the "Black Forest West group". Accordingly, either the different living/economic conditions, the low social positions, or a combination of both factors could be responsible for the tendentially lower $\delta^{15}N$ values of males from the Black Forest West region compared to males that probably come from the Kapf and Hegau/Keuper/Braunjura regions.

Females that have the highest nitrogen isotope values can be ascribed to different strontium/oxygen groups (Black Forest East, Hegau Keuper/Braunjura, Heuneburg and Kapf group). Unfortunately, the lowest nitrogen ratios cannot, with one exception, be assigned to any strontium/oxygen groups. This is also probably due to the fact that in contrast to males, no $\delta^{15}N$ and $\delta^{13}C$ values that come from the "Black Forest West group" can be assigned to a female individual (Tab. 25-26).

Another question concerns the distance of strontium/oxygen groups to the central burial. The boxplot diagram (Fig. 105) shows clearly that, in relation to the median, the burials of the "Black Forest West group" and the "Kapf group" are located much further away from the central burial in comparison to the burials of the "Black Forest East group" and the "Hegau group". The difference between the "Black Forest East group" and the "Kapf group" or the former and the "Black Forest West group" is significant (Mann-Whitney pairwise test: Black Forest East – Black Forest West: $p = 0.03324$; Black Forest East – Kapf: $p = 0.002856$).

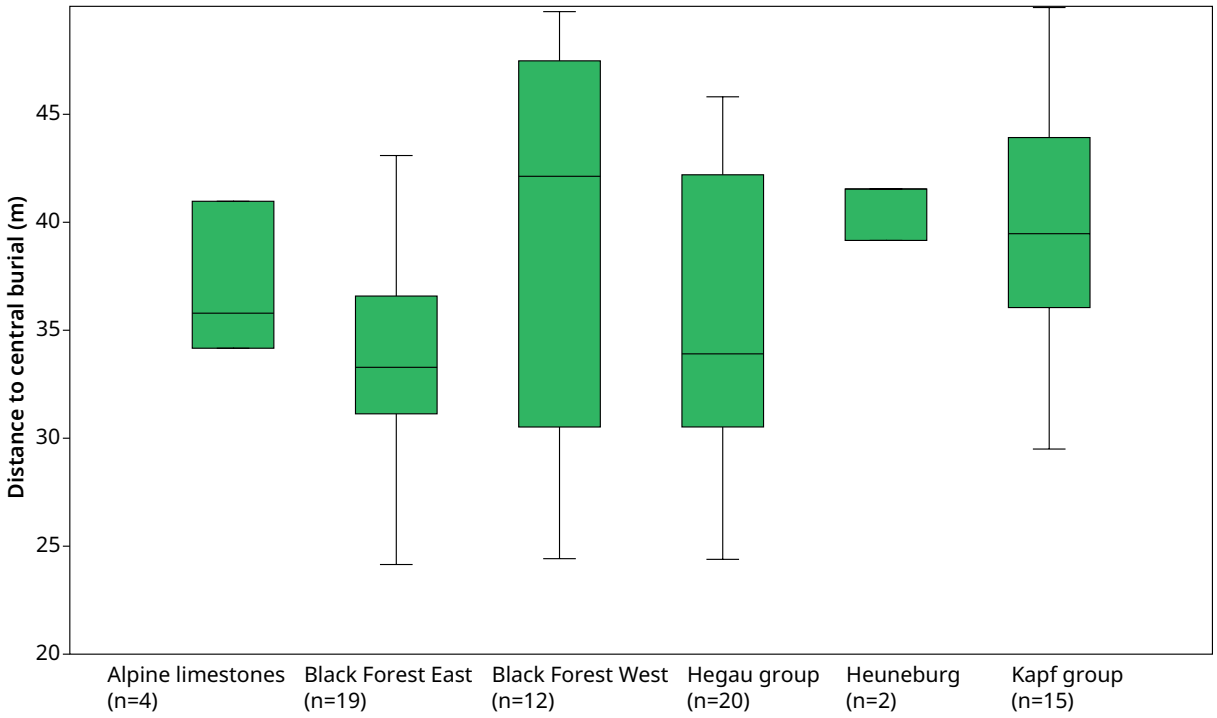


Figure 105. Strontium/oxygen groups in correlation with values concerning distance to the central burial.

If we summarise the factors furnishing quality, access to animal proteins and proximity to the central burial, it can be observed that especially the individuals of the "Black Forest West group" probably had a relatively low social status compared to the other strontium/oxygen isotope groups.

If we correlate the strontium/oxygen isotope ratios and groups with the chronological phases that H. Parzinger (Fig. 106) emphasised, it is striking that areas that are occupied predominately by the "Hegau group" in the eastern part of the burial mound are associated with grave goods that belong exclusively to individuals that are associated to H. Parzinger's phase I (1986). This includes objects that are located in the positive range of the first principal axis for females (cf. bronze "*Tonnen*" bracelets, tongued-shaped sheets and ribbed and wide band earrings).

The later phase II is linked to the objects that are situated in the negative area of the first principle axis for females. This includes hollow ornaments, which are more often situated in the western part of the burial mound and are rarely documented in the eastern part of the burial mound.

With respect to the male burials, the first phase (Ia) is linked to the vessels of type "Alb Hegau". The following phase (I) is linked to objects that range in the negative area of the first principle axis, which is associated with robe pins and stone mallets. These objects are located mainly in the eastern part of the burial mound. In contrast, objects that are primarily associated to the younger phase (II) are situated in the correspondence analysis in the positive range of the first principal axis, including rectangular belt sheets, which are mainly associated with the "Black Forest" groups. Rectangular belt sheets are also located, in contrast to the robe pins, in the western areas of the burial mound. Daggers cover both phases I and II and are distributed within the entire burial mound, except for the northern area.

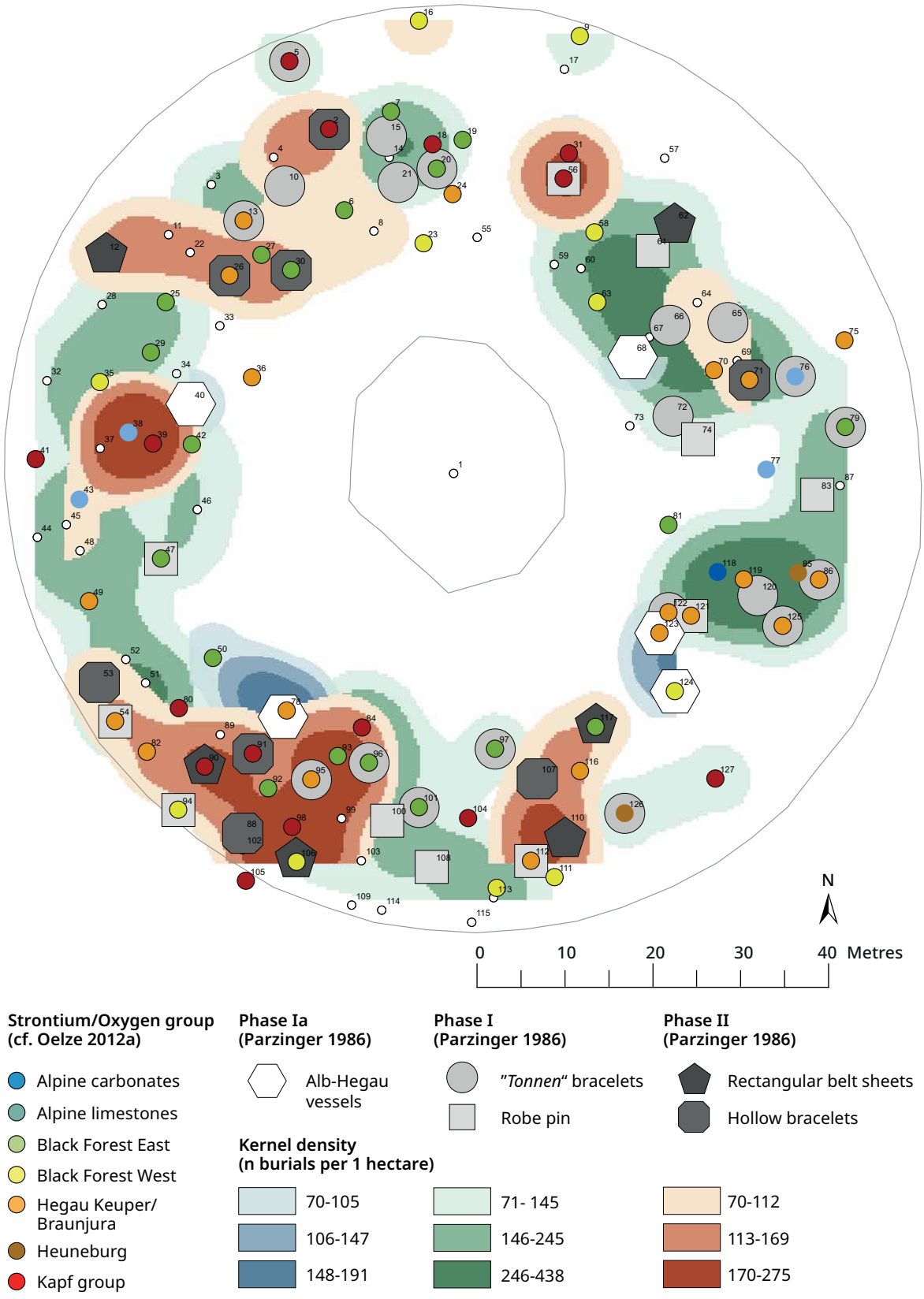


Figure 106. Strontium/oxygen isotope ratios in combination with chronological phases (Parzinger 1986) illustrated as kernel density analyses (blue=phase Ia, green=phase I, red=phase II). A selection of burial goods assigned to phases is also presented.

Summary

In sum, the Early Iron Age burial mound Magdalenenbergle provides multiple information concerning archaeological and bioanthropological inequalities of the buried individuals – especially in combination with spatial analyses.

The 129 graves of the burial mound are concentrated differently within the mound. The highest concentrations of burials are located in the southwestern and northern areas. Moreover, clusters of female and male burials can be identified, which mostly alternate.

Male burials with the highest values of grave goods include late-adult and mature individuals who were furnished with daggers. Females that have the highest values of grave goods are characterised by well-furnished and varied ornamentations. The difference in the values of grave goods between subadults and adults is higher among males than among females. Females demonstrate rather an age-independent distribution of values of grave goods that also includes infans individuals. Moreover, the values tend to decline with the oldest females. Burials with the highest values of grave goods are located throughout the burial mound, but are mainly located in the southwestern area.

Regarding the analysis of the burial pit size distribution, it can be seen that the biggest burial pits are situated in all areas of the mound and tend to be located relatively close to the main burial. With respect to the total population, the burial pit sizes increase until the adult cohort and then tend to decrease to the mature/senile age cohort. Among female burials, the biggest graves include multiple ornaments; among males they include, among other goods, daggers and vessels of the Alb-Hegau type. With respect to females, the burial pit sizes tend to be the largest among the early-adult age cohort. In contrast, the biggest burials among males belong to the late-adult age cohort. Among males, however, the differences in burial pit sizes in terms of age are not very pronounced.

Belonging to the burials that have both high values of grave goods and high burial pit sizes are – except the central burial – a late-adult male burial (grave 90) furnished with a dagger and arrowheads and four richly furnished females of early-adult and late-adult ages (graves 88, 78.2, 56.1 and 97). With respect to the correlation between grave pit sizes and values of grave goods, females show a small positive correlation. By contrast, males demonstrate no correlation. With respect to the values of grave goods, the Lorenz curves and calculated Gini indices demonstrate higher inequality within male burials in comparison to female interments.

Furthermore, the respective distances of the graves to the central burial were considered. It could be demonstrated that there is a significant positive correlation between the size of the burial pit and the distance to the central burial. However, there is no correlation between the values of grave goods and the distance to the central burial. Moreover, it could be shown that the distances to the central burial tend to be shorter with aging. In addition, the chronological factor was also integrated into the distance analysis. On the one hand, the larger the grave size the shorter the distance to the central burial. On the other hand, the burials from the later chronological phase II (Parzinger 1986) tend to be further away from the central burial.

With respect to diet and access to animal proteins, it can be noted that males show higher $\delta^{15}N$ value ranges in comparison to that of females. Late-adults, mature and especially early-adult individuals demonstrate the highest $\delta^{15}N$ ratios. Furthermore, no mature individuals can be assigned to the lowest nitrogen ratios.

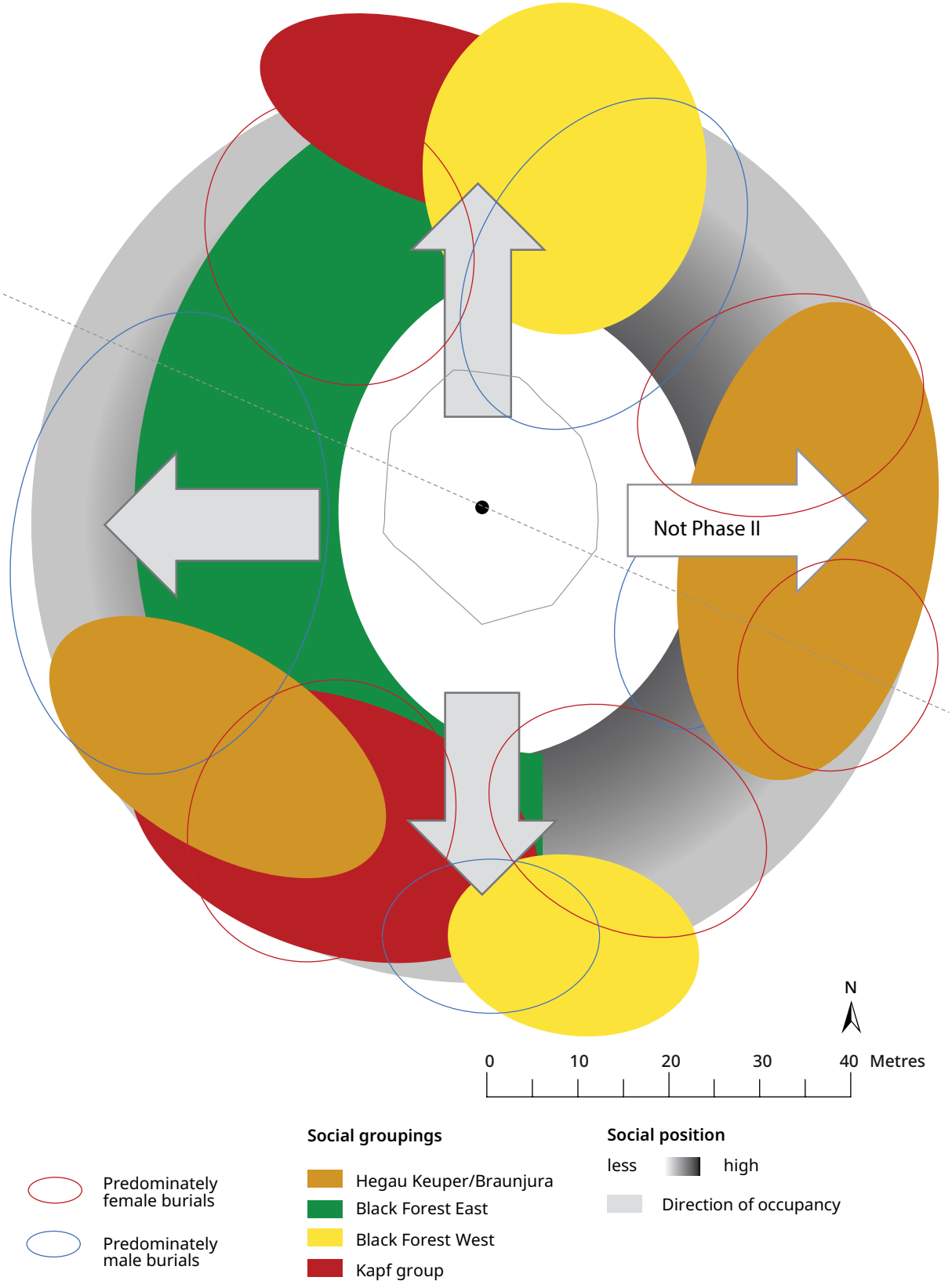


Figure 107. Model of the social organisation of the burial mound Magdalenenbergle. Illustrated are social groupings based on strontium/oxygen isotope ratios (coloured areas), the direction of occupancy (arrows: white arrow = only phase I), the separation line for different body orientations, areas of burials that demonstrate lower and higher social positions (bright to dark grey), and areas of predominately female and male burials (red and blue circles).

Females that have better access to animal proteins demonstrate in quantity and quality more well-furnished burials, *e.g.*, a high number of earrings (n > 7), "*Tonnen*" bracelets, belt accessories, miniature vessels and import items. Among males, high nitrogen ratios correlate with individuals that were furnished with antenna daggers, rare stone mallets and the so-called "Alb-Hegau" ceramics.

The relationship between nitrogen isotope ratios and values of grave goods or grave pit sizes shows positive correlations for both females and males. Moreover, individuals that have the lowest $\delta^{15}N$ ratios are interred on average at a much longer distance from the central burial when compared to the higher $\delta^{15}N$ categories. Moreover, burials that include antenna daggers in male contexts or a high number of earrings and "*Tonnen*" bracelets made of jet in female contexts are located nearer to the central burial than the remaining burials.

In order to analyse heterarchical structures of the buried community, strontium/oxygen isotope ratios were also integrated to provide information regarding the origin of the deceased. Based on the range of the strontium/oxygen isotope ratios, V. M. Oelze (2012a) identified three main groupings: the "Kapf group", the "Black Forest group" that can be subdivided into a west and an east group, and the "Lake Constance/Hegau group". It could be demonstrated that the strontium/oxygen isotope groups are clustered slightly differently in certain areas. Frequently, the same group values are located opposite from each other in the northern and southern areas of the burial mound. This kind of opposition is marked by the line of wooden pole settings and by different body orientations in the northern and southern areas of the burial mound (cf. Fig. 99; 107).

Furthermore, certain assemblages of grave goods are associated to certain strontium/oxygen isotope groupings and it could be demonstrated that individuals that belong to certain strontium/oxygen isotope groupings seemed to have different social positions. If we summarise the factors, such as furnishing quality, access to animal proteins and proximity to the central burial, it can be verified that especially the individuals allocated to the "Black Forest West" group exhibit rather a low social status compared to the other strontium/oxygen isotope groups.

Moreover, the projection of chronological data that was emphasised by H. Parzinger (1986) shows that the eastern part of the burial mound that is occupied mainly by the "Lake Constance/Hegau group" only includes burials of phase Ia and I (cf. Fig. 106-107).

Finally, the thesis of family districts as put forward by J. Müller (1994) and K. Spindler (2004) cannot be maintained. Although burial gaps between districts can be identified, these can largely be explained by erosion and ploughing, as well as by ancient plundering and the old excavation. Only one gap in the eastern and south-eastern areas (between burials 117 and 124 and between 126 and 127) could be intentional. Here, no burials of phase II and mainly burials of the Hegau group are located.

Horb-Altheim (Early Medieval period, 450-510 CE)

Late Antiquity and the Early Medieval period are characterised by upheavals that accompany the decline of the Roman Empire. Different groups of people settled the area abandoned by the Romans, including the Alemanni, who settled east of the Upper Rhine and north of the High Rhine. In addition to archaeological data, which includes documented row grave fields and rare traces of settlements in the form of post-hole structures, there are also narratives from Roman writers (*e.g.* Ammianus Marcellinus, ca. 330-395 CE), who documented names of groups that belonged to the Alemanni, led by independent kings. Also documented are warlike conflicts of the Alemanni against Romans and Franks (Geuenich 2005; Ade 2008; Christlein and Natter 1991). H. Steuer (1997) and D. Beilharz and C. Peek (2011) described the Alemanns as a society, which consisted of lineages of different rank. The house community was comprised of the head of the family, his wife, children, and, depending on the numbers of members, farmhands and maidservants as well as craftsmen. They were dependent, semi-free and free. The free group connected families by marriage, could accumulate property, and ascended in rank. In addition to possessions, proximity to the king or to the ruling families determined the respective rank. H. Steuer (1991; 1982, 440) emphasised the hierarchical structure within the family, in which each member has a specific role. In the cemeteries, the deceased were buried at the discretion of their bereaved and not their own. Similarly, S. Brather (2010, 247f.) sees the burial ritual as a process that is shaped by the ideas and intentions of the burying community. Thereby, the bereaved present their ideal conceptions of social

Figure 108. Cemetery plan of Horb-Altheim with the reconstructed grave groups and the modern disturbance in the southeastern part of the cemetery (after Beilharz and Peek 2011).

conditions in the context of performative actions and as an act of representation before an audience.

In the context of Early Medieval burial rituals, B. Hausmair (2015) emphasised that the basic social categories, such as gender and age, are emphasised in the burial ritual and are regularly reflected in the architecture of the grave and the presence or absence of age and gender-specific objects in the layout of the grave goods. Furthermore, the manner in which objects are placed in a grave shows that supplying the dead for their time in the after-world was an important element of the burial ritual.

The Alemannic cemetery of Horb-Altheim was excavated in 1999 and 2000. It measures about 60 m from west to east and 40 m from south to north. Modern ground works in the southeastern part of the cemetery caused a large disturbance. Accordingly, further burials might have existed here. D. Beilharz and C. Peek (2011, 18), who published the archaeological results in 2011, reconstructed four clusters based on the density of the burials (Fig. 108). One-third of the burials shows antique to modern disturbances, whereby ancient disturbances probably result from grave robbery.

Overall, 77 burials were excavated: 44 females, 32 males and 1 horse. From the excavated individuals, the number of females obviously exceeds that of males. The proportion of subadults, amounting to 28%, is rather low. The burials exhibit an orientation from west-southwest to east-southeast and the deceased were buried in an extended supine position with their heads to the east. 34 of the in-

dividuals had a coffin. Furthermore, 17 burial niches were identified, a tradition which originated in the Middle Danube region (Beilharz and Peek 2011; Obertová and Wahl 2007; Obertová 2008).

The burials were furnished with gender-differentiated objects. Typical burial goods of females included ornaments (ear, finger, and arm rings, beads for necklaces and belts, fibulae, and pendants), leg-wear applications, combs, spindle-whorls, and glass vessels. The males were furnished with weapons (saxes, spathas, axes, lances, shields, and bow and arrow equipment), tweezers, knives, fire steel/pocket hangers, and bags (Beilharz and Peek 2011). Grave goods assigned to both genders included belt buckles and ceramic vessels (Beilharz and Peek 2011; Obertová 2008).

Based on the burial goods and by reference to a further cemetery in Southwest Germany (Pleidelsheim, district Ludwigsburg), D. Beilharz and C. Peek (2011, 192ff.) determined five chronological phases (SD 1-5) for the cemetery of Horb-Altheim. According to the grave goods, the cemetery was used from about 450 CE to about 510 CE. As a result, the deceased from the oldest burials come from the east, probably originally from the Mid-Danube area. The burial furnishings from the following phases show traditions that come from the local and from the Western Rhine region.

Based on the period of use and the number of burials, the population size was calculated to 28.6 contemporaneous persons. According to D. Beilharz and C. Peek (2011, 22f., 205; Obertová 2008, 31ff.), the population lived in two to three surrounding household communities.

Among the burial clusters, grave group II (Fig. 108) probably represents the local leading family or elite. The deceased of grave groups I and II are equipped with relatively many import goods from the Mid-Danube region. In contrast, grave groups III and IV contain few eastern but rather local objects. Both grave groups III and IV are situated at the western part of the cemetery. Epigenetic bone and dental attributes indicate close family relationships within the grave groups. However, common characteristics can also be found between grave groups. Accordingly, close social relationships between the grave groups and families must be assumed (Beilharz and Peek 2011, 205; Obertová 2008).

Z. Obertová (2008, 137) calculated a life expectancy for the population (from birth) of 30.8 years and identified an underrepresentation of subadults, which were probably buried in an exceptional way. Further, she recorded an increased probability of death for 30-39 year-old individuals due to acute disease, armed conflicts, and a relatively high percentage of senile individuals.

With regard to temporal and cultural contexts, indications of malnutrition or chronic diseases are relatively rare in the interred individuals at the Altheim burial grounds. The dental status indicates a balanced and sufficient mixed diet with a predominance of protein and carbohydrates. The livelihood of the interred population was based on agriculture, livestock and forestry (Beilharz and Peek 2011, 206; Obertová and Wahl 2007, 592).

Spatial analysis

For a spatial analysis of the Altheim burial grounds, the burial distributions within the cemetery were first analysed by kernel density analyses in order to detect spatial patterns of the burial occupancy. The kernel density analysis yielded the highest concentration of graves in the southern area of the cemetery (Fig. 109). Here, the grave density amounts up to 1359-1696 hypothetical burials

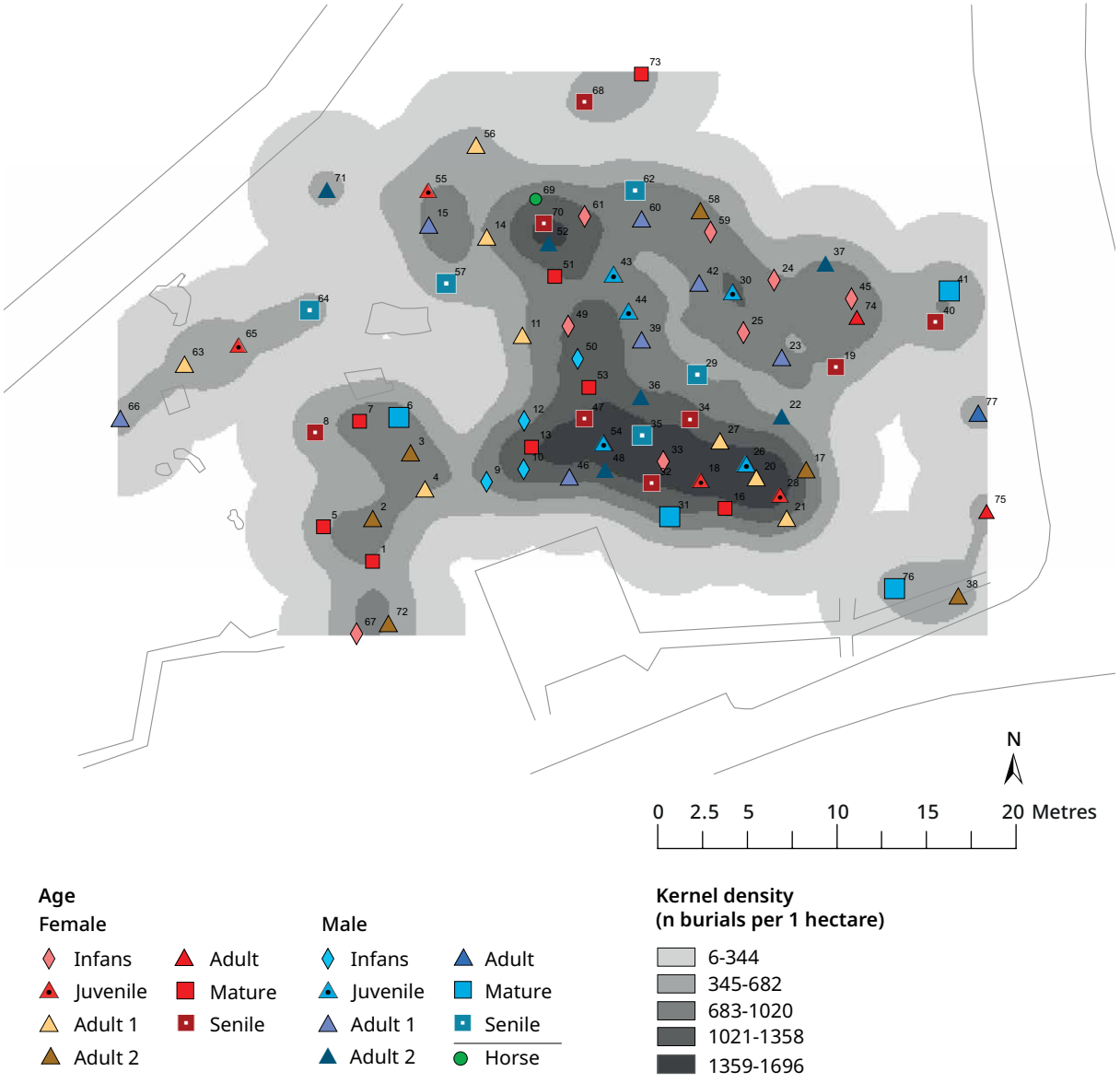
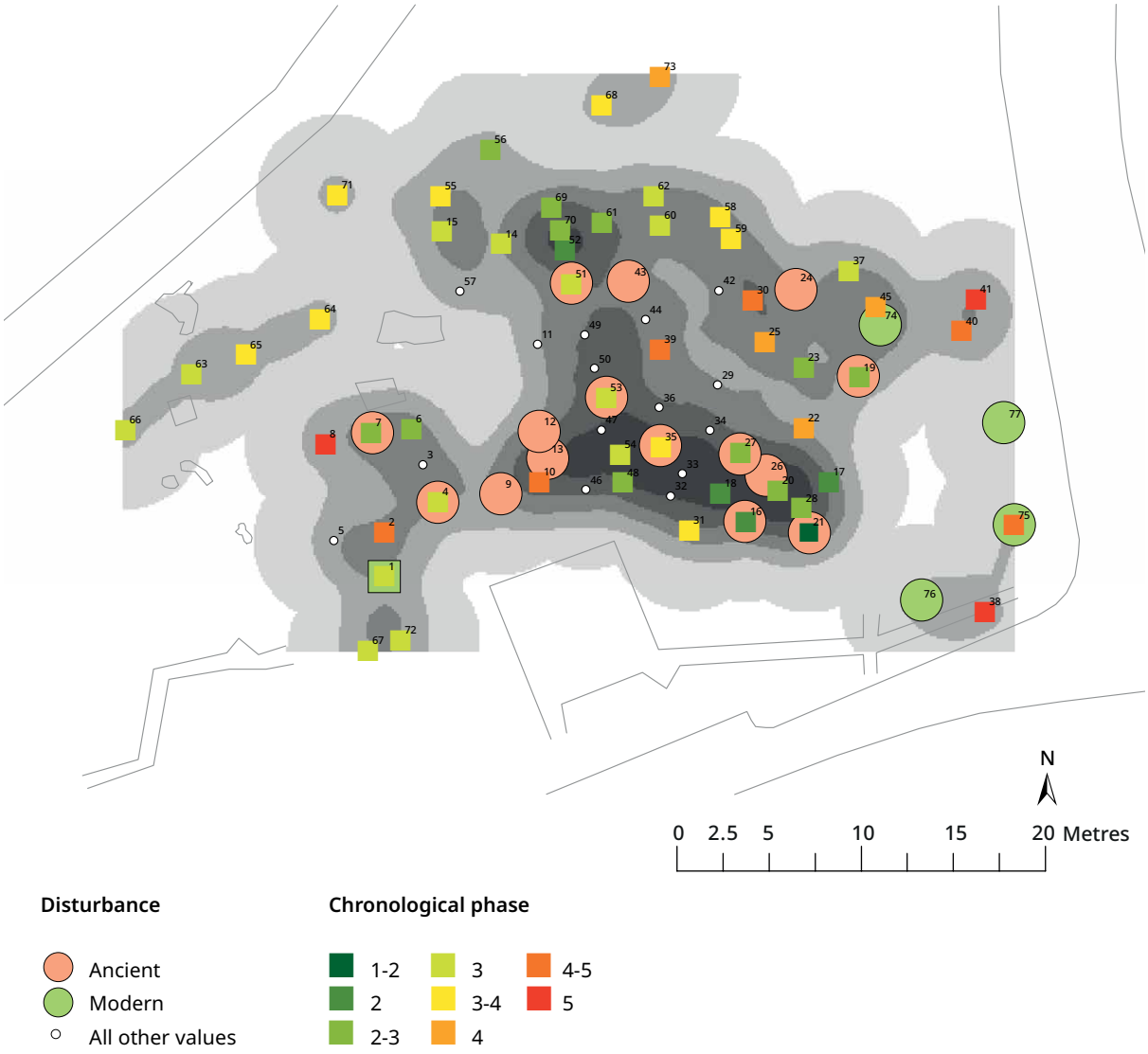


Figure 109. Burial ground with regard to kernel density analyses, ascribed genders and age cohorts.

on one hectare. A further spot of high density is detected in the northern area. The further areas demonstrate rather lower burial densities. Based on the kernel density analysis, it is hard to maintain the separation of the burial ground that D. Beilharz emphasised in grave group areas I and II.

In addition to clusters of burials, there are also individual burials, such as the male adult burials in the northwestern (grave 71) and southeastern areas (grave 77). However, the low density of burials in the southeastern area of the burial ground is especially caused by modern disturbances.

The distribution map of disturbances (Fig. 110) shows that high density areas correlate with antique disturbances as well as with the chronological phases of the burials. Among the disturbed burials are mainly graves that can be assigned to an older or middle phase of the cemetery (phase SD 1 to 3). They are located in areas with a relatively high density of graves, such as in the centre and southern parts of the burial ground. In contrast, younger dated burials that belong to phases SD 3/4 to 5 are located in areas with a lower grave density. These burials predomi-



nantly lie within the eastern and northern parts of the cemetery and were rarely confronted with antique disturbances. Moreover, modern disturbances particularly impact the burials in the eastern area of the burial ground that belong to the younger phases (SD 4/5 to 5) (cf. Beilharz and Peek 2011, 21ff.).

Furthermore, the cemetery includes clusters of relatively young (infans to early-adult individuals) and old individuals (late-adult to senile individuals). For example, one cluster that includes relatively old individuals is documented within the centre of the cemetery. This is surrounded on each side by concentrations of younger individuals. Within the cluster of relatively old deceased individuals, there is an accumulation of five senile burials (graves 32, 34, 35, 47, and 29). Moreover, mature and senile individuals are also located at the edges of the cemetery. This includes, for example, a cluster in the southwestern area with graves 1 to 8, but also 2 burials in both the northern (graves 68 and 73) and eastern (graves 40 and 41) areas of the cemetery.

Figure 110. Graves with regard to the attributed chronological phases and documented disturbances.

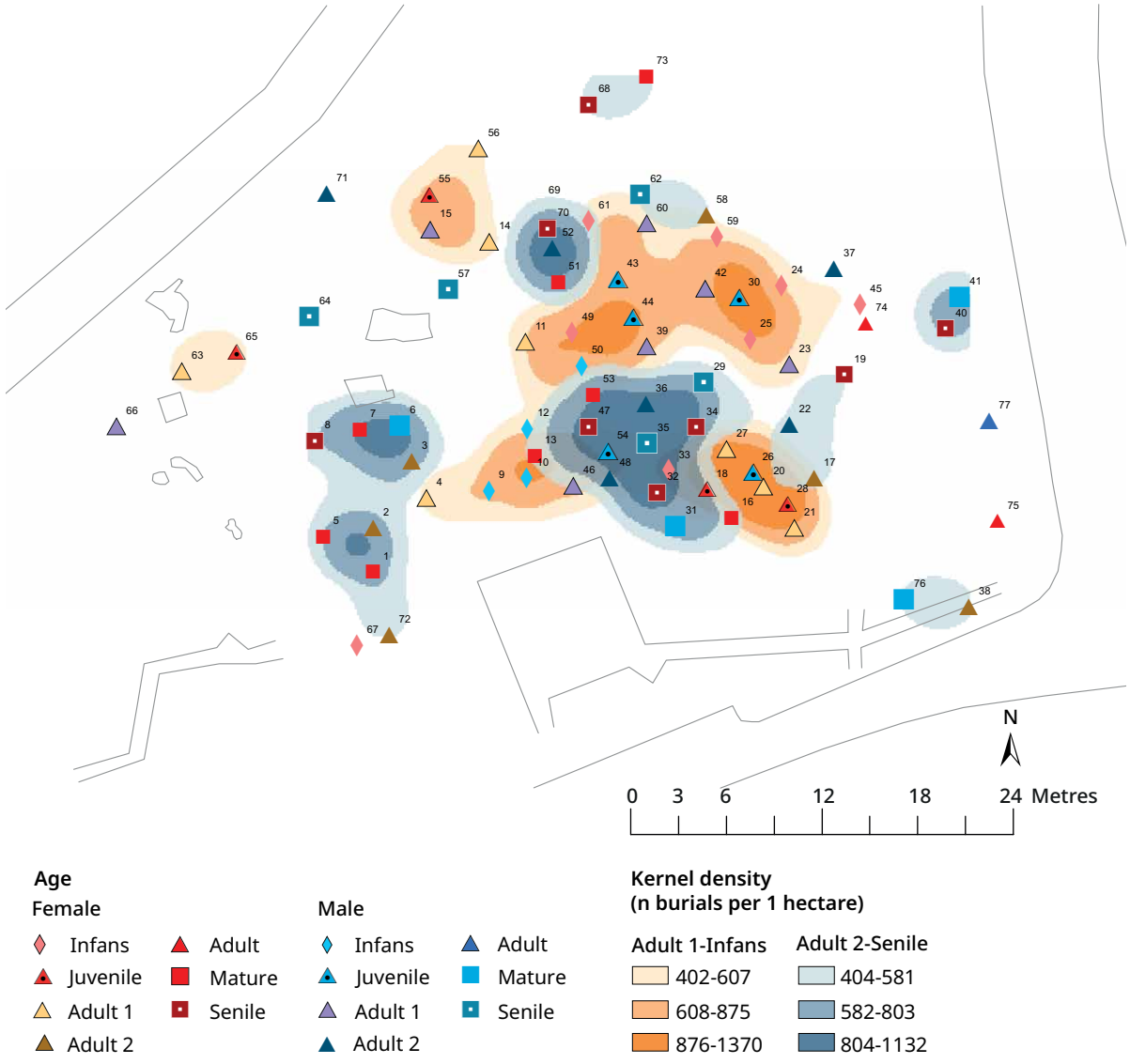


Figure 111. Graves with regard to the ascribed genders, age cohorts and the representation of grave densities related to relatively young and old age cohorts.

With respect to the concentrations of burials of infans individuals, it is conspicuous that male infans were predominantly buried in the southwestern area, whereas, in contrast, female infans were mostly buried in the northeastern area (Fig. 111).

Considering the gender distribution, the kernel density analyses demonstrate that clusters of female and male burials exist that alternate (Fig. 112). At the centre of the cemetery, a cluster of males is detectable that spans from north to south and is flanked on its eastern and western sides by female clusters. Furthermore, a relatively large female cluster is recorded in the southwestern area of the cemetery and represents almost solely grave group III.

Values of grave goods

As a first step, the distribution of values of grave goods within the cemetery is analysed. In the evaluation, values of grave goods for 76 burials were calculated. As specified in the 'Methods' chapter, values of the grave goods of each individual are based on the scarcity of the respective object types within the cemetery and

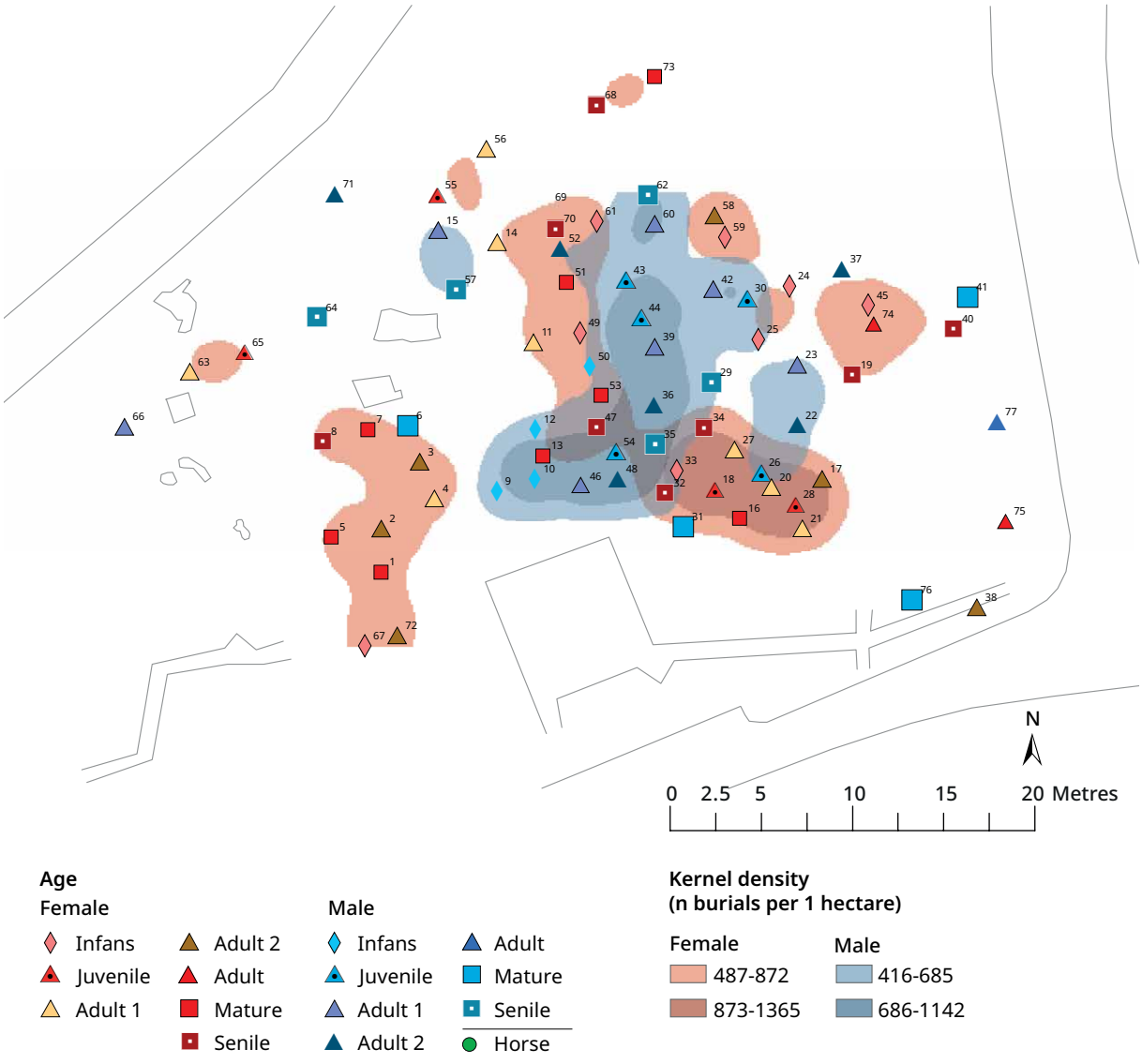


Figure 112. Graves with regard to the ascribed genders and age cohorts as well as the representation of grave densities related to genders.

on the number of grave goods assigned to each individual. Table 29 provides the calculated values of each type of objects.

Figure 113 shows the distribution of values of grave goods of each burial within the cemetery in combination with the available information on the individual gender and age.

Based on the histogram of the value distribution, five value ranges from high values (category 1) to low values (category 5) were generated by natural breaks (Jenks). Four burials with the highest values for grave goods were identified for the first category and seven for the second category. In table 30, the graves belonging to the burials of the first category are listed.

The burials with the highest values of grave goods include, on the one hand, an early-adult male interment (grave 66) furnished with, among other objects, multiple weapons and, on the other hand, females of different age cohorts. Typical for these females are furnishings with different ornament categories. Burials of the highest categories one and two are situated at the northern part of the cemetery and are not located in the centre or the southern part of the cemetery. Burials

Object types	Calculated value
Bead	0.4
Ironing fibula	2.8
Small fibula	5.8
Special fibula	38.0
Belt accessories	3.3
Bracelets	15.2
Necklace	76.0
Earring	6.3
Belt buckle	2.8
Belt buckle (ornamented)	5.8
Bag	4.5
Tweezer	12.7
Fire steel/bag strap	12.7
Scale	76.0
Glass vessel	9.5
Ceramic vessel	1.9

Object types	Calculated value
Hair pin	38.0
Finger ring	6.3
Big bead	4.0
Legwear	19.0
Comb	8.4
Spindle whorl	10.9
Knife	4.5
Wooden box	76.0
Pendant/amulet	9.5
Weaving sword	76.0
Spatha	12.7
Sax	15.2
Axe	8.4
Lance tip	12.7
Shield	19.0
Arrowhead	5.4

Table 29. Calculated values of object types.

Grave no.	Values of grave goods	Phase	Age	Gender	Grave goods
66	1.00	3	Adult 1	Male	Sax, axe, arrowheads, earring, belt buckle with fitting, bag, tweezers, fire steel/bag strap, knife, scale, ceramic vessel
73	0.84	4	Mature	Female	Bracelet, four fibulae, beads, big bead, legwear, spindle whorl, weaving sword, earrings, bag, belt accessories
25	0.72	4	Infans 2	Female	Fibulae, beads, finger ring, big bead, comb, spindle whorl, wooden box, pendant amulet, belt buckle with fitting, belt accessories
58	0.71	3-4	Adult 2	Female	Precious metal amount, four fibulae, silver necklace, beads, finger ring, legwear, pendant amulet, belt buckle with fitting, glass vessel

Table 30. First category burials with information regarding grave no., values of grave goods (normalised), age, gender and grave goods.

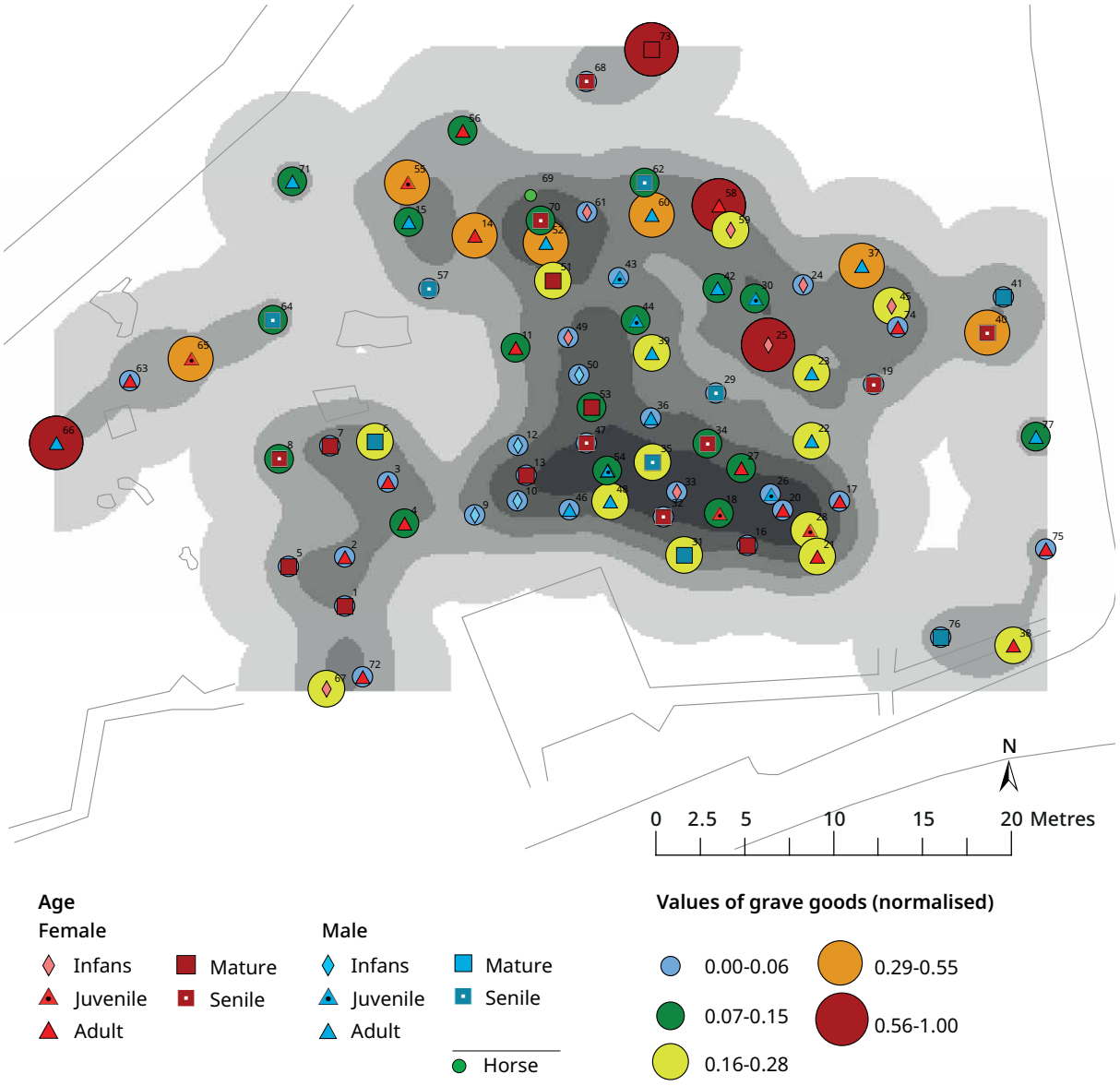


Figure 113. Distribution of values of grave goods within the cemetery in combination with the distribution of genders and age cohorts.

that belong to the second category include, on the one hand, relatively many juvenile females and, on the other hand, relatively many adult males. The distribution of the burials that belongs to the second category shapes an imaginary horizontal west-east demarcation line at the northern part of the cemetery.

However, it is has to be taken into account that those burials that demonstrate relatively low values of grave goods and are located at the centre and the southern parts of the cemetery show ancient disturbances. These disturbances could indicate grave robbery and thus bias the distribution of values of grave goods (cf. Fig. 114).

With regard to the correlation between values of grave goods and age groups, the following results can be drawn. Regardless of gender, infans, mature and senile individuals exhibit rather lower value ranges of grave goods. In contrast, the age cohorts from juvenile to late-adult display rather higher ranges of values of grave goods (Fig. 115).

Regarding genders, differences can be detected in age cohorts (Fig. 115). First, females demonstrate rather high value ranges of grave goods within the

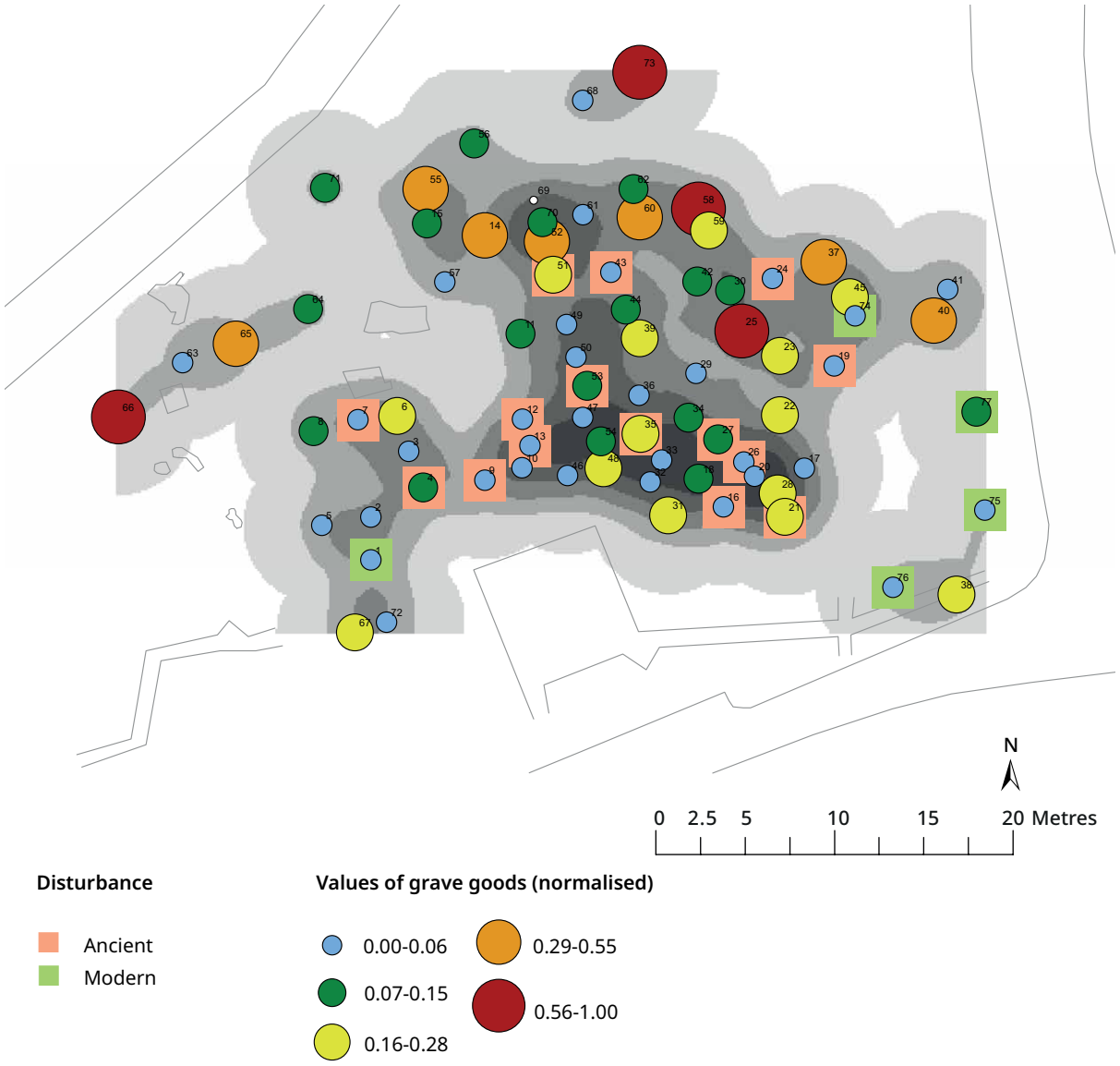


Figure 114. Distribution of values of grave goods within the cemetery in combination with the ancient and modern disturbances.

age cohorts juvenile and early-adult. Three of four juvenile females show a high quantity and quality of grave goods (graves 55, 65 and 28). Among the older age cohorts (mature, senile), the value ranges of grave goods tend to decrease. Moreover, the boxplots also demonstrate that there is an age-independent distribution of the values of grave goods among females. This can be shown in the case of eight infans females of which four of them (graves 25, 59, 67 and 45) provide above-average high values of grave goods. High interquartile distances in the values of grave goods are predominately pronounced within the subadult age cohorts, which probably indicate – despite lower sample rates – high social differences based on different lineages.

Males show a contrasting picture when compared with females. For males, the ranges of the values of grave goods increase until the late-adult age cohort, which is connected with the presence of weapon combinations, in particular. Among the age cohorts of mature and senile individuals, grave goods, including a combination with weapons, is largely no longer part of the burial custom. Accordingly, the values of grave goods decrease again to the juvenile and infans levels. High interquartile

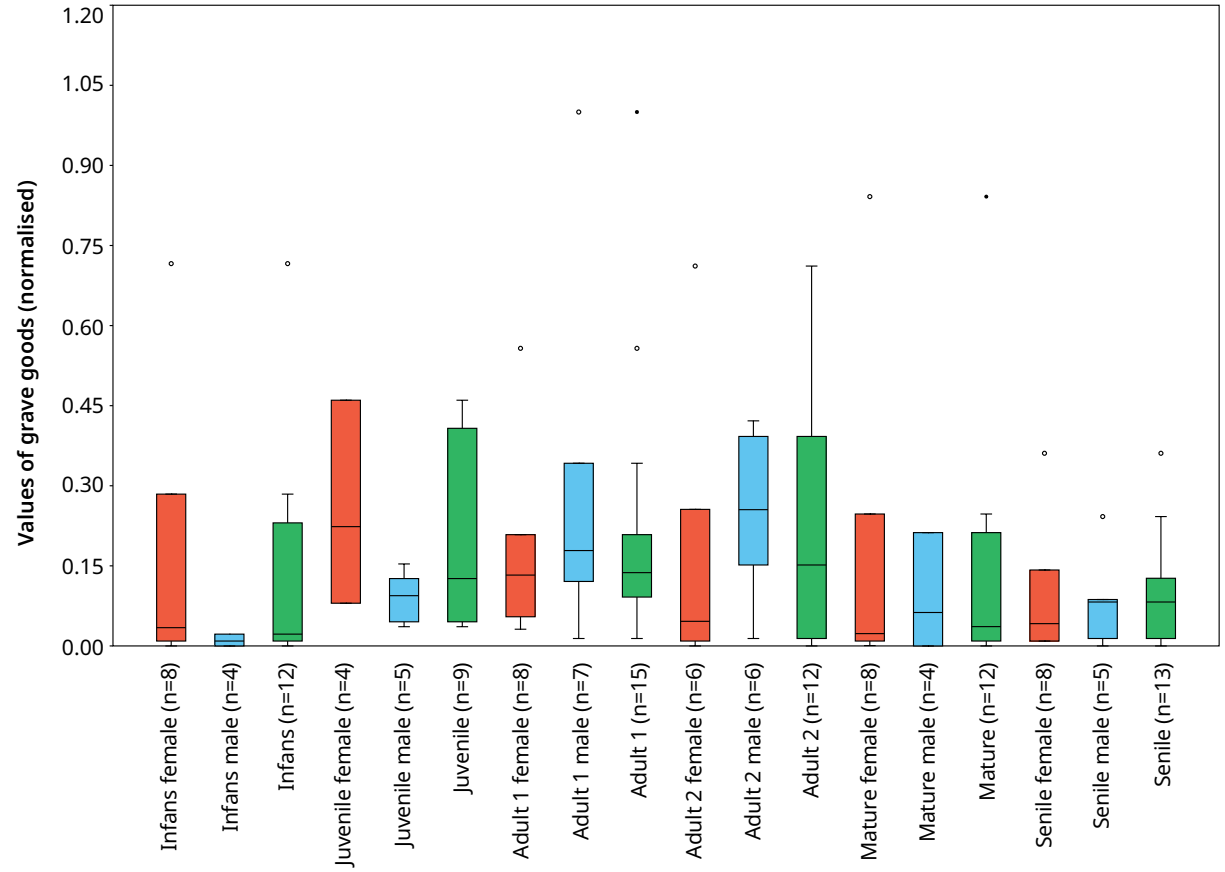


Figure 115 (above). Values of grave goods associated with age and gender categories.

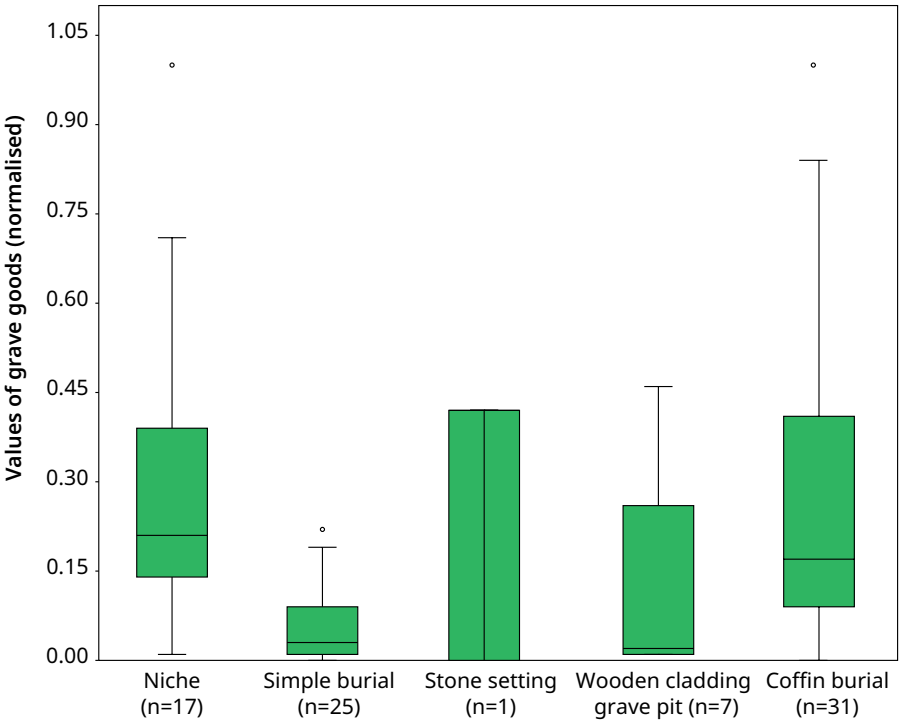


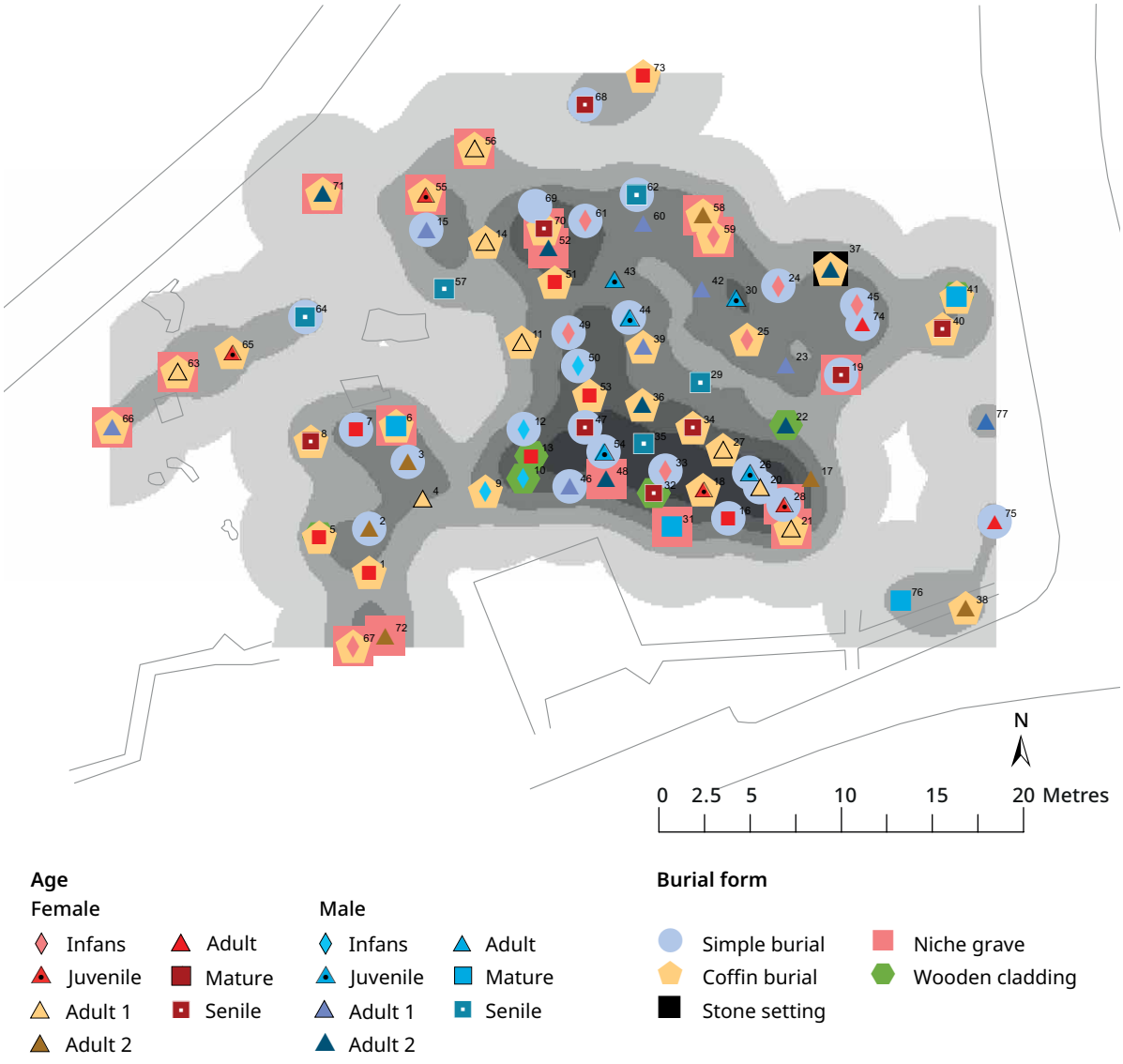
Figure 116. Grave construction characteristics associated with values of grave goods.

distances in values of grave goods are recorded in adult and mature age cohorts that accordingly show high inequalities in assigned social positions.

Furthermore, the correlation between grave construction types and values of grave goods is of high interest (Fig. 116). There is multiple evidence for grave constructions. In addition to the simple earth graves, stone settings, wood-clad burial pits, coffins, tree coffins and box coffins were used and niche graves were erected (Beilharz and Peek 2011, 25ff.). Foremost, there are differences in values of grave goods allocated to the burial types. Significant differences are revealed from simple earth burials to niche burials (Mann-Whitney pairwise: p = 5.72E-05) and from simple earth burials to coffin burials (Mann-Whitney pairwise: p = 1.21E-05).

Simple earth burials are concentrated within the centre of the cemetery in the area with the highest density of graves. These types of graves often correlate with infans burials. In contrast, coffin burials are predominantly located at the edges of high grave densities and rather at the edges of the burial ground in general. Moreover, in the southern part of the cemetery, wooden claddings have

Figure 117. Cemetery of Horb-Altheim associated with grave construction characteristics.



been applied in a few burial pits. Burials with niches for grave goods are located at the northern and the southern parts of the cemetery and are rather excluded at the centre of the burial ground with the highest grave density and the very eastern part of the cemetery (Fig. 117).

Burial pit sizes

In the following, the distribution of burial pit volumes will be used as a factor in order to demonstrate social differences of the buried persons. Other than non-biological social factors, biological determinants, such as gender and age, are equally important factors regarding the shape and size of burial pits. In addition, it is possible that different erosion processes influenced the documented grave depth and thus respective grave volumes. However, D. Beilharz and C. Peek (2011, 27) were able to demonstrate that, as a whole, uniform erosion existed within the cemetery. Thus, the grave volume can be applied in analysing social differences.

Similar to the values of grave goods, the available burial volume ranges (n = 71) were separated into ranked categories that are based on natural breaks (Jenks) within the values. As a result, in table 31 the burials of the first category belonging to the largest burial pits in relation to volume are provided.

Three males and six females belong to the first category that includes the largest burials. Male interments show mainly multiple weapons and niches and belong to rather older age cohorts. Female interments display both younger and older aged individuals. Most burials (except grave 34) are furnished with different kinds of ornaments – in two cases with a precious amount of metal. Except for graves 8 and 21, the largest burial pits are mostly associated with burials allocated to the middle phase (phase 3) of the cemetery.

Figure 118 illustrates that the largest burial pits are located in the north and west as well as in the southeastern area of the cemetery. In contrast, large burial pits are an exception at the centre of the cemetery, the place where high grave density and high subadult density of individuals are documented.

The correlation between burial volume and age cohorts demonstrates that the size of burial pits tends to increase with age. In relation to the median, senile individuals tend to have the largest graves (Fig. 119).

Regarding females, burial pits of juvenile and early-adult individuals display high volume ranges. The infans volume range is relatively low. Furthermore, the median values tend to decrease from the juvenile to the senile age cohort. However, the interquartile distances are relatively high in all age cohorts with the exception of the mature age cohort. Overall, the distribution of female burial pit sizes is similar to the distribution of values of grave goods. Accordingly, juvenile females demonstrate relatively high values both in terms of values of grave goods and in burial pit volumes. Similarly, in relation to senile individuals, both the distribution of values of grave goods and burial pit sizes is relatively low, whereby there is a relatively large interquartile distance among senile females.

In comparison, burial volumes and values of grave goods of male individuals follow a similar trend. In relation to the median, the largest graves are represented by the late-adult age cohort. This exhibits an identical development with relation to the values of grave goods. However, in comparison to the values of grave goods, the burial volume range of the mature and senile age cohorts remains rather stable at a high level and does not decrease.

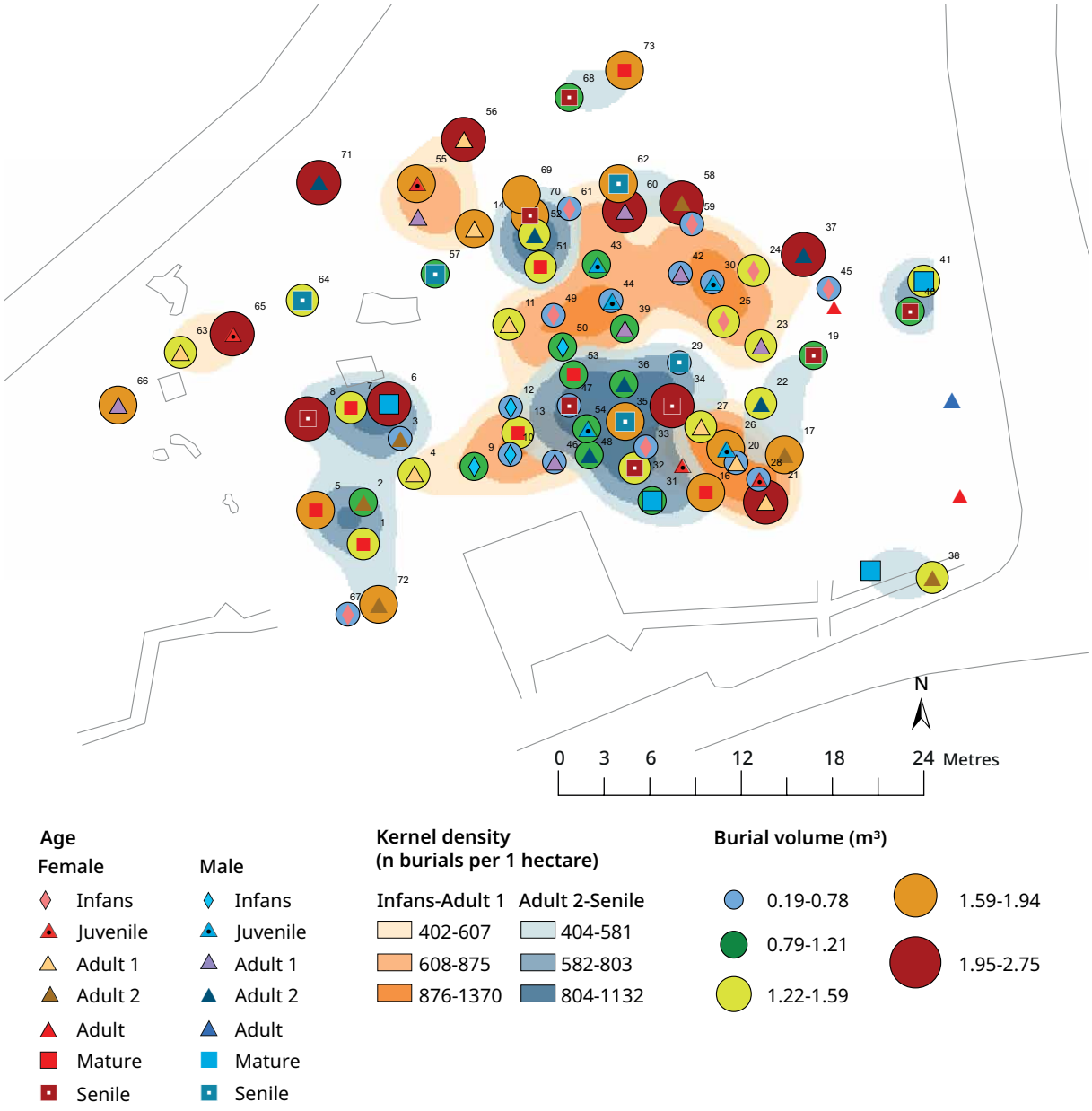


Figure 118. Distribution of burial volume categories associated to age cohorts.

Lorenz curves and Gini indices

In the following, the degree of inequality within the burial community is outlined in the form of Gini indices. Gini indices are shown in relation to the quantified distribution of grave goods. In addition to the total calculation, inequality indices related to gender are included. In total, 76 burials, including 44 females and 32 males, were integrated into the calculation.

The intersection of the Lorenz curves demonstrates that no information can be derived from the Lorenz curves themselves with respect to the social inequality degree of females and males (Fig. 120). Thus, the Gini indices have to be taken into account. With regard to the distribution of grave goods, the calculation of the Gini index for the Horb-Altheim cemetery resulted in a total value of 0.60. The Gini index of grave goods

Grave no.	Burial volume (m^3)	Phase	Age	Gender	Grave goods
6	2.74	2-3	Mature	Male	Niche, axe, belt buckle, bag, tweezers, knife
65	2.71	3-4	Juvenile	Female	Precious metal amount, finger ring, fibula, hairpin, beads, earrings, belt accessories
56	2.70	2-3	Adult 1	Female	Niche, bead, finger ring, comb, belt buckle with fitting, belt accessories, ceramic vessels
37	2.55	3	Adult 2	Male	Stone setting, spatha, axe, lance tip, shield, bag, tweezers, glass vessel, belt buckle with fitting
34	2.51	-	Senile	Female	Spindle whorl, finger ring, comb
60	2.46	3	Adult 1	Male	Axe, sax, arrowheads, bag, tweezers, belt fitting, knife, fire steel/bag strap
71	2.44	3-4	Adult 2	Male	Niche, spatha, axe, belt buckle with fitting, ceramic vessels
21	2.18	1-2	Adult 1	Female	Niche, belt buckle with fitting, belt accessories, fibula, ceramic vessels, bracelet, big bead, lot of beads
8	2.16	5	Senile	Female	Belt accessories, ceramic vessel, belt buckle, small fibula, big bead, numerous beads
58	2.15	3-4	Adult 2	Female	Niche, precious metal amount, necklace, legwear, amulet pendant, glass vessel, beads, belt buckle with fitting, four fibulae

Table 31. First category burials with information regarding grave no., burial volume (m^3), age, gender and grave goods.

for females yielded a value of 0.62 and for males a value of 0.56. Thus, the Gini index regarding grave goods is higher for females in comparison to that of males.

Values of grave goods and burial pit sizes

In order to detect burials that include both high values of grave goods and grave volumes, the normalised values of grave goods and normalised burial volumes were summarised. As a result, the graves with the highest detected values are listed in table 32.

Three male and two female individuals belong to the burial category that is comprised of the highest summarised values. Among females, juvenile, late-adult and mature individuals demonstrate the highest burial values. Typical for females are furnishings with four fibulae, multiple ornaments, and an amount of precious metal (graves 58 and 65, Fig. 121). The male burials consist of early-adult and late-adult individuals, who share multiple weaponry objects as a common characteristic (cf. Fig. 122).

All burials are located at the northern edge of the cemetery and, according to dating, all buried persons with high values of grave goods and large burial sizes belong to the middle phase of the cemetery (SD 3-4). In contrast to the richly furnished burials, there are also poorly furnished burials with few or no burial goods, such as burials 3 and 46 (Fig. 123; 124).

The fact that the furnishings of the interred individuals and the construction of the grave pits are directly related is illustrated by the correlation between values of grave goods and burial volumes (Fig. 125). Since infans individuals bias the statistical correlation based on biological growth, they are excluded.

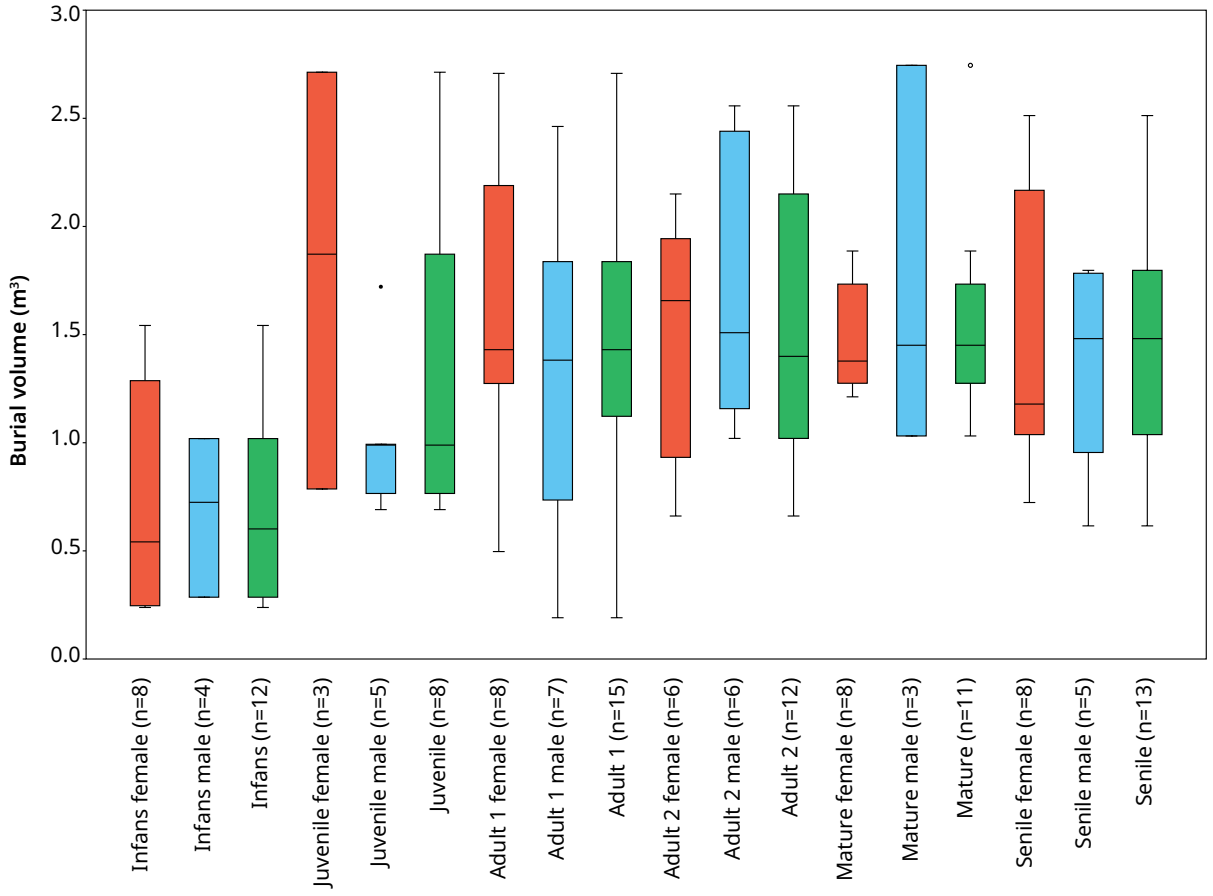


Figure 119 (above). Distribution of grave volumes in relation to age cohorts, genders and the total number of burials.

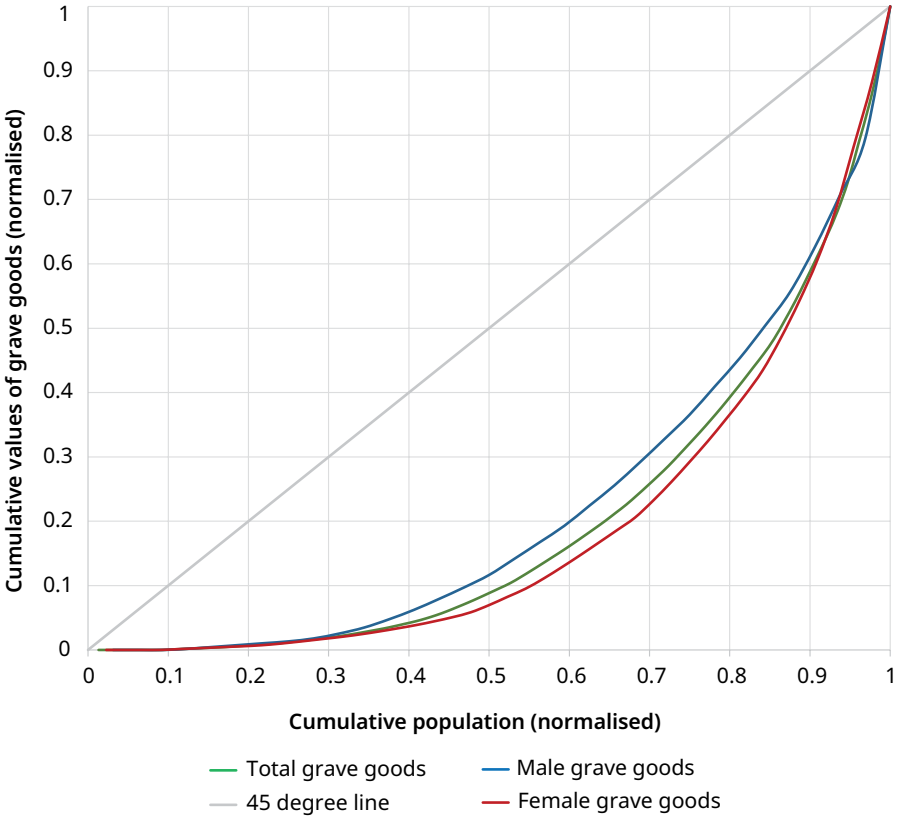


Figure 120. Distribution of values of grave goods displayed as Lorenz curves with regard to the total number of individuals, females and males.

As a result, a moderate and almost strong correlation can be observed for both females and males, which is significant in both cases (males: Linear (Pearson) r = 0.41798, p = 0.0376; females: Linear (Pearson) r = 0.4757, p = 0.0091023). Female graves 34, 56 and 65 belong to the burials that have a volume larger than 2.4 m^3. Characteristic for these burials is the presence of combs and finger rings. For men, this applies to graves 6, 37, 60 and 71. Characteristic for these mainly late-adult and mature burials is the presence of multiple weapon furnishings (cf. Tab. 32).

Distance to the next burial

In the next step, the distance between the burials is taken into account. Here, it is examined to what extent the distance between burials correlates with sizes of burial pits and/or with values of grave goods and assumptions are made about the social positions of individuals within the burial community.

The results show that there is a moderate and significant positive correlation between the burial pit volume and the distance to the next burial (Linear r (Pearson) = 0. 31492 p = 0.0079231; n = 71). However, the sizes of graves, which affect the distance to the next burial, should also be considered. This is particularly evident in the case of infans burials. Large burial pits, however, have also been laid out relatively close to the next burials. In this context, of special interest is the comparison among the adult age cohorts.

With regard to the correlation between values of grave goods and distance to the next burial, figure 126 shows that there is a small positive correlation that is not significant (Linear r (Pearson) = 0.15281 p = 0.18756; n = 76).

A further question relates to the relationship between the age cohorts of the buried individuals and the distances to the next burial. With respect to the total number of burials, the boxplot diagram (Fig. 127) shows that the distance to the next burial increases with age. However, the ranges remain stable from early-adults onwards. Adult to senile burials have been approximately buried at a similar distance from neighbouring graves. The median range is about 2.30 to 2.40 m each, with a high interquartile distance of data especially in the case of early-adult and late-adult individuals. Compared to adult burials, juvenile and

Table 32. Summarised and normalised values of grave goods and normalised burial volumes.

Grave no.	Phase	Burial value	Age	Gender	Grave goods
66	3	1.825	Adult 1	Male	Niche, sax, axe, arrowheads, earring, belt buckle with fitting, bag, tweezers, fire steel/bag strap, knife, scale, ceramic vessel
58	3-4	1.495	Adult 2	Female	Niche, precious metal amount, four fibulae, necklace, beads, finger ring, legwear, pendant amulet, belt buckle with fitting, glass vessel
73	4	1.562	Mature	Female	Bracelet, four fibulae, beads, big bead, legwear, spindle whorl, weaving sword, earrings, bag, belt accessories
65	3-4	1.314	Juvenile	Female	Precious metal amount, finger ring, four fibulae, hairpin, beads, earrings, belt accessories
37	3	1.239	Adult 2	Male	Stone setting, spatha, axe, lance tip, shield, belt buckle fitting, bag, tweezers, glass vessel

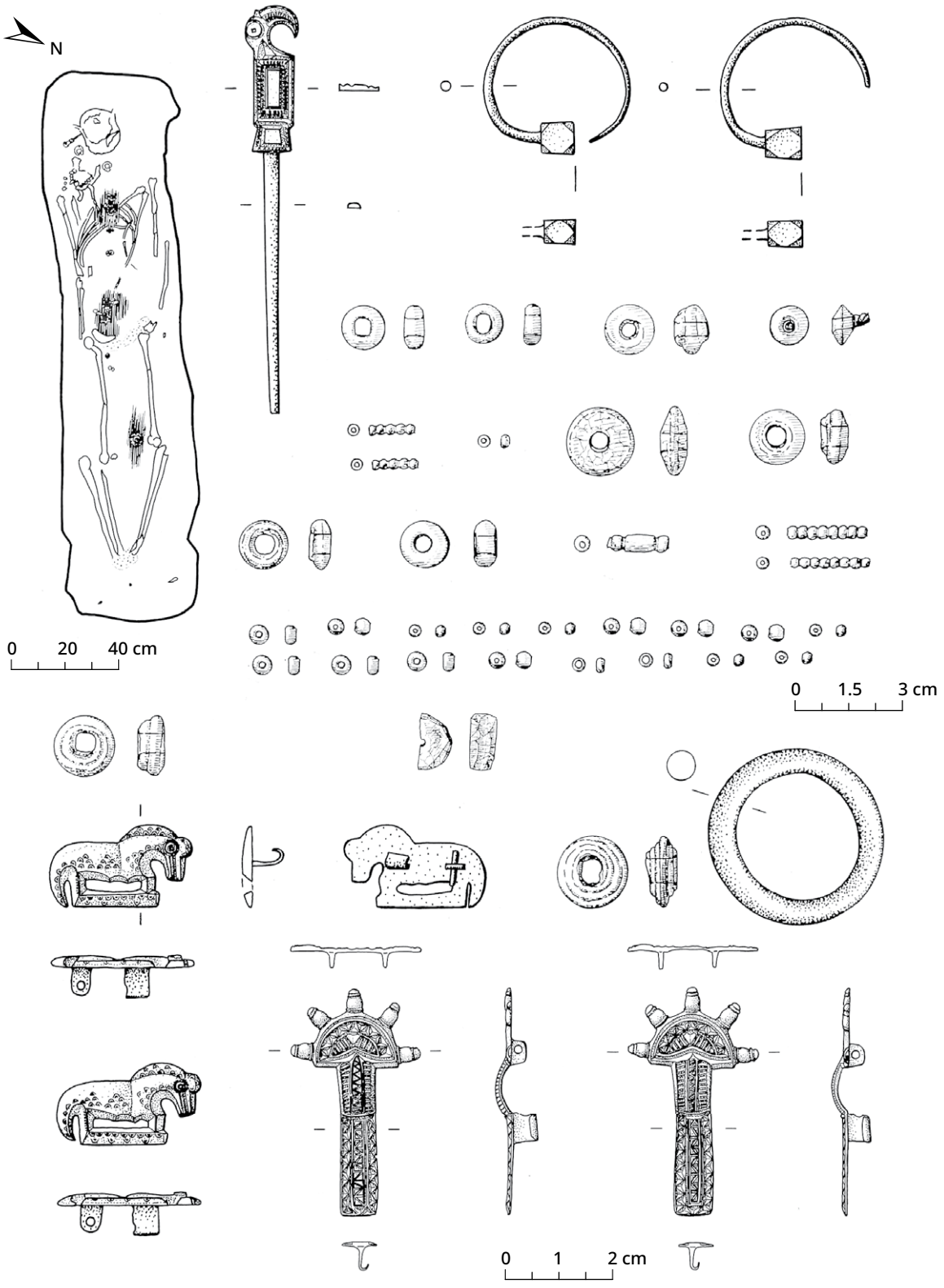


Figure 121. Female burial 65 (cf. Tab. 32). One of the burials with the highest burial value (sum of normalised values of grave goods and burial pit size) (after Beilharz and Peek 2011, Taf. 52).

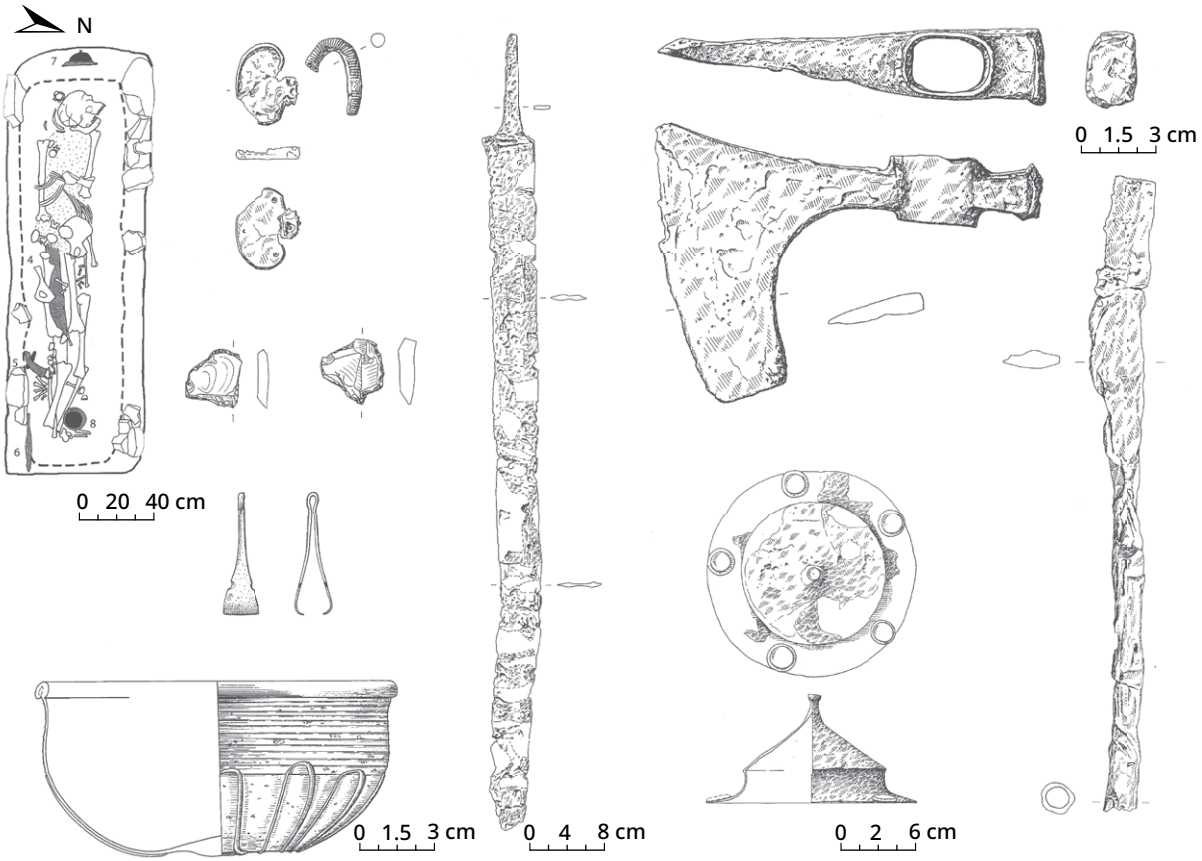


Figure 122 (above). Male burial 37 (cf. Tab. 32). One of the burials with the highest burial value (sum of normalised values of grave goods and burial pit size) (after Beilharz and Peek 2011, Taf. 26 and 27).

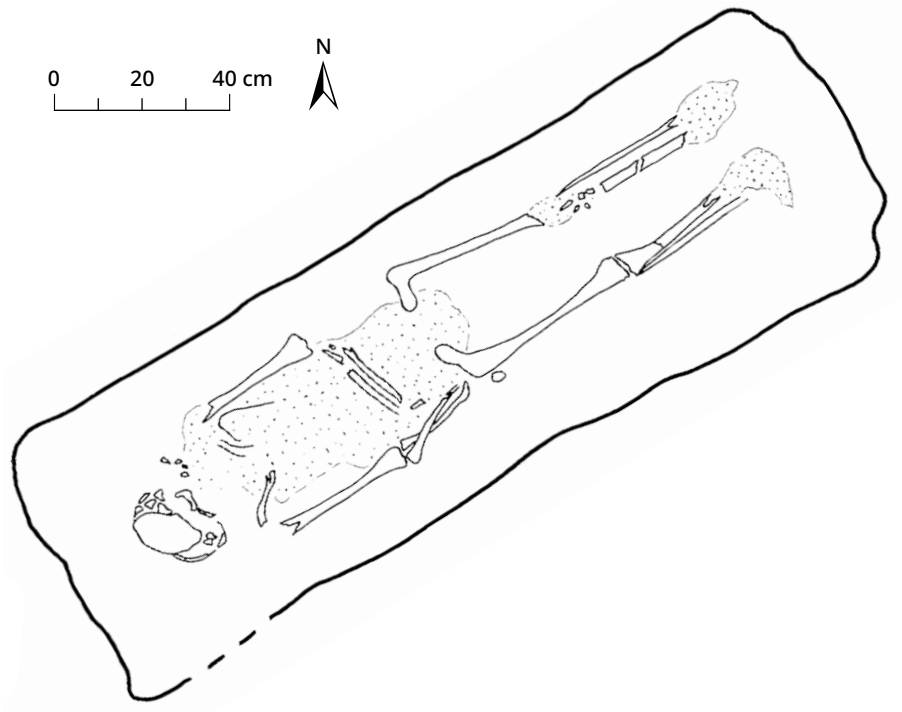


Figure 123. Female burial 3 belongs to the graves with the lowest value (after Beilharz and Peek 2011, Taf. 3).

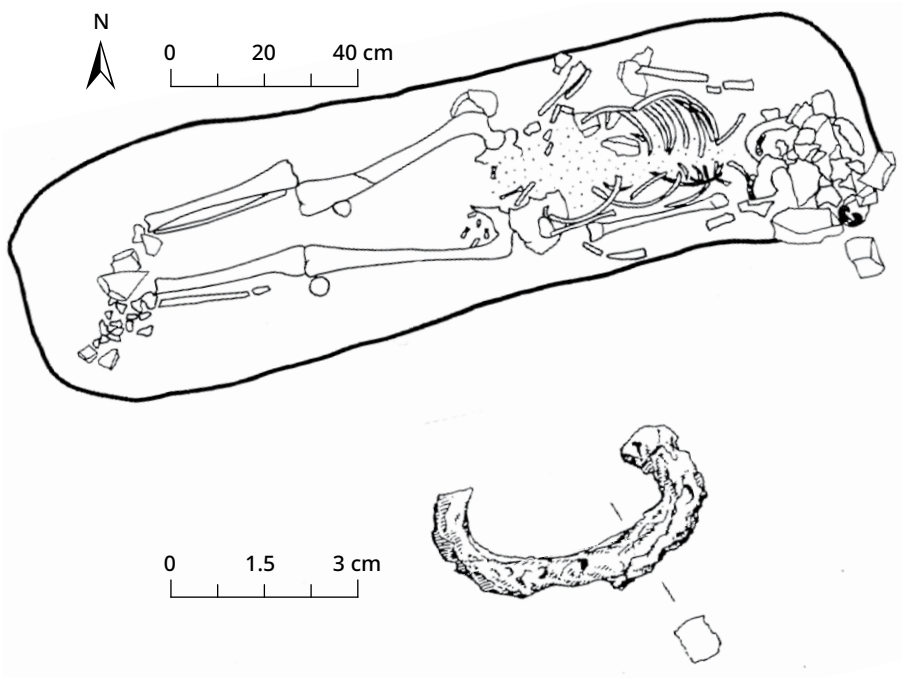


Figure 124. Male burial 46 belongs to the graves with the lowest value (after Beilharz and Peek 2011, Taf. 33).

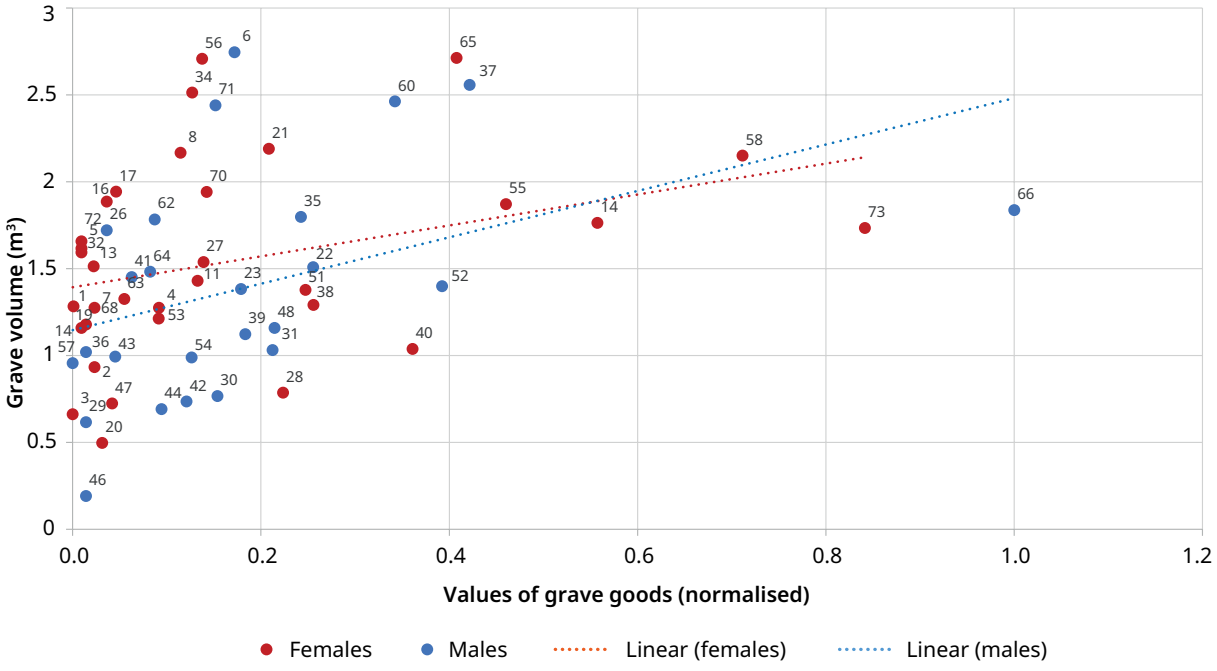


Figure 125. Correlation of normalised values of grave goods and grave volumes (m³) according to genders. Also depicted are linear tendency lines.

infans burials have been arranged closer to the next burial, which may also be explained by family ties.

With respect to females, the highest range and median is observed for early-adult females. However, this age cohort also includes the highest interquartile distance. With age, the median falls slightly. In the case of males, the highest median is found among late-adult and senile individuals. Compared to females, the range of data and the median remain stable, increase rather with age and do not fall again. Among males, high interquartile distances of data can be observed with the adult and senile age cohorts, in general. The difference between age

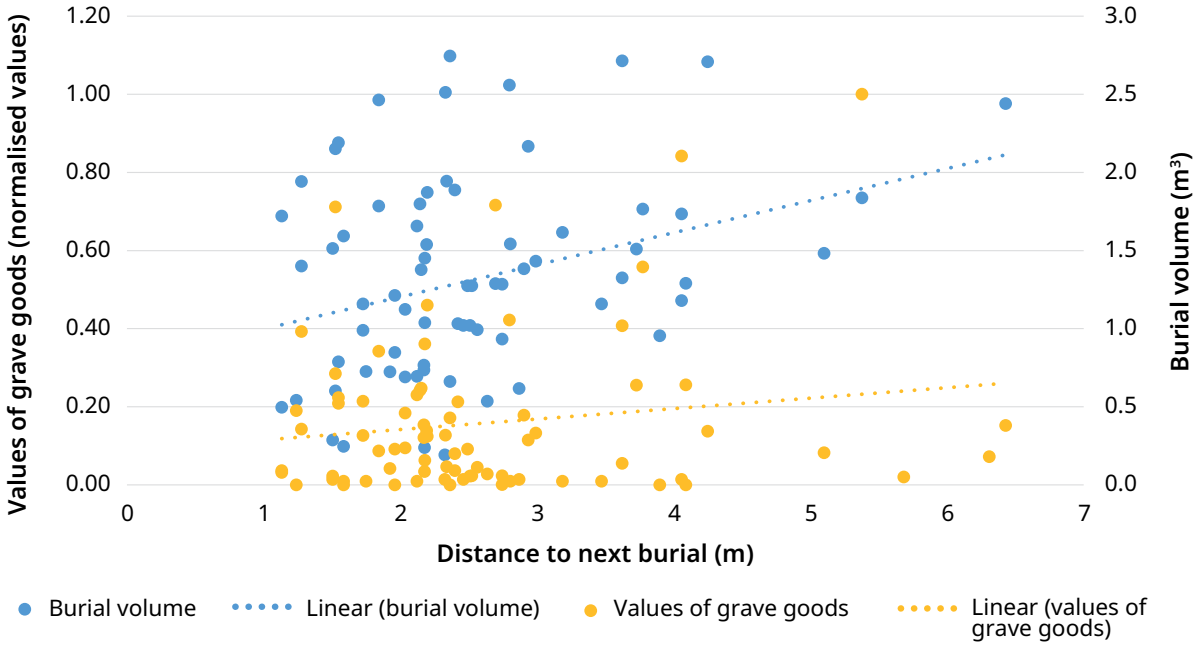


Figure 126. Linear regression between burial volumes/values of grave goods (both y-axis) and distances to the next burial (x-axis).

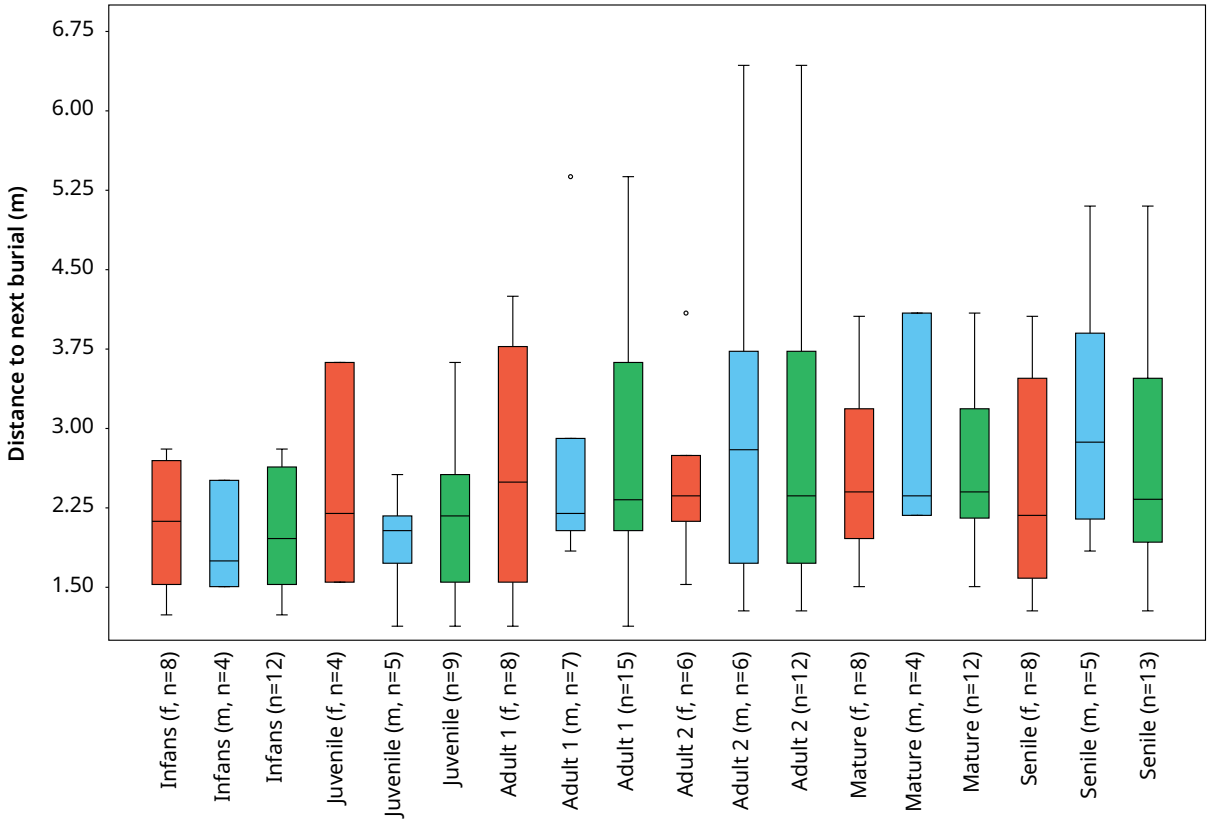


Figure 127. Ranges of distances to the next burials according to the total number of burials, genders and age cohorts.

cohorts is not significant. The clearest difference can be detected among males and here between the senile and infans age cohorts (Mann-Whitney pairwise: p (same median): 0.1133).

In sum, the distribution of data with respect to age cohorts of females, males and of the total data shows a similar picture as the distribution of data with regard to values of grave goods and burial pit volumes. However, it has to be taken into account that in the context of distributions of values of grave goods, burial volumes, and distances to the next burials the number of samples in each age cohort is relatively small.

Growth and body height

Regarding the relationship between health condition and values of grave goods or grave size, the factor growth/body height is included. For Horb-Altheim, a total number of 37 body height samples are available. Anthropological results determined 18 individuals as males and 19 as females. In total, adult males demonstrate an average body height of 1.74 m, whereas females exhibit an average body height of 1.64 m (cf. Beilharz and Peek 2011, 22).

The comparison of values of grave goods and body height shows a strong positive correlation for females and a small correlation for males (Fig. 128). The correlation is only significant in the case of females (females: Linear r (Pearson): 0.5359; p = 0.018029; males: Linear r (Pearson): 0.2443; p = 0.32857). The correlation includes adult and juvenile individuals since their body height does not differ from that of adult individuals, but excludes infans individuals. Since the burial volumes of the tall males in graves 35, 71 and 6, for instance, are disproportionate, the positive correlations cannot be explained only by bioanthropological factors.

Among females, the late-adult burial 58 and the mature burial 73 include those females whose body height and values of grave goods correlate very strongly. Characteristic for both burials is the presence of four fibulae in the form of two bow fibulae and two small fibulae as well as a large quantity of precious metal, a silver necklace in grave 58, and a weaving sword with a spinning whorl in grave 73, respectively.

Among males, burials in graves 35, 48 and 71 include the tallest individuals as well as showing relatively high values of grave goods. However, they do not belong to those male burials with the highest values of grave goods, since no information concerning the body height of males that have the highest values of grave goods (graves 37, 52, 60, and 66) is available. In general, the characteristic object type in burials 35, 48 and 71 is weaponry. Grave 48 includes a rare sax. Graves 35 and 71 include rich multiple weaponry, consisting of a spatha, an axe and a shield in grave 35 and an axe and a spatha in grave 71. The male mature interment, grave 76, which has the tallest body, has no grave goods and no information regarding grave volume is available. An existing disturbance indicates that this burial was entered in a modern context and was possibly originally richly furnished.

With regard to the correlation between body height and burial volumes, there are moderate positive correlations for both females and males (females: Linear r (Pearson): 0.31988; p = 0.21071; males: Linear r (Pearson): 0.38911; p = 0.13632) (Fig. 129). Obviously, a positive correlation between body height and grave size seems convincing. However, there is a discrepancy between the required size of a burial pit and the actual size of a grave. Some graves have been constructed much larger than necessary. It is apparent that this discrepancy is more pronounced

Figure 128. Correlation between body height and values of grave goods according to genders.

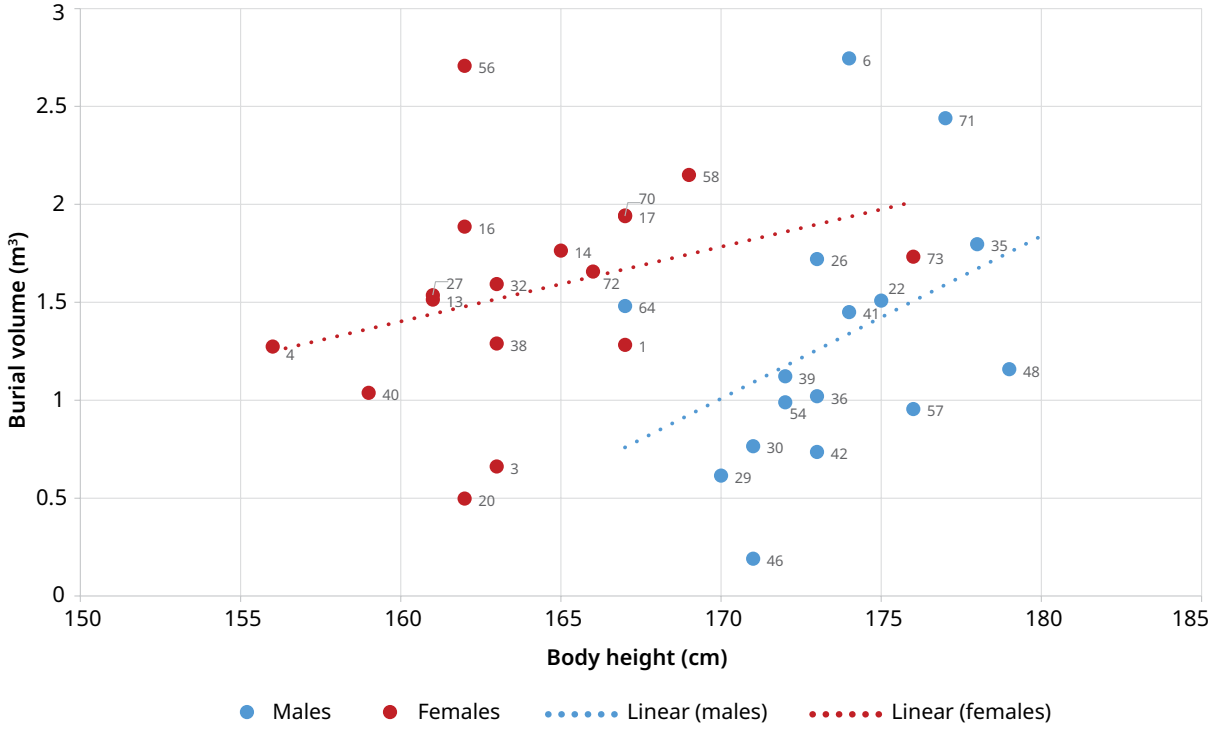


Figure 129. Correlation between body height and burial volumes according to genders.

among males in comparison to females, which could mean that the body height of males has a much stronger symbolic/social meaning or impact than those of females. The burial volumes of the tall males in graves 6, 35, and 71, for instance, are disproportionate and the positive correlations cannot be explained only by bioanthropological factors.

Moreover, the graph in figure 129 shows that within both gender clusters one person of the opposite gender is present. On the one hand, a mature female burial is noted for grave 73 that is extraordinary tall and, on the other hand, a senile male is observed from grave 63 that is rather small. Possibly, an anthropological incorrect determination was carried out in both cases. Grave 73 has an unambiguous female furnishing represented by ornaments. This person could be a male or a third gender (diverse) to whom a female decoration was attributed or to whom such a decoration was attributed by himself. In the case of the senile burial 64, there is, apart from the knife, no clear male furnishing. However, of the 17 knives found within the cemetery at least one is connected with a mature burial that was anthropologically determined to be female (grave 13). Accordingly, it is also possible that grave 64 represents another female burial of an advanced age that has an assigned knife.

Pathologies

Z. Obertová (2008, 132ff.) pointed out that the entire population of the Early Medieval site Horb-Altheim shows a relatively similar health or disease profile. Stress-related skeletal changes suggest a high level of physical work for both sexes from childhood on, which left different traces depending on the sex. Changes have been caused in males by field and handcraft work, in females by household-related activities.

Most individuals demonstrate tooth decay in the form of caries (females: 82.4%, males: 76.9%, total: ca. 78%). In Horb-Altheim, the frequent intake of carbohydrates without longer breaks and the intake of honey could have led to the high degree of caries (Obertová 2008). A linkage between values of grave goods and caries could not be detected.

Furthermore, 43.2% of males and 13.9% of females have traces of traumas and the relatively low number of buried males is an indication of possible conflicts, which might have occurred elsewhere (Obertová 2008).

Moreover, 31.1% of the population, including males and females as well as the old and the young, were affected by *cribra orbitalia*. Buried individuals in niche graves were less affected by *cribra orbitalia* (Obertová 2008). Data suggests that adult individuals without *cribra orbitalia* received larger graves than those in whom this deficiency could be proven (Fig. 130). However, the difference is not significant (T-Test: 1.5082; p (same mean): 0.13794).

Spondylarthrosis represents another pathology causing degenerative joint disease. It leads to a degenerative change of the spine and of the articular surfaces of apophyseal joints. Manifestations of spinal degenerative changes can be interpreted as indices for a relatively high workload. In the cemetery of Horb-Altheim, around 16% of the population was identified with this affliction, both males and females, mainly adult and senile individuals. Five of the six best-furnished adult burials revealed indications of spondylarthrosis, whereby this pathology is mutually exclusive to *cribra orbitalia*, except in three graves. Data also suggests that adult individuals with *spondylarthrosis* tend to have larger graves than those adult burials that do not have such a pathological attribute (Fig. 130). The high degree

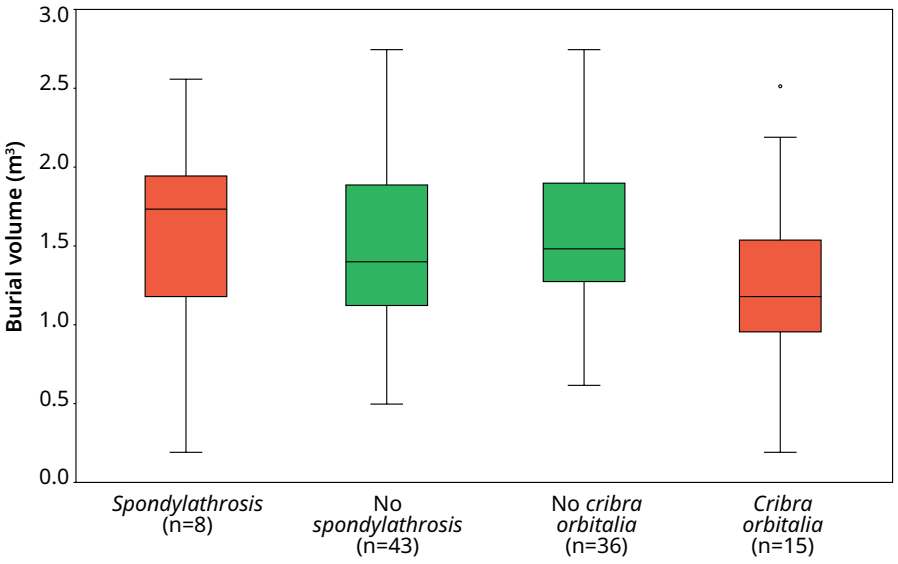


Figure 130. Burial volumes of individuals affected and not affected by *spondylarthrosis* and *cribra orbitalia*.

of values of grave goods and the burial volumes in connection with *spondylarthrosis* can be interpreted as individuals with a high reputation, who made high physical efforts and thus provided a large degree of welfare for the whole population (cf. Obertová 2008, 130).

Figure 131 shows that individuals who are affected by *cribra orbitalia* are predominantly situated in the southeastern area of the cemetery, thus in those regions in which the values of grave goods and grave volumes tend to be lower in general. In contrast, individuals that are affected by *spondylarthrosis* are located rather in the northwestern area and at the centre of the cemetery and accordingly in areas characterised by high values of grave goods and grave volumes.

Heterogeneity and transformation

A further issue reflects the analyses of heterogeneous population structures and if they become visible within the burial community, possibly indicating different roles or habitus. For this purpose, burials that include information about the grave goods were transferred into a correspondence analysis with the aim to obtain different clusters of grave goods that could indicate different roles within the community. Furthermore, the characteristics of grave goods were combined with anthological data referring to age cohorts. Since the Early Medieval society of Horb-Altheim clearly shows a separation between the traditions of grave goods for males and females, the grave goods associated with females and males were analysed in two separate correspondence analyses.

Among females (Fig. 132), a concentration of burial objects, which is characterised by their jewellery, including earrings, hairpins, fibulae, arm rings and belt buckles with fittings, cluster in the negative area of the 1st and the positive area of the 2nd principal axis. The glass vessel is also located in this area. Belonging to the burials that frequently show these characteristics are not only juvenile individuals but also adult age cohorts. Beads and big beads are arranged around the zero point. This position makes clear that beads are very frequently documented in female graves. They are present in all age cohorts. With regard to the number of beads, it is striking that a high number of beads (>20) is very often linked to infans burials as well as to juvenile and early-adult burials, but not in

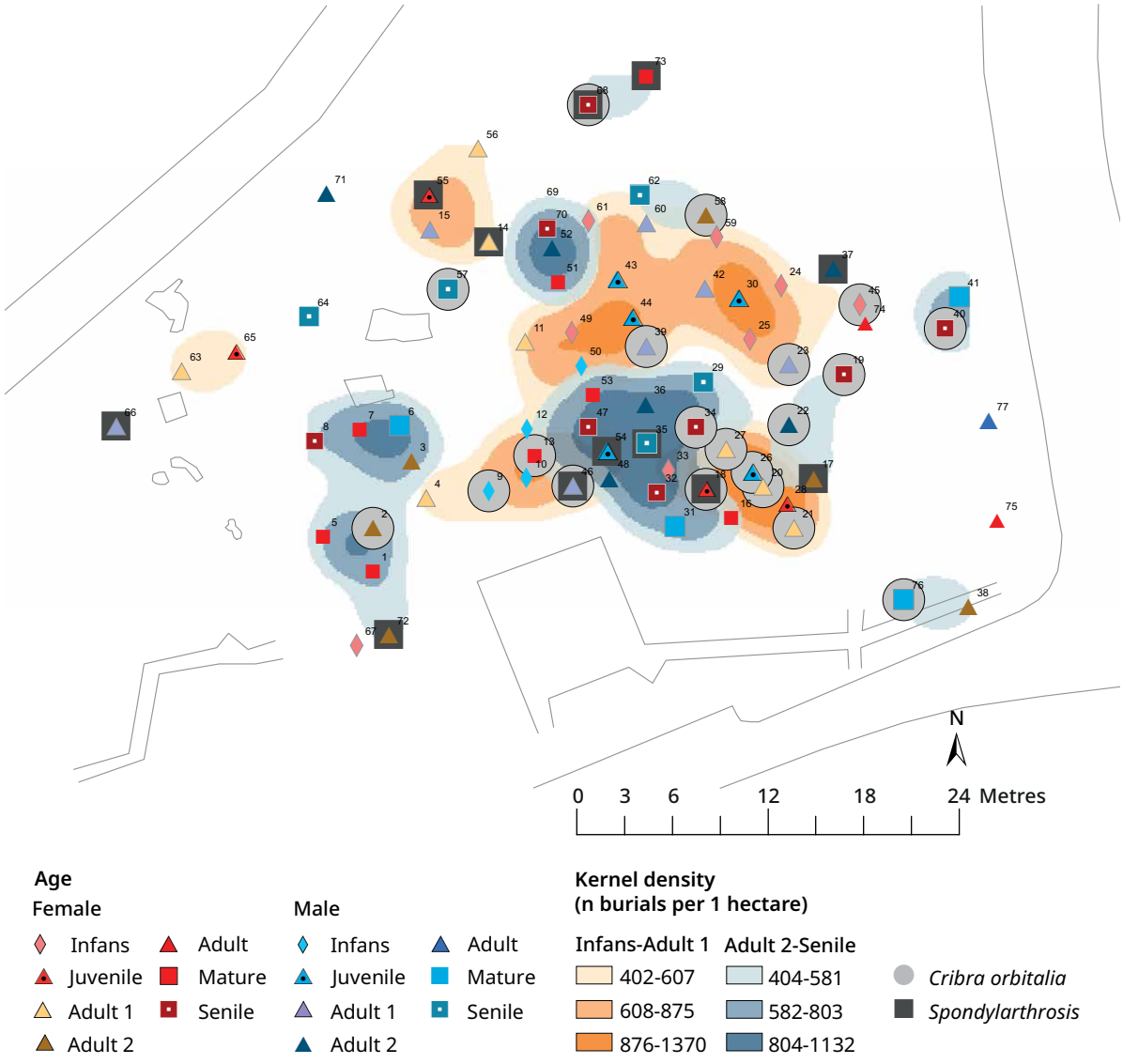


Figure 131. Cemetery of Horb-Altheim showing the distribution of *cribra orbitalia* and *spondylarthrosis* within the cemetery. Also illustrated are age cohorts and clusters of young and old individuals.

late-adult and mature burials. However, a high number of beads are recorded in senile female graves. Comb and spinning whorl objects are located at the negative range of the 1st and 2nd principal axes, frequently in combination with each other. Combs appear rarely in combination with ornaments and in connection with niche graves, but rather more frequently with accessories such as small fibulae. Combs were particularly assigned to early-adult and senile individuals. In comparison, ceramic vessels are located at the positive area of the 1st principal axis. They are often associated with simple belt buckles, but rarely with decorative objects, glass vessels and spinning whorls. Ceramic vessels occur frequently and in all age cohorts – even among males. Moreover, the combination of ceramic vessels and simple belt buckles is often recorded among mature females.

Figure 133 illustrates the distribution of the selection of certain objects (combs, glass vessels, simple belt buckles, belt buckles with fittings) based on the varying distribution in the correspondence analysis. The aim is to prove if different objects and object combinations are located in different areas within the cemetery. Combs that are located in the correspondence analysis in the negative range of the

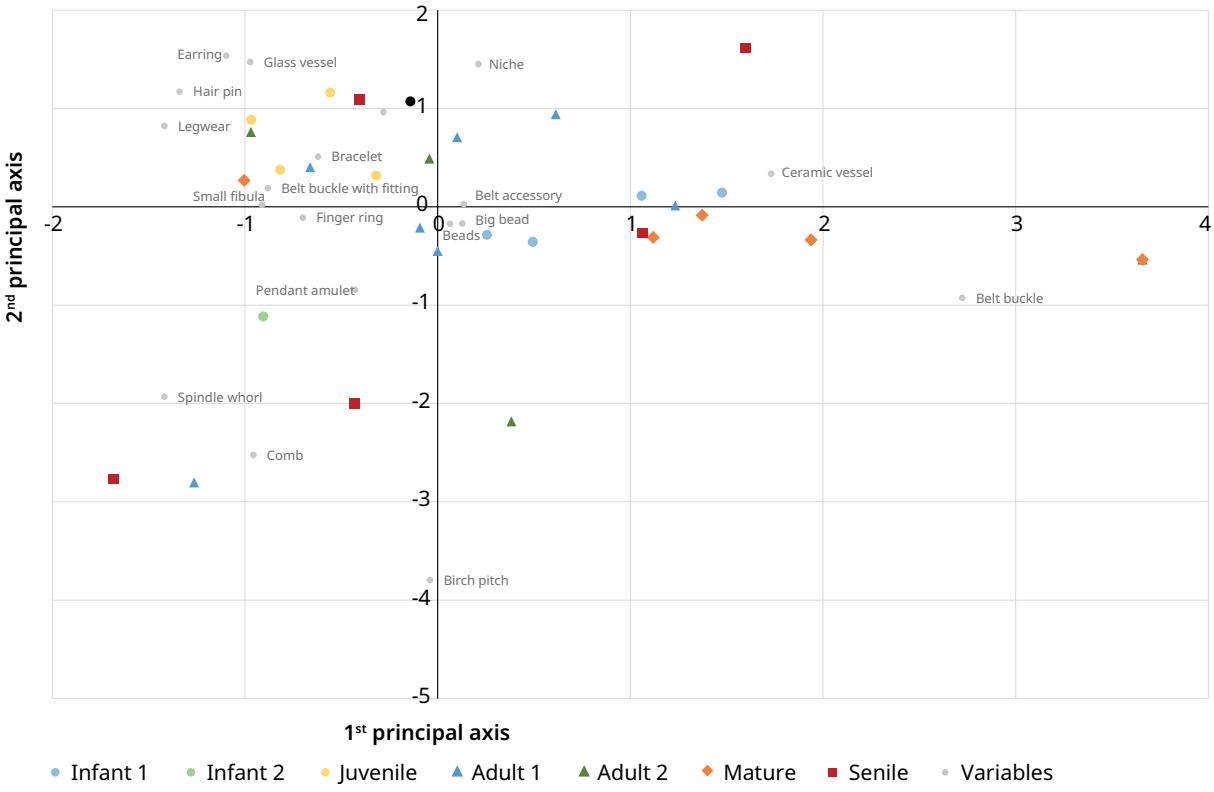


Figure 132. Correspondence analysis (CA) of categories (variables) of grave goods associated with female burials (objects) including age assignments. The CA includes the 1st and 2nd axes. The cumulative explanation in percentage, which is expressed by the first two axes, equals 49.

1st and 2nd principal axes occur frequently at the northern, central and eastern parts of the cemetery. They are often associated with early-adult and senile individuals, but are relatively rarely associated with belt buckles. Glass vessels that are located in the negative area of the 1st and in the positive area of the 2nd principal axes occur in the northern as well as in the southern part of the cemetery. In two cases, they are combined with belt buckles that have fittings. Moreover, they are not linked to a certain age cohort. Belt buckles with fittings are more likely to be found in the northern part of the cemetery, whereas belt buckles without fittings are more likely to be found in the southern and western parts.

The correspondence analysis that includes male objects (Fig. 134) shows a cluster of weapons in the negative area of the 1st principal axis that includes lance, shield and spatha depositions. Additionally, glass vessels and belt buckles with fittings are located close to these objects. Belonging to the burials that frequently show these items are, in particular, late-adult individuals. Bags and ceramic vessels occur frequently in combination with diverse and multiple objects and thus are positioned around the zero point.

Objects including a sax, an axe, arrowheads and tweezers are situated in the positive area of the 1st and 2nd principal axes. Belonging to the males, who exhibit these objects, are especially early-adult and mature individuals. Among objects that are located in the positive area of the 1st principal axis and in the negative area of the 2nd principal axis are belt buckles without fittings and knives. A relatively high number of juvenile individuals are linked to these objects.

Figure 135 illustrates the distribution of certain male objects that are located at different poles in the correspondence analysis and thus express the dissimilarity of these objects to each other. This includes a spatha (negative area of the 1st principal axis), a sax (positive area of the 1st and 2nd principal axes) and

Figure 133. Distribution of certain female objects within the cemetary based on the correspondence analysis associated with females (cf. Fig. 132).

a knive (positive area of the 1st principal axis, negative area of the 2nd principal axis). Spathas are primarily distributed at the northern and southern edges of the cemetery and partly in the eastern part. They are predominantly associated with late-adult individuals. Saxes are also located in the southern and northern parts of the cemetery, but a focus lies rather in the western area. Overall, male burials with saxes date earlier (phase SD 2 and 3) than burials with spathas, which have a focus in the phases SD 3 and 4. Saxes are mainly associated with early-adult and late-adult individuals. In one case, a sax is combined with a spatha (grave 52). Regarding knives, they are located across the entire cemetery with a spatial focus in the central area. They are often associated with juvenile and early-adult males.

If we consider belt buckles, we first recognise that those with fittings are located in the northern and western areas of the cemetery and often correlate with weapons such as spathas and saxes. In contrast, simple belt buckles without fittings are situated in the central and southeastern parts of the cemetery and are combined with spathas in three cases.

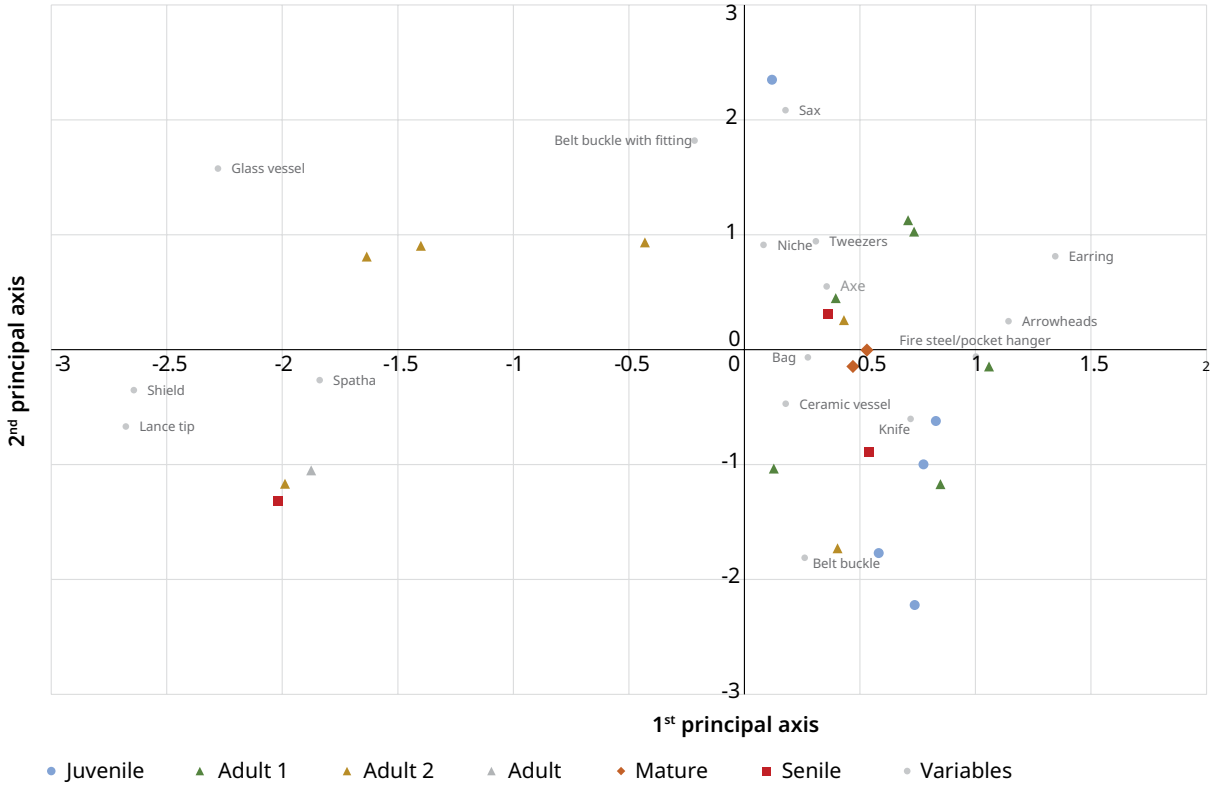


Figure 134. Correspondence analysis (CA) of categories (variables) of grave goods associated with male burials (objects) including age assignments. The CA includes the 1st and 2nd axes. The cumulative explanation in percentage, which is explained by the first two axes, equals 41.

Overall, it has been shown that it is possible to identify various and multiple object categories assigned to both females and males that have spatial foci within the cemetery. At the same time, these object categories are linked to certain age cohorts and potentially to social roles and positions. However, chronological factors regarding the analysis of heterogeneous social roles and positions may not be ignored.

In addition to correspondence analyses, the sampled strontium isotope ratios will be considered in their distribution since the origin of the individuals also represents a heterogeneous factor. A total of 28 strontium isotope ratios were sampled which can be assigned to 11 males, 15 females and 1 horse (Beilharz and Peek 2011; Obertová 2008). The $^{87}Sr/^{86}Sr$ ratios range between 0.7080542 and 0.7130542 and represent the local Muschelkalk/Keuper geology. According to D. Beilharz and C. Peek (2011, 219) as well as Z. Obertová (2008, 4), graves 53 and 46, which have the highest strontium ratios, belong to immigrated, non-local individuals and represent 7% of the population.

However, the author also suggests that the individuals from graves 6, 18, 26, 48, 52, 63 and 72, who have the lowest ratios (0.7080 until 0.7087), represent the first migrated families, originating probably from the Mid-Danube region (Beilharz and Peek 2011, 30ff.; Obertová 2008, 4). This suggestion is underpinned by the fact that all the mentioned graves demonstrate objects that date in relatively early phases (SD Phase 2-3). They also show attributes, such as niches and outstanding furnishing with early dated artifacts, which have their origin in the Mid-Danube area (Beilharz and Peek 2011, 217). It seems that they represent a kind of privileged family that is well-furnished, passing their status to the next generations and existing side by side with “simple” graves, representing a lesser degree of material wealth. Remarkably, with the exception of grave 52, all of these graves that have the lowest strontium isotope ratios are located in the southern part of the cemetery (Fig. 136).

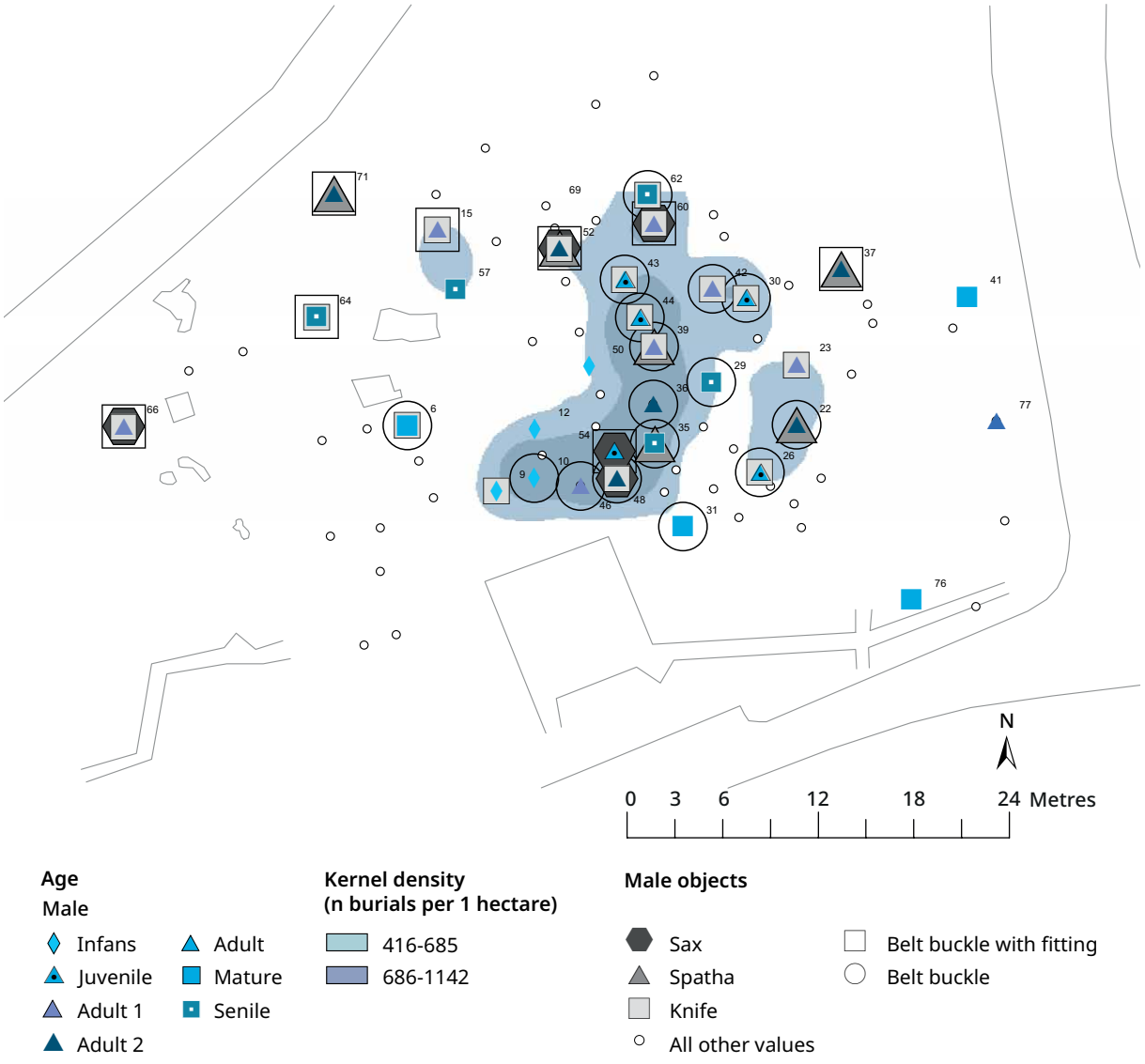


Figure 135. Distribution of certain male objects within the cemetary based on the correspondence analysis associated with males (cf. Fig. 134).

Summary

To sum up, the south and middle areas of the Horb-Altheim cemetery demonstrate the highest density of graves. As already mentioned by D. Beilharz and C. Peek (2011, 221), the eastern part of the cluster, represented by graves 16-18 and 21, has to be assigned to the oldest phase. These graves and burials 48 and 52 that are located at the northwestern area of the cemetery probably represent founder graves. From these areas, the occupation of the cemetery probably occurred in a stellar outward direction (cf. Fig. 137). The mentioned burials also show relatively low strontium isotope ratios compared to the other burials as well as a high proportion of Eastern Mediterranean grave goods that date relatively early.

Furthermore, a regulated concentration of genders and age cohorts is detectable (cf. Fig. 111; 112; 137). Consequently, the affiliation to a certain age or gender group may have had a similar or even bigger significance for the social position of an individual than the affiliation to a certain household.

The calculation of values of grave goods showed a concentration of high and very high values along an imaginary horizontal line at the northern area of

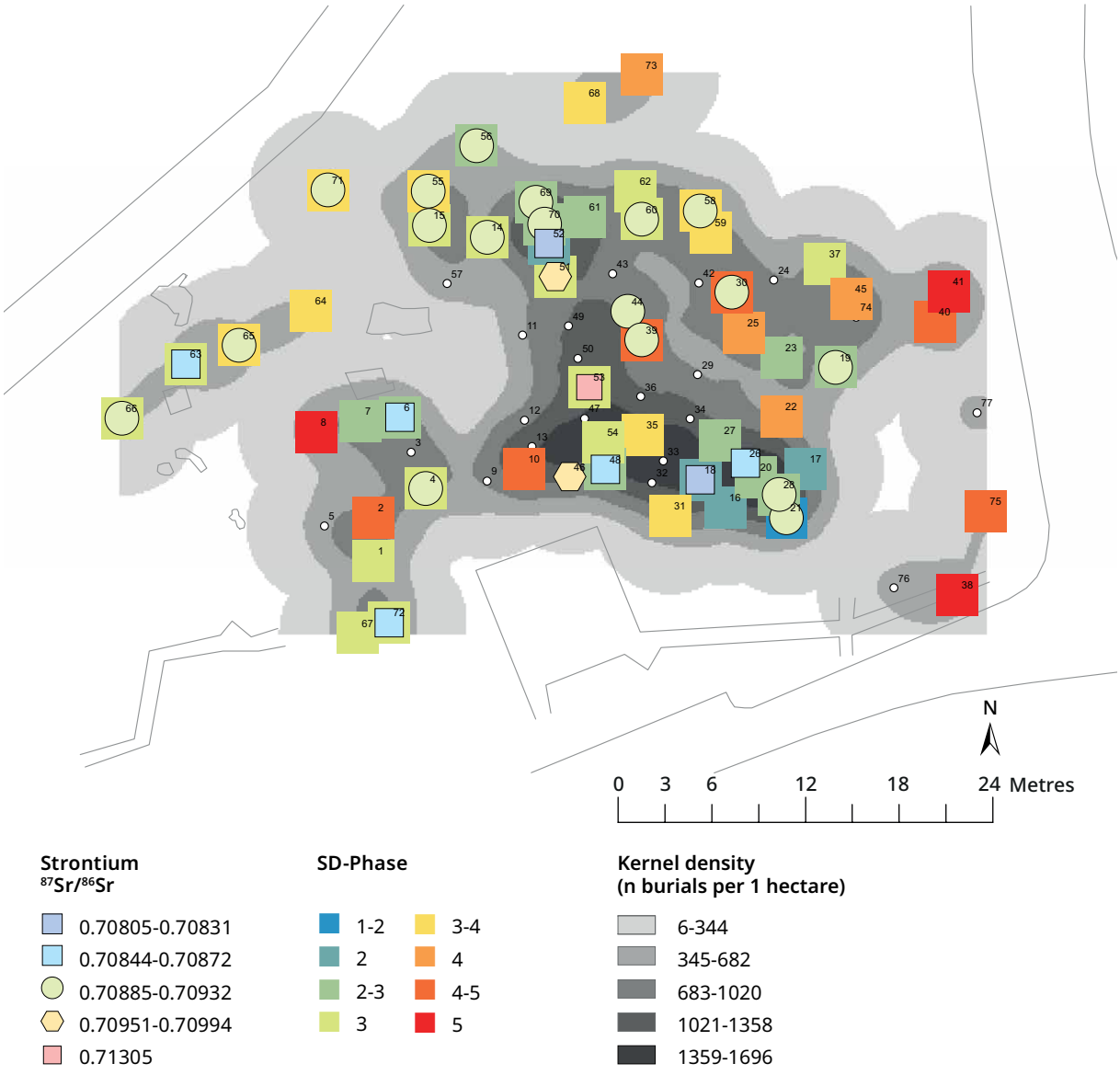


Figure 136. Distribution of strontium isotope categories within the cemetery in combination with chronological phases.

the cemetery. Since antique and modern disturbances are present at the centre and in the southern area of the cemetery, it is also possible that corresponding rich burials were also originally located in this area. As disturbances are present in combination with early dated burials in a limited area, the question arises whether they were deliberately robbed by a competing local clan.

Burials with the highest values of grave goods tend to be assigned to a later phase (cf. Beilharz and Peek 2011, 200). Females of the highest category are characterised by the presence of a large number of different jewellery and traditional dress components. Another characteristic object that is linked to highly ranked females is represented by two pairs of fibulae (two bow fibulae and two small fibulae). Males that are associated with the highest category of values of grave goods are characterised by multiple weaponry objects consisting of different kinds of weapons.

The presence of a high quality and quantity of furnishings correlates with a niche for grave goods and/or with the presence of a coffin. Simple earth graves

are associated with less richly furnished burials. These graves are located primarily in areas with the highest grave density.

Big burial pits are predominantly located at the peripheral areas of the cemetery, in areas where no large grave density exists. The biggest burials are located – similar to the highest values of grave goods – mainly at the northern edge of the burial ground (cf. Fig. 113; 118; 137).

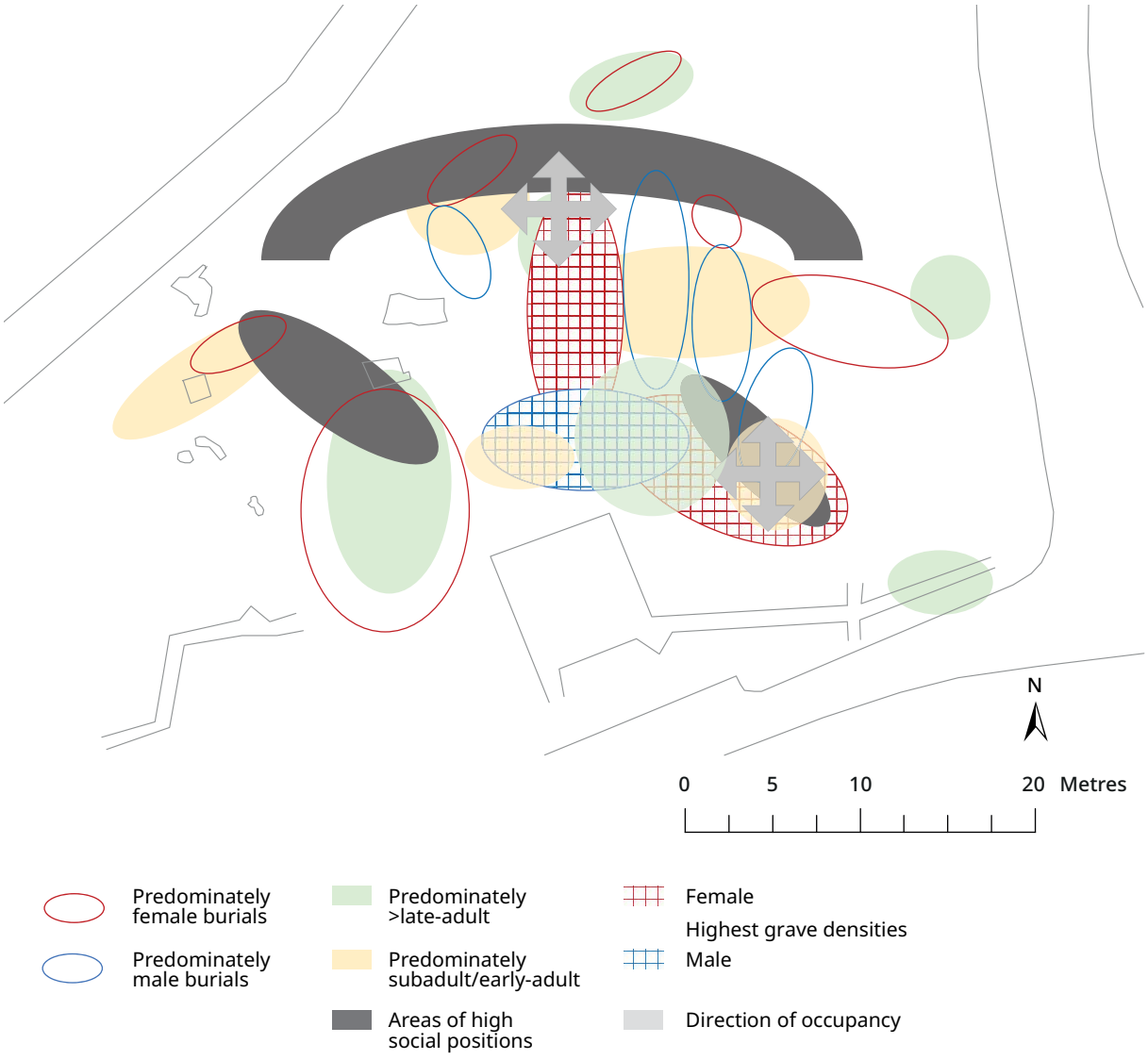
With age and gender, there are differences with regard to the distribution of values of grave goods, grave volume and the distance to the next burial. Males show the highest values of grave goods among the late-adult age cohort. For the mature/senile age cohorts, the degree of values of grave goods decreases again. A corresponding result is detectable in relation to the grave volume and the distance to the next burial. Also in this context, the late-adult individuals show the highest value ranges and medians. In contrast to the values of grave goods, medians of the attributes burial volume and distance to the next burial do not decrease with age, which could mean that the oldest males (senile) nonetheless held relatively high social positions, even though they were seldom well-furnished with multiple weapons. The data for females exhibits high social positions in the context of rather young individuals such as juveniles and early-adult individuals. Already at a juvenile age, females demonstrate relatively high values of grave goods and probably a high status. This is also confirmed by relatively high values with regard to the volume of burial pits. In contrast, the distance median values for each age cohort demonstrate no large difference. In this context, early-adults show the highest values.

Overall, with respect to values of grave goods, grave volumes and the distance to the next burial, the data correlates quite well in many aspects for both female and male contexts.

Based on the summation of normalised grave goods and burial volume values, five burials (graves 66, 58, 73, 65, and 37) may be described as interments that probably represent individuals with the highest ascribed social position: two males and three females. All of these burials are located at the northern edge of the cemetery and belong to the middle phase (phase 3) of the burial grounds. Among females, there is a higher Gini index and, accordingly, higher inequality with regard to the distribution of grave goods.

Furthermore, there is a positive correlation between the distance to the next burial and values of grave goods and especially between the distance to the next burial and burial volumes. This fact underpins the high social position of the buried persons who are located at the edge of the cemetery.

With regard to bioanthropological data, a positive correlation can be observed between growth/body height and values of grave goods and burial volumes. Conspicuous is, in particular, the strong correlation between body height and burial volumes among males that cannot only be explained by bioanthropological factors. Thinkable is a positive correlation between nutrition, growth, stature and social position. Furthermore, it is also shown that the deficiency symptom *cribra orbitalia* is associated with less richly furnished burials. Individuals affected by *cribra orbitalia* are more regularly located in the southeastern part of the cemetery, whereas *spondylarthrosis*, a pathology associated with physical stress due to a relatively high workload, is more often associated with well-furnished burials, whereby these individuals are not only more frequently located in the northern periphery but also at the centre of the cemetery consisting of older individuals. They probably held a high reputation due to high achievements.



Based on correspondence analyses, heterogeneous groupings of grave goods could be identified for both females and males that are located in different areas within the cemetery. These groups represent both a vertical social differentiation as well as diverse social roles and habitus. Different social roles and habitus are, in addition to social status, closely related to gender, age and origin of the founders who originally emigrated from the central Danube Basin.

Figure 137. Model of the social organisation of the burial ground of Horb-Altheim. Illustrated are areas of predominately subadult/early-adult (beige areas) and late-adult/mature/senile individuals (green areas), areas of predominately female and male burials (red and blue circles), the direction of occupancy (arrows), areas of highest grave densities (checked patterns), and areas of burials that demonstrate high social positions (dark grey).

Synthesis

Regarding the results of the social inequality analyses, it has to be emphasised that the included burials and grave goods are from different archaeological groups and periods. This fact limits the possibilities to directly compare the archaeological and anthropological material with each other, since these periods are characterised by different social, cultural and ecological backgrounds. Therefore, calculated Gini indices based on the distribution of grave goods are excluded in the diachronic inequality comparison.

However, data that is independent from epoch-specific grave goods are able to provide insights into the development of social inequality within the Southwest German region. This can be achieved by the analysis of the distribution with regard to the burial pit and household sizes. Furthermore, in connection with the distribution of strontium isotope ratios, a hypothesis on the social interactions of the region can also be established.

The values from figure 138 show calculated Gini indices based on the burial pit size distribution without taking infans individuals into account, since the respective cemeteries demonstrate different proportions of infans that bias the results. Within the site Lauda-Königshofen, the Gini indices of burial pit size distributions relate to the results if the circular ditches are excluded since they do not indicate individual inequality in this context. Overall, the Gini indices show relatively low values with the Neolithic cemeteries. In contrast, the Early Bronze Age and Early Iron Age burial grounds demonstrate significantly higher degrees

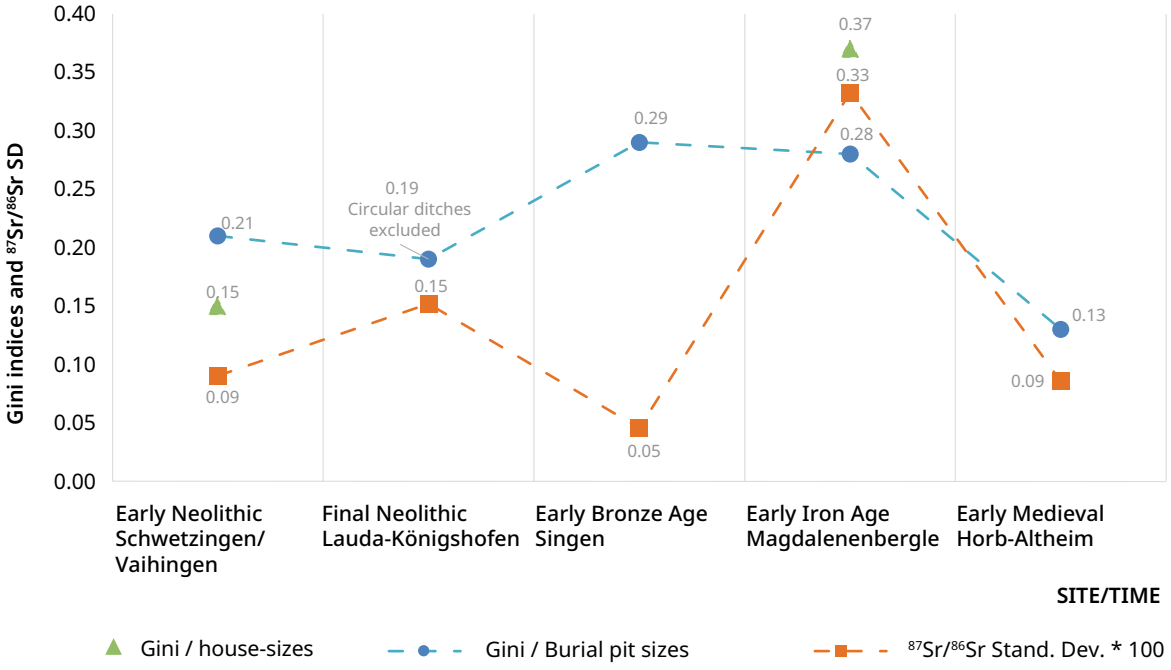


Figure 138. Diachronic comparison regarding Gini indices of burial pit sizes, house size distributions and strontium standard deviations.

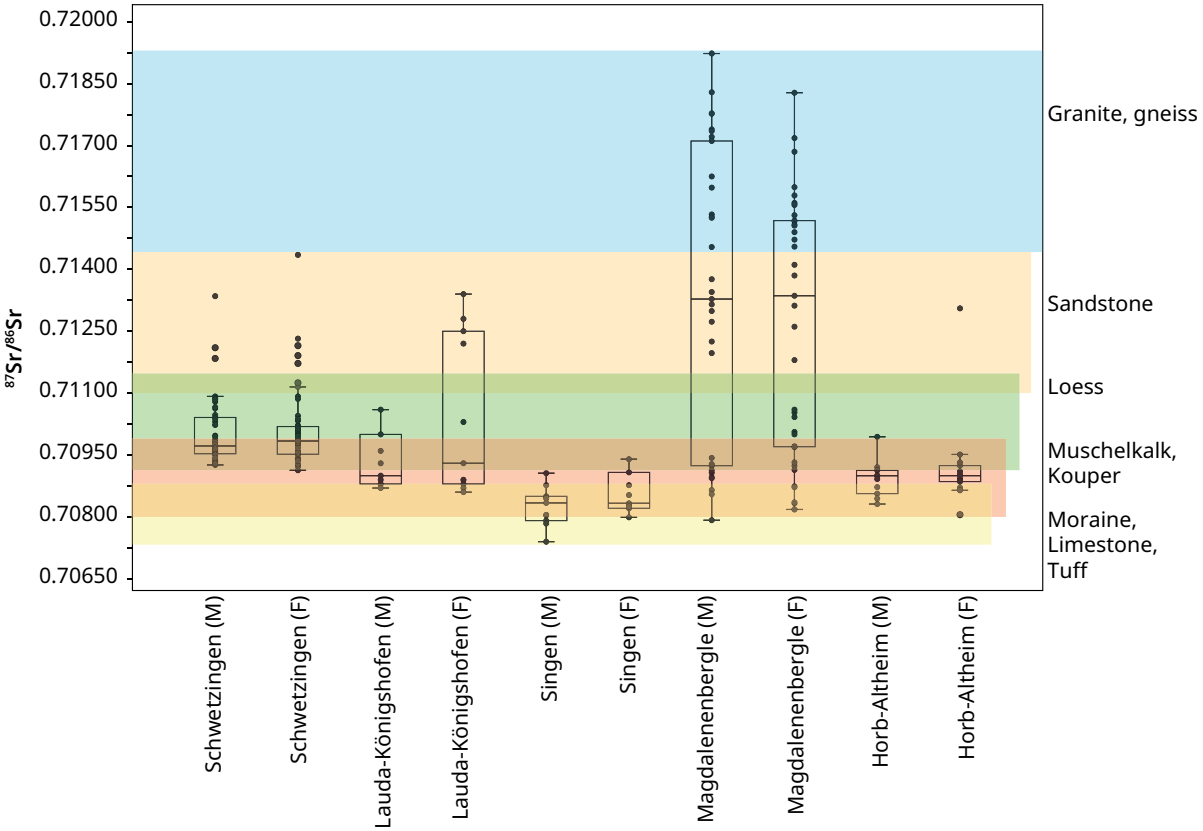


Figure 139. Strontium isotope ratios of males and females from analysed sites in correlation with the environmental variations (cf. Oelze *et al.* 2012b).

of inequality with respect to the burial pit sizes. Within the burial ground at Horb-Altheim, however, inequalities in burial pit sizes decrease again.

In addition to the distribution of the grave pit sizes, two further values are included into the inequality comparison that regards household size distribution, which has been prepared by T. A. Kohler and colleagues (2017). One includes a relatively low value from the Early Neolithic site Vaihingen that is temporally and culturally comparable to Schwetzingen, another represents a relatively high value that comes from the Heuneburg, where a cultural analogy is also possible to the Iron Age site of Magdalenenbergle. Both data correspond well with the calculated indices of the burial pit sizes.

Also included into the graph (Fig. 138) are standard deviations of strontium isotope ratios that also provide information regarding mobility and networking. For this, the standard deviations were multiplied by 100.

Figure 139 illustrates the distribution of strontium isotope ratios according to gender that come from all the analysed sites in connection with the prevailing geology. Even though the number of samples is different in each size, the different distribution ranges between the sites are striking.

As a result, the degrees of strontium isotope ratios and thus the assumed mobility degree, with the exception of Singen, correlate with the Gini indices of burial pits and household sizes and thus with the degree of inequality. A clear discrepancy between the degree of mobility and the degree of social inequality is only discernible at the Early Bronze Age site of Singen.

In the following, the overall results regarding the distances between the buried individuals are included. First, figure 140 demonstrates that the distances between the buried individuals at Early Neolithic (Schwetzingen) and Early Medieval (Horb-Altheim) burial grounds are very similar. In both burial communities, the deceased were interred relatively close to each other. This form of densely placed burials can be interpreted to represent close bonds between members of a family or household. Moreover, this form of close relations between the members of the communities at the Early Neolithic and the Early Medieval sites is also demonstrated by the low inequality degrees regarding grave sizes and by the relative low mobility degrees that are expressed by the strontium isotope ratios (cf. Fig. 138).

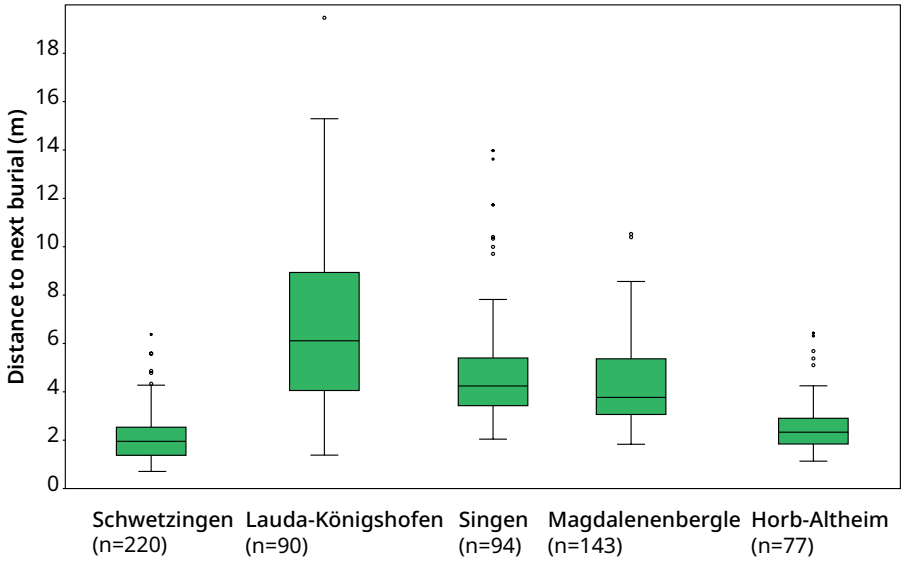


Figure 140. Burial distances to the next neighbours. Comparison of all analysed sites.

The Early Neolithic community in Schwetzingen displays two large groups (possibly clans or family associations). At the same time, a chronological younger unit in the southern area of the burial ground can be identified. Overall, the burial ground shows dense clusters of subadult individuals surrounded by adult individuals. In addition, clusters of male and female individuals have to be emphasised. The prevailing uniform and standardised grave pits and the spatial proximity of relatively many group members to each other are also reflected by the settlement structures of the Early Neolithic Linearbandkeramik, for example, in Vaihingen (cf. Strien 2005). In this context, the large houses with standardised architecture and orientation can also be interpreted as a lower degree of inequality and as a high degree of group bonding.

In the context of the Early Medieval cemetery of Horb-Altheim, the close connection between families or household members is equally supported by the arrangement of the graves in rows. This kind of arrangement is a characteristic element of Early Medieval burial places.

In contrast, the Final Neolithic Lauda-Königshofen burial ground demonstrates an opposite picture regarding the arrangement of the burials. As figure 140 demonstrates, the graves are located much further apart from each other. Compared to the Early Neolithic cemetery, Lauda-Königshofen reveals a much larger number of separated group and individual burials that can be interpreted as families or households. This spatial separation could be interpreted as expressed oppositions or differences between the households, which are, for instance, conveyed by different decoration motives on vessels and techniques of vessel production.

Moreover, competition between the families can be discerned in Lauda-Königshofen that is expressed by different sizes of circular ditches and burial mounds, of which one or two members per household are furnished with one. This may involve founder graves. Further competition is also shown by the presence of supra-regional exogamous relationships, which are expressed by "foreign" women. These "foreign" women have been furnished with above-average grave goods. At the same time, competition between households is counterbalanced by a clear internal emphasis of the family, which is expressed by the numerous multiple burials. The group of presumably unaffiliated male adults, who were buried separately from the family units, appears as a further conspicuous characteristic.

With the Early Bronze Age Singen burial ground and the Iron Age Magdalenenbergle cemetery, the measured distances between burials are much longer in comparison to the burial grounds of Early Neolithic Schwetzingen and Early Medieval Horb-Altheim, but shorter in comparison to the Final Neolithic site of Lauda-Königshofen. This result correlates with higher disparities with respect to the grave pit sizes which are much more pronounced in the Early Bronze Age site of Singen and at the Early Iron Age site of Magdalenenbergle.

Similar to the Early Neolithic site of Schwetzingen, the Early Bronze Age site of Singen shows clusters of subadults, but also of male and female individuals. Moreover, a series of detached mature male burials, which exhibit a big dagger as a prestige furnishing, are arranged in the middle of the cemetery. These burials were interred at a relative long distance from each other that could further underline their prominent positions. Altogether, two social groups can be verified for the Early Bronze Age site of Singen, whose members were buried within a short period. This Early Bronze Age site also shows a small percentage of "foreigners", although some objects, such as the Atlantic daggers, nevertheless indicate supra-regional contacts.

The Early Iron Age burial site of Magdalenenbergle does not represent a burial place in the conventional sense. It is a very large burial mound with an outstanding central burial and numerous secondary burials. The distances between the grave pits and differences among their sizes correspond approximately to those of Early Bronze Age Singen, but the burial place of Magdalenenbergle shows a much larger exchange-network in comparison to those of the burial site of Singen. The combination of a large exchange-network, outstanding burials, and existing central sites documented for this period, which is proven by the Heuneburg or the nearby Kapf site, verifies the relatively high degree of inequality within Central European Early Iron Age society. The high diversity in strontium isotope ratios demonstrates that different regional groups were buried at Magdalenenbergle.

With regard to the respective grave locations at this site, social status, regional origin, gender, age and the temporal factor are interwoven as important factors. Individuals of high rank tended to be buried closer to the central burial. At the same time, members of the same regional group were buried close to each other, but also opposite from each other. Of interest is that the spatial location within the burial mound corresponds to the regional origin of the interred persons. Thus, numerous buried individuals in the southeastern part of the mound show strontium isotope ratios that point equally in a southeastern direction towards the Hegau region, whereby a number of strontium isotope ratios in the western part of the mound point to the Black Forest region, which is located to the west of the mound.

A further aspect refers to the relationship between furnishing diversity and inequality in relation to gender. Overall, it can be assumed that both in the distribution of grave goods and burial pit sizes, the degree of inequality among females is higher at the Neolithic sites in comparison to males. In contrast, at the Early Bronze Age and the Early Iron Age sites, the situation is reversed. With respect to the Early Medieval burial ground of Horb-Altheim, there are no differences in burial pit size distributions. However, the degree of inequality associated with the distribution of grave goods is higher among females.

The fact that females from Schwetzingen are associated with a higher degree of inequality than males must be considered in the context of a fundamental discrimination against many females, especially infans females, which is shown by their sparser furnishings at the cemetery. Very few juvenile and adult females received burial goods of above-average value. Thus, those that did likely belonged to an influential lineage, probably originating from abroad, which married into the community. Males that have a high social position represent a local hunter/warrior group furnished with adzes and arrowheads (Windler 2017; Gerling 2012; Bentley *et al.* 2013).

Similar to Schwetzingen, there is also a higher degree of inequality among females within the Lauda-Königshofen site probably due to the subordination of most females and especially infans females. This is verified by the higher proportion of less well-furnished infans female burials and by the greater number of violent deaths of females (Meyer *et al.* 2009), who were also buried more frequently in collective burials (often accompanied by infans) (Trautmann 2012). However, there are several extremely well-furnished females, who presumably were part of an influential lineage within the society (Ortolf 2014). Similar to the Early Neolithic, males that have a high social position were buried with a combination or accumulation of weapons.

In contrast to the Neolithic burial grounds within this study, the Bronze and Iron Age burial grounds demonstrate higher degrees of inequality among males in comparison to females. In the Early Bronze Age site of Singen, this is shown due to both out-

standing adult male burials that represent a dagger-bearing class and the less well-furnished burials. The relatively low inequality ratio of females may be explained by the relatively large group of richly ornamented female burials (Krause 1988).

The fact that inequality is higher among males in comparison to females within the Early Iron Age burial mound of Magdalenenbergle may be explained due to the outstanding central burial, but also due to outstanding secondary burials which represent, such as those at the Early Bronze Age site of Singen at Hohentwiel, a dagger-bearing class. Moreover, females show, similar to the Early Bronze Age site, less inequality that can be explained by the lack of burials without burial goods and the large group of richly ornamented females.

The Early Medieval burial ground of Horb-Altheim demonstrates a higher inequality rate among females compared to males, which is due to outstandingly furnished females of all ages and the higher proportion of rather poorly furnished females. The possession of single and multiple weapons marks inequality among males. Adult males that have a combination of multiple and diverse weapons probably represent the upper class and leaderships of certain lineages (Beilharz and Peek 2011).

Regarding the relationship between ages and values of grave goods, burial pit sizes and distances to the next adjacent burial, differences and similarities are recognisable at all sites (Tab. 33-35). Within the Final Neolithic society, mature and senile individuals tend to show the highest degrees of values of grave goods. In all other burial communities, late-adult individuals show the highest values of grave goods. In the case of Singen, adult individuals had the highest degrees. Regarding the distribution of burial pit sizes, the oldest age cohorts of mature or senile individuals tend to exhibit the biggest burial pits at all sites with the exception of Magdalenenbergle, where late-adult individuals demonstrate the largest burials. Additionally, in Horb-Altheim early-adult individuals also have big burial sizes. With regard to the issue of the distance to the next adjacent burial, it can be demonstrated that predominately late-adult and mature/senile individuals, in the case of Lauda-Königshofen adults, are interred with the highest distance to the next burial. At Magdalenenbergle, the measured distances reflect the respective distances to the centre of the burial mound, which are not comparable to the results of the other burial grounds.

Overall, there is a correlation between highest values of grave goods, largest burial sizes and highest distances at all sites – with at least two of three factors. Furthermore, these correlations are linked to the rather old or oldest members of the respective communities. Accordingly, burials that are separated from the others rather reflect burials that have a high social position within the communities, which mainly applies to the oldest members of the burial communities.

If we regard males and females separately, the results provide a diverse picture. For females, it is obvious that at some sites, such as Schwetzingen, Singen and Horb-Altheim, infans or juvenile individuals are associated with relatively high values of grave goods. For Horb-Altheim, this is also the case in the context of burial pit sizes. Accordingly, at these sites, females were highly respected at a relatively young age – an age at which childbearing is important for the continuity of the family lineage.

For males, infans and early-adult individuals only demonstrate a relatively high quality and quantity of grave goods at the Early Neolithic site of Schwetzingen. Among all other sites, adult (Singen, Horb-Altheim) or mature/senile individuals (Lauda-Königshofen, Magdalenenbergle) can be linked to the highest values of grave goods. With respect to the burial pit sizes, either adult (Singen, Magdalenenbergle,

TOTAL	Infant	Juvenile	Adult 1	Adult 2	Mature/Senile
Schwetzingen				✓	✓ ✓
Lauda-Königshofen			✓		✓ ✓
Singen			✓		✓ ✓
Magdalenenbergle				✓ ✓	
Horb-Altheim			✓	✓ ✓	✓ ✓

Table 33. Highest median values with respect to the total sample sizes. Blue tick = values of grave goods; green tick = grave pit sizes; red tick = highest distances to the next adjacent burial.

FEMALE	Infant	Juvenile	Adult 1	Adult 2	Mature/Senile
Schwetzingen		✓		✓	✓
Lauda-Königshofen			✓		✓ ✓
Singen	✓				✓ ✓
Magdalenenbergle			✓	✓	
Horb-Altheim		✓ ✓	✓		

Table 34. Highest median values with respect to the female sample sizes. Blue tick = values of grave goods; green tick = grave pit sizes; red tick = highest distances to the next adjacent burial.

MALE	Infant	Juvenile	Adult 1	Adult 2	Mature/Senile
Schwetzingen	✓		✓ ✓		✓
Lauda-Königshofen			✓		✓ ✓
Singen			✓ ✓ ✓		✓ ✓
Magdalenenbergle				✓	✓
Horb-Altheim				✓ ✓ ✓	✓

Table 35. Highest median values with respect to the male sample sizes. Blue tick = values of grave goods; green tick = grave pit sizes; red tick = highest distances to the next adjacent burial.

Horb-Altheim) or mature/senile individuals (Schwetzingen, Lauda-Königshofen, Singen) tended to have the biggest grave pits when regarding the median values.

Anthropological data, such as the diet sample standard deviations of $\delta^{15}N$, which represent discrepancy in animal protein consumption, provide information with respect to the degrees of inequality (Fig. 141). No stable isotope data of $\delta^{15}N$ has been provided for Horb-Altheim. Therefore, data from a similar cemetery of the Early Medieval period has been integrated into the synthesis to provide a reference concerning the diet for that period. The Early Medieval cemetery from Altenerding, which dated from the second half of the 5th until the late 7th century CE, has provided 73 $\delta^{15}N$ stable isotope dates from bone collagen, of which 24 could be securely assigned to males and 33 to females (Hakenbeck *et al.* 2012).

Even though the results of the stable isotope analyses reflect different ecological and climatic conditions, fundamental assumptions can be made about subsistence economies:

Overall, the presented sites reveal subsistence economies in terms of terrestrial and omnivorous nutrition, based on C3 plants and herbivorous animals. Regard-

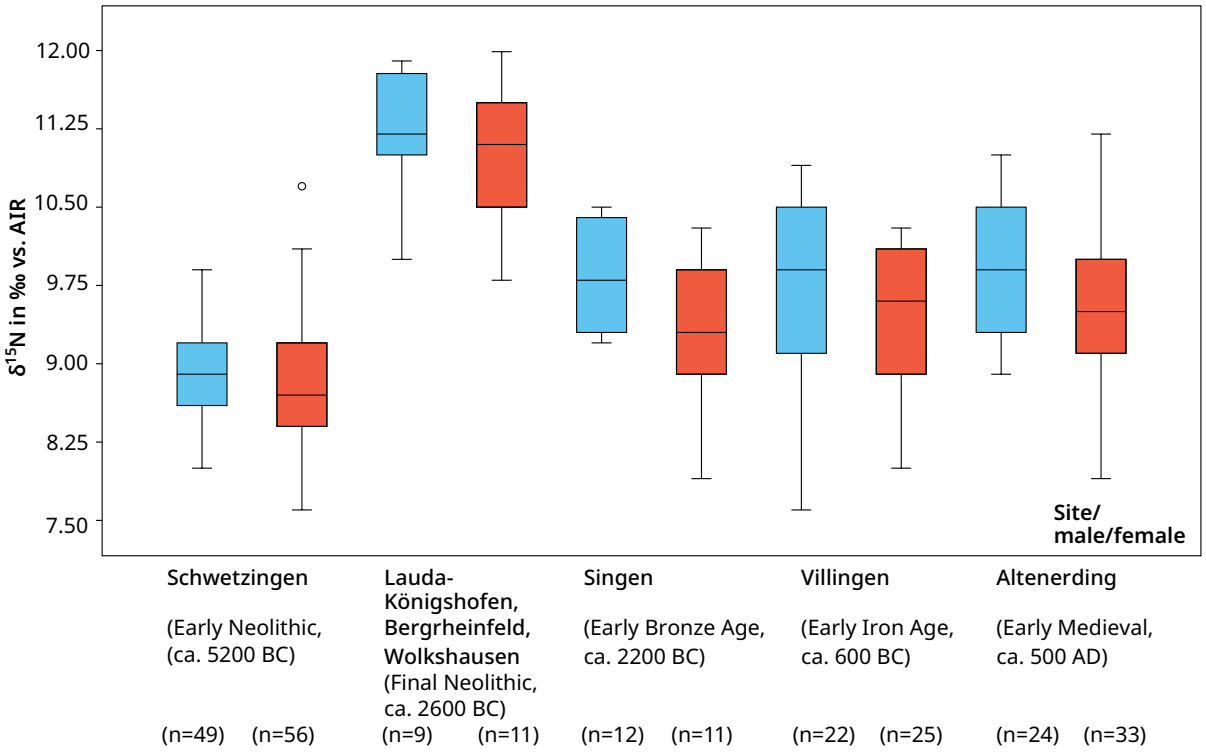


Figure 141. Nitrogen ($\delta^{15}N$) isotope ratios from the sites according to sexes (blue = male, red = female).

ing C3 plants, there are differences in used crops for Southwest Germany. While isotopic evidence indicates the mixed cropping of glume wheats in the Early Neolithic, differential manuring of naked wheat and naked barley is proved for the Final Neolithic. Moreover, isotopic analysis of crops from Early Iron Age sites demonstrates that intensities to which barley was manured depended on its cultural importance within societies (Fraser *et al.* 2013; Knipper *et al.* 2017b; Styring *et al.* 2018).

The trophic level offsets between adult humans and herbivores show, however, differences between the herbivore terrestrial fauna and adult human isotope values (δhuman-herbivore) with respect to Schwetzingen (0.3‰ for $\delta^{15}N$, Bentley *et al.* 2013), Lauda-Königshofen (4-5 ‰ for $\delta^{15}N$, Sjögren *et al.* 2016), Singen (3-4 ‰ for $\delta^{15}N$, Kupke 2010) Magdalenenbergle (3.8‰ for $\delta^{15}N$, Knipper *et al.* 2014) and Altenerding (1.7-3.4‰ for $\delta^{15}N$, Hakenbeck *et al.* 2012).

The Early Neolithic site at Schwetzingen provides relatively low $\delta^{15}N$ ratios and the small difference between herbivores and humans shows accordingly a low proportion of animal intake. This form of nutrition, which is also observable in neighbouring Vaihingen (cf. Bogaard *et al.* 2016), contained higher grain and lower red meat consumption (Kupke 2010).

In contrast, the $\delta^{15}N$ values at the Final Neolithic Corded Ware society displays rather a carnivorous diet. As M. Trautmann (2012; Menninger 2008) argues, Lauda-Königshofen was probably a subsistence economy, which focused on pasture and livestock instead of farming.

High $\delta^{15}N$ ratios are associated with certain grave goods. In Schwetzingen, adzes, flint arrowheads (males) and vessels (females) are associated with high $\delta^{15}N$ ratios, whereas in Singen this applies to awls (females) and daggers (males). In Magdalenenbergle, Villingen, this applies for a high number of earrings, "*Tonnen*" bracelets (females) and daggers (males). Diachronically, there are certain object categories that indicate a higher access to animal proteins. Although the

respective object category is related to the respective material culture and time, it is, however, conspicuous that males that are furnished with daggers or adzes always demonstrate high ratios of $\delta^{15}N$ and better access to animal proteins. Furthermore, figure 141 demonstrates that males had in mean higher $\delta^{15}N$ ratios than females except for the Early Medieval site of Altenerding.

In the following, an attempt will be undertaken to integrate the results of the analysis into the described model scheme of G. M. Feinman (2000) (Fig. 142). This model scheme distinguishes between network and corporate strategies of power achievements (cf. chapter on 'Theories of social inequality').

The Early Neolithic society of Schwetzingen appears to have been a rather egalitarian community due to the small differences in furnishings, the small differences in grave pit sizes and the dense occupation without separate outstanding burials. This is supported by the small differences in household sizes, which T. A. Kohler and colleagues have identified for the nearby settlement of Vaihingen that can be associated as a comparison example (cf. Kohler *et al*. 2017). Due to the rather low level of mobility and exchange, it is most likely that a corporative organisation can be interpreted from the finds and features of the Early Neolithic burial community. The community was probably led by late-adult and mature individuals. The few individuals that can be classified as "foreigners" were rather poorly furnished and had lower access to an animal-based diet that consisted of a relatively high level of animal proteins. However, well-furnished male infans graves also suggest an inheritance of social positions and the higher position of selected families that were probably based on the accumulation of agricultural surplus.

The Final Neolithic site of Lauda-Königshofen displays a slight degree of social inequality with relation to the differences in grave pit sizes. However, if we take the distances between burials and grave groups as well as the presence of circular ditches and probable mounds into account, higher inequalities within the burial community, and especially between grave groups and households, can be identified. Overall, we are dealing with a society that is part of a larger exchange network. The rather large proportion of well-furnished foreign females suggests a network strategy in relation to the accumulation of power, whereby the concentration of power was probably not tied to individuals, but was rather concentrated around families that held higher social positions. The relatively low quality of furnishings in the case of infans suggests that there was no inheritance of power, but rather a preservation of power in the circle of elders.

For the Early Bronze Age site at Singen, major differences can be observed with relation to the grave pit sizes and in relation to the dimensions of stone settings, whereby the setting of the stones can also be shown to be very different in terms of the amount of work involved. The separate positioning of male burials with big daggers also suggests a higher level of social inequalities compared to Neolithic cemeteries. Adult and mature males and mature females, in particular, represent higher-ranking individuals. In some cases, infans females reveal a high quality of ornaments that suggest that social positions within female lines of ancestry were inherited. The cemetery at Singen shows a rather low degree of mobility and exchange even if individual objects, such as the antenna daggers, suggest certain supra-regional contacts. Compared to the neighbouring Únětice society in Central Germany, there are no indications of an individual concentration of power, where the form of so-called "chieftains' graves" existed. For Singen, an elite of equal dignitaries can be assumed. Therefore, Singen shows rather a corporate mode of power strategy.

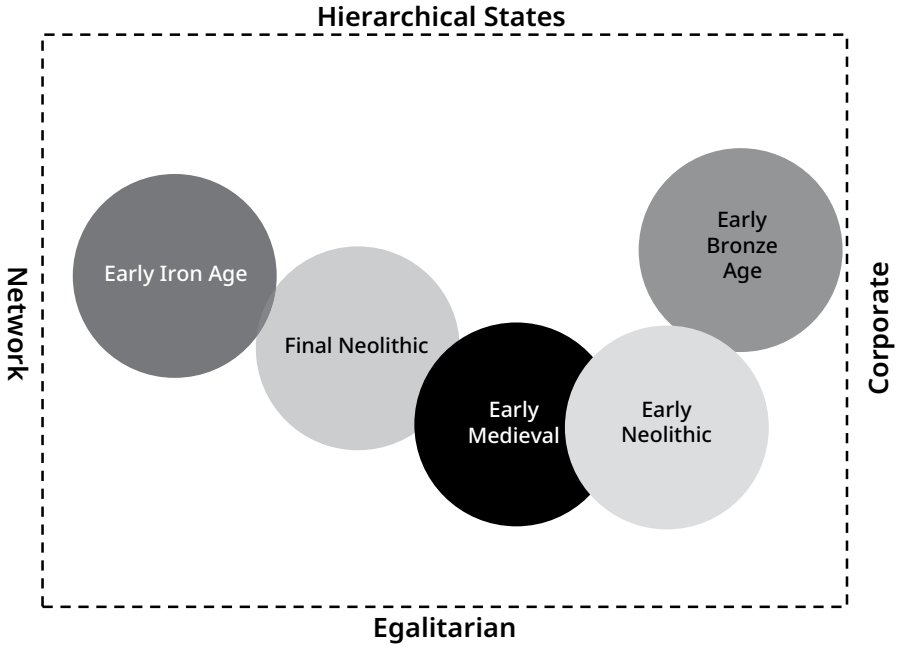


Figure 142. Model of power strategies adopted from G. M. Feinman (2000) and related to the sites being processed.

In contrast to the Early Bronze Age site of Singen, the burial community of Magdalenenbergle is a good example for a concentration of power based on the network strategy. Within a big burial mound, there is a central burial that is interpreted as a "princely burial" and represents a concentration of individual power. Additionally, central places, such as the Heuneburg and the large strategic exchange network, can be listed as aspects of centralisation. The network is illustrated by the different origins of the buried individuals at Magdalenenbergle and by the presence of foreign objects among the burial goods. The fact that there is a relatively high degree of social inequality within the burial site is also shown by the high Gini indices concerning the burial pit size distribution.

With the Early Medieval site of Horb-Altheim, only minor differences with respect to the grave pit sizes can be identified – despite differences in furnishings. Moreover, the arrangement of the graves in rows suggests a rather egalitarian society, possibly led by a late-adult and a mature male elite, which does not indicate a concentration of power by one single person. Accordingly, a corporate mode of power can also be assumed for the community in Horb-Altheim. The interpreted elite is characterised by diverse and multiple weapons in association with males and ornaments in connection with females. Since a high proportion of juvenile females has outstanding furnishings, it can be assumed that status is inherited along the female line. The material culture points to a migration society that imported cultural elements from the Central Danube region to Southwest Germany. However, the predominantly local strontium isotope ratios do not point to a larger supra-regional network in the burial community of Horb-Altheim. The assumed low degree of social inequality coincides with the results of W. Scheidel (2018), who comes to the result in his investigation that both the migration of people and the large amount of evidence for violence at that time led to a relatively low level of social inequality.

To sum up, if we add the empirical results to G. M. Feinman's model, it turns out that the results from the Early Neolithic site at Schwetzingen, the Early Bronze Age site of Singen and the Early Medieval site of Horb-Altheim fit better into the

corporate mode of power and exhibit elements of inequality. In contrast, the results of the Early Iron Age site of Magdalenenbergle points rather to a network power strategy and due to the princely burials to a relatively high degree of inequality. Due to the evidence of some burial mounds and network strategies, the Final Neolithic site of Lauda-Königshofen tends to be rather located between these poles.

However, it has to be considered that these are only preliminary results, since only one cemetery has been analysed for each period and only some periods were included in the analysis for Southwest Germany. Thus, no representative statement can be set up before other burial grounds are analysed for each epoch. This is especially the case for the burial grounds that belong to the metal ages. For example, within the older Iron Age and for the same time that Magdalenenbergle was used, a number of smaller cemeteries of the Hallstatt period in Southwestern Germany were used (Müller-Scheeßel 2013; Müller-Scheeßel 2007). These sites do not show such clear differences in furnishings and grave sizes and would therefore have shown a different picture of social differentiation at that time with the methodology implemented here.

Furthermore, this examination only looked at within-site relations from a diachronic perspective. Hierarchical or unequal social relations may well be expressed, however, as relations between different sites/cemeteries according to a horizontal perspective. As a consequence, equality within a cemetery could be well compatible with inequality in society at large. That would, for instance, be the case in including the famous burial mounds of the Únětice Culture in Central Germany and contrasting them with the Early Bronze Age society of Singen. As a consequence, future examinations should be set up in order to investigate inequality and the access to resources between the sites that belong to the same time horizon or archaeological group.

Conclusions

This investigation dealt with five cemeteries from Southwestern Germany, which date to five different periods. The aim was to identify hierarchical and heterarchical differences within the cemeteries, which are based on variations in the distribution of grave goods, pit sizes and distances between the graves. Bioanthropological and isotope data were also included in the analyses. Finally, an attempt was made to provide a diachronic comparison between the cemeteries.

The case studies include burial grounds from different epochs. Analyses were applied at the following sites belonging to different archaeological groups: Schwetzingen (archaeological group of the Linearbandkeramik, Early Neolithic, ca. 5200 BCE), Lauda-Königshofen (Corded Ware phenomenon, Final Neolithic, ca. 2600 BCE), Singen at Hohentwiel (Singen group, Early Bronze Age, ca. 2200 BCE), the tumulus Magdalenenbergle, Villingen (West Hallstatt, Early Iron Age, ca. 600 BCE), and finally the cemetery of Horb-Altheim (Alemannic, Early Medieval period, ca. 500 CE).

Social inequalities were expressed in terms of a multiproxy approach that was based, among others methods, on boxplots, linear regressions, and Gini coefficients. Social differences and inequalities could be identified for each burial ground and were emphasised with respect to genders, age cohorts and biologically independent factors. Regarding the Gini indices, social inequalities between genders were calculated by grave goods, whereas the diachronic comparison was carried out by the distribution of burial pit sizes.

Spatial analyses represent a useful tool to identify hierarchical, heterarchical or chronological differences within the burial grounds. For implementation, geographic information systems were applied. Information about social differences and inequalities were not only provided on the basis of the endowments in the single graves but also according to their spatial locations within the cemetery. In this context, it turns out that density and distance analyses are especially useful tools.

The models presented at the end of each cemetery clearly show the complexity of burial sites and the challenge to interpret them. When evaluating social structures, not only biological differences and non-biological inequalities must be taken into account but also the heterogeneity, e.g., due to differences in social roles, origins and furnishing traditions of the buried. Due to the temporal depth of cemeteries, the transformation of grave goods must also always be considered.

The results show that the degree of inequality between males and females differs. At the Neolithic sites, the degree of inequality among females is higher in comparison to that of males. We interpret this fact as a reflection of a fundamental discrimination against many females in Neolithic societies. An exception is represented by small groups of outstanding female graves that are well-furnished. In contrast, the Early Bronze Age and the Early Iron Age sites demonstrate reverse situations, in which males exhibit a higher degree of inequality and small groups of dagger-bearing males represent elites within their societies.

In addition, based on burial pit size distributions, house size distributions, and strontium isotope analyses, it was found that the Early Neolithic and the Early Medieval period cemeteries revealed rather low degrees of inequality, whereas the Early Bronze Age and especially the Iron Age sites reveal rather a high degree of social inequality. In the Early Iron Age case, the relatively high level of social inequality is probably linked to the emergence of a centralised chiefdom system and to a technologically improved and adapted subsistence economy. A network of power led to the accumulation of prestige goods and to the emergence of princely burials such as at the Early Iron Age Magdalenenbergle site. At the Early Bronze Age site of Singen, no indications of an individual concentration of power are found. In contrast, rather a large elite of equal dignitaries can be identified. If we include the power strategy model of G. M. Feinman and colleagues into the interpretation, the Early Bronze Age site of Singen shows rather a corporate power strategy mode. The decline of the inequality rate in the Early Medieval period can be associated with the turbulent phase during the migration of peoples and the large amount of evidence of violence. Both factors support the rather low level of social inequality.

However, since the analysed cemeteries only represent case studies and short phases within the longer perspective, it cannot be excluded that further peaks of social inequality existed in the Early Neolithic and the Early Medieval period and that various degrees of social inequalities existed within the respective epochs.

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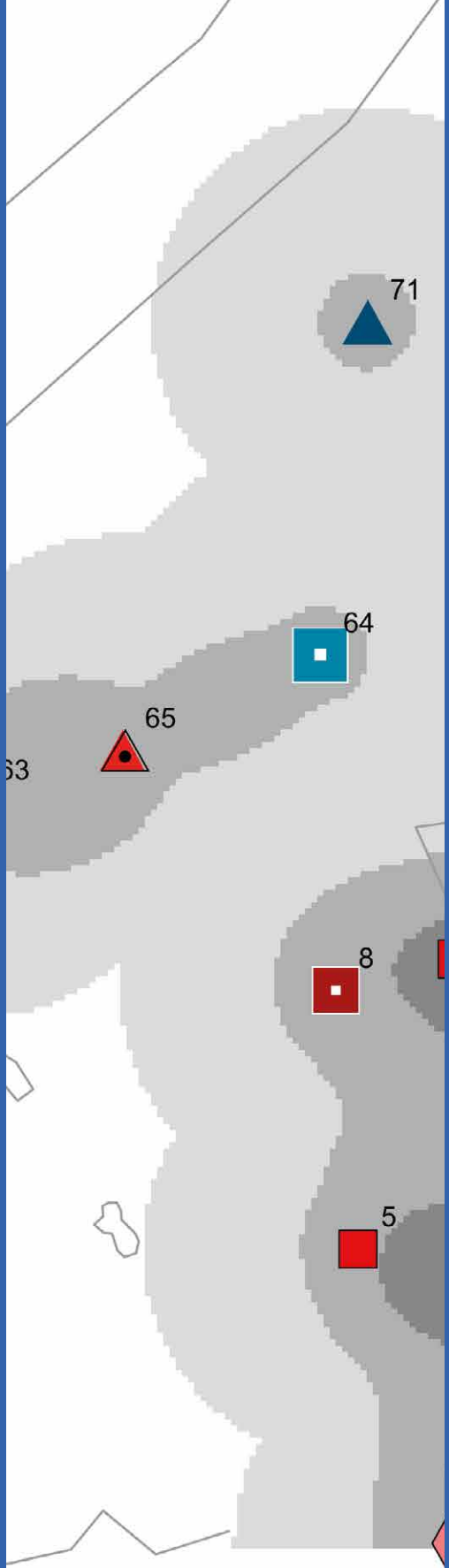
Insights into Social Inequality

A Quantitative Study of Neolithic to Early Medieval Societies in Southwest Germany

Social inequality is a subject of contemporary concern. Life capabilities and the access to resources vary significantly in rich and poor countries, between elites and others. Furthermore, inequalities based on bioanthropological and non-bioanthropological causes are almost universal. Accordingly, inequality was also inherent in past societies and archaeologists have continually examined and interpreted social inequalities in sources such as burial grounds.

This book continues such analyses with a new multi-proxy approach. It reveals social inequalities in selected past burial grounds from Southwestern Germany. The burial grounds date to the Early Neolithic (Schwetzingen), the Final Neolithic (Lauda-Königshofen), the Early Bronze Age (Singen), the Early Iron Age (Magdalenenbergle), and the Early Medieval period (Horb-Altheim). The challenge was to identify hierarchical and heterarchical differences and inequalities within the burial grounds based on a multitude of different proxies. The examination encompasses variations in the distribution of grave goods, burial pit sizes, as well as bioanthropological and isotope data. Furthermore, spatial analyses of burial grounds and, in particular, on the distances between the graves play an essential role in this examination.

The results reveal social inequalities among and within genders and age cohorts that are differently pronounced in the respective cemeteries. Furthermore, the results of multi-proxy analyses lead to the interpretation that the sites differ concerning the respective degrees of inequality and power strategy modes. In detail, it can be observed that the Early Iron Age and the Early Bronze Age sites demonstrate a relatively high degree of inequality as compared to the other sites. More specifically, the investigation of sites from the Early Iron Age and the Final Neolithic rather reveal a network-based power strategy, whereas sites from the Early Neolithic, the Early Bronze Age and the Early Medieval period tend to show a corporate-based power strategy.



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