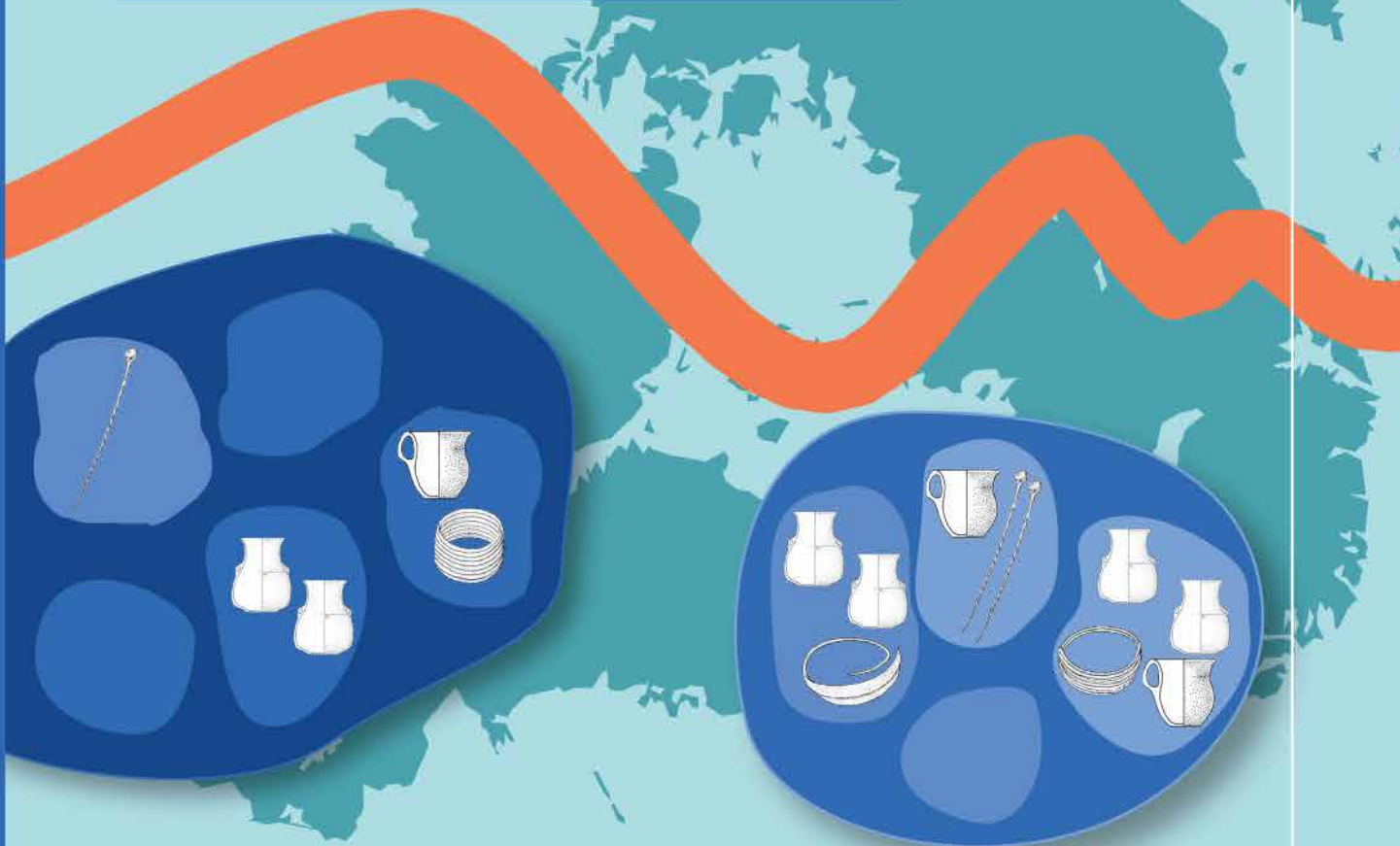


The Development of Social Inequality in the Carpathian Basin Between 5200 and 1000 BCE

A Quantitative Study on Neolithic, Copper Age and Bronze Age Cemeteries and Methodological Considerations

Fynn Wilkes

Social, Environmental, and Cultural Connectivity in Past Societies



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Grave goods: Beaker: plate 3, find 2; Round-headed needle: plate 2, find 12; Dagger: plate 2, find 25; Pot: plate 25, find 13; Noppenring: plate 28, find 16; Spiral ring: plate 23, find 7; Willowleaf-shaped ring (*Weidenblattring*): plate 56, find 16 (after Batora, J., 2000. *Das Gräberfeld von Jelšovce/Slowakei: Ein Beitrag zur Frühbronzezeit im nordwestlichen Karpatenbecken. Teil 1.* Kiel: Oetker Voges).

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Foreword 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 present the eleventh volume of the publication series **ROOTS Studies**. This 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.

The present monograph is the doctoral thesis of Fynn Wilkes, who meticulously and with profound expertise addresses the question of social differentiation primarily in Neolithic to Bronze Age communities in the Carpathian Basin. The

collection of data from burial groups and cemeteries, the critical evaluation of the significance and interpretation of archaeological findings, and finally the application of social indices developed in modern economics lead to extraordinary results. On the one hand, the examined time periods show hardly any fundamental trends of increasing average inequality in grave inventories, while on the other hand, the range of inequalities between contemporaneous burial groups grows.

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

Kiel, 2025

Eileen Eckmeier, Martin Furholt, Lutz Käppel, Johannes Müller

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Chapter 1:

Introduction

Growing social inequality is one of the major problems of the 21st century. The impact of social inequality and the need to reduce it in today's societies is reflected, among other things, in the fact that fighting social inequality is one of the 17 “sustainable development goals” of the United Nations (United Nations; United Nations 2020). In particular, inequalities in income and wealth are high in modern societies, and many nations show a widening gap between the wealth of the poorest 50% and that of the richest 10% of society (Chancel *et al.* 2022). If we look at the development of measurable income inequality over the last 200 years, we see a general increase for the first 100 years and a stagnation of the development at a high level since then (Chancel *et al.* 2022, 55-56). But is this increase in inequality a phenomenon of modern societies?

The origin of status and wealth disparities is often seen in the development of a sedentary, agricultural way of life, with the possibility to inherit wealth, which is assumed for the Neolithic (Price and Gebauer 2017, 140; Bowles *et al.* 2010). Commonly, an increase in social inequality as well as a hierarchisation within society are discussed as the usual evolution of societies in the course of prehistory (Bánffy 2010, 152-154; Dani *et al.* 2016, 219; Harding 2004, 390, 410-411; Kienlin 2008, 102; Schier 2010, 29). But if and to what extent social inequality might have steadily increased since the Neolithic or whether social inequality was subject to a fluid more cyclical development with increases and decreases over large parts of prehistory (Gronenborn 2016; Müller 2017; Stone 2018) is one topic of this thesis (Fig. 1). In the following, the development of social

inequality is examined on the basis of prehistoric societies in the Carpathian Basin (Southeastern Central Europe and Southeastern Europe) with a focus on its northern part.¹ Based on a series of cemeteries spanning the period from roughly 5200 to 1000 BCE, possible developments in social inequality are analysed on different chronological and geographical scales.

The present study uses a quantitative approach and is methodologically guided by a number of studies that have recently appeared in relation to social inequality in prehistoric societies (Basri and Lawrence 2020; Freudenberg 1989; Großmann 2021; Kohler *et al.* 2017; Marzian *et al.* 2024; Müller 1994). The data basis for the analyses is provided by a database compiled in an intensive literature research with over 6187² recorded burials from about 37 cemeteries³ (see Chapter 3). Methodologically, the main challenge was to analyse heterogeneous data sets with a unified methodology. For this reason, this thesis is to be understood as a model and accordingly follows a number of basic assumptions concerning prehistoric societies (for more details see Chapter 4).

The aims of this investigation are:

- to analyse the development of social inequality in the Carpathian Basin between the Late Neolithic and the Middle/Late Bronze Age,⁴
- to investigate the development of inequality of wealth-based segments⁵ of society,
- to contribute to the development of methodologies when dealing with burial data and social inequality,
- to discuss the observations in relation to past economic, environmental, and social processes.

In the first chapter of this study, the term “social inequality” is discussed. Moreover, a definition is developed that will be the basis of the analysis. Furthermore, an overview of the social-archaeological discourse regarding the emergence and persistence of social inequality and the development of social inequality in relation to the Carpathian Basin is presented. In order to introduce the topic against the backdrop of its geographical and archaeological framework, a brief overview of the topography, palaeoclimatic and archaeological development is provided in Chapter 2. In Chapter 3 and Chapter 4, the data set and the methods used in the investigation are presented and individual aspects of the analysis and data recording are discussed. The presentation of the results of the analysis in Chapter 5 is followed by a discussion with reference to the development of inequality and contemporaneous social, cultural, environmental, and economic developments (Chapter 6). The volume concludes with a summary and an outlook on new topics and questions that have opened up in the course of this work.

1 This focus is mainly based on the available data and the temporal coverage of the sites.

2 The number of burials is not equal to the number of graves that are listed in the cemetery/site catalogue (Appendix A), since a grave can contain more than one burial (see Subchapters 3.2.2 and 3.2.3).

3 In this study, the phrase “cemetery” has to be understood as the German term “Gräberfeld” or according to the definition of the Cambridge Dictionary: “an area of ground in which dead bodies are buried” (K Dictionaries 2014). Apart from the concept that the individuals buried together somehow form a social unit, there are no other cultural or religious considerations made when using the term cemetery in this thesis (for further data criteria see Chapter 3).

4 On the northern border of the Carpathian Basin, the Bronze Age is set to start around 2200 BCE and a shift to the Middle Bronze Age is defined to around 1500/1400 BCE. However, in the central, southern and eastern parts of the Carpathian Basin, the Bronze Age is set to start around 2500 BCE and a shift to a defined Late Bronze Age is set around 1500 BCE.

5 Further explained in Chapter 4.

1.1 Definition of social inequality

Social inequality in prehistory, its emergence, effects, and the reasons for its (im)permanence in societies have been discussed by various scholars and fields for decades (e.g. Arponen *et al.* 2016; Basri and Lawrence 2020; Beck and Quinn 2023; Hansen 2018; Hansen and Müller 2017; Hayden 2001; Kohler and Smith 2018; Mattison *et al.* 2016; Müller 1994; Price and Feinman 1995; Siklósi 2013). A comprehensive discussion on the philosophical and theoretical frame of inequality, which is not discussed in detail here, has been reviewed by other scholars (Ames 2008; Großmann 2021).⁶ Of importance for this thesis is the question of the definition of the phenomenon under study – the definition of social inequality.

Before further elaborating on the definition, the distinction between ‘inequality’ and ‘differences’ should be briefly discussed. Although often discussed under the term ‘inequality’, differences in categories, such as sex or age, are referred to as differences (Großmann 2021, 17-18). These differences become part of social inequality only through their integration into social, economic, and cultural contexts (Ames 2008, 487; Mattison *et al.* 2016, 184), for example, when an unequal distribution between grave inventories or social status is based on sex or age groups.

Looking for a definition for the term ‘social inequality’, it appears that it is closely related to the term ‘wealth’. This becomes particularly clear when one considers the common definitions of these terms. S. M. Mattison *et al.* (2016, 185), for example, defines social inequality as being the “**differential** access to power or resources, [...]”, while T. D. Price and G. M. Feinman (2010, 2) include a wider set of variables defining social inequality as to be “[...] manifested in the **unequal** access to goods, information, decision making, and power”. Considering a rather simplistic definition, as wealth being the “access to goods and services” (Haller 1970, 475), it turns out that the very basis of social inequality is usually defined to be: *the differential access to wealth*.

J. Beck and C. P. Quinn (2023) expand this definition by adding “accumulation” and “action”, to “access”, as the three main social processes that can create inequality (domains of inequality). They build their domains onto the three categories of wealth (material, relational, embodied) identified by M. Borgerhoff Mulder *et al.* (2009) as a way to “understand how these social processes become materialised in the archaeological record” (Beck and Quinn 2023, 3). In order to understand this approach, it is necessary to define the terms ‘material’, ‘relational’, and ‘embodied wealth’, as well as ‘access’, ‘accumulation’, and ‘action’.

Material wealth corresponds to our modern western understanding of wealth and includes, for example, land ownership or the amount of material possessions, while relational wealth is expressed in terms of access to social networks, for example, food networks or resource networks (Borgerhoff Mulder *et al.* 2009, 684-685; Moreau 2020, 2-3). Embodied wealth includes things that can be influenced to a limited extent and are to a certain degree biologically determined, such as strength, health, body size, cognitive abilities, as well as skill and knowledge (Borgerhoff Mulder *et al.* 2009, 684-685). As established above, such aspects are usually seen as differences and not inequality but they become inequality through their integration into social processes.

⁶ As a new presentation of the history, term and concept of inequality does not contribute any substantially new information, reference should be made above all to the recent and comprehensive elaboration by R. Großmann (2021, 17-23).

J. Beck and C. P. Quinn (2023, 6-7 tab. 1) describe access to be “the ability of people to receive or access resources [...]”. Accumulation is defined to be “the concentration of resources or valued ends” (Beck and Quinn 2023, 5-6 tab. 1). Lastly, they understand action to be “the ability to make decisions on behalf of oneself or others” (Beck and Quinn 2023, 7-9 tab. 1). The resources that are accessed or accumulated as well as the action over resources can be of material, relational or embodied nature, which results in different ways to analyse inequality of the domains of inequality within societies (see Table 1). With the domains of inequality and the categorisation of wealth in mind, the definition of inequality can be expanded as follows:

Social inequality is the differential access to, accumulation of, and action with/over material, relational and embodied wealth.

It is worth mentioning that while access and accumulation can usually be investigated without a prior assumption about the social structure of the society under investigation, analysing action requires an assumption about the social order. For example, while the sheer quantity of objects in a burial can be investigated against the background of access to material wealth, the same source (quantity of grave goods) under the assumption of a stratified society allows the interpretation that the burial represents a person who exerted action over and had access to resources.

The definition makes it clear that social inequality is a complex social phenomenon that should be best studied with respect to its sub-domains. The significance of the individual domains of inequality for the overall inequality of a society can hardly be analysed, at least for prehistoric societies, due to the difficult data record. They can be of different importance in societies with different cultural and economic systems (*i.e.* Sen 2000, 63). Furthermore, it should be noted that the individual types of wealth can also be measured in different ways and that even within these categories, different social phenomena can be captured and examined with the choice of proxy.⁷ For example, there is a difference in looking at movable and immovable material wealth (Smith 1987, 299). While immovable material wealth (*e.g.* houses) represents a group of inhabitants over the entire duration of use, movable material wealth (*e.g.* grave goods) represents a broad spectrum of sometimes short-lived groups or individual ownership.

While the definition formulated here encompasses the individual areas in which inequality occurs, it does not deal with the consequences of inequality, or the impact that the interplay of different inequalities has on the individual or societies. The distribution of access to, accumulation of and action over wealth influences both individuals and societies, within the framework of their capability to make their own decisions about their life situation. The term ‘capability’ follows Amartya Sen’s ‘capability approach’⁸ and is defined as the “[...] ability to achieve various valuable functionings as a part of living” (Sen 1993, 31). A. Sen describes functionings as “the various things that he or she manages to do or be in leading a life” (Sen 1993, 31-32).

In my opinion, the domains of inequality describe a series of functionings – or abilities – through the analysis of which we can make a statement about ca-

⁷ A proxy in this context is a measure which indirectly measures the phenomenon under study (Lexikon der Physik 1998; <https://www.spektrum.de/lexikon/physik/palaeoklimatologie/10851>).

⁸ The concept of the capability approach was introduced into archaeology by V. Arponen *et al.* (2016, 541-560).

Domain of inequality	Type of wealth	Example in archaeology
Access Ability of people to receive or access wealth	material	Number of different material types in a grave inventory/household or the overall amount of grave goods.
	relational	Centrality within a (<i>i.e.</i> resource) network. Abundance of (grave) goods might indicate position in the social network/status.
	embodied	The amount of different production techniques for objects within a grave (knowledge).
Accumulation Concentration of wealth	material	Amount/value of grave goods or household goods. Size of a house or the energy needed to build the house.
	relational	Amount of (<i>i.e.</i> resource) network links of an individual or group, without emphasis on the strength of the links or centrality. Number of prestigious items in a grave, as an indication of the status of an individual or his/her social group.
	embodied	Amount of different food sources, and/or crafted objects (might) indicate the accumulation of knowledge of a society.
Action Ability to make decisions (<i>i.e.</i> over wealth) on behalf of oneself or others.	material	The amount of (grave) goods might indicate the action over resources of the buried person or his/her social group.
	relational	Labour-intensive monuments, such as tumuli or princely seats, might show action over large numbers of people. Prestigious grave goods might indicate the power/status of the deceased over the society to be buried with such items.
	embodied	The presence of products which need a high level of craft-specialisation, can show action over knowledge.

pabilities within the societies under study. In reference to the domains “access” and “accumulation”, a higher degree of equality might indicate a society in which everyone has similar capabilities to reach and use wealth. Equality in relation to the domain “action” might indicate a higher capability as an individual to decide about oneself and one’s wealth.

So how should the following analysis of inequality in grave goods be understood in relation to the definition formulated here? Graves and grave goods, although often critically discussed in relation to their relevance for socio-economic considerations (see Subchapter 4.2), enable the investigation of different domains of inequality of a social unit (individual or burial community)⁹ at a certain point in time (moment of deposition). The following analysis intends to examine different domains, in part through the grave goods. The social index – based on number and scarcity of the grave goods (see Subchapter 4.3.2) – can be used to examine the accumulation of material wealth, while it more prominently deals with the matter of accumulation and access of and to status, and therefore relational wealth. This is because the scarcity index not only reflects the frequency of specific material categories but predominantly emphasises objects that function as markers of differentiation within material and skill-related networks, as well as indicators of social status – assuming that scarcity also marks the prestige assigned to an individual. There is no way to measure the exact proportion of material or rela-

Table 1. Domains of inequality (Beck and Quinn 2023) and their manifestation in the different types of wealth (Borgerhoff Mulder *et al.* 2009). The examples here are given with regard to archaeological data, but not exclusively with regard to graves. Columns marked in grey colour are fully or partly addressed by this study.

⁹ The term burial community is used in this thesis to refer to the people who buried the deceased and who are responsible for all matter related to the grave rite, goods and architecture.

tional wealth contained in the grave goods. It is likely that the value of grave goods changed throughout prehistory and possibly even between different societies and that their material or relational value has constantly changed in the course of time. An example of this is outlined in Subchapter 1.3, as metal objects are likely to have developed from prestige objects with high relational value to objects with high material value over the course of the Bronze Age. Furthermore, no single social index can fully capture the multi-dimensional nature of inequalities as reflected in grave assemblages.

Although only a fraction of the domains of inequality are examined, the following analysis enables a statement on the capabilities of and within the societies from the Neolithic to the Bronze Age in the Carpathian Basin in relation to material wealth but more prominently to relational wealth and their development over a period of roughly 4200 years.

1.2 Emergence and persistence of inequality

There is no single explanation for the emergence of social inequality, but rather a series of possible factors and models that favour the emergence of social inequality. In general, the high levels of social inequality that we observe in modern societies are seen to have developed from relatively egalitarian societies at the beginning of the Holocene (Mattison *et al.* 2016, 187). However, there are other models at hand that question whether there is a steady and linear increase of inequalities (see Fig. 1A) from prehistory to the present (as discussed by Müller 2017, 24-25, fig. 1). Instead of such a one-directional development, there might have been a more cyclical development with phases of high and low levels of inequalities (Gronenborn 2016; Müller 2017, 24-25, fig. 2; see Fig. 1B). A brief overview of some of the prominent models addressing the emergence, amplification and persistence of social inequality will be given in the following.

In a simplistic way, one could argue that the improving climatic conditions of the Holocene were the drivers of developing social inequality. Due to often favourable agricultural conditions, populations grew. Some researchers think that the resulting larger populations and subsequent resource pressure ultimately led to the emergence of social inequality (Žegarac *et al.* 2020). But such a climate deterministic approach neglects the rather complex and intertwined social, environmental, and technological processes that developed during prehistory, which triggered inequality (Kohler and Smith 2018, 5). It was the emergence of more complex societies and the continuous change of environments since the beginning of the Holocene that most likely favoured the emergence of social inequality (Ames 2008, 491; Paynter 1989; Siklósi 2013, 28-29; Squitieri and Altaheel 2022). To give an example, A. M. Prentiss *et al.* (2018), although in the context of hunter-gatherer-communities, summarises a model grounded in B. Haydens (1995) work, which is based on population growth describing the relation between growing complexity and emerging inequality. According to them, growing societies invest in managers or leaders to organise the cohesion of the society and the use of resources. These individuals then have the opportunity to accumulate respect and relational wealth, leading to social stratification and growing social inequality (Prentiss *et al.* 2018, 600).

In prehistory, this concept can be found, for example, in the availability of scarce or defensible resources and technological specialisation such as bronze metallurgy. These are seen at least as an amplifier if not as an origin of social inequality and stratified societies, *i.e.*, the development of a social “elite” (Dani

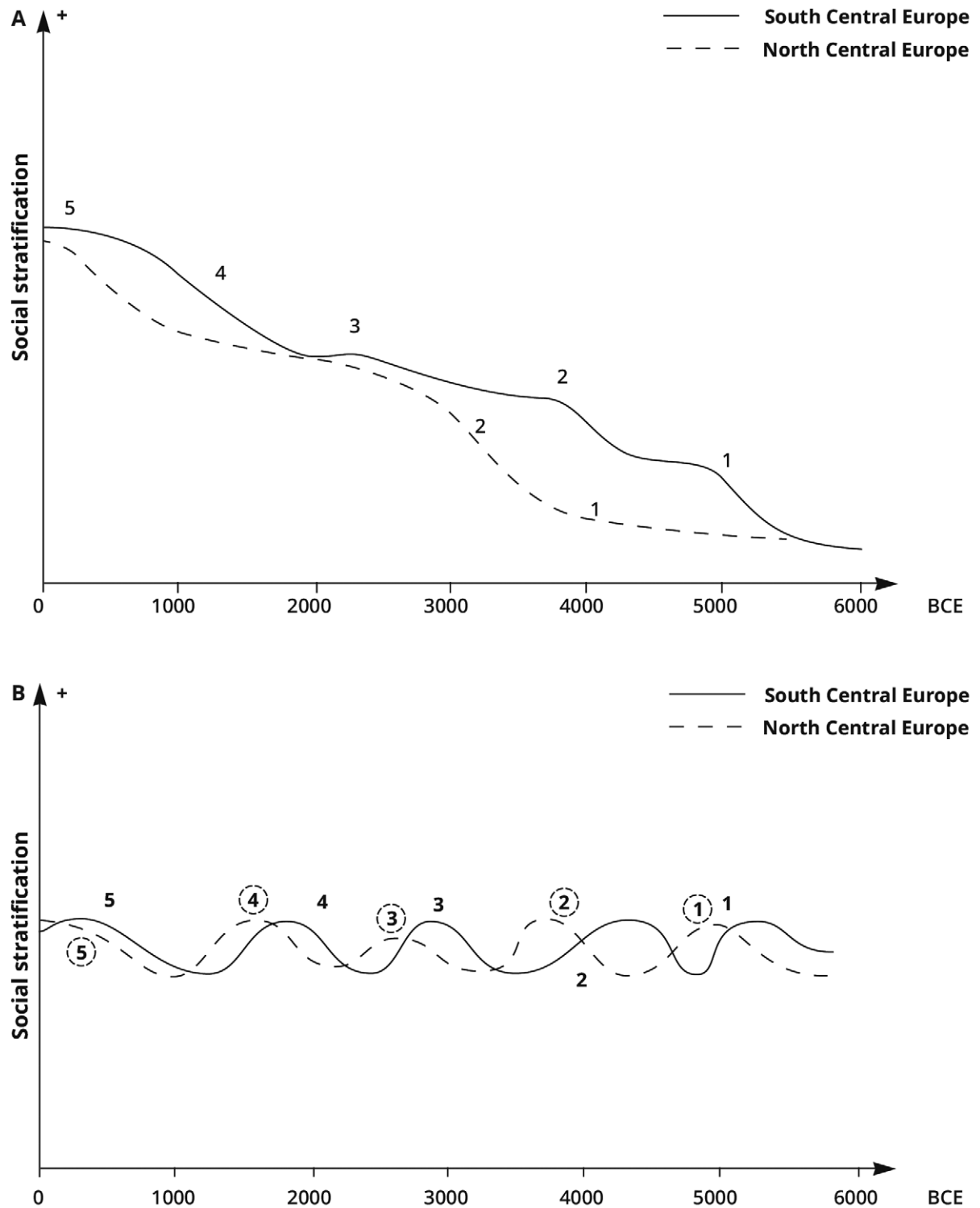


Figure 1. Two models (Fig. 1A and 1B) for the development of social inequality in the course of European prehistory (according to J. Müller 2017, 24 fig. 1 and 2).

et al. 2016; Duffy 2020, 1; Gilman 1981; Heyd and Walker 2015, 680; Mattison *et al.* 2016, 197; Oravkinová and Vladár 2021). But there are more triggers for social inequality. Furthermore, cultural processes, such as the deposition and destruction of material wealth in hoards or tombs, are thought to at least maintain, if not reinforce inequality by creating scarcity and allowing control over resources (Bradley 1982, 120; Laabs 2023). In addition to the emergence of new materials, such as copper or bronze, the mere improvement of farming techniques (*i.e.* the use of millet, the plough, and horses) and the intensification of production led to food surpluses. This can be seen as an additional driver or origin of social inequality in early farming societies (Müller 2012; Porčić 2019, 376ff.; Price and Gebauer 2017; Shennan 1993, 144; Siklósi 2013, 28-29).

In connection with improving economic conditions stand the growth of populations. As societies grow in size, the increasing number of social interactions and the resulting organisational complexity can create what G. A. Johnson (1982) termed “scalar stress”, *i.e.*, the pressure to develop hierarchical structures to manage internal tensions and coordinate the use of resources. This growing need for social managers or leaders can provide certain individuals with the opportunity to accumulate respect and wealth, potentially leading to or amplifying social inequality (Bandy 2004; Johnson 1982).

Partially tied to increasing production and populations sizes is the development of aggrandizers, *i.e.*, individuals who use their skills to gain access to and control over subsistence and resources in order to build wealth and status,¹⁰ which has already been mentioned above. These aggrandizers do not necessarily need a prestigious or scarce resource; they also develop in resource-rich societies, building primarily on their personality and skills (Hayden 1995; Prentiss *et al.* 2018, 600; Shennan 1993, 151). However, changes in subsistence, for example, from hunting to farming societies, do not always correlate with a rise of social inequality, as can be seen in examples of egalitarian small-scale horticulturalist societies (Mattison *et al.* 2016, 187).

Changing environmental (*e.g.* drought) or social conditions (*e.g.* migration), often referred to as crisis, can be sources of inequality (Mattison *et al.* 2016, 191). Under such conditions, inequality between those with greater and lower economic success arises in a situation of resource scarcity, such as the lack of food or living space, and persists until these conditions are resolved (Prentiss *et al.* 2018, 600ff.). Even without changing environments, population growth and the steadily increasing need for fertile soil can lead to scarcity and increasingly unequal access to it (Sherratt 1997, 80). Competition between social groups can also lead to higher economic investments, for example, into subsistence strategies, and ultimately to the emergence of unequal conditions between these groups (Wunderlich *et al.* 2020).

Various processes are cited for the persistence of inequality within societies. In addition to societies in which the members receive mutual benefits from the existing hierarchy (and inequality), coercion as a process in which inequality is accepted due to a lack of prospects can also be a reason for persistent and sometimes institutionalised inequality (Mattison *et al.* 2016, 193; Sherratt 1997, 81-83). This could be a situation in which no improvement can be achieved through migration or conflict. In contrast, there can be dynamics of mutualism,

¹⁰ Status refers to the position that individuals or groups have within the social structure in which they are embedded. This status can be ascribed or achieved and does not necessarily need to be linked to wealth.

where everyone benefits from existing hierarchies (Mattison *et al.* 2016, 193), for example, if an elite can offer benefits to the society, which outweigh the negative effects of the unequal situation. Lastly, through the transmission of certain types of wealth across generations, social inequality persists in many societies, and might even evolve into institutionalised inequality (Borgerhoff Mulder *et al.* 2009; Feinman and Neitzel 2023, 5ff.; Mattison *et al.* 2016, 185). Established religious and/or economic institutions might have been a key to maintain or even increase social inequality (Duffy 2020, 1).

1.3 Social inequality in the prehistory of Europe and the Carpathian Basin

The previous description of social inequality had more a general character. As the Carpathian Basin is an archaeologically rich region (see Subchapter 2.2) with equally intensive research, the following section provides a brief overview of studies and models of social inequality as well as social and economic processes during the prehistory of the Carpathian Basin and adjacent regions.

Generally speaking, the number of existing studies with regard to Neolithic societies shows that social inequality in the Carpathian Basin has been a side topic which changed over the last years (Porčić 2019; Siklósi 2004; Siklósi 2013; Wunderlich *et al.* 2020; Zalai-Gaál *et al.* 2012). Social inequality has been more commonly discussed in relation to Late Copper Age and Bronze Age societies (Bösel 2008; Dani *et al.* 2016; Duffy 2020; Giblin and Yerkes 2016; Laabs 2023; Nevizánsky 1984; O'Shea 2011; Quinn and Beck 2016; Shennan 1975; 1993).

One reason for this may be the common hypothesis that Neolithic societies in Europe were egalitarian and acephalous societies (Lüning 1988 [1991], 88), or at least societies with developed but low-scale social differentiation (Müller 2017, 25) that are still developing into more complex societies (Müller 1996, 117). Although social inequality appears not to be expressed in “dramatic displays of individual wealth and power” (Price and Gebauer 2017, 149), it is clear that social differentiation existed and continued to develop in the Neolithic (Thomas 2015). Moreover, while settlements show little differentiation (Lüning 1988 [1991], 88), graves have been the arena in which social inequality was expressed at the level of smaller social groups and predominantly in the form of differences in prestige (Porčić 2019; Raczky 2015, 246; Siklósi 2004; Siklósi 2013, 258-263; Zalai-Gaál 2008; Zalai-Gaál *et al.* 2012, 81ff.). Furthermore, while social inequality appears to be much more pronounced in Neolithic societies of flat settlements than in tell settlements in the Carpathian Basin (Siklósi 2013, 258), tell settlements in the wider area also show considerable amounts of social differentiation and competition (Müller 2012, 51).

Regarding the emergence of social inequality in the Neolithic of the Carpathian Basin, there are some possible reasons for this development. One is the increasing intensification of agricultural production and the associated management of surpluses (Hayden 1995; Müller 2012; Porčić 2019, 376; Tringham 1992). Another was shown, for example, in the Linear Pottery settlement of Vráble (Slovakia), where increasing social competition between individual settlement groups on the basis of economic specialisation might have sparked increasing inequality (Wunderlich *et al.* 2020).

During the Neolithic in the Carpathian Basin, social inequality was expressed primarily in the form of relational wealth (see Subchapter 1.1), namely in prestige goods as a sign of social rank and predominantly in burial contexts (Porčić 2019,

335; Siklósi 2013, 258; Zalai-Gaál *et al.* 2012). In the last 10 years, in particular, research shows that considerable degrees of social inequality existed during the Neolithic period but it is generally not considered to be institutionalised and persistent or hereditary (Müller 2017, 24; Porčić 2019, 376ff.; Siklósi 2013, 262).

At the end of the Neolithic in the transition to the Copper Age, some authors see an increasing differentiation within society due to the emergence of metal technology (Bánffy 2010, 152-154; Müller 2017, 25; Strahm 1994, 2ff.; Schier 2010, 29; Zalai-Gaál *et al.* 2012, 81), while other authors continue to assume a less pronounced social stratification (Nevizánsky 1984, 293). While graves continue to be the main context in which wealth disparities are clearly visible across Europe, settlements are also beginning to exhibit notable inequality (Heyd and Walker 2015, 685). In contrast to the Pontic area, the Eastern Carpathian Basin shows less drastic change in the burial customs and a slower increase in social differentiation between the Neolithic and the Copper Age (Schier 2014, 427-428). With regard to the Southern Carpathian Basin and the Balkans, there is an increase in complexity and inequality towards the Copper Age, but acephalous societies seem to remain the dominant type of social system (Chapman 2015, 169; Porčić 2019, 376).

In the course of the Copper Age and especially with the emergence of kurgans (burial mounds), there are certain groups within society often labelled as “warriors” or craftsmen who are characterised by distinct burial customs (Harrison and Heyd 2007, 196). The “Kurgan cultures” form an eruptive element, which is often seen as the reason for deep social and economic change (Raczky 2015, 246). In general, a material and relational wealth-based social elite¹¹ becomes increasingly pronounced in archaeological contexts of the Middle and Late Copper Age in the Carpathian Basin (Bánffy 2010, 154). Regionally,¹² the European Late Copper Age already foreshadows the stratified social system that develops in the Early Bronze Age (Heyd and Walker 2015, 685).

The 3rd millennium BCE in Europe and the Carpathian Basin is generally understood as a period of deep technological and social changes. In the course of the Early Bronze Age, stratified societies develop in which status and rank are now also inheritable (Dani *et al.* 2016, 219; Harding 2004, 390ff.; Müller 2017, 25; Shennan 1993, 149; Strahm 1994, 2ff.; Strahm 2010). The trigger for this strong social differentiation – which often results in hierarchical or stratified societies – is considered to be the control of individual social groups and individuals over resources and resource networks (Dani *et al.* 2016, 219; Jaeger 2017, 186; Quinn and Beck 2016, 32). The development of such “elites” is visible in the ritual, material and technological changes that evolve between 3000 and 2000 BCE (Strahm 2010). However, it should not go unmentioned that there was by no means a uniform social system in the Carpathian Basin during the Bronze Age, but rather a multitude of societies with varying degrees of social inequality and social stratification (Duffy 2020), as can be seen in the following analysis, for example, between sites of the North Pannonian Encrusted Pottery culture like Patince (Dušek 1960) and sites of the Late Únětice and Mad'arovce culture like Majcichov or Abraham I (Benkovsky-Pivovarová and Chropovský 2015a, b).

As in the preceding periods, social inequality and, from the Early Bronze Age onwards, social stratification is reflected above all in graves (Harding 2004,

11 The term “elite” refers to a segment of society that possesses an unequal share of power, wealth, or influence, often shaping the political, social, and economic conditions of a society.

12 Heyd and Walker (2015) provide the examples of the princely graves of Velika and Mala Gruda, Podgoritsa-Tološi (Montenegro), as well as the settlement of Vučedol (Croatia).

402) and only to a very limited extent inside settlements¹³ (Harding 2004, 393-394; Kienlin 2015, 61-62; Krause *et al.* 2022, 83). But in contrast to the situation inside the settlements, a clear differentiation and specialisation can be seen in the developing settlement networks (Shennan 1993, 149; Wilkes and Skorna 2025). Cemeteries, which are often large and lavishly furnished, are often organised into grave groups, which suggests that differences in wealth and status took place within and between smaller social groups such as families or lineages (Gömöri *et al.* 2018, 74; Harding 2004, 397-398; Reiter 2020, 225; Sørensen and Rebay-Salisbury 2009, 57; Točík 1979; Wilkes and Skorna 2022, 77). The rich metal inventories developed from being purely prestige objects – as in the Copper Age – into objects that are handled on the basis of their material value (Brück and Fontijn 2013, 198; O’Shea 2011, 165). The Early Bronze Age and especially the period of the developed Únětice culture¹⁴ are regarded as a phase in which wealth disparities were particularly pronounced (Müller 2017, 25).

In the transition to the Middle Bronze Age, a clear change in the display of wealth can be recognised. Burials are now more frequently biritual or deposited under tumuli and, apart from some very richly furnished graves, less social differentiation can be recognised in the cemeteries (Earle and Kristiansen 2010, 254; Harding 2004, 364ff. tab. 12.1). Although fewer copper, bronze and gold objects generally appear in burial contexts, there are sometimes large regional differences in this respect during the Middle Bronze Age (Duffy 2020, 15). The development from formerly prestigious objects to profane objects of mere material wealth, which can already be observed in the Early Bronze Age, continues. Because precious metals are now accessible to large parts of society, control of the relevant regional networks is no longer the medium for elite formation and legitimation (O’Shea 2011, 167-172). These regional contacts are replaced by more extensive (“supra-regional”) exchange networks (O’Shea 2011, 172 tab. 1; Jaeger 2018). Overall, in the course of the Middle Bronze Age and into the Late Bronze Age, it can be seen that the representation of relational wealth in funerary contexts becomes less important for large parts of the population (Harding 2004, 402). With regard to the settlements, there is a diversification of settlement types in the Middle Bronze Age. In addition to tell settlements, smaller flat settlements and large fortified settlements each occupy specific niches in the landscape and indicate different economic strategies and diverse internal social structures, as well as a developed settlement hierarchy (Earle and Kolb 2010, 77-78; Earle and Kristiansen 2010, 254-255; Kienlin 2015).

In sum, the existing literature suggests a long-term development from low-scale, prestige-based differentiation in the Neolithic towards more pronounced and regionally variable forms of stratification in the Bronze Age, heavily expressed in burial contexts.

13 While in some cases the presence of large buildings or megarons are interpreted as palaces or buildings of an upper social segment (Sântana-Cetatea Veche, Romania; Krause *et al.* 2022), in other settlements, large houses are seen as a marker for higher communal cohesion (Branč, Slovakia; Vlášar and Lichardus 1968).

14 Note that the Únětice culture and its closely related groups cover large parts of Central Europe and parts of the Northwestern Carpathian Basin.

Chapter 2:

The environmental and archaeological setting

2.1 The natural environment and climate history

The geographical focus of this work is the Carpathian Basin, a region that is situated in Southeastern Central Europe and Southeastern Europe.¹⁵ As briefly touched on in Subchapter 1.2, environmental changes can be triggers for long-lasting social developments. Therefore, the following chapter intends to give a brief overview about the working region and an insight into environmental changes during prehistory.

The Carpathian Basin (also: Pannonian Basin or [Great] Pannonian Plain; see Fig. 2) – the westernmost part of the Eurasian steppe belt – is delimited by the Carpathian Mountains to the north and to the east.¹⁶ The mostly flat landscape, which was largely covered by fertile soils developed on loess sediments (Mezősi 2017, 57ff.), was formed in the course of sedimentation of the Pannonian

15 There are many different classifications of cultural, political, and geographical macro-regions for Europe and the Carpathian Basin, in particular. For the terms ‘Central’ and ‘Southeastern Europe’, this thesis follows the classifications of the “*Ständige Ausschuss für geographische Namen (StAGN)*” which is based on the work of P. Jordan (2005).

16 As with the previous footnote, there are many different delimitations and definitions of the term “Carpathian Basin”. While in some languages the term refers to the lowlands that are surrounded by the Carpathian Mountain range and its foothills (without the Transylvanian mountains) in the boundaries of the former Pannonian Lake, in other languages, it is used for the entire landmass surrounded by the Carpathian Mountain range (including the Transylvanian mountains; Gaudenyi and Mihajlović 2022). This investigation follows the first definition.

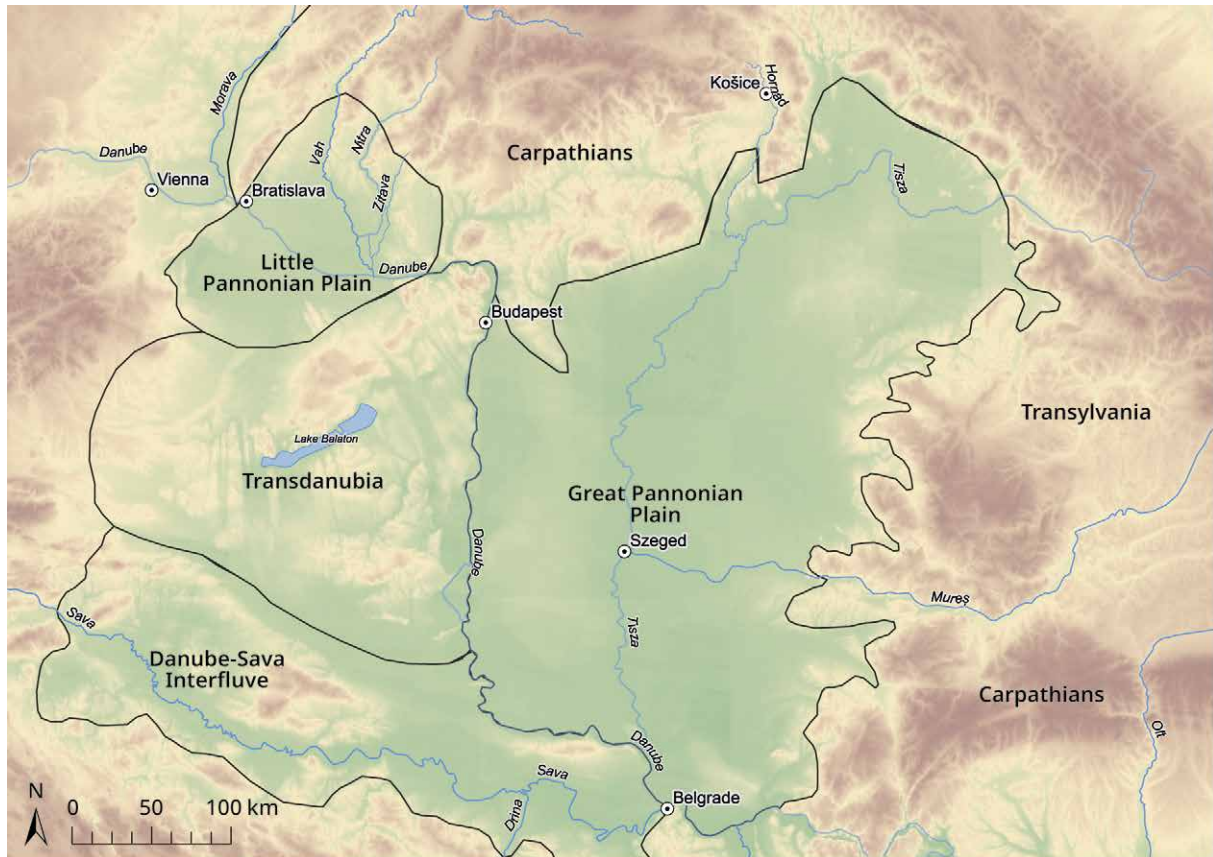
Lake, which existed between 12 to 2.4 million years ago (Kázmér 1990). Today, the largest part of the Carpathian Basin is situated in Hungary. Other modern states that have parts of the Carpathian Basin on their territory are Slovakia, Ukraine, Romania, Serbia, Slovenia, Croatia, and Austria. The main rivers of the basin are the Danube in the western part and the Tisza – a tributary of the Danube – in the east, both running roughly north-south (Lóczy 2015, 23-21; Mezősi 2017, 122ff.). The Carpathian Basin can be divided in many historical and geographical units, the four main landscape units are: Transdanubia, the Danube-Sava Interfluvium, the Great Pannonian Plain (also: Alföld) and the Little Pannonian Plain (Mezősi 2017, map on half-title; Rácz 2020, fig. 2; see Fig. 2). The basin is situated between Atlantic, Mediterranean, and continental climatic influences, resulting in a moderate continental climate (Lóczy 2015, 20-21). In modern times, the mean annual temperature range in the Carpathian Basin is higher than 10°C, reaching a maximum of 13.3°C towards the southern part of the basin (Mezősi 2017, 104-105). In Hungary – which covers most of the Carpathian Basin – the mean annual temperature ranges from 10 to 11°C (Lóczy 2015, 22), with a mean temperature in January of -1.5 to 3.5°C and in July of 19 to 21°C (Mezősi 2017, 104). The mean annual precipitation in the basin is 600 mm, with the lowest precipitations in the central part of the Great Pannonian Plain (Mezősi 2017, 105).

The climatic development in the course of the Holocene begins with a warming phase in the transition from the Pleistocene. During the Preboreal (9600-7500 BCE), the mean annual temperatures ranged between 8 and 9°C, with a mean annual precipitation of 400 mm (Kiss *et al.* 2015, 145; Mezősi 2017, tab. 1.10). During this phase, there was a rapid increase in temperatures with changes of 5-7°C within a millennium (Lóczy 2015, 20). Due to glacial melting, the mean discharge in the rivers of the Carpathian Basin was very high, so the Tisza River had a mean discharge of ca. 2500 m³/s in its middle course during this phase (Mezősi 2017, 94). A denser vegetation with large proportions of forest developed as well as areas with birch forest-steppe vegetation (Kiss *et al.* 2015, 145).

The climate during the Boreal (7500-6300 BCE) was warm and dry, with mean annual temperatures 1-2°C above present-day values (Mezősi 2017, tab. 1.10). Winters were mild and wetter conditions developed in the course of the Boreal (Gumnnior and Stobbe 2021, 50; Lóczy 2015, 20). The proportion of forest in the vegetation decreased and steppes as well as forest-steppe vegetation spread (Mezősi 2017, tab. 1.10).

In the Atlantic (6300-3700 BCE), cooler and wetter conditions developed initially, but this shifted to increasingly warm and dry climates in its course (Chapman 2018, 3; Kiss *et al.* 2015, 145; Mezősi 2017, tab. 1.10). The annual average temperatures were between 15 and 16 °C (Kiss *et al.* 2015, 145). During this phase, oak forests and oak forest-steppe vegetation developed in the Carpathian Basin (Mezősi 2017, tab. 1.10). The warmer part of the Atlantic coincides with rising population densities and the greatest extent of Neolithic tell settlements (Müller and Diachenko 2019; Raczky 2015, 243).

During the Subboreal (3700-500 BCE), a cooler, but mild and humid climate prevailed (Mezősi 2017, tab. 1.10). The mean July temperature was 17-18 °C and the mean annual precipitation was 900 mm (Gumnnior and Stobbe 2021, 50; Kiss *et al.* 2015, 146; Lóczy 2015, 20; Mezősi 2017, tab. 1.10). This phase is also called a “climatic optimum” and forests were common both in the mountains and on the plain (Mezősi 2017, tab. 1.10). However, the Subboreal contains a short-term deterioration around 2200 BCE, with cooler and wetter conditions lasting ca. 200 years before stabilising from ca. 2000 BCE onwards (Fischl *et al.* 2015, 509-510; Perşoiu *et al.* 2019, 783-787).



2.2 Chronology and archaeological cultures

There is high regionality and variability of material culture throughout prehistory on the Carpathian Basin (Buchvaldek *et al.* 2007; Gerling *et al.* 2012). As a result, a variety of material expressions developed. This partly reflects the complexity of cultural processes in the region (Staniuk 2020, 40). In relation to social inequality, this rather diverse cultural landscape already indicates the possibility for a complex system of different modes in which societies might have developed inequalities. Especially big shifts, like the rise and fall of tell settlements in the Neolithic and the Bronze Age, might have also had an impact on the level of social inequality in the respective societies and could be an expression of social developments (Porčić 2019; Windler 2017).

Chronological phasing of the Carpathian Basin is predominantly based on ceramic analyses, in connection with the stratigraphic evaluations of the settlements, especially the tell settlements (David 2002, 3; Preuss 1998a; Preuss 1998b, 5-6; Raczky 2015; Staniuk 2020, 38). In this section, the main cultural groups from which material is presented in this thesis will be briefly described (see Fig. 3). In the following, the focus is less on developments in pottery or other find categories, but more on settlement developments and specifics in burial customs. In the presentation of the cultural development, it should be noted that due to spatial and temporal overlapping of cultural groups and the analysis in certain time intervals some short-lived or peripheral cultural groups are not or only illustrated in part. It should also be pointed out that the complex interconnections and influences between regions and within specific time periods cannot be fully considered in

Figure 2. The Carpathian Basin with its main cities, rivers and historical geographical regions (based on Rácz 2020, fig. 2).

the following rather general overview. This also affects the regional variabilities in periodisation and leads to a rather generalised dating of periods in the text, as well as in the chronological chart (Fig. 3).¹⁷ Furthermore, this chapter provides an overview about the developments in material culture, which are taken up again later in the discussion of this thesis. The following chapter also functions as a supplementary for the catalogue of cemeteries (Appendix A) used in this study, since it gives background information about the archaeological culture and chronological framework of these sites.

2.2.1 Cultural groups of the Neolithic

Neolithic societies are generally characterised as exhibiting low-scale social differentiation, expressed primarily through prestige goods in burial contexts (Lüning 1988 [1991], 88; Müller 2017, 25; Siklósi 2013, 258). The four Neolithic cemeteries in this study serve as a baseline against which later developments are measured. At the outset, it is important to note that this limited number of Neolithic sites partly reflects burial practices that rarely involved large, dedicated cemeteries.

The Neolithic begins with the appearance of the first sedentary and farming societies of the Starčevo culture in Transdanubia and the Körös culture in the Tisza region between 6000-5800 BCE¹⁸ (Gronenborn and Dolukhanov 2015, 197; Oross *et al.* 2013, 105-107; Schier 2015, 100). The Mesolithic population previously living in this area adopted a Neolithic subsistence and economy through symbiosis with migrating Neolithic groups from the Central Balkans (Kalicz 1998a, 257; Preuss 1999b). The material culture, mostly barbotine pottery of the Starčevo and Körös cultures, was very similar at the beginning, which was probably due to their origin in the Central Balkans. In the course of the Early Neolithic, a greater divergence developed (Kalicz 1998a, 257). Although a large number of settlements of the Starčevo culture have been discovered over the last 20 years, the settlement density of the Körös culture, in contrast to the Starčevo culture, was higher (Kalicz 1998a, 258-259; Bánffy 2003, 6). In both archaeological cultures, the buildings were either pit-huts or surface-level buildings made in wood-clay construction and were usually single roomed (Bailey 2000, 58). Burials are known exclusively from settlements, where they often appear under house floors (Borić 2015a, 930). Individuals were usually buried in a flexed position and a slight trend towards east-west orientation is recognisable (Borić 2015a, 931; Kalicz 1998a, 259). Double burials were rare and grave groups (five-nine graves) were only occasionally present within the settlement (Kalicz 1998a, 259). Grave goods, if present at all, mostly consist of a few vessels, bone tools, or beads (Borić 2015a, 931).

At the northern edge of the distribution area of the Starčevo culture and northwest of the Körös culture, the Linear Pottery culture (LBK) emerged around 5600/5500 BCE (Bánffy and Oross 2009, 234). To what extent acculturation or migration mechanisms between remaining Mesolithic groups in the Northern Carpathian Basin and the Neolithic societies in the south were responsible for the emergence of the LBK is the subject of an ongoing discussion (Bánffy and

17 Since this thesis focusses on the Carpathian Basin with a strong coverage in its northern part, the chronological boundaries of the Neolithic, the Copper Age and the Bronze Age are based on the regional chronologies of the Slovakian-Hungarian border region. The author is aware that periods, such as the Bronze Age, do not have a uniform beginning date across the whole Carpathian Basin.

18 Due to similarities in pottery style, mainly barbotine techniques, both the Starčevo culture and the Körös culture have been discussed for a long time as a combined cultural phenomenon under the name Starčevo-Criş-Körös culture.

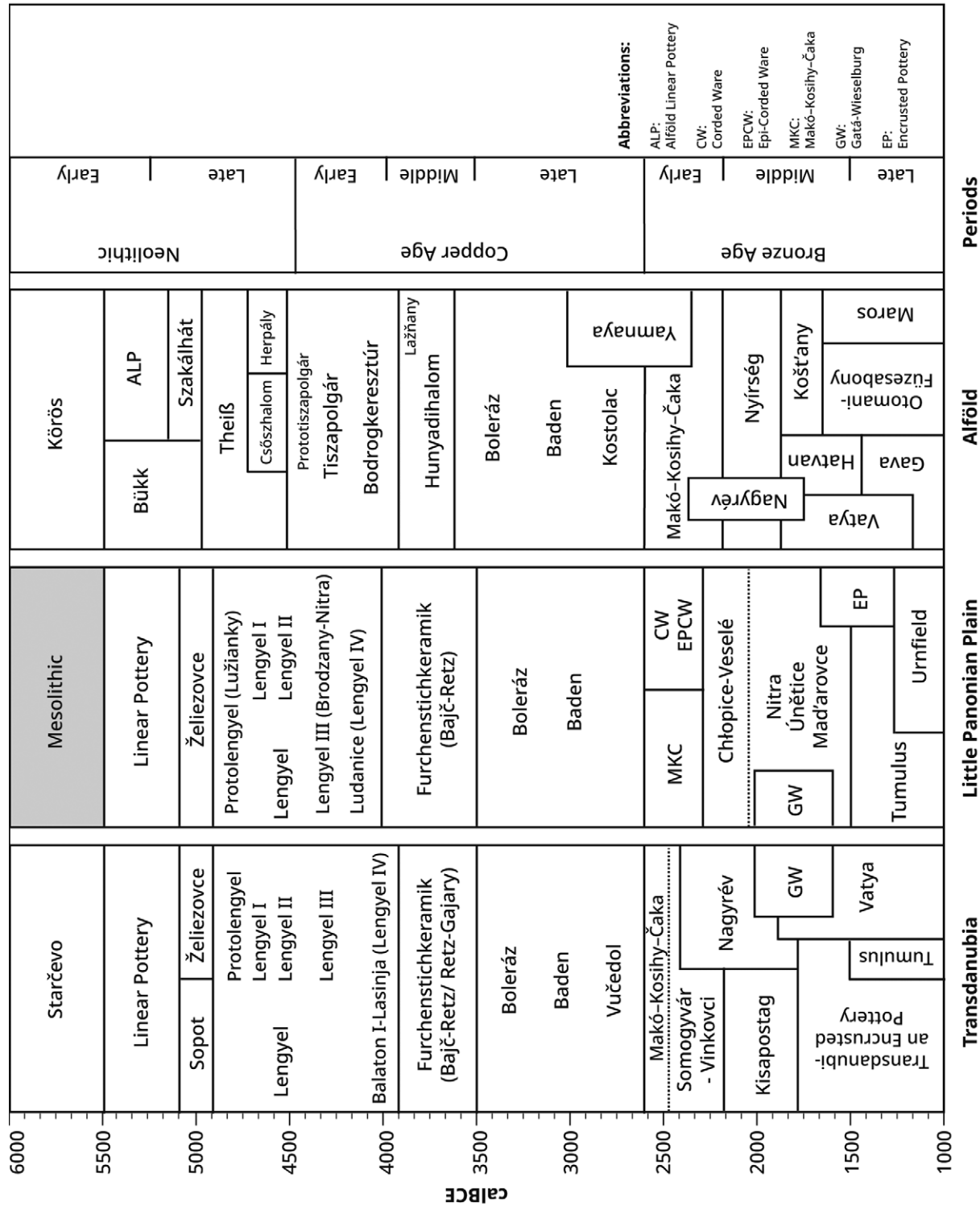


Figure 3. Archaeological cultures and chronological sequence of the three major regions of the Carpathian Basin.

Oross 2009, 220; Gronenborn 1999, 143ff.; Schier 2015, 102). Settlements of the early LBK were small and consisted of a few longhouse post constructions, and there are few known burials (Bánffy 2016, 77; Kalicz 1998c, 263). Later on, large settlement centres with up to hundreds of houses were also built (*i.e.* Furholt *et al.* 2020; Bánffy *et al.* 2013 [2016]). In addition to settlement burials, there were unique burial grounds with a primary inhumation burial tradition (Pavúk 1972; Řídký *et al.* 2015, 335; Furholt *et al.* 2020). While these LBK burial grounds are more common in the area of modern Austria, the Czech Republic and Germany, the cemetery of Nitra (Slovakia) is analysed in the following investigation (site 22¹⁹). The *Notenkopfkeramik* and the *Želiezovce* group represent the developed and late LBK in the Western Carpathian Basin and are essentially distinguished on the basis of their pottery and decoration styles (Kalicz 1998c, 264-266; Pavúk 2009). The *Želiezovce* group is often seen as a distinct cultural phase in the Western Carpathian Basin because, in addition to having similarities with the western LBK, it had a high degree of cultural contact with the Eastern Carpathian Basin and its own ceramic style is influenced by these contacts (Pavúk 2009, 253-258).

In the Eastern Carpathian Basin, the Alföld Linear Pottery culture (ALBK) developed around 5500 BCE in the area of the former *Körös* culture (Domboróczki 2010). The ALBK was formed from several local cultural groups and is characterised by its high differentiation of material culture (Preuss 1999a; Šiška 1998, 268). It differs from the western LBK, for example, in its buildings. Although also built in post-daub technique, the buildings were generally smaller and pit houses were also used (Šiška 1998, 269). Inhumation burials in grave groups and in flexed, southeast-northwest oriented position are known in small numbers, often without grave goods or only sparsely furnished (Šiška 1998, 270; Korek 1989). During the later phases of the ALBK, the *Szakálhát* group emerged under the influence of the early *Vinča* culture in the middle part of the Tisza, characterised by rectangular post-houses and thin-walled vessels (Kalicz 1998d; Pavlů 1998; Sebők 2018; Šiška 1998). In today's Eastern Slovakia on the northern course of the Tisza River, the *Bükk* culture developed under the influence of local cultural groups such as the ALBK around 5200 BCE (Šiška 1998, 272; Szilágyi *et al.* 2014, 181-182). The *Bükk* culture shows a high quality of vessel production and is the centre of an extensive lithic and ceramic exchange network (Szilágyi *et al.* 2014).

The beginning of the Late Neolithic in the Carpathian Basin can be set around 5000/4900 BCE (Kalicz *et al.* 2007, 40-45; Yerkes *et al.* 2009). In Transdanubia, under the influence of the *Želiezovce* and the *Sopot* cultures – which had emerged from the LBK in Southern Transdanubia during the Middle Neolithic (Pavúk 2007, 12) – the *Lengyel* culture developed (Kalicz *et al.* 2007). The *Lengyel* culture is divided into four developed phases (I-IV),²⁰ and a *Protolengyel* phase (Pavúk 2007, fig. 8). Settlements of the *Lengyel* culture show a wide variety of sizes (up to 30 ha) and were usually flat settlements with post-houses (Pavúk 1998, 325-326). Circular earthworks (*e.g.* roundels) were especially common in the first phases of the *Lengyel* culture (Pavúk 1998, 326). In addition, cemeteries with inhumations were located near settlements such as those in *Svodín* (Slovakia; Němejcová-Pavúková 1995) or *Aszód* (Hungary, site 2; Kalicz 1985), where individuals were buried in east-west orientation and in a flexed position (Borić 2015a, 935-936;

19 The “site” information refers to the site ID in the catalogue of this volume. References and further information regarding the site can be found in the catalogue entries.

20 Depending on the research tradition, the *Lengyel* culture is separated into three to four phases in addition to the *Protolengyel* phase.

Pavúk 1998, 327). Of the many chronological and local groups of the Lengyel culture, only the Lužianky and Ludanice groups are further considered here. The Lužianky group falls into the Protolengyel phase (Pavúk 2007, fig. 8) and was distributed in Southwestern Slovakia. The pottery reflects the development from the Želiezovce group to the Lengyel culture. Settlements of the Lužianky group are poorly studied and the burial customs (cemeteries: Lužianky and Mylnárce, both Slovakia) do not show big differences from the developed Lengyel culture (Beran 1999c; Novotný 1962). The Protolengyel site of Lužianky (site 18) has been analysed in this thesis. The Ludanice group, which dates to the late phase of the Lengyel culture (Lengyel IV) and already falls into the Copper Age, was also distributed in Southwestern Slovakia (Beran 1999b). On cemeteries of the Ludanice group (e.g. Branč and Jelšovce, both Slovakia), the individuals are buried in W-E orientation, in a flexed position and with grave goods (Beran 1999b, 64; Pavúk and Bátora 1995; Vladár 1969). The cemeteries in Branč (site 6) and Jelšovce (site 15) of the Ludanice group were included in the analysis.

On the Great Pannonian Plain, the Tisza culture developed from the Szakálhát culture between 5200 and 5000 BCE in the transition to the Late Neolithic (Kalicz 1998d, 310; Yerkes *et al.* 2009, 1077). In its course, there was an increase of the settlement density in the distribution area, which extended from the Tamiš River to the northern part of the Tisza River in the Carpathian Basin (Kalicz and Raczky 1987, 14-19; Tálas and Raczky 1987, 9). From 5100/5000 BCE onwards, tell settlements with dimensions of 1 to 30 ha and buildings with one- to three-room structures in wattle and daub construction are common for the Tisza culture and appear first in contexts of the Tisza culture in the Carpathian Basin (Kalicz 1998d, 310; Raczky 2015, 243). Burials are found within settlements and may be in smaller burial groups (Borić 2015a, 935). Usually, burials were gender-differentiated, in a flexed position and east-west orientated. Grave goods included pottery, bone tools, jewellery, and flint tools (Kalicz 1998d, 311) like in the small burial site of Kisköre-Gát (Hungary) that has been analysed in this thesis (site 16; Korek 1989; Chapman 2000). After a short formative phase of the Tisza culture, there was a regionalisation and the development of the Herpály culture in the east, the Csőszhalom group in the north and a further development of the Tisza culture in the area of the middle and southern Tisza (Kalicz 1998d, 313-315; Kalicz and Raczky 1987, 30). While flat settlements also existed in the Herpály culture in addition to small tells, the settlement pattern of the Csőszhalom group consisted mainly of flat settlements (Kalicz 1998d, 313-314). Burials also occurred in both cultural groups in the settlement context, but in the Herpály culture they are located more in peripheral locations (Kalicz 1998d, 314). Around 4500/4400 BCE, there was a decline of the “tell phenomenon” in the Eastern Carpathian Basin at the transition to the Copper Age (Parkinson *et al.* 2002; Yerkes *et al.* 2009).

2.2.2 Cultural groups of the Copper Age

Following the predominantly low-scale and relational forms of social differentiation observed in the Neolithic, the Copper Age marks a phase in which new material as well as spatial and organisational conditions may have altered the expression and persistence of social inequality (see Subchapter 1.3). Changes in settlement patterns, burial organisation, and exchange networks form the empirical basis for assessing these developments. The Copper Age is represented in this study by a sound data basis of 11 sites.

The beginning of the Copper Age (4500/4400 BCE) in the Carpathian Basin was marked by structural changes of the settlement system, burial practices and exchange networks (Bánffy 1994, 291; Reed 2017, 1745-1746; Yerkes *et al.* 2009, 1080). In the Tisza region on the territory of the Tisza-Herpály-Csőszhalom cultures, there was a decline of tell settlements and a spread of smaller, dispersed flat settlements in the course of the Prototiszapolgár and Tiszapolgár cultures (Bánffy 1994; Gyucha *et al.* 2014, 277; Hertelendi *et al.* 1997; Kalicz 1998b, 331-333; Preuss 1999c). The emergence of metallurgy and an abundance of copper and gold artefacts in contexts of the Tiszapolgár culture indicate the formation of exchange networks during the Early Copper Age (Kalicz 1998b, 332-333). Control over such networks and scarce resources are considered to be potential amplifiers of social inequality (Dani *et al.* 2016, 219; Mattison *et al.* 2016, 197; see Subchapter 1.2). Burials occurred only sporadically in settlement contexts and cemeteries with standardised burial patterns become a feature of the Tiszapolgár culture (Gyucha *et al.* 2014, 280-281). In the following analysis, the Tiszapolgár site of Tibava “Hrun za cintirom” (Hungary, site 30) and the Tiszapolgár and Bodrogkeresztúr site of Tiszapolgár-Basatanya (Hungary, site 32) have been investigated. Gender-differentiated inhumations – some of them with rich grave goods in E-W orientation and a flexed position – were the dominant burial method; cremations occurred occasionally (Kalicz 1998b, 331; Preuss 1999d). From the Tiszapolgár culture, the Middle Copper Age Bodrogkeresztúr culture developed between 4300 and 4200 BCE (Brummack and Diaconescu 2014; Diaconescu 2014a; Yerkes *et al.* 2009). Beside the site of Tiszapolgár-Basatanya (site 32), the Bodrogkeresztúr sites of Jászladány (Hungary, site 13), Tiszavalk-Kendervöldek (Hungary, site 33) and Rákóczi-föld (Hungary, site 27) are part of the following analysis. Recently, a discussion emerged regarding the separation of the Tiszapolgár and Bodrogkeresztúr cultures, since radiocarbon dating showed a strong chronological overlap of pottery styles of both cultures (Raczky and Siklósi 2013).

In Transdanubia and on the Little Pannonian Plain, the Lengyel culture continued in the Early Copper Age (Pavúk 1998, 322). In this late period of the Lengyel culture (phase III-IV), the most extensive expansion occurred, and the material diversified regionally into groups under the influence of neighbouring cultures (Pavúk 1998, 322-323). In contrast to the Tiszapolgár culture, there was no significant change in material or the settlement system; the Late Neolithic characteristics of the Lengyel culture persisted (Bánffy 1995, 13). The settlement system did not change in comparison to the Neolithic phase, but there was a diversification in the variety of forms and types of decoration of the pottery (Pavúk 1998, 322-323). In Transdanubia, the Balaton I-Lasinja culture developed during the Early to the Middle Copper Age, which existed in the period from 4350 to 3950 BCE (Čataj 2016). The material shows connections to the Southern Carpathian Basin and the Balkans, but forms of the Lengyel culture are also present (Bánffy 1995, 14; Kalicz 1995, 38). In the Little Carpathian Basin, the Ludanice group developed from the Brodzany-Nitra group (Lengyel III) during the Early Copper Age (Beran 1999b). The Brodzany-Nitra group is already attributed to the Early Copper Age and in relation to the early phases of the Lengyel culture it hardly shows any painting as a decorative element on the pottery (Beran 1999a; Lichardus and Vladár 2003; Pavúk and Bátor 1995, 133). The Ludanice group (sometimes Ludanice culture) adopted elements of ceramic decoration from the Brodzany-Nitra group, but the variety of forms expanded, and stitch decorations were added (Pavúk 1998, 322). In the

area of Slovakia, dating results are available for graves of the Ludanice group on the cemetery of Jelšovce, which date between 4450 and 3960 BCE (Görsdorf 1995).

Traditionally, the Middle Copper Age in the Tisza Region is marked by the Bodrogkeresztúr culture which developed from the Tiszapolgár culture. It is important to mention that according to new radiocarbon dates, the Bodrogkeresztúr culture can be classified to the Early Copper Age (Siklósi and Szilágyi 2021). As already mentioned, the pottery styles of both cultural groups occur simultaneously in the same area for a certain period of time, but the Tiszapolgár culture disappears before 4200 BCE and forms of the Bodrogkeresztúr culture prevail until 4100/4000 BCE (Brummack and Diaconescu 2014; Raczky and Siklósi 2013). Given the overlap and proximity of material culture, it is debatable to what extent the Tiszapolgár and Bodrogkeresztúr cultures should be considered as two phases of the same cultural phenomenon (Kalicz 1998b, 333).

Fewer settlements are known from the Bodrogkeresztúr culture than in previous periods. A decrease in the number of settlements, but at the same time a high number of burials from the Bodrogkeresztúr culture, speaks against a shrinking of the population and for a change in the settlement pattern (Kalicz 1998b, 334). Only later, a caesura in settlement activity can be observed in the transition to the Hunyadihalom culture, also of the Middle Copper Age (Horváth 2004). The burials took place in a crouched position with east-west orientation and gender-differentiated depositions. Grave goods were abundant and included not only pottery but also copper and gold jewellery, large stone implements and bone tools (Kalicz 1998b, 334).

Closely connected with the Tiszapolgár and Bodrogkeresztúr cultures is the Hunyadihalom culture (also Lažňany-Hunyadihalom culture), which spread over the territory of the predecessor cultures (Kalicz 1998b, 336). As explained above, there was a sharp decline in the number of settlements at the end of the Bodrogkeresztúr culture, which is also interpreted as a decline in population (Horváth 2004; Horváth and Virág 2003, 126; Virág and Bondár 2003, 129). In addition to developments of ceramic types from local tradition, new forms indicate influences from eastern cultural groups (Horváth and Virág 2003, 126-127; Kalicz 1998b, 337). In particular, disc handles (*Scheibenhenkel*), which were prominent throughout the Balkans and the Black Sea Region in this phase, were increasingly part of the variety of forms from the Bodrogkeresztúr culture onwards and are established in the Hunyadihalom culture (Kalicz 1998b, 337). Graves were rarer than in the predeceasing cultures and a larger proportion of cremations are known. Inhumation burials were in flexed position and orientated in an east-west or a northeast-southwest direction (Kalicz 1998b, 337). According to radiocarbon dates, the Hunyadihalom culture covered the period from 4000 to 3800 BCE (Brummack and Diaconescu 2014, fig. 6; Kadrow 2016, 70).

Furchenstichkeramik with its regional groups Bajč-Retz and Retz-Gajary in Transdanubia is also part of the cultures characterised by disc handles (*Scheibenhenkel*) and it is partly contemporary with the Bodrogkeresztúr-Hunyadihalom culture (Furholt 2009, 214; Kalicz 1991, 362ff.; Ruttkay 1999, 70). Regionally, the connection with the preceding Balaton-Lásinja (I) culture and the subsequent phases II and III have not been conclusively clarified, but *Furchenstichkeramik* is an independent cultural phenomenon (Kalicz 1991, 362ff.). According to M. Furholt, *Furchenstichkeramik* consists mainly of two components: 1) small, thin-walled and furrow-engraved vessels, which 2) occur together with regional pottery from other contemporary cultures like Ludanice or Baalberge

(Furholt 2009, 214). The regional groups of *Furchenstichkeramik* appear in the period from 4000/3900 to 3600/3500 BCE (Čataj 2014, 404; Furholt 2009, 215).

From 3650 BCE onwards, there is a change in pottery styles throughout the entire Carpathian Basin with the emergence of the Boleráz group, the first phase of the Baden culture of the Late Copper Age (Furholt 2009, 230ff.). Burials are usually cremations and cremated remains are often deposited in vessels (Furholt 2009, 227 and 231; Němejcová-Pavúková 1998, 395-396). The settlements – mostly flat settlements, rarely tell-like – are evenly distributed in the Western Carpathian Basin, while they are more sporadic in the Tisza area (Němejcová-Pavúková 1998, 393). While the Boleráz phase usually covers the period from 3650 to 3350 BCE (Furholt 2009, 236-237), some dates support dating the early Boleráz phase development between 3650 and 3350 BCE, also under the influence of the Funnel Beaker culture, but largely uniformly (Horvath *et al.* 2008, fig. 4). From 3350 BCE onwards, there is a regionalisation and diversification of the ceramic ornamentation (Furholt 2009, 237-238). Following the dating of Horvath *et al.* (2008), the Boleráz phase of the Baden culture covers the period from 3650 to 3000 BCE. The developed Classical Baden culture is distinguished from the Boleráz phase mainly by a further expansion of the ornamentation spectrum of the pottery (Němejcová-Pavúková 1998, 389). Settlements are less frequent than in the previous phase, but are still distributed throughout the Carpathian Basin (Němejcová-Pavúková 1998, 389). In the course of the Baden culture, the proportion of cremations decreases, and inhumation burials predominate (Němejcová-Pavúková 1998, 395). Furthermore, cemeteries were mainly small, burials often occurred in settlements and burial traditions were less standardised (Němejcová-Pavúková 1998, 395). Two large cemeteries from the Baden culture are part of this study, *i.e.*, the cemetery of Budakalász-Luppacsárda (Hungary, site 7) and Pilismarót-Basaharc (Hungary, site 25). Radiocarbon dates indicate that the Baden culture ended around 2600 BCE (Horvath *et al.* 2008). Parallel to the Baden culture, burials in burial mounds (kurgans) spread on the Great Pannonian Plain between 3000 and 2400 BCE, which are attributed to the Yamnaya culture that migrated into the area from the Eurasian steppe belt (Gerling *et al.* 2012). The arrival of kurgan burial traditions has been linked to the emergence of warrior elites and is often seen as a social and economic shift (Harrison and Heyd 2007, 196; Raczky 2015, 246; see Subchapter 1.3). The Baden culture is followed in the Southern Carpathian Basin by the Kostolac and Vučedol cultures, which will not be discussed further here. Partially contemporary to the Baden culture on the Little Pannonian Plain is the Corded Ware cultural complex (CWCC), a cultural phenomenon that spreads over large parts of Central and Eastern Europe. In the area of Moravia and Slovakia, the CWCC appears in the period between 2600 and 2100 BCE (Peška *et al.* 2021, 202). Burials are often found in mounds and single graves, and small grave clusters are known as well (Šebela *et al.* 1990). Inhumations in gender-differentiation and grave goods are observed as the main burial rite, but cremations also occur (Beran 1999d, 104). Settlements are sparse and mostly single settlement pits have been found, but lately larger settlement contexts of the CWCC have been discovered (Peška *et al.* 2021).

2.2.3 Cultural groups of the Bronze Age

The Bronze Age marks a phase in which social inequality is widely assumed to have become more persistent and increasingly institutionalised, most clearly

expressed through funerary practices and access to exchange networks (Dani *et al.* 2016, 219; Harding 2004, 390ff.; Shennan 1993, 149; see Subchapter 1.3). At the same time, the archaeological record reveals substantial regional and cultural variability in how these processes unfolded, as outlined in the following chapters. With 22 included cemeteries, the Bronze Age represents the most densely documented period in this study.

2.2.3.1 Great Pannonian Plain and Transdanubia

The cultural development of the Bronze Age in the Carpathian Basin was recently described comprehensively by R. Staniuk (2020, 38-67). In the following, I will refer to his work and briefly summarise and augment it.

The transition from the Late Copper Age to the Early Bronze Age in the central and eastern part of the Carpathian Basin can be dated to a period around 2600/2500 BCE (Szabó 2017, 108). The two major cultural complexes of the beginning Early Bronze Age in the Carpathian Basin are the Somogyvár-Vinkovci culture in Western and Southern Transdanubia and the Makó-Kosihy-Čaka cultural complex (MKČ) extending mainly to the Great Pannonian Plain (Kulcsár 2009; Staniuk 2020, 41-42). The MKČ cultural complex probably originated from the Pit Grave culture in the easternmost foothills of the Carpathian Basin (Vollmann 2009, 271-272) and extends over Northwestern Transdanubia, the Little Pannonian Plain, the Upper Tisza Valley and the entire Great Pannonian Plain in the period from 2600/2500 to 2300/2150 BCE (Kulcsár 2009, 16ff.; Szabó 2017, 108). The characteristic ceramic form is the foot bowl with interior decoration (Kulcsár 2009, 14). Furthermore, the MKČ is characterised by a high degree of regionality in settlement and burial patterns, as well as in the material culture due to the ecologically diverse distribution area (Kulcsár 2009, 15). The settlement network is loose and decentralised, while cremation burials occur in smaller clusters (Staniuk 2020, 42).

In Southern and Western Transdanubia (Kulcsár 2009, 233ff.), following the Vučedol culture, the Somogyvár-Vinkovci culture spreads between 2600 and 2300 BCE (Kulcsár 2009, 232). The settlement pattern is diverse and in addition to fortified central settlements, a number of flat settlements of different sizes are known (Kulcsár 2009, 263ff.). Settlements are mostly characterised by clusters of pits, more rarely by individual pit houses (Kulcsár 2009, 263). The burial tradition varies from region to region. In addition to inhumations and, more rarely, cremations in burial mounds, flat graves also occur in small clusters and with a wide variety of grave goods (Kulcsár 2009, 269ff.).

In the Eastern Carpathian Basin and Northeastern Tisza area, the Nyírség culture follows the Makó-Kosihy-Čaka cultural complex. Cremation burials – sometimes in urns and either in single graves or in small grave groups – were the dominant burial tradition (Dani 1997; Kalicz 1984b, 111-112). Settlement remains were usually only expressed by clusters of pits, but surface finds and excavations indicate a relatively dense settlement network (Kalicz 1984b, 109ff.; Staniuk 2020, 42). In the area west of the Tisza to the Danube, the Nagyrév culture was formed contemporaneously to the Nyírség and Somogyvár-Vinkovci cultures, which essentially differ from each other in their ceramic forms (Kalicz 1981). Finds and features of the Nagyrév culture were found in the lower stratum of multi-layered settlements of the Central Carpathian Basin (Staniuk 2020, 43). In addition to these Early Bronze Age tells, flat settlements in post construction were also used, especially in the early phase (Schreiber-Kalicz 1984, 135ff.). The burial method of the Nagyrév culture was mainly cremation, with occasional occurrences of urn burials and, in the southern

distribution area, also inhumations in a flexed position (Schreiber-Kalicz 1984, 148). Radiocarbon dates from features of the Nagyrév culture date them to the period from 2500 to 1900 BCE (Kneisel *et al.* 2014). The Hatvan culture is considered the successor culture of the Nagyrév culture and spread between 2200-1800 BCE (Görsdorf *et al.* 2004) in large parts of the Northern Carpathian Basin, as far as South-western Slovakia and along the Tisza River. In addition to tell settlements, fortified settlements are numerous in the distribution area (Kalicz 1984a, 193; Tárnoki 2003). Burials are rare and the few known burials indicate a cremation burial rite with grave goods, often food offerings and rich metal inventories (Tárnoki 2003).

The Middle Bronze Age Otomani-Füzesabony cultural complex emerged in the eastern Carpathian Basin around 2000 BCE and lasted until ca. 1500/1400 BCE (David 2002; Furmánek *et al.* 1999; Staniuk 2020). It is characterised by fortified settlements, intensified bronze metallurgy, and predominantly inhumation burials in large cemeteries (Furmánek *et al.* 1999); Hernádkak (Hungary, site 12) and Nižná Myšľa (Slovakia, site 23) are included in the analysis.

In Western Transdanubia, the Kisapostag group spread contemporaneously to the late Nagyrév culture (Bándi 1984, 257). The Kisapostag group is characterised by its finely decorated and high-quality pottery (Staniuk 2020, 42). There is disagreement about the absolute dating of the culture, with dates ranging from 2200 to 1500 BCE (Kiss 2012, 203). Dating from Slovenia, however, limits the period from 2200 to 1800 BCE (Črešnar 2010, 131ff.). The settlements of the Kisapostag group are small and single-phased, consisting of small pit dwellings (Bándi 1984, 258-259). Only a few burials are known and, whenever present, cremations predominate (Bándi 1984, 259). In the Central Carpathian Basin, between the Danube and the Tisza (Farkas-Pető *et al.* 2014, 82 fig. 1), the Vátya culture emerged at the transition to the Middle Bronze Age in the contact zone of the Kisapostag and Nagyrév cultures (Poroszlai 2003). Settlements are numerous and both flat settlements and multi-phase settlement mounds, often on hill-tops, are common (Kovács 1984, 219-220). Cremations and urn burials on large to very large cemeteries with 300 to 1000 graves have been investigated in the past (Kovács 1984, 220). Grave goods mainly reflect the extensive material network of the Vátya culture, and a variety of objects are found (Poroszlai 2003). The cemetery of Dunaújváros-Duna-dűlő (Hungary, site 9) includes burials of the Nagyrév, Kisapostag, Vátya and Koszider cultures.

In the Northwestern Carpathian Basin, in an area between Austria, Slovakia and Hungary, the Gátá-Wieselburg group spread between 2000 and 1600 BCE (Furmánek *et al.* 1999, 40; Kiss *et al.* 2019, fig. 4). Burials of this group were generally inhumations, usually in groups interpreted as social units (Furmánek *et al.* 1999, 40; Gömöri *et al.* 2018). The sites of Hegyeshalom-Újlakótelep (Hungary, site 11) and Nagycenk (Hungary, site 21) are used in this investigation as examples from the Gátá-Wieselburg culture. Settlement finds are rare, and statements are mainly made on the basis of the burials and a number of copper and bronze hoards (Furmánek *et al.* 1999, 41).

From ca. 1500 BCE, the Tumulus culture spread across the Carpathian Basin, characterised by burial mounds with inhumations and cremations and the abandonment of earlier tell settlements (Furmánek *et al.* 1999; Staniuk 2020). Tiszafüred-Majoroshalom (site 31) and Mezőcsát (site 20) belong to this horizon, while Budapest-Békásmegyer (site 8) represents the subsequent Urnfield period and the end of the study sequence.

2.3.3.2 Little Pannonian Plain

The Bronze Age development on the Little Pannonian Plain differs from the development in Transdanubia and on the Great Pannonian Plain. This is due to a greater influence from Central Europe via the Moravian Gate. At the end of the Copper Age, the Chłopice-Veselé culture displaced the archaeological cultural-complex of the Late Copper Age on the Little Pannonian Plain (2300-2100 BCE), the Epi-Corded-Ware cultural complex (Furmánek *et al.* 1999, 25; Peška and Králík 2020; Točík 1978, 98). The Chłopice-Veselé culture originates in Lesser Poland and spread over the Moravian Gate up to the Little Pannonian Plain (Furmánek *et al.* 1999, 25-26; Točík 1979, 24). Only a small number of burial sites and settlements are known from this culture (Shennan 1993, 130-131), however, the site of Veselé (Slovakia, site 36) is included in this thesis. In the southern part covered by the Chłopice-Veselé culture, the Nitra culture, which is almost exclusively represented by burial sites, developed around 2200 BCE (Bernard 2005, 14; Furmánek *et al.* 1999, 26-29; Točík 1979, 24-29). Thus far, only single buildings and one settlement (Nitra – Priemyslová ulica, Slovakia) have been discovered (Furmánek *et al.* 1999, 29). Especially the large number of inhumation burials from the Nitra culture are seen as proof of intense settlement activity in its core region – between the Váh River and the Nitra River (Shennan 1993, 130-131; Točík 1982, 405). Burial inventories of the Nitra culture indicate an intensification of metallurgy during this period (Bernard 2005, 15). There is an intense discourse on the chronological sequence of the Nitra culture, especially regarding the transition to the subsequent Únětice culture (Wilkes and Skorna 2022, 64-66). Finds and contexts attributed to the Nitra culture date to a period between 2200 and 1800 BCE (Bátora 2018, 71ff.; Wilkes and Skorna 2022).

The Únětice culture on the Little Pannonian Plain developed from the Nitra culture under influences from Moravia and Austria (Furmánek *et al.* 1999, 34-39; Schubert 1974; Točík 1979, 34-40) and it is the main cultural group of the middle of the Early Bronze Age on the Little Pannonian Plain. While burials – mostly inhumations – are still the most prominent source, flat settlements and fortified settlements become more frequent in the archaeological record (Bátora 2018, 401; Müller-Scheeßel *et al.* 2020; Točík 1982, 408). An intensification of fortified settlement activity starts with the transition from the Únětice culture to the Mad'arovce culture (Točík 1982, 408). Around the Danube, the forms of the Únětice culture appeared together with forms of the Hatvan culture; in this area the Hurbanovo culture developed (Točík 1982, 405). The end of the Early Bronze Age on the Little Pannonian Plain is marked by the Mad'arovce culture, which developed from the Únětice culture under a strong Pannonian influence (Furmánek *et al.* 1999, 49; Furmánek and Horst 1982, 9-10). Inhumations are known from the early and late phases of the Mad'arovce culture and settlements – both flat and fortified – and are the main sources of this period (Bátora 2018, 401-402; Furmánek *et al.* 1999, 49; Schubert 1974; Točík 1982, 406). In the course of the Mad'arovce culture, influences from the east and the south of the Otomani-Füzesabony cultural complex (OFCC) became more prominent (Bátora 2018, 401). This is thought to lead to deep social and economic changes, marked by the abandonment of fortified settlements and changes in material culture (Bátora 2018, 401; Furmánek *et al.* 1999, 64; Točík 1982, 414-415).

The Early Bronze Age cultural complex of the Little Pannonian Plain is represented in the analysis by the sites of Abrahám (Slovakia, site 1), Branč (Slovakia, site 6), Jelšovce (Slovakia, site 15), Majcichov-Lúky (Slovakia, site 19) and Výčapy-Opatovce (Slovakia, site 37). These sites include material from the Nitra, Únětice and Mad'arovce cultures in different proportions.

Around the Danube, in today's Slovakian-Hungarian border region and south into Transdanubia, the Encrusted Pottery culture (*Nordpannonische Kultur*) was prominent (Furmánek *et al.* 1999, 43). On the Little Pannonian Plain, it developed under the influence of the Hatvan and Mad'arovce cultures, but retained traditions such as cremation burials from its region of origin in Central Transdanubia (Furmánek *et al.* 1999, 44). The Encrusted Pottery culture disappeared in Southwest Slovakia at the end of the Early Bronze Age under the impact of similar socio-cultural shifts that affected the Mad'arovce culture (Furmánek *et al.* 1999, 44). From this phase, the site of Patince (Slovakia, site 24) is included in the analysis.

Chapter 3: Data

The data basis for this study consists of 37 cemeteries with a total of 6187 burials, whereby the criteria of data selection is described in the next chapter. The geographical focus is on the Northern Carpathian Basin, particularly in the area of Southwestern and Southeastern Slovakia, as well as Northern Hungary (see Fig. 6; additional maps in Appendix D). The concentration of cemeteries along the Danube and Tisza River systems, with their many tributaries, is most likely due to the ecological conditions and cultural-historical developments in the course of prehistory (see Subchapters 2.1 and 2.2). While settlement and single burial clusters are more dominant in the Neolithic and the Copper Age, formal cemeteries become more prominent in the Bronze Age (see Subchapter 2.2), also affecting the present dataset. Furthermore, the concentration of cemeteries in certain time periods (Appendix D2-D3) is also a result of changing burial traditions in prehistoric communities.

Although many economic and quantitative studies investigating inequality in prehistoric and historical societies focus on houses (Basri and Lawrence 2020; Bogaard *et al.* 2019; Kerig *et al.* 2022; Kohler *et al.* 2017; Porčić 2012; 2019; Squitieri and Altaweel 2022), this thesis focuses on burials. One reason for this focus is the poor availability of house and settlement data. A large number of settlements between the Neolithic and the Bronze Age are known in the Carpathian Basin. However, for a comprehensive quantitative study, these settlements must have a certain number of reconstructable or excavated house remains, which is rarely the case. Settlements with a sufficient number of houses cluster chronologically in some periods (*e.g.* the

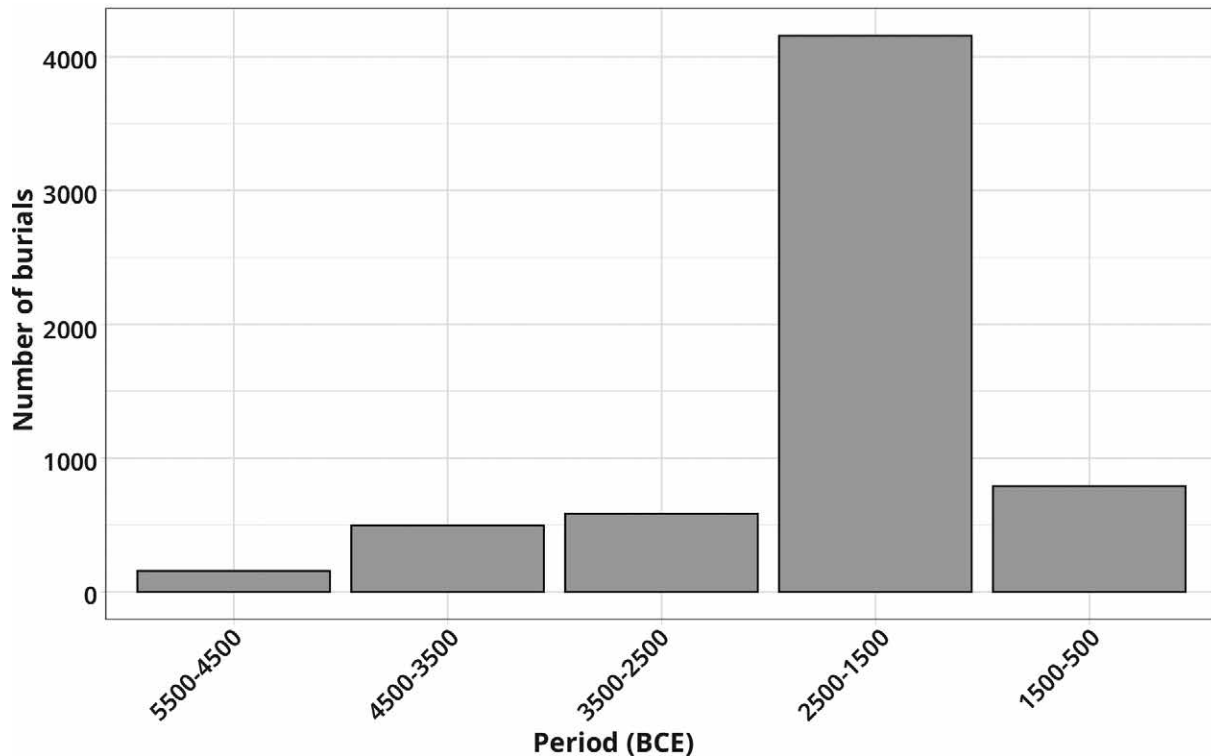


Figure 4. The number of burials in individual time periods from the cemeteries considered in this work.

Middle and the Late Neolithic, or during the LBK and the Vinča culture), which does not allow analysis over a longer period. In contrast, cemeteries with a sufficient number of graves for a quantitative analysis are available in greater numbers. Although there are also certain periods with greater availability of data (see Fig. 4 and Fig. 5; Appendix D2-D3) and single cemeteries with a comparably huge number of burials (Appendix A and Appendix D3), the overall coverage is better in the period from the Neolithic to the Bronze Age. Furthermore, for cemeteries there are often comprehensive chronological analyses available which enable the development of detailed grave sequences through typo-chronology.

Both houses and graves together allow for a variety of interpretations in relation to inequality and wealth. As already indicated in Chapter 1, graves, and the grave goods that they contain, can be understood as an expression of access to material wealth, but they also contain components of relational wealth and – with the help of scientific methods such as isotope analysis – embodied wealth. This is similar with houses which, on the one hand, provide an indication of material wealth via the type and quantity of resources used and, on the other hand, contain information on embodied and relational wealth via the construction techniques used and the size of the buildings. However, the results of inequality analyses on houses cannot be directly compared with those for graves (Ames 2008, 500; Fochesato *et al.* 2019; Kohler and Ellyson 2018). Even if the methodology is similar, it should be noted that the structure of the data is different. House size data inevitably does not contain any objects with a wealth value of zero, while cemeteries may well contain burials without grave goods and wealth values of zero. This problem has been known for some time and first solutions have already been proposed, including statistical correction factors to adjust Gini indices and the problem of insufficient data sizes (Fochesato *et al.* 2019), as well as applying more multidimensional frameworks for quantifying grave wealth itself (Nørtoft 2022).

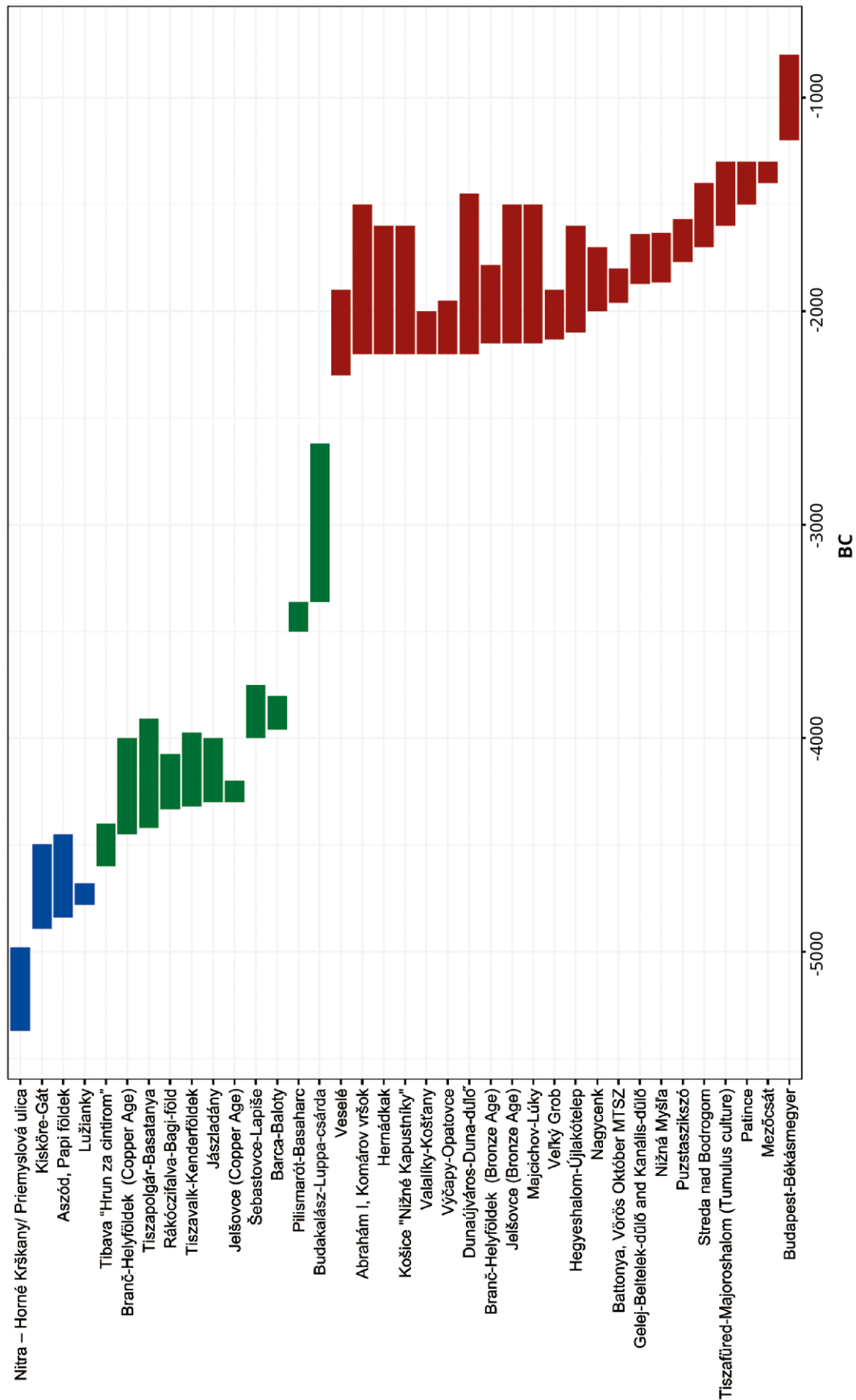


Figure 5. Cemeteries included in this study. Dating and time spans according to the information listed in the site catalogue. Neolithic – dark blue; Copper Age – dark green; Bronze Age – dark red.

A similarity between cemeteries and settlements is that they both can represent different social units. For example, one settlement may be inhabited by only a single family, while another settlement may consist of an association of several social groups. The same applies to cemeteries, which can be composed of a few individual families (Melis 2020; Wilkes and Skorna 2022), but also by a large number of families or even different settlements from a larger area (Bátora and Görsdorf 2000b; Vicze 2011).

A difference lies in the social unit, which can be examined with graves and houses. While houses allow interpretations about a group of inhabitants or house users, graves can be related both to the buried individual and to the group that buried that individual. However, both houses and graves only provide an extract and not a picture of the entire society. Houses – at least the architectural features and not the inventory – may only show the wealth of those who owned a house. With regard to graves, it is clear that only a small part of society is preserved in cemeteries (Nikulka 2016).

The better chronological resolution of burial data – though far from being perfect – and the greater availability of burial data in contrast to settlement records, since settlements tend to be only partly excavated, were key factors in choosing burials for this study. Additionally, the versatile social scale of burials, encompassing both individuals and burial communities, made them suitable for analyses of social inequality.

Burials are considered a typical object of investigation of social differences within archaeological research (Bernbeck 1997, 251ff.). However, the focus is often on sex or age differences (Beyer 2020; Großmann 2021; Endrigkeit 2014; Grünberg 2016; Siklósi 2013). Such studies require a good state of preservation, good publication quality and comprehensive analyses – especially anthropological determinations – of the cemeteries. For this reason, many studies only deal with a small number of graves or cemeteries (Freudenberg 1989; Großmann 2021; Kohler and Ellyson 2018; Müller 1994; Schulting 1995), which often originate from one culture or archaeological period (Beyer 2020; Bösel 2008; Siklósi 2013). With regard to graves, there has so far been a lack of studies that – similar to the work using house size as a proxy by T. Kohler *et al.* (2017) – carry out a diachronic analysis with a large data set.

Such a study has to reduce the factors considered in the analysis due to the heterogeneity of the data basis and the cultural phenomena. As can be seen from Table 2, even for well-publicised and investigated cemeteries there is often only a fraction of archaeological analyses available.

While other studies consider not only grave goods but also age and sex groups, as well as grave dimensions (*e.g.* Großmann 2021; Bösel 2008; Beyer 2020), in the cemeteries recorded for this investigation these categories are not widely available. Anthropological age determinations are recorded for 41% of the burials, anthropological sex determinations only for 26% of the burials and the grave depth for 80% of the burials²¹ (see the online Supplements at: DOI: 10.57892/100-259).

For this reason, no weighting by gender or age group was applied when analysing social inequality. During the early stages of the data analysis, a gender-weighted social index was determined for the individual graves at the Bronze Age cemetery of Jelšovce (Slovakia) and the Neolithic cemetery of Nitra (Slovakia), which in the subsequent analysis showed only a minimal difference of a Gini index based on a

21 While there are cemeteries where 100% of the burials have a published grave depth, most cemeteries show a patchy record with several graves without any reported grave dimensions.

Cemetery/Site	Period/Culture	Grave goods	Anthr. Sex	Anthr. Age	Grave depth	Grave length/width	Chronological analysis	¹⁴ C-datings	Other isotopes
1. Abrahám I, Komárom vršok	Bronze Age – Nitra/Únětice/Mad'arovce	+	+	+	+	+/-	+	-	-
2. Aszód, Papi földek	Neolithic – Lengyel	+	+	+	+	-	+	+/-	-
3. Barca-Baloty	Copper Age – Lažňany group	+	-	-	+	+/-	+/-	+	-
4. Battonya, Vörös Október MTSZ	Bronze Age – Maros/ Otomani	+	+	+	+	+/-	+	+	-
5-6. Branč-Helyföldek (Bronze Age)	Bronze Age – Nitra/Únětice/Mad'arovce	+	-	(-)	+/-	+/-	+	+	-
5-6. Branč-Helyföldek (Copper Age)	Copper Age – Ludanice group	+	-	-	+	+/-	+/-	-	-
7. Budakalász-Luppa-csárda	Copper Age – Baden	+	+	+	+	+	+	+	+
8. Budapest-Békásmegyér	Bronze Age – Urnfield	+	+	+	+	+	+	+	-
9. Dunaújváros-Duna-dűlő	Bronze Age – Nagyrév/ Kisapostag/Vatya/Koszider	+	-	-	-	-	+	-	-
10. Gelej- Beltelek-dűlő and Kanális-dűlő	Bronze Age – Otomani-Füzesabony	+	(-)	(-)	+	-	+	+	-
11. Hegyeshalom-Újjakótelep	Bronze Age – Gáta-Wieselburg	+	+	+	+/-	-	+/-	+	-
12. Hernádkak	Bronze Age – Otomani-Füzesabony/Košťany	+	-	-	+	-	+	-	-

Table 2 continues on the following page.

Cemetery/Site	Period/Culture	Grave goods	Anthr. Sex	Anthr. Age	Grave depth	Grave length/width	Chronological analysis	¹⁴ C-datings	Other isotopes
13. Jászladány	Copper Age – Bodrogkeresztúr	+	(-)	(-)	+	-	+	-	-
14. Jelšovice (Bronze Age)	Bronze Age – Nitra/Únětice/Madžarovce	+	+	+	+	+	+	+	+
15. Jelšovice (Copper Age)	Copper Age – Ludanice group	+	+	+	+	+	+	+	+
16. Kisköre-Gát	Neolithic – Linear Pottery/Tisza	+	+	+	+	+/-	+/-	+	+
17. Košice “Nižné Kapustníky”	Bronze Age – Otomani-Füzesabony/Košťany	+	-	-	+	+	+	-	-
18. Lužianky	Neolithic – Proto-Lengyel	+	-	-	+/-	-	+/-	-	-
19. Majcichov-Lúky	Bronze Age – Únětice/Madžarovce	+	+	+	+	+/-	+	+	-
20. Mezőcsát	Bronze Age – Tumulus	+	+	+	+/-	+/-	+/-	-	-
21. Nagycenk	Bronze Age – Gáta-Wieselburg	+	+	+	+	+	+	+	-
22. Nitra – Horné Krškany/Priemyslová ulica	Neolithic – Linear Pottery Culture	+	+	+	+	+/-	+	+	+
23. Nižná Myšľa	Bronze Age – Otomani-Füzesabony	+	+/-	+/-	+	+	+	+	-
24. Patince	Bronze Age – Tumulus	+	-	-	+	+	+/-	-	-

Table 2 continues on the following page.

25. Pilismarót-Basaharc	Copper Age – Boleraz/ Baden	+	+/-	+/-	+	+	+	+	-/+
26. Pusztaszikszó	Bronze Age – Otomani-Füzesabony	+	+	+	+	+	+	+	-
27. Rákóczi-falva-Bagi-föld	Copper Age – Bodrogkeresztúr	+	+	(-)	-	-	-	+	-
28. Šebastovce-Lapiše	Copper Age – Lažňany group	+	-	-	+	+/-	+	-	-
29. Streda nad Bodrogom	Bronze Age – Otomani-Füzesabony	+	-	-	+	+/-	+	-	-
30. Tibava “Hrun za cintirom”	Copper Age – Tiszapolgár	+	-	-	+	+	+	-	-
31. Tiszafüred-Majoroshalom (Tumulus culture)	Bronze Age – Tumulus	+	(-)	(-)	+	-	+	-	-
32. Tiszapolgár-Basatanya	Copper Age – Tiszapolgár/Bodrogkeresztúr	+	+	+	+	+	+	+	+
33. Tiszavalk-Kenderfőldék	Copper Age – Bodrogkeresztúr	+	(-)	(-)	-	+	+	+	-
34. Valálky-Košány	Bronze Age – Košťany	+	-	-	+	-	+	-	-
35. Velký Grob	Bronze Age – Únětice/Gáta-Wieselburg	+	+	+	+	+	+	-	-
36. Veselé	Bronze Age – Chłopice-Veselé	+	+/-	+/-	+	+	+	-	-
37. Výčapy-Opatovce	Bronze Age – Nitra/Únětice/Mad'arovce	+	+/-	+/-	+	+/-	+	+	-

Table 2. Sites analysed in this study in alphabetical order and information about published and unpublished datasets available for each site (references in the site catalogue). + published; - unpublished; +/- partly published; (-) publication not accessible or only “grey” literature. Cemetery numbers according to the site catalogue (Appendix A).

gender-weighted social index and the unweighted Gini index.²² Based on only two observations, this fact could be understood as anecdotal. However, it is an indication that in the present analysis, the general trend – *i.e.*, whether there was an increase or decrease – is not strongly influenced by non-weighting of sex groups.

In the following, further criteria for data collection are described and some practical considerations for dealing with heterogeneous data within individual categories are explained. This serves to improve the understandability of the data basis (see Appendix A) and as a prerequisite for a better understanding of some of the procedures described in Chapter 4 on methodology.

3.1 Data selection

Following the research question of this thesis, the data had to cover a wide spatial and temporal field. Generally, no single burials were considered, as more than one burial is required for the application of the Gini index and Generalized Entropy Measures. Thus, only cemeteries were included for the analysis, as these are thought to represent a social group (*e.g.* family, village community) and usually provide a dataset of sufficient size.

Already at the beginning of the data collection, it turned out that a complete recording of all cemeteries from the Neolithic to the Middle/Late Bronze Age in the Carpathian Basin was not possible within a reasonable time frame. Prior to data collection, a list of published and suitable (by numbers) cemeteries was compiled, from which sites from every period were selected. As no large publicly available database of grave records exists, the data had to be collected manually by comparing the variety of available published sources. Published sites, however, vary considerably in the quality and completeness of their documentation, with conflicting inventory information between catalogues or even within single publications, and selective omission of certain information, like object groups. Consequently, only a portion of the available cemetery data qualifies for systematic inclusion without extensive and often impossible re-study of the original material, and it is this portion that forms the basis of the present work. Nevertheless, as is common with archaeological datasets, the overall sample cannot be regarded as fully random, as it remains influenced by publication traditions and preservation biases. Furthermore, it became apparent during the data collection that in some regions within the Carpathian Basin there was no continuous use of cemeteries over the entire period from 5500 to 1000 BCE or there were considerable gaps in the state of research. In other cases, the known cemeteries did not meet the criteria for data selection. This mainly applies to the Southern Carpathian Basin. While formal cemeteries are far fewer in the earlier periods, the Bronze Age record is extensive. Thus, including all later sites would heavily bias the dataset, overwhelming early periods and statistically distorting summary statistics as well as linear and LOESS trend analyses. Moreover, a large amount of cemeteries throughout all periods exhibit a large proportion or even dominance of disturbed burials, which make them not representative study cases for this study. For this reason, further data collection concentrated on the Northern Carpathian Basin (see Fig. 6), with a distribution of cemeteries that is essentially divided into two regions (see Appendix E): the area surrounding the Danube

22 Jelšovce (Bronze Age): unweighted Gini index: 0.75; weighted Gini index: 0.73; Nitra: unweighted Gini index: 0.72; weighted Gini index: 0.704.



and the Tisza Valley. A total of 37 cemeteries of different sizes were recorded in a standardised database (see Appendix A), based on the following criteria:

- ▶ A burial ground must contain at least 10 burials in order to consider a sample size that allows a meaningful inequality analysis.
- ▶ Grave goods must be published.
- ▶ Chronological studies must have been published for a cemetery (e.g. typological classification or ^{14}C dating).
- ▶ The selected set of cemeteries cover the working area and the time period to be investigated.

In addition to these main criteria, consideration was also given to whether additional information, such as anthropological determinations, isotope analyses or grave dimensions, were available for the individual cemeteries. When recording data, in the case of differing information from different publications, the information of the excavator/first publisher was adopted. If other information was included, this is justified and indicated in the cemetery/site catalogue (see Appendix A). The goal of data collection was not a full collection of every available cemetery, but rather to achieve a decently sized sample of sites that cover the time period and region.

Most importantly, the main challenge of the data collection was to synchronise the very different publication strategies and the heterogeneity of the information from different cemeteries and thus to create a standardised database and comparable datasets. This was only possible by reducing individual data categories

Figure 6. Map of the cemeteries analysed in this study.

to minimal attributes. For some cemeteries, this leads to a loss of information, but opens up the possibility to include a larger number of cemeteries in the analysis.

3.2 Data acquisition and database

As previously mentioned, to compare 37 cemeteries from different time periods and with different quality and quantity of data, some standardisations have been made. Some of this standardisation was done while entering the single burials into the database and is explained in the following. Thus, before we dive into the methodology, the following subchapter offers a brief insight into the structure of the database (see Fig. 7), and provides an account of the information given in the cemetery/site catalogue (Appendix A) and of the burial information.

The project database is comprised of four levels on which information of the cemeteries was stored. At the beginning of the project, a database²³ was developed and expanded as needed (*i.e.* expansion of the material types), but the basic structure was not changed. Central information, such as anthropological information, material and object types or degrees of disturbance, could be included in the database in a standardised form through predefined options. The database in SQLite and MS Access format, as well as the main cemetery data in raw and csv tables are provided in the online supplement.

3.2.1 Cemetery/Site

Within the database, the cemetery or site represents the superordinate unit. All graves, burials, grave goods, chronological information and literature references are assigned to a site. General data was recorded for each site: the geographical coordinates, a rough indication of the archaeological cultures present in the cemetery, chronological information, literature references, brief information (*i.e.* on the history of research) and notes of observations made during data entry.

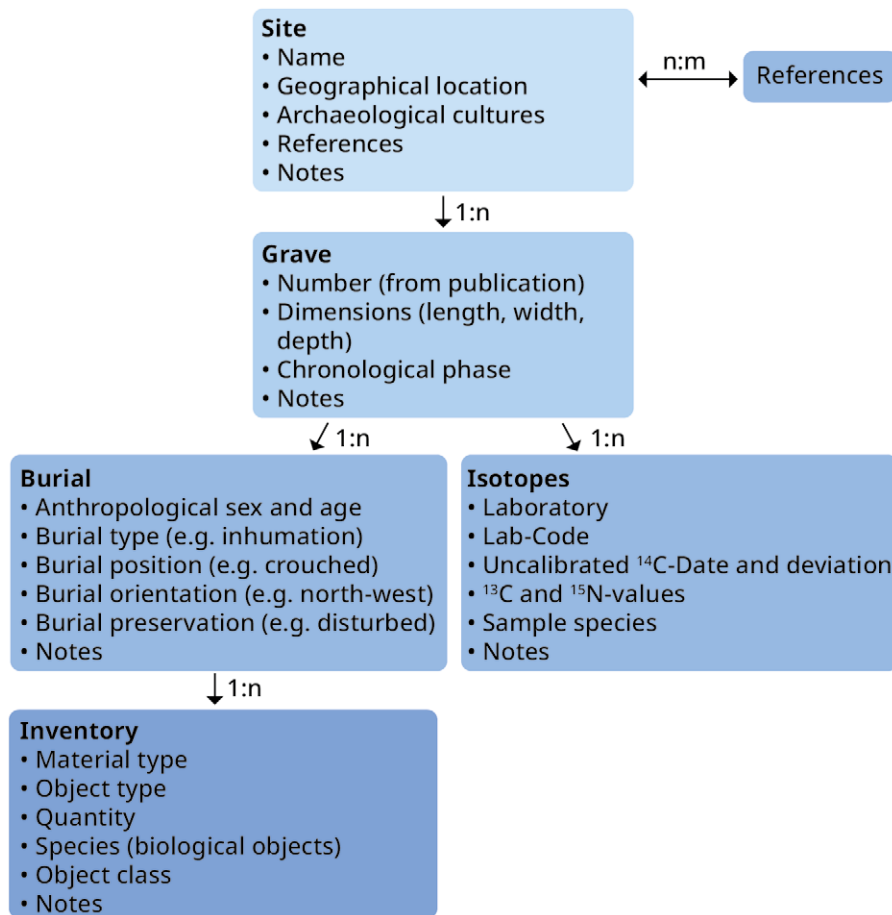
3.2.2 Grave

The individual graves are assigned to cemeteries on the second level of the database. Each grave is assigned to exactly one cemetery and, in addition to the grave number or the denomination of the grave in the corresponding publication, the dimensions of a grave (length, width, depth) and the chronological cemetery phase of a grave are assigned and stored.

3.2.2.1 Grave dimension

The dimensions of graves are not available for each of the cemeteries considered, in some cases the information is incomplete or could not be given by the excavator due to soil conditions or excavation techniques. During the data collection, it turned out that the grave depth was published more often than the grave length and width. In total, there are grave depths known for 80% of the burials in the dataset. For this reason, if any measurements of the grave dimensions are considered in studies regarding inequality, they are the grave depths (*e.g.* Bösel 2008; Großmann 2021; Müller 1994). This circumstance is not necessarily disadvantageous, as focusing on the grave depth does not bias the social index through differences in size based

²³ The database has been developed in MS Access 2019.



on sex and age (Bösel 2008, 51). However, in this analysis the grave depth has not been used, since it is not reported for every burial site (see Table 2).

Figure 7. Simplified structure of the database.

3.2.2.2 Cemetery phases

The cemetery phases, which are reported in the catalogue of the cemeteries/sites (see Appendix A), are generally based on already existing analyses. These analyses have been carried out by other scholars and are mostly based on typological analyses (e.g. Bernard 2005; Schalk 1992). In many cases, the burial site phases have been accompanied by ¹⁴C-dating to determine the absolute chronology (e.g. Bátor and Görsdorf 2000b; Benkovsky-Pivovarová and Chropovský 2015b; Bondár *et al.* 2015; Bondár and Raczky 2009). It was initially planned to also use the burial site phases to determine a more detailed development of social inequality. However, it turned out that only a fraction of the burials has been assigned to a phase with a strong underrepresentation of burials with little to no grave goods. The results of these analyses were heavily biased (mostly rich individuals) and statistically weak (very small sample sizes). Therefore, the analysis abstains from addressing individual site phases. However, the cemetery phases are reported in the catalogue to allow for future studies to include this criterion into the analysis.

3.2.3 Burial

The burials form the third level of data recording. Each burial is assigned to a site and a grave. In the case of multiple burials, they are assigned to the same grave. Most importantly, the degree of disturbance and preservation was recorded for each burial. In addition, the anthropologically determined sex and age, type of burial (*i.e.* inhumation, cremation), positioning of the deceased (crouching on the back, crouching on the side), orientation from head to feet, and general comments and notes were entered into the database, although not used in this work, but for future studies. Some of this information is reported in the burial catalogue (see online Supplements).

3.2.3.1 Degree of disturbance

The degree of disturbance has been recorded to investigate the impact of grave disturbance on the analysis of inequality (results see Subchapters 5.1.1 and 5.3; Table 3 and Table 5). Furthermore, it should be noted that the social index (Subchapter 4.3.2) has been determined by including the grave goods of disturbed and undisturbed burials. As has been shown at the Bronze Age site of Franzhausen I (Austria), disturbed or robbed graves can affect the results of social index analyses (Sprenger 1999). A comparison of the Gini index calculated only on undisturbed graves and on all graves shows that sometimes differences in grave wealth can develop from disturbances and robbery (see Table 3 and Table 5; Subchapter 5.3). However, the correlation between the ratio of disturbance and these differences is limited overall, suggesting no strong systematic bias. Moreover, the number of unrecognised disturbed graves is likely substantial, and varying publication quality in classifying robberies versus minor disturbances complicates the distinction. Additionally, many disturbed graves still contain substantial grave goods providing important information about wealth distribution. The degree of disturbance is stored in the database in three categories.

Graves are considered “undisturbed” if this is explicitly stated in the publication. In addition, graves were also classified as “undisturbed” where no indication to the contrary was given and apparently no signs of disturbance were observed.

“Disturbed” graves are those that have either been defined as “disturbed” in the publications or show the characteristics of a recent or past disturbance. It does not matter whether the disturbance was made by humans or animals. Examples of such disturbances are: Ploughing over, opening by large animals (*e.g.* wild boar), and opening by later building activity. In general, all graves count as disturbed where the completeness of the grave inventory is doubtful. A small animal passage or root penetration does not necessarily have to be a disturbance, as they do not usually remove objects from the grave.

“Robbed” graves are either clearly named as such in the original publication or show signs of robbing. A robbery shaft usually indicates a secondary opening and removal of objects. Since the intention and the temporal distance of a robbery cannot often be determined, a robbery is not necessarily of a criminal nature but can also be part of the burial rites (Aspöck *et al.* 2020).

3.2.3.2 Anthropological sex and age

The data on age and sex, if available, can be used to take age- and sex-specific burial customs into account. As so-called “functional data”, they belong to the few

data that cannot be changed by the burial community and are thus not subject to any cultural or ritual overprinting (Härke 1993). Only those sex and age data have been included in the database which have been established beyond doubt by an anthropological examination. Information based on find compositions or the type of burial (orientation of the buried) – so-called archaeological sex determinations – have not been considered. In the case of cremations, the information is mostly not available, since in this case it depends on the state of preservation and the extent of the cremation whether an anthropological analysis is feasible. Anthropological age determinations are recorded for 41% of the burials in the dataset and anthropological sex determinations for 26% of the burials. Although there are some individual cases of aDNA analysing that also allow the determination of the sex of a deceased person (*i.e.* Chyléński *et al.* 2017; Gerber *et al.* 2023), this has not been done on a larger basis or on an entire burial site.

Table 3 continues on the following page.

Catalogue No./Site	Number of burials				Date BCE	
	total burials	undisturbed burials	disturbed burials	ratio of disturbance	median	range
1. Abrahám I, Komárov vršok	205	82	123	0.60	1850	2200-1500
2. Aszód, Papi földek	32	22	10	0.31	4645	4840-4450
3. Barca-Baloty	27	12	15	0.56	3880	3960-3800
4. Battonya, Vörös Október MTSZ	141	100	41	0.29	1880	1960-1800
5-6. Branč-Helyföldek (Bronze Age)	303	201	102	0.34	1967	2150-1784
5-6. Branč-Helyföldek (Copper Age)	20	16	4	0.20	4225	4450-4000
7. Budakalász-Luppa-csárda	476	452	24	0.05	2990	3360-2620
8. Budapest-Békásmegyer	347	297	50	0.14	1000	1200-800
9. Dunaújváros-Duna-dűlő	921	921	-	-	1825	2200-1450
10. Gelej- Beltelek-dűlő and Kanális-dűlő	181	129	52	0.29	1650	1872-1639
11. Hegyeshalom-Újlakótelep	60	25	35	0.58	1850	2100-1600
12. Hernádkak	132	126	6	0.05	1850	2200-1600
13. Jászládány	40	21	19	0.48	4150	4300-4000
14-15. Jelšovce (Bronze Age)	614	291	323	0.53	1825	2150-1500
14-15. Jelšovce (Copper Age)	21	12	9	0.43	4250	4300-4200
16. Kisköre-Gát	36	30	6	0.17	4695	4893-4497
17. Košice “Nižné Kapustníky”	181	127	54	0.30	1850	2200-1600
18. Lužianky	17	15	2	0.12	4730	4780-4680

19. Majcichov-Lúky	82	61	21	0.26	1825	2150-1500
20. Mezőcsát	43	25	18	0.42	1350	1400-1300
21. Nagycenk	28	22	6	0.21	1850	2000-1700
22. Nitra – Horné Krškany/ Priemyslová ulica	72	57	15	0.21	5175	5370-4980
23. Nižná Myšľa	761	593	168	0.22	1750	1865-1634
24. Patince	35	26	9	0.26	1400	1500-1300
25. Pilismarót-Basaharc	109	99	10	0.09	3430	3500-3360
26. Pusztaszikszó	30	26	4	0.13	1670	1770-1570
27. Rákóczi-falva-Bagi-föld	83	80	3	0.04	4205	4334-4075
28. Šebastovce-Lapiše	42	14	28	0.67	3875	4000-3750
29. Streda nad Bodrogom	67	54	13	0.19	1550	1700-1400
30. Tibava “Hrun za cintirom”	42	30	12	0.29	4500	4600-4400
31. Tiszafüred-Majoroshalom (Tumulus culture)	365	112	253	0.69	1450	1600-1300
32. Tiszapolgár-Basatanya	165	126	39	0.24	4165	4420-3910
33. Tiszavalk-Kenderföldek	57	33	24	0.42	4145	4320-3975
34. Valálíky-Košťany	18	15	3	0.17	2100	2200-2000
35. Velký Grob	65	30	35	0.54	2000	2132-1900
36. Veselé	39	29	10	0.26	2100	2300-1900
37. Výčapy-Opatovce	330	273	57	0.17	2075	2200-1950

Table 3. General information about the sites used in this study. For more detailed information of the sites, see the catalogue (Appendix A and online Supplements).

Due to the differences in the availability and quality of anthropological information, the data was divided into basic categories. In the database, there are only three categories with regard to sex: *Male*, *Female* and *No information*. In cases where only a tendency towards one sex is listed (*e.g.* rather male, female?), these burials were assigned to the presumed sex. Although this creates a loss of information, this approach serves to standardise the differences in reporting the results of anthropological analyses.

With regard to age groups, a division into eight groups was made (see Table 4). This is based on the age categories that are usually reported in anthropological studies (Brandon 2018; O’Connell 2004; Ubelaker 1989). Coarser indications such as child (*infans*), grown-up (*juvenis*) or fully-grown (*adultus*) – which are often found in older publications from the 50s to 70s – were assigned to one of the age classes according to the wording.

However, since complete anthropological analyses of cemeteries are only available in a few cases (Bátora and Görsdorf 2000a; Benkovsky-Pivovarová and Chropovský 2015a), this study does not differentiate or weight between sexes and ages. A meaningful and unbiased analysis of wealth distribution by sex or age groups would require consistently available demographic data across all cemeteries. Without this,

Anthr. age group	Age range	Anthr. age group	Age range
Neonates	0-0.5	Maturus	40-60
Infans (I-II)	0.5-13	Senilis	60+
Juvenis	13-20	Infans/juvenis	0.5-20
Adultus	20-40	No information	---

Table 4. The age ranges and age groups used in the database.

any differentiation would risk bias, as missing determinations may be linked to specific demographic groups, and this bias cannot be reliably quantified across the dataset. Moreover, weighted analysis in two cases showed no substantial differences (footnote 22). The data on anthropological sex and age was nevertheless collected with the aim of keeping the possibility open for further studies.

3.2.4 Inventory

The grave goods of a burial are deposited on the fourth level of the database. Each grave good is recorded with material type, object type and their quantity. From the combination of material and object type, the grave goods are assigned to an object class (see Subchapter 4.3.1). In the burial catalogue (see online Supplements), the object classes (Appendix B) are reported since they form the basis of the analysis.

3.2.5 Isotopes

The data on the results of isotope analyses (radiocarbon dating) is stored on the same level of the database as the burial data. The data, most of which comes from publications rather than own analyses, is assigned to a grave with details of the laboratory, laboratory codes, species of the sample material, the uncalibrated date with deviation, and – if available – details of C¹³ and N¹⁵ analyses. This data – after calibration²⁴ – serves to date cemeteries and cemetery phases as precisely as possible in this study. For this, the data was either sum calibrated in OxCal or, if dating models existed in the literature, their results have been taken and are listed in the catalogue. They have been cross checked with the calibration of the reported ¹⁴C-data for a general overlap of the boundaries with the reported dates (Oxcal calibration code and results in online Supplement). The calibrated dates and uncalibrated isotope data are reported in the site catalogue (see Appendix A).

²⁴ The computation of calibrations was done using Oxcal with the IntCal20 calibration curve (Bronk Ramsey 2009; Reimer *et al.* 2020).

Chapter 4: Methodology

This thesis uses a number of analytical methods to trace the development of inequality in the Northern Carpathian Basin between the Neolithic and the Bronze Age. The core of the analysis is the calculation of inequality based on grave inventories using the Gini index (Gini 1912) and Generalized Entropy Measurements (GEM). In order to be able to apply this inequality calculation, the grave inventories were analysed with a social index (sometimes called: grave/burial index). MS Excel, MS Access, and the statistical language R (Appendix C and online Supplements) were used for the processing of data, the analysis, and calculations. The exact structure of the analysis, the problems, basic assumptions, and detailed methodology are explained in the following. Before discussing the methodology, it is important to recall that the following analysis is not intended to be a detailed analysis of inequality in individual societies or cemeteries, but rather an overview of inequality in a wider region.

4.1 Structure of the analysis

The core of this work is the collection of information of 6187 burials from 37 cemeteries.²⁵ Based on this data, the analysis describes the development of inequality which follows some basic assumptions (see Subchapter 4.2). For the analysis, the burials of the individual cemeteries were read out of the database

²⁵ They have been entered into a database over a two-year period (see Subchapter 3.2: Data acquisition and database).

together with their grave goods and other burial information. The grave goods were already classified into their functional groups in this step (see Subchapter 4.3.1). Based on the classified grave goods, a social index was determined for each burial (see Subchapter 4.3.2). In the next step, different population segments were formed based on the wealth information provided by the social indices (see Subchapter 4.3.3) and in order to examine the segments with an inequality measure, the Gini index and Generalized Entropy Measures have been calculated (see Subchapters 4.3.4 and 4.3.5).

The results of the inequality measures of the cemeteries and their individual population segments were then described in detail (see Chapter 5). The temporal progression was smoothed and described on the basis of the dating of the cemeteries (see Subchapter 4.3.10 and Appendix A) and by using a linear function on Gini and GEM measures (see Subchapters 4.3.8 and 5.5) and a LOESS regression on the Gini indices (see Subchapters 4.3.8 and 5.7). In this step, possible data effects and correlations were also examined and described (see Subchapters 4.3.7 and 5.3). Subsequently, the inequality measures of the cemeteries and the individual population segments were divided into chronological groups, these were described (see Subchapters 4.3.8, 5.5 and 5.6) and the groups were statistically tested for differences between each other (see Subchapters 4.3.9, 5.5. and 5.6). In order to evaluate the dataset, an assessment of the effect size and the sample size has been made (Subchapter 4.3.11).

4.2 Assumptions

The present work should be understood as a model study of the development of inequality in prehistory (Nakoinz 2018; Wylie 2017). In this context, a model is a simplified representation of reality, valid under specific assumptions, following B. Thalheim's definition (as outlined by: Nakoinz 2018, 107). The assumptions outlined below are not hypotheses to be tested but define the conditions or guardrails under which the model is valid. This is comparable to the assumption of the homo economicus in economic modelling, which does not claim that humans always act rationally, but produces results that are meaningful and useful within that defined simplification. The plausibility of each assumption shapes the interpretive scope of the results rather than determining their validity as such. Accordingly, the results presented here provide an approximate picture of the development of inequality in societies of the Carpathian Basin between the Late Neolithic and the Middle/Late Bronze Age, valid under the assumptions outlined below.

The most fundamental of these assumptions concerns the data source itself, namely the interpretation of burial customs and grave goods as meaningful indicators of social inequality. This question has been widely debated in archaeology (Chapman 2013; Cooper *et al.* 2022; Ekengren 2013; Hofmann 2013). Processual archaeology interprets grave goods as indicators of the social persona and status of the deceased, treating patterned differences in burial assemblages as a systematic reflection of real social and material inequalities within the living community (Hofmann 2014, 115). Post-processual approaches, in contrast, emphasize that grave goods primarily express the ideology, beliefs, and agency of the burial community rather than the actual wealth or rank of the deceased, meaning that mortuary variability may reflect cultural norms or identity construction rather than economic hierarchy (Chapman 2013; Hofmann 2014, 116).

The position taken in this study follows from the specific character of the archaeological record of the Carpathian Basin. Burials here consistently show clear differences in the quantity and quality of grave goods, repeated occurrence of richer and poorer burials within cemeteries, and broadly consistent socio-economic patterns across multiple sites and periods. In a diverse cultural landscape like the Carpathian Basin, it would be surprising, in my opinion, for purely ritual or symbolic practices to produce this level of systematic and persistent continuity over thousands of years. While ritual and symbolic meaning certainly played a role, the evidence makes it most reasonable to interpret grave goods as systematic indicators of social differences, allowing us to explore how prehistoric communities managed and displayed material and relational wealth.

Grave goods thus map the burial community's access to and action with material and relational wealth (see Subchapter 1.1; assumption 1).

A general problem of burial archaeology is the significance of the available data in relation to overall populations. Across all periods of prehistory, a high loss rate of graves is to be expected (Nikulka 2016, 100–101). Accordingly, entire societies are rarely present in a cemetery. Furthermore, it is possible that during certain periods, only some social groups – maybe based on beliefs or kinship – were furnished with a burial. Since no reliable statement regarding the size of past societies and the modes of burying is possible,

the cemeteries considered in this study are treated as a meaningful sample of prehistoric societies (assumption 2).

The assumption does not require that every member of a society is present in the record, but only that the social variation visible within a cemetery is informative about the social variation present in the wider community. This is supported by a key observation from the archaeological record of the Carpathian Basin. Across all periods considered in this study, graves and grave goods represent the primary and often the only context in which social differentiation is archaeologically visible (see Subchapter 1.3). The consistent use of burial as the main arena for the expression of social difference, as well as the largely similar composition of the wealth distributions (*i.e.* Subchapter 5.9) across the entire period from the Late Neolithic to the Bronze Age suggests that participation in the burial record, however incomplete, was not restricted to a single social segment but reflected broader social practice. The cemeteries were furthermore selected according to defined criteria (see Subchapter 3.1), which already filters for sites considered sufficiently well-documented to be analytically meaningful.

Although a large number of cemeteries are known from the prehistory of the Carpathian Basin – the prehistoric cemetery online database *donau-archaeologie.de*, for example, includes 619 sites (Thomas 2009) – 37 sites were selected here according to defined criteria (see Subchapter 3.1). While the selection follows a convenience rather than random sampling approach, something quite usual in archaeology, the sites are geographically distributed across both main sub-regions of the northern Carpathian Basin, the Danube area and the Tisza Valley, and cover the major archaeological cultures of the studied period (see Fig. 6 and Appendix A). The dataset is thus culturally and geographically diverse in a way that is appropriate for a study with the aim to study overarching trends and not individual cultural trajectories.

The selected cemeteries cover the entire period from the Late Neolithic to the Middle/Late Bronze Age and the results of the analysis are thus treated as representative trends for the development of social inequality in the period from 5200 to 1000 BCE in the Carpathian Basin (assumption 3).

Although the chronological frame of this study covers roughly 4200 years and a variety of different prehistoric societies with different cultural phenomena, all cemeteries are treated and analysed in the same way. In the frame of this thesis, the assumption is:

that in general, the depiction of material and relational wealth within burials was a basic principle of prehistoric societies (assumption 4).

This claim is a regionally grounded condition. As described in Subchapter 1.3 and 2.2, the use of the burial context as the important arena for expressing social differentiation is empirically documented for the Carpathian Basin throughout the investigated period. While the specific forms of this expression may change materially, the principle of wealth deposition as social principle in burial contexts remains consistent. It is furthermore supported by the observation, documented in Chapter 2, that settlement contexts across the same periods show markedly less differentiation, indicating that burials carried a distinct social function that was not replicated in most of the material record.

Lastly, as already outlined in Subchapter 3.2.2.2 (cemetery phase), most cemeteries have been used for considerable periods. Most cemeteries analysed in this investigation have several defined phases that are mostly based on artefact typology. Although analysing each cemetery phase separately would be preferable, this comes with several problems (see Subchapter 3.2.2.2): most critically, graves without goods, which form the important group of “the poor” in inequality calculations, are systematically underrepresented in published phase assignments. Therefore, phase-by-phase subsets would be biased towards wealthier individuals, and thus through a more homogenous dataset underreport inequality. Following this, treating multi-phase cemeteries as a whole is not merely a pragmatic compromise but the best option to achieve the analysis of all parts of society.²⁶

Therefore, for the time being, this thesis summarises all burials from a continuous phase of activity:

and treats this as a meaningful sample for the society that used the cemetery in the respective phase (assumption 5).

4.3 Methods of the analyses

4.3.1 Object classes

As part of the evaluation of the grave goods, they were assigned to object classes (see Appendix B). The classes and their subclasses were created according to the following criteria:

²⁶ E.g. the cemetery of Jelšovce has been split into two cemeteries. The first was used during the Copper Age (Ludanice Group), the second was used during the Early Bronze Age (Nitra, Ťňetice, Mad'arovce culture).

- The (probable) main function of an object type was considered. This function is essentially based on how it is usually addressed in the individual cemetery analyses, as well as on basic classification in the archaeological discourse (common-sense). The classes, formed by Thomas (2008) and Bösel (2008), served as a basis for the functional classes used in this thesis. The four main classes established by Thomas (2008) (pottery, costume, tools, weapons) were extended – similarly to Bösel (2008) – by several subclasses and the class “raw materials and fragments” was added.

The classification of grave goods according to function is – of course – already an interpretation and some object types (like knives or axes) can be assigned to several functional groups. For the classification, the author attempted to take the chronological variability of material culture over time, as well as the general interpretation of the considered cemetery analyses into account.

- To a limited extent, the material type (*e.g.* bone, bronze, flint) also plays a role in the assignment to subclasses. Metals and materials which are usually treated as prestigious in archaeological literature (*e.g.* obsidian, spondylus, amber) were generally classified into individual subclasses. This serves to take into account materials often interpreted as prestigious or status-indicating (Bernbeck 2014; Freudenberg 1989, 44-46). In some cemeteries, however, such a classification was not fully possible due to generalised (*i.e.* metal, stone) or missing material descriptions. In cases where sub-classes were combined, for example, to exclude excessive over-representation of individual objects (*e.g.* a single copper bead), this was indicated in the cemetery/site catalogue.
- In the costume, tool and weapon classes, the size of objects was considered to a limited extent by characterising certain object types as “small” or “large” in individual subgroups. While costume objects are generally functionally unambiguous, tools and weapons may overlap; axes or arrowheads, for example, can serve utilitarian or martial purposes. In such cases, the classification follows the terminology of the respective publication: objects designated as daggers or spears were assigned to “weapons”, whereas blades or knives were grouped under “tools”, in line with their contextual interpretation within the cemetery analyses.

In this study, only a few cemeteries have the complete range of object classes and subclasses. One of the reasons for the classification was to standardise the grave goods. This considers different publication qualities of the cemeteries. It also simplifies the calculation of the social index (see Subchapter 4.3.2), as unique objects then do not have a too strong influence on it.

4.3.2 Social index

While studies of inequality in modern societies can rely on a large amount of economic and population data, the data basis for prehistoric societies is problematic. Inequality calculations are usually carried out on income and wealth data, *i.e.*, data expressed in currencies (Sitthiyot and Holasut 2020). If prehistoric graves and grave inventories are used as sources, the values of grave goods and grave construction are largely unknown or have to be assumed. In archaeology, a number of methods have been developed in the past to quantify

grave inventories and determine their economic or social value, so-called social, burial, or grave indices (Beyer 2020; Bösel 2008; Freudenberg 1989; Großmann 2021; Hedeager 1990; Holten 1989; Izquierdo-Egea 2013; Laabs 2010/11 [2014]; Müller 1994; Nørtoft 2022; Rebay-Salisbury 2006; Sprenger 1999; Windler *et al.* 2013). In general, these indices measure either the presence or absence of grave goods (Hedeager 1990; Holten 1989), the quantity (Großmann 2021; Windler *et al.* 2013) or are more complex measures, which incorporate a variety of different proxies like grave depth, raw materials, and quantity (Nørtoft 2022; Müller 1994; Sprenger 1999). The different kinds of indices have different considerations regarding the phenomenon they measure. While quantities are often considered a measure of economic or material wealth, the presence or absence of objects is interpreted to be a measure for social position or relational wealth (Bernbeck 1997, 262-264; Schulting 1995, 27-28). Hence, different social indices address different facets of wealth inequality and may not necessarily result in the same observations. Moreover, these different indices require different data qualities, which are not available for each cemetery included in this thesis.²⁷ A scarcity-based approach has the practical advantage that object values are calculated from within each cemetery itself, rather than relying on external assumptions about what objects were worth. This makes the method well suited for comparing cemeteries across different regions and time periods, as is the aim of this study. For this reason, the social index related to R. Großmann (2021) was chosen as a comparatively simple measure.

The social index is determined from the frequency of an object class²⁸ (see Subchapter 4.3.1) in the cemetery and the number of grave goods of the buried person. The rarer an object type occurs, the higher its value. The reasoning behind this is straightforward: objects that appear rarely in a cemetery were likely harder to obtain, possibly because of costly materials, specialised production, or long-distance exchange. In the absence of prehistoric price data, scarcity therefore provides a useful relative measure of value without having to impose modern assumptions on past societies. In contrast to R. Großmann (2021), the material of the grave goods was taken into account to a limited extent in the classification of the object classes (see Subchapter 4.3.1), but still the workload for manufacturing and the distance to the origin of a resource were not included in the analysis. The division into object classes (see Subchapter 4.3.1) primarily serves a functional classification of the artifacts. In addition, it also ensures that artifacts which occur only once do not influence the value of a grave too much. Without this grouping, a single obviously ordinary unique object could artificially inflate a grave's value, making it appear wealthier than it actually was. The classification into object classes thus ensures that the index reflects broader patterns of unequal access rather than individual outliers.

The value of an object class results from the number of buried individuals in the cemetery divided by the number of objects in an object class. For example, with 200 buried individuals and 25 small tools (*i.e.* blades) in a cemetery, the value of one small tool is 8.

$$Value_{object\ class} = \frac{number\ of\ burials}{number\ of\ objects\ of\ a\ certain\ object\ class}$$

²⁷ As stated in Chapter 3, only 80% of the burials have a reported grave depth, only 41% have a reported anthropological age analysis and 26% have information about anthropological sex determination.

²⁸ Similar to the “*Exklusivität*” of Freudenberg (1989, 45).

The individual values of the object classes are multiplied by the amount that they are present in the burial. So, if a buried person has three small tools, their combined value is 24. In the next step, the values determined in this way are summed up for each burial (*e.g.* pottery + small tools + small jewellery). In a final step, the grave values are normalised to the range from 0 to 1 by dividing the individual burial values by the highest grave value of a burial site or phase. This results in a social index for each burial which lies between 0 and 1. Lastly, the methodology described here for calculating the social index was carried out by taking all burials of a cemetery without gender and age differentiation.

Following the definition of social inequality and the domains, as well as types of wealth established in Chapter 1 (see Table 1), the approach described above is a marker of several domains and types of wealth. By analysing the quantity of grave goods and to a certain extent also material differences, the selected social index enables analyses of the access to, accumulation of and action over material wealth. Through the separation of grave goods into potentially prestigious material types, as done in the reclassification of grave goods into object classes (see Subchapter 4.3.1), the access to, accumulation of and action over relational wealth is addressed by the analysis. While the social index accounts for material wealth, its primary analytical value in this study lies in capturing relational wealth, as it emphasises access to and control over scarce and potentially prestigious object types that serve as markers of differentiation within material, skill-based, and status-related networks. Calculations of the social index, as described in Subchapters 4.3.1 and 4.3.2, were performed in Excel.

A possible objection to the frequency-based social index is that scarcity alone does not necessarily indicate social value. However, graves are not random assemblages of material culture. The deposition of objects in burials represents a deliberate act by the burial community, shaped by social norms and conventions (Chapman 2013; Hofmann 2013). The burial context can therefore be understood as a filter that ensures predominantly socially meaningful objects enter the archaeological record. Communities are unlikely to expend materials or labour in burials without purpose. As outlined in Subchapter 1.2, the creation and management of scarcity constitute fundamental mechanisms through which inequality emerges and persists (Bradley 1982, 120; Laabs 2023; Gilman 1981). A scarcity-based index therefore captures a principle that is central to the dynamics of inequality itself.

The social index predominantly measures relational wealth within a cemetery, with values derived from intra-site frequencies. Objects that appear unremarkable from a supra-regional perspective can attain elevated values if access was restricted within a given community, whether due to material scarcity, social conventions, or ritual practices. Conversely, when objects appear commonly across many burials, even when perceived as an extraordinary commodity in archaeology, this indicates broader access and potentially lower value. These patterns represent valid measurements of differential allocation of goods and power. A safeguard is provided by the aggregation of artefacts into functional object classes (see Subchapter 4.3.1), which prevents individual rare but potentially insignificant objects from disproportionately inflating burial values. Where additional modifications to the object classes were necessary, these are documented in the site catalogue (see Appendix A).

The validity of this approach is supported, for example, by the work of R. Großmann (2021) who identifies correlations between his scarcity-based social indices and other social markers like dietary patterns or burial site topography

but also, in retrospect, by the present dataset itself. Cemeteries with higher index-based inequality also exhibit greater material diversity, a broader range of functional object groups, and larger populations (see Subchapters 5.10 and 5.11). If the index merely captured random rare objects of no social significance, no systematic relationship with these independent markers of societal complexity would be expected. While more complex indices exist (*e.g.* Großmann 2021; Müller 1994; Nørtoft 2022), they require data such as grave depth or anthropological determinations that are unevenly reported across the 37 cemeteries (see Subchapter 3.2). A frequency-based approach avoids excluding burials for which it remains unclear whether social, depositional, or post-depositional processes are responsible for the missing information.

4.3.3 Segments of society

The individual segments of society were formed on the basis of the social index. If one follows the explanations from Chapter 1 on different types of wealth, the social indices are to be understood as a measure of material but more prominently relational wealth as described above. The social segments are therefore both:

- ▶ social segments, which indicate the social status of the deceased and the people who buried them, and
- ▶ wealth segments, which indicate the material possessions of the deceased and the people who buried them.

In order to subdivide these segments, all burials were sorted according to their social index and divided into deciles. It is important to note that there is no unified system to define “class” borders or borders for social or wealth segments. The individual segments are outlined below, and their classification follows some basic assumptions and the general ordering into deciles from the field of modern social and economic sciences (Baizidi 2019; Bundeszentrale für politische Bildung 2020; Goebel *et al.* 2010; UBS 2023).

The segments have been analysed with the Gini index to gain an understanding of the development of inequality over time in social groups at certain ends of the wealth distribution. Since the Generalized Entropy Measures (GEM) can already be adjusted to address certain ends of the wealth distribution (see Subchapter 4.3.5), the segments have not been analysed with GEM, but a GEM[0], GEM[1] and GEM[2] have been calculated instead. The use of both the Gini index and the GEM provides an additional robustness check, allowing an assessment of whether the observed patterns and developments correlate across different inequality metrics.

Moreover, the general distribution of social indices in the whole dataset was investigated. It appears that roughly 40% of the burials can be considered to be poor and have no or very few²⁹ grave goods and therefore an index of under 0.005. The 10% wealthiest burials have an index between 0.1 and 1. The remaining 50% of burials fall into the index range of 0.005 and 0.1.³⁰ The segments were therefore formed by considering this general distribution of wealth in the dataset (further information on the distribution of the social index see Subchapter 5.9).

²⁹ In general, burials with a social index between 0 and 0.005 have only a single vessel or objects of a generic and often occurring grave good.

³⁰ This is comprised mostly of burials with at least one ceramic vessel and up to an average grave assemblage.

4.3.3.1 Gini_{all} index and GEM[1]

In this study, the Gini index (for an explanation see Subchapter 4.3.4) has been calculated for different segments of society. Additionally, an analysis between the Gini index incorporating only the undisturbed burials and the Gini index calculated on all burials showed differences in some cemeteries (Subchapter 5.3; Table 3 and Table 5; Supplement B), though the overall correlation between disturbance ratio and Gini differences is limited. Since often a high number of burials were clearly robbed but still contained a number of finds, the intention was to not exclude these burials from the analysis. Further although impacted by potential loss of wealth their social index values still resemble a minimal estimate of their potential wealth. However, disturbed burials can be considered to show a biased figure of grave wealth, since specific objects were often targeted by robbers. To account for this potential bias, a median Gini index was taken between the Gini index of all the burials without disturbance (Gini_{undist+dist} index) and the Gini index for all burials – undisturbed and disturbed – within a cemetery (Gini_{undist+dist} index). The median approach for Gini_{all} index ensures comparability across all cemeteries regardless of disturbance rates, while segment-specific measures (Gini_{low}, Gini_{upper}, Share_{upper}, GEM) benefit more from maximizing sample size than from disturbance correction.

The GEM[1] serves as the accompanying Generalized Entropy Measure and can be compared to the Gini_{all} index. Beside the development in the Gini_{all} index of the entire society, or all graves of a cemetery, two segments have been formed.

4.3.3.2 Gini_{low} index and GEM[0]

The first segment is comprised of all graves except the wealthiest 10 percent and is denoted as the Gini_{low} index.³¹ By leaving the wealthiest decile of the population out, the author intends to shed light on inequality within the average population, namely what would be referred to as the “lower and middle class” (Baizidi 2019). Discussions about inequality in prehistory are often driven by the wealthiest segments of society since they are highly visible and often interesting from a material point of view. This is present in models on the emergence of inequality, like the aggrandizer model (Prentiss *et al.* 2018, 600) or the focus on Bronze Age elites or individuals with “high-status” artefacts (Dani *et al.* 2016; Knipper *et al.* 2015; Marzian *et al.* 2024; Meller 2019; Zich 2016).

In such studies, by focussing on the wealthy part of society, the development of inequality among the main part of the “common” society is neglected. Therefore, by analysing the Gini_{low} index, it is investigated whether the development of inequality among the lower and middle wealth segments of society develops in the same way as in the entire population. In addition to the Gini_{low} index, the GEM[0] has been analysed to add another analysis that deals with the lower end of the wealth distribution.

4.3.3.3 Gini_{upper} index, GEM[2] and Share_{upper}

The second segment under observation is the wealthiest decile (10th decile) of the population. Referring to the previous segment, one could say this is the “upper class” (Baizidi 2019). In contrast to the Gini_{low} index, this analysis explicitly examines the wealthiest section of the population (see Subchapter 4.3.3: Gini_{low}).

³¹ Like the sorting in UBS (2023), table 1-5.

Its equivalent Entropy Measure is the GEM[2], which puts weight on the upper end of the wealth distribution. Examining the relationship between the Gini index and the GEM[2] therefore provides an indication of the robustness of the observations and developments identified.

In addition, this group has been treated in a different way compared to the aforementioned segments. Not only the Gini index, but also the share of wealth that the uppermost decile of society holds of the entire societies' wealth ($\text{Share}_{\text{upper}}$) has been analysed. This analysis is less an observation about the inequality within this segment, but more an investigation of the concentration of societies' wealth especially in this societal segment. By comparing it to the Gini_{all} index, the author aims to investigate the impact that the wealthiest segment of society has on inequality.

4.3.4 Gini index and Lorenz curve

The Gini index, or Gini coefficient, is a measure of the inequality in a distribution or, in other terms, a measure of concentration within a sample (Kamps and Krämer 2018a). The method was developed by the Italian Corrado Gini (Gini 1912) and is considered one of the most common measures of income and wealth inequality.

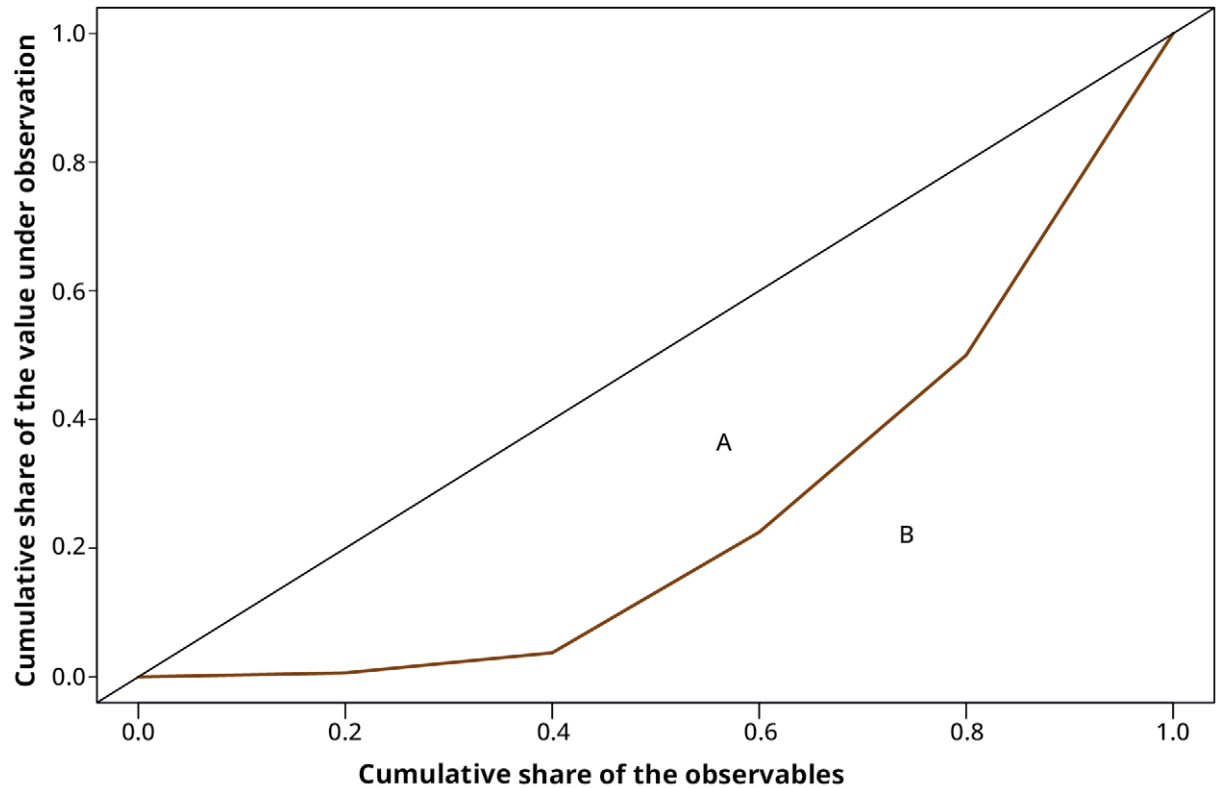
The Gini index is calculated using a Lorenz curve (Fig. 8). On the x-axis, a Lorenz curve shows the cumulative share of the observables of a distribution, ordered from lowest to highest value. On the y-axis, the cumulative share of the value under observation within a group is plotted (Kamps and Krämer 2018b; Kohn and Öztürk 2017). With reference to income distribution, a Lorenz curve (Fig. 8; brown line) shows how much of the income is earned by a certain part of a population (Requate 2022).

The Gini index is determined from a Lorenz curve (Fig. 8; brown line) and the straight line of an equal distribution – a hypothetical Lorenz curve for a perfectly equal distribution – a so-called: line-of-equality (Fig. 8; black line). The area between the two curves (Fig. 8; Area A) corresponds to the Gini index (Kamps and Krämer 2018a). Thus, if a variable is more evenly distributed within a sample, the line-of-equality and the Lorenz curve are relatively close to each other and the area between them is small. If the variable is more concentrated, the area is larger. The Gini index has values between 0 and 1, where 0 indicates a total equal distribution and 1 indicates total unequal distribution (Kerig *et al.* 2022). This derivation of the Gini index using the Lorenz curve (G_L) is expressed by the following formula³² (also Fig. 8), where A is the area under the line-of-equality and B is the area under the Lorenz curve:

$$G_L = \frac{A - B}{A}$$

It turns out that the Gini index has a lower limit of 0, but only a theoretical upper limit of 1. Giving an extreme example of a society with maximal possible inequality, where four have no wealth and one member owns everything, the formula mentioned above would not return a Gini index of 1 but a considerably lower value and even adding more members without wealth would lead to the

32 If the Gini index is calculated directly on the data (G), as was done in this paper, the following formula by Stocker and Steinke (2022) is used:
$$G = \frac{2 \sum_{i=1}^n ix(i)}{n \sum_{i=1}^n x(i)} - \frac{n+1}{n}$$



Gini index only approaching 1 (Marzian 2021, 34-35). In order to account for this fact and to put the Gini index into relation of its methodological limitations, the so-called Lorenz-Münzner coefficient, or the normalised Gini index (G^*), can be used (Brell *et al.* 2017, 53ff.). The Gini indices reported in this paper are normalised values and were calculated using the following formula, where G^* is the normalised Gini index, G the classic Gini index and n the sample size.

$$G^* = \frac{n}{n-1} G$$

The Gini index is considered a relatively simple inequality measure that also has some weaknesses, but despite alternatives it is often used in economics, the social sciences and archaeological studies. This may be due to the simplicity of the method and its comprehensibility, but it is also due to the good comparability of the results (Cowell 2000, 149-150). With reference to archaeological data, the different groups of data (settlements, hoards, cemeteries) and the socio-cultural interpretations derived from them, a methodological debate has been taking place in recent years (Bogaard *et al.* 2019; Fochesato *et al.* 2019; Fochesato *et al.* 2021). At the core of this was the establishment of the comparability of Gini indices from studies with different research objects (*e.g.* grave goods, house sizes) and the often small sample sizes when dealing with archaeological data.

It should be noted that the Gini indices determined here are only comparable to those determined using the same, or a similar, methodology (Ames 2008, 500; Fochesato *et al.* 2019). A correction for various potential biases as proposed by M. Fochesato *et al.* (2019) was not conducted, since it seems correcting for different sizes of societies is conflating scale effects that might be important. A comparison of Gini indices based on other proxies (*e.g.* house/tumulus sizes) is not directly pos-

Figure 8. Lorenz curve, black line = line of equality, brown line = line of observed inequality; A = area between the line of equality and the line of observed inequality, B = area under the line of observed inequality.

sible, as in some cases other types of inequality are present (inequality of wealth vs. inequality of social status or embodied vs. relational wealth) and different proxies have special characteristics (see Chapter 3).

4.3.5 Generalized Entropy Measures

While the Gini index is a robust measure of inequality, one of its drawbacks is its unsatisfying decomposability into subgroups. Usually Generalized Entropy Measures (short: GEM) are proposed to tackle the problem of weak decomposability (Cowell 1989) and to investigate inequality in certain parts of a population (*i.e.* Marzian *et al.* 2024; Windler *et al.* 2013). Since the GEM cannot be calculated for datasets containing zero-values, graves without grave goods have been assigned a value of 0.001 for the GEM analysis. Entropy measures evaluate how much each individual value (*i.e.* of wealth) differs from the average and sums those differences. It is calculated using the following formula (Rohde 2008, Form. 15.5; Windler *et al.* 2013):

$$GEM[\alpha] = \frac{1}{\alpha(\alpha - 1)} \left[\frac{1}{N} \sum_{i=1}^N \left(\frac{y_i}{y} \right)^\alpha - 1 \right]$$

with y_i being the value of an individual (*i.e.* social index of a grave), y being the average value of the population (*i.e.* average social index of the burial site) and α being a weight which emphasises the distance between individual values of the distribution. By implementing low α values, the lower end of the distribution, *i.e.*, the less wealthier individuals, are emphasised, while a higher value puts a focus on the upper part of the distribution, *i.e.*, the wealthier individuals (Cowell 1998; Shorrocks 1980, 623). While α can take any real value, usually 0, 1³³ and 2 are used as standard values (Windler *et al.* 2013). Regardless of which weight is used, a GEM value of 0 or close to 0 indicates an equal distribution while there is no upper margin to indicate maximum inequality. A comparison of GEM results with the Gini index therefore also functions as a form of robustness check (for further robustness checks, see online Supplement G), as consistent patterns across measures with different sensitivities strengthen the reliability of the observed trends.

4.3.6 Standard errors and confidence intervals of the Gini index

Although a basic assumption of the analysis is that the considered cemeteries are a representative sample of prehistoric society, the analysis must not neglect the fact that only a part of prehistoric society is being examined. The determined Gini indices are therefore only an approximation of the actual Gini indices of a society as a whole, which may result in a different Gini value if a different sample of the same society would be available (Mittelhammer 2013, 295-296). This variability based on the sample under consideration can be expressed with an estimation function. This estimation function (sampling distribution) makes it possible to determine a standard error, which can be interpreted as a measure of the statistical inaccuracy of the index calculation (Marzian 2021, 36ff.).

³³ The GEM of $\alpha=1$ is also known as the Theil index.

Based on the work of J. Marzian (2021) on inequality calculations at prehistoric burial mounds in Europe, the benefits of an asymptotic versus a bootstrap standard error³⁴ were weighed for this work. The calculation of the asymptotic standard error, as opposed to a bootstrapping procedure, is less sensitive to extreme values in small sample sizes (less than 20 observations; Marzian 2021, 39, 42). In general, a bootstrapping approach would be preferable for the sample sizes considered here (Cowell and Flachaire 2015, 413-414). However, since the underlying data set considers cemeteries and cemetery phases with very different numbers of graves, including some with very few graves and extreme single outliers of the social index, the asymptotic approach was chosen to calculate the standard error. The calculation of the asymptotic standard error (ASE) is done with the following formula (Marzian 2021, 40):³⁵

$$ASE(G^*) = \sqrt{\frac{1}{(n\bar{x})^2} \sum_{i=1}^n (Z_i - \bar{Z})^2}$$

The calculations of the confidence intervals are based on the standard error. Since the exact distribution function of the total society is not known, but it can be shown that an asymptotic procedure can be based on a standard normal distribution, the confidence intervals (CI) can be determined with the percentiles of a normal distribution (Marzian 2021, 40-41). The confidence interval for the 2.5% and 97.5% percentiles is determined as follows:³⁶

$$CI_{0.95}(G^*) = [G^* - |z_{0.025}|ASE(G^*); (G^* + |z_{0.975}|ASE(G^*))]$$

In this study, the standard error and confidence intervals of the Gini_{all} index were calculated and reported to assess the certainty of the inequality measures of the individual cemeteries. They also allow a comparison between the cemeteries and give an indication of the possible existence of differences in the inequality measures. In other words: If the confidence intervals strongly overlap, this could indicate a non-existent difference between the cemeteries. In addition, a significance test was performed (see Subchapter 4.3.9) for the medians of the individual cemeteries, but the confidence intervals are better suited as a visual indication.

4.3.7 Correlation coefficients

Correlation tests according to Pearson and Spearman (R Core Team 2019) were used to check the correlation of the inequality measures with certain variables, such as grave disturbance, burial ground or society size and chronological sequence (R Core Team 2019). On a scale from -1 to 1, these tests indicate whether there is a linear negative (-1), positive (1) or no correlation (0) between two statistical variables (Bahrenberg and Giese 1975, 144 ff.). It is important to mention here that an existing correlation is not necessarily a causal relationship, but that it is

34 An asymptotic standard error approximates the standard error when only subsamples of a distribution have an unknown mean and standard deviation, while a bootstrap approach draws random subsamples from a distribution and gives a range of possible values that can be calculated from the dataset.

35 $\bar{x}$ = mean social index of the group under analysis; Z_i = a particular term; $\bar{Z}$ = mean of all Z_i 's; j = a positive integer of an interval

$Z_i = -(G^* + 1)x_{(i)} + \left(\frac{2i-1}{n}\right)x_{(i)} - \frac{2}{n}\sum_{j=1}^i x_{(j)}$ (Marzian 2021, 40).

36 $z_{(0.025/0.975)} = 2.5\%$ and 97.5% -percentiles

$ASE(G^*)$ = asymptotic standard error of the normalised Gini index.

possible that both variables are influenced by other unknown variables (Bortz and Schuster 2010, 159-160).

To use the Pearson correlation, the data must be at least in an interval scale. The Spearman or rank correlation coefficient can also be applied to ordinal scaled data (Sachs 2004, 511 ff.). In the present analysis, the Pearson correlation was used between the proportion of grave disturbance in a cemetery and the $Gini_{all}$ index, as well as for the correlation between the size of the cemetery and the $Gini_{all}$ index. As the chronological sequence is an ordinal scaled value (ranking), the Spearman correlation was used for the correlation between the chronological phase and the $Gini_{all}$ index. Other correlations that were analysed included:

- ▶ correlations between individual inequality measures and individual segments of society,
- ▶ correlations between the number of grave goods and the number of burials,
- ▶ correlations between the Gini index and GEM[1],
- ▶ as well as various other observations, such as site size, the number of graves without grave goods, the number of burials, the number of material types, and the number of functional groups.

4.3.8 Descriptive analysis

The data on the inequality of 37 cemeteries between the Neolithic and the Bronze Age was analysed in this thesis. In order to describe the development over a time axis, it helps to summarise the data and analyse it with different methods. Three methods were chosen in this work. Firstly, the results of the Gini index and GEM analyses were examined using a linear model. In the second step, the data was analysed using a LOESS regression and finally the cemeteries were divided into two and three time slices, and their characteristics³⁷ were compared with each other in the form of boxplots.

4.3.8.1 Linear trend

This method is used to determine a linear function for a set of data points that best represents the data. For this purpose, a line is determined in such a way that the sum of the squared vertical distances (residuals) between the individual data points and the straight line is minimal (Bahrenberg and Giese 1975, 130-131). This method is used, for example, in regression analysis to determine the relationship between two dependent or independent characteristics (Wollschläger 2013, 108ff.).

In the present case, however, the method of linear least squares is mainly used to describe the development of social inequality³⁸ over time (curve fitting). Questions about the statistical relationship between time and inequality are dealt with in Subchapter 4.3.7 and Subchapter 5.3. In this study, linear trends and their functions were determined using R (function: `lm`). The R^2 -value given with the results (coefficient of determination) is an indication of the proportion of an effect that can be described by the linear model. While a selection of figures is shown in the following, the linear trends of all metrics can be found in the online supplement (Supplement B).

³⁷ Characteristics: Median, range, minimum and maximum value; boxplots.

³⁸ That is, the different measures introduced in Subchapter 4.3.3: $Gini_{all}$, $Gini_{low}$, $Gini_{upper}$, GEM[0], [1], [2] and $Share_{upper}$.

4.3.8.2 LOESS regression

A LOESS regression, or locally weighted scatterplot smoothing, is a method that, among other things, is used to discuss and visualise patterns within a dataset. In this work, it is used to gain a better understanding and observation of the development of inequality within the two time periods with the best data coverage (5200-3000 BCE and 2200-1000 BCE). The LOESS curve has been computed by plotting the Gini indices of the cemeteries on a time axis. Then a LOESS regression was performed using R (loess) and the LOESS curve was generated (Fahrmeir *et al.* 2009, 339-340; R Core Team 2019). For this method, a polynomial is computed for each point that incorporates a predefined set of values and weights them based on the distance to the original point (Cleveland 1979). The span of weighted data points, *i.e.*, the value that indicates how many values are considered in each polynomial, was also determined using R (R function `optim`; span: 0.4) (R Core Team 2019). An analysis of the entire time period was not done due to the lack of data between both time periods (3000-2200 BCE). This would have resulted in an interpolation of this time period based on only two data values and therefore would have put too much weight on these two measurements. Similar to the linear trends, only a selection of figures are shown in the following, the LOESS trends of all metrics can be found in the online supplement (Supplement B).

4.3.8.3 Boxplots

Boxplots (also: Box-Whisker-Plots) can be used to visualise and evaluate the central tendencies and dispersion of a data set. They allow the graphical comparison of a variable across several groups, in this work: between individual time periods (Bortz and Schuster 2010, 45; Wollschläger 2014, 537-538). As a standardised procedure, five parameters of a distribution are reported in a boxplot (five-number summary): the median, the minimum and maximum, and the first and the third quartiles (25th and 75th percentiles). It is therefore easy to make a statement about the differences in median values and ranges between individual groups. In this study, the values of the time periods were also compared with each other and additionally tested for the significance of the differences in the median and range using statistical tests (see Subchapter 4.3.9).

The data was divided into the three major archaeological time periods central to this investigation – the Neolithic, the Copper Age, and the Bronze Age – as part of the analysis, utilising box plots. This division is based on the classification of the sites into their respective archaeological periods as presented in their primary publications. The three mentioned periods are distinguished by significant social, ecological, cultural, and technological changes, as detailed in Subchapters 1.3 and 2.2. Subdividing the data according to these archaeological periods enables an analysis and discussion on potential changes in social inequality in relation to these defining characteristics.

4.3.9 Significance testing

Significance tests are an established statistical tool to determine differences or effects between data sets. The chosen test depends on the type and quality of the data. Significance tests are about determining the probability of error, *i.e.*, the probability that a hypothesis is accepted or rejected (Bahrenberg and Giese 1975, 98). Put simply, a significance level of 0.08, for example, indicates that the probability that the tested effect (*i.e.* no difference between two groups) is present

in 8% of possible samples (Blocker *et al.* 2006). Based on a defined boundary, a statement is made whether this effect is strong enough to reject or accept the hypothesis. In many studies, a boundary or significance level of 0.05 (p-value) is used (Bahrenberg and Giese 1975, 98-99).

In general, it has been increasingly emphasised in recent years that significance tests exert too much influence in the scientific process (Bortz and Schuster 2010, 112-113) and are often applied incorrectly (Benjamini *et al.* 2021; Hirschauer and Becker 2020). An important point of criticism is that it has been shown that the results of studies whose analyses were classified as “statistically significant” cannot be reliably reproduced (Amrhein *et al.* 2017; Colquhoun 2017). Another problem is that p-values, or statistically significant results, are interpreted as a prerequisite for the existence of an effect. On the one hand, this disregards the strength of the effect and, on the other hand, leads – consciously or unconsciously – to a “hunt” for the lowest possible p-value (p-hacking; Hirschauer *et al.* 2016). Moreover, this neglects the possibility of effects that might simply not be defined enough to analyse them with statistical testing. Another point that is particularly relevant for the present study is that significance tests are sensitive to very small and particularly large samples (Lin *et al.* 2013). The issue of sample size is further emphasised when looking at the dataset in this study and testing for the size of a statistical meaningful sample as presented in Subchapter 5.4 (methodology in Subchapter 4.3.11). This test already indicates sample sizes – in an optimal scenario – of at least 32 to 42 samples (cemeteries). A suggestion for dealing with significance testing is that p-values should be interpreted to a lesser extent to accept or reject results, and instead as an additional value to determine the degree of reliability of the measurements (Amrhein *et al.* 2017).

In the present study, significance tests were carried out for a number of analyses, in particular to assess the extent to which there was a change in inequality measures between individual groups. However, these groups are, in a statistical sense, very small (*e.g.* 4 Neolithic against 22 Bronze Age observations). For the reasons mentioned above, this can lead to misinterpretation of the reported p-values. In addition to the descriptive statistics, the reported values therefore serve as an additional indication when discussing the development of inequality and the strength of changes. Results of all significance tests are included in the online supplement (Appendix C; Supplement B). Further, although not an alternative to formal significance testing, robustness and sensitivity checks have been conducted in order to validate the observations and trends. These checks are either inherently built in the study already, for example by using alternative metrics (in this study GEM and Gini index) or have been conducted additionally, for example by artificially modifying the dataset (*e.g.*, Leave-one-Out) to check whether the developments discussed later in this study are a result of the chosen methodology and data processing decisions. These robustness and sensitivity checks are useful in scenarios where significance tests do not hint towards statistically validated changes – potentially through small sample sizes – but where visible changes are present in the analysis. In such scenarios, these additional tests can give an indication as to whether visible trends are robust and somewhat a real observation or not and merely a product of the chosen methodological framework. They thus may be seen as a different mode of statistical validation. A full description and the results of these tests can be found in online Supplement G.

4.3.9.1 Comparison of median inequality measures between time groups and single sites

To test the significance of the difference in the median Gini index between time groups, some basic considerations have to be made. Since the Gini index, as most inequality metrics, only allows for ordinal interpretations (Cowell and Jenkins 1995, 425), it is not possible to test the Gini values of two cemeteries for their statistically significant difference with a conventional t-test (Bahrenberg and Giese 1975, 107-110; Sheskin 2000, tab. I.9; Wollschläger 2014, 389-390). In order to test for significant differences in the median Gini values of the cemeteries and Gini values of the individual societal segments for each time period (*e.g.* the Neolithic vs. the Copper Age) separately, a non-parametric test procedure is used. In the present work, the Wilcoxon-Mann-Whitney test (short: Wilcoxon test) is used for ordinal scaled data of two independent samples that do not need to be normally distributed³⁹ (for a detailed description of the Wilcoxon-Mann-Whitney test, see Sheskin 2000, 513-526). To compare whether there is a statistical difference between the single sites, a similar test – the Kruskal-Wallis test – followed by a Dunn's test have been used. The Kruskal-Wallis test follows the same assumption as the Wilcoxon test, but it can be used to compare more than two samples (Wollschläger 2014, 390-391). The Dunn's test is the appropriate post-hoc test to run pairwise multiple-comparisons on non-normally distributed samples if the Kruskal-Wallis test shows the general presence of significant differences (Dinno 2015).

For the Wilcoxon, the Gini indices and Generalized Entropy measures of the cemeteries were each divided into the three main archaeological periods (the Neolithic, the Copper Age, and the Bronze Age). The successive time groups were then tested for differences in the statistical software R using a Wilcoxon test (`wilcox.test`) (R Core Team 2019). In case of the Kruskal-Wallis test and a Dunn's test, the wealth distribution of the graves of the single cemeteries (*i.e.* the social index values of each burial per cemetery) have been analysed by using the statistical software R (`dunn.test`) and the R package “psych” (`kruskal.test`) (R Core Team 2019; Revelle 2023).

The Wilcoxon, the Dunn's and the Kruskal-Wallis test work by ranking the values of two or more independent samples. The tests check to what extent these values have a different median in rank. The null hypothesis of the tests is that there is no difference in the median of the two samples. The alternative hypothesis is, accordingly, that there is a difference in the median of the two samples (Sheskin 2000, 513). If the resulting significance is below the significance level (usually 0.05), it can be assumed that there is a significant difference between the two samples (Bahrenberg and Giese 1975, 108).

4.3.9.2 Variance in inequality measures between time groups

To test the significance of the difference of the range of inequality measures between time periods in the entire societies, as well as in the individual segments of society, the Levene test has been used. Usually, one would use an F-test to test the homogeneity of the variance. However, the F-test requires data that is normally distributed, which in the present analysis is not always the case. Therefore, the Levene test provides a robust alternative, since it does not require normally distributed data (Sachs 2004, 619). The Levene test was carried out in R (package: “car”; Fox and Weisberg 2019).

³⁹ By applying a Shapiro-Wilk-test (in R: `shapiro.test`) to all 37 measurements of each societal segment, it appears that all but the Gini_{all} index are normally distributed. The Gini_{all} index was tested for the fit to other distributions and showed the best fit to a Gamma-distribution (R package: `goft`, `gamma.test`).

4.3.10 Chronological determinations

The chronological determinations for the cemeteries, as well as for the individual phases, refer to different data. Where available (see catalogue in Appendix A), the results of radiocarbon analyses were used to determine the period of use. This information has been verified by applying sum calibrations (Supplement D). In the case of cemeteries for which only relative chronological information is available, the information on the period of use, as well as the classification of the cemetery's chronological phases, refers to the absolute chronological boundaries of the respective cultural phase or cultural group to which they are assigned (see Subchapter 2.2; Fig. 3).

If, for example, only the information “Nitra culture” is available for a cemetery, its dating is based on established studies on the Nitra Culture, and it is placed in the period 2100-1800 BCE and in the archaeological period “Bronze Age”. If there are several burial site phases for the cemetery – which are reported in the cemetery/site catalogue and the online Supplements, but have not been used for analysis due to the heavy fragmentation of the dataset, these phases are divided over the assumed period. With three phases in the Nitra culture cemetery, this means that each phase covers a time window of 100 years. If there is any limiting information (*e.g.* early Nitra culture), this is considered accordingly. The periods of the individual phases and the cemeteries are listed in the site catalogue (see Appendix A).

4.3.11 Effect and sample size

A statistical analysis, which goes beyond a pure description of the analysed data, attempts to prove or reject differences and correlations between samples on the basis of a null hypothesis using, for example, significance tests. As a basis for such an approach, it is necessary to determine a number of parameters. These are the effect size (Bortz and Schuster 2010, 108; 126-127) of the statistical effect between the samples, the intended test power – *i.e.*, the probability of how often a null hypothesis is correctly rejected⁴⁰ (Bortz and Schuster 2010, 107ff.; Sachs 2004, 196) – and finally the size of the sample required to be able to prove a possible significant difference (Bortz and Schuster 2010, 126-127).

In the present case, these individual parameters were analysed using only the Gini_{all} index values and the data set aggregated in two time periods (before and after a gap in the dataset: 5200-3750 BCE and 3750-1000 BCE). An independent Wilcoxon-Mann-Whitney U test was applied to provide an indication on the size of the effect and the required sample size (Subchapter 5.1.1). By applying these broad criteria, the aim is to determine whether general statements can be made about the sample and effect size. The effect size was calculated using the R package “coin” (wilcox_effsize). According to J. Cohen (1992), the resulting *r*-values are to be evaluated as follows: *r*= 0.1 weak effect size, *r*=0.3 medium effect size and *r*=0.5 strong effect size. The required sample size was determined on the basis of the respective effect size and by using the software “G*power” (Faul *et al.* 2007; Faul *et al.* 2009) for a test power of 0.95 and 0.8.

⁴⁰ The test power is usually not set lower than 80% (0.8).

4.3.12 Analysis of the quantity of grave goods, site size, material types, functional object groups and social inequality

To better understand the processes influencing inequality and its development, the dataset was analysed for additional characteristics of the sites and material goods. These characteristics were examined in relation to the measures of inequality for individual sites.

Regarding grave goods, the analysis included reclassifying them into functional object groups, as well as assessing the total number of objects in a cemetery and the average number of objects per grave. These metrics were then compared with the site size and archaeological period (results in Subchapter 5.8). For this analysis, every grave good was considered, regardless of its size, function, or material type. This approach means that even small items, such as beads or bone fragments, were included without weighting in the object mass. The aim of the analysis was to explore how different societies managed material goods in relation to wealth inequality and, where applicable, to identify distinct patterns.

To examine the relationship of social inequality, technological developments and knowledge in more detail, measures of inequality were analysed in relation to the number of material types and functional groups (presence/absence). Grave goods were standardised into functional object classes and material groups (Subchapter 4.3.1; Supplement C) to account for varying publication quality. These values were tested for potential correlations with the collected inequality measures (Gini index and GEM[1]) using a Pearson correlation analysis (results in Subchapter 5.11).

Finally, the size of the cemeteries was tested for correlation with the measures of inequality (results in Subchapter 5.10). The reported number of graves for each cemetery, as stated in the catalogue, was used as a measure of size. Although in most cases only a portion of the cemeteries is known, excavated, or published, this number can be considered an approximate value for the actual size of the cemetery and possibly even the society it represents.

Chapter 5: Results and implications of the analysis

In the course of the analysis, 37 cemeteries with 6187 burials, mostly from the northern part of the Carpathian Basin, have been evaluated (results see Table 4 and Table 5). It should be noted that the chronological and geographical coverage is not balanced and that chronological and geographical gaps exist in the dataset. This is mainly due to the state of research and the specifics of the local material culture in certain prehistoric periods (see Chapter 2 and Chapter 3). The results are also to be understood against the background of some basic assumptions and the interpretation of social inequality in funerary contexts that underlies this thesis, which were elaborated on in Chapter 3 and Chapter 4.

Given the multi-metric and multi-method structure of the analysis, a brief note on the interpretation of results is necessary before the findings are presented. The study applies three complementary analytical approaches: linear regression, aggregated time-period comparisons, and LOESS regression, as well as and seven metrics sensitive to different parts of the wealth distribution (Subchapter 4.3). Some divergence between these is not only expected but analytically informative. Developments are described as confirmed trends where at least one metric reaches $p \leq 0.05$ with directionally stable results in the robustness checks (Supplement G), as directional tendencies where direction is consistent across metrics but no significance threshold is reached, and as stagnation where results are non-significant and show no directionally consistent signal across methods. Such findings are treated as indicative of a probable pattern rather than as proven developments. This interpretive framework should be kept in mind throughout the following presentation of results.

The following section presents the findings of this study in a structured manner. Initially, the general characteristics of the dataset are explored, focusing on the development of inequality within different societal segments through Gini and GEM analyses. Subsequently, temporal trends are examined using linear and LOESS regression. The influence of grave good quantity, characteristics of the social index, and their distributions are then analysed in relation to the inequality metrics. Finally, the results of analyses on site size, technology, and resource access in connection with inequality measures are discussed in detail.

5.1 General presentation of the Gini indices of the individual social segments

The $Gini_{all}$ indices of the individual cemeteries are quite high (Table 5; Fig. 9), with values ranging between 0.59 and 0.86.⁴¹ These values appear exceptionally high, especially when compared to other studies on social inequality in prehistoric societies (Basri and Lawrence 2020; Ellyson *et al.* 2019; Kohler *et al.* 2017; Schreiber *et al.* 2022; Squitieri and Altaweel 2022). Many previous studies focus on more defined forms of wealth, such as material wealth, using straightforward proxies (*e.g.* Basri and Lawrence 2020; Bogaard *et al.* 2019; Fochesato *et al.* 2019; Kohler *et al.* 2017). Therefore, as outlined in Subchapter 3.1, no direct parallels can be drawn between these studies and the individual values in this thesis – a tendency in development can be compared at most. In addition to different types of wealth, the structure of the data typically used (*e.g.* house sizes, storage volumes) differs from the data we obtain from burial sites. Cemeteries may include zero values for graves without grave goods, which is not the case when considering house sizes and which are a reason of higher Gini indices from burial data (Fochesato *et al.* 2019). Furthermore, the analysis of wealth in cemeteries depends on the social index methods used. Index methods that, for example, consider grave dimensions or assign fixed values to burial processes also produce a social index value for graves without goods, which avoids zero values and can lead to a lower Gini index (*e.g.* Beyer 2020; Großmann 2021; Nørtoft 2022; Yu *et al.* 2019). However, studies on relational wealth inequality in prehistoric funerary data, which report relatively high Gini indices (Marzian *et al.* 2024; Windler *et al.* 2013), indicate that the values discussed in this investigation are not unique occurrences.

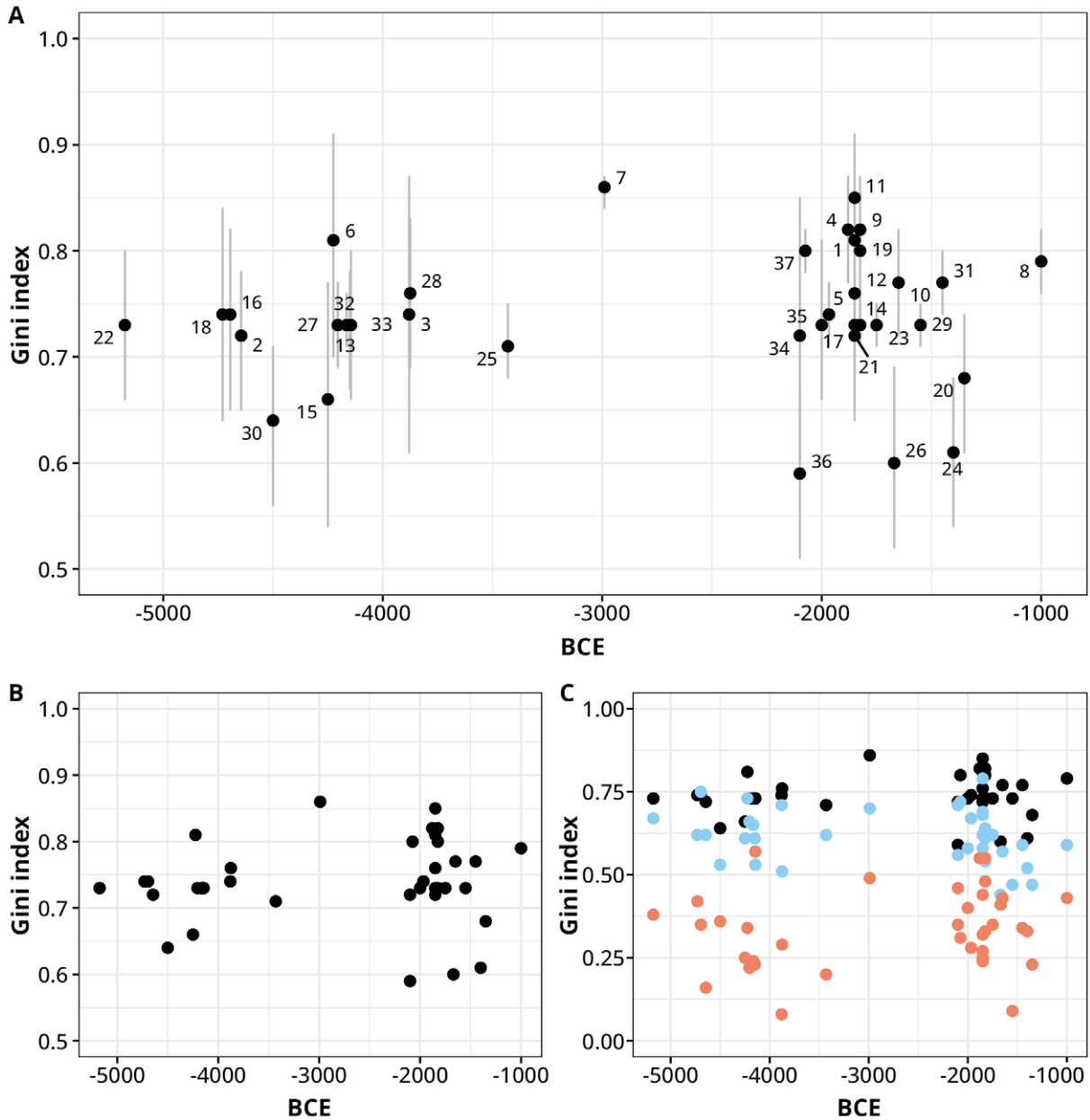
Additionally, the $Gini_{all}$ ⁴² indices exhibit partially very high confidence intervals (see Fig. 9). The resulting overlap of confidence intervals is already an indication of a lack of significant differences⁴³ when analysing developments between sites and time periods (see Subchapters 5.4, 5.5 and 5.6) and may be due in part to the small size of some cemeteries. Particularly small sample sizes can result in high standard errors and therefore high confidence intervals when using either conventional asymptotic or bootstrap methods. Instead of using a 95% confidence interval, as is common in the natural sciences, it was decided to use an 80% interval for the presentation of the data.⁴⁴ Given that the confidence intervals are already very large, 80% intervals still provide the necessary indication of

41 Lowest value: Veselé (Cat. No. 36); Highest value: Budakalász-Luppa-csárda (Cat. No. 7).

42 Lorenz curves of the $Gini_{all}$ index for each cemetery can be found in Appendix E.

43 While there are statistically significant differences between the inequality measures of several of the individual cemeteries (online Supplements; Dunn's test), the Wilcoxon test results between aggregated time periods shows no statistically significant differences between archaeological periods (Appendix C, Wilcoxon test).

44 As was done in the study of T. Kohler *et al.* (2017) on house size data.



high uncertainty in the Gini indices while allowing for better graphical presentation of the results. Moreover, a lower confidence interval accounts for the low to moderate statistical effect size discussed in Subchapter 5.4, which already indicates that potential statistical differences are not robustly pronounced. Nevertheless, despite the heterogeneity in the size of the data sets and high confidence intervals, there are differences between the wealth distributions of the individual burial grounds (Kruskal-Wallis test; p -value: $2.2e^{-16}$). Significant differences exist especially between the cemeteries with a medium and a high number of graves (online Supplements; Dunn's test).

Compared to the $Gini_{all}$ index, the $Gini_{low}$ and $Gini_{upper}$ indices show lower values. This is because both indices consider subsets of the burial sites, allowing for a detailed examination of certain parts of the wealth distribution. These subsets are often more homogeneous in their composition of social indices (see Subchap-

Figure 9. A) $Gini_{all}$ index of the individual sites (black dots) and 80%-confidence intervals (grey lines), numbers indicate the catalogue numbers; B) $Gini_{all}$ index of the individual sites (black dots); C) $Gini_{all}$ index (black dots), $Gini_{low}$ index (blue dots) and $Gini_{upper}$ index (coral red dots) of the individual sites.

Catalogue No./Site	Gini index undisturbed burials (Gini _{undist} index)	Gini index all burials (Gini _{dist-undist})	Median (Gini _{all})	Confidence interval (80%)	Gini _{low}	Gini _{upper}	Share _{upper}	Median date BCE
1. Abrahám I, Komárom vršok	0.80	0.81	0.81	[0.84;0.77]	0.79	0.27	0.64	1850
2. Aszód, Papi földék	0.72	0.72	0.72	[0.78;0.65]	0.62	0.16	0.6	4645
3. Barca-Baloty	0.72	0.76	0.74	[0.87;0.61]	0.71	0.08	0.59	3880
4. Battonya, Vörös Október MTSZ	0.82	0.82	0.82	[0.87;0.77]	0.55	0.55	0.77	1880
5-6. Branč-Helyföldék (Bronze Age)	0.72	0.76	0.74	[0.77;0.71]	0.68	0.28	0.6	1967
5-6. Branč-Helyföldék (Copper Age)	0.79	0.82	0.81	[0.91;0.70]	0.73	0.34	0.66	4225
7. Budakalász-Luppa-csárda	0.84	0.87	0.86	[0.87;0.84]	0.71	0.49	0.81	2990
8. Budapest-Békásmegyér	0.79	0.78	0.79	[0.82;0.76]	0.59	0.43	0.68	1000
9. Dunaújváros-Duna-dűlő	0.82	0.82	0.82	[0.83;0.80]	0.54	0.48	0.76	1825
10. Gelej - Beltelek-dűlő and Kanális-dűlő	0.78	0.77	0.77	[0.82;0.72]	0.57	0.43	0.68	1650
11. Hegyeshalom-Ujjakótelep	0.89	0.82	0.85	[0.91;0.80]	0.68	0.44	0.7	1850
12. Hernádkak	0.76	0.76	0.76	[0.78;0.73]	0.62	0.25	0.65	1850
13. Jászladány	0.70	0.76	0.73	[0.78;0.67]	0.61	0.23	0.63	4150
14-15. Jelšovce (Bronze Age)	0.71	0.75	0.73	[0.75;0.71]	0.64	0.33	0.6	1825
14-15. Jelšovce (Copper Age)	0.64	0.68	0.66	[0.77;0.54]	0.61	0.25	0.55	4250
16. Kisköre-Gát	0.71	0.76	0.74	[0.82;0.65]	0.75	0.35	0.54	4695
17. Košice "Nižné Kapustníky"	0.72	0.74	0.73	[0.76;0.70]	0.69	0.24	0.55	1850
18. Lužianky	0.75	0.73	0.74	[0.84;0.64]	0.62	0.42	0.57	4730
19. Majcichov-Lúky	0.79	0.80	0.80	[0.87;0.72]	0.61	0.55	0.7	1825
20. Mezőcsát	0.67	0.68	0.68	[0.74;0.61]	0.47	0.23	0.61	1350

21. Nagycenk	0.72	0.72	0.72	0.72	[0.79;0.64]	0.58	0.32	0.57	1850
22. Nitra – Horné Krškany/ Priemyslová ulica	0.74	0.72	0.72	0.73	[0.80;0.66]	0.67	0.38	0.55	5175
23. Nižná Myšľa	0.71	0.74	0.74	0.73	[0.75;0.71]	0.62	0.35	0.59	1750
24. Patince	0.58	0.64	0.64	0.61	[0.68;0.54]	0.52	0.33	0.5	1400
25. Pilismarót-Basaharc	0.71	0.72	0.72	0.71	[0.75;0.68]	0.62	0.2	0.55	3430
26. Puzstaszikszó	0.61	0.60	0.60	0.60	[0.69;0.52]	0.44	0.41	0.46	1670
27. Rákóczi-falva-Bagi-föld	0.73	0.73	0.73	0.73	[0.77;0.69]	0.66	0.22	0.56	4205
28. Šebastovce-Lapiše	0.80	0.72	0.72	0.76	[0.83;0.69]	0.51	0.29	0.64	3875
29. Streda nad Bodrogom	0.73	0.73	0.73	0.73	[0.75;0.71]	0.47	0.09	0.69	1550
30. Tíbava “Hrun za cintirom”	0.63	0.65	0.65	0.64	[0.71;0.56]	0.53	0.36	0.51	4500
31. Tiszafüred-Majoroshalom (Tumulus culture)	0.78	0.76	0.76	0.77	[0.80;0.74]	0.59	0.34	0.66	1450
32. Tiszapolgár-Basatanya	0.72	0.75	0.75	0.73	[0.76;0.71]	0.66	0.24	0.6	4165
33. Tiszavalk-Kenderföldék	0.73	0.73	0.73	0.73	[0.80;0.66]	0.53	0.57	0.61	4145
34. Valaalky-Košťany	0.71	0.74	0.74	0.72	[0.85;0.60]	0.71	0.35	0.51	2100
35. Velký Grob	0.75	0.72	0.72	0.73	[0.81;0.66]	0.58	0.4	0.59	2000
36. Veselé	0.53	0.65	0.65	0.59	[0.67;0.51]	0.56	0.46	0.46	2100
37. Výčapy-Opatovce	0.80	0.80	0.80	0.80	[0.82;0.78]	0.72	0.31	0.66	2075

Table 5.
The individual
results of
the $Gini_{undist}^b$,
 $Gini_{dist+undist}^b$,
 $Gini_{all}^b$, $Gini_{low}^b$,
 $Gini_{upper}$ and
 $Share_{upper}$
calculations.

Catalogue No./Site	GEM[0]	GEM[1]	GEM[2]	Median date BCE
1. Abrahám I, Komárom vršok	3.39	1.37	2.3	1850
2. Aszód, Papi földek	1.61	0.9	1.26	4645
3. Barca-Baloty	1.74	1.12	1.61	3880
4. Battonya, Vörös Október MTSZ	1.71	1.73	6.76	1880
5-6. Branč-Helyföldek (Bronze Age)	2.22	1.16	2.21	1967
5-6. Branč-Helyföldek (Copper Age)	2.59	1.27	2.17	4225
7. Budakalász-Luppa-csárda	2.92	1.88	5.74	2990
8. Budapest-Békásmegyer	1.52	1.38	3.99	1000
9. Dunaújváros-Duna-dűlő	1.5	1.7	6.27	1825
10. Gelej- Beltelek-dűlő and Kanális-dűlő	1.61	1.37	4.55	1650
11. Hegyeshalom-Újlakótelep	2.52	1.43	3.19	1850
12. Hernádkak	1.67	1.13	2.01	1850
13. Jászládány	1.75	1.11	1.93	4150
14-15. Jelšovce (Bronze Age)	2.29	1.16	2.4	1825
14-15. Jelšovce (Copper Age)	1.11	0.75	0.97	4250
16. Kisköre-Gát	3.35	1.1	1.59	4695
17. Košice “Nižné Kapustníky”	2.86	1.05	1.55	1850
18. Lužianky	1.78	0.91	1.4	4730
19. Majcichov-Lúky	2.06	1.49	4.76	1825
20. Mezőcsát	1.1	0.88	1.47	1350
21. Nagycenk	1.61	0.92	1.49	1850
22. Nitra – Horné Krškany/ Priemyslová ulica	2.62	1.04	1.91	5175
23. Nižná Myšľa	1.49	1.16	3.27	1750
24. Patince	1.06	0.73	1.13	1400
25. Pilismarót-Basaharc	1.18	0.99	1.64	3430
26. Puzstaszikszó	0.9	0.68	1.2	1670
27. Rákóczi falva-Bagi-föld	1.82	0.99	1.49	4205
28. Šebastovce-Lapiše	1.07	1	1.82	3875
29. Streda nad Bodrogom	1.47	1.16	2.01	1550
30. Tíbava “Hrun za cintirom”	0.93	0.77	1.33	4500
31. Tiszafüred-Majoroshalom (Tumulus culture)	1.4	1.25	2.97	1450

Table 6 continues on the opposite page.

Catalogue No./Site	GEM[0]	GEM[1]	GEM[2]	Median date BCE
32. Tiszapolgár-Basatanya	1.5	1.1	1.87	4165
33. Tiszavalk-Kenderföldek	1.25	1.18	3.2	4145
34. Valalíky-Košťany	2.36	0.91	1.18	2100
35. Veľký Grob	1.83	1.06	2.28	2000
36. Veselé	1.66	0.82	1.48	2100
37. Výčapy-Opatovce	2.87	1.35	2.7	2075

Table 6. The individual results of the GEM[0], GEM[1] and GEM[2] calculations.

ter 5.9) than the overall analysis of the $Gini_{all}$ index, which in turn leads to a lower Gini index. $Gini_{low}$ values range from 0.44 to 0.79 and $Gini_{upper}$ values from 0.08 to 0.57. As noted above, the generally higher $Gini_{low}$ values are partly a consequence of the greater compositional heterogeneity in the lower segment. The variation in $Gini_{upper}$ is more informative, since earlier sites such as Barca-Baloty (0.08; 3880 BCE) or Aszód (0.16; 4645 BCE) tend to show a homogeneous upper segment, whereas later sites such as Battonya (0.55; 1880 BCE), Majcichov-Lúky (0.55; 1825 BCE), or Budakalász (0.49; 2990 BCE) more frequently exhibit differentiation among the wealthier burials. This already suggests a general tendency toward greater internal stratification within the upper wealth segment over time, though exceptions such as Tiszavalk-Kenderföldek (0.57; 4145 BCE) exist. However, a simple addition of the $Gini_{low}$ and the $Gini_{upper}$ index to form the $Gini_{all}$ index is not possible, as the Gini index reflects the distribution under consideration, and this distribution can change substantially when subsets of a population are combined or analysed individually (cf. individual parts of the Lorenz curves in Appendix E).

5.2 General presentation of the individual Generalized Entropy Measures and the $Share_{upper}$

The values of Generalized Entropy Measures (short: GEM; Table 6; Fig. 10) are to be assessed differently than Gini indices. Firstly, it should be noted again (Subchapter 4.3.5) that, unlike the Gini index, the Generalized Entropy Measures do not have an upper limit, so they must always be considered in relation to their original dataset or to data which is based on the same methodology. Furthermore, the three measures, GEM[0], GEM[1], and GEM[2], place different emphasis on parts of the wealth distribution. While GEM[0] is sensitive to changes in the lower part and GEM[2] to changes in the upper part of the wealth distribution, GEM[1] has no such weighting. Developments of the GEM[1], also known as the Theil index, are thus comparable to the $Gini_{all}$ index, as are the GEM[0] and the $Gini_{low}$ index, as well as the GEM[2] and the $Gini_{upper}$ index. The observed values suggest that inequality among the lower segment of society is generally moderate, while inequality in the upper segment is often pronounced. Overall societal inequality lies at an intermediate level, reflecting both wealth concentration among the few and relative equality among the majority. GEM[0] ranges from 0.90 to 3.39, GEM[1] from 0.68 to 1.88, and GEM[2] from 0.97 to 6.76, with the wider spread of GEM[2] reflecting greater variation in upper-end wealth concentration. At sites such as Battonya (GEM[2]: 6.76), Dunaújváros-Duna-dűlő (6.27), and Budakalász (5.74),

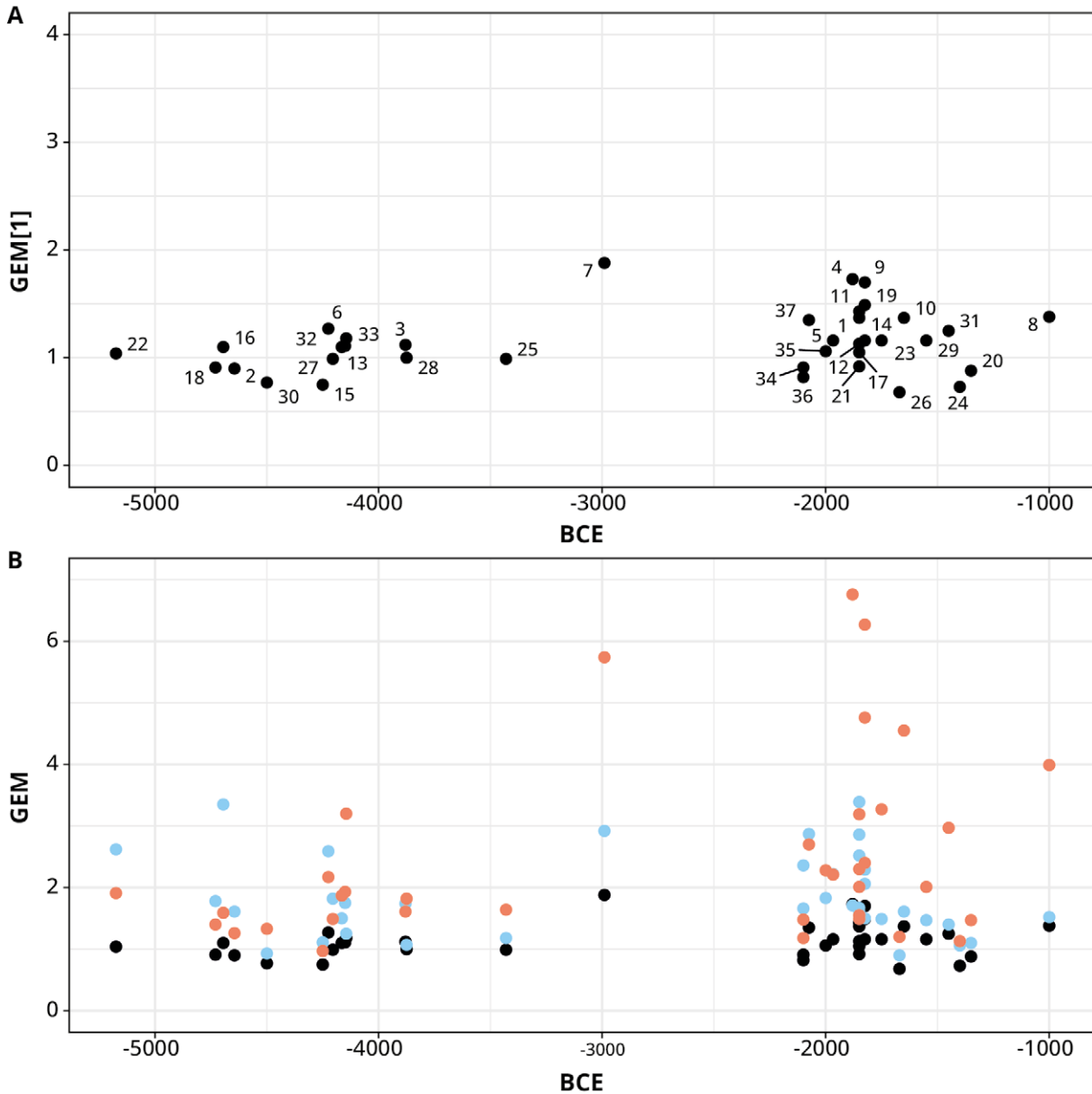


Figure 10. A) GEM[1] values of the individual sites (black dots), numbers indicate the catalogue numbers; B) GEM[1] values (black dots), GEM[0] values (blue dots) and GEM[2] values (coral red dots) of the individual sites.

high GEM[2] values coincide with moderate GEM[0] and GEM[1] values, suggesting that pronounced relational wealth concentration in the upper segment can occur independently of overall or lower-segment inequality.

While it is theoretically possible to directly compare individual values between the $Gini_{all}$, $Gini_{low}$, or $Gini_{upper}$ index since they are based on the same mathematical method, the single Generalized Entropy Measures are based on individual mathematical functions. Therefore, only the trends of the development, not the individual values between the GEM[0], GEM[1] and GEM[2], can be meaningfully compared. Lastly, the $Share_{upper}$ – the proportion of wealth held by the upper 10% of the wealth distribution of the entire wealth within a cemetery – shows relatively high values and on first sight a similar scattering like the $Gini_{all}$ index and GEM[1]. Nevertheless, despite the heterogeneity in the size of the data sets and high confidence intervals, there are differences between the wealth distributions of the burial grounds (Kruskal-Wallis test; p-value: $2.2e^{-16}$). Significant differences

Variable 1	Variable 2	Correlation coefficient	p-value
Gini _{all} index	Gini _{low} index	0.47	0.00
Gini _{all} index	Gini _{upper} index	0.24	0.16
Gini _{all} index	Share _{upper}	0.87	0.00
Gini _{upper} index	Share _{upper}	0.26	0.11
Gini _{upper} index	Gini _{low} index	-0.15	0.39
Gini _{all} index	GEM[1]	0.89	0.00
Gini _{low} index	GEM[0]	0.84	0.00
Gini _{upper} index	GEM[2]	0.63	0.00
Δ Gini _{dist} to Gini _{dist+undist} index	Ratio of disturbance	0.35	0.03

Table 7. Results of the correlation analysis between the individual inequality measures, as well as for the ratio of disturbance. The reported correlations have been calculated using the Pearson correlation coefficient (for a detailed correlation matrix see online Supplement).

exist especially between the cemeteries with a medium and high number of graves (online Supplement B; Dunn's test). As shown below, this stems from a strong correlation between these measures.

5.3 Correlations of the applied inequality measures

As an evaluation of the relationships between the different inequality measures, as well as the impact of the ratio of disturbance (Table 3), correlation analyses were conducted using the Pearson method (Table 7). There are moderate to strong correlations between the Gini_{all}, Gini_{low}, and Gini_{upper} indices and their respective Generalized Entropy Measures. This finding is not surprising, since the Gini index in these cases and the respective GEM investigate the same subset of the wealth distribution. Nevertheless, it shows that it is very likely that the results of the Gini index and GEM analysis reflect the same developments. The observed correlation thus provides an indication of the robustness of these observations (full correlation matrix see online Supplement).

Additionally, there is a moderate correlation between the Gini_{all} and Gini_{low} indices, most likely due to the Gini_{low} index which investigates a high proportion (90%) of the Gini_{all} index data. Conversely, there is only a weak correlation between the Gini_{all} and Gini_{upper} indices, which might be due to the small proportion of data that the Gini_{upper} index investigates of the Gini_{all} index data. A strong correlation exists between the Gini_{all} index and the Share_{upper}. Given that the Gini_{all} index investigates the concentration of wealth in society and the Share_{upper} is just a more illustrative metric of this phenomenon, this correlation is comprehensible.

The moderate correlation between the Gini_{upper} index and the Share_{upper}, along with the increasing Share_{upper} over time (described below), indicates a potential trend. This trend suggests a growing concentration of wealth in the uppermost part of the wealth distribution as their access to wealth increases. This observation indicates the presence of a relational wealth-based differentiation in the upper part of society or the development of a more subdivided wealthy elite in this part of society as their access to wealth increases.

Furthermore, there is a weak negative correlation between the Gini_{upper} and Gini_{low} indices, showing that with a growing inequality in the upper part of the

Social segments and effect size	Test power 0.95/ significance level 0.1	Test power 0.8/ significance level 0.1	Test power 0.95/ significance level 0.05	Test power 0.8/ significance level 0.05
Gini _{all} index ($r=0.2$)	898	474	1136	650
Hypothetical effect size $r=0.8$	58	32	74	42

Table 8. The minimum samples sizes needed for a statistical meaningful analysis, with calculations based on the real effect size of the Gini_{all} index and a hypothetical effect size, two commonly used test powers and two different significance levels.

wealth distribution, inequality in the lower part of the wealth distribution tends to decrease. Given that there is an additional growing concentration of wealth in the upper part of the wealth distribution over time (as described below), this hints towards a decreasing possibility or the desire to develop and showcase relational wealth differences in the lower part of the wealth distribution.

In the course of the analysis, it became apparent that there is a notable difference between the Gini index which only considers the undisturbed graves (Gini_{dist} index; Table 5) and the Gini index measured on all graves (Gini_{dist+undist} index; Table 5). While the correlation between the ratio of disturbance and the difference in the Gini index (Δ Gini_{dist} to Gini_{dist+undist} index) is limited overall ($r = 0.35$), individual cemeteries occasionally show differences between disturbed and undisturbed Gini values. To account for this variability and the potential bias from targeted robbing, the median Gini index from the Gini_{dist} and Gini_{dist+undist} indices were determined for each cemetery (see Table 5) and used for further considerations of the inequality development (referred to as Gini_{all} index; see Subchapter 4.3.3.1). For segment-specific measures (Gini_{low}, Gini_{upper}, Share_{upper}, GEM), values from all graves were used, as these benefit more from maximizing sample size (see Subchapters 3.2.3.1 and 4.3.3.1). Overall, the strong correlation between the disturbance-adjusted Gini_{all} index and GEM[1] ($r = 0.89$), which is based on all graves including disturbed ones, indicates that the different methodological approach of forming the Gini_{all} index does not produce significant discrepancies that are altering the discussion of segment-specific and overall inequality. The following discussion therefore emphasizes temporal trends and structural relationships rather than absolute values.

5.4 Boundaries of the analysis: Statistical significance, effect size and sample size

The data for this study has been collected following what in social sciences would be described as a convenience and purposive sampling approach (Misoch 2015, 193; Palinkas *et al.* 2015). Sites have been selected based on their availability in the literature as a main criterion and they also had to fit a certain size (min. 10 burials) and chronological criteria (good cover of the time period; Subchapter 3.1). Emphasis was put on including a variety of different material cultures. Data collection from the literature is a time-consuming task, hence before starting the study, a sample size was determined that was based on a hypothetical strong effect size ($r=0.8$; Table 8). For the moment, the present sample is regarded as representing the prehistoric social landscape. As will be shown below, the observed effect size for the development of mean inequality over time ($r = 0.2$) turned out to be considerably smaller than the hypothetical basis for this estimate, which has implications for the required sample size discussed in the following (Table 8). Determining this effect size is itself a methodological contribution, providing a

point of reference for future research designs and for evaluating existing studies with smaller samples, though the specific values apply to the methodology used here and may differ for other social indices. Based on this, a sample size of at least 32 and up to 42 cemeteries was determined as the basis of this study.

However, when analysing the statistical difference of mean development between the aggregated time periods, it was possible to determine the real effect size. Consequently, the real minimal required sample size was calculated. In order to be able to make a statement about the extent to which a meaningful sample size was achieved in the subsequent analysis, a test for test power and the required sample size was carried out splitting the data into subsets for two time periods (5200-3750 BCE and 2250-1000 BCE) as an example. For this purpose, the G*Power software was used (Faul *et al.* 2007; Faul *et al.* 2009), and an analysis was carried out for the case of a non-parametric Wilcoxon-Mann-Whitney-U test with independent samples.

The effect size was determined with the help of R (package: “coin”) and is reported below for the comparison between the time periods 5200-3750 BCE and 2200-1000 BCE for the $Gini_{all}$ index. As can be derived from the analysis, the statistical effect between the two time periods is of small to medium size ($r=0.2$). The sample size required for the development of a statistical meaningful analysis range from 474 to 1136 cemeteries (Table 8), with the lower numbers already being a result of a lower test power and a lower significance level. The sample size underlying this study is therefore a weak basis to make statistically proven statements of specifically a mean development of inequality over time.

This is further emphasised by the results of the various statistical tests conducted during the analysis. First, as described in Subchapter 5.1, the confidence intervals of the Gini index already suggest weak but noticeable statistical differences between sites. The Kruskal-Wallis test⁴⁵ confirms that such differences exist within the $Gini_{all}$ indices of the dataset overall, and the Dunn’s test (online Supplements) further demonstrates statistically significant differences between the $Gini_{all}$ indices of individual sites. However, when comparing aggregated time periods, the analysis of statistical differences in median inequality using the Wilcoxon test (Appendix C, Wilcoxon test), as well as Levene tests for differences in the range of inequality (Appendix C, Levene test), reveal no statistical differences between three time periods, while the results are more nuanced when dealing with two time periods. Here especially the development of ranges shows a sound statistical validation.

Therefore, the following conclusions can be drawn from the analysis of social inequality in grave contexts:

- The results discussed in this study should be interpreted as indicative trends rather than statistically proven developments. Limitation in sample size is a common characteristic in many archaeological studies (Cowgill 2015, 6), as the necessary volume of data for robust statistical analysis is often unattainable.
- Future research employing a similar methodology to investigate the development of social inequality will need to collect a significantly larger dataset to make statistically reliable statements.

If increasing the dataset is not feasible, the methodology should be refined to enhance the effect size. This could potentially be achieved through alternative

45 Kruskal-Wallis test; p-value: 2.2×10^{-16} (value usually used in R to indicate a p-value very close to 0).

index methods that develop a social index based on a variety of additional factors such as grave architecture (e.g. Bösel 2008; Endrigkeit 2014; Großmann 2021; Müller 1994) or workload analysis (Nørtoft 2022).

Since the cemeteries used in this thesis are only a fraction of the funerary record from the Carpathian Basin, it would be possible to advance the dataset in the future.

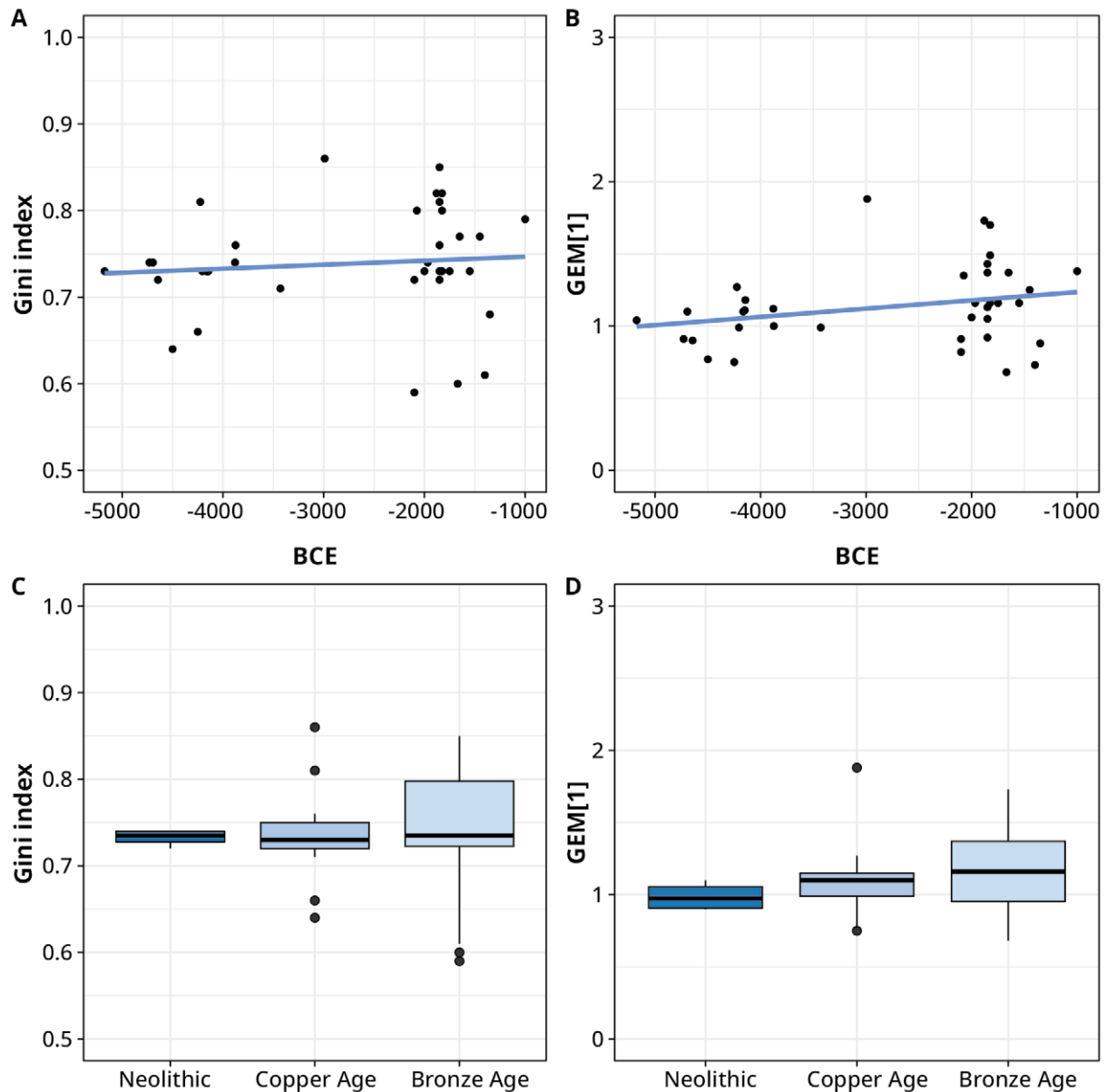
5.5 Trends in the mean development of inequality

Starting with the results of the development of social inequality, we first turn to an assessment of the general temporal development – as described by a linear trend function – between the Neolithic and the Bronze Age. The $Gini_{all}$ index does not show a clear change over the analysed time period (Fig. 11, A and C). The average $Gini_{all}$ index has the value of 0.73 around 5200 BCE and increased only marginally to 0.75 by 1000 BCE. This change does not represent a statistically significant increase (p-value: 0.54).⁴⁶ The average GEM[1] value (Fig. 11, B and D), which analyses the unweighted, overall inequality within a population, shows a similar pattern. Between 5200 and 1000 BCE, there is only a slight increase in the GEM[1] from 1.1 to 1.2, which also does not represent a statistically significant change (p-value: 0.12). Based on the not statistically significant change over the considered period and the marginal changes in the $Gini_{all}$ index and the GEM[1], one cannot speak of a general increase or decrease in social inequality. Importantly, this trend and the trends presented in the following are consistently supported by the median values of aggregated inequality measures across two (Early and Late) and three (Neolithic, Copper Age, and Bronze Age) time periods. While the mostly non-significant differences between periods do not statistically prove these development, they nonetheless indicate the robustness of the observed patterns and trends beyond the linear trend analysis alone (Appendix C). Further checks on robustness or sensitivity indicate the persistence of the trends under different scenarios of data omission (see online Supplement G).

In the lower part of the wealth distribution, a slightly different picture emerges. The difference in the $Gini_{low}$ index (Fig. 12, A and C) between 5200 and 1000 BCE is more pronounced, with a decrease from 0.65 to 0.58 compared to the $Gini_{all}$ index. However, this change also does not appear to be statistically significant (p-value: 0.12). Changes in GEM[0], which focus on the lower part of the wealth distribution (Fig. 12, B and D), are small, decreasing from 1.9 to 1.8 between 5200 and 1000 BCE, with no statistically significant change (p-value: 0.79). Evaluating these results is challenging because a purely objective and statistical view would also suggest stagnation over the entire period. The absolute greater change in the $Gini_{low}$ index compared to the much smaller change in the $Gini_{all}$ index, and the also slight decreasing trend in the GEM[0], at least suggests that with more data, a statistically detectable, though small decrease in social inequality in the lower part of the wealth distribution may be observed.

In the upper part of the wealth distribution, there are small to moderate changes. The $Gini_{upper}$ index (Fig. 13, A and C) increased from 0.3 to 0.37 between 5200 and 1000 BCE, with no statistical significance of this change (p-value: 0.28). The share that this upper part of the wealth distribution holds of total wealth ($Share_{upper}$)

⁴⁶ This thesis works with a common 0.05 significance level, although the quality of data, visible in the effect size, might justify a less rigid significance level of 0.1.



also increased during the observed period from 0.56 to 0.64 (Fig. 14), but this increase is once more not statistically significant (p-value: 0.08). The GEM[2], which focuses on the top part of the wealth distribution (Fig. 13, B and D), shows a notable and statistically significant increase from 1.6 to 3.1 between 5200 and 1000 BCE (p-value: 0.04). Although not all changes in the upper segment show a clear and statistically significant shift, there is a more pronounced change in the upper part of the wealth distribution compared to the $Gini_{all}$ index and GEM[1]. A clear increase in social inequality among the wealthiest individuals in younger periods is likely, given the substantial and statistically significant change in GEM[2]. Thus, one can speak of a general increase in social inequality in the upper part of the wealth distribution. Correspondingly, the visible rise in $Share_{upper}$ indicates that such an increase in social inequality among the wealthiest members of society might have been accompanied by a growing amount of wealth available to be distributed within this group.

This last observation is by no means of minor importance, as with increasing inequality in the upper part of the wealth distribution, this additional wealth

Figure 11. Development of social inequality analysed in cemeteries (black dots) between 5200 and 1000 BCE. A) Development of the $Gini_{all}$ index between 5200 and 1000 BCE described by a linear regression (blue line); B) Development of the GEM[1] between 5200 and 1000 BCE described by a linear regression (blue line); C) Development of the $Gini_{all}$ index between archaeological periods; D) Development of the GEM[1] between archaeological periods.

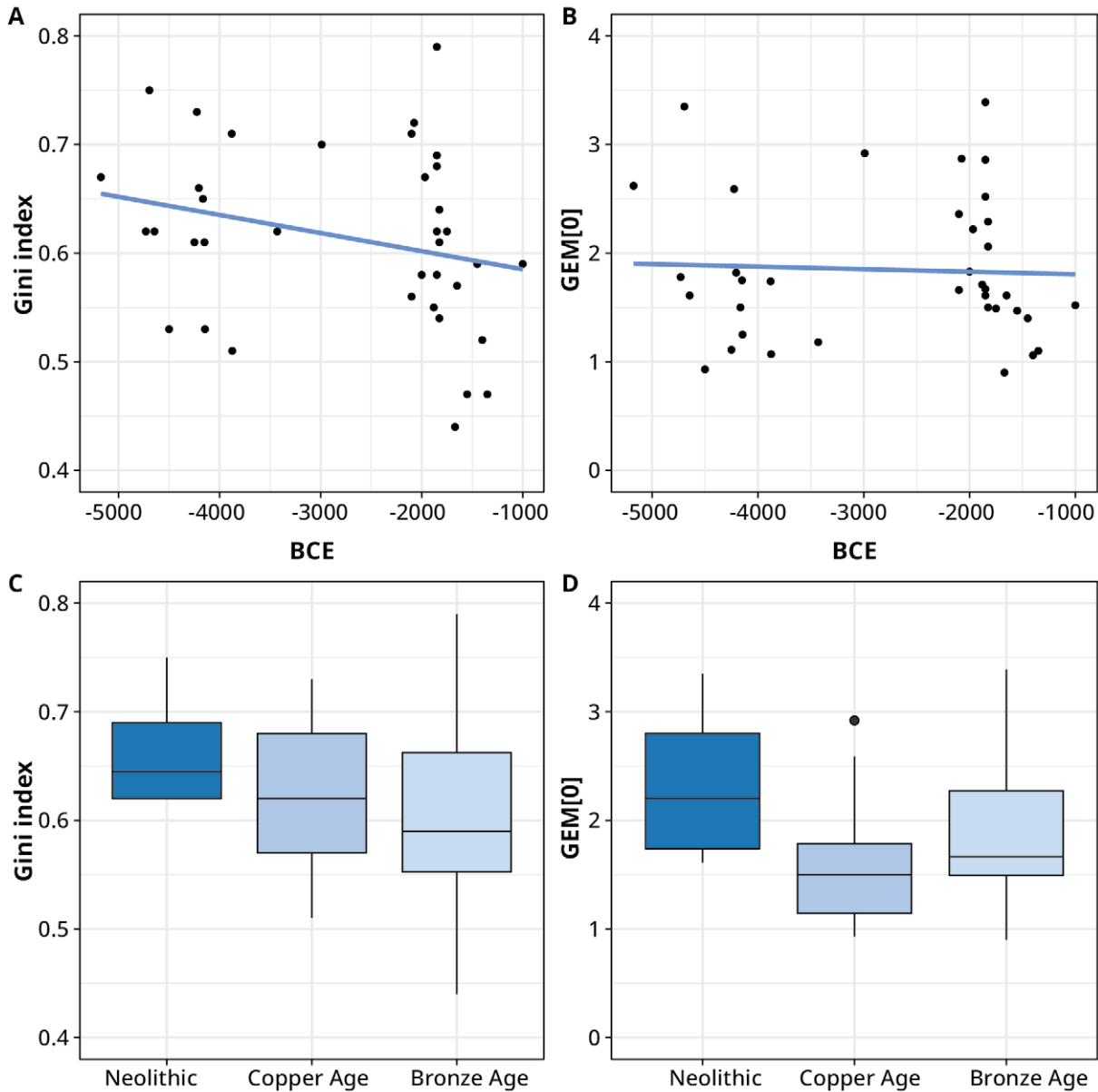


Figure 12. Development of social inequality analysed in cemeteries (black dots) between 5200 and 1000 BCE in the lower end of the wealth distribution. A) Development of the $Gini_{low}$ index between 5200 and 1000 BCE described by a linear regression (blue line); B) Development of the $GEM[0]$ between 5200 and 1000 BCE described by a linear regression (blue line); C) Development of the $Gini_{low}$ index between archaeological periods; D) Development of the $GEM[0]$ between archaeological periods.

seems to be used to differentiate the differences in status within an ever-smaller proportion of society. Thus, even within the wealthier part of society, there appears to be a trend towards a “privilege” of differentiating relational wealth in burials exclusively for the very top of the wealthiest segment.⁴⁷ Alternatively, there may be a loss of significance and a decreasing possibility for the representation of relational

⁴⁷ Although the $Gini_{low}$ index is higher than the $Gini_{upper}$ index, and $GEM[2]$ exceeds $GEM[0]$, this does not reflect a contradiction but rather the differing sensitivities of the measures. The $GEM[0]$ puts emphasis on the lower-end disparities, while the $GEM[2]$ gives more weight to upper-end differences. This reflects the fact that, despite substantial inequality within the lower segment, its overall impact on inequality ($Gini_{all}$ index and $GEM[1]$) is limited in absolute terms, whereas $GEM[2]$ captures the strong divergence between the top and the rest, even if the top is internally homogeneous. Notably, the $Gini_{low}$ index and $GEM[0]$ slightly decline over time, while the $Gini_{upper}$ index and $GEM[2]$ increase considerably – indicating that both Gini and GEM consistently reflect a temporal shift toward rising inequality in the upper segment ($Gini$ index) and by the upper segment (GEM). However, the persistently high $Gini_{low}$ index, suggests disparities between the “poor” and the “very poor”, which could also be due to the chosen segment boundaries.

wealth outside of this top part of the wealthiest segment, as is often assumed for the Middle and the Late Bronze Age (Brück and Fontijn 2013, 198; Harding 2004, 364ff., 402, tab. 12.1; O'Shea 2011, 165).

5.6 Trends in the development of inequality: The range of inequality measures

Besides versatile developments in the mean trend of inequality measures – especially between social segments – a differentiated development in the range of social inequality can also be observed between 5200 and 1000 BCE. Across entire societies, as indicated by the $Gini_{all}$ index and the GEM[1], there is a clear increase in the difference between the highest and lowest inequality measurements between time periods⁴⁸ (Fig. 11, C and D; Table 9 and Table 10). In the $Gini_{all}$ index, there is a sharp increase from a range of 0.02 in the Neolithic to 0.22 in the Copper Age. A less pronounced but notable increase also occurs in the Bronze Age, to a range of 0.26. The range in the GEM[1] also increases notably between the Neolithic and the Copper Age, from 0.2 to 1.13. However, by the Bronze Age, there is a slight decrease in the GEM[1] range to 1.05. This observation of a growing range is evident to varying degrees in almost all further inequality measures. For instance, in the lower part of wealth distribution, the range of the $Gini_{low}$ index increases from 0.13 in the Neolithic to 0.35 in the Bronze Age (Fig. 12, C and D; Table 9 and Table 10), and the range of the GEM[0] increases from 1.74 to 2.49. In the upper part of wealth distribution, the $Gini_{upper}$ index shows a notable increase between the Neolithic and the Copper Age, from 0.26 to 0.49 (Fig. 13, C and D; Table 9 and Table 10), with a slight decrease in range to 0.46 in the Bronze Age. The GEM[2], in contrast, indicates an increase between the successive periods, from 0.65 in the Neolithic to 5.63 in the Bronze Age. Finally, an increase in range is also observed in the $Share_{upper}$ values (Fig. 14, B; Table 9 and Table 10), with the difference between highest and lowest values increasing from 0.06 in the Neolithic to 0.31 in the Bronze Age, and already reaching 0.3 in the Copper Age, significantly higher compared to Neolithic cemeteries. However, similar to the analysis of mean inequality, the range of social inequality shows no statistically significant variation across three individual time periods (Appendix C). When analysing within two aggregated time periods – Early and Late – potentially also due to increased subsample size, a significant increase in the range becomes evident for the $Gini_{all}$ index, $Share_{upper}$, GEM[1], and GEM[2] (online Supplement B), lending strong statistical support to the observed pattern. While caution is warranted given the sensitivity to subsample size, the convergence of multiple significant results across different metrics strongly suggests that the increasing range of social inequality represents more than a mere trend and is likely reflective of a genuine developmental process. Verifying this widening of the range with additional robustness checks, supports the developments outlined in the here (see online Supplement G). However, further data will be needed to fully proof this conclusion.

48 The time periods date as follows: the Neolithic 6000-4500 BCE (the earliest site in this study is Nitra – Horné Krškany/ Priemyslová ulica (Cat. No. 22) which dates around 5200 BCE), the Copper Age 4500-2500 BCE, and the Bronze Age 2500-700 BCE (the youngest site in this study is Budapest-Békásmegyer (Cat. No. 8) which dates around 1000 BCE). The cemeteries have been assigned to the periods based on the assignment made by their excavators or the respective chronological studies, which are mentioned in the catalogue.

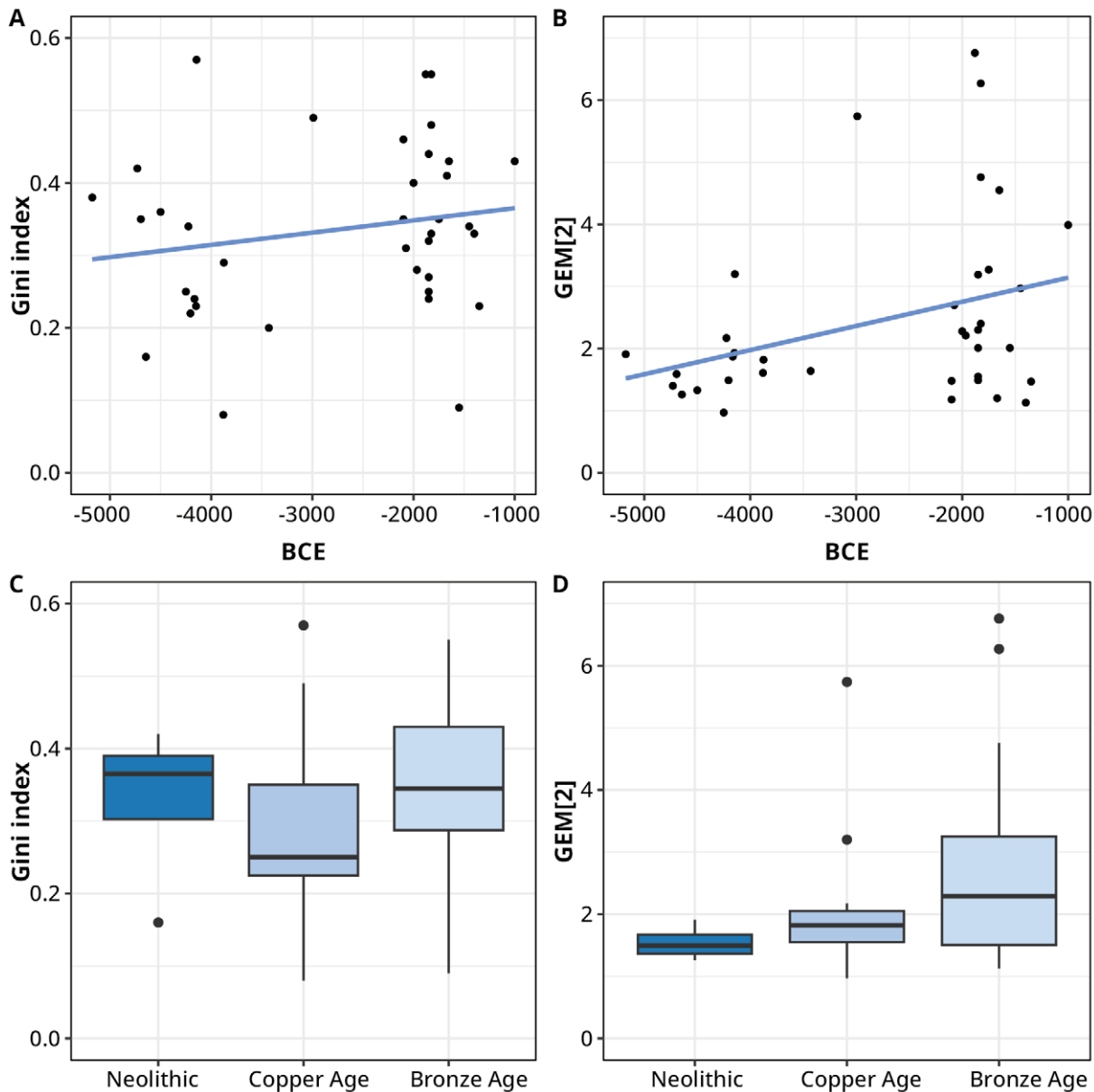


Figure 13. Development of social inequality analysed in cemeteries (black dots) between 5200 and 1000 BCE in the upper end of the wealth distribution. A) Development of the $Gini_{upper}$ index between 5200 and 1000 BCE described by a linear regression (blue line); B) Development of the GEM[2] between 5200 and 1000 BCE described by a linear regression (blue line); C) Development of the $Gini_{upper}$ index between archaeological periods; D) Development of the GEM[2] between archaeological periods.

While not consistently clear across all parts of the wealth distribution, the examination of minimum and maximum values with the $Gini_{all}$ index and the GEM[1] (Table 10) indicates that the increase of the range is not only due to greater highest inequality but also involves a reduction of the lowest inequality. Thus, alongside increasingly unequal societies during the younger prehistory, there were also societies showing a more equitable distribution of relational wealth.

5.7 Temporal dynamics of inequality: LOESS regression analysis

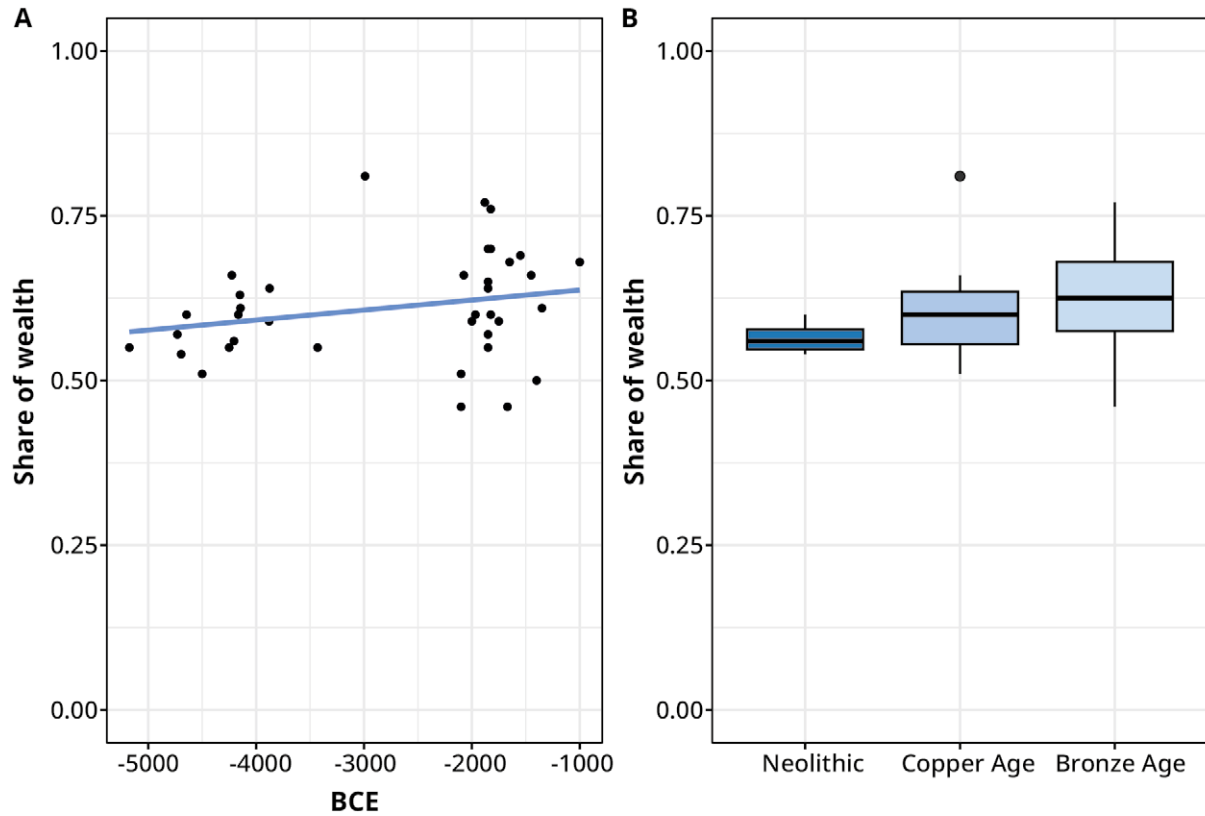
In addition to analysing the general development of social inequality – specifically the long-term trend observed from the data spanning from 5200 to 1000 BCE, as presented in the previous sections – a more detailed picture emerges from examining the moving average using LOESS regression analysis (Locally Estimated Scatterplot

Period	Gini _{all}	GEM[1]	Gini _{low}	GEM[0]	Gini _{upper}	GEM[2]	Share _{upper}
Neolithic	0.02	0.2	0.13	1.74	0.26	0.65	0.06
Copper Age	0.22	1.13	0.22	1.99	0.49	4.77	0.3
Bronze Age	0.26	1.05	0.35	2.49	0.46	5.63	0.31

Table 9. Range of inequality measures in the Neolithic, the Copper Age and the Bronze Age.

Period	Gini _{all}	GEM[1]	Gini _{low}	GEM[0]	Gini _{upper}	GEM[2]	Share _{upper}
Neolithic	0.72 : 0.74	0.9 : 1.1	0.62 : 0.75	1.61 : 3.35	0.16 : 0.42	1.26 : 1.91	0.54 : 0.6
Copper Age	0.64 : 0.86	0.75 : 1.88	0.51 : 0.73	0.93 : 2.92	0.08 : 0.57	0.97 : 5.74	0.51 : 0.81
Bronze Age	0.59 : 0.85	0.68 : 1.73	0.44 : 0.79	0.9 : 3.39	0.09 : 0.55	1.13 : 6.76	0.46 : 0.77

Table 10. Lowest and highest value of the single inequality measures in the different time periods.

Figure 14. A) Development of the Share_{upper} between 5200 and 1000 BCE described by a linear regression (blue line); B) Development of the Share_{upper} between archaeological periods.

Smoothing). This analysis reveals a wave-like pattern where social inequality goes through temporally limited phases of increase and decrease (Fig. 15 and Fig. 19).⁴⁹ This finding does not contradict the earlier observation of an overall stagnation in social inequality across entire societies ($Gini_{all}$ and $GEM[1]$), since it suggests that the regression curve fluctuates around a central value and tends to return to a level between 0.7 and 0.75 ($Gini_{all}$ Index) or between 1 and 1.2 ($GEM[1]$) after periods of increase or decrease. Thus, although there are changes in inequality during certain time periods, no lasting change can be observed in this higher temporal resolution, too. Overall, the meandering pattern might suggest cyclical trends (Fig. 16) in the development of inequality, rather than a linear development (cf. Gronenborn 2016; Müller 2017, 25-26). Such cyclical patterns have been commonly investigated for the description of ecosystems and further developed for an application to social systems (Fath *et al.* 2015). However, reconstructing complete social cycles would require investigating entire social systems and various proxies, not just analysing social inequality (Garmestani *et al.* 2009; Gronenborn *et al.* 2017; Gronenborn *et al.* 2018; Gunderson and Holling 2002).

A large gap in the dataset between 3750 and 2100 BCE⁵⁰ can be observed. This gap is not exclusive to this study and – beside a lack of cemeteries that fit the criteria of this thesis – insufficient data coverage can also be observed in settlement data during this time period in the Carpathian Basin (Duffy *et al.* 2025). It is very likely that due to the weak data coverage and therefore weak local fitting, the course of the regression line in this period is misleading and might be highly affected by possible outliers. For this reason, this time period will not be further discussed and developments in the time period from 5200 to 3750 BCE as well as from 2100 to 1000 BCE⁵¹ are discussed in more detail.

5.7.1 First Meander: from 5200 to 3750 BCE

The first meander in the development of social inequality is visible between 4800 and 4200 BCE (Fig. 15 bottom and Fig. 19). During the transition from the Late Neolithic to the Early Copper Age, social inequality decreased between 4800 and 4500 BCE (minimum: $Gini_{all}$ index: 0.67; $GEM[1]$: 0.8), but rose back to approximately its original level between 4500 and 4200 BCE. In this period, several well-documented social and economic developments were observed that could have influenced this temporary change in social inequality not only in the Carpathian Basin (Gronenborn *et al.* 2018). However, within the scope of this work, no binding statement can be made regarding the individual significance or correlations of influences on temporary changes in inequality.

During the transition from the Late Neolithic to the Early Copper Age in the Carpathian Basin and Southeastern Europe, the decline of tell settlements gave way to a network of smaller, short-lived and dispersed flat settlements (Bánffy 1994; Gyucha *et al.* 2014, 277; Hertelendi *et al.* 1997; Kalicz 1998b, 331-333; Kruk and Milisauskas 2018; Mlekuž Vrhovnik 2019, 279; Parkinson 2002; Windler 2017). This period also witnessed a shift from relying on primary to secondary animal products

⁴⁹ Although only the $Gini_{all}$ index and $GEM[1]$ are shown in this chapter, this wave pattern can also be observed to various extents in the other inequality measures and parts of the wealth distribution.

⁵⁰ Only two cemeteries fall into this time period: Pilismarót-Basaharc (Cat. No. 25) and Budakalász-Lupa-csárda (Cat. No. 7). Although both sites belong to the Baden group, they show a large difference in measured inequality, which might be a hint of a more complex dynamic of social inequality in this time period that is not sufficiently covered by the present data.

⁵¹ 5200 to 3750 BCE is covered by 13 cemeteries; 2100 to 1000 BCE is covered by 22 cemeteries.

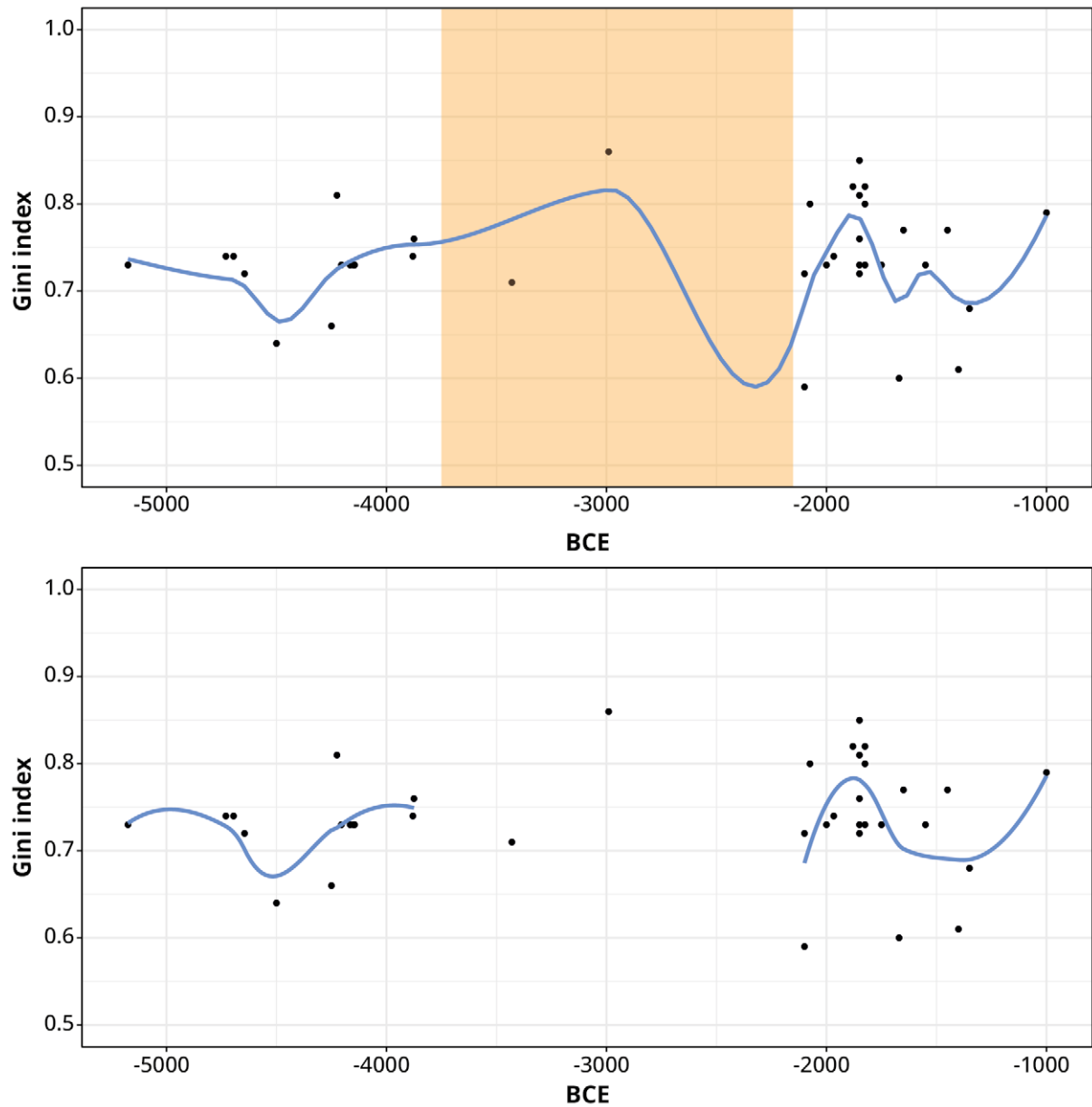


Figure 15. Development of the $Gini_{all}$ index described by a LOESS regression for the depiction of a higher temporal resolution; black dots: cemeteries. Top) LOESS regression on the entire dataset, including a large period with insufficient data coverage (3750-2100 BCE marked in light orange; span: 0.4); bottom) LOESS regression on two subsets, before and after the period with insufficient data coverage (span: 0.8). Figures of the other social segment are in online Supplement B.

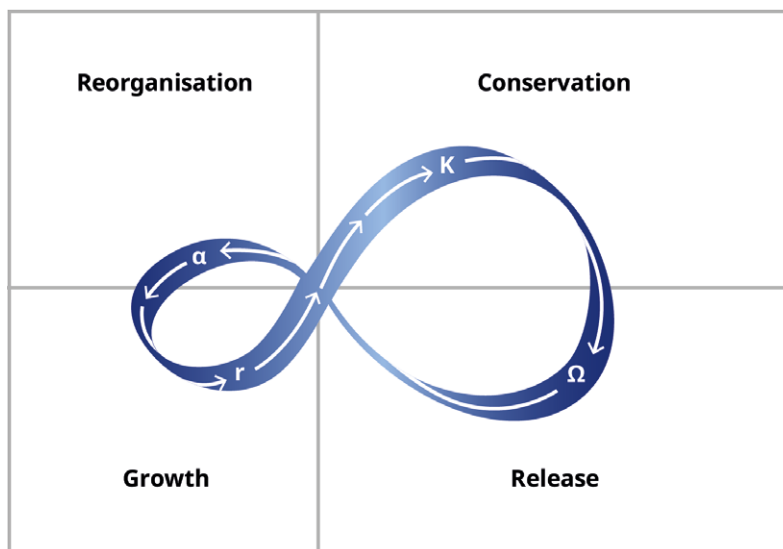


Figure 16. The adaptive cycle (after Garmestani *et al.* 2009).

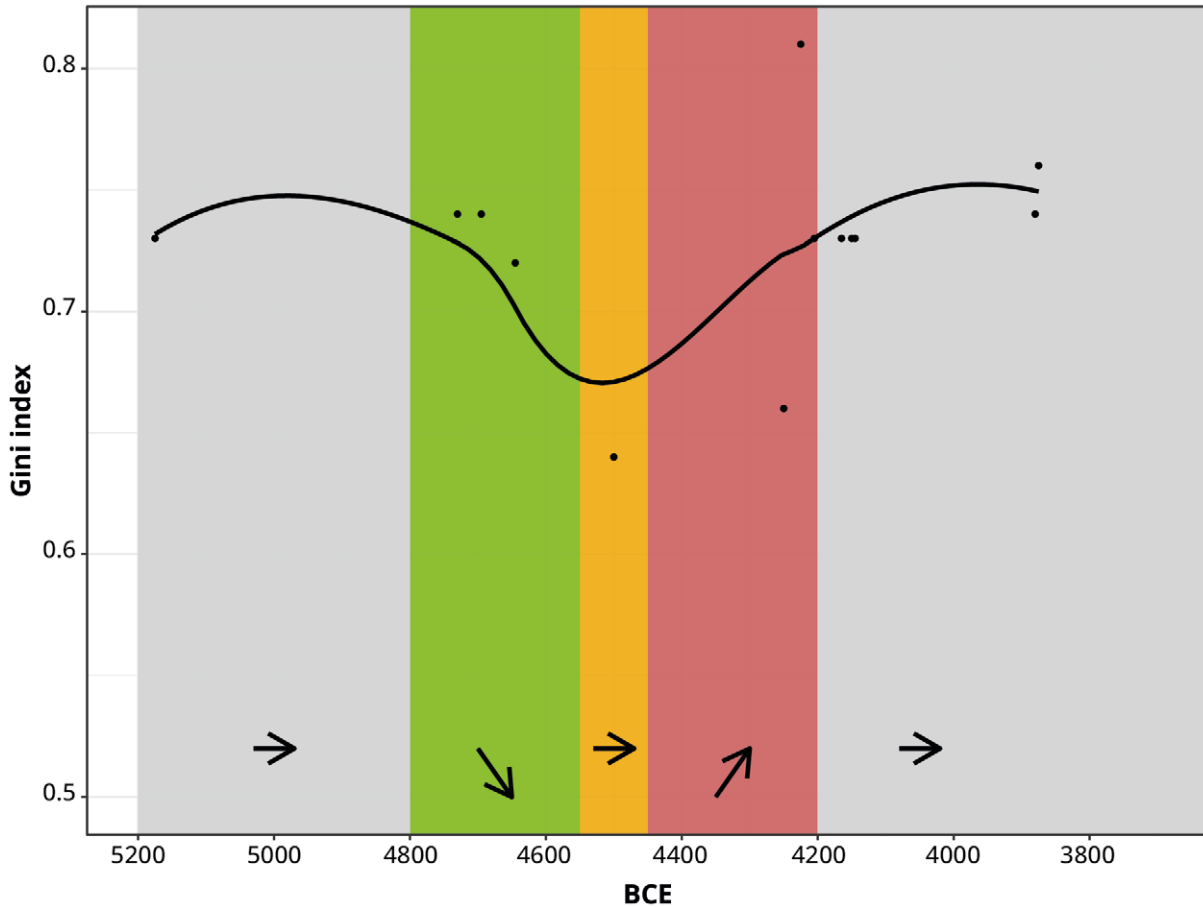


Figure 17. LOESS regression (span: 0.8) of the $Gini_{all}$ index between 5200 and 3750 BCE. Arrows indicate an increase, stagnation or decrease of social inequality in the colour-marked time periods. Grey: general stagnation; green: decrease; orange: tipping point; Indian red: increase.

(Parkinson 2006), potentially stabilising food resources, while climatic fluctuations, alternating between cold and warm periods, possibly put pressure on food stability (Botić 2016, 21-22).

Between 6000 and 5000 BCE, there was a notable increase in population density, followed by a significant decline around 4000 BCE (Müller and Diachenko 2019). This demographic shift coincided with changes in settlement patterns and population density (Müller and Diachenko 2019; Parkinson 2006; Parkinson *et al.* 2021). The concentration of people in tells and larger settlements,⁵² which occurred between 5000 and 4500 BCE (Duffy *et al.* 2025, fig. 3), likely led to stress and resource overexploitation, such as the use of wood and clay, challenging the sustainability of these settlements (Gyucha *et al.* 2010, 119ff.; Parkinson *et al.* 2021).

W. A. Parkinson (2006) argues that the changes in settlement patterns were more likely due to “scalar stress”, a societal stress developing from high organisational requirements due to population concentrations (Johnson 1982), rather than ecological factors. The size of the Late Neolithic tell settlements did not inherently require hierarchical organisation (Porčić 2019, 369), but their size necessitated

⁵² Some examples of such tell and larger flat settlements of this time period are: Balatonszárszó-Kis-erdei-dűlő (flat settlement, Hungary, 10 ha, Oross *et al.* 2013); Bordoš (tell and flat settlement, Serbia, 50 ha, Hofmann *et al.* 2019); Drenovac (flat settlement, Serbia, 35 ha, Rassmann *et al.* 2021); Hódmezővásárhely-Kökénydomb (tell, Hungary, 6 ha, Raczky *et al.* 2022); Uivar (tell, Romania, 12 ha, Schier and Draşovean 2020); Polgár-Csőszhalom (tell and flat settlement, Hungary, tell 4 ha; flat-settlement 28 ha, Raczky and Anders 2010); Őcsöd-Kováshalom (tell-like, Hungary, 21 ha, Hofmann *et al.* 2019; Raczky and Füzesi 2017); Vrablé – Vel’ke Lehemy (flat settlement, Slovakia, 50 ha, Furholt *et al.* 2020).

some form of political or organisational structure to manage internal tensions (Parkinson 2006). Without effective organisational structures or in cases of strong inequality, tensions within society could lead to migration or violence, contributing to the development of smaller settlements (Bandy 2004; Johnson 1982) across the Carpathian Basin and leading to a temporal limited decrease of inequality.

It can be assumed that increased organisation or political power may result in a rise of high-status individuals potentially in the phase prior to the decrease of social inequality, thereby increasing or consolidating relational wealth inequality. In contrast, the fragmentation of societies into smaller units as a reaction of such consolidating inequalities could counteract this trend by limiting the need and opportunities for leading roles, which might be rewarded with a high-status. This might be evident in the temporarily limited reduction of relational wealth disparities observed between 4800 and 4500 BCE.

5.7.2 Second Meander: from 2100 to 1000 BCE

The second meander is well-supported by data⁵³ and can be observed between 2100 and 1750 BCE (Fig. 15, bottom and Fig. 19). In contrast to the first meander described above, this period does not exhibit a temporary decrease but rather an increase of measured inequality, reaching its maximum around 1875 BCE (maximum: Gini_{all} index: 0.78; GEM[1]: 1.3). By 1700 BCE, the Gini_{all} index and by 1600 BCE, the GEM [1] returned to their initial values (Gini_{all} index: 0.69-0.7; GEM[1]: 0.95-1) and remain within this range until a new increase begins around 1400 BCE. This incline towards the end of the observed period can also be attributed to the weak data coverage⁵⁴ at the end of the time series, which, due to local fitting of the regression line, heavily weights the last data point of the time series. For this reason, this last increase, or the implied meander starting around 1400 BCE, will not be discussed further. Regarding the developments between 2100 and 1750 BCE, there are various other processes which occur contemporaneously to the temporary change of social inequality, for example, around 2200 BCE in general, a period of social, material and climatic change starts throughout Europe (cf. Meller *et al.* 2015).

Placing this meander of the inequality development in an archaeological context reveals a series of profound and contemporary cultural, economic, and ecological changes. From 2200 BCE onwards, copper and bronze metallurgy intensified, visible in the increasing number of metal artefacts and leading to expanded exchange networks and presumably raw material dependencies (Fischl *et al.* 2013, 363; O'Shea 2011, 165; Schauer *et al.* 2021, fig. 2 (3000-2000 BCE); Vandkilde 2019). As various scholars discussed, a local elite emerged in the form of chiefdoms and ranked societies in the Copper Age which were not only marked on the basis of exploitation or the control of resource networks but also by status and prestige, as indicated by richly furnished graves that formed the basis for the social organisation of Bronze Age societies (Dani *et al.* 2016, 219; Harding 2002, 324ff.; Harding 2004, 390, 410-411; Müller 2017, 25; Shennan 1993, 149).

In addition to the changes in material culture and resources, the Early Bronze Age cemeteries in Southwestern Slovakia and Eastern Central Europe show increased

⁵³ Of 22 cemeteries from the Bronze Age, 15 date in the time period from 2100 to 1750 BCE.

⁵⁴ There is a 350-year gap between the median date of the sites of Mezőcsát (Cat. No. 20) and Budapest-Békásmegyer (Cat. No. 8) at the end of the time series.

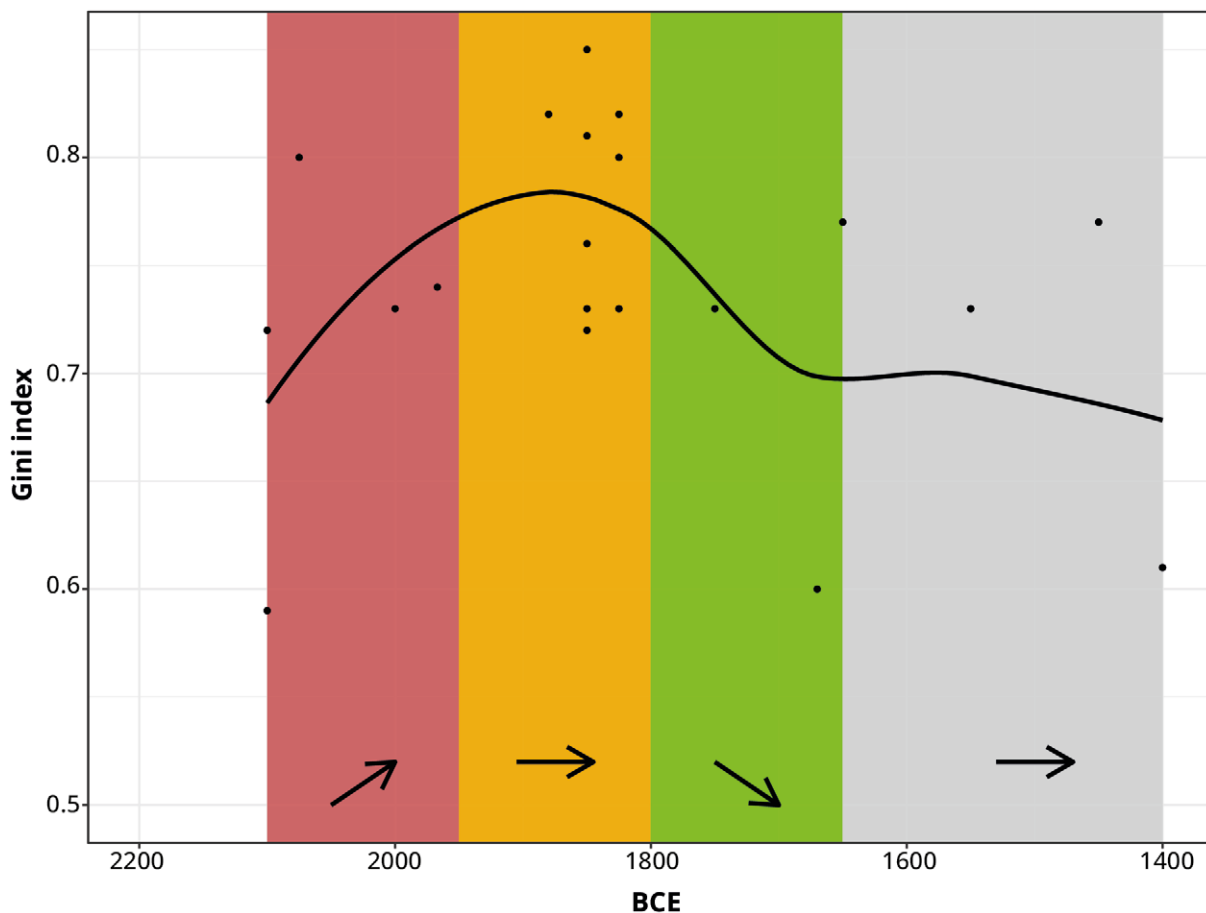


Figure 18. LOESS regression (span: 0.8) of the $Gini_{all}$ index between 2200 and 1400 BCE. Arrows indicate an increase, stagnation or decrease of social inequality in the colour-marked time periods. Grey) general stagnation; green) decrease; orange) tipping point; Indian red) increase.

trauma and violence, suggesting heightened willingness for conflict⁵⁵ (Hukelova 2016, 203-222). This is further emphasised by the increasing number of weapons in grave contexts between 2200 and 1500 BCE (Hårde 2006, 364ff.; Harding 2002, 315ff.). From an environmental perspective, there is a short-term climate deterioration in the Carpathian Basin between 2200 and 2000 BCE that may have contributed to social and economic instability, although it might not have been the cause for an abrupt change (Fischl *et al.* 2015, 516). This climatic fluctuation is initiated by a drier phase in the Late Copper Age which gave way to cooler, wetter conditions around 2200 BCE, which lasted for about 200 years, followed by a more stable and favourable climate phase with warmer, wetter temperatures from 2000 to 1500 BCE (Constantin *et al.* 2007, 334-336; Demény *et al.* 2019; Fischl *et al.* 2015, 509-510; Michczyńska *et al.* 2007, 804; Perşoiu *et al.* 2019, 783-787; Pleskot *et al.* 2020, 11).

Population density in Southeastern Europe rose significantly from around 2500 BCE (Müller 2015, 210, fig. 17.3, 17.8; Müller and Diachenko 2019), although we cannot observe a clear increase of density within the settlement record (Duffy *et al.* 2025, fig. 3). The settlement network evolved from small, often short-lived Copper Age settlements⁵⁶ to a more complex system with functionally

⁵⁵ German: *Gewaltbereitschaft*.

⁵⁶ E.g. Balatonszárszó-Kis-erdei-dűlő (Lengyel phase, flat settlement, Hungary, 3 ha, Oross *et al.* 2010); Vésztő-Bikeri (flat settlement, Hungary, 1.5 ha, Parkinson *et al.* 2021); Branč-Helyfölk (Ludanice group, flat settlement, Slovakia, 1.5 ha, Vladár and Lichardus 1968); Jelšovce (Ludanice group, flat settlement, Slovakia, min. 3 ha, Pavúk and Batora 1995); Svodín (Lengyel culture, flat settlement, Slovakia, Němejcová-Pavúková 1995).

specialised centres in the Early and the Middle Bronze Age, often becoming tells in the Eastern and Central Carpathian Basin⁵⁷ and fortified sites in the north⁵⁸ (Bátora 2018; Dani *et al.* 2019; Furmánek *et al.* 1999; Gogâltan 2017; Müller-Scheeßel *et al.* 2020; Skorna *et al.* 2018; Staniuk 2021; Točík 1978). Tells and larger fortified settlements appeared between 2200 and 1500 BCE throughout the Carpathian Basin and were replaced by a dense network of interconnected smaller settlements with regional large “mega-forts” from 1400 BCE onwards (Bátora 2013; Furmánek *et al.* 1999, 111ff.; Kristiansen and Larsson 2005, 125; Molloy *et al.* 2023). Although the mean settlement size might not have changed much in comparison to earlier periods, the maximum settlement size clearly rose in the second half of the Bronze Age (Duffy *et al.* 2025, fig. 3). It can be assumed that like in the Neolithic, tell settlements show high levels of population concentration in comparison to flat settlements⁵⁹ (Artursson 2010, 101).

Similar to the first meander, when considering the period from 2100 to 1000 BCE, especially in terms of the development of settlement networks, one would expect a change in social inequality that accompanied the entire evolution of the settlement network – from the concentration of population in tell settlements from around 2200 BCE to their dissolution around 1500 BCE (Artursson 2010, 100ff.; Staniuk 2021). While an influence of population and settlement dynamics can be linked to the increase between 2100 and 1850 BCE, it appears that from 1850 BCE onwards, the decrease in social inequality was facilitated by other processes. Attempting to explain the increase in social inequality between 2100 and 1850 BCE, two developments are noteworthy:

- The population increase in Southeast Europe from 2500 BCE onwards (Müller 2015, 210, fig. 17.3, 17.8; Müller and Diachenko 2019), accompanied by the concentration of population in densely populated tell and fortified flat settlements, such as Kakucs-Turján (Jaeger 2018), Feudvar near Mošorin (Falkenstein *et al.* 2014; Hänsel and Medović 1991) or Nitriansky Hrádok-Zámeček (Točík 1981), might be understood as an increasing population pressure and stressor on societies. To what extent climatic deterioration between 2200 and 2000 BCE triggered this formation of larger settlement communities – for example, to achieve greater food security and a division of labour – cannot be reliably assessed (Fischl *et al.* 2015). However, population growth can be considered a trigger for a more differentiated organisation of societies due to scalar stress (Johnson 1982). Studies show that individuals or groups occupying an organisational function or possessing certain valuable skills within societies can attain high esteem, possibly in connection with high

57 E.g. Feudvar near Mošorin (tell, Serbia, 7.2 ha, Falkenstein *et al.* 2014; Hänsel and Medović 1991); Kakucs-Turján (tell, Hungary, 2.2 ha, Jaeger 2018; Jaeger *et al.* 2021a; Staniuk 2020); Mezőcsát-Laposhalom (tell-like, Hungary, 8.2 ha, Kienlin *et al.* 2018); Százhalombatta-Földvár (tell, Hungary, up to 6 ha, Kovács *et al.* 2020); Vrablé – Fídvár (tell-like, Slovakia, 14.2 ha, Bátora *et al.* 2012).

58 E.g. Nitriansky Hrádok-Zámeček (fortified flat settlement, Slovakia, 2 ha, Točík 1981); Spišský Štrvok (fortified/tell-like settlement, Slovakia, 0.7 ha, Jaeger 2014); Veselé – Hradisko-Podzámске (fortified flat settlement, Slovakia, Marková and Staššíková-Štukovská 2015).

59 The increase in density is not observed in the Bronze Age sample of the study by Duffy *et al.* (2025), which can be attributed to the tell settlements not meeting their criteria for inclusion in the calculations for the Gini index and settlement density. Consequently, their findings do not provide a definitive statement on population density in Bronze Age tell settlements; however, examining the Neolithic sample offers an opportunity to make a general statement about population density in tell settlements.

relational wealth⁶⁰ (e.g. Henrich and Gil-White 2001; Koski *et al.* 2015, 531; Price and van Vugt 2014). It is noteworthy, however, that such a role can, but must not be “rewarded” with a high status by a society (mutualism; Mattison *et al.* 2016), but can, alternatively, be claimed forcefully and exploited to extract wealth (coercion; Mattison *et al.* 2016). In the latter case, through exploitation of material goods and the increase of material wealth, individuals also gain the possibility to invest in return increases of their relational wealth (*i.e.* feasts; Bliege Bird and Smith 2005).

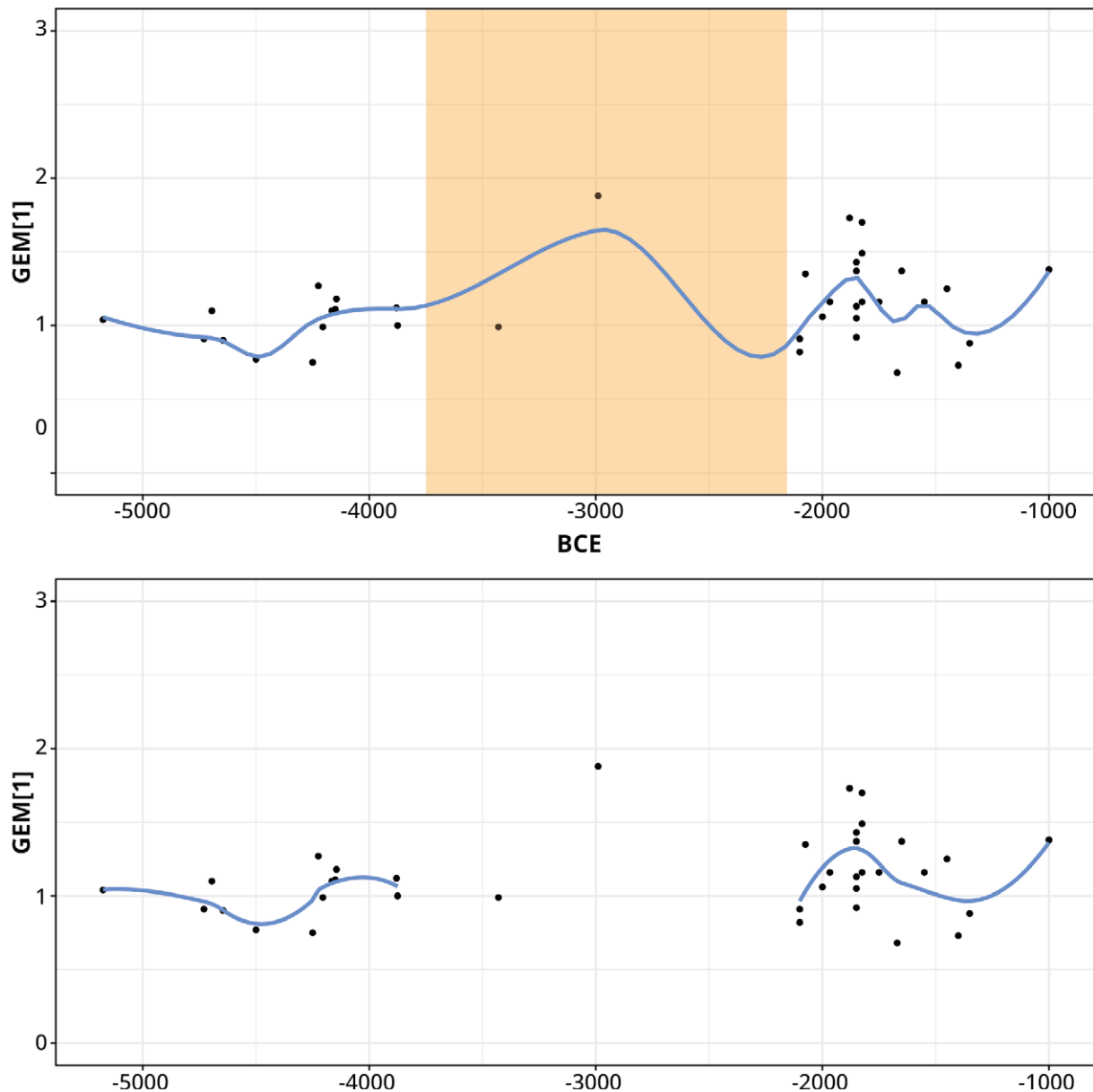
- The establishment and expansion of copper and bronze metallurgy, which experienced intensification throughout the Copper Age and the Bronze Age (Kiss 2020; Powell *et al.* 2017; Radivojević *et al.* 2019, 163ff.; Schauer *et al.* 2021, fig. 2; Vandkilde 2019, 6). In the Early Bronze Age, bronze objects functioned often as prestige and status symbols, alongside an increasing availability of metal (Kristiansen and Larsson 2005, 112ff., 134f.). Control over resource networks or even resource deposits taken over by individuals or groups could have led to an unequal distribution of these status-signifying materials within and between societies.

The increase in markers of violence and weaponry in graves from this period could be another development related to the rise in social inequality (Hårde 2006, 364ff.; Harding 2002, 315ff.; Hukelova 2016, 202ff.). Whether increasing levels of social inequality were the cause of conflicts or whether trauma and weapons were expressions of a suppressed population group cannot be clarified. In the first case, the concentration of population in fortified and tell settlements as a response to increasing willingness for conflict from outside could be assessed, drawing individuals into population agglomerations where they might have had to align themselves with hierarchy (“the lesser evil”). In this case, groups that ensure security (*i.e.* warriors) or hold the monopoly on violence and offer the “service” of protection would be expected to have higher status and relational wealth. In the second case, traumas and violence would be interpreted as signs of intra-societal conflicts. In this case, violence could originate from groups that already possess high relational wealth and use violence to enforce and secure their status within their society (oppression). Alternatively, it could come from those seeking to achieve more relational wealth or to overcome existing wealth disparities, such as through rioting. However, the links between inequality and violence in European prehistory have not been investigated on a quantitative basis, yet.⁶¹ It is also likely that an increasing concentration of power, visible in increasing social inequality, would lead to decreasing violence.⁶² This idea follows the theory of H. Arendt, who claims that power and violence are opposites and do not occur together (Arendt 1970, 56). Pierre Clastres (2010) further elaborates that the nature of power – whether it is coercive or not – determines its effectiveness as a counter

60 “They [political leaders] shape social dynamics directly, through, for example, organizing collective action and enforcing rewards and sanctions, and indirectly, by embodying cultural ideals and modelling successful and appropriate behavior. In return, leaders often receive special rewards or privileges.” (Garfield *et al.* 2019, 59).

61 A current study developed by Johannes Müller *et al.* (2024) suggests a potential decrease in violence with increasing inequality during prehistory in Central Europe. However, the data basis for the Carpathian Basin is weak. Therefore, these observations need to be verified for other parts of Europe, beyond Central Europe, in the future.

62 Other scholars might describe this with the presence of politics, a concentration of the violence monopoly but also a system of conciliation (*i.e.* gifts, feasts) that might be implemented (Helbling 2006, 119ff.).



to violence. To make a conclusive statement regarding conflict and violence as the backdrop of this temporary increase of social inequality, we require a more detailed data foundation. Until then, any assertions remain tentative.

Following this phase of increased inequality, social inequality appears to decline, marked in a decline of the $Gini_{all}$ index and the GEM[1]. While the settlement network does not fundamentally change in this phase of decreasing inequality between 1850 and 1750 BCE, this decline could in turn be attributed to the following factors:

- During the Early Bronze Age, and particularly from the Middle Bronze Age onwards, a shift in the representation and differentiation of status differences in cemeteries can be observed among the majority of society. There is less emphasis on showcasing status differences broadly across society. Instead, only a few individuals receive distinguished and often very rich grave treatment

Figure 19. Development of the GEM[1] described by a LOESS regression for the depiction of a higher temporal resolution; black dots: cemeteries. Top) LOESS regression on the entire dataset, including a large period with insufficient data coverage (3750-2100 BCE marked in light orange; span: 0.4); bottom) LOESS regression on two subsets, before and after the period with insufficient data coverage (span: 0.8).

(i.e. warrior graves,⁶³ tumuli), while the remaining members received relatively simple and less differentiated funerary treatment (Furmánek *et al.* 1999, 164ff.). This indicates that high relational wealth and elevated status were established for a small segment of society. For the rest of society, the differentiation of status and relational wealth no longer played a significant role (Brück and Fontijn 2013, 198; Harding 2004, 364ff., 402, tab. 12.1; O'Shea 2011, 165). It is also possible that the decreasing trend in social inequality in the lower part of the wealth distribution (Gini_{low} index and GEM[0], Subchapter 5.5) stems from an effort to achieve societal cohesion through lower levels of inequality.

- Additionally, the expansion and development of resource networks (Harding 2002, 300ff.; Kristiansen and Larsson 2005, 127f., 134f.; Vandkilde 2019, 6ff.), which might have led to more diverse sources of valuable and often prestigious resources and increased trade, may have contributed to a reduction in resource dependencies. As resources become increasingly available and accessible, the importance of status-related differences through these prestigious materials diminishes. This leads to a reduction in social inequality, or at least to a reduction of relational wealth-based inequality in funerary contexts.

Certainly, the temporary changes in social inequality between 5200 and 3750 BCE, as well as between 2100 and 1000 BCE, cannot be attributed to a single factor. The processes outlined here are intended as an explanatory attempt rather than as definitive evidence. One fact emerging from these developments is that social inequality, in a closer temporal analysis, presents itself as a dynamic and potentially multi-causal phenomenon. Furthermore, the stagnation of overall social inequality (Gini_{all} index and GEM[1]) over a period of 4200 years, already indicated by the linear analysis (Subchapter 5.5), is also depicted by a meandering around a mean value within the LOESS analysis. This suggests a fluid nature rather than a permanent change in social inequality from the Late Neolithic to the Late Bronze Age. Although not investigated in this thesis, there might be regional differences that lead to different patterns of the development of inequality when analysed in a high temporal resolution.⁶⁴ Lastly, the observations of the LOESS analysis might indicate that the development of social inequality is part of complex social cycles.

5.8 Inequality, social index and the quantity of grave goods

After thoroughly examining the results of individual inequality analyses and the development of mean values and ranges over the period from 5200 to 1000 BCE, further analyses of the dataset will be conducted in the subsequent section. In addition to analysing material, object groups and the sizes of burial sites, this section will begin with an evaluation of grave good quantities, followed by social indices. Especially, the investigation of the social index aims to identify some of the dynamics that can be connected to the development of social inequality (mainly by comparing the Gini_{all} index and GEM[1] within the dataset. The social index reflects the relative wealth of a burial within each cemetery, enabling a

⁶³ E.g. Balatonfűzfő (Hungary) Grave 6 (Ilon 2015 [2016]); Čaka (Slovakia) Cremation grave II (Točík and Paulík 1960); Csögle (Hungary) tumulus (Kemenczei 1988, Taf. 20, 206).

⁶⁴ Regional comparisons have not been made, since it would divide the data into even smaller portions and thus further decrease statistical comparability through small sample sizes.

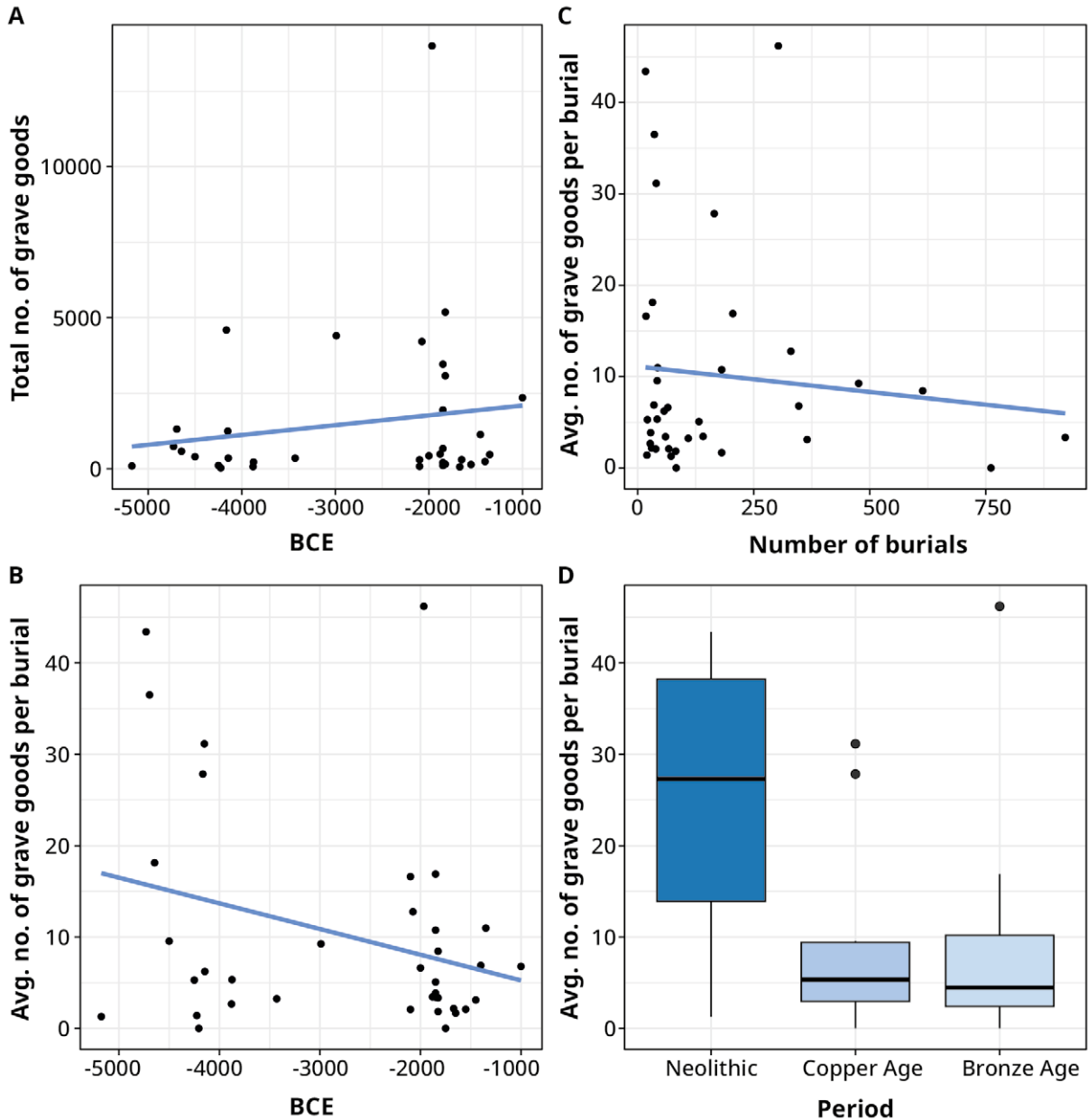


Figure 20. Developments and relations of grave goods in the dataset. A) Development of the total number of grave goods per burial between 5200 and 1000 BCE, black dots – sites, blue line – Linear regression line as a depiction of the general development; B) Correlation between the average number of grave goods per burial and the total number of burials per site (Method: Pearson, p-value: $4.61e-5$, r-value: 0.01), black dots – sites, blue line – correlation line; C) Development of the average number of grave goods per burial over time, black dots – sites, blue line – Linear regression line as a depiction of the general development; D) Development of the average number of grave goods per burial in three archaeological periods, black dots – outliers (sites).

neutral comparison of wealth distributions. To capture material-level dynamics, it is useful to examine some specific object groups and their index values (Subchapter 5.11.1). Additionally, we will later analyse the quantities of material and functional classes and their implications as markers of technological changes and material networks for social inequality.

As a reminder for the following chapters, since the social index is calculated and standardised for each cemetery individually (see Subchapter 4.3), a high or low social index of a burial cannot be directly compared between burial sites in

terms of the materiality or quantity of grave goods. As described in Chapter 4, this was done to attribute to differences in the burial rite and material culture that are present in different time periods and regions. Starting with the analysis of the grave good quantity, the total number of grave goods increases over time (Fig. 20, A). Since the cemeteries tend to considerably increase in size during prehistory (see Subchapter 5.10), this increase of total grave goods is not a surprise (Fig. 25, A). By comparing the average number of grave goods per burial on each cemetery,⁶⁵ it appears that during the Neolithic, more objects were deposited in graves on average (Fig. 20, C and D). During the Copper and the Bronze Age, this value decreases and seems to remain on a stable level (Fig. 20, D). This observation seems not to be affected by the general smaller size of cemeteries in the Neolithic and the Early Copper Age, since there is no or only a weak negative correlation between the average quantity of grave goods per burial and the size of the cemeteries.⁶⁶

We can further observe a high range of the average quantity of grave goods in burials during the Neolithic in comparison to later periods (Fig. 20, D). Whether this is a result of a high variability of cultural practices in the burial rite between different regions has to remain unclarified at this point and might only be assumed. The Neolithic sites come from three different material backgrounds of which especially the Tisza and Lengyel groups occasionally deposit a larger quantity of objects in the burials,⁶⁷ especially necklaces or other costume goods that consist of a larger quantity of small artefacts. In the Bronze Age, the present sample consists of many different regional material groups, such as the Únětice, Maros, Otomani-Füzesabony, Tumulus, Urnfield or Vátya groups. Although there are some exceptionally richly furnished burials⁶⁸ and a bigger variety of material cultural groups in later periods, the average amount of grave goods per burial is much lower and exhibits a smaller variance.

One observation made during the analysis is that there is a variety of $Gini_{all}$ indices that occur with different quantities of grave goods per burial. While economic or environmental factors may be a reason for certain material limitations in individual cases – such as economic limitations in the form of social or subsistence minima – (Wilkes and Skorna 2025), it might very well be an indicator for the significance of the handling of relational wealth in burial contexts and societies. Beside a cluster of sites with moderate levels of inequality and a variation of different quantities of grave goods per burial, which might represent the “common” way of dealing with wealth (Fig. 21, grey dots and black dots), there are more clusters formed by the proportions of inequality and grave good quantity. A variety of conclusions can be drawn from the individual clusters:

- A low number of grave goods per burial with low to moderate inequality⁶⁹ (Fig. 21, blue dots) may suggest a lesser significance of the representation of relational wealth through grave goods, potentially acting as a levelling mechanism, or is due to a lack of a cultural practice of relational wealth representation.

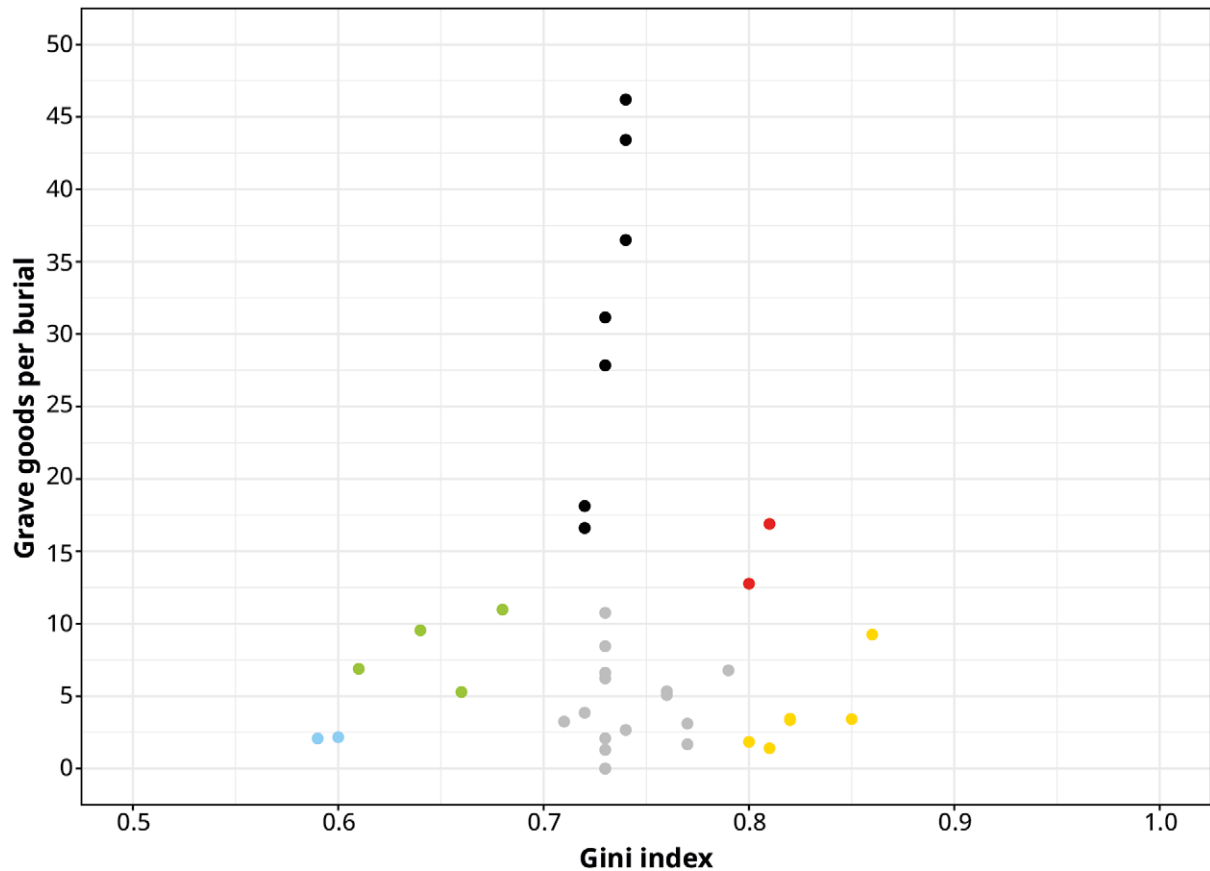
⁶⁵ This analysis includes every object, regardless of object size. Beads were included since – although they are small – some time investment is required for their construction.

⁶⁶ Pearson correlation coefficient: -0.1.

⁶⁷ E.g. Aszód (Cat. No. 2) graves 101, 173, 174; Lužianky (Cat. No. 18) grave 1/1942; Kisköre-Gát (Cat. No. 16) graves 4, 21, 34.

⁶⁸ E.g. Jelšovce (Cat. No. 14) graves 329, 410; Majcichov-Lúky (Cat. No. 19) grave 4; Dunaújváros-Duna-dűlő (Cat. No. 9) grave 9; Budapest-Békásmegyer (Cat. No. 8) grave 125; Budakalász-Luppa-csárda (Cat. No. 7) grave 91; Hernádkak (Cat. No. 12) graves 39, 110; Nižná Myšľa (Cat. No. 23) graves 280, 282/283; Výčapy-Opatovce (Cat. No. 37) grave 116.

⁶⁹ Veselé (Cat. No. 36): $Gini_{all}$ index 0.59, avg. quantity of grave goods 2.1; Puzstaszikszó (Cat. No. 26): $Gini_{all}$ index 0.6, avg. quantity of grave goods 2.2.



- ▶ A moderate to high number of objects per burial with low to moderate inequality⁷⁰ (Fig. 21, green dots) may indicate a representation of relational wealth in the burials without particularly distinguished individuals, due to social norms or for the purpose of maintaining social cohesion.
- ▶ A high number of objects per burial with moderate to high inequality⁷¹ (Fig. 21, red dots) may suggest that relational wealth is strongly expressed in graves and may play a role in society.
- ▶ In cemeteries where there are few grave goods per burial but the inequality is moderate to high⁷² (Fig. 21, yellow dots), it might be possible that societies reserved grave goods only for particularly high-status members.

This comparison already suggests a wide range of societies that may have embedded relational wealth to varying degrees into their burial rite but more importantly into their social organisation, and therefore exhibiting varying levels of social inequality.

As outlined above, trends, such as an increase in the total number of grave goods over time, a decrease of the average number of grave goods per burial over time, and a complex interplay between grave goods quantity, social inequality and potentially societal roles, can be observed. These findings suggest diverse approaches to representing relational wealth and social inequality across different

Figure 21. Average number of grave goods per grave in relation to the $Gini_{all}$ index; blue dots – sites with low inequality and a low number of grave goods per burial, green dots – sites with low inequality and a moderate number of grave goods per burial, grey dots – sites with moderate inequality and a low to moderate number of grave goods per burial, black dots – sites with moderate inequality and a high number of grave goods per burial, red dots – sites with high inequality and a moderate number of grave goods per burial, yellow dots – sites with low inequality and a low number of grave goods per burial.

70 Mezőcsát (Cat. No. 20): $Gini_{all}$ index 0.68, avg. quantity of grave goods 11; Tibava “Hrun za cintirom” (Cat. No. 30): $Gini_{all}$ index 0.64, avg. quantity of grave goods 9.5.

71 Abrahám I, Komárov vršok (Cat. No. 1): $Gini_{all}$ index 0.81, avg. quantity of grave goods 16.9.

72 Nitra – Horné Krškany/ Priemyslová ulica (Cat. No. 22): $Gini_{all}$ index 0.73, avg. quantity of grave goods 1.3; Hegyeshalom-Újlakótelep (Cat. No. 11): $Gini_{all}$ index 0.85, avg. quantity of grave goods 3.4.

periods and regions, which ultimately might be a driver for a growing spectrum of social inequalities in the analysed time period. Moreover, the presence of high social indices in graves that exhibit a specialised profession which often only have very few grave goods and which is described in Subchapter 5.11.1 might further hint towards a knowledge and technology-based or embodied wealth driven influence on social inequality.

5.9 Distribution of the social index

The distribution of social indices – as a marker of the burials' wealth – appears relatively consistent across the different time periods⁷³ (Fig. 22). The distributions are, as expected, heavily tailed and exhibit the “80-20 ratio” characteristic for a Pareto distribution (Metcalf and Casey 2016, 38-39; Pareto 1964, fig. 54). This distribution already shows that relational wealth, which is measured by the social index, is not equally distributed and echoes the relatively high inequality measures presented in Subchapters 5.1. and 5.2. Only in the distribution of social indices in Neolithic sites does a slight deviation from a typical Pareto distribution appear, with an increasing proportion of observed burials having index values between 0.05 and 0.4. But this might be just an effect of the relatively small Neolithic sample (157 burials), which therefore might be sensitive to outliers. Moreover, in comparison to the Copper Age and the Bronze Age samples, the lower proportion of graves with few common or no grave goods exhibited in the Neolithic sample of this study has been observed in a study before regarding Middle to Late Neolithic burial practises (cf. Siklósi 2013, 189-190).

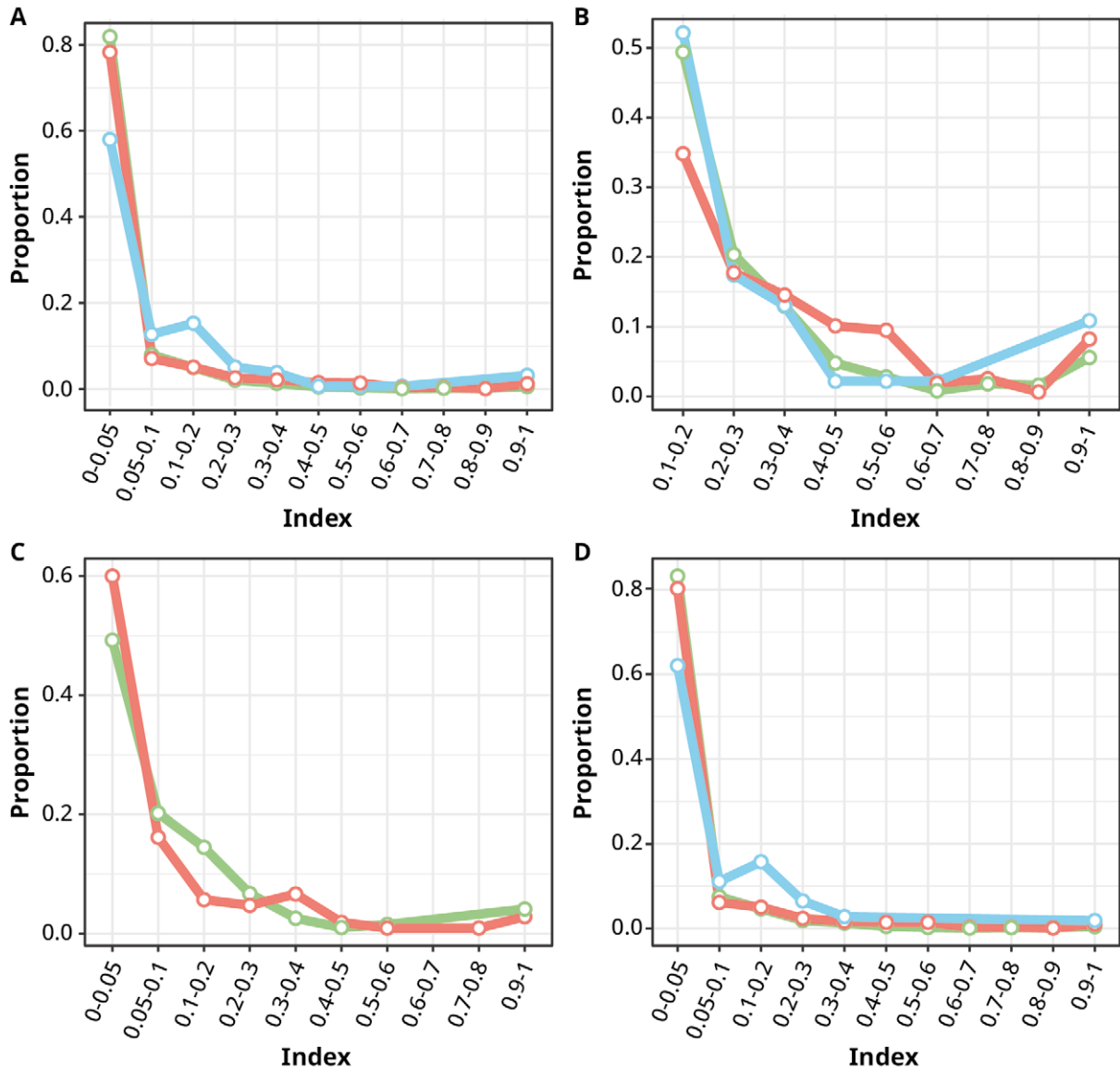
Subsequently, an analysis is conducted on the social index value distribution limited to the span of 0.1 to 1. (Fig. 22, B),⁷⁴ so all graves with a small or no-index are excluded. The distribution in the Copper Age burials stands out. Here, it is evident that up to an index value of 0.6, there is a higher proportion of burials compared to the other two periods. The proportion decreases clearly in the range of 0.6 to 0.9, and then slightly increases again in the range of 0.9 to 1. Even though a minority of individuals are considered in isolation here, it appears that within the Copper Age burial grounds, there is a slightly more balanced distribution and therefore less differentiation among individuals with a moderate social index (index values 0.1-0.6). A more distinct differentiation seems to occur only between this middle part of society and the wealthiest individuals.

In contrast, the distributions in the Neolithic and the Bronze Age show a steep decline in the proportion of graves with social indices in the range of 0.1 to 0.5. This trend persists in the Bronze Age until a slight increase again in the range of 0.9 to 1. In the Neolithic period, there are no graves in the range of 0.7 to 0.9, but the proportion of graves in the range of 0.9 to 1 is higher than in the Copper Age and Bronze Age distribution, as well as in the index range 0.6 to 0.7.

Based on this data, no clear statement can yet be made regarding possible societal influences in the Bronze Age, also due to the greater range of social inequality in this period. In contrast, the Neolithic period appears to show more pronounced disparities among individuals with moderate and high social indices. On the one hand, there is a group that stands out due to their grave goods and mod-

⁷³ Of the total of 6187 burials, 157 belong to the Neolithic, 1082 belong to the Copper Age and 4948 belong to the Bronze Age.

⁷⁴ In total, there are 706 burials with an index value above 0.1. Among these, 46 are from the Neolithic period, 158 belong to the Copper Age, and 502 belong to the Bronze Age.



erate social indices, clearly distinct from the large proportion of graves without grave goods. On the other hand, there seems to be a clearly differentiated group characterised by the gap in index values between 0.7 and 0.9 that is distinguished by a marked disparity in relational wealth, indicated by a high social index.

To understand the differences in cemeteries with relatively high and low inequality, the distributions of social index values were examined across different time periods and the dataset was divided into sites with a $Gini_{all}$ index higher and lower than 0.7⁷⁵ (Fig. 22, C and Fig. 22, D). A higher total number of burials belongs to sites with a $Gini_{all}$ index higher than 0.7 (5889 burials),⁷⁶ compared to the number of burials from sites with a $Gini_{all}$ index lower than 0.7 (298 burials).⁷⁷ Among burial sites with a $Gini_{all}$ index higher than 0.7 (Fig. 22, D), a distribution of the social index similar to the Pareto distribution can be observed (similar to Fig. 22, A).

Figure 22. Distribution of the social index values per period. Proportion of social index values was determined for each chronological phase individually. A) Distribution of all social index values (0 to 1); B) Distribution of the social index values in the range 0.1 to 1; C) Distribution of all social index values at sites with a $Gini_{all}$ index below 0.7; D) Distribution of all social index values at sites with a $Gini_{all}$ index above 0.7; blue – Neolithic, coral red – Copper Age, green – Bronze Age.

⁷⁵ This value roughly represents the median or moving average across the three periods under consideration. Moreover, there are no Neolithic sites that have a $Gini_{all}$ index less than 0.7.

⁷⁶ Of these 5889 burials, 157 belong to the Neolithic, 977 to the Copper Age and 4755 to the Bronze Age.

⁷⁷ Of these 298 burials, 105 belong to the Copper Age and 193 to the Bronze Age.

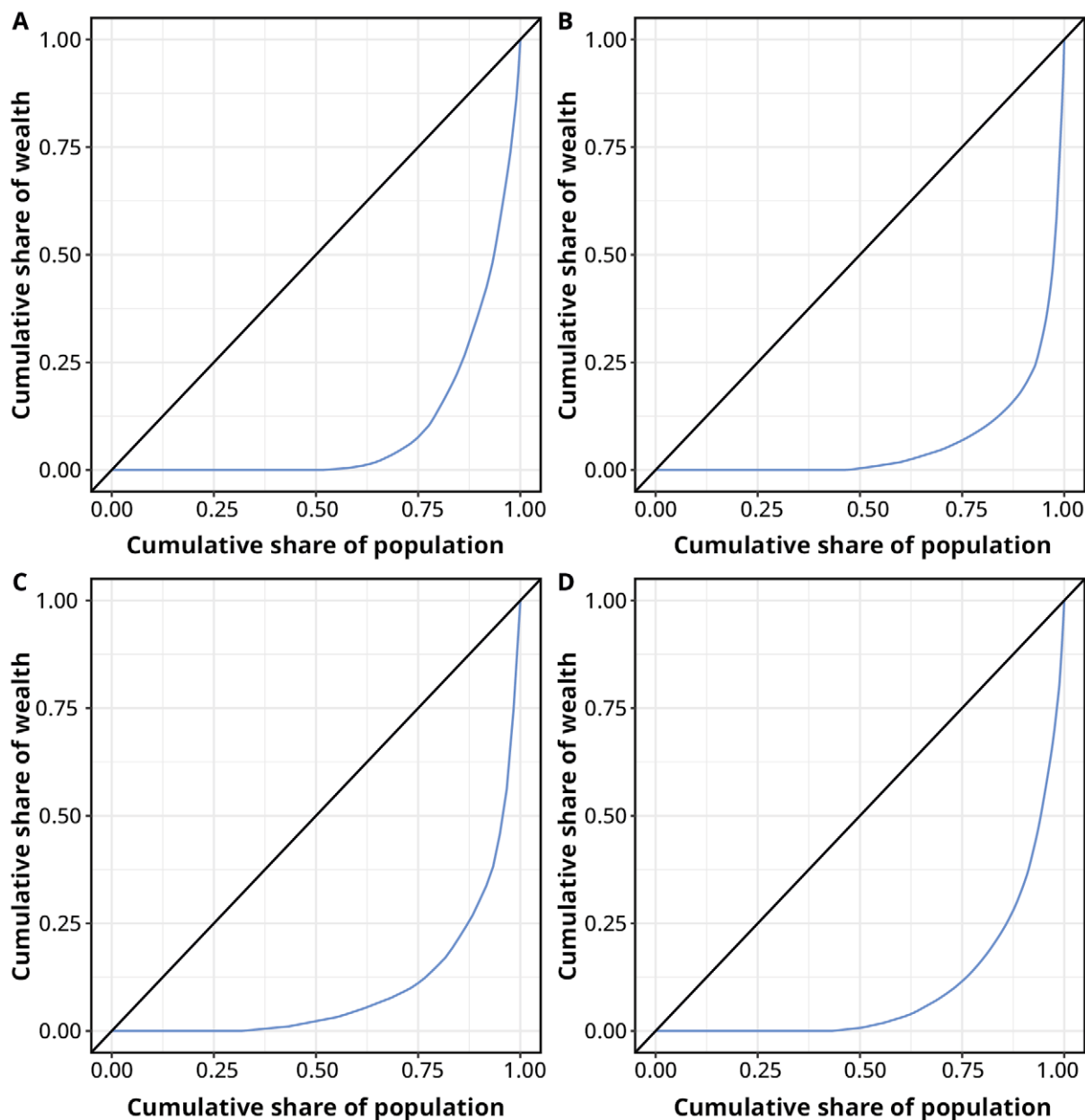
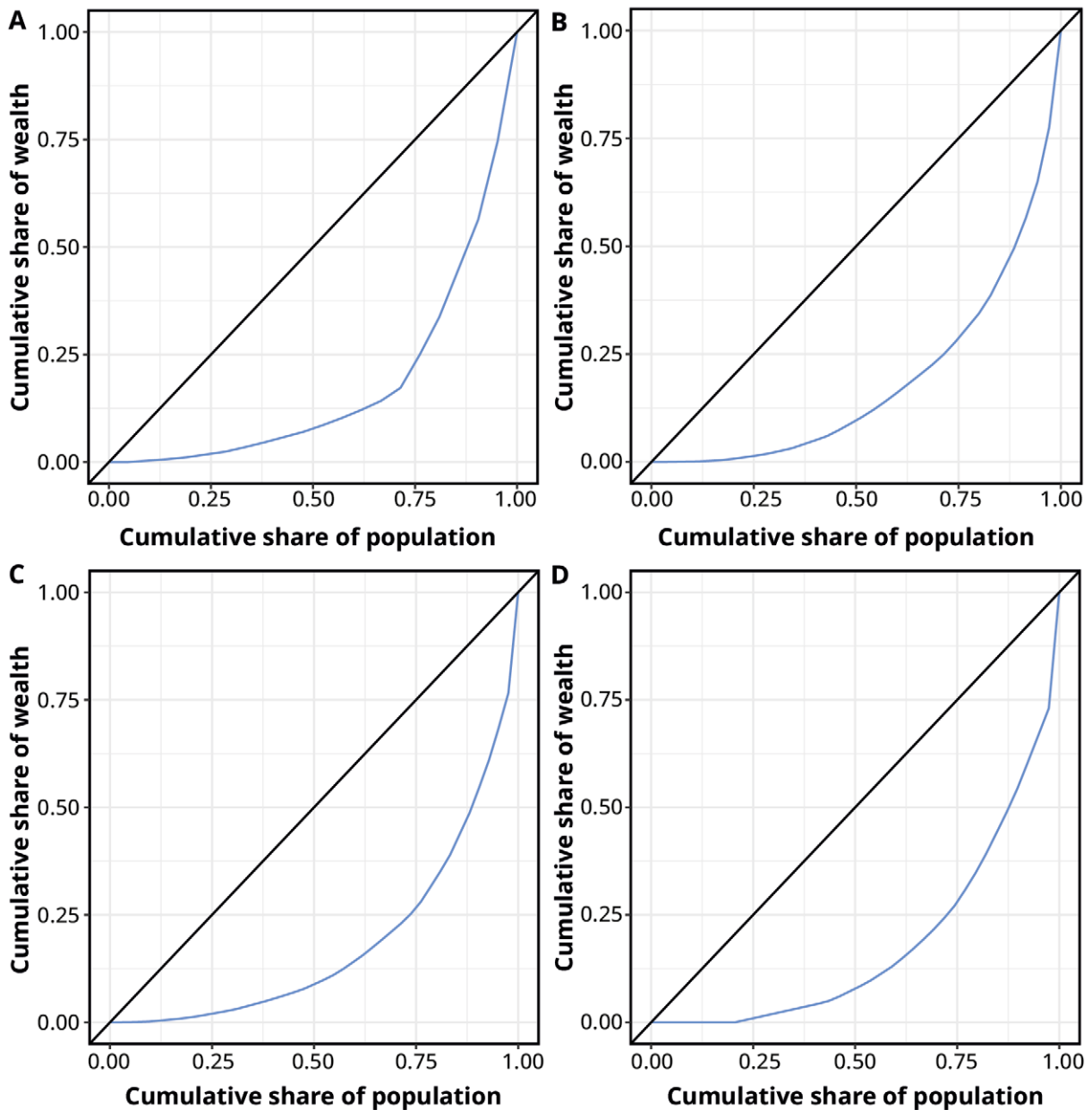


Figure 23. Lorenz curves of sites with a relatively high $Gini_{all}$ index. A) Abrahám I, Komárom vršok ($Gini_{all}$ index: 0.81); B) Budakalász-Luppa-csárda ($Gini_{all}$ index: 0.86); C) Hegyeshalom-Újlakótelep ($Gini_{all}$ index: 0.85); D) Výchapy-Opatovce ($Gini_{all}$ index: 0.8); black line – line of total equality; blue line – line of observed inequality/Lorenz curve.

Furthermore, in cemeteries with a $Gini_{all}$ index above 0.7 (Fig. 22, D), a significant proportion of the graves exhibits minimal to no grave goods. These typically have an index below 0.05 and often feature no more than a ceramic vessel or another generic and common object (*e.g.* a single bone bead, one flint flake, one animal bone) as a grave good. These burials constitute 60 to 80% of the distribution. In contrast, there are a few individuals, who achieve moderate to maximum index values (index: 0.1–1). Consequently, some cemeteries exhibit very high $Gini_{all}$ indices, such as the Abrahám I, Komárom vršok, Budakalász-Luppa-csárda, Hegyeshalom-Újlakótelep, or Výchapy-Opatovce sites.⁷⁸ This is illustrated by the Lorenz curves of these burial grounds, which only start to rise steeply in the upper share of the population (Fig. 23).

⁷⁸ $Gini_{all}$ indices: Abrahám I, Komárom vršok (Cat. No. 1): 0.81; Budakalász-Luppa-csárda (Cat. No. 7): 0.86; Hegyeshalom-Újlakótelep (Cat. No. 11): 0.85; Výchapy-Opatovce (Cat. No. 37): 0.80.



Conversely, burial sites with Gini_{all} indices below 0.7 (Fig. 22, C) present a different scenario. Neolithic burial grounds are densely clustered around the mean of 0.73, limiting a detailed discussion to the distributions observed in the Copper Age and the Bronze Age. In both periods, the distribution of index values exhibits a less pronounced decline in the distribution curve (Fig. 22, C). However, in the lower to middle part of the distribution, there is a more diversified distribution of wealth indices, countered by a small group of individuals with maximum index values in the upper part of the wealth distribution. Compared to the distribution of wealth in sites above a Gini_{all} index of 0.7, these burial grounds demonstrate a more balanced distribution, reflected in lower Gini_{all} indices. Notable examples for such a more balanced distribution of wealth are the Bronze Age cemeteries of Patince or Veselé, as well as the Copper Age burial grounds of Jelšovce and Tibava

Figure 24. Lorenz curves of sites with a relatively low Gini_{all} index. A) Jelšovce (Copper Age; Gini_{all} index: 0.66); B) Patince (Gini_{all} index: 0.61); C) Tibava "Hrun za cintirom" (Gini_{all} index: 0.64); D) Veselé (Gini_{all} index: 0.59); black line – line of total equality; blue line – line of observed inequality/Lorenz curve.

“Hrun za cintirom”.⁷⁹ In these cases, the Lorenz curves (Fig. 24; for all Lorenz curves see Appendix E) exhibit a rise already in the lower and middle share of the population, indicating a more equal distribution of wealth within these societies.

From the examination of the distribution of social indices, the picture emerges that the main drivers of high inequality measures, methodologically speaking, are the numerous graves with few common or no grave goods. In the context of relational wealth, or the representation of status in burial contexts, this is not merely a methodological peculiarity but might be understood as a true reflection of prehistoric society. A large portion of the prehistoric population seems to have had little relational wealth, or in large parts of society, there was little emphasis on depicting status differences with a growing tendency between the Neolithic and the Bronze Age (cf. Harding 2004, 402f.; Kristiansen 1999, 185). Only about 20-40% of the population – in the present analysis, those with a social index higher than 0.1 – appears to have noticeable levels of relational wealth, which appear to be the driver for varying degrees of inequality between cemeteries and therefore societies. However, it is important to stress that within this 20-40% of the population, significant differences often exist in the distribution of relational wealth between cemeteries and time periods. These differences are evident in the changing patterns of Lorenz and distribution curves (for all Lorenz curves see Appendix E), and this part of society largely contributes to the varying levels of social inequality in the analysed cemeteries.

5.10 Site size and inequality

It can be observed that the size of burial sites increases on average over time (Fig. 25, A). The range of differently sized cemeteries also expands between the Neolithic and the Bronze Age (Fig. 25, B). This can not only be derived from the presented funerary data but also fits to general observations of cemeteries and settlements in the Carpathian Basin and the further region, as shown in the following.

Neolithic cemeteries of the Carpathian Basin are predominantly small- to mid-sized (10-150 burials), like in Lužianky, Kisköre-Gát Nitra-Horné Krškany or Mórágý⁸⁰, with only very few particularly large burial concentrations, such as Aszód-Papi földek, Zengövárkony, or Alsóynék-Bátaszék,⁸¹ which can be understood as exceptional occurrences even when compared in the wider geographic region.⁸² The Copper Age sees a slight increase of cemetery sizes, but in general they remain small- to mid-sized, for example, the sites of Barca-Baloty, Jászládány, Rákóczi-falva-Bagi-föld or Pilismarót-Basaharc⁸³ with exceptions of larger cemeter-

79 Gini_{all} indices: Patince (Cat. No. 24): 0.61; Veselé (Cat. No. 36): 0.59; Jelšovce (Copper Age, Cat. No. 15): 0.66; Tibava “Hrun za cintirom” (Cat. No. 30): 0.64.

80 Lužianky: 17 burials, Cat. No. 18, Novotný (1962); Kisköre-Gát: 37 burials, Cat. No. 16, Korek (1989); Nitra-Horné Krškany: 76 burials, Cat. No. 22, Pavúk (1972); Mórágý: 109 burials, Depaermentier *et al.* (2020).

81 Aszód, Papi földek: 220 burials, Cat. No. 2, Kalicz (1985, 98); Zengövárkony: 368 burials, Dombay (1960, 195); or Alsóynék-Bátaszék: 2300 burials, Depaermentier *et al.* (2020); Zalai-Gaál *et al.* (2014, 285-286).

82 Larger Neolithic cemeteries in the adjacent regions are: Modlniczka 2: 39 burials, Poland, Czekaj-Zastawny (2021, tab. 1); Kralice na Haně: 70 burials, Czech Republic, Pažinová and Bistáková (2022, 265-266); Kleinhadersdorf: 90 burials, Austria, Neugebauer-Maresch and Lenneis (2015, 21ff.) or Vedrovice: 110 burials, Czech Republic, Whittle *et al.* (2013, 114ff.).

83 Barca-Baloty: 27 burials, Cat. No. 3, Šiška (1972); Jászládány: 40 burials, Cat. No. 13, Patay (1944/45); Rákóczi-falva-Bagi-föld: 83 burials, Cat. No. 27, Csányi *et al.* (2010); Pilismarót-Basaharc: 109 burials, Cat. No. 25, Bondár *et al.* (2015).

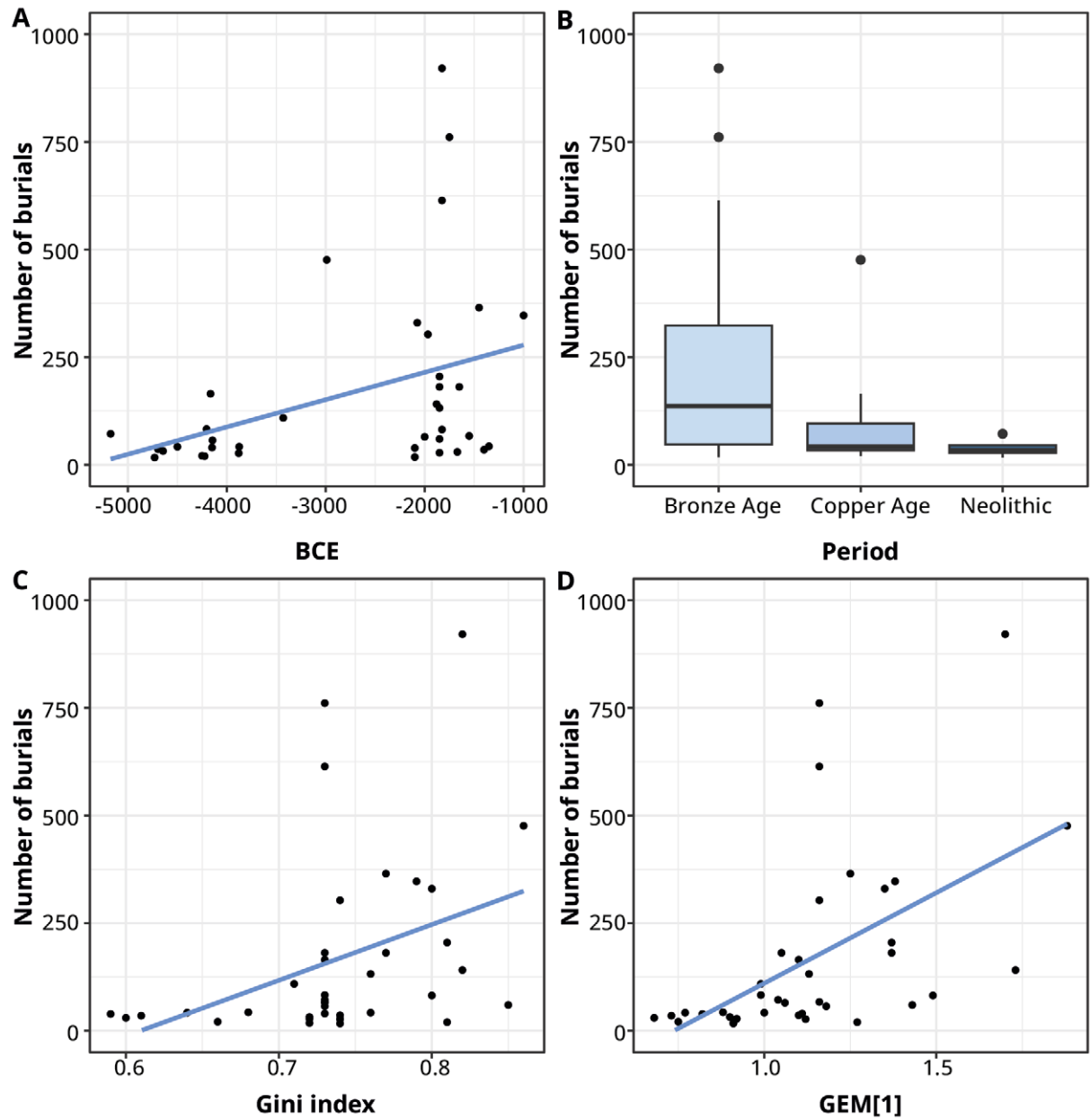


Figure 25. A) Development of the average site cemetery size over time depicted by a linear trend function; B) Difference of cemetery size between archaeological periods; C) Correlation between the number of burials per cemetery and the $Gini_{all}$ index (Method: Pearson, p-value: 0.02, r-value: 0.38); D) Correlation between the number of burials per cemetery and the GEM[1] value (Method: Pearson, p-value: $5e-04$, r-value: 0.54); black dots – sites; blue line: regression line).

ies such as Tiszapolgár-Basatanya or Budakalász-Luppa-csárda.⁸⁴ Lastly, during the Bronze Age, there is a growing number of large cemeteries (>150 burials; Fischl *et al.* 2015, 516), while many societies still use small- to mid-sized cemeteries.⁸⁵ Among the large ones are the sites of Výchapy-Opatovce, Tiszafüred-Majoroshalom, Jelšovce, Nižná Myšľa⁸⁶ and Dunaújváros-Duna-dűlő.⁸⁷

Assuming that the number of the recorded graves in each cemetery serves as an indicator of the original size of the respective society,⁸⁸ we can derive a visible growth of average group or society sizes towards later prehistory (Fig. 25, A). Additionally, as with the observations made in the analysis of the inequality measures (Gini_{all} index and GEM[1]), there is a higher variety of group sizes towards the Bronze Age (Fig. 25, B). Both a growth in maximum size of societies and a higher variety of societies of different sizes can not only be observed in burial sites but also in the settlements of the Carpathian Basin, although the average settlement size seems to remain stable over time (Duffy *et al.* 2025).

In settlements, we see this towards the end of the Neolithic, as well as in the shift from the Early to the Middle Bronze Age, namely in an increasing diversification of settlement size and of the settlement network, for example, when tell settlements dissolve (Molloy *et al.* 2023; Müller-Scheeßel *et al.* 2020; Parkinson *et al.* 2021; Staniuk 2021). Additionally, the densely populated (Duffy *et al.* 2025, fig. 3) – though not necessarily large – tell settlements of the Neolithic and the Bronze Age may have acted as amplifiers of social inequality or at least as central hubs where such inequality developed, serving as focal points for a ruling group (Gogâltan and Borş 2022, 115ff.). Their dissolving might be a driver for lower inequality, as seen in the decrease of the lowest inequality measures. Furthermore, in the course of the Middle Bronze Age with the appearance of so called “mega-forts”, such as Corneşti-Iarcuri (Szentmiklosi *et al.* 2011), Sântana-Cetatea Veche (Gogâltan *et al.* 2020; Krause *et al.* 2022) or Csanádpalota-Földvár (Szeverényi *et al.* 2022), we can track great population agglomerations and growing levels of social organisation and inequality, as well as an increase of the maximum settlement size (Gogâltan and Borş 2022, 116ff.; Harding 2017, 13; Molloy *et al.* 2020, 311-312).

In relation to social inequality, it is evident that there is a moderate correlation between overall inequality (Gini_{all} index and GEM[1]) and the size of the cemeteries (Fig. 25, C and Fig. 25, D). Cemeteries with more than ca. 150 burials show Gini_{all} indices over 0.73, while lower inequality values only appear in smaller cemeteries. Following the idea that the size of burial grounds is an indicator of the original

84 Tiszapolgár-Basatanya: 165 burials, Cat. No. 32, Bognár-Kutzián (1963); Budakalász-Luppa-csárda: 476 burials, Cat. No. 7, Bondár and Raczky (2009).

85 E.g. Nagycenk: 28 burials, Cat. No. 21, Gömöri *et al.* (2018); Patince: 35 burials, Cat. No. 24, Dušek (1960).

86 Výchapy-Opatovce: 330 burials, Cat. No. 37, Točík (1979); Tiszafüred-Majoroshalom: 365 burials published, 1003 burials known, Cat. No. 31; Kovács (1975); Jelšovce: 614 burials, Cat. No. 14, Bátora and Görsdorf (2000a and b); Nižná Myšľa: 761 burials, Cat. No. 23, Olexa and Nováček (2013); Dunaújváros-Duna-dűlő: 921 burials published, up to 1600 burials known, Cat. No. 9, Vicze (2011).

87 Large Bronze Age cemeteries are not exclusive to the Carpathian Basin and also occur in adjacent regions. Some of the better-known sites are: Mokrin: 312 burials, Serbia, Giric (1971); Žegarac *et al.* (2020); Ljubljana-Dvorišče SAZU: 334 burials, Jernejčič (2014, 363) and Franzhausen I and II: 716 and 1400 burials, Austria, Neugebauer-Maresch and Neugebauer (1997, 10).

88 Although most cemeteries are not fully excavated, the author treats the size of the cemeteries as indicative of the original size of their societies. Furthermore, contrary to settlements, cemeteries might reflect the size of societies on a micro-regional level and thus the analysis of the development of settlement and cemetery size over time might not necessarily measure the same social scale, especially since there are examples of local settlement systems that included a network of different sized settlements within a micro region (e.g. Artursson 2010; Hofmann *et al.* 2025; Molloy *et al.* 2023; Müller *et al.* 2020).

size of the society, it can be inferred that larger societies have a higher potential for greater social inequality. Nevertheless, in small cemeteries we also observe the full range of social inequality from relatively low to high $Gini_{all}$ values, so there are more drivers for high inequality than just population size.

From a methodological perspective, it could be argued that one reason for this relatively higher inequality might be the higher probability of graves without grave goods in larger cemeteries, which could have a methodological effect on a higher Gini index (Fochesato *et al.* 2019). However, it appears that there is only a low and statistically insignificant correlation between the proportion of graves without grave goods and the size of the burial grounds.⁸⁹ Therefore, no rule can be derived that it is more likely to find a higher proportion of individuals with low relational wealth or low status in larger societies. Thus, the abovementioned interpretation that larger societies may promote greater inequality is not affected by the proportion of no or low wealth individuals. In short, the measured higher inequality might not be a mere methodological artefact but rather based on social processes.

For the lower part of the wealth distribution ($Gini_{low}$ index and GEM[0]), the size of the society does not seem to have an impact on social inequality in this part of society; no correlation exists between the two values (Fig. 26, A and B). In contrast, there is a moderate to strong correlation between the size of the burial ground and inequality at the upper end of the wealth distribution ($Gini_{upper}$ index and GEM[2]; Fig. 26, C and D). The smallest cemeteries seem to exhibit only lower GEM[2] values, while medium to large-sized cemeteries tend to have a higher GEM[2] measure. One possible interpretation is that larger societies promote greater differentiation within and also caused by the wealthy segment of the population. This could have its origin in individuals (“aggrandizers”) taking certain societal functions or a leading role in resource exploitation and control (Hayden and Villeneuve 2010, 137-138; Mattison *et al.* 2016, 193; Prentiss *et al.* 2007, 322-323; Prentiss *et al.* 2018, 600; Shennan 1993, 151), which manifests in a stronger differentiation of relational wealth (Clark and Blake 1994; Johnson 1982, 409-410) through the creation of dependencies or by investing in status-enhancing measures.

The tendency of higher inequality measures, *i.e.*, of the $Gini_{all}$ index, GEM[1], in larger cemeteries fits to the model of scalar stress developed by G. A. Johnson (1982, 413ff.), regarding growing inequality with increasing group size, which has been discussed for a variety of societies in Eurasia and America (Alberti 2014; Bandy 2004; Ellyson 2022; Parkinson 2006; Porčić 2019). From the perspective that large cemeteries (>150 burials) do not exhibit inequality measures lower than 0.7, this may suggest a threshold at which societies either undergo fissioning,⁹⁰ collapsing or further growth that is accompanied by levels of greater inequality (Alberti 2014; Tainter 1988, 193ff.), such as through aforementioned influential or exploiting individuals or through collective power, to organise these societies.

In summary, the analysis of cemetery size and different inequality measures show a moderate to strong correlation. While not exclusively associated with mid-to large-sized cemeteries (>150 burials), there is a noticeable trend towards greater inequality within these larger sites. They also show no low inequality measures ($Gini_{all}$ index <0.7). Lower levels of inequality exclusively appear in small- to mid-sized cemeteries (<150 burials). There is also an increasing trend in the average size of cemeteries towards later prehistory, which can be interpreted as a growing

⁸⁹ Pearson correlation coefficient: 0.22, p-value: 0.192.

⁹⁰ G. Alberti (2014) gives a critical threshold for the occurrence of scalar stress at a population size of 122 to 170 individuals.

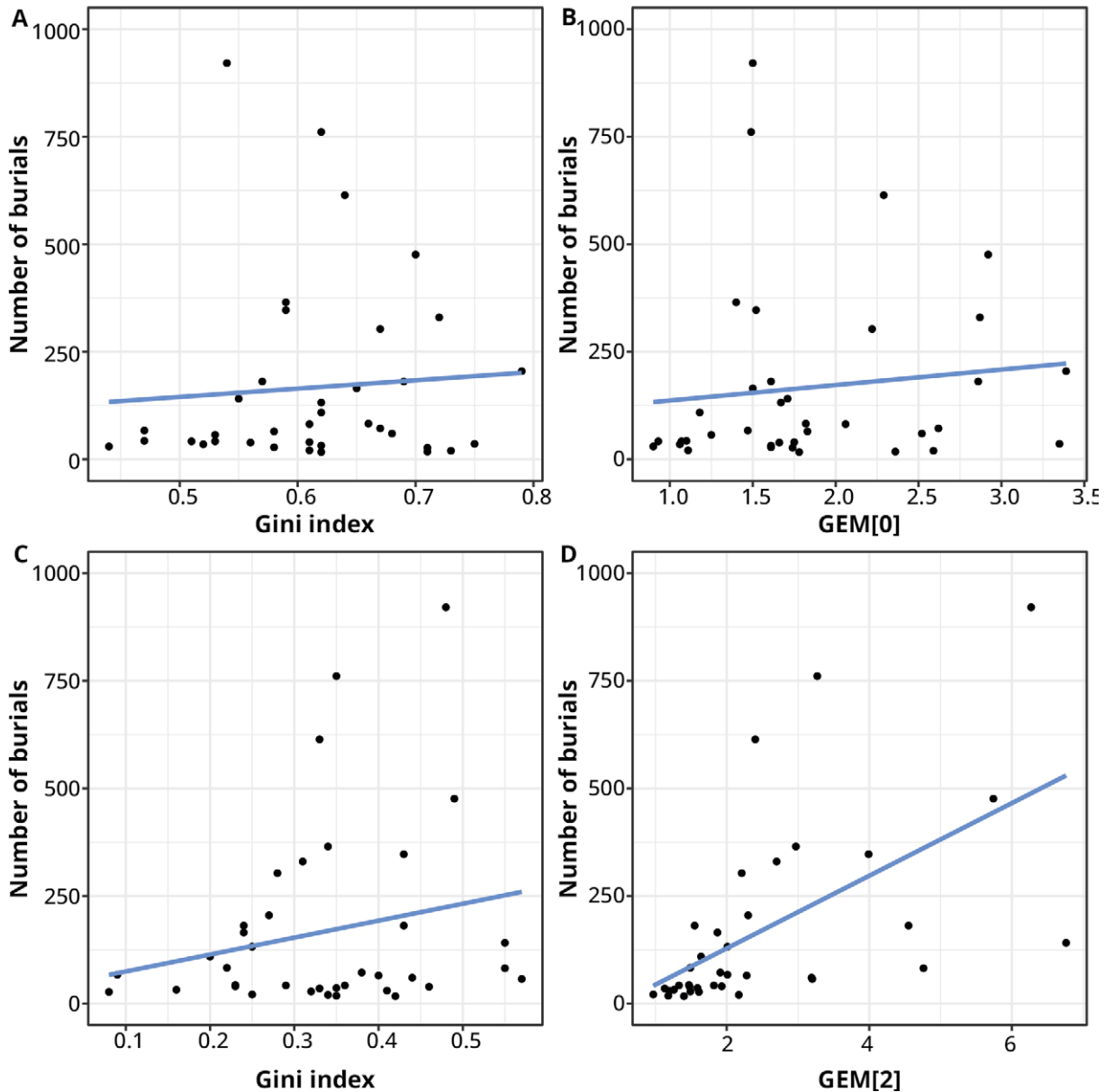


Figure 26. A) Correlation between the number of burials per cemetery and the $Gini_{low}$ index (Method: Pearson, p-value: 0.67, r-value: 0.07); B) Correlation between the number of burials per cemetery and the GEM[0] value (Method: Pearson, p-value: 0.51, r-value: 0.11); C) Correlation between the number of burials per cemetery and the $Gini_{upper}$ index (Method: Pearson, p-value: 0.2, r-value: 0.22); D) Correlation between the number of burials per cemetery and the GEM[2] value (Method: Pearson, p-value: $2e-04$, r-value: 0.57); black dots – sites; blue lines: regression lines.

number of large (regional) societies in the Carpathian Basin. Although it is likely that the sites in this study might not be fully representative in terms of site size, the comparison in the wider geographic region seems to prove the observation of increasing average group or cemetery size in the course of prehistory, although this is not fully mirrored in settlement data⁹¹ (Duffy *et al.* 2025). On basis of these observations, as a result of scalar stress, group or society size might be one of the factors for an increasing upper margin of social inequality in the course of prehistory. This might lead to either the fissioning of societies or the emergence of controlling, organising, and/or exploiting social groups, resulting in larger, more unequal societies, and smaller societies with varying degrees of social inequality.

⁹¹ In settlement data of the Carpathian Basin, we can observe an increasing size of the largest settlement, especially with the foundation of Middle Bronze Age mega-forts, but the average settlement size remains stagnant (Duffy *et al.* 2025).

Catalogue No./Site	Number material types	Number of functional groups	Total number of grave goods	Number of grave goods per burial	Number of burials
1. Abrahám I, Komárov vršok	8	14	3463	16.9	205
2. Aszód, Papi földek	7	9	580	18.1	32
3. Barca-Baloty	5	7	72	2.7	27
4. Battonya, Vörös Október MTSZ	8	13	486	3.4	141
5. Branč-Helyföldek (BA)	12	15	13998	46.2	303
6. Branč-Helyföldek (CA)	4	9	28	1.4	20
7. Budakalász-Luppa-csárda	11	14	4405	9.3	476
8. Budapest-Békásmegyer	14	14	2354	6.8	347
9. Dunaújváros-Duna-dűlő	9	11	3077	3.3	921
10. Gelej-Beltelek-dűlő and Kanális-dűlő	5	8	303	1.7	181
11. Hegyeshalom-Újlakótelep	5	8	205	3.4	60
12. Hernádkak	11	14	670	5.1	132
13. Jászládány	8	11	1246	31.2	40
14. Jelšovce (BA)	14	15	5185	8.4	614
15. Jelšovce (CA)	8	10	111	5.3	21
16. Kisköre-Gát	6	6	1314	36.5	36
17. Košice "Nižné Kapustníky"	10	16	1947	10.8	181
18. Lužianky	7	8	738	43.4	17
19. Majcichov-Lúky	9	11	151	1.8	82
20. Mezőcsát	7	12	472	11.0	43
21. Nagycenk	5	9	108	3.9	28
22. Nitra – Horné Krškany/ Priemyslová ulica	8	7	93	1.3	72
23. Nižná Myšľa	-	12	-	-	761
24. Patince	4	8	241	6.9	35
25. Pilismarót-Basaharc	4	7	353	3.2	109
26. Puztaszikszo	2	4	65	2.2	30
27. Rákóczi-falva-Bagi-föld	-	12	-	-	83
28. Šebastovce-Lapiše	7	8	224	5.3	42

Table 11 continues on the following page.

Catalogue No./Site	Number material types	Number of functional groups	Total number of grave goods	Number of grave goods per burial	Number of burials
29. Streda nad Bodrogom	5	8	140	2.1	67
30. Tibava “Hrun za cintirom”	7	10	401	9.5	42
31. Tiszafüred-Majoroshalom	11	13	1133	3.1	365
32. Tiszapolgár-Basatanya	13	16	4594	27.8	165
33. Tiszavalk-Kenderföldek	8	15	355	6.2	57
34. Valálíky-Košťany	8	10	299	16.6	18
35. Veľký Grob	7	12	430	6.6	65
36. Veselé	7	9	81	2.1	39
37. Výčapy-Opatovce	10	15	4213	12.8	330

Table 11. Number of material types, functional groups and burials, as well as total number of recorded grave goods and the number of grave goods per burial for the individual sites.

5.11 Technology, resource access and inequality

An explanation for the increase of the range of inequalities between 5200 and 1000 BCE focusses on a variety of developments in technology and subsistence. There are a number of developments that include technological innovations, a broadening of subsistence strategies and an increase in productivity that happened from the Neolithic to the Bronze Age. A large number of these “innovations” are particularly evident during the Copper Age (Fig. 28; after Hansen *et al.* 2016, fig. 1). The study of these innovations provides a complex picture of interrelated developments which, in addition to other effects on societies (Hansen *et al.* 2016, 779ff.), might have also resulted in a widening of the range of social inequality.

Let us outline some of the major technological and economic developments between 5200 and 1000 BCE. Starting in the Late Neolithic, a change or a broadening of the subsistence strategy is characterised by the use of “secondary products” during the emergence of pastoral economies (Milisauskas and Kruk 2011, 304ff.), as well as by the use of a wider range of plants (Filipović *et al.* 2020; Reed 2017), livestock, and hunted animals (Milisauskas and Kruk 2002; Orton 2012; Parkinson 2006). This opened up the possibility of creating greater food security and the production of surpluses (Milisauskas and Kruk 2002). As a result, a larger population could be fed, and labour previously tied up in food production could be made available (Gilman 1981). This labour potential could now be engaged in the utilisation of the new copper and later bronze materials. As a result, an increasing specialisation of individual “craftsmen” and a supra-regional exchange network developed between 4500 and 2000 BCE. In addition to such craftsmen, human resources could now also be available to activate administrators, who dealt with the management of the growing and increasingly complex societies as well as with the management of trade and resource networks (Prentiss *et al.* 2018, 600). These highly specialised craftsmen, administrators and managers now possessed the skills and the opportunity to accumulate respect and wealth, leading to social stratification and growing social inequality (Gilman 1981; Prentiss *et al.* 2018, 600; Shennan 1993, 151). Additionally, there might have been individuals who used their position to gain control over scarce or defensible resources and used

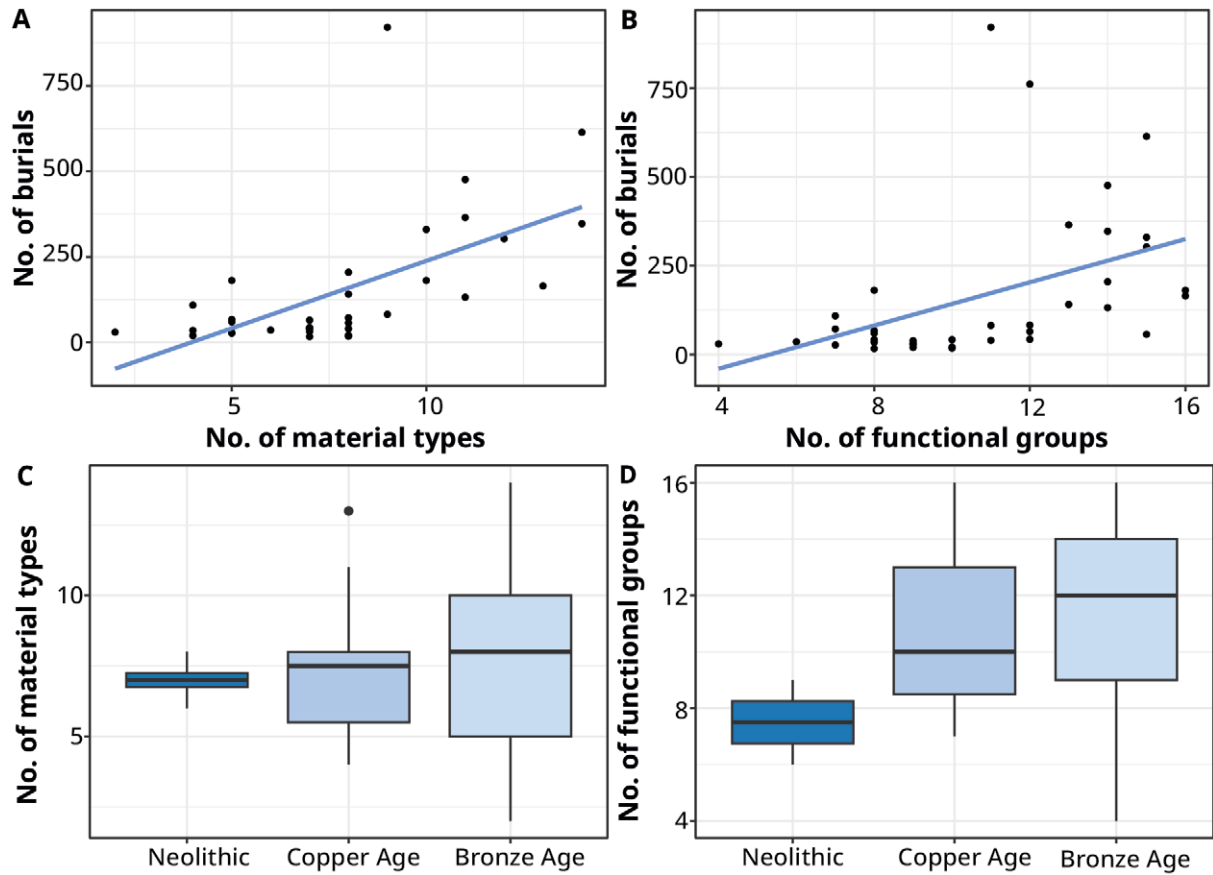


Figure 27. A) Correlation between number of burials and number of material types (Method: Pearson, p-value: 0.05, r-value: 0.49); B) Correlation between number of burials and number of functional groups (Method: Pearson, p-value: 0.06, r-value: 0.44); C) Box-Whiskers-Plot of number of material types per archaeological period; D) Box-Whiskers-Plot of number of functional groups per archaeological period. black dots – sites; blue lines: regression lines.

them to build wealth and create dependencies (Dani *et al.* 2016; Gilman 1981; Oravkinová and Vladár 2021).

How these developments influenced the increase of the inequality ranges between 5200 and 1000 BCE might be explained in three points:

- ▶ The developments outlined here do not occur everywhere at the same time, nor do they occur simultaneously in every society (Milisauskas and Kruk 2011, 234; Reed 2017, 1748). While comprehensive specialisation already took place in one society in one period of time, another society may still have been at a “lower” level of technological and social development.
- ▶ Due to a wide range of specialisations (*e.g.* copper processing, agriculture, trade), there is a parallel development of societies that put an emphasis on different specialisations which might be also organised differently and therefore deal with the distribution of wealth differently.
- ▶ Increasing specialisation and the associated dependence on scarce or defensible resources that are not available everywhere (*e.g.* metals, amber, stone) inevitably led to a division into societies with better access to resource networks and those that are more dependent on these “network nodes”. This can be reflected in a different availability of certain types of wealth (Subchapter 1.1) – namely different access to material resources, skills, or social contacts – and thus also to various degrees of social inequality.

Turning towards the data of this study, when considering measures of technological development or material advances, identifying a reliable metric is challenging. While

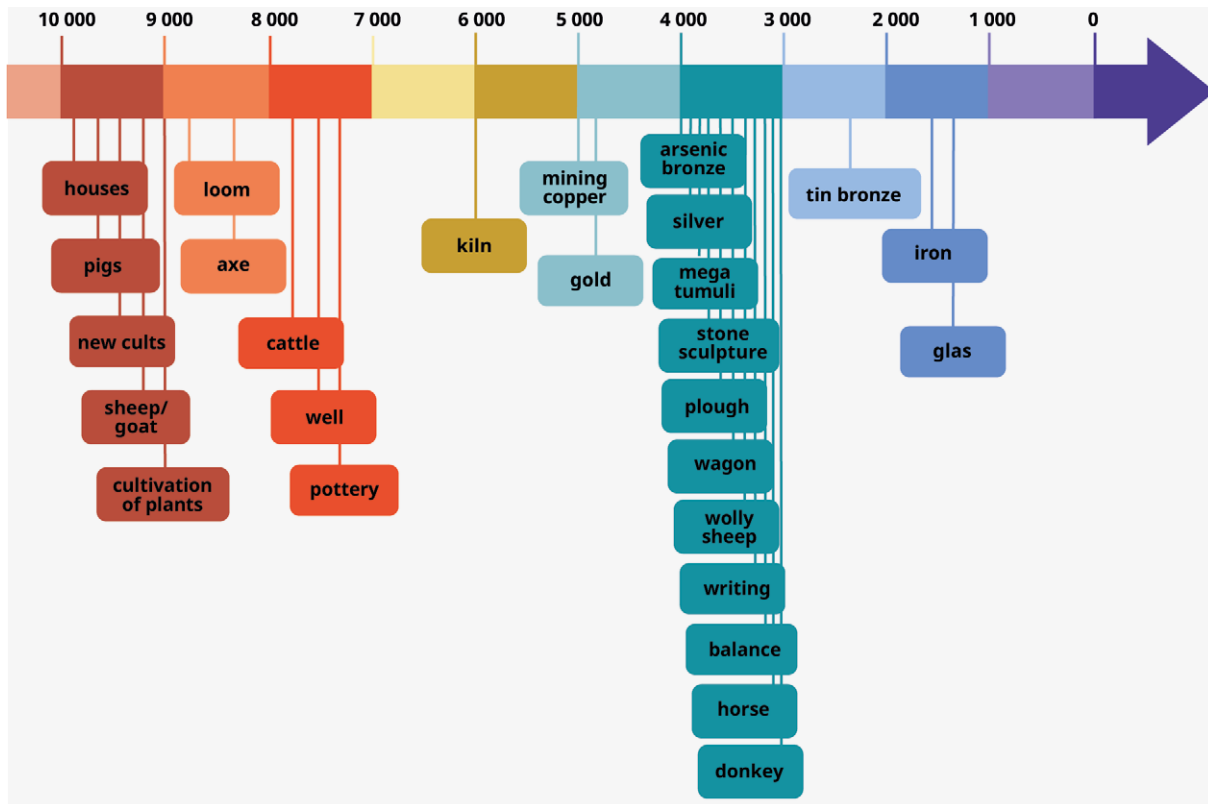
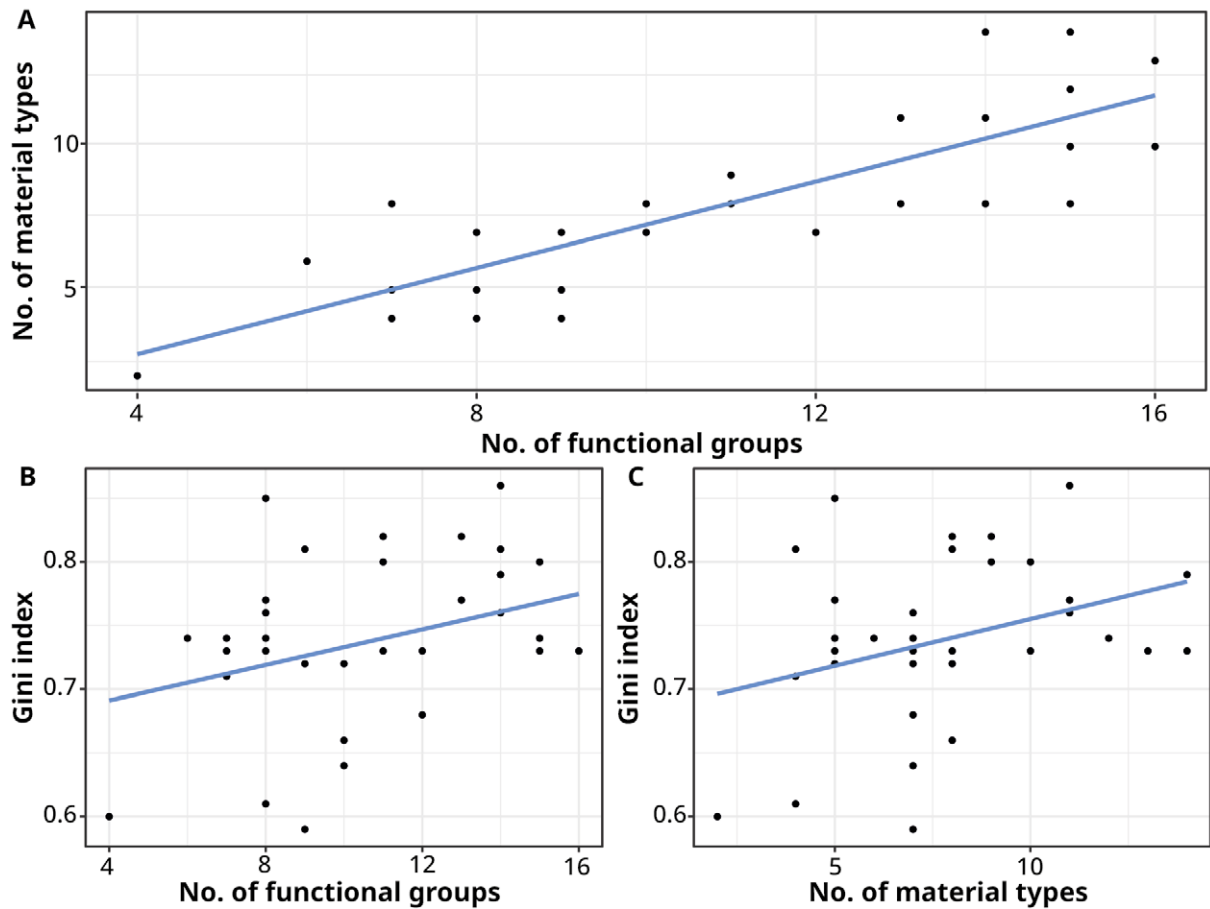


Figure 28. Main innovations in prehistoric Europe. The dates indicate the first widespread use of an innovation and not the first appearance (after Hansen *et al.* 2016, fig. 1).

the influence of cultural processes and traditions on grave good depositions should not be overlooked, it can be inferred that the diversity and quantity of different material types among grave goods reflect a society's access to, or even control over, resources (see Table 11). Furthermore, the distribution of functional groups may serve as an indicator of a society's technological capabilities (see Table 11).

The findings reveal a moderate positive correlation between the variety of material types, functional object groups and the size of burial sites (Fig. 28). Larger burial sites tend to exhibit more diverse materials and a broader range of functional grave goods (Fig. 27, A and B). This diversity suggests that larger populations had better access to various materials and techniques, which contributed to a wider selection of functional object groups in graves. Additionally, increased material and functional diversity in burials is positively correlated with social inequality within the burial community, as more material types correlate with higher inequality measures.

From the Neolithic to the Bronze Age, both the median amount and range of material types in burials between sites expanded (Fig. 27, C and D), likely influenced by advancements in technology and the availability of new resources, such as metals. This increasing material diversity appears to be linked to a rising range of social inequality, potentially due to differences such as restricted or controlled access to certain prestigious materials between societies. In other words: While some societies had control over or a good position within material resource networks, others had restricted access to them. Over time, the growth in range and mean number of functional groups (Fig. 27, D) reflects these trends, as certain functional object types – such as imported or metal costume artefacts and weapons – became markers of status or wealth. Control over these resources



may have also extended to specialised manufacturing knowledge or connections with skilled craftsmen.

Despite these trends, there is variation in the levels of diversity of material and functional groups across societies, suggesting unequal access to resources and technology between societies, which is further increased during prehistory. Some societies, particularly smaller ones, may lack the necessary networks to acquire certain materials and skills, or might intentionally exclude certain materials from burial practices. This variability might contribute to evolving differences of social inequality.

Looking at the societies as a whole, larger burial sites show a moderate correlation with increased material and functional group diversity, suggesting that larger populations had greater access to material resources and technological knowledge, leading to higher levels of social inequality. However, technological innovations did most likely not occur simultaneously in every region, nor did every society specialise in the same technology, leading to knowledge discrepancies between societies. Furthermore, over time, material variety expanded with technological advances, and control over (presumably) prestigious resources became a source of social distinction. Not all societies, however, exhibited high material and technological diversity, reflecting varied access and social practices, which contributed to a growing range of social inequality.

A differentiation by social segment further refines this picture, and mirrors the pattern already observed for site size in Subchapter 5.10, where cemetery size was shown to correlate with inequality in the upper segment but not in the lower

Figure 29. A) Correlation between the number of material types and the number of functional groups (Method: Pearson, p-value: 0.01, r-value: 0.82); B) Correlation between Gini_{all} index and number of functional groups (Method: Pearson, p-value: 0.04, r-value: 0.35); C) Correlation between Gini_{all} index and number of material types (Method: Pearson, p-value: 0.01, r-value: 0.46).

segment. An analogous structure emerges when the analysis of material and functional groups is extended to all available inequality metrics (full correlation table in online Supplement B). For the lower segment ($Gini_{low}$ and $GEM[0]$), neither material types nor functional groups show a meaningful association with inequality (r : 0.26 and r : 0.23; both non-significant). For the upper segment, by contrast, $Share_{upper}$ correlates positively with functional groups (r : 0.36, p : 0.03) and shows a similar tendency for material types (r : 0.32, p : 0.06), with $GEM[2]$ showing a comparable trend (r : 0.29–0.31, p < 0.10). $Gini_{upper}$, however, shows no such pattern (r : 0.11, non-significant), indicating that material and functional diversity relates not to greater differentiation within the wealthy, but to a larger differentiation between the wealthiest segment and the rest of the society. This further supports the interpretation that differential access and control to material resources and technological knowledge functions primarily as a mechanism of elite wealth concentration, leading to elevated social positions. Such wealthy groups are presumably capable of attaining high status and prestige by offering a manager function over various resources (Gilman 1981), in the course taking a managing position (as has been outlined for hunter-gatherer-communities by: Hayden 1995; Prentiss *et al.* 2018).

Lastly, the intercorrelation between site size, period, and material diversity does not negate this conclusion. The expansion of available material types from the Neolithic to the Bronze Age is not a statistical artefact but a technological reality. Neolithic communities could not deposit bronze or copper objects simply because those materials did not yet exist as accessible resources. Material diversity therefore increases across periods as a direct consequence of technological development. Crucially, both site size (Subchapter 5.10) and material and technological diversity produce similar overall and segment-specific pattern, namely no effect on the lower segment, a positive effect on the upper segment. This convergence across two independent predictors strengthens the interpretation of the upper segment as an increasing driver of inequality – something already observed in various studies (Subchapter 1.2 and 1.3) but only possible to grasp by an analysis of specific social segments.

5.11.1 Excursus: Craftsmen, warrior or hunter graves?

When addressing technological developments, some observations within the cemeteries should not go unmentioned. In some cases of Bronze Age cemeteries analysed in this thesis, graves with a high social index have only a low number of or even only one grave good. These graves achieve a high social index not through a large number of relatively rare objects, but through individual objects that are extremely rare. These objects often indicate a particular profession, status or role in society, such as daggers, lance heads or wrist guards, suggesting a role as a hunter or warrior,⁹² or moulds indicating a craftsman.⁹³ In these instances, the high social index may also reflect the differences in relational wealth of such warriors, hunters, and craftsmen, but not necessarily in status or rank.⁹⁴ Although

92 E.g. Budapest-Békásmegyer (Cat. No. 8) grave 125; Budakalász-Luppa-csárda (Cat. No. 7) grave 35; Hernádkak (Cat. No. 12) graves 39, 96, 122; Jelšovce (Cat. No. 14) graves 24, 234; Výčapy-Opatovce (Cat. No. 37) grave 310.

93 Nižná Myšľa (Cat. No. 23) graves 133, 280; Dunaujváros-Duna-dűlő (Cat. No. 9) grave 1029.

94 Although the discussion of craftsmen is usually connected to Bronze Age societies and the crafting of metal artefacts, there are without doubt specialised crafters in Neolithic and Copper Age societies for non-metal materials such as bone, leather/fur or stone (e.g. Augereau 2019; Bátor 2002, 207ff.; Harding 2002, 308ff.; Müller *et al.* 2013, 419).

these status differences are often discussed (Bátora 2002; Dolfini 2021, 826ff.; Falkenstein 2006/2007, 34ff.; Fischl *et al.* 2015, 515; Gogâltan and Borş 2022, 116; Harding 2015, 116; Jaeger and Olexa 2014, 172ff.; Jockenhövel 1982; Kristiansen and Larsson 2005, 113; Strahm 1994, 2-8; Strahm 2010), at least burials interpreted as craftsmen are usually not exceptionally richly furnished (Găvan 2015, 180; Kienlin 2007; Nessel 2013).

Therefore, it might be likely that craftsmen do not necessarily exhibit a significant difference in material wealth or status, or “rank” in the traditional sense, which would include not only profession-indicating objects (such as raw materials, moulds, weapons, *etc.*) but also a variety of traditional prestige goods (such as amber or gold). Instead, the relatively high social index in this study may reflect their relational wealth, demonstrated by the importance of their profession for society, even if their graves contain few items but include rare professional equipment. This could represent a form of relational wealth that highlights not just status or rank of an individual but the significance of a practical function for society (*i.e.* a profession). While this conclusion might apply to craftsmen graves, warrior graves – which become more frequent towards the end of the European Bronze Age (Kristiansen 1999, 176) – are usually interpreted as a display of high status and power of the buried individual (Harding 2015, 111ff.; Kristiansen 1999, 180ff.; Sperber 1992, 70-71; Tarbay 2015, 46f.).

Chapter 6: Discussion

Using a quantitative approach, this thesis aims to determine the development of social inequality between the Late Neolithic and the Middle/Late Bronze Age in the Carpathian Basin, its relation to other socio-economic processes and to test a methodology which can be transferred to a larger dataset. On the basis of 37 cemeteries and 6187 burials, the development of disparities of relational and material wealth in individual social segments and in different temporal resolutions has been analysed. The aim is to use established measures of inequality, the Gini index and the Generalized Entropy Measures, to take a broad look at dynamics of social inequality in prehistoric societies. Furthermore, this work follows an exploratory approach by demonstrating the methodological and interpretative possibilities when analysing different social segments and temporal scales.

In order to avoid misunderstandings, two considerations relating to the analysis and the results should be highlighted again at this point.

- The focus of this investigation is to a lesser extent on the individual cemeteries⁹⁵ and their individual inequality measures and wealth distributions, but on analysing the general development, aggregated median values and ranges. The aim is to make statements on the increases and decreases of social inequality and some processes influencing these developments between the Neolithic and the Bronze Age in the Carpathian Basin.

⁹⁵ The particularities of dealing with burials in relation to measures of inequality have already been described in detail in Chapter 3.

- This thesis deals with graves, which – as mentioned previously (Subchapters 1.1 and 4.2) – can be interpreted in many different ways in terms of their significance as a measure of wealth. Accordingly, the following discussion and the results presented above can be interpreted as a measure of the distribution of both: material and relational wealth.

The following section summarises and highlights the main outcomes of the analysis, examines their interrelationships, and discusses them in the context of the long-term developments outlined in the previous chapter.

6.1 A development of social inequality?

The results point to various developments and relationships concerning social inequality in burial contexts within the Carpathian Basin between 5200 and 1000 BCE. One obvious observation compared to other quantitative studies of social inequality using similar methodologies, such as inequality measures, is the high level of social inequality in burial contexts (Subchapters 5.1 and 5.2). This discrepancy is partly due to the differing nature of the data (Fochesato *et al.* 2019; Subchapters 4.3.4 and 5.1). Additionally, it is conceivable that, unlike settlement contexts, cemeteries may represent a different cross-section of society.⁹⁶ Moreover, the data shows that differences between cemeteries are mainly driven by differences in the wealth distribution of the wealthiest 20-40% of society (Subchapter 5.9). If the wealth analysed in graves is understood as predominately relational wealth, one can deduce from this that relational wealth differences or differences in status in the majority of society played a minor role. Regardless of methodological differences, the inequality measures – particularly the Gini index – indicate levels of wealth inequality of sizes found in modern states (Grimm *et al.* 2022, appendix B2) and are therefore not unseen in human societies.

Beside the considerable high levels of social inequality, quantitative studies of grave inventories (Großmann 2021; Windler *et al.* 2013; Windler 2017) and houses (Kohler *et al.* 2017; Porčić 2019) from prehistoric contexts using inequality measures (*e.g.* the Gini index or GEM) suggest a general increase in social inequality from the Neolithic to the Bronze Age. This is supported by social developments in the Carpathian Basin and surrounding regions during this period. For example, the emergence of local elites controlling resources and exchange networks, along with the specialisation of craftsmen enabled by copper and later bronze metallurgy, further underscores a continuous rise in social inequality (Bánffy 2010, 152-154; Dani *et al.* 2016, 219; Harding 2004, 390, 410-411; Kienlin 2008, 102; Schier 2010, 29; Shennan 1993, 149; Zalai-Gaál *et al.* 2012, 81). Against these known developments, this study expected a clear and statistically significant increase in inequality between the Neolithic, the Copper Age, and the Bronze Age (Fig. 1; Müller 2017, 25-26).

Surprisingly, the results of the analysis of the available dataset reveals no clear upward or downward trend in overall social inequality across societies (Gini_{all} and GEM[1]; Fig. 11; Table 10) during the period studied (Subchapter 5.5). The explanations for this observation are varied. From a statistical perspective, the wide dispersion of data, referred to as the “range” in this study, methodologically results in

⁹⁶ With regard to houses, it can be assumed that only homeowners/house communities (Flohr 2016) or, in relation to burial mounds, only the wealthiest individuals are represented in the data (Marzian *et al.* 2024).

a balanced linear development. In other words, a linear function is only partially suitable for describing the dataset. Nevertheless, this evaluation indicates no clear developmental trajectory over the studied period.

Beyond this statistical assessment, results related to site size (Subchapter 5.10), technology and resources (Subchapter 5.11), and the quantity and distribution of grave goods (Subchapter 5.8) highlight a wide variety of archaeological phenomena associated with graves and social groups. This diversity reflects varying degrees of inequality among societies. As the study does not focus on an isolated archaeological culture or microregion, the growingly wide ranges, resulting in a steady level of mean social inequality, likely represent the socio-cultural diversity of the study area from the Neolithic to the Bronze Age.

While the analysis of the entire societies ($Gini_{all}$ and GEM[1]; Fig. 11 and Table 12) shows no significant trends, a more nuanced picture emerges when individual societal segments are examined. Although not many statistically significant differences were found, trends in inequality development within the upper and lower societal segments are apparent. Social inequality in the lower segment visibly decreased between 5200 and 1000 BCE, whereas inequality in the upper segment increased notably during the same period (Subchapter 5.5). Changes in the lower segment ($Gini_{low}$ and GEM[0]; Fig. 12 and Table 12) are subtler compared to the upper segment ($Gini_{upper}$ and GEM[2]; Fig. 13 and Table 12), where both median values and linear functions show a marked rise.

This observation is important, as increasing inequality in the upper wealth distribution in addition to the increased wealth concentration ($Share_{upper}$) suggests that additional wealth was used to emphasise status differences within an increasingly smaller proportion of society. Within the wealthiest segment, a trend toward the exclusive display of relational wealth in burials for the topmost part becomes evident. Alternatively, there may have been a loss of significance in representing relational wealth outside this elite, as suggested for the Middle Bronze Age and the Late Bronze Age (Brück and Fontijn 2013, 198; Harding 2004, 364ff., 402, table 12.1; O'Shea 2011, 165) and by decreasing inequality in the lower segment of society.

Examining individual social segments reveals a clearer trend over time. Across the entire period (Fig. 14) and within individually analysed periods, there is an increase in wealth concentrated within the upper societal segment ($Share_{upper}$). This supports the hypothesis that an elite class increasingly accumulated wealth through control over resources and access to networks, as well as monopolising knowledge related to the production of prestigious materials (e.g. specialised craftsmen; see Subchapters 1.2 and 1.3).

In contrast, inequality within the rest of society ($Gini_{low}$) decreased slightly but consistently (Figures 12 a and c and Table 12), offsetting the increase in the upper segment and resulting in stagnation in the $Gini_{all}$ index. Despite assumptions of increasing stratification during prehistory, the lower segment shows a decline in inequality. Possible explanations for this include:

- The increasing concentration of wealth among the richest members of society may have limited opportunities for wealth disparities to develop among the rest of society. This raises the question why societies tolerated such imbalances over long periods, potentially due to mechanisms of “mutual benefits” or “coercion” (Mattison *et al.* 2016, 193). Societies may have accepted dominant elites in exchange for societal benefits, such as management or protection

(mutual benefits), or may have been forced to accept such dominance due to a lack of alternatives or insufficient pressure to provoke rebellion (Mattison *et al.* 2016, 193).

- In later periods, the display of wealth disparities in funerary contexts became more prominent among the wealthiest individuals (Earle and Kristiansen 2010, 254; Harding 2004, 364ff., table 12.1). Conversely, the importance of wealth display diminished for the rest of society (Harding 2004, 402ff.).
- A more equal distribution of remaining wealth may have been a deliberate or unconscious effort to sustain societal cohesion in response to the growing wealth of elites.

It is difficult to determine which of these processes is most directly related to the observed trends. However, it is likely that a combination of these mechanisms, varying across time and space, influenced the different development of inequality within individual societal segments in the Carpathian Basin. Social inequality in the Carpathian Basin between 5200 and 1000 BCE appears to have undergone time-limited cycles, with “waves” of increasing or decreasing inequality fluctuating around a stable mean, a pattern that only becomes visible through the high-resolution temporal analysis employing LOESS regression (Subchapter 5.7; Supplement F), rather than the coarser boxplot or linear approaches (Subchapter 5.5.). Both meanders documented in the LOESS analysis carry identifiable archaeological signatures (Subchapter 5.7; Fig. 15; 19; Supplement B): the first, reaching its minimum $Gini_{all}$ value of 0.67 during the transition from the Late Neolithic to the Early Copper Age, coincides with the demographic dispersal following the collapse of tell-settlement communities; the second, peaking at a $Gini_{all}$ maximum of 0.78 around 1875 BCE (Subchapter 5.7.2), aligns with the intensification of bronze metallurgy, the emergence of fortified settlement centers, and elevated frequencies of skeletal trauma in burial assemblages of the Northern Carpathian Basin, as outlined in detail in Chapter 5.7. The stability of both meanders across all segments and metrics (Supplement B) provides additional assurance that these fluctuations reflect genuine developments rather than sampling artefacts.

Such cyclical patterns in social processes have been discussed in the context of broader societal dynamics (*e.g.* Gronenborn *et al.* 2017). It is important to note that cycles are not identifiable through a single phenomenon, such as social inequality, alone. Typically, they require a combination of contemporary developments – for example, the degree of hierarchical organisation, the prevalence of prestige goods, settlement size or duration, *etc.* – which, when analysed in correlation, can indicate a broader societal cycle or boom and bust phases (Feaser *et al.* 2019; Gronenborn *et al.* 2017; Müller 2013; Müller 2017; Scholtus and Müller 2023). In the present analysis, there is thus only evidence to suggest that the mean level of social inequality in the Carpathian Basin between 5200 and 1000 BCE did not change in a sustained and lasting manner. However, distinct phases – possible cycles – can be observed. These cycles likely manifested not only in measurable but temporarily limited changes of social inequality but also in other developments, which have not been quantified in this study. Nonetheless, as noted above, cycles require a combination of indicators, and some potential influences fulfilling this role have already been discussed in detail in Subchapter 5.7.

Regarding the development of the mean level of social inequality, we can summarise that the analysis reveals several key outcomes regarding social inequality in burial contexts in the Carpathian Basin between 5200 and 1000 BCE. Despite high

	Mean inequality 5200-1000 BCE	Range of inequality 5200-1000 BCE
$Gini_{all}/GEM[1]$	→	↗
$Gini_{low}/GEM[0]$	↘	↗
$Gini_{upper}/GEM[2]/Share_{upper}$	↗	↗

Table 12. General development of the mean inequality and the range of inequality in the different analysed social segments for the time period 5200-1000 BCE.

levels of inequality comparable to those seen in modern states, no clear long-lasting trend of increasing or decreasing disparity was identified during this period. Instead, the findings highlight segment-specific developments: Inequality within the lower societal segment decreased slightly, while the upper segment experienced a significant rise in wealth concentration and inequality. This suggests a growing disparity, with elites increasingly emphasising relational wealth in burial practices, particularly among the wealthiest individuals, while the broader population displayed fewer wealth distinctions in burials. However, analysing whole societies reveals no change in inequality, most likely due to the development in both social segments counteracting each other.

Additionally, the analysis points to cyclical patterns of inequality, with fluctuations over time. These cyclical fluctuations appear to coincide with periods of documented demographic and ecological stress, as well as economic change, notably around 4800-4200 BCE and 2250-1750 BCE, suggesting that inequality in the Carpathian Basin was sensitive to broader systemic pressures. Together, these outcomes suggest that aggregate measures of inequality alone may not capture the full picture of segment-specific and temporally differentiated analyses, which can reveal developments that would otherwise remain hidden. However, even with weak statistical validation of the developments discussed above and in the following, the trends observed in this study are not merely a result of single study design choices and hold over two different metrics (GEM and Gini index), as well as in different data modification scenarios. The trends can thus be seen as robust trends (online Supplement G).

6.2 A growing range of social inequalities

In contrast to the development of the mean inequality (Subchapter 5.5), there is a clearly increasing trend in the ranges in all social segments between 5200 and 1000 BCE (Subchapter 5.6, Fig. 11, Fig. 12, Fig. 13 C and D, Table 12, Supplement C). This finding receives direct statistical validation from the Levene tests for variance homogeneity comparing an Early (5200-3000 BCE) and a Late (3000-1000 BCE) time period, which yield significant results for the $Gini_{all}$ ($p=0.03$), $Share_{upper}$ ($p=0.02$), $GEM[1]$ ($p=0.03$), and $GEM[2]$ ($p=0.02$) (Supplement B.2, Table c), and is further supported by the robustness and sensitivity checks of Supplement G, in which the range increases prove to be among the most stable observations in the dataset. In general, the changes are much more pronounced than in the previously discussed analysis of the mean and median values.

An expansion in the spectrum of social inequalities inevitably raises the question of what triggers might underlie this development. In this regard, various reasons can be identified and analysed. One reason for an increasing diversification in levels of social inequality may lie in demographic developments, particularly changes in the range of societal sizes. In addition to observations that population increases occurred during the Neolithic and later during the Bronze Age

(Müller 2013; 2015; Müller and Diachenko 2019; Schmidt *et al.* 2021), the analysis of site size reveals a clear increase in the average size and growing diversity of the size of cemeteries between the Neolithic and the Bronze Age (Subchapter 5.10).

This increase is not due to a decline in smaller cemeteries or, more broadly, smaller societies, but rather stems from the growth of large and very large cemeteries, or societies, over the course of prehistory. As already described in Subchapter 5.10, there is also a correlation between the size of a cemetery and the measured social inequality, so while sites tend to increase in size during prehistory, so does the upper margin of measured social inequality.

A related development becomes apparent when examining the relationships between individual societal segments and society size. It appears that social inequality in the lower segment of society does not depend on the overall size of the society. However, in the upper segment, a clear correlation between inequality and the total size of the society is demonstrable. This seems to reflect that as a society grows larger, the need arises for mechanisms of social organisation, such as the formation of a hierarchical societal structure (Johnson 1982; Prentiss *et al.* 2018). If these mechanisms cannot be established, the society risks long-term fragmentation due to “scalar stress” (Johnson 1982). This correlation between society size and upper-segment inequality suggests that the emergence of pronounced hierarchies was not an inevitable cultural development, but may have been a response to the organisational demands of larger communities. This raises the possibility that elite formation, especially in the later half of the study period, was not always culturally driven or based on the initiative of aggrandizers or managers to cease resources or power but may also have been a structural consequence of demographic growth, a distinction that has implications for how we interpret the emergence of hierarchy in prehistoric societies in general.

The convergence of site size data, inequality measures, and the wider archaeological record suggests that the Neolithic–Bronze Age transition in the Carpathian Basin was not a uniform process of increasing stratification, but a gradual fragmentation into societies with increasingly different organisational forms. Smaller, egalitarian, acephalous, and minimally stratified societies (Lüning 1988 [1991], 88; Müller 2017, 25) during the Neolithic gave way to sometimes large, complex, highly stratified societies dependent on status and resources in the Bronze Age (Dani *et al.* 2016, 219; Harding 2004, 390ff.; Müller 2017, 25; Shennan 1993, 149; Strahm 1994, 2ff.; Strahm 2010), yet the results suggest that egalitarian and highly stratified communities continued to coexist throughout this period. This development is most likely one reason for the broadening range of social inequality, particularly the rising upper limit of social inequality within individual societies over the course of prehistory.

Another reason for the expanding spectrum of social inequality may lie in advancing technological and economic development. The analysis of the distribution of functional and material groups in the cemeteries (Subchapter 5.11) points to a variety of different technological levels, likely resulting from disparities in technological knowledge and resource availability. These differences also appear to be linked to the size of societies, with larger societies generally having better access to diverse technologies and materials.

In addition, potential differences stemming from the spread of technologies, focused but limited specialisations in smaller societies, and dependencies on local resource availability suggest that the diversification of levels of social inequality – resulting in decreasing, as well as increasing levels of social inequality – can be connected to the increasing availability of materials and technologies.

Furthermore, the emergence of new societal groups, such as craftsmen or warriors (Subchapter 5.11), which arose during prehistory due to technological innovations, also highlights this trend. These groups could reinforce functional social differentiation as reflected in burial practices, which in the current analysis might have driven the upper margin of social inequality measures further up.

Lastly, as demonstrated in Subchapter 5.8, various cultural processes may influence the degree of social inequality observed between societies. While the results do not conclusively identify the specific processes responsible for differing levels of inequality, certain patterns emerge. These patterns, particularly in the measured inequality and the average quantity of grave goods per burial (Fig. 20), suggest differing emphasis on the display of relational wealth in graves. This, in turn, may reflect the varying significance of relational wealth differences and handling within the respective societies.

The widening range is best understood not as statistical noise, but as the material signature of a region-wide diversification – one in which different communities developed different responses to the challenges of demographic growth, resource access, and technological change. On the one hand, these societies had different sizes and structures, such as hamlets and large settlements or families and tribes, with different cultural practices regarding the exhibition and meaning of wealth and wealth differences. On the other hand, these societies had different access to technology, innovation and resources, which enabled differences in production and distribution of wealth within and between societies. That this diversification is visible across all social segments simultaneously, and that the range increases are among the statistically best-supported findings in the dataset (Supplement B.2) suggests that the growing spectrum of social inequality represents a structural feature of the Neolithic to the Bronze Age transition in the Carpathian Basin rather than an accumulation of isolated local developments.

6.3 Methodological issues: Sample sizes

In addition to analysing the development of social inequality, the chosen methodology was examined using statistical tests as part of this thesis (Subchapters 4.3.11 and 5.4). One important outcome of this analysis is the determination of a suitable sample size, which is needed to create a statistically meaningful study. As shown in Subchapter 5.4 on the basis of the effect size and the required sample size (Table 8), the present study with 37 cemeteries does not have a sufficient database for a clear statistical proof of any development of social inequality. Given the defined selection criteria, the reliance on published material, and the considerable effort required for manual data collection (see Subchapter 3.1), this number nevertheless represents a substantial and methodologically consistent sample, and to date the largest sample analysed in this manner for the Carpathian Basin. A larger or differently composed sample could, however, reveal more nuanced patterns, although the robustness and sensitivity checks indicate a relative stability of the observed trends (online Supplement G). It can be seen that there are statistically significant differences between the Gini index of individual sites (Dunn's test). However, this is not carried over when analysing the single time periods (Wilcoxon test). To create a meaningful sample when comparing these aggregated time periods, we would need several hundred more burial sites (Table 8).

The analysis of the sample size conducted of the comparisons of mean values shows that at least 474 burial sites (Table 8) are required for a statistically robust

analysis of social inequality. This number already takes into account a lower effect size and a more tolerant significance level than is typically used in natural science or medical studies. If we bear in mind that the cemetery and burial catalogue of donau-archaologie.de (Thomas 2009) contains a total of 619 entries for the Carpathian Basin, it becomes clear that it is hard to provide statistically validated evidence for a specific development in this region on the basis of grave inventories. If we further recognise that this thesis invested three years into the collection of data, it becomes clear that a study involving a minimum meaningful sample of 474 or even more burial sites will be an even more time and labour-intensive matter.

But beside the possibility of increasing the sample size in future studies to improve the statistical and explanatory strength of the dataset, there is also a possibility to look for a proxy which provides a stronger effect size when comparing burial sites. The social index, which was used in this study, has been chosen to include a larger set of sites into the analysis. Other approaches to develop a social index might prove to be more robust and might result in a smaller necessary sample size. This can be illustrated for the case of a very strong hypothetical effect size ($r = 0.8$; Subchapter 5.4, Table 8), which results in a reduction of the number of necessary cemeteries to a number from 32 to 74 (Table 8). To bolster the strength of a wealth or social index, one could think about building an index which combines several measures beside scarcity, such as grave dimensions (Großmann 2021; Bösel 2008), absence-presence of material and object types (Hedeager 1990) or labour investment (Nørtoft 2022). Further different statistical approaches, which usually are better suited in dealing with small sample sizes, such as a Bayesian approach, might be helpful to increase the statistical strength of an analysis of grave inventories and inequality. Lastly, to address the issue of high confidence intervals and the correlation between cemetery size and inequality measure, a weighting of inequality measures based on site size, confidence intervals or a combined approach could be applied to further bolster the strength of the analysis.

If we transfer the results of this thesis to other studies about social inequality, the extent to which the sample size affects other data sets and studies about social inequality in prehistoric societies (*e.g.* house sizes, storage pit volumes, *etc.*) can only be surmised. It should be assumed that other studies on social inequality in prehistoric societies also require significantly larger sample sizes. This also underlines the fact that quantitative analyses based on inventories of grave goods from a single cemetery do not provide strong evidence when it comes to the discussion of an overarching development of social inequality. Nevertheless, small sample sizes are a common problem in quantitative and especially social archaeology (Cowgill 2015, 6), which should not be ignored when discussing the credibility of results. They are usually a limiting factor to the explanatory power and the range of statements that can be made.

For the present analysis, it should be clearly noted that the formal significance tests applied to differences in mean inequality between aggregated time periods are structurally underpowered given the current sample size, and p-values from those specific comparisons should not serve as the sole criterion for evaluating the findings. The range increases, by contrast, receive direct statistical validation through the Levene tests for variance homogeneity (Supplement B.2), and the GEM[2] increase is confirmed by both the linear regression ($p=0.04$) and the two-period Wilcoxon test ($p=0.02$). This distinction between the magnitude of evidence of different findings should be kept in mind throughout the interpretation. However, the lack of statistical significance does not mean that the findings obtained from a small data

set are invalid or obsolete (see Subchapter 4.3.9). A link with other archaeological findings, such as site sizes, burial patterns, or material and technological observations, provides evidence that developments and patterns of social inequality in the present data set have an echo in other simultaneous developments. Furthermore, while the matter of significance has been tested on developments of means, the analysis of ranges shows stronger statistically validated proofs. Both means and ranges are independently validated through the comprehensive robustness and sensitivity checks reported in Supplement G, confirming that the documented trends are stable across different data modifications and analytical parameterisations, and cannot be attributed to individual site outliers or methodological choices alone. This constitutes a mode of empirical confirmation distinct from formal significance testing but directly connected to the question of whether the observed patterns are genuine and on the basis of Supplement G, the answer is that they are! Until a dataset of sufficient size becomes available, the results of this thesis should be read as empirically grounded observations whose full statistical generalisability to a wider population of cemeteries awaits confirmation from future, larger-scale studies and as a productive analytical framework that establishes benchmarks against which such studies can orient and evaluate themselves.

Chapter 7:

Conclusion and Outlook

This investigation explores the dynamics of social inequality in the Carpathian Basin between the Late Neolithic and the Middle/Late Bronze Age by addressing four primary research aims (Chapter 1). These aims are analysed through a quantitative framework, focusing on burial contexts and using inequality measures to understand societal dynamics.

7.1 Analysing the development of social inequality

The first aim of this thesis is to analyse the development of social inequality in the Carpathian Basin over time. Across 37 cemeteries spanning 4,200 years, the analysis produces $Gini_{all}$ values between 0.59 and 0.86 (Supplement A.1), a range comparable to modern state-level wealth inequalities, yet identifies no sustained directional change in this overall level across the study period (see Table 12). Rather than a linear trajectory, the higher-resolution LOESS analysis points to a pattern of cyclical fluctuation in which temporary increases or decreases return to a stable central value, with broader societal processes, demographic, ecological, and economic, operating as the likely drivers of each meander (Subchapter 5.7; Supplement G.3).

What makes the overall stability analytically significant rather than a null outcome is its structural origin. The stable $Gini_{all}$ might not reflect the absence of change but potentially the simultaneous operation of two partially counteracting developments: a subtle directional shift towards lower internal differentiation

within the lower 90% of the wealth distribution, alongside a statistically confirmed increase in wealth concentration within the uppermost decile. This structural interplay is visible across multiple independent metrics and remains consistent under the full range of robustness checks reported in Supplement G. The two tendencies carry unequal weight: the upper-segment concentration is statistically more grounded through the GEM[2] significance and the Levene test results for the $\text{Share}_{\text{upper}}$ and Gini_{all} (Supplement B.2), while the lower-segment homogenisation represents a consistent directional tendency supported by cross-metric agreement but not by formal significance.

While the mean levels of inequality do not show a clear long-term trend of increase or decrease, the range of inequality demonstrates a clear increasing development over time. This widening range reflects increasing diversification among societies in terms of inequality levels, suggesting that while some communities remained relatively egalitarian, others developed pronounced disparities. These findings highlight the growing complexity of prehistoric societies. Processes, such as developments in the size of societies, technological and material advances, as well as cultural particularities, may be among the chief causes for such an increasing variance of inequalities. One example of the impacts that this observation might have had on past societies is that this increase in range means that individuals in the Bronze Age were practically able to change the level of inequality they were exposed to by migrating to other parts of the Carpathian Basin, while individuals during the Neolithic were not able to do so. This has implications beyond migration and it suggests that in the course of the Neolithic to the Bronze Age individuals and communities had a growing and lastly meaningful agency in navigating social structures. Further it means that inequality was not always imposed from above or the acts of an “elite” but was also the product of deliberate social choices and dynamics, such as demographic growth, wealth handling or migration.

7.2 Investigating the development of wealth-based segments

The second aim focuses on understanding how inequality developed within wealth-based segments of society. This thesis highlights segment-specific developments (see Table 12), revealing divergent trends within the upper and lower societal segments. The direction of change differed systematically between these groups: the 90% less wealthy part of society showed a consistent tendency towards greater internal homogeneity and a decreasing impact on overall inequality, while the uppermost decile experienced a marked intensification of internal differentiation and inequality impact (Supplement B.2). As discussed in Chapter 6, the evidential basis for these two tendencies is difficult: the upper-segment concentration is statistically confirmed, while the lower-segment homogenisation represents a robust directional tendency awaiting larger-sample verification. Although the scale of the measures might seem counter-intuitive at first look, with relatively high lower-segment Gini indices against lower upper-segment Gini values, it is the direction of the temporal trends and their interplay with the GEM that yields the most explanatory power, since each metric is shaped by its own methodological composition (*i.e.*, homogeneity of the subsample). These trends suggest a shift in the handling of wealth, as well as growing disparities within parts of the societies, with an increasing focus on displaying relational wealth among the wealthiest individuals, while wealth distinctions diminished among the broader population.

The findings also point to a growing range of inequality over time in the individual societal segments, with larger societies showing the potential for higher levels of inequality, particularly within their upper segments. This further highlights the impact of a relatively small, wealthy group. Their growing wealth is able to offset the decreasing inequality experienced by the majority of the society, leading to a stagnation of inequality within society as a whole. Crucially, this means that the absence of a clear trend in the entire society is not a null result but a substantive finding, since it suggests the presence of a structural interplay between elite wealth consolidation and broader social levelling, two processes that appear to have been present simultaneously.

7.3 Contributing to methodological development

A key objective of this thesis is to contribute to the development of methodologies for analyses of burial data and social inequality. The study underscores the limitations of small sample sizes, highlighting the need for datasets exceeding 474 burial sites – in the case of future regional studies of the Carpathian Basin using the same methodology – in order to achieve statistically robust conclusions. Moreover, the relatively low effect strength observed here, besides being influenced by sample size, also reflects the inherently multi-dimensional character of social inequality, where burial data only form one kind of overall inequality, as outlined in Chapter 1.1 (see Table 1). Despite these limitations, the study demonstrates the potential of quantitative approaches when analysing and interpreting past societies, using established inequality measures. However, it should be proposed that methodological adjustments, such as enhanced social indices or Bayesian statistical techniques, are necessary to improve future analyses. The future development of methodologies should aim to further address the challenges of interpreting complex burial data and provide a foundation for more robust databases for the explorations of prehistoric inequality. Based on my findings, a closer engagement with different parts of societies, using different methodological approaches to validate robustness, is advised in future work and one methodological contribution of this thesis. Lastly, developing robust social indices that bolster effect strengths might be the most important methodological tool to increase the statistical reliability of inequality studies based on burial data.

7.4 Discussing observations in relation to economic, environmental, and social processes

The final aim is to contextualise the findings within broader economic, environmental, and social processes. The analysis reveals that inequality levels were influenced by factors such as cemetery size, access to resources, cultural practices, and technological developments. The diversification of these factors contributed to an increasing range of social inequality between the Neolithic and the Bronze Age, reflecting the growing complexity and variability of societal structures. This broadening range of inequality, coupled with increasing opportunities for migration and social mobility, underscores the dynamic interplay between societal change and inequality. The findings align with known developments during this period, such as the emergence of elites, specialisation in craftsmanship, and advancements in metallurgy, which likely further contributed to stratification within societies. Additionally, cyclical patterns of inequality highlight the intercon-

nectedness of social inequality with other societal phenomena, such as resource distribution, population dynamics, and social organisation, which are observable in time periods of increasing or decreasing changes in inequality.

In conclusion, this investigation provides important insights into the development of social inequality in prehistoric societies, offering an understanding of wealth-based societal segments, contributing to methodological advancements, and situating the findings within broader social-economic contexts.

Nevertheless, as with any study, this thesis has its limitations and unresolved aspects that require further development. The data and results presented here should be seen as a starting point for future research. As such, I want to briefly outline directions for future investigations that may derive from the data that I collected.

In this study, a division of the dataset into regional subgroups was not feasible. Part of the analysis already indicated that the overall sample size is relatively small in a statistical manner, and further subdivisions would have undermined the reliability of regional analyses. Future research should therefore aim to develop robust datasets on micro-regional scales to allow for meaningful and statistically robust comparisons of local developments.

Although the burial phases of the sites are reported in the catalogue, many graves could not be reliably assigned to any specific phase. Methodological attempts to include unassigned graves only increased the confidence intervals, weakening the conclusions. While detailed chronological developments may be possible in well-dated cemeteries like Pilismarót-Basaharc (Cat. No. 25), a broader integration of burial phases must wait until more chronological data becomes available across multiple sites.

The same limitation applies to analyses of violence and demography in connection with inequality. Although fragmented and basic osteological assessments exist for nearly all sites in this study, detailed studies on trauma or disease are rare throughout the prehistoric archaeology of the Carpathian Basin (some exceptions: Strouhal 1978; Koel 2011; Hukelova 2016). Until a larger number of such analyses are published, these kinds of investigations will remain restricted to individual sites or site phases.

Finally, recent international research highlights the importance of combining inequality data with other socio-economic indicators (Duffy *et al.* 2025; Müller *et al.* 2024; Kerig *et al.* 2025; Kohler *et al.* 2017; 2025). Many significant patterns only emerge from large, high-quality datasets – ones that require continental or even global perspectives and interdisciplinary collaboration.

Despite the challenges posed by limited data, this study demonstrates the value of quantitative approaches in the identification of trends and lays a foundation for future research, emphasising the importance of growing datasets and refined methodologies to fully analyse the complexities of prehistoric inequality in the Carpathian Basin and beyond. I hope that, although still modest in scale, my work will contribute a valuable piece to the broader puzzle of understanding social inequality throughout prehistory.

Summary

This thesis deals with the development of social inequality in the Carpathian Basin between 5200 and 1000 BCE on the basis of cemeteries, as well as with the development of a methodology for analyses of these cemeteries. The aim is to recognise a possible development and to describe it with regard to contemporaneous social, economic, ecological, and technological processes. A quantifying and statistical procedure was chosen as the methodological approach, on the one hand, to work out general trends and developments, and, on the other hand, to determine the possibilities and limitations of such an analytical procedure.

The first chapter introduces the theoretical framework by developing a definition of the term “social inequality”, which serves as a basis for an understanding of the results of the analysis. The following definition was developed as part of this discussion:

Social inequality is the differential access to, accumulation of, and action with/over material, relational and embodied wealth.

This definition combines the theory by J. Beck and C. P. Quinn (2023) about the different forms in which social inequality is expressed with different types of wealth identified by M. Borgerhoff Mulder (*et al.* 2009) as part of an ethnographic analysis. Following this definition, graves and their grave inventories can be understood as a proxy for analyses of the distribution of predominantly relational

wealth as well as material wealth. Relational wealth is relevant, since grave goods are given to a deceased person by their burial community,⁹⁷ which (can) express the position of the deceased within society. In addition, the type of material and the object type of grave goods show the extent to which the deceased and their burial community had access to or even control over exchange networks. Material wealth is illustrated by the extent and type of grave furnishings. Material wealth is significant, since it can therefore be assumed that social groups with a low level of material wealth were not able to provide grave goods for deposition to the same extent as rich groups. In the course of the first chapter, however, it is also shown that the proportion of material and relational wealth that can be measured via grave inventories does not remain constant and cannot be determined precisely. The first chapter also deals with theories on the emergence and persistence of social inequality, as well as giving a brief overview on the development of social inequality in Central Europe and the Carpathian Basin.

The second chapter begins with an introduction about the geographical framework and the ecological and climatic development of the Carpathian Basin. The second part of the chapter deals with the archaeological setting, development, and relationships between archaeological cultures. The archaeological part, in particular, is linked to the cemetery catalogue and provides further information on the individual archaeological cultures and a basis for the relative dating of cemeteries without absolute dating results.

The third chapter deals with the data basis and the strategy for data acquisition. As part of the work, a database was created with the help of which a standardised data record of the cemeteries with information on burial form, anthropological determinations (gender and age), chronological information (cemetery phase), grave goods, grave construction and possible isotope analyses could be stored. During the data collection process, it became apparent that only grave goods were published on a large scale and that further information on gender, age or grave construction was incomplete. The further analyses therefore concentrated on grave goods, as they were the only proxy that made it possible to evaluate as many cemeteries as possible.

Chapter 4 explains the analysis process and the individual methods that are implemented. In preparation for the actual analysis, the grave goods were categorised into functional groups and a social index was determined for each burial based on the frequency of these groups within a cemetery (Großmann 2021). A normalised Gini index and an asymptotic standard error as well as a Generalized Entropy Measure were then calculated for each cemetery (Marzian 2021) and individual social segments. Finally, the 37 cemeteries were statistically analysed together. In order to determine the general development of social inequality – *i.e.*, the extent to which there was an increase or decrease – the data was analysed using linear regression and in two and three chronological groups. In order to recognise a temporally high-resolution development, the cemeteries were analysed with the help of a LOESS regression. As part of the analysis, the individual chronological groups were tested for statistically significant differences using the Wilcoxon-Mann-Whitney-U test and the Levene test.

Chapter 5 presents the results of inequality and further analysis, such as correlations between inequality and materiality, site sizes or cultural indications. At the same time, the characteristics of the data are analysed and presented.

⁹⁷ In this case, the term burial community refers to the people who buried the deceased and are responsible for the grave furnishing.

Chapter 5 also provides some analogies to other archaeological cases and already provides a short discussion on some of the presented processes.

Chapter 6 deals with an in-depth discussion of the results. There are several indications that the developments in social inequality visible in this study can be synchronised with other archaeological findings. For example, no clear and steady increase in social inequality is recognisable in burial contexts. Although an increasing concentration of wealth in the richest segment of society can be recognised, social inequality in the rest of society tended to decrease during this period. In relation to the entire society – *i.e.*, the richest 10% and the remaining 90% – a stagnation can be recognised. At a higher temporal resolution, there are signs of a cyclical development in social inequality, with periods in which there are clearly recognisable increases or decreases in social inequality in the grave context. These recognisable fluctuations coincide with time periods (4800-4200 BCE; 2250-1750 BCE) in which broader social, economic, ecological and, in some cases, technological transformations take place.

Furthermore, it is also evident that a description of the development of social inequality on the basis of mean values does not verify a very pronounced development, at least with the available database. This is due to the large dispersion of the data in some cases. Looking at the ranges, in contrast, a clear but not statistically significant increase can be recognised. In the discussion, this increase was primarily discussed against the background of an increasing size of societies, technological development and specialisation, as well as cultural practices which appear to represent a valid explanatory approach.

It has been shown that for a statistically meaningful study on social inequality in burials, *i.e.*, a study in which it is possible to identify significant differences, either a proxy must be developed which produces a significantly stronger statistical effect or a significantly larger data set (at least 474 cemeteries) must be available. This problem, which often occurs in archaeological evaluations, means that the results of the present work do not allow a clear statement on the development of social inequality from a purely statistical point of view. However, this also means that there is a (unknown) possibility that the visible developments highlighted in the analysis may have existed. The plausibility of these developments can be checked by analysing and discussing the results of the analysis together with other social, economic, and ecological developments in the same period.

This work has therefore shown that, despite a reductive methodological approach, larger data sets will be required in the future for a quantitative evaluation of social inequality. With regard to the development of social inequality, it was shown that mean values are generally less suitable in order to analyse a development. However, there are indications that a cyclical development of social inequality is more likely than a steady increase. Spans appear to be more suitable for analyses of social inequality in grave inventories. It can be seen that there is a clear increasing trend in ranges over the period that has been analysed, which is accompanied by a diversification in the social practices, organisation, size, availability of resources and technological specialisation of societies.

Summary in German

Diese Arbeit befasst sich mit der Entwicklung sozialer Ungleichheit im Karpatenbecken zwischen 5200 und 1000 v. u. Z. auf der Grundlage von Gräberfeldern sowie mit der Ausarbeitung einer Methodik zur Analyse dieser Gräberfelder. Ziel ist es, eine mögliche Entwicklung zu erkennen und sie im Hinblick auf zeitgenössische soziale, wirtschaftliche, ökologische und technologische Prozesse zu beschreiben. Als methodischer Ansatz wurde ein quantifizierendes und statistisches Verfahren gewählt, um einerseits allgemeine Trends und Entwicklungen herauszuarbeiten und andererseits die Möglichkeiten und Grenzen eines solchen Analyseverfahrens zu bestimmen.

Im ersten Kapitel wird der theoretische Rahmen eingeführt, indem eine Definition des Begriffs „soziale Ungleichheit“ entwickelt wird, die als Grundlage für das Verständnis der Analyseergebnisse dient. Die folgende Definition wurde im Rahmen dieser Diskussion entwickelt:

Soziale Ungleichheit ist der unterschiedliche Zugang zu, die Akkumulation von und der Umgang mit materiellem, relationalem und verkörpertem Reichtum.

Diese Definition kombiniert die Theorie zu den verschiedenen Ausdrucksformen sozialer Ungleichheit von J. Beck und C.P. Quinn (2023) mit den von M. Borgerhoff Mulder (*et al.* 2009) im Rahmen einer ethnografischen Analyse identifizierten Vermögensarten. Gemäß dieser Definition können Gräber und ihre Grabinventare

als Indikator für die Verteilung von hauptsächlich relationalem und im begrenzten Rahmen materiellem Reichtum verstanden werden. Relationaler Reichtum ist relevant, da Grabbeigaben von der Bestattungsgemeinschaft⁹⁸ einer verstorbenen Person gegeben werden, was die Stellung der/des Verstorbenen in der Gesellschaft ausdrücken kann. Darüber hinaus zeigen die Art des Materials und der Objekttyp der Grabbeigaben, inwieweit die Verstorbenen und ihre Bestattungsgemeinschaft Zugang zu Austauschnetzwerken hatten oder diese sogar kontrollierten. Materieller Reichtum wird durch den Umfang und die Art der Grabausstattung illustriert, weil davon ausgegangen werden kann, dass soziale Gruppen mit geringem materiellem Reichtum nicht in der Lage waren, Grabbeigaben im gleichen Umfang wie wohlhabendere Gruppen bereitzustellen. Im ersten Kapitel wird jedoch auch herausgearbeitet, dass der Anteil von materiellem und relationalem Reichtum, der über Grabinventare messbar ist, nicht konstant bleibt und nicht genau bestimmt werden kann. Das erste Kapitel behandelt außerdem Theorien zur Entstehung und Persistenz sozialer Ungleichheit sowie einen kurzen Überblick über die Entwicklung sozialer Ungleichheit in Mitteleuropa und im Karpatenbecken.

Das zweite Kapitel beginnt mit einer Einführung in die geographischen Rahmenbedingungen sowie die ökologische und klimatische Entwicklung des Karpatenbeckens. Der zweite Teil des Kapitels beschäftigt sich mit dem archäologischen Kontext, der Entwicklung und den Beziehungen der archäologischen Kulturen. Insbesondere der archäologische Teil ist mit dem Gräberfeldkatalog verknüpft und liefert weitere Informationen zu den einzelnen archäologischen Kulturen sowie eine Grundlage für die relative Datierung von Gräberfeldern ohne absolute Datierungsergebnisse.

Das dritte Kapitel behandelt die Datenbasis und die Strategie zur Datenerhebung. Im Rahmen der Arbeit wurde eine Datenbank erstellt, mit deren Hilfe ein standardisierter Datensatz der Gräberfelder mit Informationen zu Bestattungsformen, anthropologischen Bestimmungen (Geschlecht und Alter), chronologischen Informationen (Gräberfeldphase), Grabbeigaben, Grabkonstruktionen und möglichen Isotopenanalysen gespeichert werden konnte. Im Verlauf der Datenerhebung zeigte sich, dass nur Grabbeigaben großflächig publiziert wurden und weitere Informationen zu Geschlecht, Alter oder Grabkonstruktionen unvollständig waren. Die weiteren Analysen konzentrierten sich daher auf Grabbeigaben, da diese der einzige Proxy waren, der es ermöglichte, möglichst viele Gräberfelder auszuwerten.

Kapitel vier erklärt den Analyseprozess und die verwendeten Methoden. Zur Vorbereitung der eigentlichen Analyse wurden die Grabbeigaben in funktionale Gruppen kategorisiert, und für jedes Grab wurde auf Grundlage der Häufigkeit dieser Gruppen innerhalb eines Gräberfelds ein sozialer Index bestimmt (Großmann 2021). Für jedes Gräberfeld wurden ein normalisierter Gini-Index und ein asymptotischer Standardfehler, sowie Generalisierende Entropy Maße, für die gesamten Gräberfeld, als auch einzelne soziale Segmente berechnet (Marzian 2021). Abschließend wurden die 37 Gräberfelder statistisch gemeinsam analysiert. Um die allgemeine Entwicklung sozialer Ungleichheit – also das Ausmaß einer Zunahme oder Abnahme – zu bestimmen, wurden die Daten mittels linearer Regression sowie in zwei und drei chronologischen Gruppen analysiert. Um eine zeitlich hochauflösende Entwicklung zu erkennen, wurden die Gräberfelder mittels LOESS-Regression analysiert. Im Rahmen der Analyse wurden die

⁹⁸ In diesem Fall bezeichnet *Grabgemeinschaft* diejenigen Personen, die eine Verstorbene / einen Verstorbenen bestattet haben und für die Ausstattung des Grabes verantwortlich waren.

einzelnen chronologischen Gruppen mit dem Wilcoxon-Mann-Whitney-U-Test und dem Levene-Test auf statistisch signifikante Unterschiede geprüft.

Kapitel fünf präsentiert die Ergebnisse zur Ungleichheit sowie weitere Analysen, wie zum Beispiel Korrelationen zwischen Ungleichheit und Materialität, Fundortgrößen oder kulturellen Indikatoren. Zudem werden die Charakteristika der Daten analysiert und präsentiert. Kapitel fünf führt außerdem archäologische Beispiele und eine kurze Diskussion zu einigen der vorgestellten Prozesse auf. So zum Beispiel im Bezug zu den Entwicklungen im Siedlungssystem, Demographie und Technologie, welche im Zusammenhang zur sozialen Ungleichheit betrachtet werden.

Kapitel sechs befasst sich mit einer eingehenden Diskussion der Ergebnisse. Mehrere Indizien legen nahe, dass die in dieser Studie sichtbaren Entwicklungen der sozialen Ungleichheit mit anderen archäologischen Befunden synchronisiert werden können. Beispielsweise ist im Bestattungskontext kein klarer und kontinuierlicher Anstieg der sozialen Ungleichheit erkennbar. Obwohl eine zunehmende Konzentration von Reichtum im reichsten Segment der Gesellschaft festgestellt werden kann, nahm die soziale Ungleichheit im übrigen Teil der Gesellschaft in diesem Zeitraum tendenziell ab. Bezogen auf die gesamte Gesellschaft – also die reichsten 10% und die übrigen 90% – lässt sich eine Stagnation erkennen. Bei einer höheren zeitlichen Auflösung zeigen sich Hinweise auf eine zyklische Entwicklung sozialer Ungleichheit, mit Perioden, in denen deutliche Zunahmen oder Abnahmen der sozialen Ungleichheit im Bestattungskontext erkennbar sind. Diese Schwankungen fallen mit Zeiträumen (4800-4200 v. u. Z.; 2250-1750 v. u. Z.) zusammen, in denen umfassende soziale, wirtschaftliche, ökologische und teilweise technologische Transformationen stattfanden.

Darüber hinaus wird deutlich, dass eine Beschreibung der Entwicklung sozialer Ungleichheit auf Basis von Mittelwerten zumindest mit der vorhandenen Datenbasis keine ausgeprägte Entwicklung zeigt. Dies liegt zum Teil an der großen Streuung der Daten. Betrachtet man jedoch die Spannweiten, so lässt sich ein deutlicher, wenn auch nicht statistisch signifikanter Anstieg erkennen. In der Diskussion wurde dieser Anstieg vor allem vor dem Hintergrund zunehmender Gesellschaftsgrößen, technologischer Entwicklungen und Spezialisierungen sowie kultureller Praktiken betrachtet, die eine valide Erklärungsmöglichkeit darstellen.

Es hat sich gezeigt, dass für eine statistisch aussagekräftige Untersuchung sozialer Ungleichheit in Bestattungen entweder ein Proxy entwickelt werden muss, der einen signifikant stärkeren statistischen Effekt erzielt, oder eine deutlich größere Datenbasis (mindestens 474 Gräberfelder) erforderlich ist. Dieses häufig in archäologischen Auswertungen auftretende Problem bedeutet, dass die Ergebnisse der vorliegenden Arbeit aus rein statistischer Sicht keine eindeutige Aussage zur Entwicklung sozialer Ungleichheit erlauben. Es besteht jedoch die Möglichkeit, dass die in der Analyse sichtbaren Entwicklungen existiert haben könnten. Die Plausibilität dieser Entwicklungen kann überprüft werden, indem die Ergebnisse der Analyse zusammen mit anderen sozialen, wirtschaftlichen und ökologischen Entwicklungen derselben Zeit analysiert und diskutiert werden.

Diese Arbeit hat gezeigt, dass trotz eines reduktiven methodischen Ansatzes in Zukunft größere Datensätze für eine quantitative Bewertung sozialer Ungleichheit erforderlich sein werden. Hinsichtlich der Entwicklung sozialer Ungleichheit zeigte sich, dass Mittelwerte im Allgemeinen weniger geeignet sind, um eine Entwicklung zu analysieren. Es gibt jedoch Hinweise darauf, dass eine zyklische Entwicklung sozialer Ungleichheit wahrscheinlicher ist als ein stetiger

Anstieg. Spannweiten scheinen besser geeignet zu sein, soziale Ungleichheit in Grabinventaren zwischen Gräberfeldern zu analysieren. Es lässt sich feststellen, dass sich über den analysierten Zeitraum ein klarer zunehmender Trend in den Spannweiten zeigt, der mit einer Diversifizierung der kulturellen Praktiken, Organisation, Größe, Verfügbarkeit von Ressourcen und technologischen Spezialisierung von Gesellschaften einhergeht.

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Appendices

Appendix A: Cemetery/Site catalogue

The information of the individual graves, burials and grave goods are in the online supplement. The raw burial data can be found in a SQLite and MS Access Database; for each cemetery the individual burials, their available information (age, sex, disturbance, phase, grave dimensions) – if reported – as well as the grave goods are stored. Moreover, the burial information is included in raw data tables in the online Supplement E. The criteria of data selection are reported in Chapter 3

1. Abrahám I, Komárov vršok

County/District: Trnava Region, Galanta District, Slovakia

Absolute dating: 2200-1500 BCE (no ¹⁴C)

Period(s): Early Bronze Age

Archaeological cultures: Nitra, Ťňetice, and Maďarovce cultures

Chronological phases: 3 phases after Benkovsky-Pivovarová and Chropovský (2015b); Nitra (2200-1900 BCE), Ťňetice (1900-1700 BCE), Maďarovce (1700-1500 BCE)

Number of graves: 189 graves

Description: During the construction of a railway in 1938, the first inhumation graves were discovered, and during sand quarrying in 1946, more graves were opened. In 1954-55, excavations of the burial ground by the Archeologický ústav of the Slovenskej akadémie vied in Nitra discovered 181 inhumation graves and 2 urn

graves. During investigations between 1966-68, 2 further inhumation graves and 1 urn grave were found. The finds are stored in the Museum of Galanta and the Slovak National Museum in Bratislava. Anthropological analyses of sex and age were carried out by J. Jakab, but in 48 cases no determination was possible. The site covers the Early Bronze Age with material of the Nitra, Únětice and Mad'arovce cultures, which also form the three main chronological phases (Benkovsky-Pivovarová and Chropovský 2015b, 132 ff.).

The information on which this work is based comes from the catalogue published by Benkovsky-Pivovarová and Chropovský (2015a) and in some cases it indicates multiple burials based on anthropological analysis. During the excavation, these multiple burials were not recognised; only later did skeletal material from several individuals appear. Since grave goods in these cases could not be unequivocally assigned to one of the buried, they were attributed to the main burial. In some cases, it is stated that the burials were secondarily displaced. As this could be due to root or animal activity and is a special case to be distinguished from human disturbance, these burials are not treated as disturbed burials in the analysis. In total, 82 individuals were undisturbed and are part of the analysis.

Radiocarbon dating(s): –

References: Benkovsky-Pivovarová and Chropovský 2015a; Benkovsky-Pivovarová and Chropovský 2015b

2. Aszód, Papi földek

County/District: Pest County, Aszód District, Hungary

Absolute dating: 4840-4450 cal BCE (Kalicz and Raczky 1987)

Period(s): Late Neolithic

Archaeological cultures: Lengyel culture (Lengyel I-II)

Chronological phases: 3 phases after Diaconescu (2014b); formative (4840-4710 cal BCE); Ia (4750-4650 cal BCE); Ib/IIa1 (4550-4450 cal BCE)

Number of graves: 224 graves, 31 graves fully published

Description: The Aszód-Papi földek settlement and burial site was discovered in 1959 and several excavations took place between the 1960s and 1990s. Over the years, 224 graves have been discovered, of which 131 have been disturbed. Part of the cemetery was divided into three grave groups (A-C) by N. Kalicz (1985), of which only grave group A was published in its entirety. This thesis refers to this completely presented grave group, which consists of 31 graves. The publication of grave group A lacks a published anthropological determination of age and sex. A detailed listing of the anthropological analysis that has been carried out by Z. Zoffmann was not available.

Chronological studies on Aszód were presented by Siklósi (2013), Zalai-Gaál *et al.* (2014) and Diaconescu (2014b). This work refers to the chronological division according to D. Diaconescu, which classifies the cemetery into three typo-chronological phases (Lengyel formative, Ia and Ib, or IIa1). Of the seven published ¹⁴C-dates from Aszód (Kalicz and Raczky 1987), only one can be assigned to the cemetery (see below).

Radiocarbon dating(s): VERA-2073 (5901±57 BP)

References: Kalicz 1985; Kalicz and Raczky 1987; Siklósi 2013; Diaconescu 2014b; Zalai-Gaál *et al.* 2014

3. Barca-Baloty

County/District: Košice Region, Košice IV District, Slovakia

Absolute dating: 3960-3800 cal BCE (Brummack 2015)

Period(s): Middle Copper Age

Archaeological cultures: Lažňany group

Chronological phases: 1 phase

Number of graves: 27 graves

Description: The Barca-Baloty burial site was discovered in 1965 by the Archeologický ústav of the Slovenskej akadémie vied in Košice. During the excavations in 1965 and 1966, 27 graves of the Lažňany group and some graves of the Piliny culture were uncovered. The burial tradition of the Lažňany group was bi-ritual with both inhumations and cremations. Of the total of 27 Copper Age graves, 15 are to be considered disturbed. The excavator S. Šiška assumes an approximate total size of the burial site of 40-50 graves. ¹⁴C-dating on human bones published in 2015 by S. Brummack date the site to the period 3960-3800 cal BCE.

A number of graves have a varying number of sherds as grave goods in addition to complete vessels. These sherds were combined into one vessel unit in the analysis if there were more than 2 sherds and if there were 1-2 sherds they were not considered further in the analysis. The site is close to the contemporary burial site of Šebastovce-Lapiše.

Radiocarbon dating(s): MAMS-14242 (5002±29 BP); MAMS-14243 (5208±27 BP); MAMS-14244 (5102±24 BP); MAMS-14245 (5088±27 BP); MAMS-14250 (5074±27 BP); MAMS-14252 (5096±27 BP); MAMS-14253 (5102±26 BP)

References: Brummack 2015; Šiška 1972

4. Battonya, Vörös Október MTSZ

County/District: Békés County, Mezőkovácsháza District, Hungary

Absolute dating: 1960-1800 cal BCE (O'Shea *et al.* 2019)

Period(s): Early to Middle Bronze Age

Archaeological cultures: Otomani culture, Maros culture

Chronological phases: 3 phases after Szabó (1999); Early Bronze Age (EBA); Transition Middle Bronze Age (TMBA); Middle Bronze Age (MBA)

Number of graves: 132 graves

Description: The Bronze Age cemetery of Battonya (Vörös Október MTSZ) was discovered in 1964 in the course of sand mining and reported to the Móra Ferenc Museum in Szeged. The first excavations were carried out as early as 1965, during which 60 graves were examined. Further excavations in the following years uncovered 19 more graves. These ca. 80 graves (Grave 1-79, 132) form "Gräberfeld I", which lies to the southwest of a road that runs through the site. Between 1973 and 1979, to the north-east of this road, the Bronze Age "Gräberfeld II" with 51 graves (Grave 80-131) was discovered during sand quarrying and investigated. Both cemeteries seem to have been laid out separately from each other, but the find material points to a simultaneity. Both grave concentrations are seen to be independent social groups that settled in the region at the same time. The graves in both cemeteries are biritual with inhumations and cremations. An anthropological determination of age and sex has been published for some of the graves.

Chronologically, the site dates to the period 1960-1800 cal BCE (O'Shea *et al.* 2019). In addition to types of the Otomani and Hatvan cultures, types of the Maros culture also occur in the burial sites. Some forms of the Nagyrév culture are also present. The burial site is roughly split into 2 to 3 phases, with an Early Bronze Age Phase, a transitional phase towards the Middle Bronze Age and some burials that belong to a Middle Bronze Age Phase (Szabó 1999, 23-26).

To avoid overrepresentation of a single Dentalium bead (Grave 110), it was assigned to the object class: Costume – Metal artefacts (small).

Radiocarbon dating(s): OxA-31068 (3576±29 BP); OxA-31069 (3566±28 BP); OxA-31070 (3510±27 BP); OxA-30986 (3485±37 BP); OxA-30987 (3588±34 BP); OxA-31071 (3532±29 BP); OxA-31072 (3514±28 BP); OxA-31073 (3525±29 BP); OxA-31074 (3556±29 BP); OxA-31075 (3528±32 BP); OxA-31076 (3572±28 BP); OxA-31077 (3623±29 BP); OxA-31078 (3569±31 BP); OxA-31079 (3496±31 BP); OxA-31080 (3554±29 BP); OxA-31081 (3574±29 BP)

References: Gazdapusztai (1968); Szabó (1999); O'Shea *et al.* (2019)

5-6. Branč-Helyfölkdek

County/District: Nitra Region, Nitra District, Slovakia

Absolute dating: Copper Age: 4450-4000 BCE (no ¹⁴C); Bronze Age: 2150-1784 cal BCE (Gerloff 1993)

Period(s): Early Copper Age; Early to Middle Bronze Age

Archaeological cultures: Ludanice group; Nitra, Únětice, and Mad'arovce cultures

Chronological phases: Copper Age: 1 phase after Lichardus and Vladár (1964); Bronze Age: 3 phases after Bernard (2005); Branč I (group A), Branč I (group B/a), Branč III (group C/D/b) and a Únětice and Mad'arovce culture phase

Number of graves: 307 graves; Copper Age: 19 graves; Bronze Age: 283 graves, 5 graves from younger periods

Description: The cemetery was excavated between 1961 and 1962 by Jozef Vladár and the Archeologický ústav of the Slovenskej akadémie vied in Nitra. The majority of the 307 inhumation graves have been assigned to the Nitra culture (237 graves) and a smaller group to the Únětice and Mad'arovce cultures (46 graves). Furthermore, graves from the Germanic period (2 graves), the medieval period (3 graves) and Copper Age burials of the Brodzany-Nitra group (2 graves) and the Ludanice group (17 graves) have been uncovered. The 17 graves of the Ludanice group, as well as the 283 Bronze Age graves form the basis of the analyses. Of the 283 Nitra to Mad'arovce culture graves, 51 burials are disturbed.

A comprehensive social and economic analysis of the cemetery was conducted by S. Shennan (1975). More recently, Christel Bernard (2005) made a detailed analysis of the grave of the Nitra Phase and assigned them to 3 phases. The graves of the Únětice and Mad'arovce cultures form the 4th phase of the burial site. In total, five ¹⁴C-dates have been published by Gerloff (1993), which date to the Early Bronze Age (2150-1784 cal BCE).

The deceased have been anthropologically analysed and anthropological age and sex are reported. The anthropological age and sex of the Nitra culture graves listed in the catalogue of this thesis are according to the catalogue of C. Bernard (2005). Questionable assignments (*e.g.* Knabe? or Mädchen?) are not listed or only if they are clarified (see Bernard 2005, footnote 132). The anthropological age was reported in general classes (*e.g.* child, grown-up) in the original catalogue of Vladár (1973) and only in a few cases were age ranges reported.

For the Únětice and Mad'arovce graves, the results of the anthropological analysis from the original catalogue (Vladár 1973) are listed in this thesis. In cases where the anthropological sex is questionable, it is not listed and only the age class (e.g. adultus) is stated. Of the 45 graves of the Únětice and Mad'arovce cultures, 31 are robbed or disturbed.

The 17 graves and grave goods of the Ludanice group were published by Lichardus and Vladár (1964). According to their analysis, only a fraction of the original burial site has been excavated. Most of the burials appear to be *infans* or *juvenis*, but there is no statement as to whether a detailed anthropological analysis of the bones has been carried out. Therefore, age and sex determination are not included in the list of graves.

For the calculation of the social indices, to avoid overrepresentation, one animal bone (grave 259) was assigned to the find category: Organics, Raw material/ Fragments, as well as one Costume – Bead (non-metal) to the find category Costume – Metal Beads/ Spiral tubes in the Copper Age assemblage.

Radiocarbon dating(s): GrN-12816 (3665±20 BP); GrN-12817 (3665±20 BP); GrN-12818 (3655±25 BP); GrN-12819 (3670±25 BP); GrN-12820 (3535±25 BP)

References: Lichardus and Vladár (1964); Vladár (1973); Shennan (1975); Gerloff (1993); Bernard (2005); Wilkes and Skorna (2022)

7. Budakalász-Luppa-csárda

County/District: Pest County, Szentendre District, Hungary

Absolute dating: 3360-2620 cal BCE (Siklósi 2009)

Period(s): Late Copper Age

Archaeological cultures: Baden culture

Chronological phases: 3 phases after Bondár and Zalai-Gaál (2017); Budakalász I (3360-2920 cal BCE), Budakalász II (3270-2900 cal BCE); Budakalász III (3020-2670 cal BCE)

Number of graves: 437 graves

Description: The cemetery of the Late Copper Age in Budakalász-Luppa-csárda was excavated between 1952 and 1961 in the course of sand mining. A total of 437 graves of the Baden culture, an estimated 85 to 90% of the cemetery, one grave of the Early Bronze Age and two graves of the Early Iron Age could be documented. The site was published in an anthology by Bondár and Raczky in 2009 after many years of effort. The cemetery is considered the largest cemetery of the Late Copper Age in the Carpathian Basin. Burials took place both as inhumations and cremations. An anthropological analysis was carried out by Köhler (2009).

A total of 14 ¹⁴C-datings date the site to the period 3360-2850 cal BCE (Siklósi 2009). Based on the pottery inventory, Bondár and Zalai-Gaál (2017) were able to divide the cemeteries of the Baden culture into several phases and periods. For Budakalász, they define seven periods, which are divided into three occupation phases. In the present analysis, the occupation phases are considered for the chronological division of the cemetery. It should be mentioned that only one grave could be assigned to occupation phase 1 and four graves to occupation phase 2. Only the occupation phase 3, with 41 assigned graves, seems to be strongly present in the cemetery. Since the presence of the occupation phases 1 and 2 is weak, they are not analysed separately. The dates given for the phases are derived from the calibrated ¹⁴C-dates given by Siklósi (2009) and by Bondár and Zalai-Gaál (2017). A

comprehensive analysis of the social structure at the cemetery was carried out by Chapman (2000), identifying possible family groups.

In order to exclude an overrepresentation of certain single objects in the analysis, some categories were grouped. These categories are: Tool – Non-metal (small) and Tool – Non-metal (large) have been grouped; Weapon – Non-metal (small) and Weapon – Non-metal (large) have been grouped.

Radiocarbon dating(s): VERA-3543 (4295±40 BP); VERA-3544 (4170±40 BP); VERA-3545 (4215±40 BP); VERA-3546 (4455±30 BP); VERA-3547 (4375±35 BP); VERA-3548 (4445±35 BP); VERA-3549 (4340±35 BP); VERA-4375 (4420±35 BP); VERA-4376 (4370±35 BP); VERA-4377 (4460±40 BP); VERA-4378 (4465±40 BP); VERA-4379 (4440±40 BP); VERA-4381 (4400±40 BP); VERA-4382 (4510±35 BP)

References: Bondár and Raczky (2009); Siklósi (2009); Köhler (2009); Bondár and Zalai-Gaál (2017)

8. Budapest-Békásmegyer

County/District: Budapest County, Budapest District III, Hungary

Absolute dating: 1200-800 BCE (no ¹⁴C)

Period(s): Late Bronze Age

Archaeological cultures: Urnfield culture

Chronological phases: 3 phases after Váczi (2010); Phase HaA2 (1200-1050 BCE); Phase HaA2-B1 (1050-950 BCE); Phase HaB1-B2/3 (950-800 BCE)

Number of graves: 329 graves

Description: The cemetery was excavated between 1960 and 1983 partly as a rescue excavation. Besides 329 graves of the Late Bronze Age Urnfield culture, a cemetery with 150 graves of the Late Copper Age Bell Beaker culture could be investigated. The information in this paper refers to the Late Bronze Age cemetery published by R. Kalicz-Schreiber, N. Kalicz and G. Váczi. The excavator assumes that the necropolis originally contained about 500 graves of the Urnfield culture. The burial tradition was cremation burial and about 30% of the cremations were in urns. Anthropological analyses of cremations were carried out by B. Heußner (2010), who noted that the results may be inaccurate due to methodological limitations when dealing with cremations.

Chronologically, the cemetery dates to the Late Bronze Age and can be divided into three phases on the basis of the metal and pottery inventory. The occupation falls into the period 1200-800 BCE (Ha A2-Ha B2/3), but is only established typo-chronologically. ¹⁴C-dating has only been carried out for the graves of the Bell Beaker culture (Staniuk 2021). The assignment of phases listed in the Appendix is based on figure 636 by Váczi (2010).

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small) and Costume – Artefacts (non-metal) have been grouped; Costume – Metal Beads/Spiral tubes and Costume – Beads (non-metal) have been grouped. Furthermore, some burials were only excavated partly and therefore are not included in the inequality analysis.

Radiocarbon dating(s): –

References: Heußner (2010); Kalicz-Schreiber *et al.* (2010); Váczi (2010)

9. Dunaújváros-Duna-dűlő

County/District: Fejér County, Dunaújváros District, Hungary

Absolute dating: 2200-1450 BCE (no ¹⁴C)

Period(s): Middle Bronze Age

Archaeological cultures: Nagyrév, Kisapostag, Vátya, and Koszider cultures

Chronological phases: 3 phases after Laabs (2013); Phase A1 (2200-1950 BCE), Phase A2 (1950-1650 BCE), Phase B (1650-1450 BCE)

Number of graves: 921 graves (published); 1600 graves known

Description: The Middle Bronze Age cemetery at Dunaújváros takes on a special role within Hungarian archaeology in terms of its research and dimensions. The site was excavated within a few months in 1951 in the course of construction work, under the changing direction and collaboration of a number of renowned archaeologists (e.g. J. Korek, A. Mozsolics, P. Patay). In her publication of the find material, M. Vicze (2011) describes the conditions during the excavation, during “the harshest years of Communist rule in Hungary” (Vicze 2011, 13), as problematic, as the construction work for a factory took priority over the archaeological research.

More than 1200 graves could be investigated, but at the same time about 400 fell victim to the construction work and many more in areas where no excavations were allowed. M. Vicze also describes the “odyssey” of the finds, which were stored for years in various archives and disappeared in parts until they were analysed between 1986 and 2011. In her 2011 dissertation, M. Vicze provides an overview of the surviving excavation documentation and the remaining find material from 921 graves, some of which she herself describes as fragmented (Vicze 2011, 18f.).

The cemetery covers the entire Middle Bronze Age in Hungary and was continuously used from 2200 to 1450 BCE. It provides a cross-section of the archaeological cultures of this period, from the Nagyrév to the Koszider cultural phase. The majority of the graves are cremation and urn burials, only a small part were inhumations. No ¹⁴C-dating is available, nor is much information on the degree of disturbance or anthropological investigations. A detailed chronological study of the cemetery was presented by J. Laabs (2013) in his master’s thesis; its occupation phases were considered in this work.⁹⁹

However, as the Dunaújváros-Duna-dűlő cemetery is one of the largest and longest used cemeteries in the Carpathian Basin, the author has included it in this work despite the problems of data quality and treats the graves as undisturbed graves.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal Beads/Spiral tubes and Costume – Beads (non-metal) have been grouped; Tool – Non-metal (small) and Tool – Non-metal (large) have been grouped.

Radiocarbon dating(s): –

References: Vicze (2011); Laabs (2013; 2023)

10. Gelej-Beltelek-dűlő and Kanális-dűlő

County/District: Borsod-Abaúj-Zemplén County, Mezőcsát District, Hungary

Absolute dating: 1872-1639 cal BCE (only 1 ¹⁴C-dating, Kiss *et al.* 2019)

Period(s): Middle Bronze Age

Archaeological cultures: Otomani-Füzesabony culture

⁹⁹ The author wants to thank Julian Laabs for sharing his data of the burial site and for help during the process of analysing.

Chronological phases: 2 phases after Thomas (2008); Gelej I (1850-1750 BCE); Gelej II (1750-1650 BCE)

Number of graves: 175 graves, Beltelek-dűlő: 22 graves, Kanális-dűlő: 153 graves

Description: In 1941, graves of the Otomani-Füzesabony culture were discovered near Gelej on the “Kanális-dűlő” plot in the course of rescue excavations. During further excavations in 1962 and in the period 1966-68, more graves of the Otomani-Füzesabony and Piliny cultures were investigated. In 1962, graves of the Otomani-Füzesabony culture were also discovered in a distance of about 180m from the “Kanális-dűlő” burial ground on the “Beltelek-dűlő” site. The graves of the Middle Bronze Age were published in 1979 by T. Kemenczei and subjected to a detailed cemetery analysis by M. Thomas in 2008.

The burials are inhumations; an anthropological analysis of the age and sex of the buried was not carried out. Age and sex determinations reported in other publications are based on comparative studies of Otomani-Füzesabony burial sites, which indicate specific sex-related burial rite. Regardless of this, these sex determinations based on archaeological markers are not included in the burial list of the present work.

The phase classification is based on the work of M. Thomas. There is only one published ¹⁴C-date for the site, which is why the chronological classification of M. Thomas and the dating of the Otomani-Füzesabony culture are also considered in this study when dating the cemeteries. In general, the Otomani-Füzesabony culture is dated to the period 1900 to 1500/1450 BCE. M. Thomas places both cemeteries in period 2 and 3 (Gelej I and Gelej II) of his five periods of the Otomani-Füzesabony burial sites. On the basis of this information, it is assumed in the following that both cemeteries were in use in the period 1850-1650 BCE.

In the present study, only the graves of the Middle Bronze Age Otomani-Füzesabony culture are examined. Furthermore, due to the spatial proximity, both cemeteries are treated as part of the same social group and analysed together.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small), Costume – Metal artefacts (large) and Artefacts (non-metal) have been grouped; Costume – Metal Beads/Spiral tubes and Costume – Beads (non-metal) have been grouped.

Radiocarbon dating(s): DeA-11506 (3423±29 BP)

References: Kemenczei (1979); Schalk (1992); Thomas (2008); Kiss *et al.* (2019); Laabs (2023)

11. Hegyeshalom-Újlakótelep

County/District: Győr-Moson-Sopron County, Mosonmagyaróvár District, Hungary

Absolute dating: 2100-1600 BCE (no ¹⁴C)

Period(s): Early Bronze Age

Archaeological cultures: Gáta-Wieselburg culture

Chronological phases: 1 phase

Number of graves: 59 graves

Description: The cemetery of Hegyeshalom-Újlakótelep was discovered in 1965 and 1966 during excavations accompanying construction work. The cemetery is comprised of 59 graves of the Early Bronze Age Gáta-Wieselburg culture and was presented in short and tabular form by E. Melis (2020). The dominant burial type is inhumation, with only one cremation in the cemetery. More than half of the burials are either disturbed (in the past and recently) or robbed. An anthropological analysis

of the partly poorly preserved bones was carried out and published by Z. Zoffmann (1999). In individual cases, E. Melis lists anthropological determinations that deviate from Z. Zoffmann's analysis, which are based on later research.

There are no ¹⁴C-dates for the cemetery and a detailed chronological analysis has not yet been published. Based on the ceramic and metal inventory, the cemetery can be assigned to the Gáta-Wieselburg culture, which exists between 2100-1600 BCE in the Northwestern Carpathian Basin. Since E. Melis (2020) combines all graves in her social analysis and treats them as one phase, the cemetery is also considered as single-phased in this study.

In order to avoid overrepresentation of certain object groups the following groups were combined in the analysis: Costume – Metal Beads/Spiral tubes and Costume – Beads (non-metal) have been grouped.

Radiocarbon dating(s): –

References: Zoffmann (1999); Melis (2017); Melis (2020)

12. Hernádkak

County/District: Borsod-Abaúj-Zemplén County, Miskolc District, Hungary

Absolute dating: 2200-1600 BCE (no ¹⁴C)

Period(s): Early and Middle Bronze Age

Archaeological cultures: Otomani-Füzesabony culture

Chronological phases: 3 phases after Schalk (1992); Hernádkak I (2200-2100 BCE); Hernádkak II (2100-2000 BCE); Hernádkak III (2000-1600 BCE)

Number of graves: 132 graves

Description: The cemetery of Hernádkak was excavated between 1934 and 1935. The 132 graves of the Otomani-Füzesabony culture were mainly inhumations. Due to destruction during the Second World War and the distribution of the finds to museums in Cambridge and Budapest – as a result of foreign funding – the cemetery information was not published until 1992 by E. Schalk. An intensive analysis and typological classification of the find material was not only carried out by E. Schalk but also later by W. David (2002). Due to the division of the find material and the age of the excavation, E. Schalk had to rely on reports, photos and the existing find objects, which limited the possibilities for further analysis. An anthropological analysis of the cemetery was never carried out.

In her cemetery analysis, E. Schalk (1992, 183ff.) works out three groups on the basis of the find material, which she regards as the three occupation phases of the cemetery. There are no absolute dates for the cemetery of Hernádkak, which is why the present study is based on Schalk's classification in phase A1 and A2 of the Bronze Age according to Reinecke (2200-1600 BCE). It places its Phase I and II in Stage A1 (2200-2000 BCE) and Phase III in Stage A2 (2000-1600 BCE). Moreover, Laabs (2023) assigns Hernádkak to his phase I-II, which covers the period (2200-1700/1600 BCE). Although the cemetery is generally assigned to the Otomani-Füzesabony culture, forms of the Hatvan culture and the Košťany group are also found among the grave goods, which speaks for the relatively early dating in relation to other cemeteries of the Otomani-Füzesabony culture.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small) and Costume – Artefacts (non-metal) have been grouped; Costume – Metal Beads/Spiral tubes and Costume – Beads (non-metal) have been grouped; Tool – Metal (small) and Tools – Non-metal (small) have been grouped. Furthermore, since there were

only a very small number of Organics, Raw material/Fragments, they were excluded in the analysis.

Radiocarbon dating(s): –

References: Schalk (1992); David (2002); Duffy (2020); Laabs (2023)

13. Jászladány

County/District: Jász-Nagykun-Szolnok County, Jászapáti District, Hungary

Absolute dating: 4300-4000 BCE (no ^{14}C)

Period(s): Early – Middle Copper Age

Archaeological cultures: Bodrogkeresztúr culture

Chronological phases: 2 phases after Zalai-Gaál (2016); Jászladány I (4300-4150 BCE); Jászladány II (4150-4000 BCE)

Number of graves: 40 graves

Description: The site was discovered and excavated in the 1930s. In addition to 10 to 12 probably destroyed graves, 40 graves were documented and published by P. Patay in 1944/45. The burial ground is assigned to the Copper Age Bodrogkeresztúr culture and typo-chronologically divided into two occupation phases by I. Zalai-Gaál (2016) on the basis of the pottery (*Belegungsphase* 3 and 4; here Jászladány I and II). Anthropological analyses were carried out as part of a doctoral thesis by I. Pawn (2012). Unfortunately, the raw data or the anthropological determinations of the individual graves were not listed in detail. Apart from only one cremation grave, the majority of burials were inhumations.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small) and Costume – Artefacts (non-metal) have been grouped.

Radiocarbon dating(s): –

References: Patay (1944/45); Lichter (2001); Pawn (2012); Zalai-Gaál (2016)

14-15. Jelšovce

County/District: Nitra Region, Nitra District, Slovakia

Absolute dating: 4300-4200 cal BCE (Görsdorf 1995); 2150-1500 cal BCE (Görsdorf 2000)

Period(s): Early Copper Age; Early Bronze Age

Archaeological cultures: Ludanice group; Nitra, Únětice, and Mad'arovce cultures

Chronological phases: at least 4 phases after Bátora and Görsdorf (2000b); Görsdorf (1995; 2000) and Pavúk and Bátora (1995); Ludanice (4300-4200 cal BCE); Nitra (2150-1870 cal BCE); Únětice (1870-1730 cal BCE); Mad'arovce (1730-1500 cal BCE)

Number of graves: 636 graves; Copper Age: 20 graves; Bronze Age: 616 graves

Description: Finds from the Jelšovce cemetery were discovered during surface collections in the 1960s and 70s. Between 1982 and 1987, the site was investigated by Jozef Bátora and the Archaeological Institute of the Slovak Academy of Science Nitra (AI SAW). In the process, 636 inhumations from the Copper Age Ludanice group (20 graves) and the Early Bronze Age Nitra, Únětice, and Mad'arovce cultures (616 graves) were excavated. The cemetery has a high number of disturbed graves (more than 300). A comprehensive anthropological analysis of the bone material is available. Strontium isotope analysis (Reiter and Frei 2015), carbon and nitrogen isotope (Skorna and Wilkes forthcoming) and in-depth bone analysis (Koel 2011; Weihmann 2010) were carried out on individual graves.

The chronological analysis by J. Bátora and J. Görsdorf is based on the evaluation of the find material, in connection with ^{14}C -dating (Görsdorf 2000) and has been discussed critically in the past (Benkovsky-Pivovarová and Chropovský 2015b). However, more recent analyses indicate that the general division of the cemetery into three typo-chronological groups (Nitra, Únětice, and Mad'arovce cultures), as already presented by Bátora, can still be assumed (Skorna and Wilkes forthcoming).

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Tool – Non-metal (small) and Tool – Non-metal (large) have been grouped.

Radiocarbon dating(s): Bln-4420 (3379±40 BP); Bln-4422 (3312±40 BP); Bln-4424 (3371±57 BP); Bln-4489 (3417±55 BP); Bln-4490 (3384±40 BP); Bln-4377 (3465±45 BP); Bln-4419 (3497±40 BP); Bln-4487 (3543±46 BP); Bln-4488 (3546±45 BP); Bln-4374 (3570±40 BP); Bln-4378 (3630±50 BP); Bln-4421 (3502±47 BP); Bln-4491 (3675±52 BP); Bln-4375 (4320±45 BP); Bln-4375 (4320±45 BP); Bln-4376 (5465±45 BP); Bln-4379 (5210±50 BP); Bln-4380 (5260±50 BP); Bln-4408 (5520±67 BP); Bln-4425 (5984±41 BP)

References: Pavúk and Bátora (1995); Görsdorf (1995); Bátora and Görsdorf (2000a); Bátora and Görsdorf (2000b); Görsdorf (2000); Bátora and Schultz (2001); Weihmann (2010); Koel (2011); Reiter and Frei (2015); Skorna and Wilkes (forthcoming)

16. Kisköre-Gát

County/District: Heves County, Heves District, Hungary

Absolute dating: 4893-4497 cal BCE (Giblin *et al.* 2013)

Period(s): Late Neolithic

Archaeological cultures: Linear Pottery culture; Tisza culture

Chronological phases: 2 phases after Korek (1989); LPC (-); Tisza (4893-4497 cal BCE)

Number of graves: 37 graves

Description: The Kisköre-Gát site was discovered in 1962 in the course of construction work on a dam of the hydroelectric power station near Kisköre. Between 1962 and 1966, the site of the Tisza culture was excavated and a settlement with several grave clusters – a total of 37 inhumation graves – came to light. Part of the site had already been destroyed during embankment works in the 19th century. The find material was published extensively by J. Korek (1989) and he argues on the basis of the burial rite for the possibility that at least 4 graves can be assigned to the Linear Pottery culture. The cemetery was anthropologically evaluated by I. Lengyel (1989) and age and sex determinations are available. Lengyel also underlines the presence of an older Linear Pottery burial group on the basis of chemical analyses. A comprehensive analysis of the social structure at the cemetery was carried out by Chapman (2000), identifying possible family groups. Furthermore, Siklósi (2013) carried out a socio-economic analysis of the burial site, with the main finding of atypical burial customs in relation to age and sex of the deceased. The ^{14}C -dates originate from building structures that are related with the burials (Kohl and Quitta 1970).

In the analysis, only the graves from the Tisza culture are considered.

Radiocarbon dating(s): Bln-179 (5995±80 BP); Bln-515 (5890±120 BP)

References: Kohl and Quitta (1970); Korek (1989); Lengyel (1989); Chapman (2000); Siklósi (2013); Giblin *et al.* (2013)

17. Košice “Nižné Kapustníky”

County/District: Košice Region, Košice IV District, Slovakia

Absolute dating: 2200-1600 BCE (no ¹⁴C)

Period(s): Early and Middle Bronze Age

Archaeological cultures: Košťany culture; Otomani-Füzesabony culture

Chronological phases: 3 phases after Schalk (1992); LPC; Košice I (2200-2100 BCE); Košice II (2100-2000 BCE); Košice III (2000-1600 BCE)

Number of graves: 181 graves

Description: During excavations by J. Pastor (1969) in 1955 and 1966, a total of 181 graves of the Early and Middle Bronze Age were discovered. Inhumations are the dominant burial type on the cemetery. J. Pástor assigns the site predominantly to the Košťany culture, only in the periphery are graves of the Otomani-Füzesabony culture. In her comparative and statistical typo-chronological analysis, E. Schalk (1992) divides the cemetery into three phases with two phases building on each other and a clearly material and typologically separated third phase. Since absolute chronological data is lacking, the dating of the cemetery is based on the comparative chronology of E. Schalk (1992). According to this, the cemetery is to a large extent contemporary with the cemetery of Hernádkak and can be assigned to a period between 2200 and 1600 BC.

Sex and age determinations are published, but it is not clear whether these determinations were made archaeologically or anthropologically. For this reason, this information has been omitted from the Appendix. Graves 1-5 have been destroyed in large parts and are therefore not listed further.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis:

Weapon – Non-metal (small) and Weapon – Non-metal (large) have been grouped; Tool – Metal (small) and Tool – Metal (large) have been grouped.

Radiocarbon dating(s): –

References: Pastor (1969); Schalk (1992); Thomas (2008)

18. Lužianky

County/District: Nitra Region, Nitra District, Slovakia

Absolute dating: 4780-4680 BCE (no ¹⁴C)

Period(s): Late Neolithic

Archaeological cultures: Lužianky culture/ Proto-Lengyel

Chronological phases: 1 phase after Regenye *et al.* (2016 [2020])

Number of graves: 17 graves

Description: The Lužianky cemetery was investigated in 1942 and 1956 by V. Budinský-Krička and B. Novotný. Both cremations and inhumations are present in the cemetery with 17 Late Neolithic graves. Part of the cemetery was destroyed during construction work in 1941. J. Regenye *et al.* (2016 [2020]) assigned the graves of Lužianky to a single phase on the basis of a typological analysis. The dating of the Lužianky culture that is used here to date the burial site is based on the chronological analysis of Trampota and Květina (2020). An anthropological analysis was carried out on part of the graves by V. Vlček (1961).

Radiocarbon dating(s): –

References: Vlček (1961); Novotný (1962); Regenye *et al.* (2016 [2020])

19. Majcichov-Lúky

County/District: Trnava Region, Trnava District, Slovakia

Absolute dating: 2150-1500 BCE (only one ¹⁴C-date)

Period(s): Early – Middle Bronze Age

Archaeological cultures: Nitra, Únětice, and Mad'arovce cultures, Tumulus culture

Chronological phases: 3 phases after Benkovsky-Pivovarová and Chropovský (2015b); Nitra (2150-1900 BCE); Únětice (1900-1800 BCE); Mad'arovce (1800-1650 BCE); Early Tumulus (1650-1500 BCE)

Number of graves: 82 graves

Description: The biritual burial ground of Majcichov was discovered in 1954 and excavated in 1955 by B. Chropovský of the Archaeological Institute of the Slovak Academy of Science Nitra (AI SAW). A total of 57 inhumations and 26 cremations were excavated. The publication of the cemetery was carried out by Benkovsky-Pivovarová and Chropovský (2015a), who based their work on the original documentation and anthropological analyses carried out until then. Due to the large time gap and the repeated re-numbering of the graves in the past, Benkovsky-Pivovarová and Chropovský (2015a) mention inaccuracies in the assignment of the results of the anthropological analyses, which were carried out within the framework of an unpublished diploma thesis by Tichá (1968). The anthropological determinations listed in the appendix are therefore also affected by these inaccuracies.

Although there are graves with forms of the Nitra, Únětice and beginning Tumulus cultures, the main period of use falls into the Late Early Bronze Age, namely into the Mad'arovce culture. Benkovsky-Pivovarová and Chropovský (2015b) divide the cemetery into four typo-chronological phases of the Nitra, Únětice, Mad'arovce and Tumulus cultures. In the course of a research stay in 2021, a ¹⁴C-analysis could be carried out on charcoal remains (*Quercus*) from grave 30 (MAMS-52294). The result (95%: 1881-1699 cal BCE) confirms the typo-chronological assignment of the grave to the Mad'arovce culture.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis:

Tool – Non-Metal (small) and Tool – Non-Metal (large) have been grouped, as well as Costume – Bead (non-metal) and Costume – Metal Beads/ Spiral tubes.

Radiocarbon dating(s): MAMS-52294 (3474±21 BP)¹⁰⁰

References: Tichá (1968); Benkovsky-Pivovarová and Chropovský (2015a); Benkovsky-Pivovarová and Chropovský (2015b)

20. Mezőcsát

County/District: Borsod-Abaúj-Zemplén County, Mezőcsát District, Hungary

Absolute dating: 1400-1300 BCE (no ¹⁴C)

Period(s): Middle Bronze Age

Archaeological cultures: Tumulus culture

Chronological phases: 1 phase after Hänsel and Kalicz (1986)

Number of graves: 43 graves

Description: The Mezőcsát cemetery was discovered by amateur archaeologists before 1958. Until 1962, the cemetery was excavated by E. Patek and N. Kalicz and about 100 graves of different epochs were discovered. In addition to graves of the Early Copper Age, the Late Bronze Age, the Iron Age and the Sarmatian Period,

¹⁰⁰ Unpublished date by the author of this thesis.

about 40 body graves and 3 cremation graves of the Middle Bronze Age Tumulus culture were excavated. The Middle Bronze Age graves are part of the present analysis and were published by Hänsel and Kalicz (1986).

In their material analysis, they discuss an occupation sequence of the cemetery, but point out that a sequencing on the basis of the available find material is difficult. Chronologically, they compare the cemetery with neighbouring cemeteries of Gelej and Igrici, and position Mezőcsát chronologically after the other two aforementioned cemeteries in the second half of Phase C1 according to Reinecke (ca.1400-1300 BCE). Three anthropological analyses of the bone material are published in the catalogue, in the following the data of J. Nemeskér and T. Tóth were included, which often correlate.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small) and Costume – Artefacts (non-metal) have been grouped; Costume – Metal Beads/Spiral tubes and Costume – Beads (non-metal) have been grouped.

Radiocarbon dating(s): –

References: Patek (1968); Hänsel and Kalicz (1986)

21. Nagycenk

County/District: Győr-Moson-Sopron County, Sopron District, Hungary

Absolute dating: 2000-1700 cal BCE (Gömöri *et al.* 2018)

Period(s): Early Bronze Age

Archaeological cultures: Gáta-Wieselburg culture

Chronological phases: 2 phases after Gömöri *et al.* (2018); Early phase (2000-1850 cal BCE), Late phase (1850-1700 cal BCE)

Number of graves: 27 graves

Description: Between 2004 and 2005, the Early Bronze Age cemetery of the Gáta-Wieselburg culture of Nagycenk was excavated in the course of construction works. In 27 graves, 29 individuals were buried as inhumations. A catalogue of the graves as well as an analysis of the cemetery was presented by Gömöri *et al.* (2018). Anthropological analyses were carried out by Zoffmann (2008).

Three graves could be dated using the radiocarbon method and place the cemetery in the period 2000-1700 cal BCE. The small cemetery can be separated into an early and a later phase on the basis of typological features. Gömöri *et al.* (2018) interpret the cemetery as the burial place of two households with a high socio-economic status.

Radiocarbon dating(s): uncalibrated data not published; DeA-8020; DeA-10076; DeA-10114

References: Zoffmann (2008); Gömöri *et al.* (2018)

22. Nitra – Horné Krškany/ Priemyslová ulica

County/District: Nitra Region, Nitra District, Slovakia

Absolute dating: 5370-4980 cal BCE (Whittle *et al.* 2013)

Period(s): Middle Neolithic

Archaeological cultures: Linear Pottery culture

Chronological phases: 2 phases after Pavúk (1972); Early phase (5370-5175 cal BCE), Late phase (5175-4980 cal BCE)

Number of graves: 76 graves

Description: The cemetery of Nitra – Horné Krškany (also known as Nitra – Priemyslová ulica) was discovered and excavated in 1964 and 1965 during construction work. Only a part of the cemetery was investigated, as other parts were not available due to building coverage and agricultural use. The cemetery is assigned to the younger Linear Pottery culture and has been extensively evaluated since its investigation. In addition to the comprehensive cemetery catalogue with associated cemetery analysis (Pavúk 1972), the 77 inhumation graves were comprehensively anthropologically examined (Crubézy *et al.* 1997; Tvrdý 2016) and ^{14}C -dating, as well as isotope analyses (strontium, C^{13} and N^{15}) were carried out (Whittle *et al.* 2013).

The results of the individual analyses show that the Nitra cemetery is a typical cemetery of the Linear Pottery culture. The range of objects does not show any significant deviations in a supra-regional comparison. With regard to the age distribution, it is evident that a somewhat lower proportion of subadult individuals were buried in the Nitra cemetery than in other LBK cemeteries. With regard to the isotope analyses, it is found that individuals with certain grave goods (adzes and *Spondylus* objects) tend to have a higher N^{15} signal. The results of the strontium isotope analysis indicate a rather local connection of the burials, but the female individuals show a slightly higher variance in the values.

Beside the two more recent anthropological analyses by Crubézy *et al.* (1997) and Tvrdý (2016), there is the initial analysis of J. Jelínek which is part of the original cemetery catalogue (Pavúk 1972) and whose results are reported in this thesis. Pavúk (1972) identified an early and later phase based on the ceramic inventory of the graves.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Artefacts (non-metal) and Costume – Artefacts (Import) have been grouped.

Radiocarbon dating(s): OxA-24574 (6222±37 BP); OxA-24575 (6226±36 BP); OxA-24095 (6298±33 BP); OxA-24576 (6196±36 BP); OxA-24577 (6216±36 BP); OxA-23793 (6221±35 BP); OxA-24578 (6138±34 BP); OxA-24579 (6317±34 BP); OxA-24580 (6227±35 BP); OxA-23794 (6219±35 BP); OxA-24581 (6083±35 BP); OxA-24582 (6328±36 BP)

References: Pavúk (1972); Crubézy *et al.* (1997); Whittle *et al.* (2013); Tvrdý (2016)

23. Nižná Myšľa

County/District: Košice Region, Košice-okolie District, Slovakia

Absolute dating: 1865-1634 cal BCE (Jaeger *et al.* 2023)

Period(s): Middle Bronze Age

Archaeological cultures: Otomani-Füzesabony culture

Chronological phases: 3 phases after Olexa and Nováček (2013; 2015; 2017) and Jaeger *et al.* (2023); R BA2 (1865-1780 cal BCE), R BA2/BA3 (1780-1695 cal BCE), R BA3 (1695-1634 cal BCE)

Number of graves: 792 graves

Description: The Middle Bronze Age cemetery in Nižná Myšľa was investigated between 1977 and 2013 by the Eastern Slovak Museum and the Archaeological Institute of the Slovak Academy of Sciences. Investigations are still ongoing, but the publication of the 792 graves of the Otomani-Füzesabony culture discovered until 2013 was carried out in three volumes between 2013 and 2017 (Olexa and Nováček 2013; 2015; 2017), as well as in the course of T. Nováček's (2018) disser-

tation. An anthropological analysis of the buried individuals as mainly inhumations is available.

Nižná Myšľa represents one of the largest and best studied sites of the Otomani-Füzesabony culture and several chronological systems are available for the cemetery. The graves can be divided typo-chronologically on the basis of the pottery and the bronze needles into 2 main phases and a transitional phase. The phase classification of L. Olexa and T. Nováček was adopted, while the absolute dates were taken from M. Jaeger *et al.* (2023). The chronological groups of both works overlap in large parts.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Weapon – Metal (large) and Weapon – Non-metal (large) have been grouped.

Radiocarbon dating(s): Poz-41433 (3540±35 BP); Poz-41434 (3540±35 BP); Poz-140326 (3490±30 BP); Poz-140327 (3465±35 BP); Poz-140413 (3415±35 BP); Poz-140414 (3435±35 BP); Poz-140374 (3485±35 BP); Poz-140372 (3485±35 BP); Poz-140373 (3460±35 BP); Poz-140415 (3415±35 BP); Poz-140324 (3420±30 BP); Poz-140325 (3415±30 BP); Poz-140328 (3405±30 BP); Poz-140332 (3435±30 BP); Poz-140330 (3395±30 BP); Poz-140334 (3370±30 BP); Poz-140331 (3340±35 BP); Poz-140333 (3360±30 BP)

References: Olexa (1987); Olexa and Nováček (2013; 2015; 2017); Jaeger and Olexa (2014); Nováček (2018); Jaeger *et al.* (2021b); Jaeger *et al.* (2023)

24. Patince

County/District: Nitra Region, Komárno District, Slovakia

Absolute dating: 1500-1300 BCE (no ¹⁴C)

Period(s): Early – Middle Bronze Age

Archaeological cultures: (North Pannonian) Encrusted Pottery culture

Chronological phases: 2 phases after Dušek (1960); Older (1500-1400 BCE), Younger (1400-1300 BCE)

Number of graves: 35 graves

Description: The cemetery of the Early to Middle Bronze Age in Patince was investigated in 1956 by Mikuláš Dušek and the Archeologický ústav of the Slovenskej akadémie vied in Nitra. A total of 33 cremation graves and 2 inhumation graves could be investigated, but part of the burial ground was destroyed by the construction of a levee in the past. The excavator assumes that the cemetery had between 45 to 50 graves. Overall, the cemetery was considerably disturbed by various ground impacts. The cemetery was published in the form of a catalogue with cemetery analysis (Dušek 1960). An anthropological analysis of the cremated remains and further scientific analyses were not carried out.

M. Dušek (1960) deals in detail with the find inventory of the graves and assigns part of the graves to an older phase of the cemetery, but he does not give any information regarding the graves of a resulting younger phase. The pottery inventory shows parallels to the Mad'arovce, Hurbanovo and Kisapostag cultures. In general, the less pronounced North Pannonian Encrusted Pottery culture in Southwestern Slovakia is dated contemporaneous with the Mad'arovce culture at the transition from the Early to the Late Bronze Age (Lichardus and Vladár 1997).

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small) and Costume – Metal artefacts (large) have been grouped.

Radiocarbon dating(s): –

References: Dušek (1960); Lichardus and Vladár (1997)

25. Pilismarót-Basaharc

County/District: Komárom-Esztergom County, Esztergom District, Hungary

Absolute dating: 3500-3360 cal BCE (Bondár *et al.* 2015; Hamilton 2015)

Period(s): Middle – Late Copper Age

Archaeological cultures: Boleráz group; Baden culture

Chronological phases: 3 phases after Bondár *et al.* (2015); Horizon I (3645-3525 cal BCE), Horizon II (3500-3360 cal BCE), Horizon III (3330-2920 cal BCE)

Number of graves: 106 graves

Description: The Copper Age burial ground at Pilismarót-Basaharc was discovered in 1959 during construction work. During the first excavations, 196 Avar graves and 6 Copper Age graves were unearthed. Between 1967 and 1972, the Copper Age part of the site was specifically investigated and a total of 116 cremations (106 recorded from the Bondár *et al.* 2015 catalogue) of the Boleráz group (Baden culture) were found. The excavations were supervised by Nándor Fettich, Ida B. Kutzián and Mária Bondár and the Copper Age part of the cemetery was published in 2015.

The catalogue includes a comprehensive cemetery analysis in which M. Bondár identifies three phases on the basis of the archaeological material. By means of ¹⁴C-dating (Hamilton 2015), she is able to confirm these phases and to determine their absolute chronological. An anthropological analysis of the cremated remains was carried out by K. Köhler (2015), but only in a few cases was enough diagnostic material for a comprehensive analysis available. In general, the Pilismarót-Basaharc cemetery is one of the largest cemeteries of the Baden culture and is considered the largest known cemetery of the Boleráz group.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Weapon – Non-metal (small) and Weapon – Non-metal (large) have been grouped.

Radiocarbon dating(s): SUERC-45840 (4472±34 BP); SUERC-45841 (4422±34 BP); SUERC-47875 (4614±30 BP); SUERC-45849 (4527±34 BP); SUERC-45843 (4391±35 BP); SUERC-47873 (4416±30 BP); SUERC-45844 (4605±34 BP); SUERC-45850 (4074±34 BP); SUERC-47874 (4507±30 BP); SUERC-47879 (4698±30 BP); SUERC-45842 (4723±34 BP); SUERC-47870 (4837±27 BP); SUERC-45848 (4662±34 BP); SUERC-47871 (4670±30 BP); SUERC-47872 (4624±25 BP)

References: Bondár *et al.* (2015); Hamilton (2015); Köhler (2015)

26. Puzstaszikszó

County/District: Heves County, Füzesabony District, Hungary

Absolute dating: 1770-1570 cal BCE (Kiss *et al.* 2019)

Period(s): Middle Bronze Age

Archaeological cultures: Otomani-Füzesabony culture

Chronological phases: 2 phases after Thomas (2008); Phase I, Phase II (1770-1570 cal BCE)

Number of graves: 30 graves

Description: Between 1957 and 1959, F. Kőszegi investigated 30 Bronze Age graves in Puzstaszikszó in a gravel quarry. Part of the cemetery had already been destroyed at the time of the excavations. There are 7 cremation graves and 23 inhumation graves

on the cemetery. An anthropological analysis was carried out by T. Hajdu (2006). In addition to the cemetery analysis attached to the grave catalogue (Kőszegi 1968), the cemetery was re-evaluated by M. Thomas (2008) and analysed in relation with the contemporaneous cemeteries of the Otomani-Füzesabony culture (*e.g.* Streda nad Bodrogom, Gelej, Hernádkak).

Thomas (2008) divides the material from the biritual cemetery into two phases. A chronological study by V. Kiss *et al.* (2019) lists only one ^{14}C -date for the cemetery (grave 10), but in the text a period of 1770-1570 cal BCE is given for the cemetery, which is based on three ^{14}C -dates (graves 8, 10 and 11). These three graves fall into phase II according to Thomas (2008), which in any case comprises the largest part of the cemetery with 16 graves (only 2 graves assigned to phase I). According to Thomas, there is a chronological overlap with the Gelej cemeteries.

Radiocarbon dating(s): DeA-6747 (3373 $\pm$ 28 BP), 2 more unpublished

References: Kőszegi (1968); Hajdu (2006); Thomas (2008); Kiss *et al.* (2019); Laabs (2023)

27. Rákóczifalva-Bagi-föld

County/District: Jász-Nagykun-Szolnok County, Szolnok District, Hungary

Absolute dating: 4334-4075 cal BCE (Csányi *et al.* 2009; 2010)

Period(s): Middle Copper Age

Archaeological cultures: Bodrogkeresztúr culture

Chronological phases: 2 phases after Csányi *et al.* (2009; 2010); West group (4333-4237 cal BCE), East group (4228-4046 cal BCE)

Number of graves: 79 graves

Description: The Copper Age cemetery of Rákóczifalva-Bagi-föld (also Bivaly-tó 1/C) was investigated in the course of levee construction work between 2005-2007 by the János-Damjanich-Museum in Szolnok and the Archaeological Institute of Loránd-Eötvös-University in Budapest. In total, 79 inhumation graves of the Bodrogkeresztúr culture were excavated. The find material, as well as a brief chronological analysis, was presented in two papers by M. Csányi *et al.* (2009; 2010), although it should be noted that the cemetery plan does not include any labelling of the individual graves and thus, apart from the graves directly addressed in the text, no others can be classified into the two chronological-geographical groups. An anthropological analysis was published by Z. Zoffmann (2015). The cemetery of the Bodrogkeresztúr culture is unusual both in its age and gender structure and in the fact that it is a completely recorded and almost undisturbed cemetery (Csányi *et al.* 2010, 244).

With regard to the find material, it should be mentioned that the tabular presentation of the grave inventories does not provide any information on the number of beads. In the text, however, M. Csányi *et al.* (2010, 259) mention bead belts and chains, which is why a number of 100 beads was assigned to each grave with beads. Furthermore, no measures (depth, length, width) of the graves are reported.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small) and Costume – Artefacts (non-metal) have been grouped; Weapon – Metal (large) and Weapon – Non-metal (large) have been grouped.

Radiocarbon dating(s): VERA-4198 (5285 $\pm$ 30 BP); VERA-4199 (5290 $\pm$ 35 BP); VERA-4758 (5285 $\pm$ 40 BP); VERA-4759 (5415 $\pm$ 35 BP); VERA-4200 (5380 $\pm$ 30 BP); VERA-4201 (5450 $\pm$ 35 BP); VERA-4202 (5365 $\pm$ 35 BP); VERA-4762 (5400 $\pm$ 45 BP); VERA-4763 (5315 $\pm$ 40 BP)

References: Csányi *et al.* (2009; 2010); Szilágyi (2015); Zoffmann (2015); Siklósi and Szilágyi (2021); Siklósi *et al.* (2022)

28. Šebastovce-Lapiše

County/District: Košice Region, Košice IV District, Slovakia

Absolute dating: 4000-3750 BCE (no ¹⁴C)

Period(s): Middle Copper Age

Archaeological cultures: Lažňany group

Chronological phases: 2 phases after Šiška (1972); Old (4000-3875 BCE), Young (3875-3750 BCE)

Number of graves: 42 graves

Description: In 1966, the cemetery of Šebastovce-Lapiše was discovered in the vicinity of the burial site Barca-Baloty which also dates into the Middle Copper Age Lažňany group. Between 1967 and 1970, the cemetery was systematically excavated by the Archeologický ústav of the Slovenskej akadémie vied in Košice under the direction of S. Šiška. In his 1972 publication on the cemetery, he states that the cemetery was completely investigated, but that part of it may have already been destroyed by agriculture or human occupation.

On the biritual cemetery, 42 graves were excavated, most of them were inhumations (ca. 21 burials). Overall, a large proportion (65%) of the graves were disturbed by a younger Avar burial ground and deep ploughing. Moreover, the preservation of the bones is very poor, and there is no anthropological analysis of the graves, nor ¹⁴C-dating. S. Šiška (1972) divides the cemetery into an Older and a Younger phase on the basis of the typological characteristics of the grave goods. Since there is a direct connection with the Barca-Baloty cemetery, both geographically and archaeologically, it can be assumed that the cemetery was occupied in the same period (dating according to Brummack 2015).

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Tool – Metal (small) and Tool – Metal (large) have been grouped, Tool – Non-metal (small) and Tool – Non-metal (large) have been grouped.

Radiocarbon dating(s): –

References: Šiška (1972)

29. Streda nad Bodrogom

County/District: Košice Region, Trebišov District, Slovakia

Absolute dating: 1700/1600-1400 BCE (no ¹⁴C)

Period(s): Middle Bronze Age

Archaeological cultures: Otomani-Füzesabony culture

Chronological phases: 3 phases after Thomas (2008); Streda I (1700-1600 BCE), Streda II (1600-1500 BCE), Streda III (1500-1400 BCE)

Number of graves: 67 graves

Description: The biritual cemetery of Streda nad Bodrogom was excavated in 1955 by B. Polla of the Archeologický ústav of the Slovenskej akadémie vied Košice in the course of construction work. In his published catalogue of the burial site, Polla (1960) notes that several graves had been destroyed in the years before. He further mentions that the excavation only covered a small part of the burial site. The graves have not been anthropologically examined and no ¹⁴C-dating has been carried out.

An extensive cemetery analysis and periodisation was carried out by M. Thomas (2008). He identified and assigned graves to three phases (Streda I-III). Laabs (2023) classifies the site to his last chronological phase (phase III) in the period 1700/1600-1400 BCE.

Radiocarbon dating(s): –

References: Polla (1960); Thomas (2008); Sørensen and Rebay-Salisbury (2009); Laabs (2023)

30. Tibava “Hrun za cintirom”

County/District: Košice Region, Sobrance District, Slovakia

Absolute dating: 4600-4400 BCE (no ¹⁴C)

Period(s): Early Copper Age

Archaeological cultures: Tiszapolgár culture

Chronological phases: 2 phases after Zalai-Gaál (2016); Tibava I (4600-4500 BCE), Tibava II (4500-4400 BCE)

Number of graves: 41 graves

Description: The burial site of the Tiszapolgár culture in Tibava (also known as Tibave or Tiba) was discovered by K. Andel in 1953-54. Due to the anticipated destruction of the archaeological site caused by agriculture, the burial ground containing 41 graves, was excavated in 1955-56, followed by the excavation of a nearby prehistoric settlement in 1957. The site, according to I. Bognár-Kutzián (1963), can be attributed to the Lúcky group, which is dated to the Early Tiszapolgár culture. Zalai-Gaál (2016) also places the material from Tibava in the first half of the Tiszapolgár culture. Šiška (1964), Meisenheimer (1989), and Zalai-Gaál (2016) all identify both an earlier and a later phase of the burial site, with this study following the chronological analysis of Zalai-Gaál (2016).

According to Diaconescu (2014a), who conducted ¹⁴C-dating on burial and settlement remains of the Tiszapolgár culture, the Tibava burial site can be placed in the initial half of the period spanning from 4600-4200 cal BCE. There are no published anthropological analyses of the cemetery.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small) and Costume – Metal artefacts (large) have been grouped.

Radiocarbon dating(s): –

References: Bognár-Kutzián (1963); Šiška (1964); Nevizánsky (1984); Meisenheimer (1989); Zalai-Gaál (2016)

31. Tiszafüred-Majoroshalom

County/District: Jász-Nagykun-Szolnok County, Tiszafüred District, Hungary

Absolute dating: 1600-1300 BCE (no ¹⁴C)

Period(s): Middle – Late Bronze Age

Archaeological cultures: Tumulus culture; Otomani-Füzesabony culture (not fully published)

Chronological phases: 3 phases after Kovács (1975); Early (1600-1500 BCE), Middle (1500-1400 BCE), Late (1400-1300 BCE)

Number of graves: 365 graves

Description: Intensive archaeological research has been carried out in the vicinity of the present-day town of Tiszafüred since the 1870s. Settlements and burial grounds of the Copper and Bronze Ages, the medieval period, especially of

Baden, Tumulus, Otomani-Füzesabony and Koszider cultures, as well as of Avar origin, were investigated between 1870 and 1975. At the Majoroshalom site, a total of 2286 graves were uncovered between 1965 and 1972, of which, according to Kovács (1975), 1003 belong to the Bronze Age (estimated at 60-70% of the original cemetery) and 1283 to the Avar period. Of the Bronze Age graves, a catalogue with detailed information on grave goods is available for 365 biritual graves of the Tumulus culture (Kovács 1975). The more than 600 graves of the Otomani-Füzesabony culture, as well as isolated graves of the Hatvan culture, have only been published in parts (Thomas 2008).

Anthropological analyses are available for more than 400 of the Otomani-Füzesabony and for 34 (or 47?) graves of the Tumulus culture (Hajdu 2012; Zoffmann and Hajdu 2017), but they cannot be synchronised with the data from the cemetery catalogue (Kovács 1975) without doubt. There are no radiocarbon dates from the cemetery, but Kovács (1975) works out three chronological phases on the basis of the find material. In some cases, there are discrepancies between the cemetery catalogue and the information given in the cemetery analysis (Kovács 1975). Roughly 65-70% of the burials are disturbed and only 30-35% are undisturbed or “confused”.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Costume – Metal artefacts (small) and Costume – Artefacts (non-metal) have been grouped; Costume – Metal Beads/Spiral tubes and Costume – Beads (non-metal) have been grouped; Weapon – Metal (small), Weapon – Metal (large), Weapon – Non-metal (small) and Weapon – Non-metal (large) have been grouped.

Radiocarbon dating(s): –

References: Kovács (1975); Thomas (2008); Hajdu (2012); Zoffmann and Hajdu (2017)

32. Tiszapolgár-Basatanya

County/District: Hajdú-Bihar County, Hajdúnánás District, Hungary

Absolute dating: 4420-3910 cal BCE (Raczky and Siklósi 2013)

Period(s): Early – Middle Copper Age

Archaeological cultures: Tiszapolgár culture; Bodrogkeresztúr culture

Chronological phases: 4 phases after Raczky and Siklósi (2013); Tiszapolgár Phase (4375-4260 cal BCE); Transitional Phase (4235-3855 cal BCE); Bodrogkeresztúr A Phase (4245-4030 cal BCE); Bodrogkeresztúr A+B Phase (4175-4040 cal BCE)

Number of graves: 156 graves

Description: The Copper Age cemetery of Tiszapolgár-Basatanya has been known since the late 19th century. After initial investigations in the 1920s to 1940s, with single smaller excavations, the cemetery was extensively excavated from 1950 to 1954 under the direction of I. Bognár-Kutzián. As early as 1963, she presented a comprehensive evaluation and catalogue of the cemetery, in which she demonstrated the importance of the site for the research of the Hungarian Copper Age. The dominant burial site included inhumations and a large part of the burials were anthropologically examined (age and sex). The information regarding age and sex group reported in the Appendix are taken from Meisenheimer (1989) who in turn refers to Acsádi *et al.* (1970). Another analysis was carried out by Pawn (2012), although its results are not reported in detail for each individual grave.

The material from Tiszapolgár-Basatanya can be clearly separated into two different archaeological cultures. According to Meisenheimer (1989), there are about 57 graves of the Tiszapolgár culture and 87 of the Bodrogkeresztúr culture,

whereby she speaks of a clear chronological separation, and notes that some scholars even discuss the possibility of two independent cemeteries. Recent radiocarbon dating, however, shows that the sequence of the individual cultural phases was continuous (Raczky and Siklósi 2013).

For this work, the chronological analysis of Raczky and Siklósi (2013) is relevant for the dating of the site and its phases. ¹⁴C-dating from the 1980s has a high error range by today's standards and is therefore not suitable for fine chronological models but is reported below (Benkő *et al.* 1988 [1989]).

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small) and Costume – Artefacts (non-metal) have been grouped.

Radiocarbon dating(s): Deb-441 (4090±180 BP); Deb-122 (4850±150 BP); Deb-465 (5020±170 BP); Deb-214 (4980±140 BP); Deb-350 (5010±180 BP); Deb-354 (5090±190 BP); Deb-481 (5210±170 BP); Deb-464 (5460±170 BP); Deb-428 (4240±180 BP); Deb-355 (5220±220 BP); Deb-348 (5020±180 BP); Deb-349 (5060±170 BP); Poz-36364 (5470±40 BP); Poz-36365 (5190±40 BP); Poz-36367 (5480±40 BP); Poz-36368 (5320±40 BP); Poz-36369 (6100±50 BP); Poz-36370 (5260±40 BP); Poz-36371 (5340±40 BP); Poz-36372 (5260±40 BP)

References: Bognár-Kutzián (1963); Acsádi *et al.* (1970); Benkő *et al.* 1988 [1989]; Meisenheimer (1989); Pawn (2012); Raczky and Siklósi (2013)

33. Tiszavalk-Kenderföldek

County/District: Borsod-Abaúj-Zemplén County, Mezőkövesd District, Hungary

Absolute dating: 4320-3975 cal BCE (Borić 2015b)

Period(s): Middle Copper Age

Archaeological cultures: Bodrogkeresztúr culture

Chronological phases: 3 phases after Zalai-Gaál (2016); Tiszavalk Phase I (4320-4205 BC); Tiszavalk Phase II (4205-4090 BC); Tiszavalk Phase III (4090-3975 BC)

Number of graves: 57 graves

Description: As early as 1952, several inhumation graves and traces of settlements from the Copper Age were uncovered in the Kenderföld (also Kenderföldek) area of Tiszavalk during rescue excavations. After a large number of graves were destroyed during dam construction work in 1966, extensive excavations were carried out between 1966 to 1967 and in 1975 under the direction of Pál Patay. Of an estimated 100 graves dating to the Middle Copper Age (Bodrogkeresztúr culture), 57 could still be investigated. Other graves date to the later Sarmatian period, and younger settlement finds partly overlapped Copper Age graves.

An anthropological analysis was carried out by Pawn (2012), but the results of his analysis are not listed for the individual graves and therefore cannot be included in the Appendix. However, he states that compared to other Copper Age cemeteries in the area, Tiszavalk-Kenderföldek has a greater variance in burial customs, as well as a greater genetic diversity.

According to the extensive typo-chronological analysis of Zalai-Gaál (2016), the pottery can be typologically divided into three phases of the developed Bodrogkeresztúr culture. A series of four radiocarbon dates place the cemetery chronologically to the period between 4320 and 3975 cal BCE (Borić 2015b).

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Costume – Metal artefacts (small), Costume – Metal artefacts (large) and Artefacts (non-metal) have been grouped.

Radiocarbon dating(s): OxA-24908 (5425±32 BP); OxA-24909 (5329±33 BP); OxA-24910 (5330±33 BP); OxA-24911 (5334±36 BP)

References: Patay (1978); Pawn (2012); Borić (2015b); Zalai-Gaál (2016)

34. Valalíky-Košťany

County/District: Košice Region, Košice-okolie District, Slovakia

Absolute dating: 2200-2000 BCE (no ¹⁴C)

Period(s): Early Bronze Age

Archaeological cultures: Košťany culture

Chronological phases: 2 phases after Schalk (1992); Košice I (2200-2100 BCE); Košice II (2100-2000 BCE)

Number of graves: 18 graves

Description: In the course of rescue excavations in 1960, the archaeological department of the Eastern Slovakian Museum in Košice examined part of a cemetery with 18 inhumations. The cemetery is the eponymous site of the Košťany culture, a local Early Bronze Age group with connections to the Otomani-Füzesabony culture.

An anthropological analysis of the bone material was not reported in the publication of the find material by Ján Pastor (1962). There is also no radiocarbon date for the site, but a chronological classification based on typological features by E. Schalk (1992). She places the finds from Valalíky-Košťany in her Košice I and Košice II phases and thus at the beginning of the Early Bronze Age in Eastern Slovakia.

Radiocarbon dating(s): –

References: Pastor (1962); Schalk (1992); Thomas (2008)

35. Veľký Grob

County/District: Trnava Region, Galanta District, Slovakia

Absolute dating: 2132-1940 cal BCE (author, one ¹⁴C-date); 2100-1900 BCE

Period(s): Early Bronze Age

Archaeological cultures: Ťňačice culture

Chronological phases: 2 phases after Lichardus and Vladár (1997); Veľký Grob I (2100-2000 BC), Veľký Grob II (2000-1900 BC)

Number of graves: 64 graves

Description: The Veľký Grob cemetery (“Za potoky”) was excavated between 1953 and 1955 by the Archeologický ústav of the Slovenskej akadémie vied in Nitra under the direction of B. Chropovský (1960). A total of 64 graves of the Early Bronze Age, mainly of the Ťňačice culture, were uncovered while the Nitra culture and forms of the Ťňačice-Wieselburg culture are also present on the burial site (Točík 1979). A large number of the graves have been disturbed or robbed.

According to Benkovsky-Pivovarová and Chropovský (2015b), the burial site can be dated to the beginning of the middle of the Early Bronze Age. In the context of this work, a ¹⁴C-date was carried out on an antler bead from grave 61, which supports the statement of Benkovsky-Pivovarová and Chropovský. However, since a single ¹⁴C-date is not of great significance, the dating is based on the relative chronological data. Lichardus and Vladár (1997) classify some of the graves into two occupation phases on the basis of the grave goods.

An anthropological analysis by J. Jakab is listed in the more recent catalogue by Benkovsky-Pivovarová and Chropovský, but this information differs in part from the observations made during the excavation (excavation: child skeleton; analysis: adult

male), and in many cases, a number of age and sex determinations or even multiple individuals are also listed for single burials. For this reason, it is impossible to select the age and sex of a burial from the various data without re-analysis of the bone material, and therefore no anthropological information is given in the Appendix.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis:

Costume – Metal artefacts (small) and Costume – Artefacts (non-metal) have been grouped; Weapon – Metal (large) and Weapon – Non-metal (large) have been grouped.

Radiocarbon dating(s): MAMS-52295 (3645±22 BP)¹⁰¹

References: Chropovský (1960); Točík (1979); Lichardus and Vladár (1997); Benkovsky-Pivovarová and Chropovský (2015a; 2015b)

36. Veselé

County/District: Trnava Region, Piešťany District, Slovakia

Absolute dating: 2300-1900 BCE (no ¹⁴C)

Period(s): Late Copper Age – Early Bronze Age

Archaeological cultures: Chłopice-Veselé culture; Únětice culture

Chronological phases: 2 phases after Benkovsky-Pivovarová and Chropovský (2015b); Veselé I (2300-2100 BCE), Veselé II (2100-1900 BCE)

Number of graves: 39 graves

Description: In 1939, the first inhumation graves from the Late Copper Age and the Early Bronze Age were found in the “Zámojská” area in Veselé. Further investigations by the Slovak National Museum in Bratislava and the Archaeological Institute in Martin from 1941-1942 and in 1949 discovered more graves. The first publication of the cemetery and the find material was completed by V. Budinský-Krička in 1965. Another comprehensive and updated publication was presented by Benkovsky-Pivovarová and Chropovský (2015a). Due to relocations of find material in the course of World War II and the destruction of parts of the National Museum in Bratislava, the find material is no longer complete today and a comprehensive anthropological analysis is no longer possible, but individual graves were analysed by J. Jakab and these results were presented in the 2015 publication of the site.

A large part of the graves has been disturbed by soil cultivation. Due to the small amount of preserved organic material, no ¹⁴C-dates are available from the cemetery. Nevertheless, the Veselé cemetery is considered one of the most intensively chronologically discussed sites at the transition from the Copper to the Bronze Age (Wilkes and Skorna 2022). The focus is on the origin of the Chłopice-Veselé culture, which is either connected to the Corded Ware tradition of Southern Poland or is of more local origin. There is also disagreement as to whether the burial ground is still to be assessed as a Copper Age site or already as a Bronze Age site. The more recent analysis of the find material by Benkovsky-Pivovarová and Chropovský (2015b) shows that a large part of the graves can be assigned to the Epi-Corded Ware culture and a small part shows forms of the early Únětice culture.

Radiocarbon dating(s): –

References: Budinský-Krička (1965); Lichardus and Vladár (1997); Benkovsky-Pivovarová and Chropovský (2015a; 2015b)

¹⁰¹ Unpublished date by the author of this thesis.

37. Výčapy-Opatovce

County/District: Nitra Region, Nitra District, Slovakia

Absolute dating: 2200-1950 cal BCE (Wilkes and Skorna 2022)

Period(s): Early Copper Age (?); Early Bronze Age

Archaeological cultures: Ludanice group (?); Nitra culture; Ůnětice culture

Chronological phases: possible 3 phases after Bernard (2005)

Number of graves: 319 graves

Description: Between 1951 and 1954, the Early Bronze Age cemetery of Výčapy-Opatovce was excavated under the direction of A. Točík and J. Róth. An anthropological analysis by E. Strouhal (1978) was already available when the cemetery was published by A. Točík (1979). The 319 inhumations can mainly be assigned to the Nitra culture, a small part dates to the transitional phase of the Nitra to the Ůnětice culture and for 8 to 12 graves an affiliation to the Early Copper Age Ludanice group is discussed (Lichardus and Vladár 1964; Porubský 1955). Due to construction work and the presence of a brickyard in the area of the site, it is believed that 60-80 graves might have been destroyed over the years.

Current ¹⁴C-dates confirm the chronological classification into the Early Bronze Age, but cast doubt on the presence of a Copper Age phase (Wilkes and Skorna 2022). The ¹⁴C analysis also shows that previous typo-chronological phases by different authors (Bernard 2005; Lichardus and Vladár 1997) are unlikely and that a new analysis of the find material is required. In this work, therefore, a division into occupation phases is not made, but the phases according to C. Bernard (2005) are listed in the Appendix.

In order to avoid overrepresentation of certain object groups, the following groups were combined in the analysis: Weapon – Non-metal (small) and Weapon – Non-metal (large) have been grouped; Tool – Non-metal (small) and Tool – Non-metal (large) have been grouped.

Radiocarbon dating(s): MAMS-52297 (3682±23 BP); MAMS-52298 (3691±23 BP); MAMS-52299 (3668±31 BP); MAMS-52300 (3694±23 BP); MAMS-54235 (3685±22 BP); MAMS-54236 (3743±23 BP)

References: Porubský (1955); Lichardus and Vladár (1964); Točík (1963; 1979); Strouhal (1978); Lichardus and Vladár (1997); Bernard (2005); Wilkes and Skorna (2022)

Appendix B: Object classes

Class/ Sub-class	Material(s)	Object type(s)
1. Ceramics		
1.1 Pottery	Ceramic	Beaker Lid Goblet Ladle <i>"Kumpf"</i> Spoon Miniature pot Bowl Cup Amphora Urn Bottle Pot (general) Jug Jar Kantharos Storage vessel Pan Vase unknown
1.2 Pottery (special forms)	Ceramic	Figurine (general) Figurine (zoomorphic) Wagon model Pedestal
2. Costume		
2.1 Costume – Metal artefacts (small)	Bronze Copper Metal (undefined)	Pendant Sheet metal Wire Fibula Ring (Finger) Garment ornaments Ring (Hair) Case Necklace Button Rivet Ring (Ear) Ring (undefined) Disc <i>"Schläfenring"</i> Jewellery (undefined) Spiral Stick Tutulus Ring (Foot) Zylinder

2.2 Costume – Metal artefacts (large)	Bronze Copper Metal (undefined)	Ring (Arm) Ring (Leg) Belt Belt buckle Ring/Collar (Neck) Needle Pedestal Headband
2.3 Costume – Artefacts (non-metal)	Cardium Dentalium Antler Pottery Bone Coral Shell / Snail Tooth (animal) Stone	Amulet Pendant Bangle “Grandel” Belt/Belt buckle Hairpin Necklace Tusk Button Rivet Ring (Ear) Plate/ Disc Jewellery (general) Sticks “Verteiler”
2.4 Costume – Metal Beads/ Spiral tubes	Bronze Copper Metal (undefined)	Bead Tube/ Spiral tube
2.5 Costume – Beads (non-metal)	Cardium Calcite Dentalium Antler Limestone Bone Marble Shell/ Snail Nacre Stone (general) Tooth (animal)	Bead Plate Tube/ Spiral tube
2.6 Costume – Artefacts (Import)	Amber Faience Glass Gold Spondylus	Pendant Ring (Arm) Tin Ring (Finger) Fragments Belt buckle Ring (Hair) Button Ring (Ear) Bead Ring (unspec.) Discs Jewellery (general) Spiral Rod Tutulus Ornamental sheet

3. Weapon		
3.1 Weapon – Metal (small)	Bronze	Arrowhead
3.2 Weapon – Metal (large)	Bronze Copper Metal (undefined)	Axe Dagger Spearhead
3.3 Weapon – Non-metal (small)	Chert Flint (undefined) Bone Antler Chert Jasper Obsidian Quartzite Radiolarite	Arrowhead
3.4 Weapon – Non-metal (large)	Ambolite slate Amphibolite Andesite Basalt Calcite Antler Bone Marble Nephrite Sandstone Slate Stone (general)	Bracer Axe Dagger Club/Mace
4. Tool		
4.1 Tool – Metal (small)	Bronze Copper Metal (undefined)	Awl Semi-finished product Combination tool Chisel Tweezers
4.2 Tool – Metal (large)	Bronze Copper Metal (undefined)	Axe Blade Knife
4.3 Tool – Non-metal (small)	Chert Flint (undefined) Antler Chert Jasper Limestone Kaolin Ceramics Bone Limnoquartzite Shell Obsidian Opal Quartzite Radiolarite Sandstone Stone (general) Tooth – animal	Awl Drill Adze Smoother Semi-finished product Blade Scraper Spoon Chisel Knife Needle Cross cutter Sickle Spindle whorl Point Graver Trapeze undefined Tool (general) Loom weight

4.4 Tool – Non-metal (large)	Andesite Antler Bone Quartzite Sandstone Slate Stone (general) Tuffite Ceramics	Weight Smoother Pick/Hoe Semi-finished product Hammer Grinding stone Mill stone Tool (general) Sharpening stone Casting mould
Organics, Raw material and Fragments		
	Bronze Copper Metal (undefined) Chert Flint (undefined) Antler Chert Obsidian Quartzite Radiolarite Slate Stone (general) Tooth – animal Cardium Dentalium Graphite Hematite Charcoal Horn Daub Bone Copper Leather Metal (undetermined) Shell/snail Ochre Limnoquartzite	Ingot Rubble stone Rubble stone Core Pebble Raw material Tooth Botanical remains Fragments Sherd (single) Undefined Flake Bones (other) Bone (Hand/foot bone) Bone (Jaw bone) Bones (long bones) Bone (Ribs) Bone (Skull) Bone waste

Overview of object classes to which grave goods are assigned. A table of unified material groups as well as the values of the object classes per cemetery are part of the online supplement.

Appendix C: Results of the significance tests

	n	Gini _{all}	Gini _{low}	Gini _{upper}	Share _{upper}	GEM[0]	GEM[1]	GEM[2]
Early	14	0.73	0.62	0.27	0.58	1.74	1.07	1.63
Late	23	0.74	0.58	0.35	0.64	1.67	1.16	2.30

Median values for the individual inequality metrics given for an Early (5200-3000 BCE) and Late (3000-1000 BCE) time period.

	n	Gini _{all}	Gini _{low}	Gini _{upper}	Share _{upper}	GEM[0]	GEM[1]	GEM[2]
Early	14	0.17	0.24	0.49	0.15	2.42	0.52	2.23
Late	23	0.27	0.35	0.46	0.35	2.49	1.2	5.63

Ranges for the individual metrics given for an Early (5200-3000 BCE) and Late (3000-1000 BCE) time period.

Significance test results for difference in variance (Levene) and median (Wilcoxon) between the Early (5200-3000 BCE) and Late (3000-1000 BCE) time periods. Significant differences meeting a 0.05 significance level are marked in bold; significant differences meeting a 0.1 significant level are in italics.

Metric	Levene p	Wilcoxon p
Gini _{all}	0.03	0.24
Gini _{low}	0.42	0.36
Gini _{upper}	0.74	<i>0.07</i>
Share _{upper}	0.02	<i>0.07</i>
GEM[0]	0.96	0.51
GEM[1]	0.03	0.14
GEM[2]	0.02	0.02

	n	Gini _{all}	Gini _{low}	Gini _{upper}	GEM[0]	GEM[1]	GEM[2]	Share _{upper}
Neolithic	4	0.74	0.65	0.37	2.20	0.98	1.50	0.56
Copper Age	11	0.73	0.62	0.25	1.50	1.10	1.82	0.60
Bronze Age	22	0.74	0.59	0.35	1.67	1.16	2.29	0.63

Median values for the individual inequality metrics in three archaeological periods.

GEM[0]	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.31	0.64
Copper Age	0.31	-	1
Bronze Age	0.64	1	-

GEM[0]	Neolithic	Copper Age	Bronze Age
Neolithic	-	1	0.4
Copper Age	1	-	0.99
Bronze Age	0.4	0.99	-

GEM[2]	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.84	0.28
Copper Age	0.84	-	0.66
Bronze Age	0.28	0.66	-

Gini_{all}	Neolithic	Copper Age	Bronze Age
Neolithic	-	1	1
Copper Age	1	-	1
Bronze Age	1	1	-

Gini_{low}	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.97	0.4
Copper Age	0.97	-	1
Bronze Age	0.4	1	-

Gini_{upper}	Neolithic	Copper Age	Bronze Age
Neolithic	-	1	1
Copper Age	1	-	0.39
Bronze Age	1	0.39	-

Share_{upper}	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.71	0.43
Copper Age	0.71	-	1
Bronze Age	0.43	1	-

Results of the Wilcoxon test between three chronological groups. The summary statistics and boxplots for each time period can be found in the online supplement.

GEM[0]	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.49	0.49
Copper Age	0.49	-	0.98
Bronze Age	0.49	0.98	-

GEM[1]	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.39	0.13
Copper Age	0.39	-	0.63
Bronze Age	0.13	0.63	-

GEM[2]	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.4	0.14
Copper Age	0.4	-	0.33
Bronze Age	0.14	0.33	-

Gini_{all}	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.2	0.07
Copper Age	0.2	-	0.43
Bronze Age	0.07	0.43	-

Gini_{low}	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.55	0.46
Copper Age	0.55	-	0.72
Bronze Age	0.46	0.72	-

Gini_{upper}	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.67	0.76
Copper Age	0.67	-	0.66
Bronze Age	0.76	0.66	-

Share_{upper}	Neolithic	Copper Age	Bronze Age
Neolithic	-	0.28	0.06
Copper Age	0.28	-	0.39
Bronze Age	0.06	0.39	-

Results of the Levene test between three chronological groups. The summary statistics and boxplots for each time period can be found in the online supplement.

R-Codes

The following codes are based on the formulas in Chapter 4.3 and on the work of J. Marzian (2021). They are the basis of Gini calculations in this thesis. GEM calculations have been done by using the R package “entropy”. The supplement files include a more detailed code.

Normalized Gini index

```
Gini_norm = function(x){

s = sort(x = x, decreasing = FALSE)
n = length(x = s)

G_norm = (2/n*(sum(x = s)^(-1)*(sum(x = c(1:n)*s)))-1/n-1)*n/(n-1);
return(G_norm)

}
```

Asymptotic standard error

```
ASE_Gini = function(x){

s = sort(x = x, decreasing = FALSE)
x_bar = mean(x = s)
n = length(x = s)
index = c(1:n)
Z = c(1:n)
G = Gini_norm(x = s)

for (i in 1:n) {

Z[i] = -(G+1)*s[i]+(2*index[i]-1)/n*s[i]-2/n*sum(x = s[1:i])

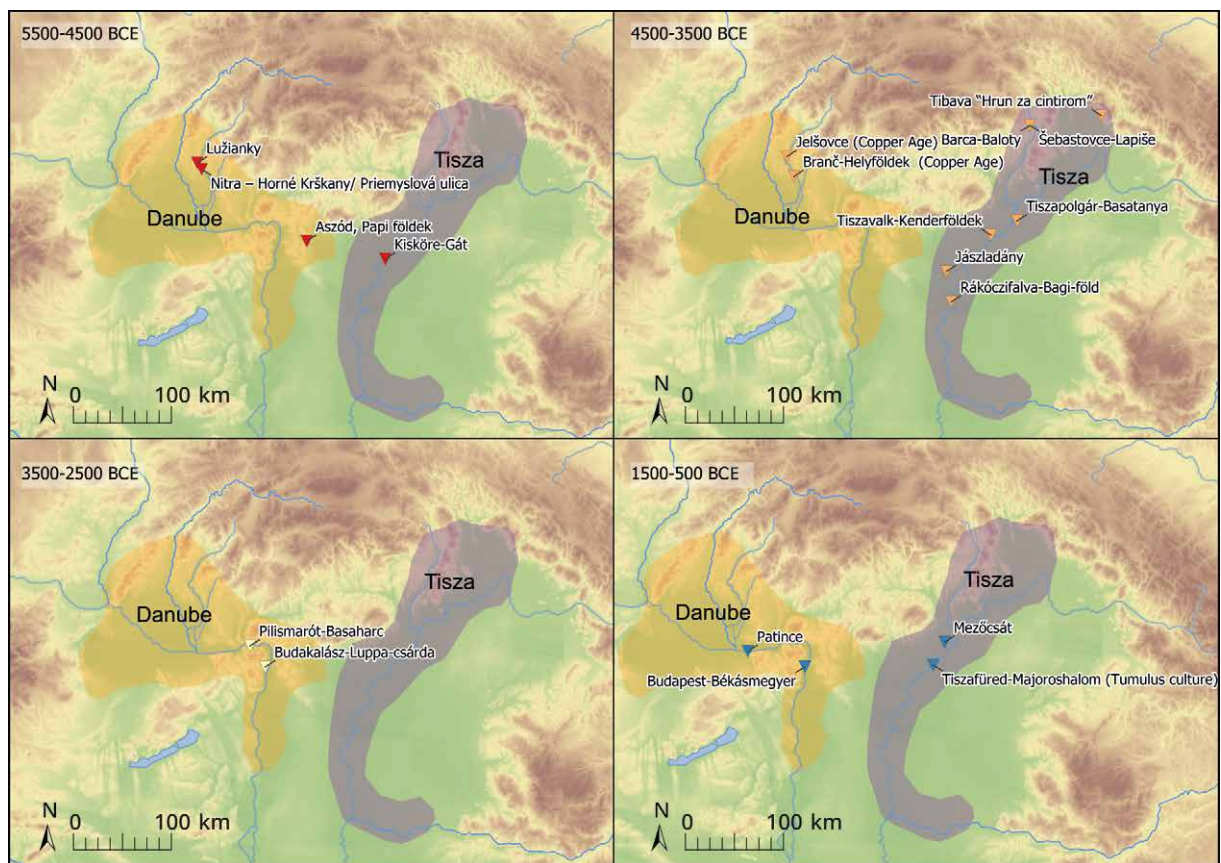
}

Z_bar = mean(x = Z)

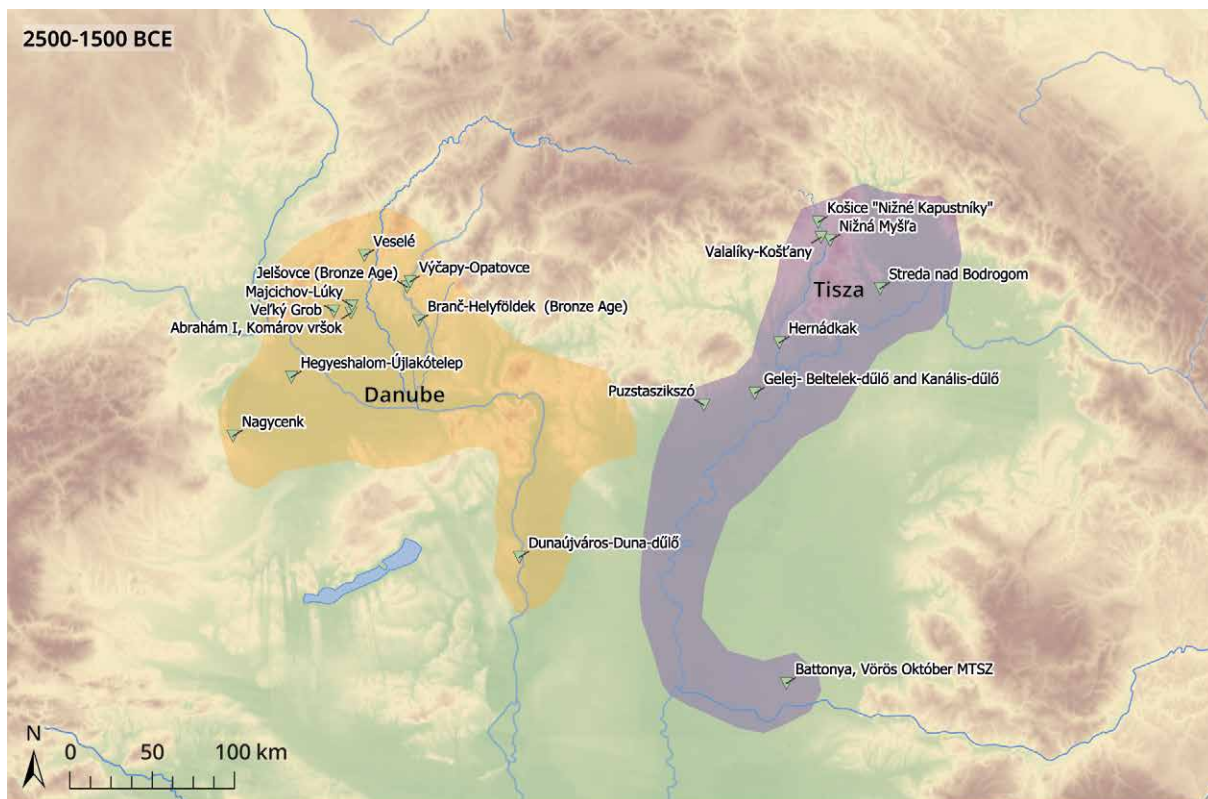
ASE = (1/(n*x_bar)^2*sum(x = (Z-Z_bar)^2))^0.5;
return(ASE)

}
```

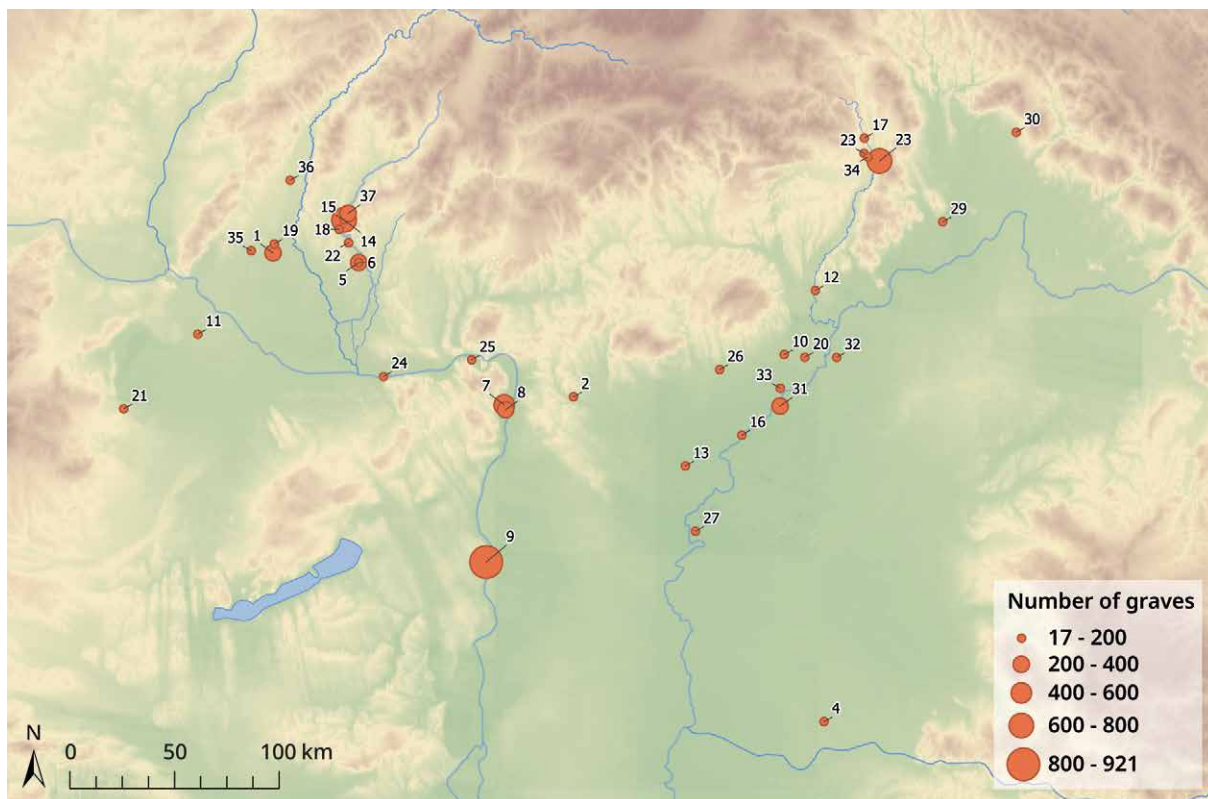
Appendix D: Maps



Appendix D1. Sites per 1000-year time period (2500-1500 BCE see Appendix D2).



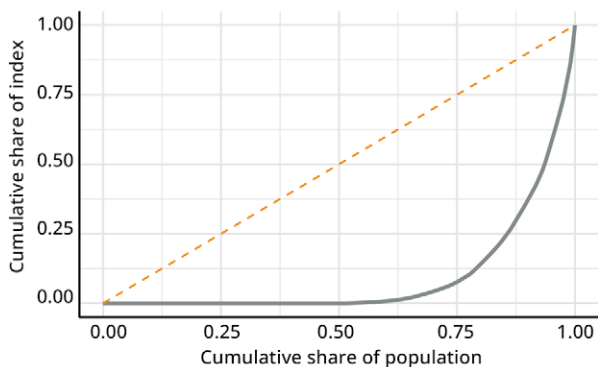
Appendix D2. Sites in the time period 2500-1500 BCE.



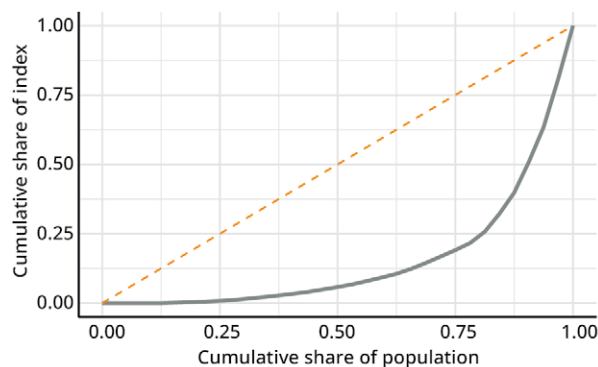
Appendix D3. Sites analysed in this thesis and the number of graves in the single cemeteries (numbering according to catalogue).

Appendix E: Lorenz curves

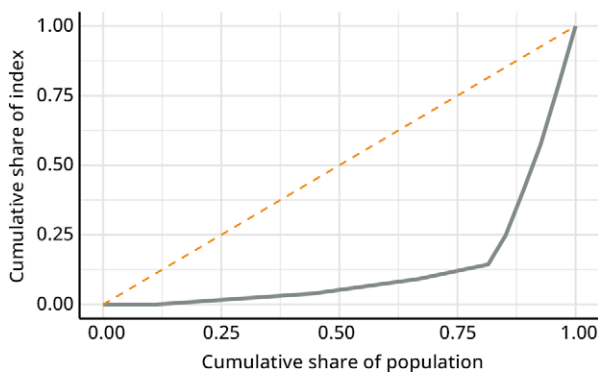
Abrahám I, Komárov vršek



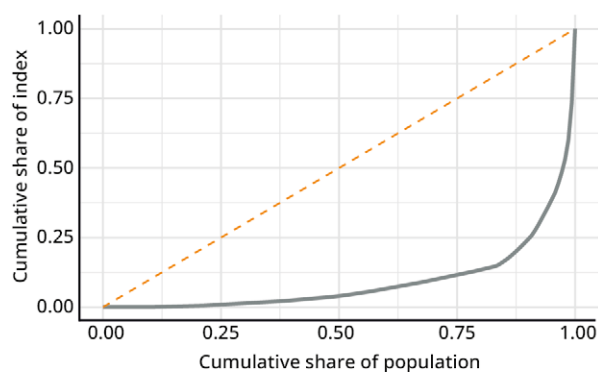
Aszód, Papi földek



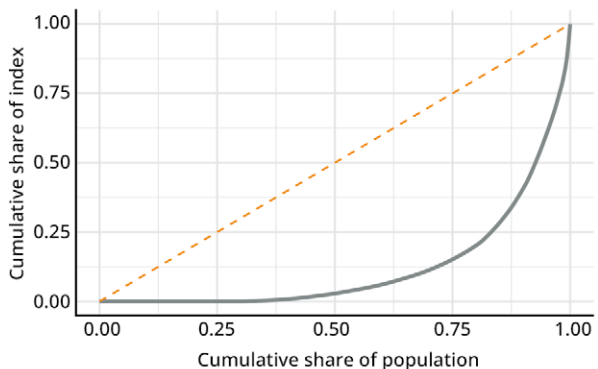
Barca-Baloty



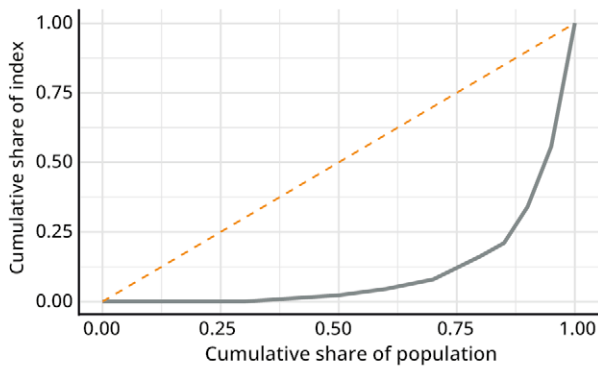
Battonya, Vörös Október MTSZ



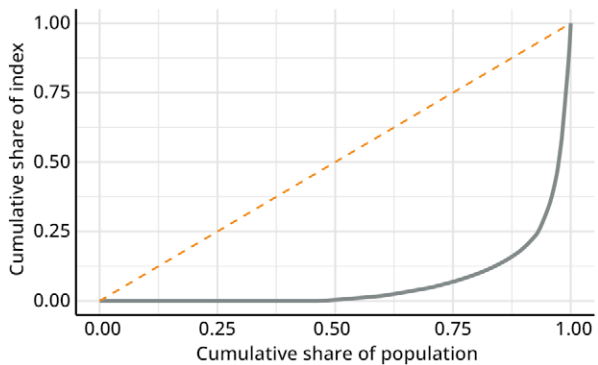
Branč-Helyföldek (Bronze Age)



Branč-Helyföldek (Copper Age)



Budakalász-Luppa-csárda



Budapest-Békásmegyer

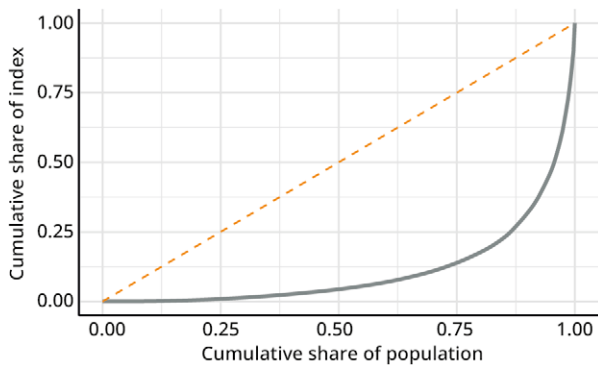
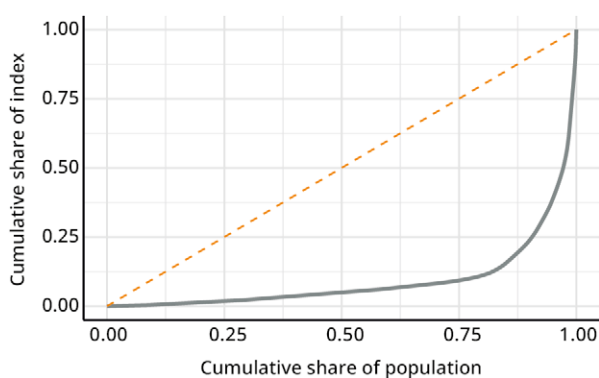
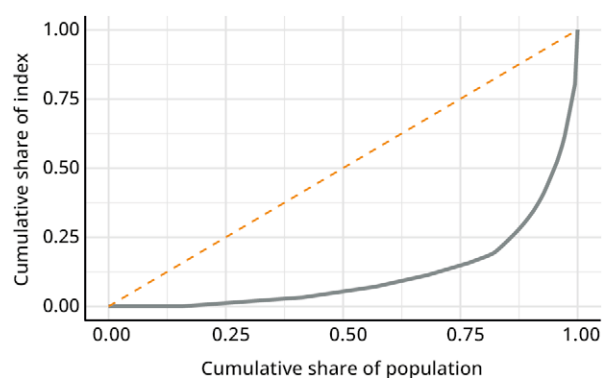
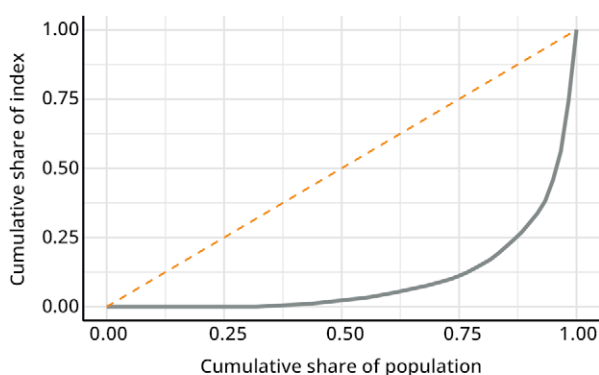
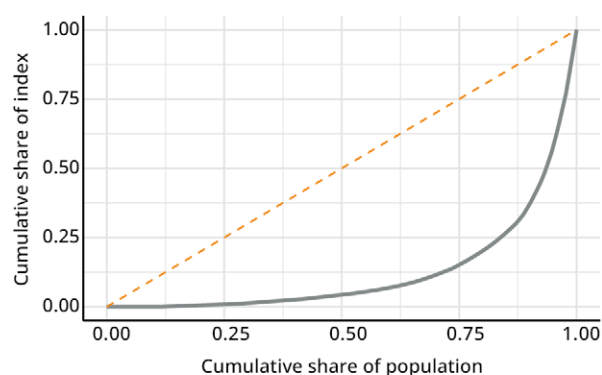
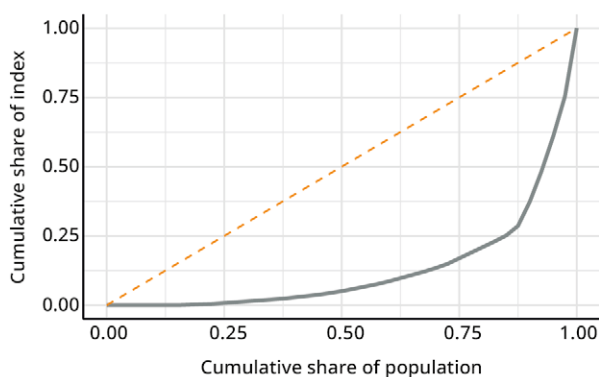
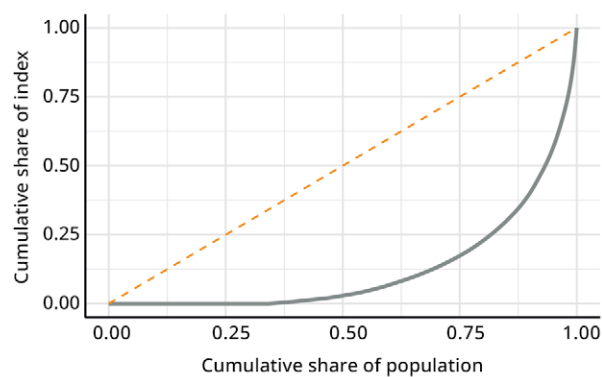
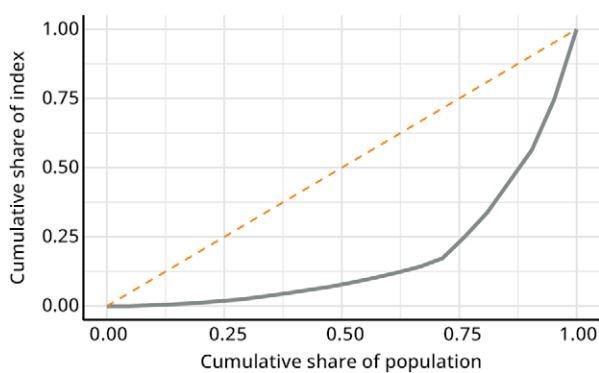
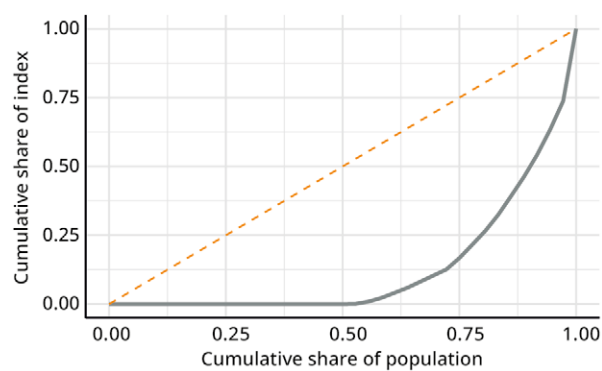
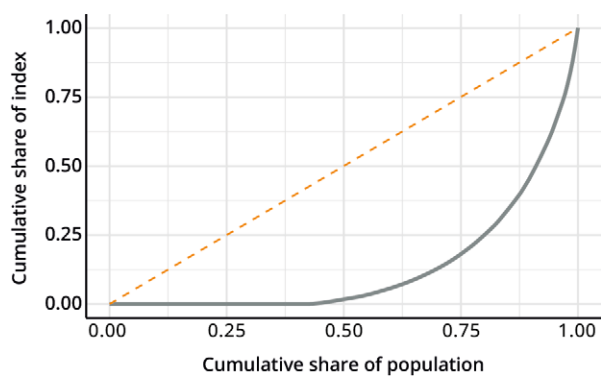
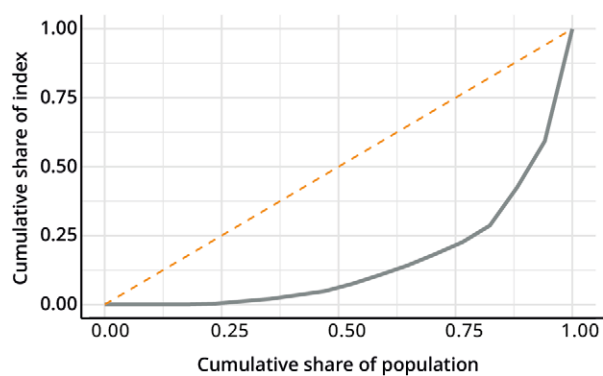
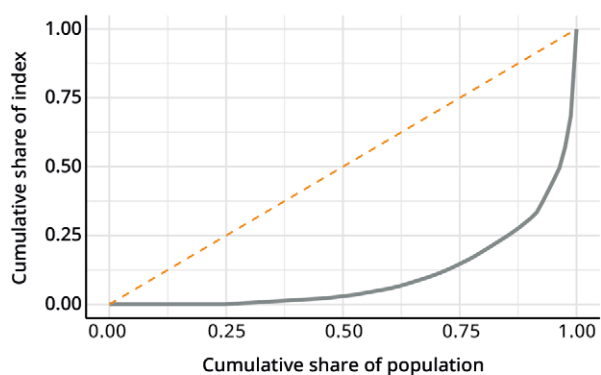
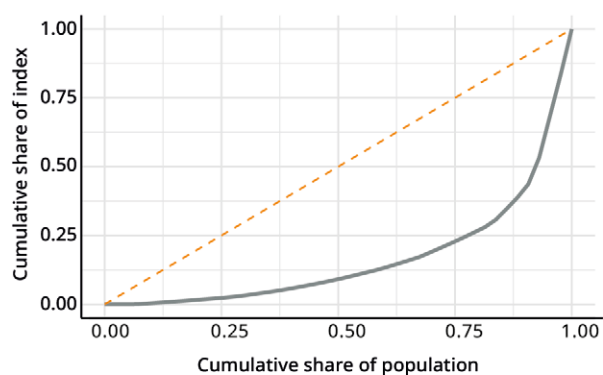
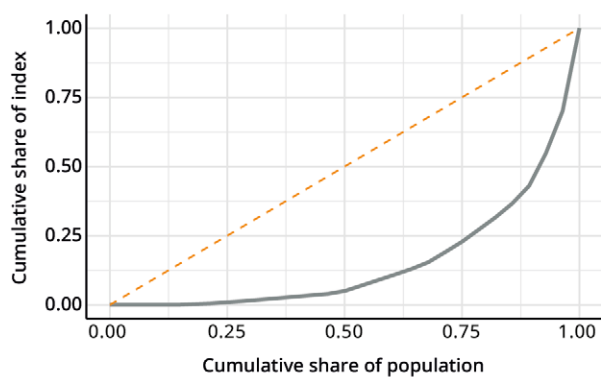
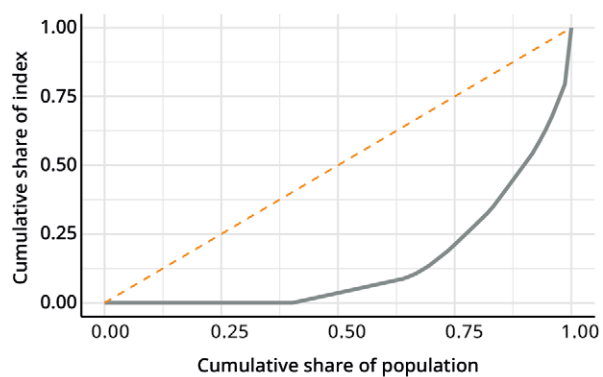
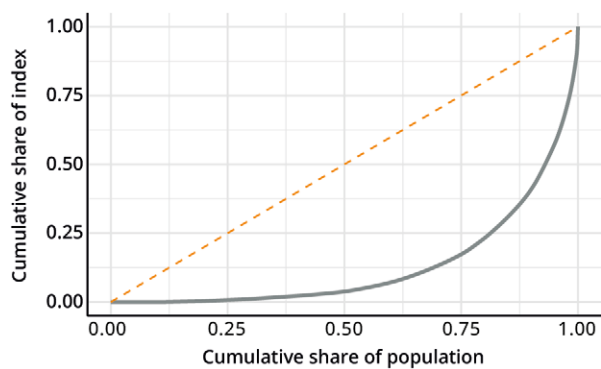
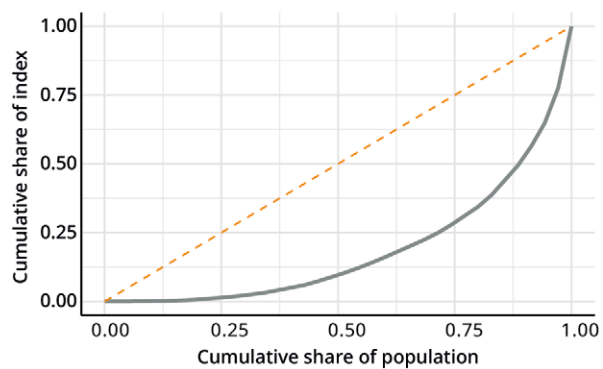
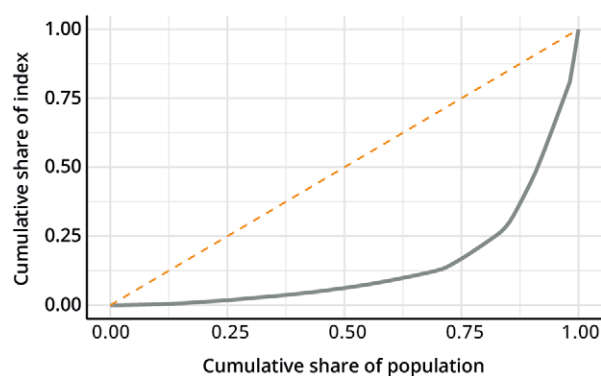
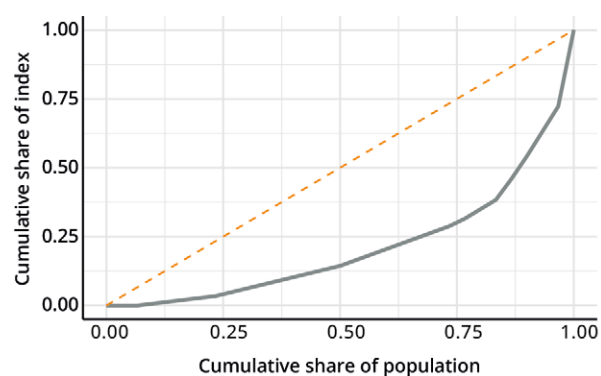
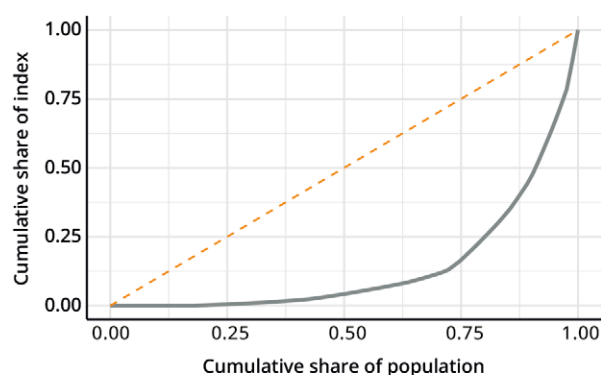
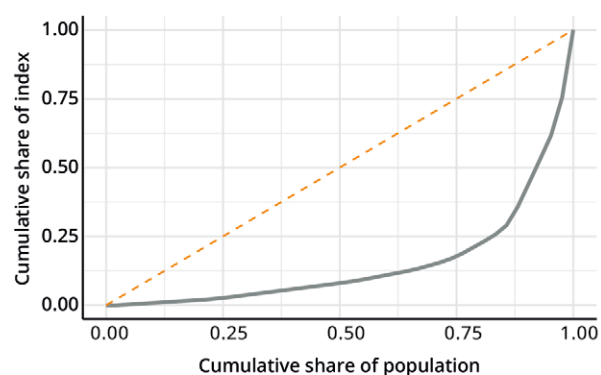
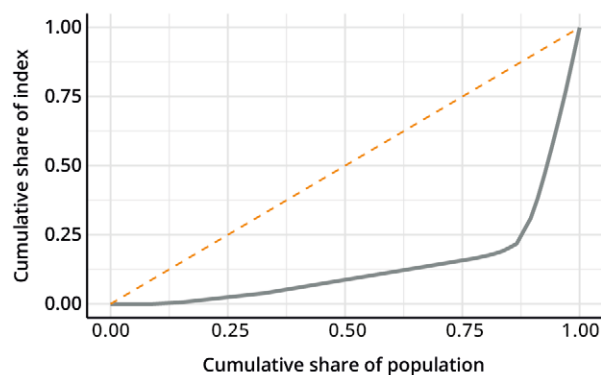
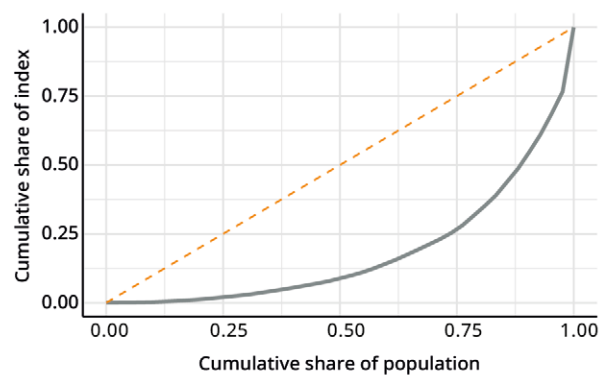
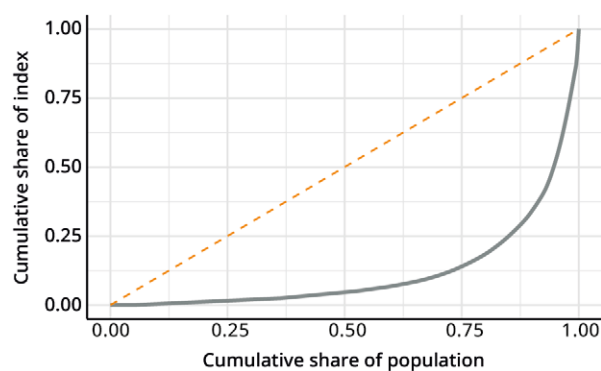
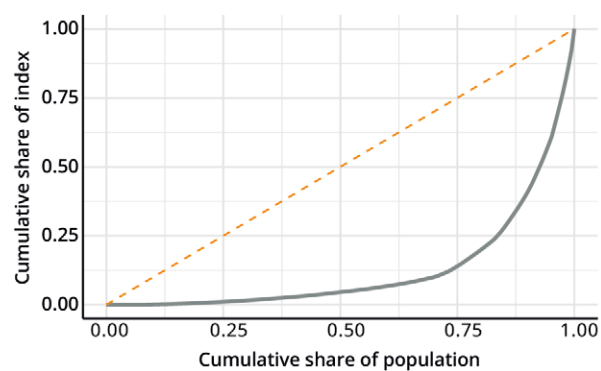
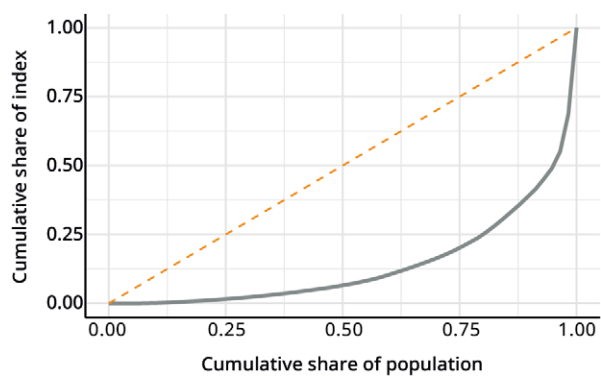
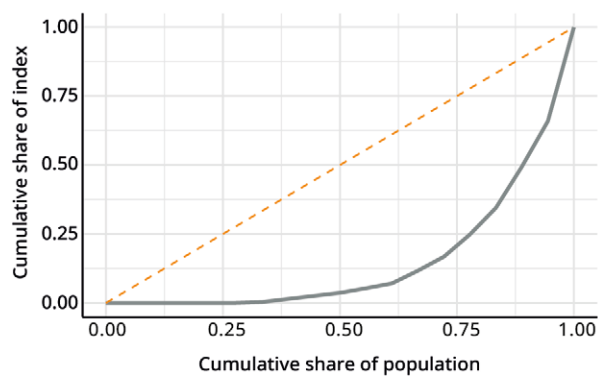
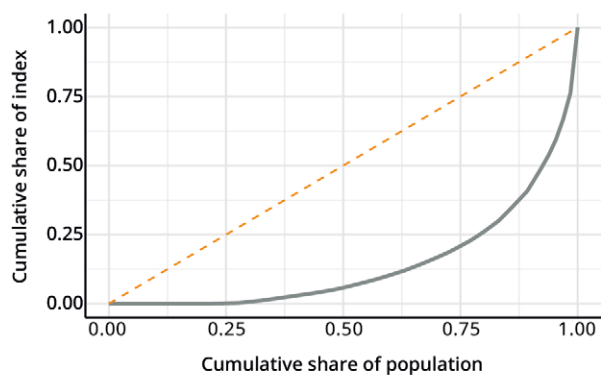
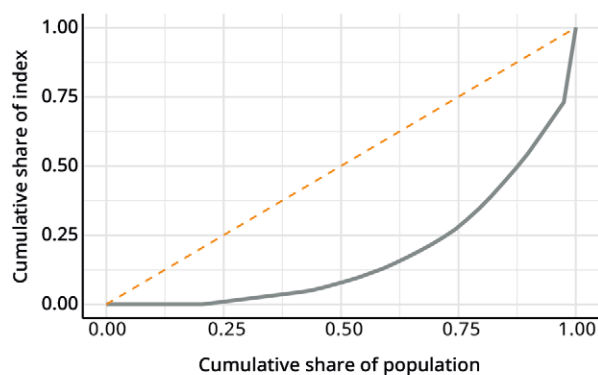
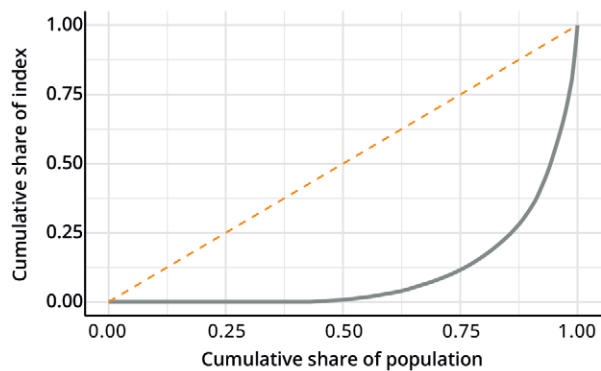


Figure Appendix E1. Lorenz curves for each cemetery/site analysed in this investigation.

Dunaújváros-Duna-dűlő**Gelej-Beltelek-dűlő and Kanális-dűlő****Hegyeshalom-Újlakótelep****Hernádkak****Jászladány****Jelšovce (Bronze Age)****Jelšovce (Copper Age)****Kisköre-Gát**

Košice "Nižné Kapustníky"**Lužianky****Majcichov-Lúky****Mezőcsát****Nagycenk****Nitra-Horné Krškany/ Priemyslová ulica****Nižná Myšľa****Patince**

Pilismarót-Basaharc**Puzstaszikszó****Rákóczi-falva-Bagi-föld****Šebastovce-Lapiše****Streda nad Bodrogom****Tibava "Hrun za cintirom"****Tiszafüred-Majoroshalom****Tiszapolgár-Basatanya**

Tiszavalk-Kenderföldek**Valalíky-Košťany****Velký Grob****Veselé****Výčapy-Opatovce**

Appendix E1, continued.

Database and Supplements (online)

The online Supplement accompanying this thesis contains data, analysis code, and results that are important for the study but could not be fully included in the printed volume. It provides additional documentation of the data basis, analytical framework, and results discussed in the main text and allows a more detailed insight into the empirical foundation of the thesis.

The Supplement is organised into several file spaces. The first file space, “Supplement A to G,” includes thematic supplements that document central elements of the analysis. Supplement A contains the results of the statistical analyses, while Supplement B provides the results of summary statistics, significance tests, as well as the linear and LOESS analysis figures of all social segments. The data tables of the analysis in two time periods (Early and Late) are also listed. Supplement C documents object class values per site, functional groups, object assignments, and generalised material types. Supplement D includes the chronological data used in the analyses. Supplement E consists of catalogues of reclassified burial inventories and normalised index values per burial. Supplement F includes various additional figures that have been an outcome of the analysis but have not been further discussed in the main body of work (regional or cultural separation of data). Supplement G provides robustness checks of the trends and development discussed in the text. These materials contain information that was crucial for analysing the burial sites of the study or results that could not be fully included in the tables of the main text. They form the empirical basis of the analyses presented in this thesis.

The second file space, “Burial Database,” contains the raw burial database on which the study is based. The database is provided in its original format as well as in an open, non-proprietary format (SQLite) suitable for long-term archiving. It documents structured information on sites, graves, burials, and inventories and preserves the original data structure and terminology used during data collection.

The third file space includes R code and example data frames necessary to reproduce the analytical procedures used in the thesis, such as data processing, calculation of inequality measures, and figure generation. These files are provided to support transparency of the analytical workflow.

The online Supplement is available via the Open Data Portal of Kiel University at DOI: 10.57892/100-259.

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The book series 'ROOTS Studies' presents scientific research that proceeds from the implementation of individual and cross-disciplinary projects within the Cluster of Excellence 'ROOTS – Social, Environmental and Cultural Connectivity in Past Societies' at Kiel University. The series addresses social, environmental, and cultural phenomena as well as processes of past human development in light of the key concept of 'connectivity'. The results of specific research topics and themes across various formats, including monographs, edited volumes, proceedings of conferences and workshops as well as data collections, are the backbone of this book series.

The **Cluster of Excellence ROOTS** explores the roots of social, environmental, and cultural phenomena and processes that substantially marked past human development. In a broad interdisciplinary conceptual framework, archaeological and historical 'laboratories' are investigated under the basic assumption that humans and environments have deeply shaped each other, creating socio-environmental connectivities, which still persist today. A better understanding of interwoven past socio-environmental dynamics will shed light on the 'roots' of current challenges and crises under diverse economic, ecological, and social conditions.

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A Quantitative Study on Neolithic, Copper Age and Bronze Age Cemeteries and Methodological Considerations

This dissertation investigates the dynamics of social inequality in the Carpathian Basin between the Late Neolithic and the Middle/Late Bronze Age (5200–1000 BCE) through a quantitative analysis of burial contexts. Employing statistical methods, including Gini indices and Generalized Entropy Measures, the study evaluates the extent, development, and underlying factors of inequality within prehistoric societies.

Key findings reveal a complex, cyclical pattern of inequality, challenging the notion of linear progression. While the overall mean levels of inequality show no consistent long-term increase or decrease, a significant broadening of inequality ranges is evident. This suggests increased societal diversification, with some communities maintaining egalitarian structures while others exhibited pronounced stratification. The research highlights that these disparities were likely driven by factors such as societal size, technological advancements, resource distribution, and cultural practices. A focused examination of wealth-based societal segments uncovers divergent trends: A slight equalisation among less wealthy societal segments contrasts with a marked concentration of wealth within wealthy groups.

This work underscores the interplay of social, cultural, and material developments in shaping prehistoric inequality, providing a foundational framework for further exploration into the dynamics of past societies.

